VOLUME 17 PART 2 SPECIAL AUGUST 1998 ISSUE

BRITISH TELECOMMUNICATIONS ENGINEERING

Included in this Issue

Proceedings of FITCE '98— the 37th European Telecommunications Congress 'Diverging Roles in a Converging Marketplace'

The Journal of The Institution of British Telecommunications Engineers

BRITISH TELECOMMUNICATIONS ENGINEERING

VOL 17 ■ PART 2 ■ SPECIAL AUGUST 1998 ISSUE

Dear Reader

This edition of *British Telecommunications Engineering Journal* has been given over to the Proceedings of this year's Congress of the Federation of Telecommunications Engineers of the European Community (FITCE), held in London from 24–28 August 1998. The IBTE was one of the sponsors of the Congress, and hence has been able to bring all the papers to the readership of the *Journal* in this special edition. The editors would like to thank the Comité de Direction of FITCE for giving permission to publish the articles.

The 43 papers, on the theme 'Diverging Roles in a Converging Marketplace' have originated from many European countries, including Austria, Belgium, France, Germany, Greece, Ireland, Italy, The Netherlands, Spain and the United Kingdom. They have been written by authors of many different nationalities in their own style, making the feel of the *Journal* very different from a regular issue. However, it was felt that, on this occasion, the different style is acceptable given the vast range of topics this edition brings to our readers.

Because the size of this edition is much larger than normal, it has not been possible to include the *Structured Information Programme*. However, this will continue with the next, October 1998, edition of the *Journal*.

We hope that you will find the Congress papers interesting and we would like to hear your views on this edition of the *Journal*, together with any suggestions you might have for future articles. You may e-mail the editorial team on Journal@ibte.org or write to us at IBTE Office, Post Point G012, 8–10 Gresham Street, London EC2V 7AG.

With best wishes,

Yours sincerely,

Paul Nichols

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Proceedings

'Diverging roles in a converging marketplace'

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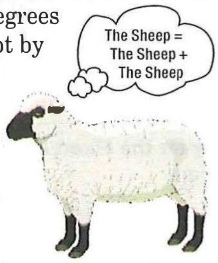
One Versus More

Welcome to London. During your stay here I hope you have a chance to have a look around at this historic city, but also remember it is a working city. Much of the work relies on telecommunications; the financial industry would be nothing without the extensive telecommunications infrastructure. For more than 10 years occupants of this financial centre have had a choice of telecommunications suppliers. Regrettably this has in some places resulted in pavements which are uneven from their repeated removal and replacement to install the ducts to provide the access for the various operators.

But why is this multiplicity of suppliers a good thing? I am reminded of a visit I had about 20 years ago by a telecommunications expert from communist Russia. It was his first visit to Western Europe and naturally I asked him about his impressions and I was surprised at his response. He was stunned by the inefficiency; why, he asked, were there so many suppliers of the same products? Everything from sweets to groceries, from furniture to cars could be bought from many different sources. What had happened to economies of scale? Notwithstanding this obvious defect in the Western economy he confessed that the supply situation was wonderful compared to that at his home. It was at this point that I realised that detailed technical efficiency is not paramount. In telecommunications, the merit, or otherwise, of a transmission system is argued on the basis of how efficiently bits are used, but how often is that the point? We could be using a much more efficient speech coding system than PCM but in the fixed network that has not proved relevant. What is actually needed is the matching of needs to offerings and, in some way, multiple suppliers seem to be able to do that better.

It is interesting that there seems to be a fundamental cultural difference between 'one' and 'more than one'. Language distinguishes between singular and plural, usually in the endings of words—why English does not accord this distinction to 'sheep' is, perhaps, one of those things that makes life interesting. However language does not distinguish between degrees of plurality except by the addition of a number. Similarly in life you distinguish between one and more; this morning you probably enjoyed one breakfast; you would not have enjoyed more breakfasts!



What I am leading to is the cultural shock that results in the move from monopoly in telecommunications to an environment of multiple suppliers. As my Russian visitor revealed, it is easy to give a reason why a single supplier is a good thing, but the practice is different.

This conference is being held at a very interesting time with some participants from regions well down the route of multiple suppliers, others have still to grasp the nettle and many are in a transitional state. One difference between a single entity and multiple entities is that multiple entities can have relationships and these give rise to regulators that codify the relationships. Technology is now rarely about efficiency and now is about meeting needs. Things that were once done by one organisation are now often done by many. Conversely convergence means that in some cases multiple functions are now one. In this case the regulators also have to converge. The transition either way between

one and more-than-one strikes at fundamental human feelings leading to the stress and excitement currently a feature of our industry.

Let us consider some examples of one-to-many:

- At any one place the telecommunications monopoly will end and more than one network operator will be trading.
- Individual operators who used to operate in one state, under one rule of law and set of social values, are now spreading across multiple physical and territorial boundaries.

And of many-to-one:

- Information technology, entertainment, computing and telecommunications are merging into a single, seamless, yet-to-be-named, industry.
- The multiplicity of territories are being seen by the larger players as one big territory—the World.

This is the environment in which we are holding our conference and many of the papers reflect the technical, commercial and social forces of change described above. I would like to thank the authors for the thought and effort they have put into preparing the papers to share their ideas with us. I would also like to thank you, the audience, for joining in what I am sure will be memorable event.

John Griffiths
Queen Mary and Westfield College, University of London

Chris Wheddon

Tumultuous Change

The communications world is undergoing tumultuous change. The drivers for this change are produced by:

- the power of the network through optical fibre and compression technology,
- the power of computer systems, and
- the power of digitalisation of content.

We are seeing the convergence not only of these technologies but also of other industries: hardware, software, communications, content and multimedia distribution.

This Congress on the theme 'Diverging Roles in a Converging Marketplace' addresses many of the issues of this tumultuous marketplace.

As Chairman of the organising committee, I am immensely indebted to my committee colleagues who have worked so hard in the preparation of what will be, with the contribution of the delegates, a most successful Congress.

I send my personal and warmest greetings to all the delegates attending the 37th FITCE Congress.

Chris Wheddon
Director, Systems Engineering
British Telecommunications plc

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The FITCE '98 Executive Committee would like to extend its sincere thanks to the following companies and organisations. Without their support and collaboration, this congress would not have been possible.

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SIEMENS	**Siemens AG** Hofmannstraße 51 D-81359 München Germany www.siemens.de	Theatre visit to Starlight Express (Wednesday)

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Session Chairmen

Andy Valdar	1. The Market Place
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Antonio Como	3. Working Across Boundaries
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Bruno Jacobfeuerborn	5. Intelligent Network Services
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John Sweeney	13. Futures
John Griffiths	14. Into the Millenium

Opening Ceremony—Keynote Speakers

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Signor Franco Bigi	European Commission, DGXIII
Dipl.-Ing. Guntram Kraus	President of FITCE

Round Table Panel

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Signor Franco Bigi	European Commission, DGXIII
Mr Chris Earnshaw	BT plc
M. Michel Feneyrol	France Télécom
Mr Kevin Fogarty	Eurescom
Herr Frank Heller	Deutsche Telekom AG
Prof. Sergio Treves	Alcatel Italia
Mr Peter Walker	OFTEL

Klaus Schenke

Portability and Preselection in Germany since 1998

Telecommunications will play a key role in the development of the future information society.

To force this development the German goverment decided to liberalise the telecommunications market in Germany, with the target to improve telecommunications and to create modern and good value for money services.

The chosen high degree of liberalisation is not comparable with that one can find in any other developed economy of the world.

Core elements of the liberalisation are the Telecommunications Law (Telekommunikationsgesetz, TKG) and the regulation to protect telecommunications customers (Telekommunikation - Kundenschutzverordnung, TKV).

When the TKG came into force on 1 August 1996, many changes took place for the previous monopoly, Deutsche Telekom. This paper will present especially the requirements, resulting from the Article §43, paragraphs (5) and (6) of TKG and its influences on technical realisations and working processes.

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Article §43: Numbering

Paragraph (5) In their networks, the carriers shall ensure that users may keep the numbers assigned to them when they change carrier but not location (carrier portability); they shall be charged solely the costs incurred once for customer change.

Paragraph (6) In their networks telecommunications carriers shall ensure that each user is free in his choice of long-distance carrier; such choice shall be enabled by means of permanent preselection which can be overridden by a carrier selection prefix each time a particular call is made.

These legal restrictions forced the imcumbent to realise that the customer:

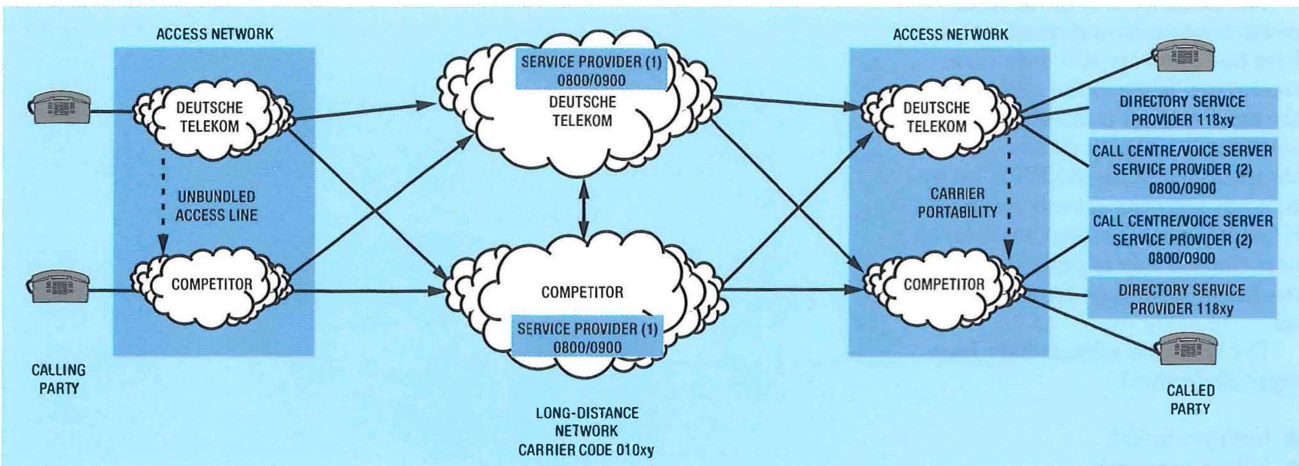
- can port his/her telephone number to another local exchange carrier as long as he/she stays at the same location,
- can make his/her long-distance calls by changing the preselection with any inter-exchange carrier preferred, and
- can decide 'call-by-call' to override the preselected carrier to benefit from special offers.

To realise these rights of the customers the incumbent as well as the other carriers in a multi-carrier environment have to implement technical measures in their networks. In doing so, the incumbent has to safeguard any existing features, offered in the past only by Deutsche Telekom, like ISDN-features, so that they continue to work perfectly, and to ensure that tariff information is delivered to customer equipment with the same quality, although these are now passing through gateways to the networks of the other carriers. (See Figure 1.)

The provision of all these facilities are made even more difficult by the great number of new carriers with their very different business models such as:

- rebiller,
- reseller,
- service provider,
- local exchange carrier,
- inter-exchange carrier, and
- full-service provider.

Figure 1—Multi-carrier environment



As on 26 May 1998 there are about 90 carriers which have a carrier code 010xy to act as an interexchange carrier and about 46 carriers which have a portability code to act as a local exchange carrier.

For most of these carriers telecommunications is a new business and they have no experience in this field.

To safeguard that on the 1 January 1998 competition in the field of telecommunications could start and services could be provided and offered in a multicarrier environment, a task force was created in the middle of 1996. The name of this task force is *Arbeitskreis für technische und betriebliche Fragen der Numerierung und der Netzzusammenschaltung* (AKNN); that is, the task force for technical questions and processes concerning the interconnection of networks and of numbering. Members of this task force are all interested carriers and the Regulierungsbehörde.

This task force has installed subgroups to work on special issues, such as:

- signalling,
- tariff information,
- billing,
- portability,
- preselection,
- unbundled access line,
- etc.

These subgroups work on the details of the different issues and prepare recommendations on specifications, which are presented to AKNN. The AKNN has to agree these unanimously. These recommodations of the AKNN have been and are still the basis for the implementation of the technical network components as well as of the processes between the carriers.

The discussions to set up these recommendations and specifications have been, and are still, very time consuming. While in the subgroups the main interest is directed to find a solution agreeable to all members, the discussion in the AKNN is led by business interests of every carrier. So it happens that decisions are delayed or postponed only to prevent a marketing advantage for a competitor.

The following subjects have been especially critical:

- business model;
- billing, invoicing;
- price transparency (that is, premium-rate service; same service charge for the end user independent of the access network used); and
- accessibility/interconnection.

Highly disputed are also all questions concerning the acceptance of costs.

Deutsche Telekom is of the opinion that the principle whereby the party responsible is liable for the damages should be imposed. This means any investment on the part of the incumbent necessary to realise competition should be paid for by the new carriers. Further, the competitor should pay for all services gained from the incumbent.

Competition in the German telecommunications market has been in full swing since 1 January 1998. Because of Deutsche Telekom's disadvantageous position caused by the regulations, the new carriers are able to win significant market shares, almost without making their own investments, by offering low-priced and low-quality services.

Deutsche Telekom accepts this challenge and will answer proactively with innovative products and with a new price policy. Deutsche Telekom will prove its competitiveness in this interesting and dynamic market.

Biography

Klaus Schenke
Deutsche Telekom

Dipl.-Ing. Klaus Schenke is head of Deutsche Telekom's entire numbering project '98. He studied communications engineering at Stuttgart University, graduating in 1968. In March 1980 he became project manager for teletex and telex services in the Federal Postal Ministry, and in May 1986, became the head of the telex, fax and teletex services section. In August 1994 he became head of section for televoting/teledialogue services. He was given Board of Management mandate in April 1997 to be in charge of the entire cross-divisional numbering project '98. He is responsible for the development of concepts and the subsequent introduction in the company, and the arrangement and introduction of administrative processes and interfaces with competitors.

Leon McCarthy

Using Customer Satisfaction Measurement as a Key Strategic Tool and Driver of Customer-Focused Change in a Transforming Organisation

As the environment in which Telecom Eireann operates undergoes extensive transformation, Telecom Eireann itself recognises the need for customer-oriented change. But how can an organisation focus on customer needs without knowing what is important to customers, what makes their experiences satisfactory or unsatisfactory and ultimately what will make them loyal when they possess the power and have the choice to leave.

The Customer Barometer *is a key tool for Telecom Eireann, not only as a means of measuring transformation but also as a mechanism for focusing the organisation on what is important to customers. It also provides focus on what needs to happen before customers are truly loyal and satisfied with every 'moment of truth' they have. Bringing customer measures to the heart of Telecom Eireann business allows the organisation to align its business units with customer demands, adapt to changing needs and equip employees with a tool that empowers and enables them to maximise customer loyalty.*

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Telecom Eireann Background

Telecom Eireann is the national, majority state-owned, supplier of telecommunications service in Ireland, with a current turnover of £1·3 billion, an after tax profit of £155 million and approximately 11 000 employees. The market in which Telecom Eireann operates has changed dramatically over the past few years. The liberalisation of alternative infrastructure, the development of competition in the mobile market and the emergence of alternative suppliers in public payphones and value-added services account for some of these changes. However, probably the single greatest development occurred in May this year when it was decided to end Ireland's derogation on voice telephony to the Year 2000 and introduce full competition from the end of 1998.

Telecom Eireann Transformation

While all these environmental changes were transforming the market in which Telecom Eireann operates, Telecom Eireann itself has recognised the need to realign the organisation to the realities of the marketplace. Hence in 1997 a major transformation programme began:

- to develop new structures to align the organisation around the customers it serves,
- to develop processes to deliver superior customer service, and
- to complete an innovative partnership deal with the coalition of unions.

These programmes have been designed to transform Telecom Eireann into a world-class, customer-focussed, investing, competitive supplier of telecommunications services, with a vision that is to meet customer requirements fully, first time, every time, at competitive prices.

A key objective is to retain existing customers and to continue to acquire new customers in a marketplace where customers have a choice. It has been recognised throughout Telecom Eireann that future profits will be driven by customer loyalty. The need for change is driven by the need to become more customer focused and to deliver world-class customer service in order to maximise satisfaction levels for customers in every moment of truth customers have with the organisation. Experience from other incumbent telecommunications providers competing in deregulated markets shows that only extremely satisfied customers remain loyal, and dissatisfied customers will leave and not say why.

For Telecom Eireann, the effect of the transfer of power to customers is not being underestimated. Today customers:

- are far more knowledgeable about their communication needs;
- have international experiences of service, price and products from other competitive telecommunications markets;
- are aware of the advent of competition in the Irish market; and
- are more demanding of service companies based on their experiences with companies outside the telecommunications environment; for example, retailers, airlines and financial services.

In recognising that excellent customer service must be a key competitive advantage on which to build long-term customer loyalty, Telecom Eireann developed a critical success area on which to focus:

'To manage the customer experience to maximise customer loyalty.'

Managing the Customer Experience

An investigation of traditional measures of customer satisfaction and loyalty proved that many of the measures did not measure real customer satisfaction and were making the organisation too comfortable that current satisfaction was excellent.

Furthermore an in-depth investigation within the organisation discovered that the averages associated with traditional measures were blurring the real perceptions of customers and that the measures focused on experiences that were important to the organisation not the customer. In addition, many of the results were so high level that they were inactionable for local management and so infrequent that in most cases it was too late to take action.

It was recognised that changing behaviour could only be possible with credible, accurate, consistent, timely, actionable measures of customer satisfaction.

In September 1997, Telecom Eireann decided to invest in a new integrated measurement system so that everyone within the organisation could benefit from using a superior model of measuring customer satisfaction. The integrated measurement system incorporated both employee and customer satisfaction, two of the most important measures of a successful organisation. The objectives established for the customer measurement tool were as follows:

- measure the total customer experience as defined by the customer;
- provide tangible information for the organisation with customer comments to back up any numerical data;
- present indisputable data—that is statistically valid and robust;
- provide frequent and timely feedback to enable action throughout the organisation;
- provide direction to the organisation on what is important to customers, how satisfied they are with those factors and how the organisation can change to satisfy needs fully;
- provide a customer measure to balance the internal organisation measures; and
- enable benchmarking against other telecommunications providers and other service companies.

Traditional Measures

- Inconsistent methods across business units
- Infrequent
- Inaccurate
- Inactionable
- Internal focus

Customer Barometer Key Objectives

- Driven by the customer's agenda
- Tangible information
- Reliable
- Frequent
- Supported with verbatim comment
- Provide strategic and local direction
- Measures effect of transformation

Defining the Customer Experience

The task was to develop and implement a process to measure customer satisfaction that achieves the objectives outlined above. Starting with the outputs from many customer focus groups, Telecom Eireann began to define the customer experience from a customer's viewpoint. While Telecom Eireann thought that many of the interactions were important, the focus groups identified what the important factors were to customers.

From the focus groups it became apparent that customers' perceptions of Telecom Eireann were determined by:

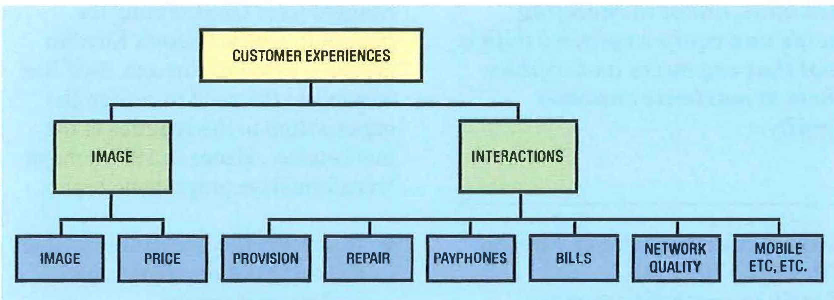
- the sum of customer experiences such as encounters with customer service or usage of Telecom Eireann products and services; and
- Telecom Eireann's image, dominated by Telecom Eireann's reputation and perception of price levels.

The subsequent tool (Figure 1) that was developed was called the *Customer Barometer* as it was established to provide the organisation with a barometer of what customers think. Driven by the customer, it provides a mechanism for continuous improvement in that it delivers an ongoing measure that tracks customer satisfaction and helps to steer the organisation in the direction that will deliver customer focused-improvements.

The Image Survey: A Barometer of Customer Perceptions of Telecom Eireann

The image part of the *Customer Barometer* provides Telecom Eireann with a customer perspective on what attributes customers want to see from their ideal telecommunications

Figure 1—Integrated measurement tool—customer satisfaction



company. In addition, it provides a current evaluation of Telecom Eireann against these attributes.

Similar to most telecommunications companies, the most important attributes are value for money and an efficient, customer-focused and service-oriented company. In addition to giving each factor a weighting of importance, the *Customer Barometer* also provides Telecom Eireann with relative *proof points* where it can demonstrate to customers how it delivers on each factor.

For example a key proof point is the delivery of a responsive, fast efficient service. Providing fast turnaround times, same-day service, timely appointments, knowledgeable staff, making no mistakes and giving product guarantees would all demonstrate that the company was efficient.

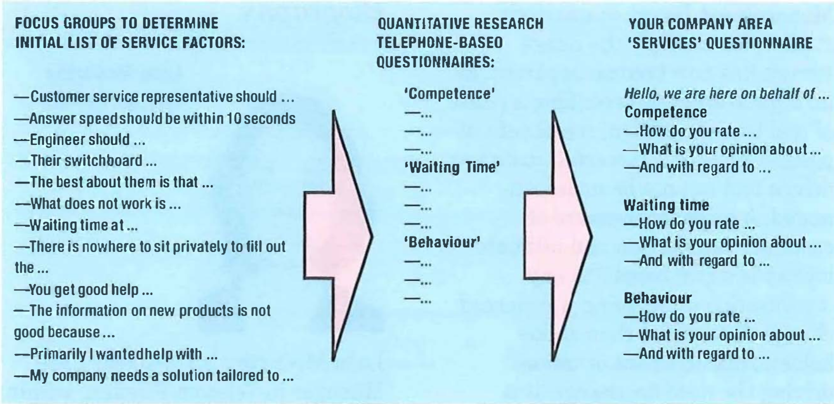


Figure 2—Determining priority factors for customers within interactions

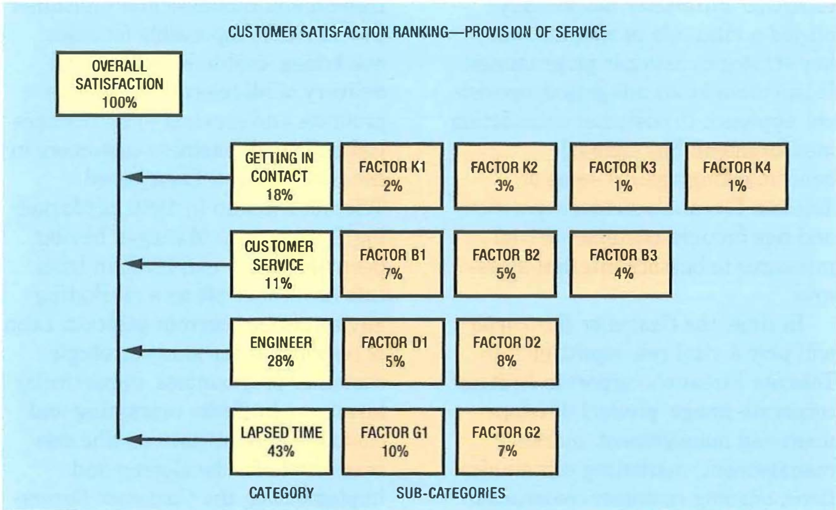


Figure 3—Determining weighting of importance of each factor

The Interaction Survey: A Barometer of Customer Satisfaction with Telecom Eireann Experiences

Experiences with Telecom Eireann, whether it be receiving a bill, contacting a customer sales and service centre, meeting an engineer, buying or using a Telecom Eireann product are all deemed to be highly important to customers in developing their perceptions of the organisation.

Therefore the customers' image of the organisation is directly formed by the experiences they have had interacting with it. The challenge for Telecom Eireann was to determine from the hundreds of types of interactions that happen on a regular basis, which were the most important. In addition to customers determining the most important interactions, those interactions with high levels of dissatisfaction, as well as those that engage a large proportion of workforce, were included. In total there are approximately 10 key interactions customers have with Telecom Eireann and customer satisfaction with each of these is measured on an ongoing basis and distributed within the organisation.

The methodology used to determine priority interactions and image attributes was firstly to conduct focus groups with customers to identify all factors of importance. Quantitative telephone research was then engaged to distil all the factors down into the statistically most important factors. See Figure 2.

Then, using regression analysis, a relative weighting of importance was placed on the individual factors within the interaction. (See Figure 3.)

For example, when a customer orders a telephone line, 40 factors have been identified that can influence his/her satisfaction, from getting in contact, the speed of answer in the sales and service centre, the range of information given, to the timeliness of the engineer arriving to the customer's home and the quality of the engineer's work. Then by using regression analysis the 40 factors were distilled down to the most important ones influencing overall satisfaction.

Then, on a regular basis, customer satisfaction with these factors is measured. Using a 10-point scale, where 1 is terrible and 10 is excellent, customers' perceptions are obtained and their evaluation of the service they received. The number of satisfied customers can then be determined by summing the numbers of customers giving 8, 9 and 10 ratings. In early test phases of the *Customer Barometer* it was statistically determined, and backed up with verbatim comments, that it is only those customers giving an 8, 9 and 10 who were satisfied with their experience. Customers giving 6, 7 were found to be indifferent and anything less than 5 was proved to have an overall negative perception of the organisation.

Another powerful message to the organisation is apparent when customer satisfaction measures are compared to internal Telecom Eireann service measures. While the organisation has a quality of service target that is to connect 90% of residential customers within 11 days, the *Customer Barometer* balances this with a measure of customer satisfaction with the lapsed time from order placement to order completion.

Bringing the Message from Customers into the Organisation

Monthly reporting to senior management on frequent interactions and reporting to the Telecom Eireann

Management Board on quarterly studies, for example the image survey, has now become apparent. As an organisation transcending a phase of real transformation, the benefit of possessing such a powerful, customer driven tool can not be underestimated. A constant measure of customer satisfaction and ultimate loyalty is a real benefit to any organisation undergoing widespread change. But rather than stakeholders, management or unions driving the need for change, it is customers who are doing so.

While still a relatively new concept within the organisation, the *Customer Barometer* has already played a vital role in shaping many key strategic customer programmes. It has brought an integrated, consistent approach to customer satisfaction measurement, has enabled benchmarking against some of Telecom Eireann's strategic partners and has brought customer-driven measures to balance internal measures.

In time, the *Customer Barometer* will play a vital role inputting into Telecom Eireann's corporate strategy, corporate image, product development and management, market management, marketing communications, ongoing customer communications, advertising strategy, pricing strategy, operations management, business process re-engineering, customer service strategy, customer complaints strategy, customer contact strategy and channel development.

However, the real benefits of the *Customer Barometer* will be delivered when timely, actionable reports are disseminated within the organisation; ownership of customer satisfaction belongs to all employees and Telecom Eireann achieves its vision by delivering on customer requirements 'first time, every time at competitive prices'.

Biography

Leon McCarthy
Telecom Eireann

Leon McCarthy is Customer Care Manager in Telecom Eireann, within the Business and Consumer Services Business Unit. Telecom Eireann is the national telephone company in Ireland and Business and Consumer Services are responsible for sales, marketing, customer service and delivery of all telecommunication products and services to all residential and small business customers in the Irish market. Leon joined Telecom Eireann in 1996 as Marketing Programmes Manager, having been previously employed in Irish Life Assurance plc as a marketing adviser. In her current position, Leon is responsible for many strategic customer programmes, in particular loyalty and affinity marketing and customer care initiatives. She was responsible for developing and implementing the *Customer Barometer* (Telecom Eireann's customer satisfaction measurement tool) and is responsible for rolling out the *Customer Barometer* and its key messages within the Business and Consumer Services organisation of 7000 employees. Leon has a Bachelor of Commerce degree and a Masters of Business Studies degree from University College Dublin. She recently completed a Diploma in Direct Marketing and won Direct Marketing Student of the Year in 1996.

Dino R. Russo

Advice from The Trenches

Challenges for Telcos: Service and Network Management in a Multi-Provider Environment

The opening of the European telecommunications market to competition is stimulating the creation of new joint ventures and alliances in increasing numbers. The adage 'the whole is greater than the sum of the parts' would lead one to believe that these partnerships will be formidable competitors in this new open market—leveraging existing plant (networks), operations, and sales channels. However, even though cultural differences can be overcome and networks can be pieced together, the real challenges facing these partnerships are in the area of systems which run the business—especially those systems supporting customers. IT organisations are faced with the Herculean challenge of creating the 'glue' that will allow these partners to operate in a seamless fashion—an effort which is often severely underestimated, or even ignored, when these partnerships are formed. This paper focuses on identifying key problem areas and provides some practical advice for overcoming the challenges, and avoiding some of the mistakes. Forewarned is forearmed.

The Multi-Provider Environment

One can hardly pick up a newspaper today without reading a business story about a start-up, merger, buyout, or alliance in the telecommunications industry. This industry is estimated to be worth approximately $750 billion and the players—new and old—want a share. Liberalisation, especially in Europe, places the incumbent PTTs in the unenviable position of losing market share within their own countries to the new competition that can attack their most lucrative markets. In order to maintain or increase revenue, many of these companies are looking beyond their traditional borders—to provide trans-border or global services through mergers, acquisitions, and alliances.

It appears that in the boardroom, these partnerships† are seen to be ideal. The partners provide the same types of services, have sales channels, have facilities, and so forth. Not only can markets be extended, but potentially operational cost efficiencies can be gained through elimination of duplication. A rosy picture indeed. However, each rose has its thorns and this paper endeavors to point out some of those thorns so they may be avoided or at least handled with care.

The Common Bond—Satisfying the Customer

The one constant in this environment of change are customers and their expectations. Customers demand quality of service. This expectation includes not only that their network service operates efficiently, but that the service surround is seamless as well. Moreover, they are requiring that this be accomplished at competitive prices. With these requirements in mind, let us examine some of the challenges of the multi-provider environment.

Network and Service Management Challenges

Providing complete and seamless network and service management in a single-provider environment is difficult at best. Established telcos have a myriad of systems and technologies in use (so-called *legacy systems*) which have often been designed on a per-service basis. For example, it is not uncommon for there to be completely separate system stacks for voice and data services. Likewise, it is not uncommon for separate system stacks to exist between related products (for example, frame relay and asynchronous transfer mode (ATM)). Network management centres often suffer from 'console overload'—having a separate terminal on the desk for each network or service operated. Customer service personnel wear round holes in the carpet due to the need for 'swivel-chair integration' among the various service management systems.

On the surface it would seem that the multi-provider environment is hopeless. Luckily, in most cases, these partnerships only offer a relatively small number of services that require interworking. For purposes of discussion, let's examine the challenges of implementing a single service in a multi-provider environment.

† Regardless of the ultimate business definition, this paper refers to these relationships as *partnerships* because integration can never be achieved instantaneously.

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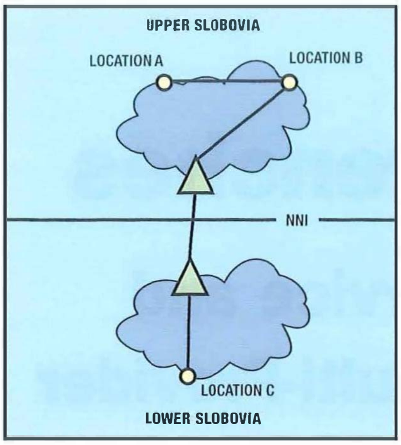

Figure 1

Scenario

Figure 1 depicts a partnership between UST (Upper Slobovia Telecom) and LST (Lower Slobovia Telecom). These partners have joined to offer a trans-border frame relay service. Both UST and LST have existing in-country frame relay services with similar features. Because UST and LST use different network technologies, they will connect their networks using a network-to-network interface (NNI).

From a customer perspective, a UST customer will be able to purchase a permanent virtual circuit (PVC) from Location A to Location C and have the same service that they have had between Locations A and B.

Assumptions that create challenges

It is a fact of business and of life that decisions must be made based upon incomplete information. In most of these cases, assumptions are made regarding the areas where information is unavailable or there is not enough time to investigate properly. It is the quality of these assumptions that bears heavily on the outcome of these decisions. Let us examine three common gross assumptions that will lead to trouble in this multi-provider environment.

Assumption 1—My network plus your network = super network

Few would argue that most telcos today are fixated on networks—wires, switches, towers, etc. It is these networks which are the backbone of the enterprise. Connecting various network technologies is common practice. Therefore, if partner networks can interconnect, there is the basis for extended service. It is also likely (as is the case within our scenario) that even though two partners may have different network technologies in place, this challenge can be overcome through the clever use of interconnect technology which allows traffic to cross boundaries. However, providing a quality service across such a network is much more complex. What problems/challenges have not been considered?

Problem: Lowest common denominator Network technology providers face a competitive environment and as such they often use equipment features to differentiate among themselves. Telcos often leverage these features when providing services in order to provide some market differentiation. In a homogeneous network, this is not an issue. However, when combining networks, rather than gaining the best of both feature sets, one usually finds the situation whereby there is only a subset of features that are common across the networks.

Problem: Non-Standard Standards In the telecommunications industry standards bodies abound. Through their collaborative efforts, many standards have been proposed and adopted which are designed to protect telcos from vendor lock-in and to allow for the construction of systems and processes which are independent of the underlying network technology. Therefore, activities such as network or service management in a heterogeneous environment that are standards based should be simple.

Practical experience shows otherwise. In our frame relay scenario, customers expect that the service provides minimal network delay. This requires the provider to measure and report this delay to the customer. Since both vendor switches record delay statistics, then meeting this requirement should be simple, right? Wrong! The two vendors measure delay slightly differently. Additionally, the delay is measured at a different time interval. The result of these differences is that there is no logical way of using these statistics to compute a meaningful delay measurement across the service.

Assumption 2—I provide service; you provide service; therefore we can provide service

For the purpose of this discussion, a service environment is that set of systems and operational components that provide the necessary service surround for a telecommunications product or service. As one would expect, each partner will have at least rudimentary service environments to support provisioning, trouble management, alarm management, billing and so forth. Assumption 2 usually has one of the two following variants:

- *my service environment interconnected with your service environment = seamless service environment*, or
- *everyone will use my (or your) service environment.*

Problem: Standards In the first case, considering both partners have service capabilities, then providing seamless service is simply a matter of interconnecting systems and processes in much the same way as networks are interconnected.

In the service environment there are few standards that exist and probably fewer that have been implemented. Additionally, there is no one process that is universally accepted for dealing with a network fault, provisioning a service, progressing a trouble ticket, or providing the customer a bill. To make matters more complicated, few legacy systems that support these processes represent information in a similar fashion. Take the simple example of a trouble ticket. Most trouble ticket systems have the concept of problem severity. However, one represents a severe problem as a '1'; the next system represents the same problem as a '4'. The implications of this trivial example are obvious and the customer suffers. Although this situation can be easily overcome by agreeing a standard representation, other problems such as being able to identify customers in the same way across systems are not so trivial to overcome.

Problem: Inter-system dependencies In an effort to avoid the challenges imposed by interworking at the system level, one set of systems may be adopted for a particular function. Using the same trouble ticket scenario, this would certainly eliminate the problem of information representation. However, most systems do not operate in a vacuum. One problem has been traded for another. For example, trouble-ticket systems typically depend upon inventory systems that hold information about the customer, services, and networks. Perhaps the alarm management system is integrated with the trouble management system so that trouble tickets are created automatically. Can these dependent systems be adopted en masse?

Assumption 3—Partnerships are forever

Not many people get married with the assumption that there will be a divorce in their future; however, it does happen. In recognition of this fact, some couples are creating prenuptial agreements or contracts which document what is expected in the case of a divorce. Businesses have been doing this for years, sending hoards of lawyers to negotiate large contracts which spell out in gross detail various and sundry aspects of such a dissolution. However, many decisions that are made during the 'courtship and honeymoon' seem to ignore the prospect of divorce.

Problem: Total dependency on partner system(s) Continuing with our scenario, assume that UST has a billing system that can produce bills in all known languages. LST, rather than building this capability into its own billing system, agrees that UST will do all billing for the new service. On the surface, this has the immediate benefit of reducing time to market and overall cost of service launch. However, what happens when UST and LST are divorced? Not only must LST extend their network or find another partner in Upper Slobovia, but to maintain the same level of service for its customers, it must build the multi-language billing capability.

Problem: Proprietary interfaces In order to alleviate some of the problems discussed previously, UST and LST have decided to interconnect certain key systems; for example, their trouble-management systems. In order to save time and money, rather than build a standards-based interface, LST builds a custom/ proprietary interface to match UST's system. When UST and LST are divorced and LST wishes to partner with someone else (not unusual in today's business environment), the interface that they have built is useless.

Recommendations

The picture painted above seems extremely bleak. On the surface it would seem as though the multi-provider environment is doomed to failure as none of the simple assumptions that would allow these ventures to succeed are viable.

On the other hand, it is also unlikely that any single telecommunications company has the resources to go it alone. So, what can be done to increase the opportunity to succeed in the multi-provider environment?

Engineering due diligence

Due diligence is a process which seeks to assure that a business proposition is sound. Due diligence can take place at many levels including engineering. The success or failure of due diligence can be attributed to the quality of questions being asked and answered. Some recommendations to improving due diligence follow.

Ensure that engineering understands the business strategy

Without a clear understanding of the business strategy, it is impossible to conduct due diligence properly. Asking a network engineer the feasibility and cost of interconnecting two networks may be the wrong question unless the engineer understands that the business plans to provide a seamless service with no degradation of functionality or service level. The cost of simple interconnection may be X whereas the cost of providing seamless service may be $10X$.

Ensure that the engineering team includes not only network personnel, but also operations and systems personnel

It never ceases to amaze me the number of times business decisions are made based upon a single point-of-view: that view generally being network related. Network management, service management, and even billing often seem to be secondary considerations or afterthoughts. To overcome this short-sightedness, all aspects or viewpoints need to be considered. This is best accomplished by a multi-faceted team.

Be forewarned that 'the devil is in the details'

Although networks can be joined and systems can be interconnected, communication is nonexistent if there is not a common language including both syntax and semantics. Adequate due diligence would include:

- identifying the key entities or objects that are involved in communication;
- identifying the key attributes of these objects;
- comparing the business rules surrounding any of these key attributes, especially attributes which are derived or calculated (include temporal dependencies); and
- identify how objects or key attributes across systems can be cross-referenced.

Self-preservation strategy

Pessimists are never disappointed because they always expect the worst. From a strategy perspective, it is always wise to examine the ramifications of partnership dissolution. This is not to say that there are not acceptable risks. However, there are some things that should be considered to mitigate risk.

Follow tactical decisions with strategic plans

There is never enough time to do things right, but there is always enough time to do them over.

It is often the case that the priority of getting a product to market will override other considerations. Because of these circumstances, tactical solutions are put into place. The problem is that in many cases, the ramifications of such tactical solutions are soon forgotten.

To overcome this situation, always identify and cost the strategic solution. Tactical solutions should have a convergent path toward the strategic solution. Development plans, costs, and any business case documentation should show both solutions, potentially progressing in parallel.

Maintain autonomy through interfaces

In order to maintain autonomy, interfaces between network and service management systems are critical. Proprietary interfaces, although sometimes expedient, have two shortcomings: if the partner goes away, it is useless; or if another partner joins, the likelihood that it will be useful is small. Implementing a standards-based interface can help overcome both of these shortcomings.

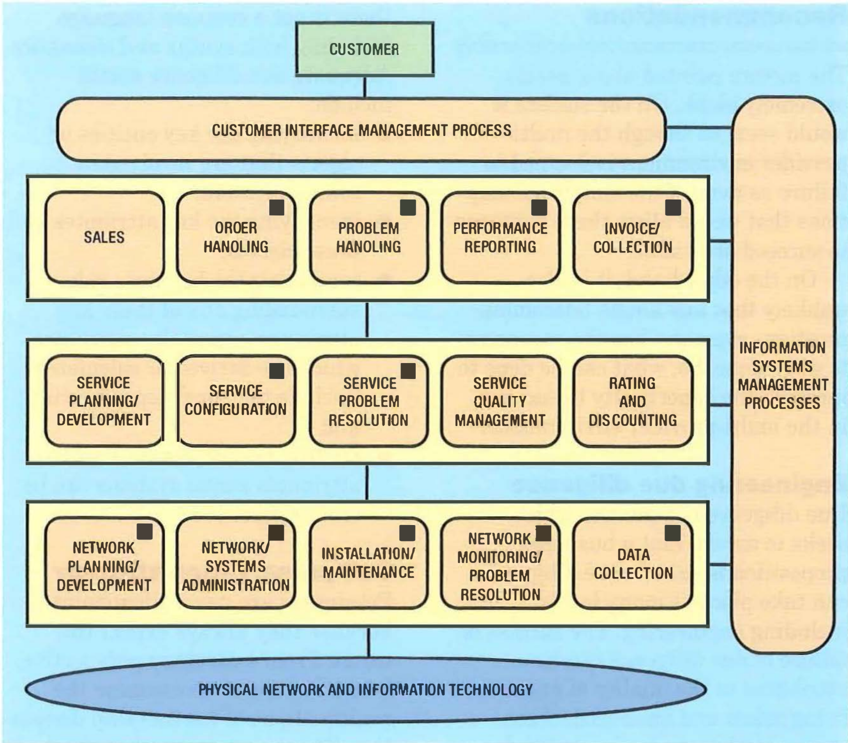

Figure 2

A simple tool

Figure 2 is a generally accepted business process model developed by the Network Management Forum (NMF)†. The processes marked with the small squares were viewed as potentially involving an inter-company process link. In the case of partnerships, it is likely that all processes are affected and require scrutiny as to how the processes interact. Using this model as a checklist can help to ensure that no major process boundary is overlooked.

This simple model can and should be extended to depict the inter-process links (for example, what is the linkage between order handling and service configuration?) which may depend upon the business model of the partnership.

Conclusion

Because of the business opportunities created by liberalisation, it is likely that you will become involved in a partnership of one form or another. As engineers, some of you will no doubt be faced with the 'opportunity' to make it work. When this opportunity does arrive, perhaps you will reflect back to some of this simple advice from the trenches—and avoid some of the problems and situations described. However, if on the other hand you prefer challenge—particularly a Herculean one—then by all means, ignore this advice. After all, I would appreciate a less-competitive environment.

† The NMF has developed more detailed descriptions of each of the service-management processes as well.

Biography

Dino R Russo
British Telecommunications plc

Dino is a Senior Technical Advisor (STA) at the BT's US Systems Engineering Centre headquartered in Reston, VA. In his role as STA, he functions as a consultant to BT and its affiliates in the areas of systems, software engineering and IT strategy. In his role as consultant to Concert Communications, he has been and continues to be responsible for systems architecture—especially in the area of information solutions and data warehousing. Additionally, he is acting on Concert's behalf as the technical interface to Alliance partners who are adopting or considering adopting one of Concert's information solutions known as the Concert managed reporting environment (CMRE). Prior to joining BT, he was a principal in TRIGON Software Engineering, a consulting firm specialising in object-oriented development. At TRIGON, he assisted in number of commercial and governmental large-scale object-oriented projects with responsibility for methods, architecture, design, and mentoring. He has been involved in the telecommunications business arena since 1990.

Jim Freeze

Telecommunications Operators and Suppliers—The New Relationship

Gestalt: An organised whole that is more than the sum of its parts.

New ways of working together are breaking the mould of conventional supplier/operator relationships in the telecommunications industry. The concept of vendor-partner is enabling operators to move fast and be flexible in business, supported by a supplier who shares some of the risk and is committed to shared goals. With an example from Nortel's experience with operators, this paper examines the catalysts for such a shift and the potential benefits for everyone involved.

Introduction—Catalysts for Change

Advances in telecommunications technology are traditionally targeted at producing more efficient and manageable networks, faster transmission speeds, leaps in capacity, to be able to create and support advanced voice, data, and increasingly, multimedia services. With the systematic dismantling of public telecommunications monopolies and the emergence of network privatisation, new sets of features—services or 'capabilities'—are being offered to the telecommunications carriers by suppliers in the battle for differentiation and market share among an ever-more varied operator and carrier customer base.

A result of this competition is that the old rule book for equipment suppliers to the operator community, entitled: 'A survival guide to working in a near or total monopoly climate', must be torn up and replaced by more flexible approaches more recognisable as a truly competitive multidimensional commercial environment.

New licensed operators (NLOs) and existing carriers alike are targeting the emerging markets—the additional subscribers as teledensities increase; the extra or new services that are becoming available and affordable. The networks themselves are expanding—huge investment deals are making headlines in Europe, such as Cable & Wireless Communications' Network 2000 contract, multi-hundred-million investments by BT in next generation and pan-European backbone networks and Worldcom/MCI's upgrade for Internet traffic. New operators not even publicly recognised last year are planning to be in business this year with aims on new as well existing customer segments. Not only is the reach and functionality of their networks increasing, but also the scope of their services.

Redefining 'Service'

Mindful of competition and the much-vaunted convergence of voice/data/image/video, some vendors are adopting new methods of working, with the operator's overall goals at the forefront. These solutions relate not only to the equipment and system platforms supporting the variety of end-user services, but also new, additional services with which the carrier can augment its portfolio and attract new customers.

The new rule book focuses on the revised aims of the vendor: to help the operator become established in a short period of time; where necessary to provide practical help to enable the operator make the business leaps necessary to take advantage of new opportunities as they appear in the volatile marketplace.

The effect is to add significant value to the capability of operators as they strive to offer a attractive, evolving portfolios of services presented in innovative commercial packages. This is to be done in a climate of continual change and risk—while the vendor still aims to make a profit and grow as an enterprise.

The more adventurous telecommunications equipment suppliers are responding to the new regional, national and global carriers' needs by offering not only new types of equipment and platforms, but also by undertaking roles that, traditionally, are the domain of the operators themselves and related businesses, such as consultants and systems integrators.

The traditional models of supply and procurement—usually preferred supplier agreements—are now reserved for adding additional capacity to existing networks that carry the current portfolio of products and services offered by the major PTOs. But new demands are being placed on vendors that transform the nature of that conventional commercial arrangement.

For example, vendors are being called upon to offer services such as:

- service definition, development and implementation;
- system and service integration;
- defining and implementing operational processes;
- training—from sales to technical;
- market development and communication;

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- network modelling, planning, design and engineering, including alternative strategies for the operator;
- management of network operation and services;
- competitive analysis;
- project management involving both the vendor's own and third-party equipment, whether new or legacy; and
- most significantly, actual operations and maintenance of the network on behalf of the operator.

Immediate Benefit

These new relationships are being forged for reasons that significantly benefit the operator:

- a need for highly specialised skills unavailable in the operator's own organisation;
- the need to reduce the time taken for the service delivery cycle;
- the scope of changes needed in the operator's network and systems demands a unique relationship or organisation with the vendor;
- the operator can benefit from the vendor's experience gained in other network and business engagements;
- the way the operator chooses to manage the business may need a long-standing commitment from the vendor, far beyond equipment supply; and
- custom designs of products and networks may be needed to differentiate the service and product portfolio in the eyes of end-users.

NLOs and incumbent carriers together share the need for dramatic changes in network architectures, service capabilities and improvements in the way their networks are operated and managed. They are actively seeking a vendor willing to enter into new forms of relationship with them to meet these new demands.

For a vendor, the answer is to offer a new, service-based portfolio which is sufficiently flexible to encompass not only its own product portfolio, but any third-party contribution that an operator may involve in the overall network or service solution. The result of this complex patchwork of requirements is a variety of relationship—engagements—being entered into increasingly around the world. It is a trend that is growing in direct response to the catalysts of deregulation, competition, technical advances and end-user expectations.

Ask your Supplier

Operators, historically, are largely self-sufficient—particularly in expertise—relying on equipment suppliers simply to develop, then deliver the boxes. The in-house teams specify, install, configure and maintain the network components, augmented by massive research and development investment, such as BT's Martlesham Laboratories.

Few service providers today can afford the traditional resource budget. Even those that have such resources monitor their effectiveness closely. Time-to-market for telecommunications projects, once measured in years, is today beginning to mirror those in the computer industry. Development timescales for new entrants for both suppliers and suppliers, for instance, are measured in months or even weeks.

The complex traditional 'gating' processes—specification, prototype, customer trial and the like—leading to general availability, are no longer viable: the market opportunity might well have evaporated or end-users taken their business elsewhere.

NLOs tend to be run more like conventional companies than state institutions. In many cases, investors are prepared to gamble tens and hundreds of millions of dollars on a handful of influential, far-sighted individuals whose job is to identify the operator's business case and sell services. They prefer to concentrate on their core business and hire the appropriate technical and operational expertise. The former monopolies, too, are undergoing rapid transformation into leaner, fitter business entities.

Increasingly, operators are turning to the equipment vendor to provide that knowledge. Having completed the market analysis, decided money can be made out of a particular service portfolio specified to particular quality-of- service levels, they are beginning to engage their chosen supplier to design, implement and even operate and expand the network. The role can extend to acting as prime contractor and integrating third-party systems and services as the solution demands.

Operator consortia are also recognising that infrastructure reach, market share and access to know-how are powerful competitive tools. Witness the continuing reshuffles as carriers and Internet service providers (ISPs) link up. This has driven the telecommunications vendors to initiate mergers and partnerships with IT networking companies for Internet protocol (IP) technology such as terabit routers to cope with future IP demands, further adding to the value proposition offered by 'new supplier' that is both 'telecommunications and data capable'.

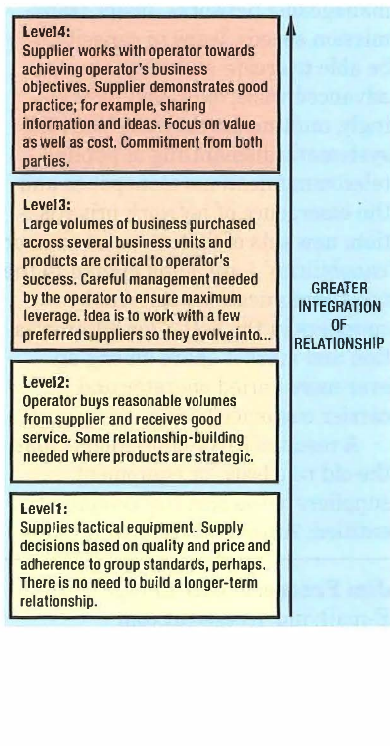
The NLOs, in particular, have a different mission to their former monopoly rivals: notably a penchant for buying in resources to keep in-house overheads as low as possible while retaining optimum flexibility. They recognise the few global telecommunications equipment providers capable of meeting their needs have the experience they are prepared to buy—most importantly, an understanding of carrier-grade service and the associated operations knowledge.

Enter the Vendor-Partner

Operators entering into these new style of relationships may consider the supplier in different ways, from *supplier* to *integrator* or even *partner*, but for consistency, the supplier will be termed *vendor-partner* here. The barriers to the new relationships are fast being eroded, such as the historically adversarial approach; the complex bureaucracy associated with purchasing and the lack of a consistent, market leadership.

The nature of the possible levels of relationships can be characterised by the four levels shown in Figure 1.

Figure 1—The levels of supplier / vendor relationships



The criteria for an operator/vendor-partner alliance can be contrasted with the, admittedly worst-case, traditional relationship:

Essential for the new relationship
- Deal aims to deliver value and low cost.
- Highly-effective cross-functional teams.
- Practices 'root cause' problem-solving.
- Focus is on trust.
- Ideas and information are shared.
- Proprietary data is respected and protected by both parties.
- Each works to earn the commitment of the other party.

Objective metrics are applied in decision-making
- Drawbacks of a traditional arrangement.
- Concerned only with price.
- Suffers from functional isolation.
- Relationships are adversarial—finger-pointing.
- Emphasis is on watertight, rigid contracts.
- Useful or even necessary information is often withheld.
- Data can be leaked to each other's rivals.
- No interest in wider benefits to the other.
- Decisions are by and large political.

Marked contrasts are also visible between behaviours of the new and old:

The new—for peak performance
- Long-term relationship sought.
- Partners' suggestions actively sought and shared.
- Vertically integrated, top management support.
- Quality improvements high on the agenda.
- Both parties committed to the same long-term goals.

The old—inefficient
- Short-term deals the norm.
- Ideas from the other party resisted.
- No vertical decision-making path through the organisation.
- Quality is a low priority.
- Goals are inconsistent or change unpredictably.

The outcomes on which the relationship derives shifts from the traditional to what one operator has described as a 'world class' approach:

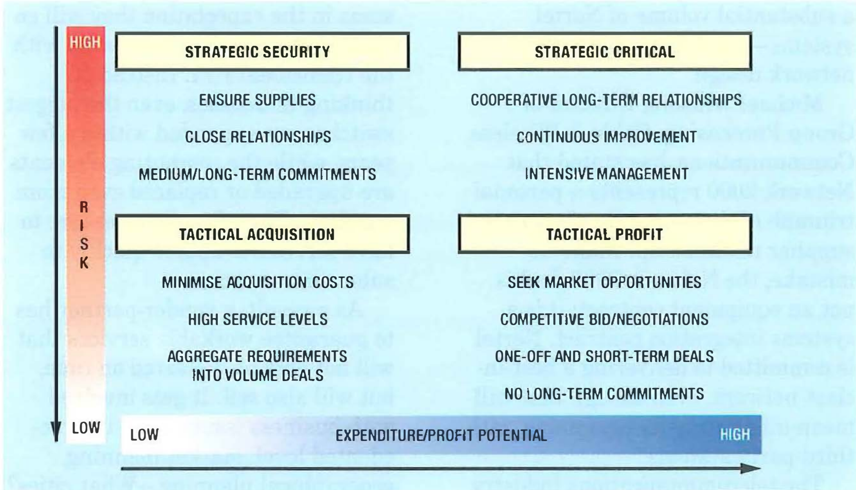


Figure 2—Supplier relationship strategies

Traditional approach
- Supplier is selected through a competitive bid process focused on tender conformance rather than whether it is the optimum solution.
- The short-term nature of any resulting commitment provides only limited incentives to perform beyond the strict contractual obligations.
- Further opportunities for mutual benefit are neither identified nor explored owing to the limited disclosure of information inherent in this type of relationship.

'World class' approach
- The longer-term commitment is itself an incentive to invest in ensuring performance improvement.
- The open exchange of information helps both parties understand how goals can be achieved.
- Improved communication avoids misunderstandings and missed opportunities.
- Defining objectives clearly and without 'hidden' agendas provides a platform for continuous improvement, leading to world-class performance by all parties... and world-class performance leads to competitive advantage.

Risk and rewards

As well as a shifting of responsibilities on to the vendor, the new commercial relationships involve the vendor taking more risks. No longer does it ship the equipment and take payment, but rather 'pay as you play'—often no significant payments until the equipment is in service and subscribers connected. One consequence is that the vendor is obliged to do as much as possible to guarantee the operator's success in the marketplace.

The relationship that the operator and supplier has then can be considered in terms of the mutual risks and the rewards that can be achieved for each type of relationship strategy (see Figure 2).

It is interesting to note that this sort of financial commitment is becoming the norm—the 'table stakes' in the telecommunications operator's inevitable business gamble. While the commercial risks have grown, some once-influential spoiling tactics no longer carry the same weight: undercutting on price by a local supplier, for instance, has less relevance if the operator is searching for a long-term vendor-partner.

An Example—Cable & Wireless Communications

So what is such an arrangement like in practice? One very recent example is Cable & Wireless Communications' Network 2000 project. This is a £400 million upgrade and expansion of its entire UK national network that will deliver unprecedented speed, capacity and reliability for corporate and business customers while ensuring substantial operating efficiencies for CWC.

At its heart is a three-year partnership between CWC and, as strategic supplier, Nortel. By sharing research, expenditure and personnel, the two companies are developing a network that incorporates best-in-class technology.

As prime integrator, Nortel will ensure equipment from Cisco, Newbridge, Alcatel and others—plus a substantial volume of Nortel systems—is integrated into the network design.

Michael Winslow, Director of Group Purchasing, Cable & Wireless Communications, has stated that Network 2000 represents a personal triumph of the new style of operator/supplier relationship: 'Make no mistake, the Network 2000 deal is not an equipment contract: it is a systems integration contract. Nortel is committed to delivering a best-in-class network, even though that will mean integrating its equipment with third-party systems.'

The telecommunications industry, he feels, is generally backward in its supplier relationships, still favouring an aggressive, adversarial stance that is both outdated and wasteful. He continues: 'It is far more productive to explain our objectives to a proven supplier such as Nortel and ask how it can contribute to our reaching them.'

In selecting Nortel as the primary integrator for Network 2000, involving several technologies and third-party suppliers, CWC required:

- extensive fixed-network experience, backed up by significant knowledge and resources;
- a world player in all the major telecommunications technologies that can create synergies across them all, including voice, data, intelligent networks, mobile, transmission, multimedia and radio access;
- a detailed understanding of issues critical to the future of a public network, including network management and data networking;
- demonstrated extensive integration experience involving legacy and new systems and large projects;
- like C&W, is a global player, experience gained can be transferred smoothly to other parts of C&W, as well as the services and capabilities developed; and
- research and development resources that can give C&W early insights into new developments and their impact and evolution.

Ready for Change

The structure of such new deals helps minimise the risk to both sides at a time when the risk scenario is changing. NLOs are borrowing huge sums in the expectation they will go cash-positive rapidly compared with the traditional PTT. Instead of thinking in decades, even the biggest switches are expanded within a few years, while the computing elements are upgraded or replaced even more regularly. Therefore the pressure to have services available quickly to subscribers is intense.

As a result, a vendor-partner has to guarantee workable services that will not only be delivered on time, but will also sell. It gets involved with business issues to an unprecedented level: market planning, geographical planning—What cities? What services? What tariffs?

Through experience and by understanding the cost structure of the operator, a vendor-partner can minimise the operator's entry cost into the market. Contributing factors are the way the network is designed, how products are deployed and how the network is managed.

A popular distinction between the traditional telecommunications engineer and the business-oriented personnel akin to the IT industry is that of the *Bell-heads* and *Net-heads*, respectively. NLOs tend to favour the skillsets associated with Net-heads: purchasing, mergers, growth plans and business techniques, preferring to buy in Bell-head skills as required. Vendors, too, are experiencing a shift in which the Net-heads have an equal voice with the Bell-heads upon whom its business is based.

There are increasingly more mergers, evident by recent purchases of small, vibrant companies with vital, often unique, technologies to offer by the larger telecommunications vendors. Perceived opportunities in the marketplace were the catalyst for such moves, buying in the necessary technology skills. Learning from the fast-moving, IP and computing-oriented world, the global suppliers must re-invent itself to offer the services necessary for such new relationships with its customers.

Based on Trust

The other side of the coin to risk is trust—the confidence that lies at the heart of the new operator/vendor-partner relationship, as evidenced by a number of very significant projects throughout Europe.

Trust can be defined as the expectation held by one trading partner about another—that the other behaves or responds in a predictable and mutually-acceptable manner. Predictability in behaviour enables long-term planning. Three types of trust can be distinguished that drive the relationship forward:

- *Contractual trust* Keeping promises, whether written or oral, and abiding by the accepted rules of business practice and behaviour as a whole.
- *Competence trust* An expectation that the partner will perform competently (such as technology, management or administration) and in accordance with professional standards.
- *Goodwill trust* An 'open' commitment and willingness to do more than is required formally. It involves being prepared to accede to a request from the partner—or to any mutually recognised opportunity—that would improve the partner's performance. The trust implies that partners refrain from opportunistic—and so potentially damaging—behaviour.

CWC's Michael Winslow encapsulates the consequences of such a relationship based on trust:

- 'We're dealing with a global supplier, here. We can assume the equipment works and there will be a 'fitness for purpose' clause in the contract anyway. So let's not waste time: let's organise the best deal. If the relationship exists—if the trust is there—with a clear business plan and capable products, we can manage our way to the desired outcome.'
- 'None of this is rocket science—accountability drives the relationship, fuelled by shared goals. Should a strategic supplier cause us problems, it is less the fact that equipment has failed or a service is not happening, but more that the strategy for C&W in that area is threatened. We sink our roots deep and expect a high degree of integration with that supplier.'

Traditionally, contracts full of penalties and liabilities were fire doors in case of trouble. While it would be naïve to suggest no such obligations need be explicit, a modern trust-based relationship can complete the necessary legal affairs relatively quickly and assume that both sides know what they are expected and are capable of doing.

Today, the participants rely on service-level agreements that cut swathes through orthodox warranties. Delays in implementation by a vendor can have significant adverse affects on the operator's marketing campaigns, for example. It pays for a plug 'n' play approach and can expect the vendor to deliver performance to an agreed level.

The vendor becomes responsible, for instance, for providing capacity, rather than a switch of a particular size and functionality. This 'you figure it out' approach demands that both sides be willing to 'go the extra mile' where necessary. The operator enjoys a continued, consistent level of service and the vendor can look forward to long-term business with its resources, if not necessarily its equipment, at the front of the queue.

Everyone can Benefit

Contractual obligation is making way for best practice—what a commercial relationship should be when both sides have matured in the relationship.

In the first few years, an NLO's capital expenditure on equipment is at most 20%, the rest being marketing, labour and other operational expenses. So, for example, the importance to the NLO is not so much whether to buy another switch, but working with the vendor-partner to reduce those operational costs.

Spares management—for decades a source of healthy additional revenue for suppliers, providing extra cabinets or cards for emergencies, for instance—is revised completely in a new-style relationship. Whereas the cost of moving line cards between switches could end up being greater than buying entirely new spare cards, the operator can consider whether it is necessary even to own the cards in the first place. Why support a warehouse full of spares just to feel the network is resilient when it is the vendor who knows what is needed and how to maintain it best? In an operator/vendor-partner relationship, it can now be the vendor who bears the cost of that flexibility.

Likewise, an operator no longer has to forecast its network needs months in advance so that a vendor can plan its manufacturing. If an operator needs equipment, that need will be measured in hours, not months—it is a measure of the supplier's capabilities to be able to meet these new expectations.

These changes are now even permeating through to traditional service providers as the often newly-privatised owners begin to ask the kind of searching questions about suppliers and strategies that conventional businesses are already familiar with answering. They can benefit from the new-style relationships particularly for introducing new services, such as Centrex.

The vendor capable of entering such an agreement can integrate the relevant components and provide billing and management expertise—the business processes that benefit from experience. The vendor adds consultancy and training to the conventional equipment and support package, right down to the type of brochure with which to market the managed services to end users. Further downstream, the vendor can offer mature planning and modelling services that the NLO would otherwise have to support in-house.

Goodwill to All

In some ways, a new operator/vendor-partner relationship could be viewed as a high-risk strategy. Both parties are opening doors and enabling dialogues that would not have been thought possible in the telecommunications community less than a decade ago.

However, there are checks and balances to be put in place that underline what is often simply a mixture of common sense and a professional means of doing business, while the potential rewards are substantial. While the stakes have risen, the overall market is growing, particularly as the Internet and multimedia aspects of operator business expand. New content brings new services; NLOs can look to vendors for innovation in service delivery and management mechanisms, through to marketing and support.

In a fixed contract, the supplier meets the fixed terms, results are determined by market forces and any improvements are usually added only as the pace of the market dictates. Under a contract with incentives, on the road towards a full-scale alliance, the supplier's commitment is more open-ended, depending on how the supplier sees the opportunities and is willing to stretch itself on behalf of the operator. Results relate directly to the supplier's skills and the pace of development is driven by the operator as it searches for greater-than-market value, differentiation and competitive edge.

In an operator/vendor-partner alliance, both parties seek continuous improvement; the results are determined by the skills of both parties; it is the customer who wants the greatest possible value and both parties contribute to the improvement process. The traditional arm's length arrangement between vendor and operator is replaced by a partner relationship based on a high degree of commercial trust.

This new-style relationship epitomises a continuing shift in emphasis that pervades both the computing and telecommunications industries: from hardware to software, from proprietary systems to open standards and from system builders to system integrators. Ultimately, such alliances enable everyone to win: the vendor can give an operator the best who, in turn, can give its customers the best.

Biography

Jim Freeze
Nortel

Jim Freeze is Senior Manager, Customer Network Programmes for Public Carrier Accounts in Nortel Europe. He manages the design of Nortel's multi-product network solutions in Europe for both existing and new public telecommunications carriers. He is currently working for Nortel in Maidenhead in the UK. He has over 25 years experience working for Bell Canada and internationally in a wide variety of engineering management positions related to the planning and provisioning of telecommunications networks.

Dave Simpson

Life with the Regulator

This paper examines what is meant by regulation, and its role in promoting and maintaining competitive markets. An overview of the functions of OFTEL, the UK telecommunications regulator is provided. The paper goes on to describe the various external stimuli that may cause regulators to intervene in markets. It also serves to illustrate the increasing challenges for the telecommunications regulator in a converging marketplace.

Introduction

This paper examines what is meant by regulation, and its role in promoting and maintaining competitive markets. It also illustrates the increasing challenges for the telecommunications regulator in a converging marketplace.

OFTEL

In 1984 the UK government established OFTEL (the Office of Telecommunications) as an independent regulatory body as part of its liberalisation of the telecommunications sector. Since its inception, OFTEL's role has effectively been the management of change from monopoly towards full competition. From an initial duopoly (BT and Mercury) the UK has now over 200 licensed operators, including five national carriers, four mobile operators and over 60 companies licensed to operate international facilities. In addition there is increasing competition in the provision of the local loop with cable and radio fixed access providing alternatives to BT. There is also a large and flourishing market in advanced and value added services, run by independent service providers such as personal numbering, voice mail and Internet access.

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Regulatory Principles

The regulator, in so far as telecommunications services is concerned, is responsible for ensuring the provision of services which satisfy the needs of consumers. These needs are expressed in terms of quality, choice and value for money. OFTEL believes this can be best achieved through the promotion of effective and sustainable competition, to secure lasting benefits for consumers. As a result, OFTEL has five high-level objectives which, while promoting competition in the telecommunications market, also aim to protect consumers (particularly the vulnerable and disadvantaged) in areas where competition has yet to fully develop. The objectives are:

- promoting fair, efficient and sustainable network competition;
- promoting fair, efficient and sustainable services competition;
- securing licence enforcement and fair trading;
- securing a fair distribution of the benefits of competition between different groups of customers;
- protecting consumer interests especially where effective competition is not yet fully developed.

It is the regulator's role to implement policies and monitor the market to ensure these objectives are met. The regulator must only intervene where market forces will not deliver an acceptable outcome. Knowing whether or when to intervene is as important as deciding what intervention is required (although they are obviously closely related).

Powers

While the UK telecommunications sector continues to grow in size and complexity, the adoption of harmonised European Directives, and in particular the new (EU-based) competition law, has changed the tools which are used to implement policies.

To a certain extent the effectiveness of a regulator can be measured by the power it has to enforce its policies and how effectively it uses those powers. If the regulator has no 'teeth', even its most fundamental policies can be ignored. OFTEL has warmly welcomed the reform of UK competition law, which proposes OFTEL to have concurrent powers with the Office of Fair Trading to enforce new prohibitions on anti-competitive behaviour in the telecommunications sector.

The introduction of harmonised European Directives has placed significant responsibilities on regulators within member states. It is important for OFTEL to offer its experiences of regulating a highly competitive UK market back into Europe to influence the development of new Directives, in particular the 1999 EU review of the overall regulatory framework. It is also important to bear in mind that UK policies may not be appropriate for other EU states because of the different levels of competition in their individual markets. In the same way, certain other member states' policies may not be appropriate for the UK market. There are several other reasons why issues may vary between member states beyond their current level of competition. For example members may have different attitudes to the appropriate degree of rebalancing, overall penetration and the extent of the Universal Service burden. Policies may also be affected by attitudes to competition in network infrastructure and services.

The Telecommunications Market

Certain markets have specific characteristics that require the presence of a dedicated regulator. Various unique factors within the telecommunications sector lead to the conclusion that this is one such market.

The UK telecommunications market has evolved from that of a nationwide, vertically integrated statutory monopoly. The government used this monopoly to raise funds for public service objectives and provide services, leading to significant price distortion. These distortions were evident in the excessive prices charged for national and international calls, which were significantly above costs, and the below-cost charges for line rental. In addition, the incumbent had control over key services, such as apparatus approval, UK-specific telecommunications standards, numbering and directory enquiries.

Telecommunications also has some unusual technological and economic features, one of which is the significant fixed cost of building and maintaining a network. This cost acts as a significant barrier to entry for new operators.

The high fixed costs associated with telecommunications networks means that realistically customers will only take their (access) service from one operator to avoid paying multiple line rentals. This produces a bottleneck since calls to a particular customer can be delivered only by this operator. If this operator decides to charge excessive amounts for call termination on its network, or restricts the type of services available to the customer, then this can affect the provision of other network services. The regulator must ensure it has sufficient powers to prevent such behaviour by operators who have significant market power.

Reasons for Regulatory Intervention

Before a regulator chooses to intervene in a market there must be a clear purpose and expected outcome. This section describes a number of external stimuli that may cause the regulator to intervene.

Anti-competitive practices—abuse of dominant position

Harm to other market players

An existing operator may deliberately wish to remove competition within a market. It may restrict new competitors by introducing or increasing barriers to entry, or drive out existing players by using predatory prices. Whatever the method used it can be considered as a deliberate move to distort the market in such a way as to benefit the one operator.

One way of introducing such distortion is for an operator to exploit the externalities present in telecommunications networks. As described earlier, the high fixed costs associated with telecommunications networks mean that subscribers generally connect to only one network operator. Any calls made or received by the subscriber must pass through that network operator. This operator may decide to increase the charge it levies on other operators to deliver calls to its customers. This price increase will affect incoming calls from other operators only, and hence will not affect its own customers. The net result is that call charges on competing networks will increase, while those on the original operator's network will remain the same, making the competing operator's services less attractive relative to the incumbent's.

This kind of behaviour is most likely to occur where there is a dominant operator who is able to dictate call termination prices to other operators. The result is that calls cost more to deliver for the small operators, so customers are more likely to remain with the dominant operator's network.

Exploitation of consumers (high prices)

A common definition of dominance is the ability to raise prices without the risk of losing market share. Preventing excessive pricing by dominant operators is a prime regulatory objective. In the UK retail price caps are used to mimic the downward price pressure of a competitive market on a dominant incumbent in areas where it faces little or no competition.

Exploitation of adjacent markets

In markets with significant vertical integration, dominance in one part of the chain can be used to exert influence, and even dominance in other areas. This is particularly true where the dominant operator controls a core component, such as the delivery mechanism. It is for this reason that BT's network and value-added services divisions are separated, to prevent BT's dominance in one sector (basic telephony) being used to leverage BT's own services. Controlling the spread of dominance is a key regulatory objective and one that will increase in significance as markets converge and vertical integration becomes tighter. This issue is discussed later from the perspective of set-top boxes and premium content in digital TV networks.

Anti-competitive practices—cartel behaviour

Where a number of operators form a consortium and make business decisions together they can exhibit cartel behaviour, and effectively operate as single dominant operator. Closed markets where there are a small number of players can be particularly prone to this type of activity. Cartel-like behaviour can be seen in the area of international undersea cables where consortia of major operators effectively control the resources needed to lay and maintain cables, and the ability for mutual restoration.

Interoperability

Interoperability is the fundamental function of networked services. All services carried across networks require the presence of more than one party. Where the calling and called party are on different networks, the calling customer has no market impact on features delivered by the network of the called customer, so market forces will not necessarily deliver.

In order for an operator to offer full connectivity to its users, it must interconnect with other networks. A small network can therefore offer the equivalent connectivity to a dominant operator by simply interconnecting with it. The dominant operator gains little from the arrangement, and indeed may in fact lose out since (potential or even existing) customers now have the choice of two operators who can offer the same connectivity. If the dominant operator was to refuse to interconnect with another operator, the second operator's network would effectively become isolated, only allowing connectivity from and to its own subscribers. A new customer looking for the operator with the best connectivity would have little choice but to connect to the dominant operator's network. In addition, dominant operators can gain a competitive edge on competitors when launching new products if interconnection arrangements are not in place.

The dominant network supplier refusing to interconnect increases that operator's dominance, since subscribers are attracted to the most valuable network in terms of connectivity, fragmenting the market, with islands of unconnected networks.

This concept extends to facilities such as Directory Enquiries (a natural monopoly), where details of subscribers must be exchanged to produce a complete directory. Here there is the added complication of passing customer information between competing operators.

Regulatory intervention is common within this whole realm, requiring the negotiation of interconnection between operators. In the UK we have gone further and noted that the externality effect extends to new services, even when basic telephony is already interconnected. Hence the need is seen for services like CLI, ringback-when-free, etc. to be launched as interconnect services when the dominant operator launches them at retail level.

Consumer protection

It is stated clearly in the 1984 Telecommunications Act that OFTEL has a specific responsibility to protect the needs and interests of consumers, particularly the most vulnerable.

OFTEL's policy has been to protect the customer by the promotion of competition within markets, leading to more choice of higher-quality and lower-priced services. Most directly OFTEL imposes price controls on certain operators to ensure customers receive the fairest deal.

In addition to this more general consumer protection, OFTEL deals directly with customer complaints, and represents consumer interests in a number of fora. OFTEL continues to encourage initiatives such as relating to BT's Low User Scheme and the provision of BT's Typetalk service, which allows text/voice relay for users of text telephones.

Social objectives

The consumer protection obligations on the regulator aim to prevent market externalities distorting the market in a way that disadvantages the customer. Occasionally the regulator, acting under government authority, may implement social policies that deliberately distort the market. One such example is that of the Universal Service Obligation which aims to specify a minimum set of telecommunications services for all customers. Social objectives are only mandated where it is believed that the consumer would not be served adequately through normal market forces. It is OFTEL's social objectives that ensure free access to the emergency services through 999/112, the provision of public call boxes, including in rural areas, and low-cost Internet access for schools.

Management of scarce resources

Within some markets there are certain services which need to be centrally coordinated. Within the telecommunications market, numbering is one such example. Numbering represents a scarce resource, which is required by all operators, since clearly each number must be unique and meaningful. Policies regarding numbering must be transparent and accountable, insofar as customers must understand the type of number they are calling (and hence the tariff likely to be charged). The distribution of numbering ranges must also be impartial so as not to show undue favour to any particular operator. It is the regulator's role to oversee this process, whether through a third party or by direct control of the numbering space. OFTEL was responsible for the introduction of geographic number portability in UK fixed networks.

Other examples include radio spectrum and even wayleave agreements (where limited access is available). With all scarce resources, there lies an implied obligation that the operator to whom the resource is allocated will use it effectively or where practical, the resource should be shared. For example it would clearly be inappropriate for an operator to reserve access to radio spectrum solely for the purpose of preventing competitors from using it.

Essential requirements

Finally, there are a number of requirements that are mandated for the protection of both customers and network operators. These include such aspects as the security of network operations and network integrity, which can be achieved only through industry cooperation. These aspects relate to the overarching importance of telecommunication networks to society as a whole, especially relating to public safety, but even to the economic well-being of the country. It is important that networks should be resilient to both internal failures and external threats and that particular attention is paid to the needs of emergency organisations of all kinds. The network is an essential resource when other forms of public emergency occur.

It is the regulator's role to ensure such requirements are met and to encourage best practice where possible. Care must be taken to ensure that these essential requirements are not excessive and act as a significant barrier to entry for new or small operators.

The Regulator's Response

All of the external stimuli detailed above cause the regulator to act within the market in some form. In some cases OFTEL's power is derived directly from the 1984 Telecommunications Act, in some case from specific conditions written into licences, but increasingly European Directives are placing strong obligations on national regulators to intervene in certain areas.

The New World

Convergence, the word used to describe the blurring of the boundaries between telecommunications, information technology and broadcasting, has brought new challenges to regulators. While initially these challenges seem formidable, when broken down they reveal a number of familiar issues. Two sectors are detailed below to give an introduction to some of the key areas of regulatory concern within the differing 'converged' industries:

Digital TV

Digital TV will be for many consumers the first real taste of a converged marketplace. It will allow a host of new services, delivered by satellite, cable TV and conventional broadcast networks. Like telecommunications the high fixed costs associated with networks will mean that consumers are likely to subscribe to only one service provider and hence possess only one set-top box (STB), the device which decodes digital transmissions for viewing on a conventional TV set. The technology within an STB that prevents access to unauthorised channels and services is called a *conditional access* (CA) system. Control of this technology is a potential bottleneck in that it can be used to prevent other content providers accessing customers on certain networks. This type of behaviour may occur where vertical agreements have been entered into between content providers and CA providers to create joint dominance, or where a single company is sufficiently dominant to control both aspects on its own. STB technology can also be used to prevent other content providers' electronic programming guides (EPGs) from being viewed by the customer, thus making navigation of the other content providers' services difficult.

Where a dominant operator decides on a technology for its STB, it is important that other operators are able to use the same technology to prevent the furtherance of the dominance. This is important since if certain services (provided by the dominant operator) are only available over its network then customers may be locked in to that network, to the detriment of other networks. It is also important that other content providers are able to offer their services over the dominant operator's network for the same reasons. If left to the marketplace the likely result would be dominance by the one player, who would then have little incentive to offer competitive pricing or quality content.

The key element within the STB that provides the interoperability is the application programming interface (API), which acts as the operating system on which all the services are run. The choice of API affects players in integrated markets who must ensure their products and services operate on this platform. Smaller service providers may not be able to reauthor their product or service to run over multiple APIs and will logically chose to author for the dominant API, hence perpetuating the critical mass associated with the dominant API.

The regulator is increasingly protecting against the exploitation of dominance in the area of APIs, since this is an area that can easily allow dominant operators to control integrated markets. This will continue to be an important issue within Digital TV and the wider IT industry.

Internet

The Internet is an example of a network that has seemingly grown without any external regulation. This is not quite true, as it can be argued that the Internet is made up of many telecommunications links, available at reasonable rates and quality only through regulation or competition. Furthermore there are natural monopolies within the Internet which have been tightly controlled for technical reasons, such as Internet protocol (IP) address allocation and domain name registration. It is the regulator's role to ensure that appropriate independent bodies are in place to allocate such resources.

The way in which the dominant PTOs (for example, BT) can compete against independent service providers is also regulated to ensure dominance in telephony and infrastructure does not unduly distort the Internet market.

One area of commonality with the telecommunications world is that of interconnection (peering). As networks grow in size, whether through customer growth or acquisition, they risk becoming dominant. Dominance can provide strong disincentives to peer with smaller networks. The inevitable consequences are increased barriers to entry for new players. The non-settlement based peering model traditionally used throughout the Internet backbone has exacerbated this situation. It is with this in mind that regulators might encourage neutrally owned Internet exchange points, such as the LINX in the UK, which are free from commercial bias.

Conclusion

It is clear from the examples above that there is much commonality between the telecommunications market and the new converging sectors. The regulator must ensure that policies are technologically neutral to prevent distortion between sectors. The way forward for regulation is to regulate through market forces where possible, relying on general competition law where there is market failure. Certain reasons for regulatory intervention are not strictly competition issues, such as the social objectives, interoperability of new services and the essential requirements. These will continue to be subject to specific rules and measures.

The pace of change and implementation of new technology is ever increasing with companies being thrust into markets of which they have little previous experience. In such a rapidly changing environment it is not a trivial task for the regulator to make sense of the chaos. In one direction the regulator is tied to existing policies and new laws, yet in another the market is progressing rapidly and the regulator must provide comfort to encourage investment in new emerging markets.

To this add the enlarged scope of operation to include broadcasting and IT as well as the existing telephony infrastructure, and the increased globalisation of the industry through developments such as the Internet. The regulator's role continues to offer opportunities and challenges seldom experienced elsewhere.

Biography

Dave Simpson
OFTEL

Dave Simpson is currently working as a Multimedia/Telecommunications Specialist in the Technical Branch of OFTEL, the UK telecommunications regulator. His responsibilities include the regulatory aspects of emerging technologies such as the Internet and digital TV. Before joining OFTEL he worked for Cable and Wireless Communications in its Network Development Division, where his responsibilities included implementing an international Internet telephony trial, the development of a fixed radio access product and general network access issues. Dave graduated from Sheffield University in 1993 with a degree in Electronics (Information and Systems) Engineering. He is an Associated Member of the Institution of Electrical Engineers.

Isabella Förster and Anton Jandl

Social Aspects at the End of Monopolism

Since 1 January 1998, historically evolved market regulations and monopolies in the telecommunications sector have broken up and have been transformed into competitive markets. A radical change was thus brought about which posed an enormous challenge to the established suppliers. One of these new challenges was and still is the radical change of the structure within the PTA (Post and Telekom Austria).

Most deeply affected by these changes are without doubt the employees, who through their many years of work in the company have acquired specific behaviour and through a social learning process have grown into a social relation network and who identify with a very specific social role. The thus developed patterns of behaviour and attitudes are characterised by the working conditions and content of work. Changed conditions require, however, new behaviour and reactions as well as flexibility and the capacity for creative action. The central challenge of the telecommunications companies is to create structures which enable development, distribution as well as control of the increasing complexity.

The successful restructuring and continuity of power will depend on whether and in what way it is successful in leading the employees out of their familiar environment, getting them acquainted with the new rules of the game and awakening the relevant potentials which enable them to manage future knowledge and complexity.

Dealing with Change

Through the liberalisation of the telecommunication market, the formerly usually state-owned companies have to come to terms with a completely changed environment and with competition in the market. Historically evolved power regulations and monopolies have broken up. Both established suppliers and new competitors are confronted with enormous challenges. Moreover, the telecommunications sector is one of the fastest expanding markets in the world. This means fast change and the courage for innovation.

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Private enterprises have always been exposed to the pressure of the market but, despite its monopoly, legislative obligation to deliver services and products without payment or below their value was imposed on the PTA. Monopolies have developed their own structures and have also influenced the behaviour of the employees. Familiar organisational concepts, rules and processes can be understood as systems of interpretation, with whose aid individuals construct the reality of the organisation and bestow it with meaning. For example, companies within a certain branch usually develop their own language in order to describe their market, the technology and the relations to other areas of trade and industry. Their action is geared towards the threats and changes which become visible through this system of interpretation. Companies organise their environment in precisely the same way as their internal procedures and thus transform the reality with which they are confronted. The self-image of organisations thus is decisive in the shaping of almost all aspects of their mode of functioning and in their effect on the environment of which they are part. This is the reason why organisations have to devote a lot of attention to the finding and developing of an adequate sense of identity. This is where the problems for the employees of our telecommunication company arise.

The self-image of a monopoly is different from one of a company which is geared towards free enterprise. Moreover, there is a strong discrepancy between self-image and the image of the other. The management usually sees the process of change in the telecommunications company as a problem of a change in technology, structures and the abilities and motivations of the employees. This is also partly true, but in our case effective changes are based on a change of ideas and values, which are meant to guide actions. Attitudes and values which supplied recipes for success in the monopoly-like companies for which our employees worked until the liberalisation are clearly an obstacle in today's situation. Therefore, programmes of change have to include creating a new company ethos which has been made necessary by the new situation and finding a way of developing it.

Organisation is primarily based on mutual systems of interpretation which influence action. It shows the importance of dealing with changes in the culture of companies through which the necessary activities can be achieved more easily. Because in the end changes in the organisation develop in the minds of the people involved in it, an effective change of organisation implies cultural change.

The transformation from a monopoly to a competitive market can only be managed in a successful way, as well as in a short time, if the management is conscious of the symbolic implications of the values of an organisation and, in the transitional phase, carefully deals with the employees and with the procedures which characterise the everyday life of the company.

Only when it is acknowledged that organisations are fundamentally of a human nature and that the human being and not technology has to stand in their centre will programmes of change bring the desired result. Because of the employees, many years of work in a company with a monopoly one can speak of a class-related socialisation. Through a social learning process the employees have grown into a social relation network and identify with a very specific social role which cannot be changed at will. The thus developed patterns of behaviour and attitude are marked by the working conditions and content of work, which again are dependent on specific characteristics of organisations. Mechanically structured organisations—monopolies—can be adjusted to changed conditions only with great difficulty because they are not prepared for innovations. Changes require the reduction of hierarchies, loss of power, acquisition of new behaviour, flexibility, capability for creative action as well as the management of knowledge and complexity.

Hierarchy and Power

Wherever fundamental changes are on the horizon, interests are affected. Positions and privileges, fine-spun networks and spheres of influence are threatened. Why is something already existing so difficult to change? The key is power.

The most obvious source of power is official authority, a kind of legitimised power, which is respected and acknowledged by all who interact with one another. In a hierarchical structure, as is characteristic of monopolies, more or less all employees are endowed with authority. The exercise of power extends as far as the customer; that is, a self-reproduction of legitimacy takes place. As the sociologist Max Weber has stated, legitimising is a kind of social confirmation which is indispensable for the stabilisation of power relations. The primary form of official authority in most organisations is bureaucratic and is usually connected with the position held by a person. The different positions in an organisation are defined by rights and duties which create the sphere of influence. The positions in an organisational space thus determine areas of delegated authority. The more authority is transformed into power through the consent of others who are bound by the order of their superiors, the more a structure of authority is also one of power. But authority is not only what is transmitted from the management of the organisation downwards and further delegated by superiors. Authority is only effective as far as it is legitimised from below.

The nature of the power pyramid is thus that a high degree of power falls to those at the base of the pyramid as well as to those at the top. The trade unions have naturally realised this and channel as 'counter organisation' the power of the bottom levels of the pyramid in order to challenge the power of those at the top. Frequently the organisation structure with its strictly hierarchical safeguarding is employed as an instrument of power and thus greatly restricts the overall effectiveness of the company. Examples of this are:

- The cult of individual responsibility often leads to competition instead of cooperation.
- Information, overview, influence and personal commitment increase upwards and decrease downwards—at a time when entrepreneurial thinking and action would strongly be in demand at the basis.
- Thinking in positions—instead of in duties and processes—obstructs or prevents thinking and action in dynamic orders of events; that is in process chains.
- Too much information seeps away on the way downwards and upwards.
- Too many supervisors in horizontal and vertical spheres of influence who daily endeavour to justify their existence.
- Because of insufficient networking and unequal distribution of power, individual personal weak spots become an intolerable risk for the whole organisation or great parts of it.

Meanwhile we know the disadvantages of conventional organisations in a completely changed modern world and we also know the conceptual basis of future-oriented organisations. Even so, respective changes are incredibly slow-moving in reality since every change of the organisation always also means a change of power.

Why is a balance of power so difficult to change?

People who only know the way of hierarchical power will heavily object to an organisational form which primarily calls for social competency; firstly, because they do not think they could gain the necessary influence within the framework of such an organisation, and secondly, because they do not think that such an organisation can exist in reality. The change which our employees have to cope with not only means a change of structure but also a change of culture. Values, mental attitudes and norms of actual behaviour are at the centre. Within the context of the liberalisation of the telecommunications market this means to redefine relations to the customer. The task hereby is to change the mental attitude of our employees because the mere lip service 'the customer is always right' is too little.

An important source of power is required in the newly established organisation, one which is based on the ability to motivate employees to change behaviour and put those things into action which contribute to mutual interests. Part of the leadership qualities of the new management therefore is the ability to define the reality of others. The American social scientist W. I. Thomas has developed a fundamental theorem which, put in a nut shell, goes: 'If men define situations as real they are real in their consequences.'

While the authoritarian executive tries to 'sell', 'order' or force a reality on their subordinates, a more democratic-minded executive makes it possible for definitions of a situation to develop from the opinions of others. The influence of the democratic manager is much more subtle and more symbolic. He/she takes time to listen, to summarise, to integrate and to lead the discussion and only intervenes in important decisions. He/she puts forward images, ideas and values which help those involved to see the particular situation in a meaningful context. He/she controls the meanings which are assigned to a situation and operates with a kind of symbolic power which is decisive for the way in which people perceive their reality and consequently their behaviour. Especially in the telecommunications company where the qualified employees have to be retained, such executives are in demand in the management because it is extremely difficult to change human behaviour in reality—and most of all that of people who were used to controlling others.

The actual distribution of power in a new organisation is another aspect which can be changed only with difficulty. Because those in power, among other things, show commitment towards not losing it. In other words: power tends to preserve itself. Should an existing power structure be undermined and changed, in order to help to get the change accepted a corresponding counter-power has to be set up. The fundamental maxims of action for the one who has decided to change an existing balance of power are the following:

- Neither to condemn power in general nor the current persons in power, but to specifically build up power themselves and employ power in order to change conditions.
- On principal and systematically question all privileges of power and status symbols.
- Consequently to look out for like-minded people and to create a core team of allies.
- Gradually to build up an extended network of allies which is carefully looked after and coordinated by the core team.
- When the 'home power' is stable enough: preparation for a concerted action for the achievement of the mutual aims.

There is a reason why we have especially made the aspect of power in connection with changes within an organisation a subject of discussion. That is, power is a taboo. One does not write or speak about it. Power plays a very central role in the life of people and in the working of organisations—but officially it is no subject for discussion. The strength of the taboo is discernible in the training of managers where the issue of power simply does not appear. But power is one of the most important instruments for carrying through decisions in connection with changes. In the framework of the hierarchy everybody is exposed to power every day—but the issue of power does not exist. As long as power remains a taboo, it will not be talked about in a critical manner and there is no great danger that an existing balance of power is being questioned and its change proposed. The unwritten prohibition to talk about the prevailing balance of power in a specific organisation has therefore got a deeper meaning. And those who want to effect change have to deal with this taboo.

- Power as such is neither good nor bad.
- Power is an instrument for the carrying through of decisions in organisations. Large organisations are not manageable without the employment of power.
- Power should not be tabooed but made transparent and regularly questioned critically, especially with regard to its aims.

Those who want to control processes of change and move things in organisations cannot afford bashfully to try to avoid the subject of power. They must know the laws which form the basis of the creation and preservation of power; firstly, because they must question and if necessary change an existing balance of power, and secondly, in order to do this they need power themselves and if they have not got it already they must build it up.

Management of Complexity and Knowledge

Through the liberalisation of the telecommunications sector we move towards a world characterised by a technical progress which is constantly increasing in speed. Through this progress our employees are more and more often confronted with complexity as well as change. Not only does the number of tasks increase but also the confrontation with dynamic open processes as well as changed basic conditions which are characterised by a network of interdependencies.

In the past, on account of the monopoly, the path towards an unlimited growth was the only path into the future. Because of the competitive pressure companies have to become aware of their size, they have to initiate measures of re-dimensionalisation and to take the appropriate measures to reach the optimal size of the organisation. With the recognition of the scarcity of resources, of possible shortages and limited possibilities of growth-oriented progress companies are challenged to improve their business competence for the future or to increase their capacity for solving problems. In order to cope with this change and to manage the new complex problems, organisations are forced to adjust and to change themselves and to anticipate developments. In the future survival will depend among other things on the ability to learn as a collective.

How then do organisations guarantee that they will survive as a system in their environment, that they will change and especially that they will learn? For that, organisations have to identify knowledge.

Every member of the organisation possesses, be it on an individual or on an organisational level, a 'reservoir' of possibilities of knowledge and action. The creation of an internal transparency of knowledge at the same time means the creation of an awareness on the part of the organisation concerning its abilities. What kind of experts are on board and what kind of contribution can they make to the building up of organisational competencies? What other internal networks are important in the exchange of information? The transparency about collective knowledge is also important. One way to form an impression of one's own efficiency is also the systematic comparison of one's own abilities and performance with those of competitors. Benchmarking at the same time is also occasion to the search of new sources of knowledge and abilities. A specific identification of knowledge creates a transparency of knowledge which provides a better orientation within the organisation and a better access to the external field of knowledge.

Besides the identification of knowledge, making visible informal structures and networks is important for an organisation. The more unstable the formal organisation, the more stable is the informal organisation which basically constitutes a central nervous system and supports processes of collective thinking and action. Informal network structures can be made visible through interviews with employees whereby the respondents state with whom they speak about their work, whom they trust and who gives advice to whom concerning technical questions. The result of such inquiries are networks of consultation, of trust and communication which clearly show the various qualities of relationships. Knowledge about this could be used in the arrangement of future project teams. Networks are the most important aid in the identification of experts and sources of knowledge. A network is distinguished by a mutual basic interest of its members, a consistent orientation towards persons and the voluntariness of participation. The relationships between the participants are based on the principle of exchange. The communication in networks therefore follows radically different laws than processes of a well-ordered exchange of information in a hierarchically structured company.

The mutual trust built up and reinforced through personal contacts makes an informal-direct style of communication possible which allows those participating in the network quickly to orientate themselves in a fast-changing environment. This will only work if everybody contributes their own knowledge. Networks therefore are polycentric entities which do not come to an end with the leaving of individual participants. Many organisations do not make use of such networks of experts. Often they do not even know about their existence, of the fields of knowledge which are dealt with or of the memberships of their own employees in varied external networks. Changes in the organisation, or external influences—liberalisation—on organisations are frequently breeding grounds for the creation of such networks.

Besides identifying already existing knowledge, organisations constantly have to acquire new knowledge. Everyday knowledge stabilises our expectations and gives security. The import of new knowledge destabilises this security and thus provokes defensive reactions in organisations. These reactions are also justified in a number of places because some organisations give the impression that they are no longer able to make important decisions without external advisers. They become dependent on their advisers. Especially since advisers are as a rule interested in further assignments, the issue of to which purpose external know-how is needed has to be weighed carefully. For telecommunications companies which, coming from a monopoly, have to face competition from now on, the acquisition of knowledge is crucial in order not to lose market shares too quickly. So, for example, the knowledge about customers is important for a successful treatment of power. From the perspective of knowledge management, however, not only the knowledge about the customer but also the ideas and experiences in the customers' minds are important. For it has already been shown that the ideas of customers are the largest source of innovations for the company. Those who want to specifically fulfil the wishes of customers not only have to know their needs and use their ideas but also have to communicate with them in a well-adjusted language. Not only do advertising slogans have to strike the right note but also by inquiries and complaints customers have to feel that they are understood.

Organisations have to distribute identified and acquired knowledge on a broad basis. Because only if identified and acquired knowledge is also available in the relevant areas of decision-making bodies can it be utilised for the entire organisation. The threat to the effective distribution of knowledge usually starts from abrupt changes in the organisational structure. These changes can interrupt conventional channels of distribution or make the building up of completely new infrastructures necessary. But distribution of knowledge also is only possible and sensible within certain boundaries. Not everybody has to know everything. The true sense is to enable individuals or groups access to the respective knowledge necessary for the specific fulfilment of their duties and for the smooth course of organisational processes.

The limited capabilities which one individual is able to master makes a specialisation on the principle of the division of labour absolutely necessary. The extent of the distribution of knowledge has to be appropriately related to the organisational and personal circumstances of a company. In a strongly hierarchical command structure it is comparatively easy to lay down relevant knowledge in a department-specific manner, and to limit its circulation. The price for this is, however, restriction of flexibility and reaction time. But the more flexible the structures of an organisation are, the more important it is to also build up a certain redundance of knowledge through the sharing of knowledge.

However, also here barriers have to be overcome because people do not impart their knowledge to others automatically. Individual barriers of sharing exist. These concern both the willingness as well as the ability to share knowledge. Employees see certain areas of their personal knowledge as part of their company-internal basis of power. It is necessary therefore in an organisation to create suitable general conditions which enable a just-in-time-delivery of the required knowledge. Suitable seems rather the communication of knowledge between the employees who for this purpose use the created infrastructures of a knowledge network in the organisation. Especially in dynamic, knowledge-intensive branches such as the telecommunications company it is important to keep the employees' level of knowledge on a continuously high level. For that, both the socialisation of employees as well as their constant training and further education is necessary. Socialisation refers to the familiarisation with organisational values and norms, the communication of fundamental behaviour or role expectations: in short the settling into a newly-created culture of the company.

The culture of the company therefore has a very strong influence on the way changes in a company are put into action. It is not very difficult to change the structures of a company. Those who want to change the behaviour of employees, however, can easily overestimate their capabilities. Before managers decide to change the culture in their area of responsibility, they have to take into account one thing: behaviour is learned—and to learn a culture means to unlearn the previous culture which has developed and consolidated itself over decades.

We have written this article with the intention of creating an awareness of the fact that we easily tend to excessive simplification and that our manner of organising is strongly influenced by our way of thinking about organisations. We can, however, overcome problems only by learning to see and understand organisations in a new way because only in this manner can new behaviour develop.

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Biographies

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Anton Jandl, born 1952, was educated in telecommunications engineering at the polytechnical school, Graz. Since 1972 he has held various positions at the Post and Telekom Austria (PTA). From 1990–1994 he studied sociology and philosophy (Master's degree) at the Karl-Franzens-University Graz. He is presently project manager in the PTA-headquarters, service section.

José Roberto Ramírez

Regulatory Changes of Telecommunications in Spain for the New Era of Globalisation and Liberalisation

Telecommunications is an important pillar of the economy because of its impact on investment, growth, modernisation and development. It is being transformed globally by technological and regulatory changes, the liberalisation of the market, the privatisation of state monopolies and new consumer demands. Different countries respond to this international framework of interdependence, globalisation and intensification of commercial flows and international capital movement with various models of regulation market structure, adapted to the new environment. This article analyses the most recent changes, the regulatory situation and the panorama of agents and enterprises in the Spanish telecommunications sector.

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Globalisation and Liberalisation of Information and Communication Technologies

In an increasingly global world the telecommunications business is also becoming a global business due to the nature of its services (international traffic and services to multinational customers) and investment (mobility of capital), and through the response of the operators by means of the internationalisation processes (acquisition of privatised public operators, procurement of new licences in other countries and strategic alliances).

The globalisation process is running parallel to the liberalisation tendencies that are appearing at worldwide level, tendencies that have knocked down the barriers that divided the businesses of local, long-distance and international telecommunications, cable TV and audiovisual into separate compartments. Geographic frontiers between different countries are also being overcome.

In the United States, the Telecommunications Act of 1996 has come to transform the model that emerged after the legal dismembering of AT&T and the creation of seven Regional Bell Operating Companies (RBOCs) that were providing the local telephony service in their respective assigned regions, and kept a separation between the local, cable and long-distance businesses.

Currently, any enterprise in the sector can enter in local, long-distance, and international telephony, and the audiovisual contents markets, and the exclusivity in the current franchises for infrastructures has disappeared, although some restrictions related to cross-ownership in the distinct businesses still remain.

In Europe, ever since 30 June 1987, when the European Commission (EC) published the *Green Paper on the Development of the Common Market for Telecommunication Services and Equipment*, a process of market opening has been developed with the liberalisation of terminal equipment, the opening of public markets, the liberalisation of services, the open network provision (ONP), the reorganisation of the telecommunication services sector and other reforms during recent years, with the target of culminating in the fully liberalised market this year, 1998.

Worldwide, and especially in the developing countries, negotiations in the GATT†, the GATS* and afterwards in the WTO‡, impelled from the outset by the pressure of the financial American enterprises, have culminated in liberalisation agreements that have been effective since 1 January 1998. Many developing

† General Agreement on Tariffs and Trade

* General Agreement on Trade in Services

‡ World Trade Organization

countries have signed these agreements recognising the possible competitive advantages for their economies in a global environment, especially considering their labour market potential. Commitments to liberalise services and to reduce restrictions on foreign investment in telecommunications, and an almost general commitment to open the telecommunications markets in the developing countries by the year 2000, are the most important goals.

In the transformation process, from challenges to opportunities for investment and telecommunications development in different countries that have been triggered by these changes, there are three common elements: the privatisation of the public operators (the former PTTs), the opening of markets to competition, with the concession of new licences, and finally, the creation of independent regulators. Spain has also followed this model.

Transition to the Competitive Market in Spain

The role of Telefónica

The history of telecommunications in Spain, since Telefónica was created in 1924, has evolved around the monopoly of this company in telecommunications networks and services, in a different way from that of other countries that have followed the model of public operator (PTT), because the State as shareholder has never had the majority of shares in Telefónica, not even when it was partially nationalised in 1946. Telefónica has always been mainly a mercantile private company.

Consequently, the full privatisation process of Telefónica presented very few legal complications, nor was it necessary to change the legal status of the organisation. It was simply a matter of the placement of shares owned by the State in the stock markets, in stages from 1987 until full privatisation in 1997.

The evolution of the legislative framework

In the legislative plane, the main laws that have driven the process to liberalise telecommunications in Spain are the Telecommunications Ordering Act (1987) and the General Telecommunications Act (1998). In the period between these Acts, important events such as the concession of new licences for mobile and fixed telephony, the creation of an independent regulator (Telecommunications Market Commission—CMT) and the full privatisation of Telefónica have taken place.

In any case, the process started by the EC Green Paper of 1987 obliged the European States to adapt the regulatory framework. In Spain this resulted in the Telecommunications Ordering Act—LOT (Law 31/1987) and the Telecommunications First National Plan, implementing for the first time an integrated regulatory framework in the sector. Afterwards, a new contract between the State and Telefónica was signed, the Advisory Board of Telecommunications (Consejo Asesor de las Telecomunicaciones) was created in 1991, as an institution for consultation and participation of the telecommunication agents, and the LOT was modified to permit major competition in services (data, mobile, etc.) in 1992.

In 1994, the Government established the liberalisation targets until 1998, impelling the promulgation of legislation on satellite and cable telecommunications, and the creation of a second operator of mobile telephony in 1995 (AIRTEL).

The Government changed in 1996 and, after some hesitation, the full liberalisation date was fixed as 1 December 1998. Afterwards, an independent regulator, the Telecommunications Market Commission (CMT), was created, the launching of a second operator of basic services (Retevisión, that has operated from 1997) was promoted, interconnection tariffs and conditions were regulated, the third licence for fixed telephony was awarded to LINCE Consortium in May 1998, 43 cable franchises were offered for tender, and finally, the third licence of mobile GSM telephony was awarded in June 1998 to Retevisión Móvil.

The General Telecommunications Act (1998)

The General Law of Telecommunications will govern telecommunications rules in Spain in future. This legislation develops such concepts as the procedure of concession of general authorisations and licences, the interconnection, the public and universal service obligations, the powers of the State and CMT, the adaptation of equipment certification process to European rules and the transformation of existing licences; all of this, with the objective of promoting full competition in telecommunications. On the other hand, this law does not cover radio and television legislation.

The law also aims to incorporate European directives to the Spanish legal framework, specifically Directives 90/387/ EEC on common internal market of telecommunications services, 92/44/EEC and 97/51/CEE on ONP for leased lines, 95/62/EEC on ONP for telephony, 96/19/EEC on full competition in telecommunications markets, 97/13/EEC on common framework for general authorisations and individual licences, the 97/33/EEC on interconnection, universal service and interoperability according to ONP principles, and 97/66/EEC on personal data protection and privacy.

Some legislation already implemented, concerning interconnection tariffs and conditions, numbering, CMT functions and powers, telecommunications infrastructures in buildings, basic telephony, etc. is also incorporated, and the great majority of the previous legislation, that includes almost all of the Telecommunications Ordering Act, the Satellite Telecommunications Act, Cable Telecommunications Act, and Home Distribution TV, etc. is repealed.

Other aspects covered by this legislation are:

- obligations of dominant operators, defined as the operator with more than the 25% of market share,
- infrastructure sharing due to public service obligations,
- limitations in the number of licences for services using the frequency spectrum, and
- transformation of current licences and authorisations.

The Telecommunications Market Commission (CMT)

Created by the Liberalisation Act of 1996, the CMT's functions cover all the fields of regulation but are oriented to arbitration and control. The CMT has a nine-member Council (President, Vice-president and seven advisers) appointed by the Government for a six-year period, with the possibility of one re-election. They cannot be dismissed, and are obliged to a severe incompatibility regime.

Different areas including legal, administration and management, information systems, external relations, networks and services, markets, economic analysis, audiovisual and licences are covered by its functional organisation. Financial and budgetary autonomy is guaranteed by a budget authorised by Parliament.

The general purpose of CMT is to guarantee, on behalf of the citizens, effective competition in the telecommunications, audiovisual services, telematics and interactive services markets.

The powers of the CMT include:

- mandatory instructions to the operators;
- interpretation of telecommunication contracts (licences, etc.), control of concentration processes, share capital ownership and agreements between agents;
- being consulted about proposed tariffs for services (if there is market dominance), and fixing interconnection maximum prices;
- awarding of licences and authorisations for services (except public bidding process), control of public service obligations fulfilment and numbering assignment;
- arbitration in conflicts between operators;
- advising the Government; and
- punishing the non-compliance of its instructions.

The Government exercises political control through the Board member appointment, and through the CMT annual report on market development. The decisions taken by the CMT can be appealed against at tribunals.

Legislation pending

The General Law of Telecommunications establishes a general framework that needs to be developed in detail by means of ministerial orders and decrees, which will cover:

- general conditions for networks and services under the general authorisations' regime,
- general conditions for operators under the individual licence's regime,
- minimum conditions for interconnection,
- numbering conservation and portability,
- scope of universal service, obligatory services, and other public service obligations,
- designation of operators for universal service provision,
- criteria for cost accounting system used to fix interconnection prices (CMT),
- financial information requirements for operators (CMT),
- general criteria for calculating universal service net cost (CMT),
- structure, organisation and control mechanisms for the Universal Service National Fund,
- quality of service and networks operation under public service obligations,
- telecommunicatiosn infrastructure in buildings,
- legal regime for testing laboratories,
- conditions for the operators and the installation of telecommunications equipment, and
- management conditions for the frequency spectrum.

This pending development opens multiple possibilities. Much previous legislation has been repealed, and the Government has a wide margin to guide the process. Summing up, the process could be considered as a complete 're-regulation' of the market and these rules will establish most of the market structure.

The Communications and Information Technology Sector in Spain

Sector statistics

The communications and information technology market in Spain totalled 29·15 billion ECU in 1997, with a growth of 15·1% over the previous year (see Table 1). Direct employment totalled 205 000 employees, an increase of 5·7% over 1996.

Telecommunications operators and service providers have 81 000 employees (+7·2%) and the electronic industry 42 000 (+2·4%). Investment in research and development amounted to 655 million ECU in 1997.

Main telecommunications operators in Spain today

The entrepreneurial groups that operate in the sector and the final result of the various awards have configured an interesting mix of operators in the three large businesses (fixed telephony, mobile and cable) (see Table 2). This reconfiguration is still incomplete. Both Telefónica and Retevisión and its partners are configured as global operators playing in the three businesses. Neither Airtel (BT and Airtouch) nor Lince (France Telecom) have yet completed that objective. It will be interesting to see how the situation evolves.

Table 1 Revenue by Sector

	Revenues in 1997 (billion ECU)	97/96 (%)
Telecommunication operators and service providers	12·99	17·6
Audiovisual services	2·57	13·3
Electronic industry	9·90	14·6
Distribution and sales	0·26	12·5
Software and computer services	2·33	12·4
Integration and systems	0·45	6·4
Audiovisual support and others	0·65	2·8
Total	**29·15**	**15·1**

1 ECU = 168 peseta = 1·095 US$ *Source*: Aniel.

Table 2 Telecommunications Groups in Spain

Fixed Telephony	Mobile Telephony	Cable
Telefónica	Telefónica Móviles	Telefónica (16 months after other players)
?	Airtel (Airtouch, BT, etc.)	?
Retevisión (Stet)	Retevisión Móvil	(Endesa & other Electric Co., partners of Retevisión)
Lince (France Telecom)	?	Cableuropa

Source: collated by the author.

Conclusions

In the route towards a fully liberalised telecommunications market in Spain, the regulatory framework and the basic market structure are becoming stable. However, this market could still undergo big changes, because of:

- the cable companies evolution, their local and regional development, and the alliances between them and with other telecommunications and audiovisual companies;
- the level of development reached by the new fixed and mobile operators before full liberalisation (1 December 1998), when many newcomers will enter the market;
- the impact of the convergence between telecommunications and audiovisual, and especially the audiovisual contents business; and
- the regulation level and asymmetry.

Biography

José Roberto Ramírez
Telefónica

José Roberto Ramírez graduated as Superior Telecommunication Engineer at the Polytechnic University of Madrid in 1983. After working in university, the army and the telecommunications industry, he joined Telefónica of Spain in 1986, where has occupied several positions in the areas of technology, advanced services and international, and strategic planning and business development. Currently he is an expert in the area of institutional relations, involved in functions related to corporate management and liaison with organisations and associations in the telecommunications sector. He has also been a member of the Board of the Spanish Association of Telecommunications Engineers (COIT/AEIT) since 1995, where he is responsible for the employment area. He is a member of the Commission of Strategy and the Group of Experts in Telecommunications Regulation (GRETEL), and has participated in FITCE activities as a member of the Study Commission.

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The Path of Liberalisation in Italy

The paper traces the steps followed by the Italian Government and Telecom Italia to reach the full liberalisation of the telecommunications market. The process started with the data transmission; it was followed by the mobile telephone market; the last step is the liberalisation of voice telecommunications services. This paper deals with technical, economical and operational aspects of the interconnection and it ends with an overview of the Telecom Italia business in the international environment.

Introduction

The Italian experience of the mobile telephone market and the evolution of other important European markets indicate that competition can improve business in telecommunications.

Regarding the liberalisation process, the paper describes the evolution of regulation and the characteristics in the interconnection of other licensed operators (OLOs) in Italy.

The Regulation in Italy

The liberalisation, which is already widespread in the telecommunications field, was completed in Italy on 1 January 1998. This date marks the end of a deregulation process that has been put into place over the last decade.

In the European Union the process started in 1990 with the issue of the 90/388/EC Open Network Provision (ONP) Directive. The adoption of the ONP Directive opened competition for data transmission services based on circuit and packet switching, closed user group (CUG) and value-added services ('103/95' and '420/95' decrees).

During 1994, the mobile market liberalisation process began with GSM licences being granted to Telecom Italia and Omnitel Pronto Italia (OPI). In the second half of 1995, Telecom Italia Mobile (TIM—the new company for GSM and total access communication system (TACS) services founded within the STET Holding) and, five months later, Omnitel Pronto Italia started their commercial mobile services based on the GSM digital standard.

The full adoption of the EU Directive in Italy and the institution of the National Regulatory Authority for Communications have completed the path of liberalisation in Italy in the last three years. In 1997, the Italian Parliament approved the '249' Law that institutes the Communications Authority. The Authority will regulate both infrastructure and service contents by means of two commissions. In the same year the '318/97' Decree was issued: it is very similar to a Telecommunication Act, containing all the measures related to the application of ONP to voice telephony, implementation of full competition in the telecommunications market and interconnection principles.

The '318/97' Decree set up the regulatory framework; specific decrees for each area were issued: licences (November 1997), numbering (February 1998), universal services contribution (May 1998), interconnection (due in June 1998).

Liberalisation Process

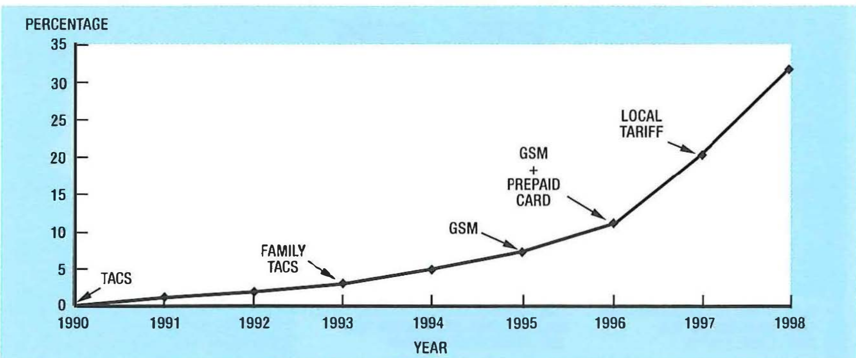
Data transmission and value-added services

Telecom Italia offers data transmission based on digital data circuit (CDN) implemented on a flexible network. This network uses DXC 1/0 (data cross-connect), MUX-F (flexible multiplex) and backup transmission lines fully controlled by a network management centre. Telecom Italia has so far equipped about 232 000 CDN at the speed up to 2 Mbit/s.

For business customers an *ad hoc* solution has been implemented with fibre optic to the company building and flexible service access equipment (for data, voice and multimedia services). Up to the end of 1997, about 1500 locations were served. Many other initiatives are carried on for business and residential customers (ATM network, Internet service, etc.).

In 1995 the liberalisation of the data transmission market favoured the growth of other companies marketing data communication services. For instance, in 1995 Infostrada, a company owned by the Olivetti Group and Mannesman, started their services providing data transmission on an ATM/frame relay network which today reaches all the

Figure 1—Rate of penetration in the Italian market



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main cities; Albacom, a company shared by BT, BNL, ENI and Mediaset, developed their data network spread which now has over 104 points of access.

Mobile services

In 1985, Telecom Italia started the cellular mobile service using a bandwidth of around 450 MHz; in 1990 it launched the TACS in the 900 Mhz frequency and after only three years introduced the *family contract*, to serve residential customers.

The GSM system started in 1995 and after only one year both operators marketed the pre-paid card. From the end of last year both operators also launched the local tariff (Figure 1).

Thanks to technological innovations, both operators sell services to corporate, professional and residential customers. The next technical/commercial steps in this market are the commercial agreements between fixed and mobile operators, the increase of mobile to mobile traffic, Internet services, carrier selection and number portability.

In Italy the penetration of the mobile telephone service has increased by about 50% per year, with peaks of 100%. All this is thanks to competition and technological progress. At the end of April 1998 the total number of mobile customers was about 14 million.

Voice services on fixed network

Since the beginning of 1998 telecommunications has been fully liberalised. Every licensed operator can provide any telecommunications service and can obtain interconnection to the Telecom Italia network. Currently, there are many operators interested in the Italian market. Some of them have already obtained the license and the carrier selection code for long-distance calls.

Interconnection

Telecom Italia started to manage interconnection aspects with GSM mobile operators OPI and TIM in 1995.

At the moment many licensed operators have requested interconnection and traffic services to Telecom Italia. For interconnection of fixed and mobile operators, technical, economical and operational aspects have to be considered.

From the technical point of view important matters are:

- networks (for example, fixed verus mobile) and related routing principles;
- point of interconnection (POI) location: POI located on one operator's site or midway between operators;
- physical and service interconnection and related interoperability;
- resource sharing (for example, numbering);
- integrity, security, traffic control and quality of services;
- charging and payments for interconnection links and services; and
- testing of interconnected operators.

Figure 2 – Conveyance of calls

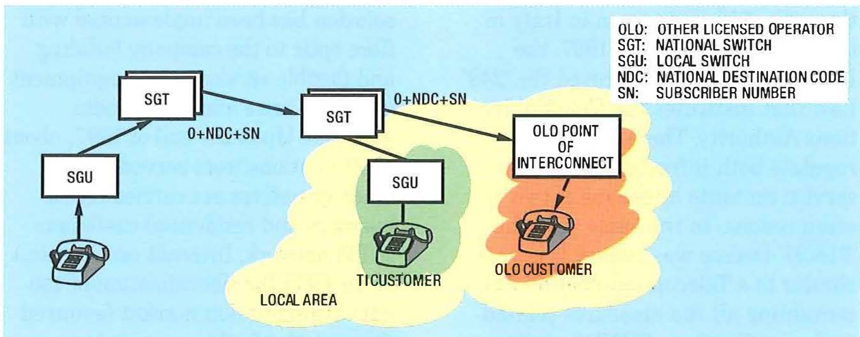
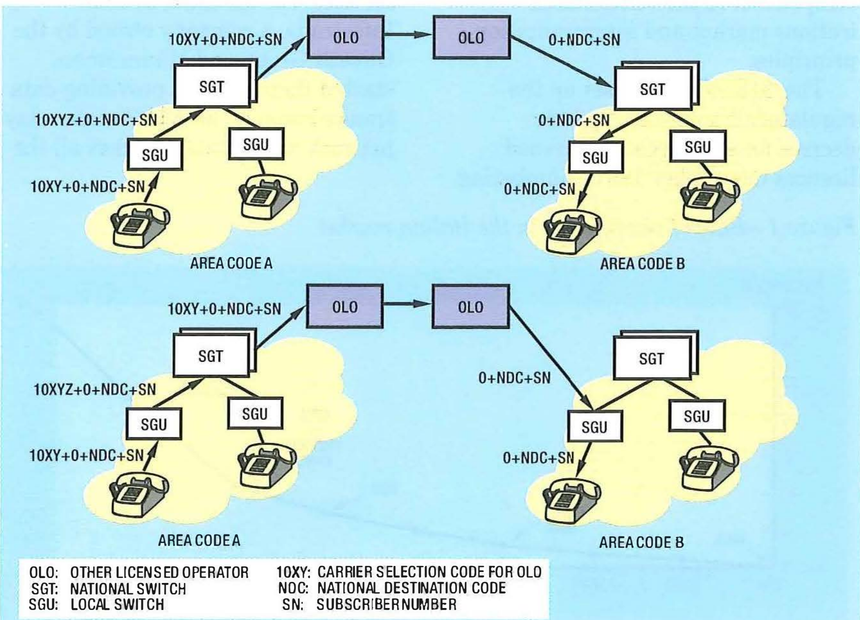


Figure 3 – Carrier selection



The standard interconnection interface is based on the ISUP protocol and associated signalling. This represents the reference interconnection offer for the provision of switched interconnection services such as conveyance and carrier selection. Telecom Italia and CSELT are actively involved in the definition of standards for interconnection at a forum under the auspices of the regulator, where all operators (fixed and mobile, incumbent and new entrants) are involved.

Conveyance of calls (Figure 2) allows basic interoperability; users of one operator are allowed to call users of other licensed operators both at national and international level. Carrier selection (Figure 3) allows users to choose the preferred carriers for long-distance calls. Supplementary services related to basic call control are under consideration in the interoperability framework.

Numbering is a key issue in a fully liberalised context. Italy started a numbering plan restructuring process on 19 June 1998 (complete selection – selection of '0', national destination code and subscriber number for all types of calls) and it will be completed by 29 December 2000, when the first digit will represent a specific service. This will create adequate numbering space both for new services and new operators.

A Government Decree, concerning numbering management, issued at the beginning of 1998, defines the rules for numbering assignment: in particular in the fixed telephony it assigns numbering blocks of 10 000 numbers per operator and local area.

In the new scenario integrity, security of the network, quality of the services and economical transactions have to be carefully considered in order to avoid legal controversies.

Concerning economical aspects, two different classes of services can be considered. The first is included in an *Interconnection List*, necessary to interconnect efficiently two networks for voice telecommunications; it conforms to the rules of the Accounting Regulator. The second is offered on the basis of bilateral commercial agreements.

The new operators can evaluate many services in terms of 'make or buy'.

The Interconnection List prepared by Telecom Italia is based on fully distributed costs. An accounting system based on long-run incremental cost is under evaluation.

The Interconnection List, issued on 1 July 1997, describes the standard services that allow:

- conveyance of calls originated from OLO customers and terminated to Telecom Italia customers; and
- carrier selection (access to long-distance operator services for Telecom Italia customers).

In the latter case the OLO will pay Telecom Italia the access charge according to the Interconnection List. The Interconnection List is based on the principle of reciprocity: for calls originated from Telecom Italia customers and terminated to another network, Telecom Italia will pay the access charge to the other network operator.

In the Interconnection List there is also information regarding:

- points of interconnection to the Telecom Italia network;
- physical interconnection modalities, services of leased lines between Telecom Italia and OLO nodes; and
- switched services at each interconnection point.

Concerning the operational aspects, unlike the case of mobile operators, for fixed network interconnections there is a big impact on Telecom Italia's network planning process. The growth of points of presence and network coverage together with the increasing number of interconnected operators will influence the traffic dimensioning and the network-creation process.

New operational processes will be related to fixed interconnected operators: provision of physical access, data management amendments, testing of transmission and switching equipment, charging and payments, maintenance, etc.

Telecom Italia is seeking the cooperation of the new entrants to define the new interoperability model and relationship.

Telecom Italia International Experiences

Telecom Italia is developing experiences as a new entrant in foreign countries. This business area has a tradition that already boasted significant examples, like that in Argentina. But the past experience was represented by acquisitions of dominant operators in foreign countries rather than entering in competition with the incumbents.

Recently two operations are going on in Spain and France; these are the first experiences of Telecom Italia as a new entrant in a foreign country. At the end of 1997 the general agreement of interconnection between Retevision (a privatised consortium formed from Telecom Italia, ENDESA—Spanish society for the production of electricity, and Union Fenosa—group operating in the electronic field) and Telefónica has been signed in Spain.

Retevision, Telecom Italia and CSELT have given an effort in order to sign the contract and clarify issues related to the architecture of the network and involved management process. The condition to obtain the licence from the Spanish Regulator (CMT) is the coverage of the country through the opening of an interconnection point in all the 50 Spanish provinces by 1 August 1998, starting with 15 operating nodes on 1 January 1998.

The negotiation aspects involved the definition of the services, tariff structures and a wide range of legal implications. The service started with the offer of carrier selection; in the future it will be extended to the direct access (by means of copper or radio) to service based on the intelligent network (for example, freephone) and to a wide range of additional value-added services. Concerning the technical level, the complex operation to ensure the interoperability between new and incumbent networks is a top priority aspect.

The provision of carrier selection was a success in terms of reducting cost for customers; that is, a reduction of 25% has been achieved.

In France the operation, started in 1996, is going on with Bouygues STET (BS), a holding of Telecom Italia—Bouygues.

It controls three other companies: a technical one (NETCO), that is preparing the long-distance network infrastructure and two commercial ones—BS Enterprise and BSV Residentiel—that take care of residential and business users.

The market will be devoted to offering carrier selection to end-users. BS has been assigned first digit 9. The interconnection process is still ongoing.

Conclusions

The Italian telecommunications market has been fully liberalised since 1 January 1998. Competition in telecommunications will increase the number of services offered and improve the related quality. Telecom Italia is actively taking part in this change defining all the aspects connected to the interconnection.

That implies a revision of some existing processes and the definition of new ones: planning, provisioning, maintenance, charging and billing. There may be also the need to adapt the company organisation to the competitive scenario.

Telecom Italia is operating in such a way that the interconnection with other fixed operators can be a competitive opportunity to increase revenues.

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Biographies

Angelo Gambaro
Telecom Italia

Angelo Gambaro joined Telecom Italia in 1976. He worked in the commercial area until 1989. Since then he has been working in network planning; he has been responsible for network architecture and technical regulation and is now involved in interconnection activities.

Roberto Cavaggion
Telecom Italia

Roberto Cavaggion joined Telecom Italia in 1996 and worked mainly on numbering planning and management. Now, with the full liberalisation of telecommunications, he is involved in the interconnection activities.

Bianca Papini
CSELT

Bianca Papini joined CSELT in 1987 and she was involved in the definition at international level (ITU and ETSI) of the specification for the DSS1 protocol for ISDN networks. In 1991 she began an activity on numbering and addressing. Then in 1995, she was involved in the national numbering plan restructuring process with Telecom Italia and the Ministry of Communications. At present she is responsible for the research unit dealing both with numbering and addressing and interconnection issues.

Giovanni Roso
CSELT

Giovanni Roso joined CSELT, the research laboratory of Telecom Italia Group, in 1971 and was involved in the development of digital switching systems. In 1981 he began his activity in the field of network planning, publishing numerous papers on topics related to local network evolution. At present, he is responsible for the research unit concerned with the study and development of cost accounting system and interconnection economics.

Uwe Stahl

Interconnection

Regulation and its Impact on Networks

Introduction

In Europe, interconnection has become an issue because of the ongoing liberalisation and the related regulation. To enhance competition, new public network operators (PNOs) shall be allowed to connect their customers via the access facilities of incumbent operators. Interconnection of the networks of different PNOs is required to enable communication between the customers of different operators. Further, it is needed to allow transit connections via alternative-long distance carriers, and to let service providers interconnect with operator's networks. Last but not least, customers shall be allowed to change network operators without changing their telephone numbers.

This paper provides an overview of the technical implementations of interconnection in Germany—which to a large extent also apply to other European countries—focusing on the switching network interconnection with carrier selection and number portability.

Regulation in Germany

The interconnection regulation in Germany complies with the European regulatory framework. PNOs with significant market power have to grant unbundled access to their networks. This includes access to the twisted copper pairs at the main distribution frame. Providing collocation is mandatory, whereas it is the incumbent operator's decision to provide either physical or virtual collocation. Carrier selection has been required for 1998 including both preselection and call-by-call selection, while the EU requires preselection by 2000. The same applies to number portability for wireline customers and service number portability for service providers. Mobile number portability has been postponed for reconsideration by the end of this year to allow implementation according to GSM standards.

The German Telecommunications Act was issued in mid-1996, after an open industry forum was founded, consisting of operators (full members), the regulator and suppliers (both consulting members), which produced the necessary interconnection specifications. The timely implementation by 1998 was a big challenge which was met because of the high speed of the specification process and parallel product development by the equipment suppliers.

The Basics of Switching Network Interconnection

Switching network interconnection requires exchanges with specific interconnection functions. PNOs implement these functions at selected exchange sites, commonly referred to as *gateway exchanges*. The gateway exchanges of different networks of PNOs are interconnected by inter-office trunk groups, consisting of $n \times 2$ Mbit/s pulse-code modulation (PCM) trunks. The specific interconnection functions comprise the:

- screening of inbound and outbound traffic (for example, to reject unauthorised use of services and features);
- signalling interworking between external and internal protocols; and
- call data recording for inter-operator accounting.

The signalling capabilities determine the set of services that is available across the networks. While the network-internal signalling is a matter of the network operator, there is a need to agree on a signalling type and a capability set for interconnection. Signalling System SS7 is used in Germany and most other EU countries for interconnection of PNOs based on the international standards. The minimum set of services according to the universal service obligations is supported by the standard SS7 ISDN User Part (ISUP). Furthermore, the ISUP supports more services and features which may be additionally agreed between PNOs. SS7 interconnection by means of a separate SS7 subnetwork ensures the interoperability of the networks, while preserving the autonomy and integrity of each of the operator networks.

Points of Interconnect

The location of the points of interconnection may depend on the:

- demand for interconnection;
- required geographical coverage (for example, regulatory obligation); and
- network structure and technology (for example, parts of the network may consist of analogue exchanges).

In Germany, no regulatory obligation for a minimum geographic coverage exists. The network of the incumbent operator Deutsche Telekom completely consists of state-of-the-art switching systems with integrated gateway functionality supplied by Alcatel and other manufacturers.

Carrier selection divides the telecommunications market into a local and a long-distance segment. Virtually all the networks are decomposed into local networks and transit networks. Within the local call areas defined by numbering, local networks of different operators compete with each other. The local

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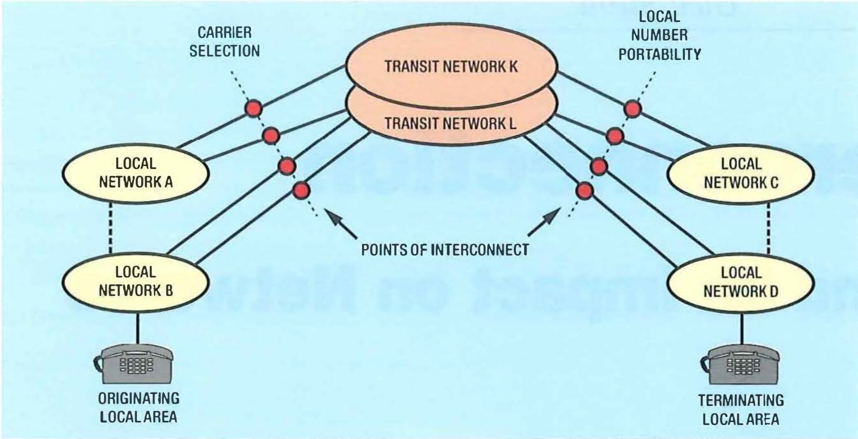


Figure 1 – Points of interconnect

networks in different local call areas are interconnected by transit networks.

As indicated in Figure 1, in case of a long-distance call, carrier selection determines the call routing towards a point of interconnection in the originating local area. In the terminating local call area, number portability requires new routing methods to select the point of interconnection to the destination local network.

Carrier Selection

Network functions

Despite subscribing to a local operator, a customer may select a transit network operator for originating national or international long-distance calls. The customer may have a pre-selected transit network or may select on a call-by-call basis by means of a dialling procedure. Depending on the customer's selection, the local network has to route the call to a point of interconnection.

As outlined in Figure 2, carrier selection requires a number of additional functions in the local network and a new gateway function in the transit network if the carrier wants to directly bill its customers. In this case, incoming calls must be screened to check whether the calling user is authorised; that is, a customer of the carrier. For this purpose, Alcatel´s IN-based screening server solution has been installed in a number of networks.

Billing approaches

Users will select a transit network operator; for example, because of a low tariff. This means that the transit network operator determines the long-distance tariff and the related call charges, instead of the local network operator. The issue is how the transit network operator bills the end customer. Two approaches co-exist in liberalised markets:

- the transit network operator directly bills the customer, or
- the billing is performed via the local operator.

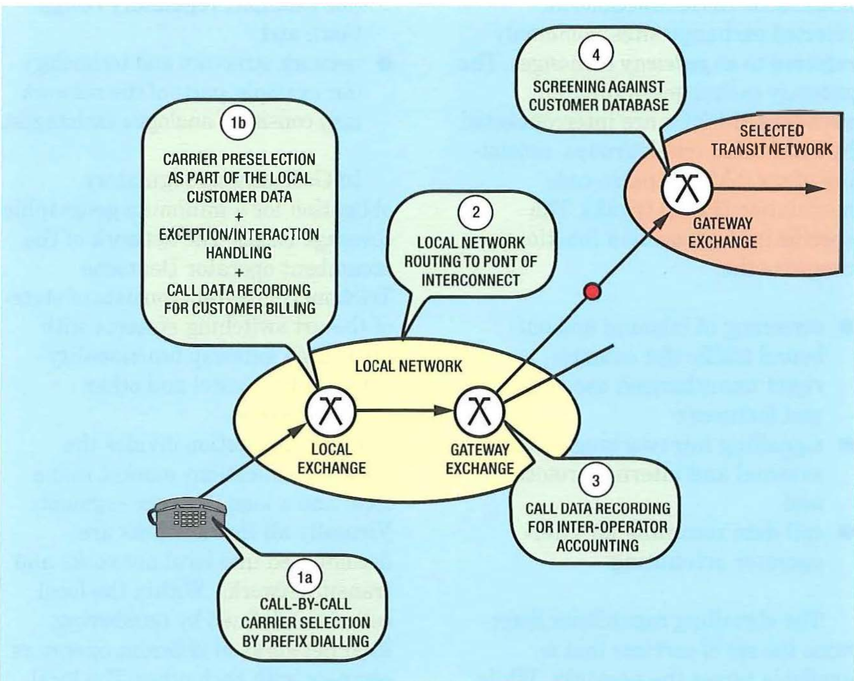
Each transit network operator decides which approach best fits the operator's business concept. Direct billing by the selected transit network operator requires screening as described above. In the case of billing via the local operator, the transit network operator prepares the data for the bill per customer account based on the calling line identity and passes on these data to the local operator. The local operator includes the transit network charges into the bill for the customer.

The advice of charge issue

Currently, advice of charge cannot be supported for connections with carrier selection. Standardisation work for the introduction of tariff signalling in the ISUP is nearly completed by the European Telelcommunications Standards Institute (ETSI), which will allow advice of charge in the near future.

The ETSI solution is illustrated in Figure 3. In a call set up with carrier selection, the selected transit carrier determines the applicable tariff for the connection and signals comprehensive tariff information backwards to the local operator's network. The local exchange receives the tariff information and generates the advice of charge signals towards the customer's terminal equipment. This may be periodic pulses for analogue lines or D-channel signals for ISDN.

Figure 2 – Network functions for carrier selection



Number Portability

The type of number portability considered in the following is the service provider portability. It means that a customer may change his/her current network operator without a change of telephone number(s). Service provider portability requires support by the numbering administration and interconnection agreements between network operators. These agreements must include the

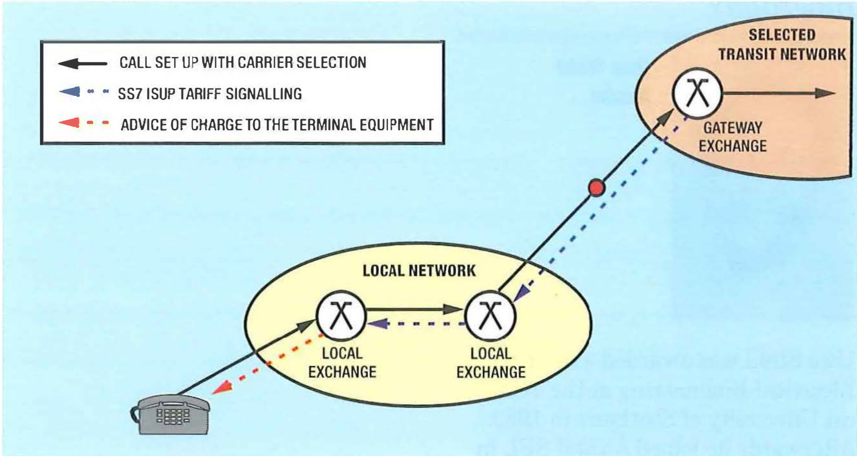


Figure 3 – Principle of ISUP tariff signalling

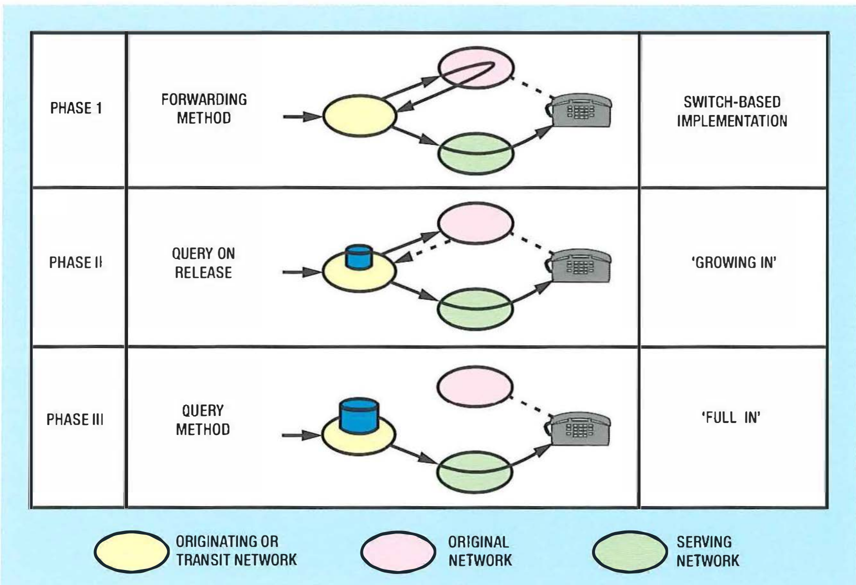
specific addressing and signalling at the points of interconnection. Service provider portability will eventually be required for:

- geographic numbers in Europe generally applied by wireline networks; and
- service numbers as applied for mostly IN-based value-added services; and
- mobile numbers.

Geographic numbers

Generally, the implementation of number portability in wireline networks will evolve in three phases characterised by different methods as summarised in Figure 4. Of course, not all phases will necessarily be implemented in every network. In particular, new operators may skip the second phase or even the first two phases.

Figure 4 – Number portability evolution



In case of the *forwarding method*, the originating or transit network routes the call to the original network to which the customer used to be connected. The original network then forwards the call (possibly again via a transit network) to the actual serving network. The forwarding function is implemented in the local switching systems. The obvious disadvantage of this method is that all incoming successful calls to customers with a ported number result in connections via the original network. Customers with ported numbers require network resources of the original network as if they were still directly connected to it. Nevertheless, the forwarding method is applied in nearly all German networks as an interim implementation because of the short time frame for the implementation of number portability and the relatively few ported numbers during the initial phase of competition.

With the *query on release method*, the transit network routes the call set up also to the original network. However, the call set up is rejected by the original network in the ported number case by sending a backward release signal indicating the cause 'unequipped'. It is up to the transit network to find out which is the actual serving network. For this purpose the transit network requires a database which maintains up-to-date routing data for ported numbers across all networks. Alcatel offers technical equipment for this advanced method under the name *Growing IN Solution* because the investment in IN increases as the call volume towards the ported customer grows. This equipment is being evaluated in a field trial.

Ultimately, in the case of the *query method*, the transit network queries the database for each call.

Service numbers

Service numbers consist of a service access code succeeded by a customer number. The service access code identifies a type of value-added service, like freephone, shared cost or premium rate. In today's state-of-the-art networks, value-added services are implemented on the basis of IN platforms. These will have to be enhanced to support number portability, initially in a way that for every call the full service number is analysed in order to identify the network operator of the service provider. When the service is provided by another network, then the service number is supplemented by routing information and call control is passed back to the switching network for delivery of the call to a point of interconnect. Service number portability has been introduced in Alcatel's IN equipment, which currently serves more than 80% of all value-added service customers in Germany. Although technically implemented for all value-added services, service number portability is today restricted to freephone owing to unresolved issues with respect to tariffing and inter-operator accounting.

Conclusion and Outlook

In Germany the regulatory requirements for interconnection have been implemented within a short timeframe which has been a big effort for both the PNOs and their suppliers. Among other factors, this challenge was met because suppliers had realised that in an environment going to be liberalised, they cannot rely on available technical specifications but need to be aware of the changes to the telecommunication marketplace and offer solutions with their product portfolio. The established sound basis for interconnection will be improved in future; for example, with respect to the provisioning of advice of charge for calls with carrier selection. Alcatel's switching systems will support this in 1999 based on an ETSI specification launched and worked out by an initiative of several suppliers. Advanced IN-based implementations of number portability are currently evaluated in field trials. Their large-scale application in networks will depend on the future growth of the number of ported customers.

Meanwhile the focus of the work within the national industry forum in Germany has shifted to inter-operational processes to facilitate efficient service management and network management across networks. An example is the specification of an electronic interface between local and transit networks supporting the processing of customers' preselection changes.

Interconnection of networks at the IN-level is becoming an issue for a number of reasons:

- sharing of IN platforms by small new operators for economic reasons;
- convergent service provisioning in the context of fixed mobile convergence; and
- the ETSI CAMEL standardisation for GSM networks.

An emerging demand for technical solutions in this area is expected.

Biography

Uwe Stahl
Alcatel

Uwe Stahl was awarded a diploma in Electrical Engineering at the Technical University of Stuttgart in 1983. Afterwards he joined Alcatel SEL in Stuttgart and initially worked on system and software design for switching equipment. Since 1989, he has been with a network strategy department and his particular area of interest is the evolution of switching networks. He is participating in the industry forum which has established the specifications for the implementation of interconnection in Germany.

Heleen de Vlaam

Cross-Border Interconnection

The circumstances and conditions under which the international exchange of telecommunications traffic is taking place are changing very fast. This is due to technical, market and regulatory developments. These developments are briefly described, but the emphasis lies on the influence of the international Basic Telecommunications Agreement of the World Trade Organisation (WTO) on cross-border interconnection. This agreement might be another impulse to change the way international telecommunications traffic is traded. The asymmetric liberalisation of markets could result in tensions between national authorities, leading to reciprocity demands and conflicts. Perhaps the WTO could provide an answer to this. However, in this article it is argued that, in the end, it is the national regulatory authority that really determines the terms and conditions for cross-border interconnection and has to deal with differences between countries.

Introduction

At the beginning of 1998 the 'Big Bang' took place in the telecommunications sector. International agreements, such as the European Directives and the much-praised World Trade Organisation (WTO) Basic Telecommunications Agreement (BTA) opened up national and international markets for telecommunications. Although the BTA must be seen as a major achievement for the negotiators, it is not the motor behind liberalisation as it is sometimes claimed to be. It is the national implementation that really determines liberalisation. However, the BTA does have a relevant influence on the way international telecommunications is realised. This article discusses the consequences of the BTA for the issue of cross-border interconnection for the exchange of international telecommunications traffic between networks. First the traditional regime of co-correspondence agreements and accounting rates is described. The paper goes on to describe how this regime is challenged by several developments, and furthermore how the WTO framework challenges the traditional system and has an impact on international trade in basic telecommunications. In the end it is argued that the implementation at the national level is the most important determinant of the terms and conditions for competition. Finally, some concluding remarks are made about the impact of the WTO and the inclination towards reciprocity.

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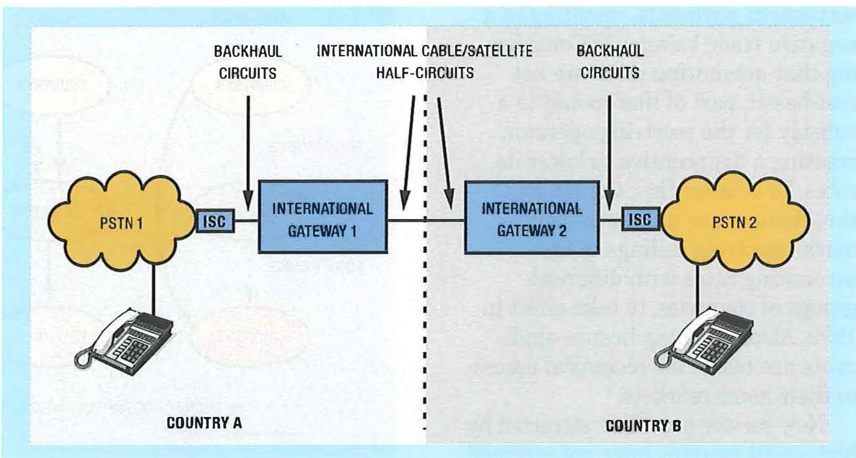
The Traditional System

The International Telecommunications Union (ITU)[N1] has played an important role in coordinating the conveyance of international traffic. Most relevant for cross-border interconnection is the telecommunications standardisation sector (ITU-T), concerned with technical, operating and tariff-related matters of international telecommunications. The ITU Recommendations aim to standardise and stimulate efficient telecommunications on a worldwide basis. The Recommendations are formally non-binding, but compliance must be aimed for.

The traditional conveyance of international traffic was realised by a cartel-like 'club' of corresponding national monopolist operators on the basis of bilateral agreements. Although alternative methods are now available, it is still the main formula for the largest volume of international traffic conveyed by the (former) monopolistic operators. International traffic is exchanged via half-circuits for which the operator on either side is responsible from a virtual midpoint. For the termination of incoming traffic the accounting-rate regime is used. The traditional system is represented in Figure 1. The accounting rates are bilaterally negotiated rates for the conveyance

[N1] The ITU is the successor of the International Telegraph Union (1865), and was established under the International Telecommunication Convention in 1932. Since 1947 it has been a specialised agency of the United Nations. Its executive body is the Plenipotentiary Conference.

Figure 1 – Traditional conveyance of traffic



of traffic between any destination in country A and any destination in country B. When A delivers traffic to B, it should pay half of the accounting rate to B, which provides for the conveyance of the traffic from its side from the virtual midpoint. This is called the *settlement rate*. After an agreed period, the total minutes of traffic between the two countries are deducted and one country pays the difference in a settlement payment to the other country. The rate charged to the customer is called the *collection* or *retail rate*.[N2]

Regime Under Pressure

The system of bilateral co-correspondence relationships is not the only option any more. The traditional system is being pressured by technological, market and regulatory developments resulting in increased bypass of the traditional regime.

Technological developments, such as optical amplifiers and wave-division multiplexers, allow for a manifold cheaper and larger capacity available. These lower costs are hardly reflected in the accounting rates or collection rates of incumbents. Furthermore, digital switching capacity enables new market entrants to process millions of calls via the cheapest routes.

Competition as a result of early liberalisation of international telecommunications in some countries (for example, North America, UK, Australia, etc.) has forced carriers in these markets to offer wholesale transport services at a price closer to actual cost. This has led to lower collection rates in these countries, but also affects traffic flows by stimulating the export of cheap dial-tone telecommunications to less-competitive markets, using re-routing technologies. The US especially suffers from large outgoing settlement payments, resulting in a negative trade balance.[N3] Considering that accounting rates are not cost-based, part of that money is a subsidy for the receiving operator, creating a disincentive to lower its rates. To counter this, the US FCC threatens to use unilateral benchmarks applying ceilings to the accounting rates with different groups of countries, to take effect in 1999. Also, incoming licence applicants are tested for reciprocal access to their home markets.

New service providers attracted by high profit margins have not accepted, and are not tied by, the long-lasting relationships and bilateral agreements that go with the co-correspondence system utilised by the former monopolists within the framework of the ITU. Instead they have adopted profitable, market-driven alternatives. The new switching technologies and the growing capacity have allowed them arbitrage[N4] and bypass of the accounting-rate regime by re-routing traffic, offering call-back or re-file services, or using own facilities for international simple resale (ISR). These issues will be even more compounded by the offering of voice over Internet. Two years ago this was still in a laboratory stage. But it has made a big leap forward and the cost savings are huge.[N5]

Call-back service providers penetrated foreign markets by providing for the international connection between customers in other countries. In this way they profit from the difference in collection rates and the fact that some countries allow discounts for large users, supporting these services.
Re-file (that is, re-routing via cheaper routes by operators) is considered smuggling by some countries. In contrast to normal transit traffic, the receiving operator is not aware of the real country of origination. Instead of long-lasting bilateral contracts and the ex-ante fixed settlements rates, capacity and minutes are traded at rates reflecting supply and demand at the moment. Suppliers of ISR are completely bypassing the accounting-rate regime, allowing for end-to-end services and self-correspondence via privately-owned whole-circuits or leased lines (see Figure 2). Only a few countries allow ISR.[N6] New technologies such as voice over frame relay, and voice over the Internet, allow for almost free international transfer of traffic, applying for instance Internet-peering. They highlight the artificiality, and vulnerability, of the traditional accounting-rates system.

Such market-driven bypass of the traditional bilateral co-correspondence regime using accounting rates contributes to lower accounting and collection rates. Considering the importance of cheap international telephony for international economic competitiveness, many governments have allowed services as call-back and re-file, simply by looking the other way. It has also appeared problematic to control foreign operators. However, the system contains little incentive for monopoly carriers to lower their international accounting rates. They are usually net receivers and they use the

[N2] To deal with competition in some markets, the accounting-rate regime was extended to include parallel accounting (that is, the same accounting rate for all operators in one country) and proportional return (that is, national operators may receive the same ratio of incoming traffic from one country as the ratio of the total outgoing traffic to that same country they have provided for).

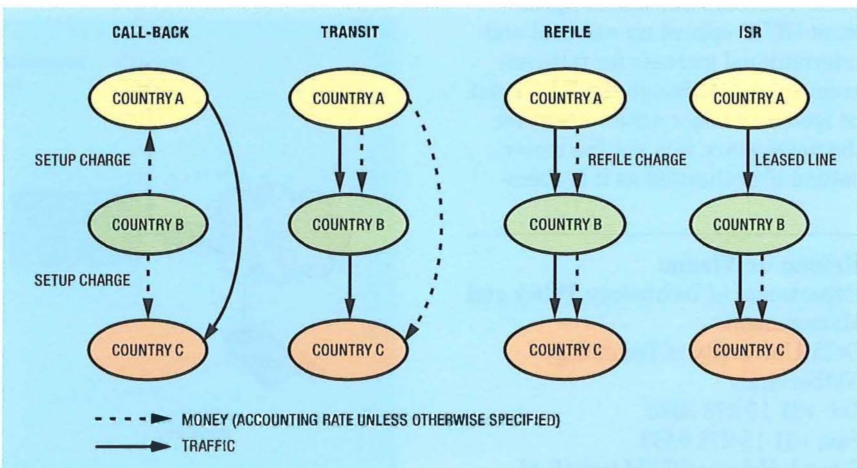
[N3] Almost half of its outpayments go to Mexico, but also a minority of European countries and some developing Asiatic countries, such as India and Pakistan, are net receivers.

[N4] Arbitrage refers to making profit by using the differences between rates in different countries.

[N5] While charging only a fraction of the current accounting rate, it still makes money. Many new operators, but also PTTs, are starting to consider using Internet protocol technology for their international hubs.

[N6] That is, Australia, Canada, Sweden, the UK and the US. ISR is only possible when allowed on both sides.

Figure 2 – Call-back, transit, re-file and ISR



accounting rates to subsidise their local calls. Furthermore, less-developed countries are depending on the currency to build their telecommunications infrastructure.

Most countries now realise that the accounting-rate regime needs to be reformed to adjust to the new liberalised environment. The US unilateral benchmarks shook up the international arena and resulted in speeding up the reform process. The issue of accounting rates and bypass is discussed within the context of the ITU, but no real progress has been made so far. While the actual technology of providing telecommunications service continues to evolve non-stop, the regulatory framework for international telecommunications has hardly changed for a long time, preventing individual consumers, businesses, and the global economy to take full advantage of the technological progress and commercial opportunities. However, an important impulse to further liberalisation within and between national markets was provided by the conclusion of the negotiations on basic telecommunications under the framework of the General Agreement on Trade in Services (GATS) of the WTO.

The WTO Basic Telecommunications Agreement

The negotiations of the Basic Telecommunications[N7] Agreement (BTA), covering services like voice telephony, data and satellites, were closed on 15 February 1997. The GATS principles of transparency and non-discrimination now apply to government measures regarding telecommunications. The cornerstone of the GATS is the *Most Favoured Nation* (MFN) principle, which extends the most favourable treatment of an operator from one country to all operators in other countries who are members of the WTO.[N8]

The BTA has its roots in the Uruguay Round Agreement of 1994.[N9] Even though most participants agreed that the inclusion of basic telecommunications was essential to further develop global markets[N10], it turned out to be impossible to include basic telecommunications in the agreement of 1994. An Annex on Telecommunications was attached to the agreement containing a section on access to and use of public telecommunications transport networks and services (basic telecommunications). It requires each Member to ensure that all service suppliers seeking to take advantage of the scheduled commitments are accorded access to, and use of, public basic telecommunications, both networks and services, on a reasonable and non-discriminatory basis. The Annex addresses access to these services by users rather than the ability to enter markets to sell such services (which is normally addressed in the schedules) to strike a fragile balance between the needs of users for fair terms of access and the needs of the regulators and public operators to maintain control over basic national telecommunications to meet public objectives.

To include basic telecommunications in the agreement, a Ministerial Decision on Basic Telecommunications was added which extended the negotiations on a voluntary basis beyond the Uruguay Round. After three years of extended negotiations on market access for basic telecommunications services under the auspices of the Negotiating Group on Basic Telecommunications (NGBT), 69 offers were made[N11]. The combined markets of the participating countries account for more than 91 per cent of the global telecommunications revenues in 1995. During the negotiations, countries were concerned about the value of market access commitments, considering the importance of a regulatory environment conducive to market entry. Therefore regulatory disciplines and guidelines were proposed to be inscribed as additional commitments in the schedules[N12]. This NGBT Reference Paper has been adopted in the schedules in full, or with minor adjustments, by most Member States, including the European Union, the USA and Japan. The Reference Paper requires Members to take appropriate measures to prevent anti-competitive practices by major suppliers[N13]. Interconnection with a major supplier should be available **at any feasible point** in the network under **non-discriminatory** terms, conditions and rates, and of a quality no less favourable than that provided for its own services[N14]. Also intercon-

[N7] Because of the different interpretation of 'basic' services in countries, it was agreed that both public and private basic telecommunications services that involve end-to-end real-time transmission of customer-supplied information were included (see Telecommunications Annex to GATS). Also, no distinction was made between basic telecommunications services provided over network infrastructure or through resale over private leased circuits. Services covered include, for instance, voice telephony, telex, telegraph, fax, data transmission, private leased circuits, fixed and mobile satellite systems and services, cellular telephony and personal communications services.

[N8] Other relevant GATS articles considering the prevalence of monopolies and the frequent presence of telecommunications providers with a dominant market provision are: Article VI on domestic regulations, which sets out rules for fair play for regulations not directly addressed by commitments in the schedules; Article VIII dealing with monopolies and exclusive service providers and Article IX on restrictive trade practices.

[N9] This round of trade negotiations led to the inclusion of services under the umbrella of multilateralism of the General Agreement on Trade in Services (GATS) parallel to the General Agreement on Trade and Tariffs (GATT). Also the GATT secretariat was replaced by the WTO with a strengthened mandate and a streamlined dispute settlement system. The WTO administers all the agreements concluded within the framework of the Uruguay Round. It consists of the Ministerial Conference, which meets every two years, a General Council, a Dispute Settlement Body and three subsidiary Councils (services, goods and intellectual property rights).

[N10] This is because telecommunications plays a dual role in the economy. First, it is a distinct and growing sector of economic activity. Second, it is an important mode of delivery for other services and for goods, both across and within borders, see Telecommunications Annex to GATS 1994.

[N11] Initially, the extended negotiations were to be concluded on 30 April 1996. However, considering the different schedules for liberalisation in the EU and the USA it is no big surprise that no agreement could be reached. In a Decision adopted on 30 April 1996 by the Council for Trade in Services, the closing date was postponed to 15 February 1997. A new body, the Group on basic Telecommunications (GBT), was responsible for further negotiations.

[N12] This approach was made possible by GATS, Article XVIII. This article allows for the negotiation of additional commitments on measures affecting trade in services that are not expressly captured by market access and national treatment.

[N13] NGBT Reference Paper, Clause 1.1. A major supplier is a supplier which has the ability to affect the participation in the relevant market for basic telecommunications services as a result of control over essential facilities, or use of its dominant position. The term *major supplier* bridges the different doctrines used in the EU (significant market power, usually measured by market share) and the USA (control over essential facilities).

[N14] Different terms, conditions and rates may be set for operators in different market segments or for public or private suppliers of services or networks.

nection must be provided in a **timely** fashion on terms that are **cost oriented, transparent, reasonable,** having regard to economic feasibility, and sufficiently **unbundled** so that the supplier need not pay for network components that it does not require. Also, upon request, it should be provided **at additional points** to the network termination points offered to the majority of users, for which the costs reflect the cost of constructing necessary additional facilities[1]. Furthermore, major suppliers are required to publish their relevant procedures and interconnection agreements, or at least a reference interconnection offer (RIO). The regulators should be independent and impartial.

The countries' commitments contain statements with regard to market access and national treatment[N15], covering not only cross-border supply of telecommunications but also services provided through the establishment of foreign firms, or commercial presence, including the ability to own and operate independent telecommunications network infrastructure. Services covered by the agreement are voice telephony, data transmission, telex, telegraph, facsimile and private leased circuit services (that is, the sale or lease of transmission capacity)[2]. The benefits of the BTA and the countries' commitments must be extended to all WTO Members on a non-discriminatory basis through the Most Favoured Nation (MFN) principle.

At the end of the negotiations nine governments filed MFN exemptions on a measure, including the USA.[N16] The agreement is enforceable by the WTO dispute settlement system.

Impact on the market

The importance of the BTA lies in the confirmation and consolidation of the trend of opening up telecommunications markets around the world. The effect of the agreement, however, depends on the details of the individual offers and how effectively they are implemented by national and international bodies. Furthermore, in the offers of most developed countries there is little which is not part of liberalisation plans already. The agreement has not yet been ratified and fully implemented by all the individual signatories to the agreement, necessary for coming into force. This is a time-consuming process.

The agreement recognises the fact that competition in telecommunications knows no national boundaries. It will end the historical cartel-like relationships between (former) monopolists. It allows foreign service providers to compete directly with national operators or service providers.

When countries allow full market access without any restrictions, a number of options are open. Using own or leased facilities or resale, services can be offered in foreign countries that are signatories to the agreement, thus legalising the bypass of the traditional co-correspondence system via ISR.[N17] Furthermore, applying the national treatment principle, interconnection of networks can take place at any level in the national network where interconnection is allowed for national or international operators, regardless of the technology used (for example, mobile or fixed). This means that the special regulatory position of the international switching centre (ISC) disappears. A major operator could terminate international traffic from any switch where interconnection is allowed, resulting in less hierarchical network architectures. This raises questions with regard to standards and switches to be used. Who is responsible for making the traffic suitable for the terminating network and to protect the integrity of the network? And, does the duty to negotiate interconnection also mean a duty to terminate international traffic? This becomes especially relevant when a local operator is considered dominant, as is the case in Finland. Finally, investments can be made in national infrastructure or participation in foreign operators. This means that end-to-end service provision becomes possible. Also the network can be extended across national boundaries, by way of building a switch in another country. This way, local interconnection can be applied for with the national major operator.

Impact on the accounting rate regime

The technological, market and regulatory developments all contribute to the collapse of the classical accounting-rate system. Even though the issue of reforming the accounting-rate regime is still dealt with at the ITU, the BTA will add to the conversion of the basic principles of international telecommunications. Moreover, it will investigate the accounting rates in the year 2000[N18]. At the moment it is still unclear whether the accounting-rate regime fits the multilateral approach of GATT. At the heart of the discussion lies the question whether interconnection should be considered a one-sided service offered by the incumbent, or a mutual service between operators.

When moving to a cost-based system, the origin of traffic will become increasingly irrelevant. The rates will be determined by the country of destination. When such rates are non-discriminatory and cost-based, the price for conveyance of international traffic is the same as the price for mutual interconnect for international traffic between similar operators.

However, cross-border interconnection does not necessarily mean the end of the accounting-rate system, even between liberalised countries. Alternatives (for example, interconnect) will force accounting rates to a level of cost plus a reasonable margin. However, mutual deals might have certain cost advantages

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[N15] Market Access (XVI) is defined primarily in quantitative terms; however, it can also include some other forms of limitation, such as caps on foreign equity participation. National Treatment (XVII) is supplementing the MFN principle, providing for treatment of foreign services or providers that is no less favourable than to domestic services or suppliers.

[N16] The US exemption relates to one-way satellite transmission of DTJ and DBS television services and digital audio services, which are considered basic telecommunications in the USA but are not part of these agreements. Also, its offer was conditional upon a critical mass of WTO members to provide market access and national treatment as well as commitments with regard to the regulatory principles contained in the Reference Paper. Besides the USA, other countries filing MFN-exemptions were Antigua and Barbuda, Argentina, Bangladesh, Brazil, India, Pakistan, Sri Lanka, and Turkey. Bangladesh, India, Pakistan, Sri Lanka and Turkey listed exemptions to permit the national operator to apply differential measures, such as accounting rates, in bilateral agreements with other operators.

[N17] Unless restrictions or exemptions are made in the national commitment.

[N18] The ITU has, since 1992, already aimed to lower the accounting rates. In the year 2000 cost orientation should be achieved. See: Report of the rapporteurs group to the December meeting of working party 2/3 at: http://www.itu.org/intset/itu-t/other/rapport2.doc.

over unilateral deals, and with similar volumes settlement might be the easiest option; for example, Internet peering[N19].

Whatever replaces the current accounting-rate system—whether cost-oriented settlement rates, termination charges, interconnect fees, or simple break-out through the PSTN—competition will demand that the resulting reduction in underlying operator costs be passed along to end users[3].

Impact on the European framework

To realise an internal market for telecommunications, the Directorate General for Telecommunications of the European Union (DG XIII) applies a double approach: liberalisation and harmonisation[N20]. The Full Competition Directive[4] opens the European market for competition in infrastructure and voice telephony. The harmonising conditions for cross-border interconnection can be found in the Open Network Provision (ONP) Interconnection Directive[5], the ONP Voice Directive[6], the ONP Leased Lines Directive[7] and the Commission Recommendation with regard to interconnection rates and cost allocation in a liberalised market, Part 1[8].

Access to international links and cross-border interconnection is arranged by a framework that revolves around the duty of suppliers of public fixed or mobile networks or leased lines with a significant market power to provide access to their networks and leased lines according to the ONP principles, much similar to those of the BTA: non-discrimination, transparency and cost-orientation. They are further elaborated on in non-binding Commission Recommendations (Part 1 and 2). But considering the high value the Commission puts on harmonisation they should not be underestimated. This means that the rates for cross-border interconnection are based upon the costs of the—national and international—facilities used. Reasonable requests for access to the network should be honoured, including at other points than usual. The Recommendations say that all interconnection points available to national operators should also be made available to international operators, while no further authorisation is needed to terminate traffic without national presence or service provision. The conditions and rates for usage of the international segment should be published in a reference offer, and call termination rates should not discriminate between national or foreign networks, or between fixed or mobile networks.

The European Union filed a commitment at the WTO secretariat to open fully local, long-distance and international services markets, regardless of technology, either based on own facilities, resale or network capacity[N21]. This means that benefits of the European regime and cost-based interconnection rates for the termination of international traffic will be made available to third country operators offering services in Europe. The European framework applies to telecommunications operators who take up residence within Europe and to leased lines with both ends within the European Union. Otherwise the WTO framework will apply.

The Role of National Regulators

Although there is an increase in international telecommunications regulation by regional authorities such as the European Union as well as international bodies such as the WTO, local regulation seems to be more decisive than international regulation.

It remains up to regulators how to interpret the international principles that are often very general. There can be major differences in national interpretations and implementations. An example of different implementations of the European framework is the unbundling of the local loop for interconnection in the Netherlands and Germany. In particular, the issue of cost-orientation and unbundling under the BTA might lead to disagreement between national regulatory authorities (NRAs). The BTA is far more general than the European ONP regime and the reference paper is more procedural in nature. For example, it is unclear whether unbundling simply refers to separating the rates for the national segment from the international gateway and capacity or whether the international gateway should also be offered unbundled[N22], as implemented in the UK and France. The only obligation is that it should be applied in a non-discriminatory manner. Therefore it is up to the NRA to decide on the meaning of unbundling, within the framework of the BTA. Such policies will determine the investments made and the level of competition that will arise. Another major issue will remain the implementation of cost-orientation. Even when 'cost-based' international interconnection charges (that is, national interconnection rates plus the costs for usage of international infrastructure) are applied to cross-border interconnection, this will mean that inefficiencies of national networks are subsidised. For instance, many US local operators still apply access deficit charges in their local rates. Therefore the implementation of the BTA will require many struggles.

The cost of providing large bulk long-distance transport has dropped below the cost of providing individual access to the nodes of the terminating network. This 'death of distance' makes local factors even more important. The dominant costs of international telephony appear to be determined by the national interconnection fee negotiated for terminating access. This is even more true for the costs for new technologies, such as Internet telephony. The NRA is in the position to oversee the local arrangements at issue. The implementation and use of the rules and regulations should inspire sufficient confidence to make the major up-front investments required in any new telecommunications network. The make-or-buy decisions will be determined by the national interconnection policies implemented by the NRAs. If the difference between the

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[N19] Although Internet peering works well in theory, in practice large ISPs are unilaterally refusing to deal with smaller ISPs, because they feel in this way they are subsidising the smaller ISPs network.

[N20] The competition rules also require cost-based interconnection and prohibit abuse of a dominant position in the relevant market. In December 1997 the Directorate General for Competition (DG IV) started an ongoing investigation of charges paid to dominant operators for international calls. The two approaches will be coordinated.

[N21] Only France and Portugal allow limited foreign participation. Portugal also requires commercial presence to deliver services.

[N22] Unbundling the international segment means offering interconnection at the cable landing station, the international switch or the site of the requesting operator.

national and local tariff is too large, competitors will either use the service of a local reseller, selling its local interconnection deal, or build as many local points of presence as possible.

Conclusion

Because incumbents still use the traditional system as their main method for the exchange of international traffic, this system will probably remain dominant for some time. At the same time, more and more effective bypass is taking place, making the accounting rates and bilateral correspondence agreements obsolete. The BTA also contributes to the demise of the old regime. But how the multilateralism of the WTO is applied to international telecommunications and cross-border interconnection is not yet certain. The BTA will result in lower transatlantic call costs, but the full benefits of the agreement are still a couple of years away.

Within the European Union, the consequences of liberalisation are that the accounting-rate regime is transformed into a cross-border interconnection service following the principles of ONP. The MFN-principle of the WTO framework extends the liberalisation benefits across the boundaries of regionalism towards global markets. Offering national treatment means that a cost-based cross-border interconnection service will be offered to any operator wishing to provide services, terminate traffic or establish itself in a foreign European country. Liberalised countries, however, want others to open up their markets to foreign operators as well. This is clearly expressed by the benchmarks proposed by the FCC which demand equivalent opening up of markets before allowing other countries to receive all the benefits of the open market in the USA. Such unilateralism is incompatible with the principles of the WTO and the ITU. However, it still remains to be seen if the international framework can effectively deal with such demands for reciprocity. Asymmetric liberalisation, together with the different implementation of the general trade principles, can easily result in tensions and conflicts. Indeed, the telecommunications sector has already proven to be a litigious industry, because of the large interests at stake.

However, the supra-national arbitration system is slow, only open for governments and often not very transparent. Given the importance of speed to the telecommunications sector, its liberalising role is limited. However, the telecommunications industry has proven to be very litigious, suggesting that a dispute before the WTO Dispute Settlement Body (DSB) is not inconceivable. But it is the NRA which plays a central role and has to take care of proper implementation and enforcement of the liberalising principles and regulations, and which determines the conditions for competition and where investments will take place. The issue of unbundling and cost allocation—at the international gateway, but also the local loop as the main, basic building block of interconnection rates and bottleneck—will be the first and most important issue to deal with.

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1 NGBT Reference Paper, Clause 2.2.
2 WTO Telecom Talks Produce Landmark Agreement. *WTO Focus*, Feb. 1997, p. 2.
3 Holland Taylor, C. The Collapse of the Present Accounting Rates System and Rise of Cost-Based Global Telephony. White paper addressed to the 19th annual Pacific Telecommunications Conference, Honolulu, Hawaii, 20 Jan. 1997.
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6 OJ L 101/24, Directive 98/10/EC of the European parliament and of the Council of 26 February 1998 on the application of open network provision (ONP) to voice telephony and on universal service for telecommunications in a competitive environment.
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Biography

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Heleen de Vlaam is a Ph.D. student at the Department of Technology, Policy and Management of the Delft University of Technology in the Netherlands. She is working on a thesis about the changing rules of the game in the telecommunications sector, with particular attention to the role of hybridity in the management of the sector and interconnection disputes. She also works part-time for DDV, an independent telecommunications consultancy. In 1995 she obtained her degree in Communications Science and International Relations at the University of Amsterdam.

Paul Nihoul

EC Telecommunications: Towards A New Regulatory Paradigm

The European Community (EC) telecommunications reform is often presented as a shift from regulation to competition. Yet some pieces of European regulation have been introduced in replacement of the national rules. More importantly, the EC liberalisation rules (competition) may not easily be distinguished from those adopted in the framework of harmonisation (regulation).

Introduction

Much has been written during the last years about European telecommunications. Numerous authors have underlined the impact economic and technical developments are likely to produce on the enhancement of productivity[N1]. The convergence between information and communication technologies will considerably improve knowledge production, diffusion and supply. If the economy is strong enough to integrate these changes, it should enjoy a more substantial growth, with the benefits that may be expected therefrom (creation of jobs, etc.)[N2].

Less attention has been devoted to the legal side of the reform undertaken by the EC authorities[N3]. In this paper, I argue that the reform is also important for the evolution of the law, in particular with respect to the mechanisms used in order to control and/or organise the economy. The attitude adopted by the EC authorities appears to signal a new era characterised by a different relationship between competition and regulation—two forms of intervention previously opposed. A new regulatory paradigm is being introduced. It has been given a definite form in telecommunications and is likely to be extended to other essential sectors[N4].

In the first part, I review the rules adopted by the EC authorities in telecommunications. I then introduce the traditional representation given about the reform, which is generally interpreted as a shift from regulation to competition. Thereafter, I analyse certain phenomena that appear to question that representation: the persistence of some regulation as well as the approxima-

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N1 This document is a revised version of some ideas defended in a doctoral dissertation recently presented at the Catholic University of Louvain, Belgium (law). The research was partly funded by Belgacom, the former Belgian telecom operator, and the Belgian Governement, under contract 'Pôle d'Attraction Interuniversitaire PAI'. I am greatly indebted to those who have helped me refine the ideas presented in the dissertation, mainly Professors Andersen, Fontaine, Horsmans, Keutgen, Lenoble and Pappalardo.

Lawyers are often criticized for the abundance of references! I have tried to address this legitimate reproach by restricting the notes to a strict minimum. I hope that will allow readers with no specific legal education to get acquainted with the ideas developed in this paper.

N2 See a. o. BADILLO, P.-Y., 1997. Has Deregulation an Impact on Productivity and Performances: Some Preliminary Results for Telecommunications, Communications et stratégies, 26, pp. 337 or CABALLERO SANZ F. and URBANO SALVADOR A. ,1997. Is There an Economic Rationale for the Liberalisation of Telecommunications Infrastructures?, in DUMORT A. and DRYDEN J. (editors), The Economics of the Information Society, Luxembourg: Office for Official Publications of the European Communities, pp. 81.

N3 'It is too easy for lawyers to fall in with the view that all questions in the telecommunications sector are fundamentally economic, and that legal instruments simply implement economic policies'. SCOTT, C. (1997). Current Issues in EC telecommunications Law, in SCOTT C. and AUDÉOUD O. (eds), The Future of EC Telecommunications Law, Series of Publications by the Academy of European Law in Trier, (19), pp. 21.

N4 Among these sectors are those with characteristics similar to telecommunications; that is, services with a considerable importance for the society and which imply heavy infrastructures (*public utilities*). See in general ARLANDIS J. 1991. Les défis posés aux politiques européennes de régulation, Communications et stratégies, (7), pp. 95 and STOEPPELWERTH A. M. 1994. Bearding the Giants: the Intersection of Deregulation and Competition Policy in the United States and Europe, Legal issues of European integration, pp. 27. For transportation, see DEBANDE O. and MONAMI E., 1996. La réglementation des chemins de fer dans l'Union européenne, in Les services publics et l'Europe : entre concurrence et droit des usagers, Actes du colloque organisé par l'Institut d'études européennes, le Centre de droit public et la Maîtrise en management public, 13-14 Décembre 1996, Bruxelles: Université libre de Bruxelles, pp. 215; KNIEPS G., 1990. Deregulation in Europe: Telecommunications and Transportation, in Majone G. (editor), Deregulation or Re-regulation? Regulatory Reform in Europe and the United States, London/NY: Pinter Publishers, pp. 72. For energy, see HANCHER, L., and TREPTE, P.-A., 1994. Competition and the Internal Energy Market, European Competition Law Review, pp. 149; SLOT, P. J., 1994. Energy and Competition, Common Market Law Review, pp. 511; STOFFAËS C. (editor) 1994. Entre monopole et concurrence: la régulation de l'énergie en perspective historique, Paris: Editions PAU.

tion between competition and regulation.

Rules Adopted in Telecommunications by the EC Authorities

In this part, I review the rules adopted by the EC authorities during the last decade in telecommunications. The objective is not to analyse these rules in an exhaustive manner: they are far too numerous and complex to allow such an exercise. The aim is rather to submit a rational classification that may serve as a framework for the development of the analysis[N5].

- *The application of competition rules to telecommunications alliances.* Competition rules have been applied to alliances formed by telecommunications operators. Several normative acts have been adopted in that respect. Guidelines were published by the Commission to announce the position likely to be adopted in future cases. The Commission also issued decisions with respect to several major alliances. These acts serve as landmarks for the evaluation of cases to come[N6].
- *Competition rules and the access to telecommunications networks.* The rules of competition have also been used to ensure an equitable access to the main telecommunications and cable TV networks[N7]. Such access is necessary to allow other undertakings to reach the customers and develop competition. At present, networks are dominated by the former national operators. That situation is not expected to change in the near future, as the experience shows that incumbent operators often maintain a significant presence despite an erosion of their market share under the pressure of competition.
- *Rules dealing specifically with telecommunications.* The norms adopted in telecommunications may not be limited to the application of general competition rules to the specific telecommunications context. Some binding instruments of general application have also been adopted by the EC authorities in connection with that sector. Among them are certain directives enacted by the Commission. Two of them were adopted by that authority in the first instance[N8]. In essence, they ordered the elimination of special and exclusive rights granted by Member States to their national operator prior to the reform. The power of the Commission to adopt such rules was questioned by several Member States, to be finally upheld by the EC Court of Justice[N9]. Comforted by that support, the Commission adopted other directives extending competition to all telecommunications markets, including voice telephony and the public networks (establishment/ provision)[N10].

  Other rules were adopted by the European Union (EU) Council and Parliament. Some relate to the procedures imposed by the Member States to select undertakings authorised to carry out an activity. The idea behind EU intervention is to ensure that procedures do not unduly hinder the internal commerce within the Community[N11].

  The EU Council and the Parliament also sought to impose some degree of openness and interoperability in the networks. That objective was mainly implemented through directives gathered under the concept of open network provision (ONP). In these instruments, the EC authorities have progressively extended their action. In some of them, they go beyond seeking network efficiency to organise the relationships among economic actors in the markets[N12].

  A final objective is pursued by the EU Council and Parliament in instruments related to the public

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[N5] For a comprehensive presentation of the instruments, see the internet site maintained by the European Commission: http//www.ispo.cec.be.

[N6] See a. o. Commission decision 94/579/EC of 27 July 1994, relating to a proceeding pursuant to Article 85 of the EC Treaty and Article 53 of the EEA Agreement (Case IV/ 34.857—BT/MCI), OJ L 223, 36; Commission decision 96/546/EC of 17 July 1996 relating to a proceeding under Article 85 of the EC Treaty and Article 53 of the EEA Agreement (Case N° IV/35.337—Atlas), OJ L 239, 23; Commission decision 96/547/EC of 17 July 1996 relating to a proceeding under Article 85 of the EC Treaty and Article 53 of the EEA Agreement (Case N° IV/35.617—Phoenix/GlobalOne), OJ L 239, 57.

[N7] See a.o. Draft Commission Communication 97/C76/06 on the application of competition rules to access agreements in the telecommunications sector: framework, relevant market and principles, OJ C 76, 9.

[N8] Commission directive 88/301/EEC of 16 May 1988 on competition in the markets for telecommunications terminal equipment, OJ L 131, 73 and Commission directive 90/388/ EEC of 28 June 1990 on competition in the markets for telecommunications services, OJ L 192, 10.

[N9] European Court of Justice, 19 March 1991, France/Commission, ECR, I, 1221 and 17 November 1992, Espagne a.o./Commission, I, 5859.

[N10] Commission directive 94/46/EC of 13 October 1994 amending directive 88/301/EEC and directive 90/388/EEC in particular with regard to satellite telecommunications, OJ L 268, 15; Commission directive 95/51/EC of 18 October 1995 amending directive 90/388/EC with regard to the abolition of the restrictions on the use of cable television networks for the provision of already liberalised telecommunications services, OJ L 256, 49; Commission directive 96/2/EC of 16 January 1996 amending directive 90/388/EEC with regard to mobile and personal communications, OJ L 20, 59; Commission directive 96/19/EC of 13 March 1996 amending Directive 90/388/EEC with regard to the implementation of full competition in telecommunications markets, OJ L 74, 13.

[N11] For terminals, the EC authorities have ordered the mutual recognition by the Member States, of the authorisations granted by a qualified national authority in Europe. See Council directive 91/263/EEC of 29 April 1991 on the approximation of the law of the member States concerning telecommunications terminals equipment, including the mutual recognition of their conformity, OJ L 128, 1. That directive has recently been codified, but no substantial change was brought to the provisions. A different approach was followed for services, where Member States are allowed to maintain national procedures. The latter have however been harmonised and a central administrative office has been created for applications regarding several Member States. See European Parliament and Council Directive 97/13/EC of 10 April 1997 on a common framework for general authorisations and individual licences in the field of telecommunications services, OJ L 117, 15.

[N12] See for instance Council directive 95/62/EEC of 13 December 1995 on the application of open network provision (ONP) to voice telephony, OJ L 321, 6. That instrument contains several provisions meant to protect the consumers vis-à-vis dominant operators. Such objectives have not connection with the concept of an open and interoperable network.

procurements within the European Union[N13]. Here again, the idea is to promote competition. These authorities want all candidates to be given a fair treatment in the procedures related to the orders placed by public entities. The decisions taken in that respect will have to be based on objective as well as non-discriminatory criteria.

An Alleged Shift From Regulation to Competition

Regulation

The rules which were in place in the Member States before the telecommunications reform was undertaken by the EC authorities belong to a category of legal instruments that may be called *regulation*. This term is used to designate a variety of realities. As a result, it is somehow dangerous: readers may grant it meanings that are not in the author's intentions.[N14]

The sense used in this paper is very specific. It is that which is attributed to the expression in the law concerning the *public utilities*. In that framework, *regulation* typically refers to rules and instructions adopted by agencies on the basis of a delegation of power by the Government and/or the Parliament. That sense is common in the United States, where agencies have developed throughout the century. It is increasingly used in European States, that tend to resort more frequently to delegations in an attempt to shield economic activities from political intrusion.

That first definition is however hardly satisfactory as it only takes into account one tradition. That in force in continental Europe (*services publics*) should not be set aside. In fact, both traditions have a substance in common. Prior to the reform, *public utilities* and *services publics* were basically placed under the supervision, coordination or even direction of public authorities. In this paper, *regulation* will thus be used to designate the rules and instructions imposed in both traditions by the public authorities on the undertakings providing services—including telecommunications—essential to the collectivity and which require heavy infrastructure investments. The two characteristics have prompted the authorities to intervene heavily in an effort to ensure that the activities are carried out in a manner consistent with the general interest, while guaranteeing the lowest possible costs for users. In fact, authorities have gone so far as to determine the parameters to be complied with by the undertakings (price, output, investment, etc.)[N15].

Prior to the EC reform

Prior to the reform, telecommunications regulation was based in most EC countries on principles of a political nature. National authority wanted to pursue equality among users, irrespective of the differences in cost that may be implied for the undertakings dealing with them. Thus a similar price was charged for any connection, be it in a city or in a remote village[N16]. Furthermore, authorities wished to favour close links within local communities. For that reason, prices charged for local communications were set below cost. The deficit was to be financed with the profit realised on lucrative markets. Special or exclusive rights were granted to the operator in such markets, in order to ensure the realisation of that kind of profit.

By enacting the reform, the EC authorities wanted to put an end to that organisation. The idea was to restore freedom on the markets by eliminating entry barriers and other unnecessary restrictions. In that framework, public authorities were set to play a limited role. Their intervention was to be limited to ensuring a proper working on the markets. In substance, their function was to be confined to the application of competition rules. There would be no need for regulation, as issues would be solved by competition and the rules associated to it.

A substantial part of the doctrine has thus warned that regulation was likely to disappear and that competition law would progressively be imposed as the only legal mechanism to be applied by the authorities in order to ensure compliance with the general interest. To take an example, that opinion was recently defended by B. Clements—a civil servant in the European Commission—at a conference in the United Kingdom. According to that author:

> 'There is an argument for abolishing regulation of the telecommunications industry in the long term and allowing a competitive market to police itself... Regulation is becoming more relaxed. The process will continue, as competition increases quality and

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N13 Council directive 92/13/EEC of 25 February 1992 coordinating the laws, regulations and administrative provisions relating to the application of community rules on the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors, OJ L 76, 14 and Council directive 93/38/EEC of 14 June 1993 coordinating the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors, OJ L 199, 84.

N14 For instance, *regulation* is sometimes used as a synonym for the general term *rules*. It then covers all sorts of norms that may be adopted by authorities, whatever their object and/or the status of their author(s). Within the EC, 'Regulation' also refers to the rules with are characterised by a general application and a direct applicability. See Art. 189 EC: 'A regulation shall have general application. It shall be binding in its entirety and directly applicable in all Member States'. 'Directly applicable' means that no national measure is needed to implement the regulation in the Member States. In that sense, regulation may be opposed to directives, which are only binding as to the result but leave to the national authorities the choice of form and method. It may also be distinguished from decisions, which are directly applicable in their entirety but have a more limited application. Finally, *regulation* refers to a variety of studies which have been undertaken in economics and social sciences, principally in the United States.

N15 As often, the sense attributed to the term depends on the context. In some countries, public utilities' shares were held by private shareholders. The rules thus had to be formulated explicitly in order to be communicated to the undertakings. Absent from such communication, the addresses would have ignored the parameters. The situation was different in countries where the capital was placed in public hands. In such cases, the instructions could be communicated informally to the board by the competent Minister or its representative. There was thus no need for the adoption of explicit rules. The form used to communicate instructions has an incidence on the research which is carried out by scholars in the area. Explicit rules may be analysed, not informal discussions as they are out of reach for most outsiders. That is probably why regulation has mainly been studied in the United States, where public utilities largely remained private. By contrast, research has been limited in Europe to the mechanisms used by the authorities in order to impose their instructions upon the undertakings, leaving aside the content of these instructions.

N16 Connection costs are significantly higher in places where the demand will be limited due to a weak population density and the absence of entities making a substantial use of telecommunications technologies.

choice without need for enforcing high standards'[N17].

The Persistence of Regulations

Community regulation

Contrary to the expectations mentioned above, one cannot say that regulation has disappeared. National rules belonging to that legal category have indeed been eliminated, mainly through the action of the Commission[N18]. They have however been replaced by others, introduced by the EC authorities.

Economic rules

Some of these rules have an economic nature. To justify their introduction, EC authorities have contended that regulation is necessary in transition to guarantee that markets will work properly before competition is sufficiently developed and can lead by itself to the best allocation of resources[N19]. According to them, some sort of control or supervision must be maintained on the former telecommunications organisation to guarantee that their power is exercised in a manner consistent with the general interest.

That argument raises a comment. The experience encountered in countries where competition is allegedly replacing regulation, does not allow one to conclude that the latter has disappeared. In the United States, for instance, AT&T—the former national monopoly whose activity was confined to long-distance communications more than 15 years ago—is still submitted to specific rules which do not apply to other competitors. A similar observation may be made for British Telecommunications (United Kingdom), whose monopoly was set aside in the 1980s. These examples show that the transition may last long enough to wonder whether it will ever cease...[N20].

Other regulation

Other rules are not limited to a transitory period. Most of them were adopted to organise the relationships among market participants. They were mainly introduced by the Council and Parliament (ONP and internal market directives).

- *Institutional rules* Some establish an institutional framework to ensure a correct application of the rules by the participants. They were among the first to be introduced by the EC authorities. Thus, the Commission ordered, as early as 1988, the Member States to entrust the regulatory responsibilities related to the terminal markets[N21] 'to a body independent of public or private undertaking offering goods and/or services in the telecommunications sector'[N22]. A similar measure was enacted in 1990 with respect to telecommunications services[N23]. Provisions were also included to that end in directive 91/263, which provided for the mutual recognition in the Community of terminal authorisations granted in one Member States[N24]. Recently, the Council and the Parliament amended ONP directive 90/387 in order to stress the requirement of independence[N25].
- *EC Actions* Other provisions identify the material actions and objectives pursued by the EC authorities. Among them is the development of a telecommunications industry within the Community. The EC authorities encourage the formation of operators funded with private

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N17 *Financial Times*, 9 October 1997, 3. That attitude corresponds to that adopted by the American authorities with respect to electronic commerce. Their position is to avoid regulation, and to leave it to the economic operators to solve themselves the issues which may arise in the course of their activities. *Financial Times*,

N18 Commission directive 88/301/EEC of 16 May 1988 on competition in the markets for telecommunications terminal equipment, OJ L 131, 73; Commission directive 90/388/EEC of 28 June 1990 on competition in the markets for telecommunications services, OJ L 192, 10; Commission directive 94/46/EC of 13 October 1994 amending directive 88/301/EEC and directive 90/388/EEC in particular with regard to satellite telecommunications, OJ L 268, 15; Commission directive 95/51/EC of 18 October 1995 amending directive 90/388/EC with regard to the abolition of the restrictions on the use of cable television networks for the provision of already liberalised telecommunications services, OJ L 256, 49; Commission directive 96/2/EC of 16 January 1996 amending directive 90/388/EEC with regard to mobile and personal communications, OJ L 20, 59.

N19 See the preamble to Council and Parliament directive 97/33/EC, par. 25: 'when effective competition is achieved in the market, the competition rules of the Treaty will in principle be sufficient to monitor fair competition ex-post so that the need for this Directive will be reconsidered, with the exception of the provisions on universal service and the settlement of disputes'.

N20 The idea is to submit dominant operators to regulation, as their power allows them to behave independently from their customers and competitors. There is no certainty that dominance will some day disappear. At present, it is carried out by the former national operators, which hold a significant advantage as they have been alone on the markets for some time and may use their experience to maintain their position. Dominance may however be conquered by other undertakings using new technology. If it is to persist as long as some dominance is observed on the markets, regulation may have to be maintained for ever.

N21 Draw up specifications, monitor their application, grant type-approval,... See Commission directive 88/301, art. 6.

N22 Commission directive 88/301, art. 6.

N23 Commission, directive 90/388, art. 7. 'Member States shall ensure that ... the grant of operating licences, the control of type-approval and mandatory applications, the allocation of frequencies and surveillance of usage conditions are carried out by a body independent of the telecommunications organizations.'

N24 Annex V to Council directive 91/263. 'The notified body, its director and the staff responsible for carrying out the tasks for which the notified body has been designated shall not be a designer, manufacturer, supplier or installer of terminal equipment, or a network operator or a service provider, nor the authorised representative of any of such parties. They shall not become directly involved in the design, construction, marketing or maintenance of terminal equipment, nor represent the parties engaged in these activities.' (Point 1). 'The notified body and its staff ... must be free from all pressures and inducements, particularly financial, which might influence their judgment or the results of any inspection' (point 2). Directive 91/263 has recently been codified, but no substantial change was brought to its provisions.

N25 See the European Parliament and Council directive 90/387, art. 5 bis, par. 2, as amended by directive 97/51. 'In order to guarantee the independence of national regulatory activities, national regulatory authorities shall be legally distinct from and functionally independent of all organizations providing telecommunications networks, equipment or services; Member States that retain ownership or a significant degree of control of organizations providing telecommunications networks and/or services shall ensure effective structural separation of the regulatory function from activities associated with ownership or control'. Several requirements are imposed upon these authorities: competence, impartiality, independence, integrity, ... Most of them are laid down in directive 91/263, annex V.

capital, allied with non-European powerful undertakings (particularly from the United States where technologies are very developed) and characterised by a global or at least multinational scope[N26].

Other requirements relate to the type of goods or services that may be distributed on the markets, or that may be provided by the undertakings. For instance, arrangements are made for technical standards to be set by international bodies. In some cases, these standards are made compulsory. In other cases, they are only encouraged[N27].

Some provisions concern the protection of market participants. Several aspects may be distinguished in that regard. Firstly, the reform introduces competition as a way to improve the user's plight. The new environment should broaden the selection available to the users. More goods and services will be available to them, as undertakings will strive to win the customers' approval[N28].

Secondly, fundamental requirements are imposed in all actions undertaken by authorities and dominant operators[N29]. These entities must behave in a transparent, objective, proportional and non-discriminatory manner[N30]. The requirements provide a protection to all participants, as they ensure that users and undertakings are given a fair treatment.

Thirdly, the provision of basic services at reasonable conditions is made compulsory to all members of the society (universal service)[N31].

Fourthly, specific protections are granted to some categories of the population. Thus, ONP directive 95/62 (voice telephony) allows national authorities to agree special tariffs for low-usage users or specific groups[N32]. Such authorities may also draw up specific conditions for disabled users and people with special needs in their use of the voice telephony service[N33]. The same instrument imposes a contract between the users and the dominant telecommunications organisation[N34]. The agreement will have to specify the service to be provided by a telecommunications organisation[N35]. Compensation and/or refund arrangements must be provided if the contracted service quality levels are not met[N36]. The exceptions to this rule must be justified by the telecommunications organisations and made clear in the users' contract[N37].

- *Control and Remedy* A last category ensures compliance by the authorities, the undertakings and the users. Procedures are used to select undertakings authorised to carry out the activities[N38]. The access to the market is thus limited to entities which—authorities have reasons to believe—will respect EC rules. Other mechanisms are established to control compliance in the course of the activities[N39].

An Approximation Between Competition and Regulation

Harmonisation and liberalisation

A second phenomenon must be examined to analyse the alleged shift from regulation to competition. A certain approximation may be observed between both interventions. Competition law is apparently used in several instances in order to reach a result which is usually associated with regulation. As for the latter, it increasingly refers to concepts used in competition law.

The general relationship between competition law and regulation will not be analysed in this paper. Such analysis may be found in my doctoral dissertation and will soon be available in English. The research will be carried out in rather concrete terms. Throughout this section, we will make reference to the framework established at the outset of this paper.

In that framework, we distinguished three categories of rules on the basis of their object: the rules of competition as applied to telecommunications alliances, such rules as applied to infrastructure access issues, and measures specifically related to telecommunications. That classification does not show clearly the relationship which exists between the first two categories and some rules belonging to the third. In fact, some telecommunications-specific measures—in particular directives adopted by the EC Commission—have a competitive nature. They aim at liberalising the markets. They

N26 See Nihoul P. Forthcoming. Les télécommunications en Europe: concurrence ou organisation de marché?, Bruxelles: Larcier, pp. 490-499.

N27 See a.o. Council directive 91/263, art. 6.

N28 That is the general justification for the introduction of competition. See a.o. Areeda, P. and. Kaplow, L., 1988. Antitrust Analysis, Boston/Toronto: Little, Brown & Company, pp. 14; Bienaymé A. 1995. L'intérêt du consommateur dans l'application du droit de la concurrence : un point de vue d'économiste, Revue internationale de droit économique, pp. 361; Hertig, G., 1984, Le rôle du consommateur dans le droit de la concurrence en Suisse, aux Etats-Unis et dans la CEE, Lausanne: Payot, titres I et II; Samuelson, P. A., and Nordhaus, W. D., 1995. Micro-économie, Paris: Editions de l'organisation, pp. 228 s.; Scherer, F. M., and Ross, D., 1980. Industrial Market Structure and Economic Performance, Boston: Houghton Mifflin Company, pp. 9; Viscusi, W.; Vernon, J.,and Harrington, J., 1992, Economics of Regulation and Antitrust, Heath Lexington (Mass), a. o. p. 260 (dans le cadre d'une discussion sur le monopole).

N29 See hereinafter for more details.

N30 These requirements are examined hereinafter in more details.

N31 See European Parliament and Council ONP directive 97/33/EC on interconnection in telecommunications with regard to ensuring universal service and interoperability though application of the principles of open network provision, OJ L 199, 32, a. o. art. 5.

N32 Art. 14, par. 2.

N33 Art. 19.

N34 Art. 7, par. 1.

N35 *Ibidem.*

N36 *Ibidem.*

N37 *Ibidem.* Other provisions grant users rights to be respected by the operators. For instance, ONP directive 95/62 (voice telephony) require the telecom organisations to respond without delay to a request for connection to the fixed public telephone network and to give the user an estimated date for the provision of service. See art. 7, par. 2.

N38 See Council directive 91/263 for terminals as well as European Parliament and Council directive 97/13 for services. These instruments are based on different principles. The first one imposes an obligation to recognise authorisations granted by Member States provided some requirements are fulfilled. The second leaves untouched the national power to impose procedures but harmonises the content thereof and sets an administrative mechanism to dispatch applications to the Member States which are concerned by the demand.

N39 For terminals, they are sketched out in Council directive 91/263.

apply competition rules so as to set aside entry barriers and other restrictions previously erected by national authorities.

Another classification may thus be drawn between two sets of rules—not three. On the one hand, the rules adopted by the Council and/or the Parliament in the framework of harmonisation (ONP, public procurement, realisation of the internal market) and on the other, the rules of competition, which are applied by the Commission in acts with an individual, collective or general application. The first group aims at organising the markets (technical standards, protection of customers, etc.). The second seeks market liberalisation: more freedom is introduced on the markets, as entry barriers are set aside.

The relationships between these groups of rules is investigated further. We have already explained the distinction which is made between both categories in the reform. Thereafter, one will demonstrate the existence of an analogy between that distinction and that which is generally made between competition and regulation. Then, one will notice that despite the shift from regulation to competition which is announced in the reform, both categories appear to be based on common principles and that the rules they contain may even be considered identical in their substance.

An analogy with competition and regulation

We have seen that the rules of competition were mainly applied to telecommunications through decisions or guidelines adopted by the EC Commission. A relationship may be drawn with the directives adopted by that same authority on the basis of Article 90 EC. These instruments open the markets by eliminating the restrictions which had been erected by the national authorities to protect their national operator. According to the EC Court of Justice, the power vested upon the Commission under that provision is not discretionary. That authority must limit its intervention to the application of EC rules—mainly those related to competition—to the covered undertaking.

By contrast, the power exercised by the EC authorities appears unlimited in the harmonisation context, as far as the objectives are concerned. One requirement has concededly to be fulfilled for the authorities to be allowed to exercise that power. Pursuant to Article 100 A par. 1 EC, the harmonisation must indeed be limited to measures 'which have as their object the establishment and functioning of the internal market'[N40]. However, that requirement is not related to the actions which are envisaged by the authorities. It rather serves as an anchor to make sure that the latter do not exercise that power in all circumstances. Once that requirement is satisfied, no limit may be imposed upon such actions, except maybe in application of the principle of subsidiarity[N41]. In that sense, harmonisation may be considered some sort of regulation, to the same extend liberalisation is to be associated with competition.

Common principles

Alleging that the reform signals a shift from regulation to competition implies, as a prerequisite, that both interventions can be distinguished. Yet, that may be questioned if the distinction is examined in the light of that made between harmonisation and liberalisation. The latter types of intervention are indeed founded on common principles, which make an opposition hardly plausible.

Transparency

One of them relates to the transparency, which the authorities want to prevail on the markets. Numerous provisions appear in liberalisation directives, with the aim of ensuring that market participants are aware of the rules applied by the authorities and the conditions proposed by the dominant operators. A similar pattern may be found in harmonisation directives adopted by the Council and the Parliament.

In both cases, the provisions are characterised by identical objectives and modalities. Clarity is imposed on the authorities as to the rules they apply on the market and on dominant undertakings as to the conditions at which they propose their goods and services.

The acts are to be brought to the knowledge of the concerned entities. Several modalities may be used to that effect. In some instances, the acts will have to be notified. In others, a publication will be sufficient.

The publication may serve different purposes. One is to give economic actors information about the rules, which apply to their situation. The knowledge of these rules is essential, as they have an incidence on business decisions. Individuals are also to be informed about their rights, as well as their duties. Thus, ONP directive 95/62 (voice telephony) provides that they are to be warned about possible adverse consequences if they do not settle their bill in time. Sometimes, EC authorities use publication to encourage a specific behaviour. Publication is also used to facilitate the comparison among services proposed by different undertakings. Finally, publication may be used to control parties set to intervene. For instance, the publication of line-leasing conditions offered by dominant undertakings will help identify possible discriminations. The user will be in a position to determine whether the conditions are, or are not, as satisfactory as those provided in the general conditions.

The communication of information is also made compulsory in some circumstances. That modality is mainly used in order to ensure the respect of EC rules by the Member States. Typically, directives require national authorities to communicate to the Commission the rules they intend to adopt in implementation of EC law. In some instances, the rules will have to be communicated in advance, to allow the Commission to verify their compatibility before enactment. Other information is to be communicated upon request by the Commission and reports may be required under certain circumstances.

[N40] Harmonisation and liberalisation may not be distinguished so clearly in other areas. Harmonisation leads to rules being adopted for the whole Community. The same comment may be made for liberalisation directives, which contain rules covering the Community. Furthermore, liberalisation increases freedom on the markets. A similar result may be achieved via harmonisation, when the EC rules which are less restrictive than those which were previously in force.

[N41] Other specific exceptions must be mentioned. For instance, Article 100A par. 3 EC imposes on the Commission the obligation to take as a base a high-level of protection in its harmonisation proposals concerning health, safety, environmental protection and consumer protection.

Independence of the authorities
A requirement for independence was introduced by the Commission with respect to the authorities called to intervene in the application of EC telecommunications law. It appears in the two instruments enacted in the first wave of liberalisation—directives 88/301 (terminals)[N42] and 90/388 (services)[N43]. The obligation was also imposed in harmonisation directives by the Council and the Parliament. Annex V to directive 91/263 stipulates the characteristics the authorities must comply with in order to qualify for a designation in the context of mutual recognition national authorisation for terminals. ONP directive 97/51 introduces more specific criteria designed to guarantee independence in countries where the capital of the former national operator is still held by a public authority[N44].

The independence requirement is not merely introduced by harmonisation or liberalisation instruments. It may also be found in the competition case law. RTT, the former Belgian telecommunications organisation, had an exclusive right for network management on the national territory. Under Belgian law, the functions devoted to the undertaking were not limited to economic activities. Some sort of regulatory authority was vested upon it, including the power to fix the criteria for connection of terminals to the network.

That situation was criticised by the EC Court of Justice: for the combination of economic activities and regulatory powers violates EC competition law, as it undermines the equality, which must exist among economic actors[N45].

Fundamental principles
The last illustration is related to some fundamental principles, which are imposed upon the exercise of the task entrusted to the public authorities. The principles stem from the pro-market philosophy, which lies behind the reform. In that system, the economic actors must be allowed to carry out their activities as they produce the wealth, which is necessary to the society. Therefore, public interferences must be limited and carefully designed[N46].

- *Equality* Authorities may not discriminate in favour of certain enterprises.
- *Objectivity* The actions must pursue aims recognised and accepted by the European Union. As far as telecommunications are concerned, these are principally values embodied in the essential requirements, which can be found in harmonisation or liberalisation directives.
- *Proportionality* This requirement is generally analysed as encompassing three criteria. Firstly, the act must be capable to realise the aim, which is pursued: there must exist a causality between the means, which are used by the authority, and the end, which is sought by it. Secondly, there must not exist a possibility to replace the measure by another, which would allow the realisation of the same objective while not affecting the protected value to the same extent. Thirdly, the measure must not produce excessive effects with regard to the value, which is protected, and that which is set aside.

The fundamental principles appear in both sets of instruments. They were introduced by the EC Commission in liberalisation directive 88/301. Pursuant to Art. 3, Member States may require economic operators to possess the technical qualifications needed to connect, bring into service and maintain terminal equipment. That possibility is, however, submitted to a specific constraint. The requirements must be established 'on the basis of objective, non-discriminatory and publicly available criteria'[N47]. The same principles were then referred to by the Council and the Parliament in some harmonisation directives. According to ONP directive 90/387, open network provision conditions must comply with a number of basic principles: they must be based on objective criteria; they must be transparent and published in an appropriate manner; they must guarantee equality of access and must be non-discriminatory, in accordance with Community law[N48].

It does not come as a surprise that the said principles were introduced by the EC Commission. Their importance is underlined throughout the liberalisation directives. In these instruments, they appear in connection with:

- the definition and abolition of special rights,
- the procedures that can be imposed to undertakings,
- the conditions which are related to vocal telephony and the provision of public networks,
- the conditions related to mobile and personal communications,
- the radio-spectrum and number attribution,
- the interconnection agreements,
- the conditions related to the access to fixed public networks, and
- the financial charges imposed upon undertakings.

A real homogeneity
Scrutinising further harmonisation and liberalisation, one finds the links between both categories to go beyond common principles. In either of them, the same issues are indeed addressed in similar ways. One may thus conclude that there exists between them a real homogeneity.

In my doctoral dissertation, that conclusion is supported by a lengthy examination of the rules which appear in harmonisation and liberalisation, with respect to three issues fundamental to telecommunications: procedures, interconnection and universal service. I then analyse EC rules on tariffs, which are imposed by telecommunications directives and general competition law, to find that similar rules may be found in these categories. From these findings, I infer that harmonisation and liberalisation cannot

[N42] Art. 6.
[N43] Art. 7.
[N44] ONP directive 90/387, art. 5 bis, par. 2, as amended by directive 97/51.
[N45] European Court of Justice, *RTT*, 13 December 1991, ECR, I, 5973.
[N46] See for instance KPMG 1996. Public Policy Issues Arising from Telecommunications and Audiovisual Convergence, Report to the European Commission, p. 171. 'We believe that regulation in any sector over and above competition law must be fully justified'.
[N47] 'Member States may... require economic operators to possess the technical qualifications needed to connect, bring into service and maintain terminal equipment on the basis of objective, non-discriminatory and publicly available criteria'. Art. 3.
[N48] Council Directive 90/387 of 28 June 1990 on the establishment of the internal market for telecommunications services through the implementation of open network provision, OJ L 192, 1, art. 3, par. 1.

Table 1 Procedures, harmonisation and liberalisation

	Liberalisation*	Harmonisation
Authorisation	• Competition	• *Idem*
	• Essential requirements	• *Idem*
	• Contribution to the universal service	• *Idem*
	• Trade Regulation : permanence, availability and quality of the service	• Respect of ONP rules
Licence	• Competition	• *Idem*
	• Essential requirements	• *Idem*
	• Contribution to the universal service	• *Idem*
	• Trade Regulation: permanence, availability and quality of the service	• ONP rules, trade regulation and other rules

* (1) Directive 90/388. (2) Directive 97/13, annex. (3) The requirement is implicit, as liberalisation directives are enacted in the framework of competition. (4) Points 1 and 2.3. (5) Art. 2, par. 3, al. 1. (6) Points 2.1 and 2.4. (7) Art. 3, al. 1; art. 3 *bis*, al. 1; and art. 4 *quater*, al. 1. (8) Point 3.2. (9) Art. 3 *bis*, al. 1 and art. 4 *quater*, al. 1. (10) Point 3: provision of emergency services, communication of customer database information necessary for the provision of universal directory information, customer protection, special arrangements for disabled people, conditions relating to the interconnection of networks and the interoperability of services. (11) Same comment: the requirement is implicit in the directives. (12) Point 1. (13) Art. 2, par. 3, al. 1. (14) See the title to point 4; allocation of numbering rights: point 4.1; effective use and efficient management of radio frequencies : point 4.2. (15) Art. 3, al. 1; art. 3 *bis*, al. 1; and art. 4 *quater*, al. 1. (16) Point 4.5. (17) Art. 3 *bis*, al. 1 and art. 4 *quater*, al. 1. (18) Obligations imposed by directives 92/44 (leased lines) (point 4.9) and 97/33 (interconnection) (point 4.5). (19) Point 4.8. (20) Conditions concerning ownership which comply with Community law and the Community's commitments vis-à-vis third countries.

really be distinguished in their substance[N49].

A similar pattern will be followed here after—somewhat in a shorter form.

Procedures

In telecommunications as in other areas, EC authorities want to realise a common market for equipment and services. They thus seek an environment where undertakings may carry out their activities in the Union without excessive hindrance. As for the provision of telecommunications services, the Member States have retained the right to impose national procedures. However, the conditions that may be imposed in these procedures have been harmonised[N50]. That task has been carried out by the Council and the Parliament in directive 97/13, but the choices made by these authorities correspond in substance to those made earlier by the Commission in the liberalisation directive, particularly in directive 96/19 with regard to the implementation of full competition in telecommunications markets.

The rules set by both sets of directives may be summarised in four points.

- Several situations may be envisaged with respect to the procedures that may be imposed to undertakings: absence of formality, declaration, authorisation and licence.
- There must exist a relationship between the procedures imposed by the Member States and the activities envisaged by the undertakings. In principle, procedures must be limited to a declaration or an authorisation. A licence—which is more demanding—may be requested in connection with voice telephony, public networks as well as mobile networks.
- The respect of some conditions may be imposed for the undertakings to engage in an activity. In substance, the essential requirements must be imposed with respect to all activities. Trade regulations may be introduced for the specific activities mentioned above. Undertakings supplying public networks may have to comply with financial obligations related to the universal service.
- The number of licences may be limited in specific circumstances (lack of availability spectrum); the licences must respect the essential requirements and the fundamental principles[N51].

Some differences appear between both sets of directives, but they are limited to points that appear to be accessory. One of them is related to the conditions under which the number of licences may be limited. The Commission specifies the activities that may be affected by such limitation. These activities are referred to in harmonisation directive 97/13 adopted by the Council and the Parliament. However, these authorities also mention other circumstances in respect of which such a limitation may occur.

Another difference appears in the explicitation of some obligations. Under directive 97/13, undertakings may have to supply information for the authority to control markets as well as for statistical purposes. The obligation is not explicitly formulated in the liberalisation directives. Yet, they certainly apply as they are inherent to the control obligations. Information is necessary for any sort of control. Thus, one may consider it legitimate for national authorities to require this information in the absence of an explicit legal basis in any directive.

The same comment may be written with respect to EC competition rules. The obligation to comply with such rules is explicitly set out in directive 97/13. One cannot find much reference to similar rules in the liberalisation directives. That does not mean, however, that they do not apply in the telecommunications sector. In fact, their application is automatic. As they have a general scope, one must conclude to their application in the absence of an exception provided in the Treaty or in application of it.

[N49] There remains institutional differences. For instance, liberalisation directives are enacted by the Commission under Art. 90 par. 3 EC. By contrast, harmonisation directives are based on Art. 100 EC, which requires an intervention by the Council and the Parliament.

[N50] In the present framework, the analysis is limited to EC rules concerning the provision of services, as regulated by Parliament and Council directive 97/13. For terminals, see Council directive 91/263.

[N51] Directive 90/388, art. 3, al. 5 for voice telephony and the provision of public telecommunications network, as well as art. 3 bis, al. 3 for personal and mobile communications.

Table 2 Interconnection, harmonisation and liberalisation

	Liberalisation (Directive 90/388) *	Harmonisation (Directive 97/33)
The Principle	'Member States shall ensure that the telecommunications organisations provide interconnection';	'Member States shall take all necessary measures to remove any restrictions which prevent organisations authorized ... from negotiating interconnection agreements'; 'organisations ... shall meet all reasonable requests for access to the network';
Fundamental Principle	'the telecommunications organisations provide interconnection ... on non-discriminatory, proportional and transparent terms, which are based on objective criteria';	'the organisations ... adhere to the principle of non-discrimination'; 'the national regulatory authority imposes conditions based on essential requirements in interconnection agreements';
Accountancy	'the cost accounting system implemented by telecommunications organisations ... identifies the cost elements relevant for pricing interconnection offerings';	'The Commission shall ... draw up recommendations on cost accounting systems and accounting separation'; 'the cost accounting systems ... are suitable for implementation of the requirements';
Regulatory Authorities	'If commercial negotiations do not lead to an agreement ..., Member States shall ... adopt a reasoned decision which establishes the necessary operational and financial conditions and requirements for such interconnection';	'national regulatory authorities may intervene on their own initiative at any time, and shall do so if requested by either party, in order to specify issues which must be covered in an interconnection agreement, or to lay down specific conditions to be observed by one or more parties to such an agreement'.

* (1) As amended. (2) Art. 4 *bis*, par. 1. (3) Art. 4 *bis*, par. 1. See also art. 3 *quinquies*, al. 3, 1st sentence. (4) Art. 4 *bis*, par. 4. (5) Art. 4 *bis*, par. 3, al. 2. The terms used in par. 1 appear to imply that the provision might be limited to the demands concerning special access to the network. However, it appears that the provision may be generalised, given the general character of the words which are used. (6) Art. 3, par. 1. (7) Art. 4, par. 2. The obligation is limited to the undertakings with a significant market power, in the meaning of the directive. It is not different from that which is provided in directive 90/388. The latter does indeed apply to the former national operators, which are set to dominate the telecom public service or network markets for a period which it is difficult to determine, given the advantage that they have in controlling the network. *Supra*. (8) Art. 6, letter a). (9) Art. 10, al. 2. (10) Art. 7, par. 5. (11) *Ibidem*. (12) Art. 9, par. 3.

Table 3 Universal service, harmonisation and liberalisation

Liberalisation†	Harmonisation*
'Any national scheme **R1** which is necessary to share **R4** the net cost of the provisions of universal service obligations entrusted to the telecommunications organisations, with other organisations **R2** whether it consists of a system of supplementary charges or a universal service fund: **R3** a) apply only to undertakings providing public telecommunications networks; b) allocate the respective burden to each undertaking according to objective and non-discriminatory criteria and in accordance with the principle of proportionality. **R4** Member States shall communicate any such scheme to the Commission so that it can verify the scheme's compatibility with the Treaty.'	'**R1** Where a Member State determines ... that universal service obligations represent an unfair burden on an organisation, it shall establish a mechanism for sharing **R4** the net cost of the universal service **R3** with other organisations operating public telecommunications networks and/or publicly available voice telephony services'. **R2** 'Contributions ... may be based on a mechanism specifically established for the purpose ... and/or may take the form of a supplementary charge added to the interconnection charge'. **R4** 'Organisations with universal service obligations shall ... calculate the net cost of such obligations'.

† Commission directive 90/388, art. 4 *bis*.
* Council and Parliament ONP directive 97/33, art. 5.

Interconnection

Competition will only emerge in telecommunications services if the providers are allowed to distribute their services via the existing networks, which are dominated by the former operators. Some rules are set in liberalisation and harmonisation directives, in order to address the issues that may result from such situation. Four rules may be distinguished:

- Dominant operators must provide interconnection to their network when the demands are reasonable.
- The interconnection conditions must comply with the fundamental principles (neutrality, objectivity, non-discrimination).
- Such conditions are to be negotiated by the parties, with an intervention by the authority in case the parties cannot agree.
- The operator must hold an accountancy system based on costs.

The issues related to interconnection were addressed specifically by the Council and the Parliament in ONP directive 97/33. Yet, a pattern appears, which is similar to that observed with respect to procedures. The choices realised by the two authorities are based in substance on decisions made in that respect by the Commission in liberalisation directives.

Universal service

The EC authorities do not wish the undertakings to carry out their activities in total freedom. They want to ensure that the development obtained in telecommunications result in advantages for the whole society. In particular, a set of minimal services should be available at reasonable conditions to all members of the society (universal service). The issue was dealt with by the Council and the Parliament in ONP directive 97/33 (harmonisation). Pursuant to that instrument:

R1 the universal service cost must in principle be borne by the operator, but the burden may be financed in another manner if and when it is excessively inequitable;

R2 the deficit may not be financed through a derogation to the rules of competition, but through a fund alimented by undertakings or through interconnection charges paid by the latter;

R3 the obligation to contribute must be limited to undertakings which provide public networks or voice telephony; and
R4 any subvention must be limited to the net cost of services which would not otherwise be provided.

These rules are set out in ONP directive 97/33, but they are not original: they mainly rest on principles previously adopted by the Commission in some liberalisation directives.

Conclusion

The reform undertaken in telecommunications by the EC authorities is often presented as a shift from regulation to competition. In this article, I have tried to bring some nuances to that statement. Firstly, some regulation has been enacted by EC authorities—and is there to stay. Secondly, one may observe a sort of approximation between competition law and regulation. In these conditions, one may not distinguish the two terms in a categorical manner.

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Biography

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Paul Nihoul has just presented his doctoral dissertation on Telecommunications in Europe: Competition or Market Organisation? Until June 98, he was a research fellow and part-time lecturer at the Université Catholique de Louvain (UCL, Belgique). He also teaches at the Université Robert Schuman, Strasbourg (France). He has a Licence in Philosophy and Letters (UCL); a Licence in Law (UCL); a Master of Laws (Harvard); a Doctorate in Law (UCL). His previous professional experience includes: Attorney and Counsellor at Law (New York, USA); Counsellor of the Belgian Minister of Finance Mr. Ph. Maystadt (Brussels, Belgium); and Referendaire at the European Court of Justice (Luxembourg).

Dr. ir. Francis Depuydt and Dr. ir. Greet Bilsen

A Methodology for Interoperable Network and Service Management System Design

This paper discusses a methodology for the design of interoperable network management solutions based on the business process needs of a telecommunications network and/or service provider. The methodology is derived from open distributed processing (ODP), and allows a top-down refinement of operational needs down to system specifications in a step-by-step approach. It is illustrated by means of a simplified real-life example (ISDN provisioning).

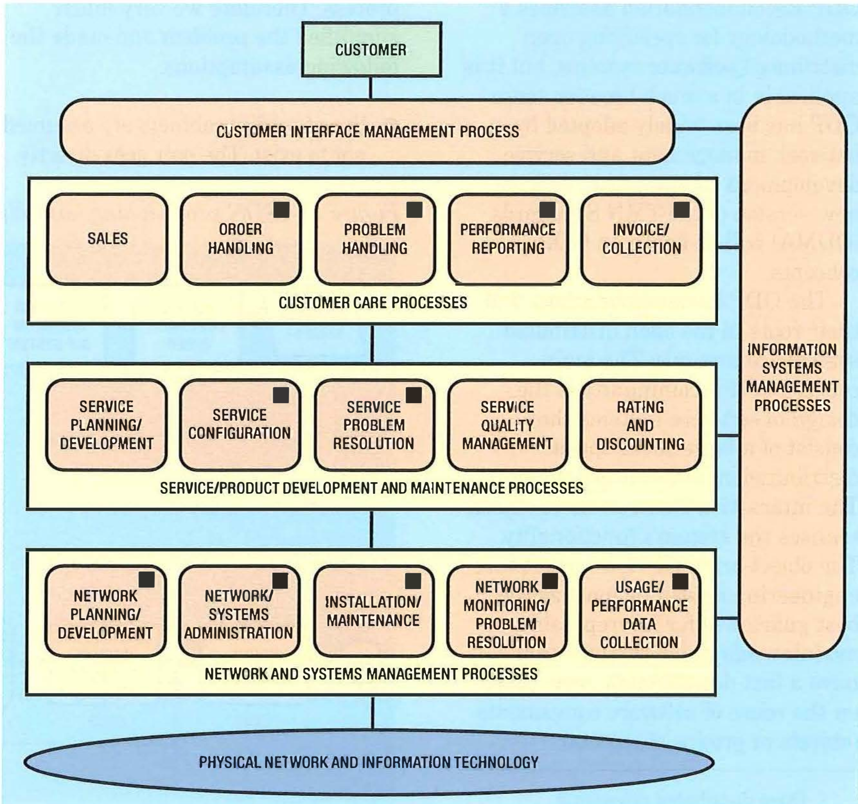
Introduction

With the opening of the telecommunications market in Europe, competition has already strongly increased and is expected to increase a lot more. Telecommunications providers—network operators and/or service providers—are competing with each other based on cost, quality and time to market[6]. Balancing these three criteria against each other is like balancing a three-legged stool, and success in balancing them will determine whether a telecommunications operator will survive or not.

Operating a network and providing services on top of that network is a complex business, which can be modelled as a set of complex, interworking business processes (such as order handling, complaint handling, network monitoring and network configuration). The more heterogeneous the network, and the more services offered on top of it, the more complex the business processes. In particular, the incumbent operators will have complex heterogeneous network, which have evolved over many years. The Network Management Forum (NMF) has elaborated a generic process model for the telecommunications provider business, shown in Figure 1[6].

Cost effectiveness and fast time-to-market can be achieved only by increasing the level of automated process flow-through; for instance, the majority of basic-rate ISDN orders should be handled at the service point and fed directly to the digital exchanges without the intervention of humans (except of

Figure 1 - The Network Management Forum SMART business process model



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course for the installation of the network termination). Automated process flow-through requires a high level of systems integration: the order handling IT systems need to interface with the network provisioning and switch configuration systems.

This is exactly the point to which less attention was paid in the past by most incumbent operators. Most of these operators have a large diversity in network management systems, some of them realised with previous generation software technology. Therefore, there is a large legacy integration problem to be solved by most of the incumbent operators.

Given the complexity of the problem, a structured approach towards integrating these systems in order to provide a solution for process flow-through is needed. In this paper, a methodology for deriving a technical solution from the business process needs is explained in a step-by-step manner. This methodology ensures that the systems developed or purchased cover business needs. It also deals at the same time with systems interoperability issues. The methodology is illustrated by a simplified but real-life process example; namely, ISDN provisioning.

The Methodology

The Move-It methodology is based on the *ODP† viewpoints*[1]. Basically the ODP Recommendation describes a methodology for specifying open distributed software systems, but it is applicable in a much broader sense. ODP has been widely adopted by network management and service development communities, and the new version of the TMN Standards (ODMA) will be based on ODP concepts.

The ODP Recommendations find their roots in the open distributed systems community. The main concern of this community is the design of software systems that consist of a large set of objects distributed on different machines. The interaction between these objects realises the system's functionality. The object-oriented view on software engineering is seen by most as the best guarantee for interoperable, modular, adaptable systems that have a fast development cycle based on the reuse of software components (objects or groups of objects).

† Open distributed processing

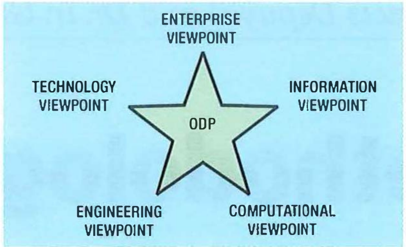


Figure 2 – The five ODP viewpoints

The ODP Framework proposes a software analysis and design lifecycle for open, distributed software systems consisting of five different (consecutive) viewpoints (see Figure 2). In each viewpoint, the system (in this case the network and service management layers in a telecommunications provider) is viewed from a different perspective, with different specific points of attention. In the next sub-sections, each viewpoint is illustrated throughout the development of an example in the telecommunications provider network management domain. In the last paragraphs, the five viewpoints are unified into a methodology for the analysis and design of network management capabilities.

The example that will be used in this section aims at the definition of a management system supporting the process of provisioning a new ISDN connection. The goal of the example is to illustrate the methodology, rather than to give a complete modelling of the management systems required for the provisioning process. Therefore we very much simplified the problem and made the following assumptions.

- Street wiring cabinets are assumed not to exist. The pair goes directly from the customer premises to the main distribution frame in the local exchange. (Important for the information model.)
- All required equipment is available, so no suppliers need to be contacted.
- No field work is required, except for installation at the customer premises.
- The relationship with billing is not taken into account.
- No special cases (for example, pre-survey required, no number availability,...) are taken into account.
- Also the testing of the lines (although very important in reality) is not considered.

Enterprise Viewpoint

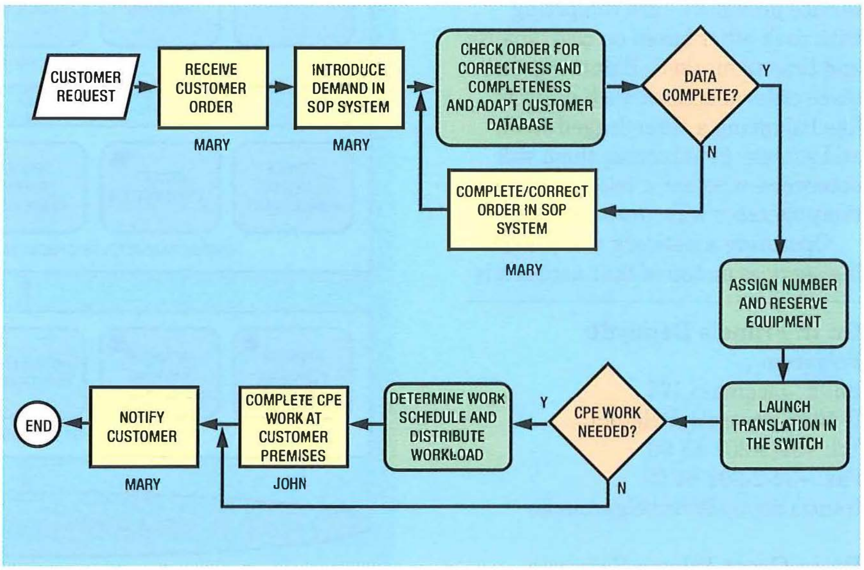
Definition

The enterprise viewpoint provides a specification of the application from the point of view of the different organisations and people that will use or operate the system. It is concerned with the various actors that partake in the process, the roles they play and the responsibilities they have. Additionally the requirements on the capabilities and the operation of the system are dealt with in the enterprise model.

Example

The methodology will be used on a process-by-process basis. Therefore we take the process flowchart as an input to the design process. For the simplified ISDN provisioning process of our example, this flowchart is depicted in Figure 3. Note that this flowchart already distinguishes

Figure 3 – ISDN provisioning (simplified) flowchart



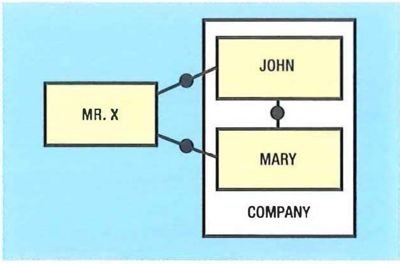


Figure 4—Enterprise model

Table 1 Example of Roles and Responsibilities

Stakeholder	Role	Responsibilities
Mr. X	Customer	● Requesting (and receiving) an ISDN connection
Mary	Sales order administrator	● Taking the order from the customer ● Launching the provisioning procedure ● Notifying the customer of order completion
John	Installation fieldforce	● Executing the required fieldwork

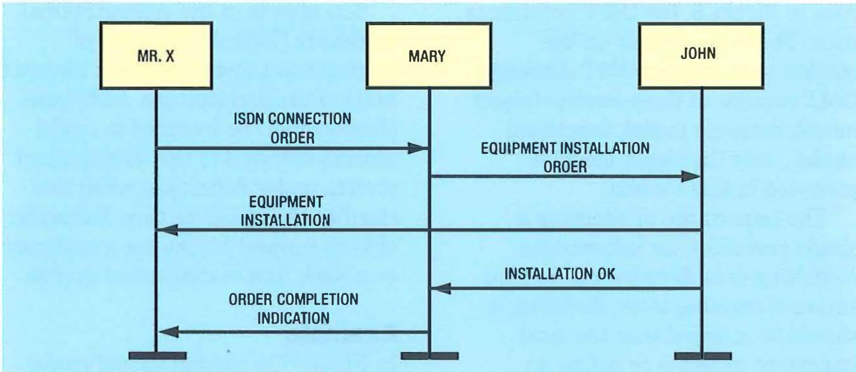


Figure 5 - Stakeholder interaction diagram example

between 'people's responsibilities' (yellow) and tasks that require some automation (green).

In Figure 4, an enterprise model for the simplified ISDN provisioning process is shown. For this process, we can distinguish three stakeholders, one external and two internal to the company. The roles and responsibilities of these stakeholders are summarised in Table 1.

The interactions between the different stakeholders are best shown in message sequence charts (MSC) such as in Figure 5.

Documents

The documents that define the enterprise viewpoint are:

- process flowcharts (such as the FMO flowcharts and Figure 3);
- enterprise model: a block diagram with reference points between blocks that make clear the relationships between the stakeholders (see Figure 4);
- stakeholder roles and responsibilities: text and tables (such as, for instance, Table 1); and
- stakeholder interaction diagram (see Fiqure 5)

Advantages

The importance of the enterprise viewpoint is:

- definition of the business goals and business environment;
- clear definition of the problem domain (plus communication tool towards staff); and
- top-down approach to network management systems analysis starts here.

Information Viewpoint

Definition

The information viewpoint defines the information that is handled by the system, at its external interfaces as well as internally in the system. This information is represented by a set of information objects that have different kinds of relationships with each other (such as association, specialisation, and containment).

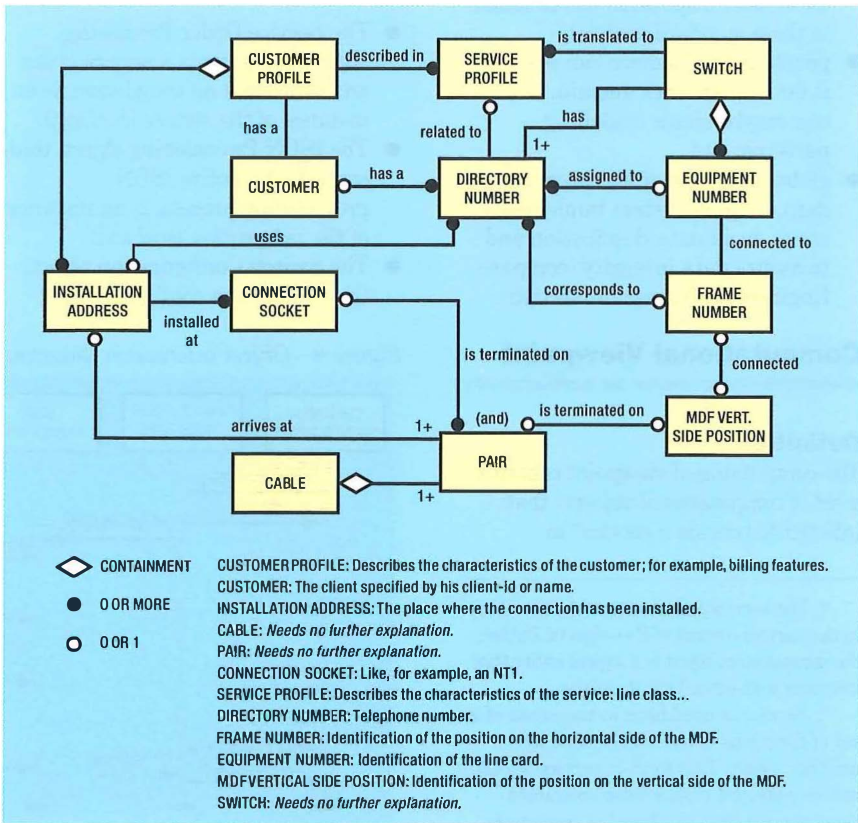
Example

An example of an information model for the ISDN provisioning process is given in Figure 6. In order not to complicate further the example, the objects have been chosen such that the information model can be understood easily. Adherence to standardised models and/or other process models has not been taken into account in this example.

Documents

The information viewpoint is documented in the following documents:

Figure 6—Information model example



- information model; and
- data dictionary: text with descriptions of each object in the information model (no detailed data dictionary has been included in this example).

The procedure most used for information modelling is the OMT object modelling technique[2] (OMT). Also in Figure 6, the OMT notation is used. There many tools on the market that support OMT. Although OMT consists of three models (object model, dynamic model, functional model), only the object model is proposed in this context.

The importance of adopting a single procedure for information modelling is uniformity and minimisation of training costs. However, it should be stressed that the most important aspect is to define an information model that is accessible to and used by everyone in the company—independent of the tools that are used to put it on paper—and that it is always kept up to date (which requires considerable effort).

Advantages

The main advantages of an information model are:

- uniform presentation of corporate data;
- information models can be based on standardised information models (or at least inspiration can be found in these standard models);
- people in one domain can see what is done in another domain, and can maybe share modelling patterns; and
- global overview of all corporate data, helping system implementers to avoid data duplication and to assure data integrity (compare Engineering Viewpoint section).

Computational Viewpoint

Definition

The computational viewpoint contains a set of computational objects† that interact to provide a service* to another object or to support a process. The communication between the objects occurs by an interface, which is used to call the methods (operations) of the object. Actually, all the focus in the computational viewpoint is on the interfaces of objects. Therefore, a lot of attention is paid to the careful definition of the functionality exported by an object through its interface.

The objects in the computational model are "logical" instances of management and/or network element units of the architecture. Additional objects might be included to model sources external to the management system under definition, when this clarifies the global picture. Examples of such support blocks are a customer or a work flow management system.

Example

In Figure 7, a computational model for our simplified ISDN provisioning process is shown. The example shows a number of logical entities (objects) that offer services at their interfaces. (An interface is represented by a black rectangul on the border of the computational object.) The objects interact by calling on these services. The figure shows four blocks defining the management system and two support blocks (yellow coloured).

The four management system blocks are instances of the Move-It architecture and can be mapped on it as follows:

- The Service Order Processing object that accepts a service order and controls it on completion, is an instance of the *service level unit.*
- The ISDN Provisioning object, that controls the entire ISDN provisioning process, is an instance of the *integration level unit.*
- The Switch Configuration object, that allows the configuration of the switch with the new ISDN number and its line-class, is an instance of the *element level unit.*
- The Digital Switch object is an instance of the *network element unit.*

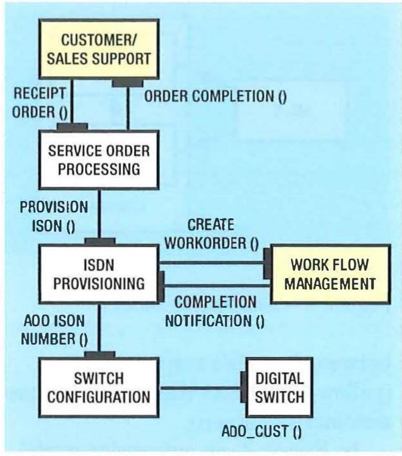


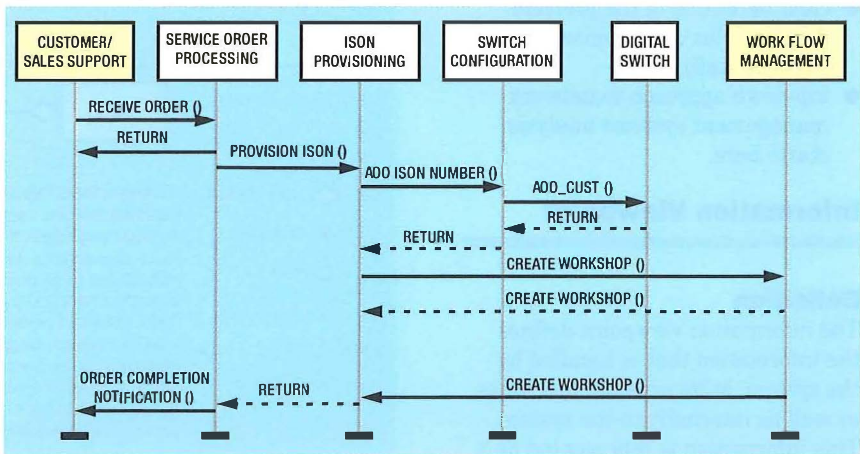
Figure 7—Computational model example

The support objects represent the ISDN requester and the installation process respectively.

The interaction of the computational objects of Figure 7 for supporting the ISDN provisioning process is shown in the object interaction diagram of Figure 8. An object interaction diagram shows a sequence of interactions between objects in a specific scenario. It does not exhaustively show all possible interactions. Usually, the scenarios are far more complicated than the ones shown in Figure 8. Hierarchical analytical methods exist to break down a complex scenario into smaller sub-scenarios, each of which could look like the one in Figure 8.

Another point that should be made with respect to the computational model is the relationship with the information model; for example, a

Figure 8—Object interaction diagram



† The term *object* should not be seen here in the narrow context of C++ objects. Rather, the computation object is a logical entity that interacts with other logical entities.

* *Service* is used here in the sense of a set of functions of one object used by another object. This kind of service should not be confused with a telecommunications service that is offered to customers.

table should be constructed to define which element in the computational model uses which information†. Using such a mapping will help in analysing the completeness of the information model and in defining the links that need to be provided between the management systems and the databases defined in the engineering and technology viewpoint.

The mapping for the ISDN example can be found in Table 2.

Table 2 - Example of mapping between computational and information model.

Computational Object	Information Objects
Service Order Processing	customer profile, customer, directory number, installation address
Switch Provisioning	installation address, connection socket, directory number, frame number, switch, MDF vert. side position, pair, cable, service profile
Switch Configuration	equipment number, directory number, frame number, service profile, switch
Digital Switch	service profile, directory number, equipment number

Documents

The documents that define the Computational Viewpoint are:

- computational model: a block model for computational objects and their relations;
- interface definition: OMG IDL* or pseudo-C/C++ for defining the interfaces to objects;
- object semantics: text for the semantics of an object (based on a template);
- object interaction diagram: MSC‡ as a notation; and
- a table that describes the mapping between the information and the computational model.

Advantages

The main advantage of using the computational model is the decoupling of a logical system representation from a physical system architecture. By doing this, one is not distracted by physical implementation issues while conceiving the logical coherence of the system. It is very risky to jump immediately to the implementation/adaptation of systems while not having thought about the functions that the system is supposed to offer to other entities at a logical level. Furthermore, starting the analysis at a logical level leaves the way still open for different implementation alternatives.

Engineering Viewpoint

Definition

The engineering viewpoint is the bridge from the logical system analysis in the computational and information viewpoint to the systems implementation. In this viewpoint, the different information objects and computational objects previously defined are mapped onto systems. Furthermore, some issues that have not been tackled before are solved in the engineering viewpoint (for instance, a security server might be required to solve some access security problems).

In the engineering viewpoint the architecture that received a 'logical' instantiation in the computational model is further instantiated into a 'physical' system architecture.

Example

In Figure 9 and Figure 10, the mappings of the information model and computational model of Figure 6 and

Figure 9—Mapped information model example

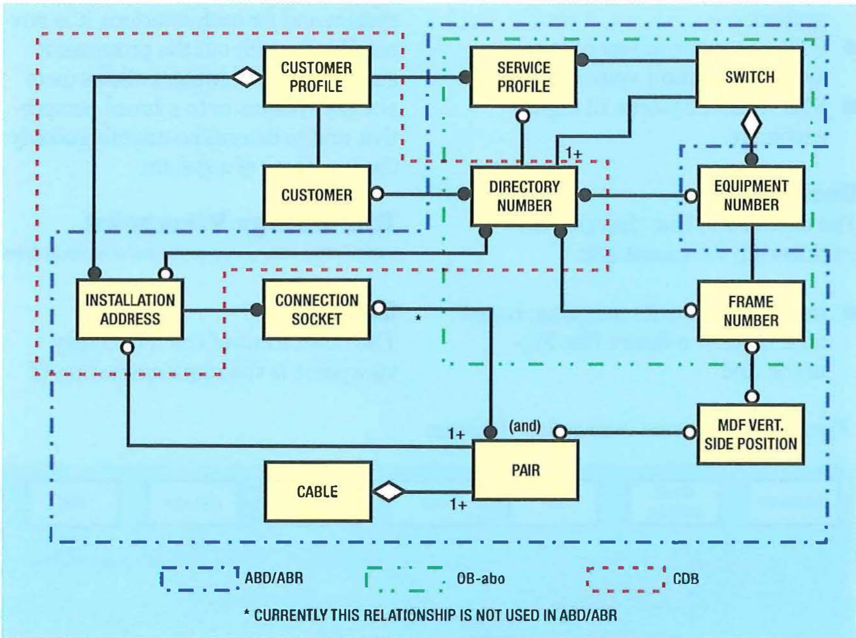
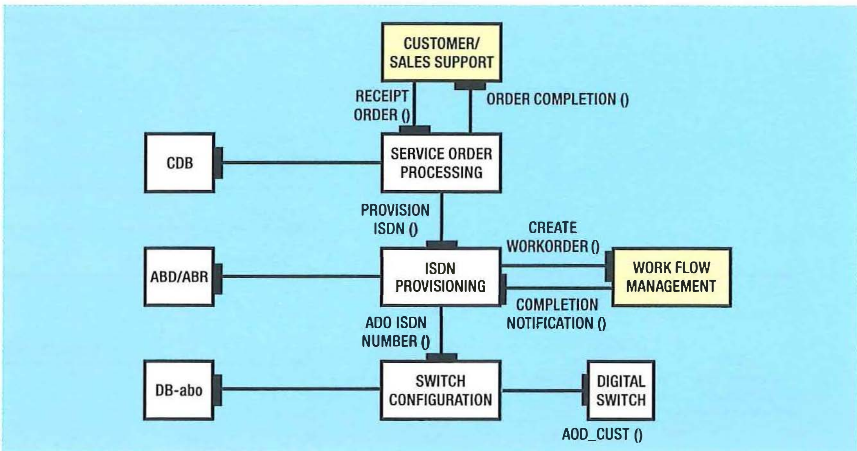


*Figure 10—Mapped computational model example***



† Information can be found in a database or can be passed via parameters

* OMG = Object Management Group; IDL = Interface Definition Language[3]

‡ Message sequence chart[4]

** Actually also the parameters of the different operations should be filled out at this stage.

Figure 7 are shown. In the example of the information model, the mapping of existing systems in Belgacom is shown. The mapping can of course also be done for yet-to-be designed systems or even to people, as in Figure 10 where the SOP and network provisioning systems do not yet exist and are currently being implemented by teams of people (and database applications). It should be noted as well that a system can incorporate several computational objects. Note further that at this point we also introduce database object instances in the architecture mapping. References to existing systems are explained below:

- ABD/ABR: copper access network inventory database;
- DB_abo: switch configuration database;
- CDB: customer database;
- SOP: service order processing system;
- NPS: network provisioning systems;
- WFN: workforce management system;
- OMC: supplier-independent switch mediation system;
- S12: Alcatel System 12 digital exchange.

Documents
The documents that describe the engineering viewpoint are:

- information model mapping: based on a table or a figure like Figure 9; and

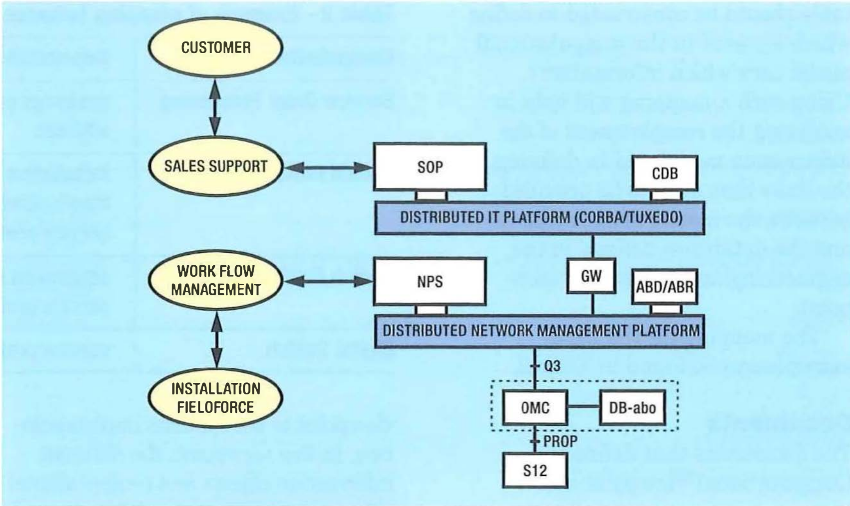


Figure 11 – System architecture example

- computational model mapping: based on a figure like Figure 10.

Advantages
The main advantage of an engineering viewpoint is traceability towards the logical system design level: for each system and for each interface, it is now possible to point out the processes it supports. This viewpoint allows us to put the systems in to a broad perspective, and to determine unambiguously the functions of a system.

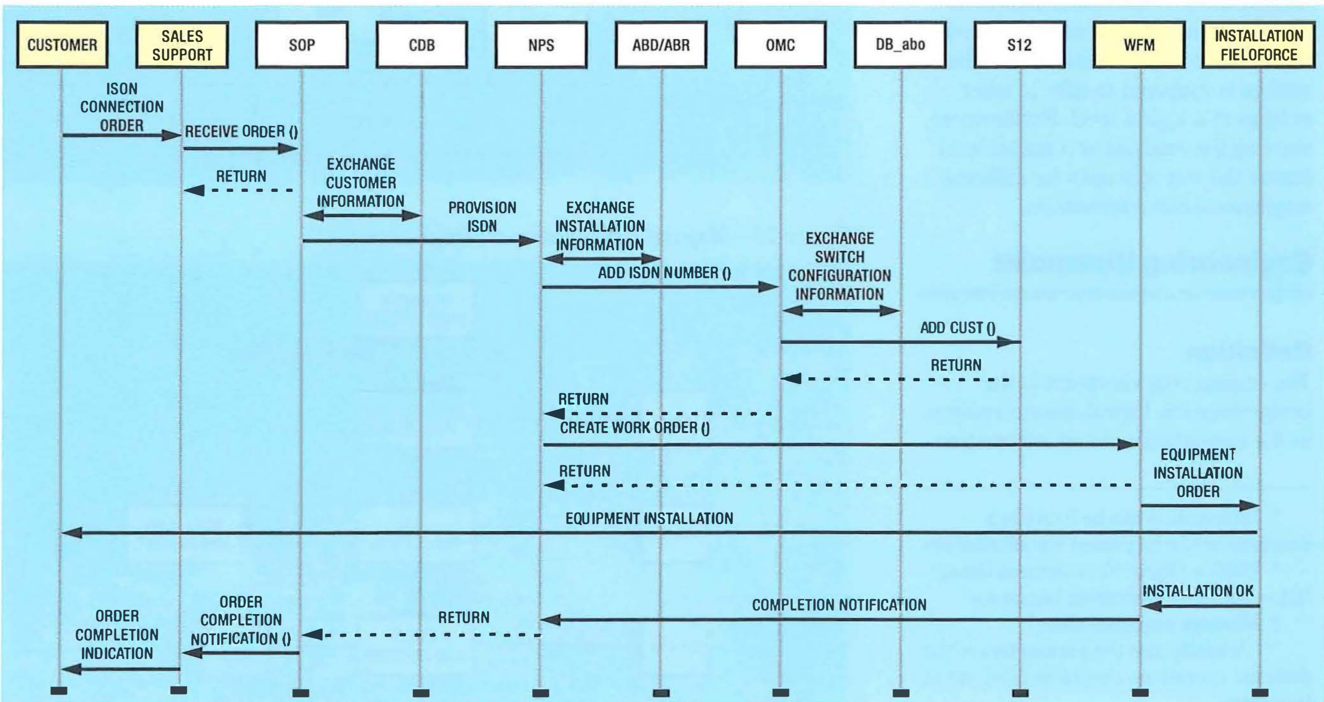
Technology Viewpoint

Definition
The main focus of the technology viewpoint is the implementation of the different interfaces between the systems (making a choice between options such as CORBA, TMN Q3, FTP, ASCII, etc.), and the implementation of non-functional requirements such as high-availability, performance, adaptability, etc. At this point the system architecture will be completed by also adding instances of interconnection units.

Example
A possible system architecture is shown in Figure 11. The interaction between people and systems is also included, as well as a choice of technology for system connectivity.

The interaction between people and systems is shown explicitly in Figure 12, using the same notation as

Figure 12 – Systems interaction diagram



for the object interaction diagram in the computational viewpoint. This diagram, however, is a refinement of the object interaction diagram. The importance of a diagram such as Figure 12 cannot be stressed enough: it is the blueprint for the implementation of a business process (such as the ISDN provisioning process) across the different teams and systems in the organisation.

Documents

The documents describing the technology viewpoint are:

- system architecture: block diagrams showing the systems and their interface implementations; and
- systems interaction diagram: message sequence charts (MSC notation).

Advantages

The technology viewpoint is the final product of the methodology. It contains the necessary level of detail to go and start writing system requirements. Also, the technology viewpoint contains a description of how legacy systems are encapsulated so that their functionality can be used by other systems (for example, by using the middleware used by the IT department).

Conclusion

Summary of the Methodology

As a summary, the methodology—shown at a high level in Figure 13—consists of the following consecutive† steps:

1. *Enterprise viewpoint:* stakeholders diagram + process flowcharts + responsibilities table + stakeholder interaction diagram.
2. *Information viewpoint:* information object model.
3. *Computational viewpoint:* computational object diagram + object interaction diagram + interface definition + mapping information vs. computational model.
4. *Engineering and technology viewpoint:* systems mapping diagram + systems interaction diagram + system architecture.

† These steps are consecutive in theory, but in practice there will be a lot of backward steps as well, certainly when working with the information and computation models.

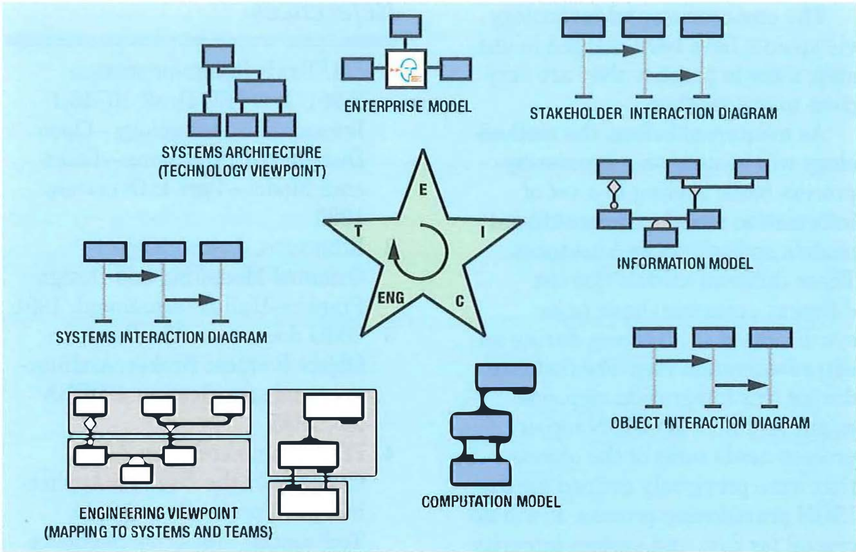


Figure 13—The Methodology

Table 3 Strengths and Weaknesses of the Presented Methodology

Strengths	Comment
A way of attacking a very complex problem by breaking it down into more manageable pieces and strongly separating the logical view from the physical implementation view	This is a common engineering best practice
ODP is fully adopted by industry and standardisation	The next generation of TMN standards (TMN2000) is going to be based on ODP
Common framework, terminology and procedures (notations) for everybody involved in network and service management (including the supplier)	Minimising misalignment between different teams; efficient communication of requirements to suppliers
Tool for communication of the global view on our network management systems to all involved	Everybody can understand how a specific system or team is linked in the global process chain of operations
Tool for analysis of overlaps and gaps in existing systems	
More efficient network management Implementation projects	No time is wasted in trying to understand each other
Weaknesses	**Comment**
No guarantee of success	But then again, no methodology can guarantee success
Considerable awareness-creation effort, and all have to adopt the methodology (or it is worthless)	Adopting a common framework might be the only way out of the network management complexity
Complexity; ODP and object-oriented concepts are fairly new to most people in a typical telecommunications provider	A certain degree of complexity is unavoidable in this domain. Furthermore, the hurdle of object-oriented thinking must be overcome since the whole network management and IT industry is adopting the object orientation paradigm
Only the technology viewpoint will be relevant to some people; the other viewpoints might be considered as bulky overheads	One cannot have a consistent technology viewpoint without first having thought about the other viewpoints

The engineering and technology viewpoints have been merged in one step, since in practice they are very close to one another.

As mentioned before, the methodology will be used on a process-by-process basis, leading to a set of information models, computational models and system architectures. These different models (for the different processes) have to be synchronised at all times, during an extra *integration* step. For instance, during this integration step, one might find that the ISDN repair process needs some of the objects that were previously defined for the ISDN provisioning process. It will be crucial for data and system integrity to detect these cases and synchronise the models accordingly.

Note further that the goal of the methodology is to guide the system developer through the definition of the system architecture and not to define the internal detail of all blocks in this system architecture. Based on the system architecture and the interface requirements specified in the computational model, the actual system specifications can be written for each block in the system architecture required to be newly built or adapted.

Strengths and weaknesses of the methodology

One methodology is most of the time as good as any other methodology. The strengths and weaknesses of the presented methodology based on ODP concepts, and some comments as to how to deal with the weaknesses, are given in Table 3.

As shown in the table, there certainly are some weaknesses with this methodology—as much as there are for any other methodology. However, the authors are convinced that a typical incumbent telecommunications provider will continue to have difficulties with network and service management if such a framework is not adopted company-wide.

Application

The presented methodology is currently being applied to a number of projects in Belgacom, such as the design of a traffic management system and the integration of the management of a fibre-optic access network into the legacy environment.

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Biographies

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Francis Depuydt received his degree in Electrical Engineering and a Ph.D. in Applied Sciences from the Katholieke Universiteit Leuven, Belgium, in 1988 and 1993 respectively. From 1988 to 1993, he did research on scheduling and register optimisation algorithms for digital signal processor design. He joined Belgacom in 1994, where he became a manager of an R&D group doing work in the area of telecommunications software quality. Since 1998, he has led the Network Management engineering group in Belgacom, where he is responsible for the development of network management solutions and long-term strategy.

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Greet Bilsen received a M.Sc. degree in Electrical Engineering and a Ph.D. in Applied Sciences from the Katholieke Universiteit Leuven, Belgium, in 1991 and 1996 respectively. Her Ph.D. research covered the development of algorithms for the assignment and scheduling of manifest applications onto heterogeneous multiprocessors. In September 1995 she joined Belgacom where she has been working in the areas of network and service management, and new technologies like TINA. In these domains she has been involved in several internal as well as European projects.

Roberto Vercelli

Quality of Service and Network Performance Issues in a Multi-Provider Environment

The new telecommunications scenario often requires that different organisations cooperate in order to make available the required service to the customer. In spite of the increased complexity of the overall system, the quality of this service as perceived by the customer shall constantly increase due to competition. It is thus necessary to identify models to be used to analyse interactions among companies that collectively offer a service and criteria to evaluate quality at the boundaries. The paper introduces a basic model and presents an example of application to a specific, realistic case.

The New Scenario

Until a few years ago, in almost each country of the European Union a monopoly was in place for telecommunications where a single company (often at least partly owned by the government) provided all the telecommunications services, from basic connectivity to value-added services, from telephony to video broadcasting.

These companies were able to define strategies, even for the long term, and impose them, counting on the revenues granted by the monopoly and the lack of negotiating strength of their customers. Two typical effects were: the definition of company standards (seen as national standards) which providers and customers had to adapt to, and the attitude of compensating inefficiencies in areas outside the core business with ad-hoc pricing policies.

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Now the results of two trends (introduced mainly 'by law' by the European Commission and Parliament)—liberalisation and privatisation—are dramatically changing the scenario. In each country a set of telecommunications operators are competing for services such as fixed and mobile telephony and data networking, and many new companies are offering value-added services, spanning from Internet access to vertical applications hosted in server factories. The former monopolists, however, hold their dominant position and are called *incumbent operators*.

The new actors are often companies born as joint ventures of companies traditionally in the telecommunications business (for example, an incumbent operator from another country), companies owning a suitable infrastructure (for example, an electric power supplier owning a telecommunications network), and investors. The deployment of a new network, or the extension of an existing one to the needed size, is however demanding on investments while, owing to competition, revenues are not certain. Thus almost all the new players in the telecommunications business decided to focus strictly on the provision of the services they believe can maximise the income per money unit spent.

On the customers' side, the request is for services having high quality of service (in general terms), a complex mix of basic features and value-added components and no geographical restrictions on availability. Furthermore, being now possible to select among alternatives, customers do want these services to be offered at a very competitive price.

The newcomers in the telecommunications business, however, are hardly in the position to offer services with all these characteristics from the beginning. Thus they often offer themselves the service components they can provide at best quality and price, and make use, for the remaining components, of third-party infrastructures and services. For instance a regional telecommunications operator could try to use the network of the incumbent operator (with which it is competing locally) to offer long-distance connectivity to its customers. The operator can also agree with a value-added service provider to present its offer jointly to the customers.

At the same time, to face competition, the incumbent operators are leaving many activities outside their main business and adopting the same cooperation-based approach, outsourcing part of the business and interacting with third parties.

It is therefore clear that, in this new scenario, the final service as perceived by a customer is the result of activities carried out by different interacting companies (sometimes cooperating on one aspect, but competing on others). In order to guarantee the proper service quality it is therefore vital to be able to keep under control the overall quality at the boundaries between such companies.

The *quality* and the nature of the *boundary* could be, however, quite different, depending on what is actually offered by a company to another one. To analyse the interconnection and quality evaluation aspects in a general way, it is important to refer to a simple model able to depict the interaction chain that generates the service, hiding, at a first level, any specific characteristic.

This paper presents an example of this kind of model (to be further elaborated), describes it in general terms and shows how this could be used in a specific case. Of course, once a model is proved to be complete and useful, it has to be used as a basis for defining the needed set of interconnection standards, the telecommunications market actors shall agree upon to increase quality and cost effectiveness of their services.

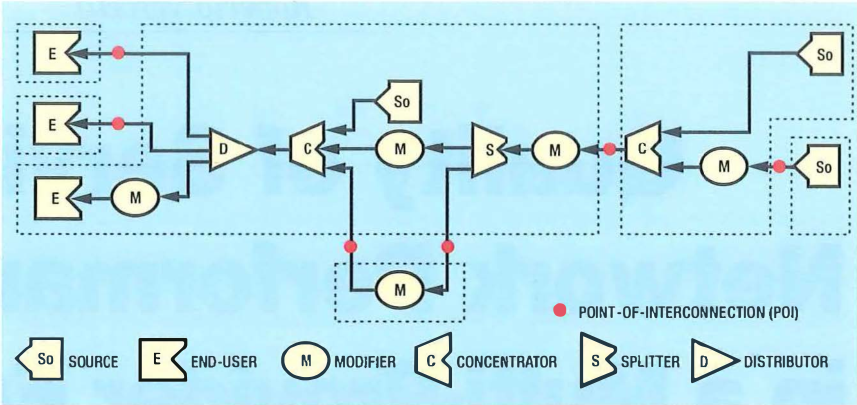


Figure 1—Example of generic LSP

The Service Generation Chain Model

To introduce the model it is to start from the analysis of real interactions among the providers of the single components of a service and the customers. From the variety of cases considered, and having in mind that the main objective is to hide too specific aspects, the concept of the *logical service path* (LSP) is here introduced. The LSP is the dynamic logical link that joins all the entities involved in the provision of a service and the users of that service. The general LSP can be depicted as a block diagram where blocks are logical entities (see Figure 1). Five types of entities are here considered:

- source and end-user,
- modifier,
- concentrator, distributor and splitter.

The point-of-interconnection (PoI) is the point along the logical path where the boundary between two different organisations is located. This is not an entity, but rather an indicator of the responsibility limits of an organisation within the service provision chain.

The identified entities are, as said before, *logical* and the related real resources they model depend on the service type. A *source* is an entity that generates value for the service; depending on the service, examples of sources could be a database, a transmitter, a Web page, etc. An *end-user* is an entity that makes use of the service without contributing to its provision; examples could be a client, a terminal, an application, a receiver. A *modifier* receives, as input, value for the service from another entity and modifies it, passing the result to another entity; an example could be a translator, carrying out document language translation. A *concentrator* receives contributions from more entities and passes them in an integrated way to another entity; an example could be a multiplexer. A *distributor* sends the received input to a set of entities; an example could be a network for video broadcasting. A *splitter* is an entity that extracts from a service different value components passing them to different entities: an example could be an e-mail server dispatching received mails.

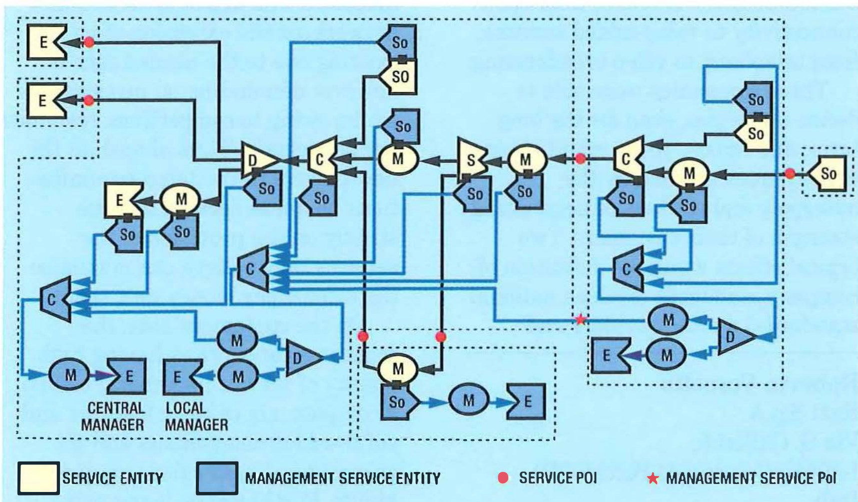
Parallel to the LSP a second path can be considered—the *logical management path* (LMP). The LMP is the dynamic logical link that joins all the management entities (within both the providers and users environment) involved in the management of a service. The management entity categories are the same identified for the LSP.

The two mentioned paths are logically connected by associating to each service entity the relevant management entities (reflecting the actual characteristics and procedures of the management systems) (see Figure 2). In general a service entity is in fact representing something managed and thus can be seen as a source of the LMP. It should be underlined that to be a source does not mean that the entity is initiating a communication or that the management traffic flows unidirectionally out from the entity (in general in fact bidirectional traffic is established between the managed entity and another entity along the logical management path). To be a source means here that the entity offers a value to the management service that is not derived from the value offered by another entity (by modifying, concentrating, distributing or splitting that value). At the same time, the terminal the management system operator uses to control the resources is a typical example of an LMP end-user.

The Interaction Levels

From the discussion above, it is clear that any model one can propose to analyse interactions between organisations jointly providing the value needed to deliver a service must consider both the interactions that take place at the service level and

Figure 2—Example of LSP and LMP interconnection



those at the management service level. At each boundary therefore two PoIs need to be identified as well as the proper entities.

The service level interaction

At the service level, the interaction between two organisations implies that the service-related value is passed through the PoI. In general, a check should be done on the 'quality' of this value (that is, a quality of service (QoS) evaluation, in the broad sense). Considering the entity types previously introduced, this can be modelled by a sequence including first a splitter, in order to separate the part that is subject to the QoS evaluation from the rest (see Figure 3-A). Then the value to be checked is duplicated (by a distributor); while one 'copy' continues feeding the service provision (being passed to the following entities along the LSP), the other one is sent to something able to measure this value (that is, a proper modifier).

The logical measurement unit can make available the measurement results to the management system, being thus a source within the LMP. If the entities of the LSP indicated above are manageable resources, the related management capabilities are also sources of the LMP. All the values to the overall management service generated by these LMP sources can be merged by a concentrator (for example, a mediation device, a multiplexer, a LAN plus a router, etc.) and passed to the following LMP entities.

Of course the model is rather general and can thus be applied to different kinds of service, implying different types of measurement. When the service is 'connectivity', the relevant QoS is defined in terms of transmission performance parameters, and measurements can be carried out in compliance with ITU-T G.821/G.826 and M.2100 Recommendations. Information can be taken from network elements having proper management functionalities and/or from transmission flow probes (commercially available, that could be equipped with additional hardware/software, if needed, in order to interface them to the management system). When the service is at a higher level (for example, access to an images database), the 'element' having proper management capabilities and the probes could be quite specific and require dedicated hardware and/or software.

It should be noted that, for a mutual check, an identical section of LSP and LMP can be envisaged at the 'sending' side of a service PoI.

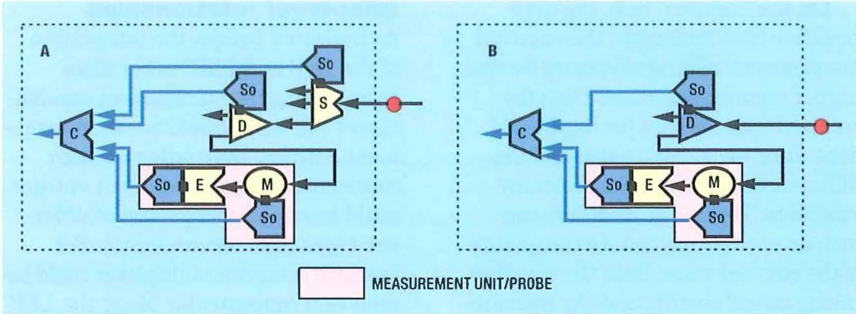


Figure 3 – Example of LSP and LMP entities at a service PoI

This allows the organisation offering the value through the service PoI to take under control and document the quality of the value itself.

The management service level interaction

Before analysing the entities that typically are present at a management service PoI, it could be useful to look briefly at the structure of an LMP reflecting a generic management system. This LMP normally shows a set of sources corresponding to management resources (for example, managed network elements, network data layer database, measurement systems and probes, customer claim centres, etc.). The value they give to the management service is merged by a concentrator and distributed by either a distributor or a splitter (for example, jointly representing the network used to transfer data). The value is then made available to a modifier (for example, a computing system that elaborates management data). The modifier output could be duplicated and sent to further modifier(s), to an end-user (for example, representing a local manager) and to a higher level concentrator.

The output of this last concentrator is further elaborated by modifiers and made available to the high-level end-user (for example, a central manager; that is, the operators of the main management centre).

In Figure 4 it is indicated that part of the information/value flow for the high-level end-user could be extracted by a splitter, and (through a proper sequence of entities not depicted in the figure) sent to external management entities. Similarly the high-level concentrator can collect management service value from external entities. These interactions are at the management service level and take place through a management PoI by passing value relevant to the specific management service.

Again it is important to introduce control and 'measurement' capabilities at both sides of the management service PoI. Figure 5 depicts the typical entities sequences.

Figure 4 – Example of LMP and related management PoI

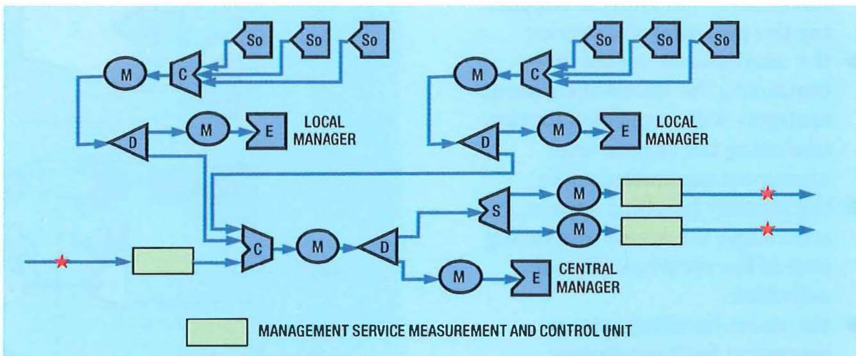
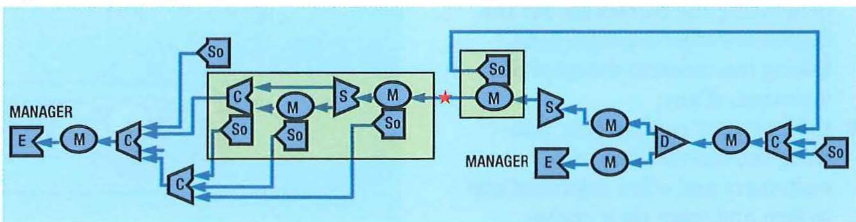


Figure 5 – Example of LMP entities at a management service PoI



On the 'receiver' side, the first modifier that intercepts the external management value should carry out the proper security activities. Then the received value is split (or duplicated, depending on the solutions) and the different components elaborated by modifiers. This set of modifiers can include entities measuring the quality of the received value. Both the modifiers taking care of security and the measurement modifiers can provide information (check results and measurements) to the management system; that is, to be additional sources on the LMP.

On the 'transmitter' side the part of the overall value related to the management service provided internally is extracted (by a splitter) and, after modifications (if needed) passed to the external entities through the management service PoI.

In general, the entities within the LMP that are of major importance for the interaction at the management service level between two organisations include those logically reflecting resources such as:

- managed components (for example, network elements, computing platforms, applications) having proper management capabilities;
- probes and measurement systems equipped with proper management capabilities and interfaces;
- the network data layer (that is, the database containing all the data relevant to the real network resources and their current configuration);
- the service data layer, containing all the data relevant to the components (hardware and software) of the systems supporting the provision of a service;
- the administrative data layer, containing the information about contracts with connected parties (including the service level agreement parameters list);
- the security handling system, controlling the access and taking care of the security-relevant activities;
- the alarm handling system, managing fault conditions;
- the accounting system, handling the charging data collection and generating the correct bill for the customers/other organisations, taking into account detected SLA violations if any;
- the customer care system, handling the interactions with customers and other organisations to face and trace their claims.

Inter-level relationships

As indicated before, the integration of the LSP and LMP takes place representing the management capabilities of the service entities as management entities. Depending on such capabilities the management entities could be one or more (even of different types) per service entity. For instance, a service multiplexer could be seen as a concentrator along the LSP, but also as a source (being a managed network element) and a concentrator (in case it allows the multiplexing also of management traffic) on the LMP. Furthermore, in general, the management service can make use of other basic services (for example, to transfer management traffic from one organisation to another where a connectivity service is used). It is thus clear that inter-level interactions could take place.

Looking at the example depicted in Figure 6, organisation C outsources the management of its resources to organisation A using the organisation B connectivity services for communications. Thus, from the LMP viewpoint, there is only a management service PoI between the organisations C and A, while from a LSP perspective there are service PoIs between A and B and between B and C.

Of course, even in case of inter-level interactions, the typical set of entities described above is to be used at the two kinds of PoI.

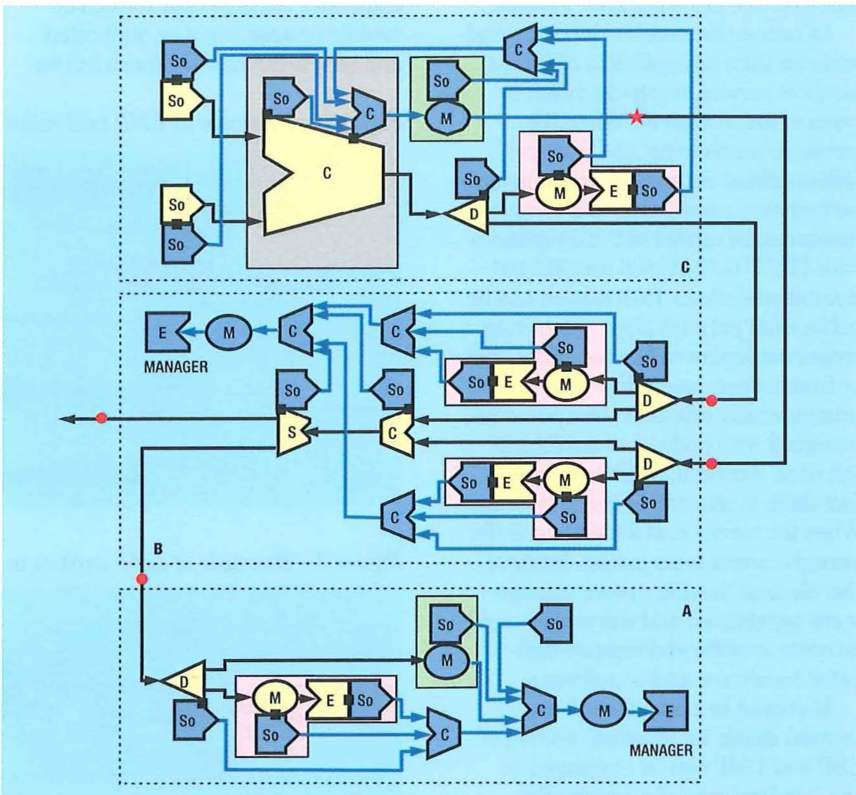
Example of New Operator Interactions

As an example of the interactions among parties that jointly offer a service in a scenario where cooperation and competition take place at the same time, we will consider here:

- a new network operator born as a joint venture of a utility company owning a long-distance network infrastructure (for example, the national railways), a company with telecommunications business experience (for example, an incumbent operator of another country) and an investor (for example, a group of banks);
- the incumbent operator of the country where the services are offered; and
- an independent Internet service provider (ISP).

The new operator will typically aim at exploiting the fibre cables of the original private network, limiting the investments in local networks, reaching its customers wherever they are located and offering a rich variety of services. Considering these objectives the newcomer in the example would like to play the role of long-distance network operator using, for the local connection, the incumbent operator's access network (for example, renting

Figure 6 – Example of LSP–LMP relationships



the access right and paying for the related traffic). This could be made possible by laws and regulations introduced in order to favour competition. The normal service bouquet that an operator is today expected to offer includes telephony (with added-value services (for example, freephone numbers, virtual answering machine, follow-me etc.)), switched and semi-permanent data connectivity and Internet access. We suppose here that the new operator will exploit, for Internet access provision, the brand name, tradition, experience and resources of an already well established, independent ISP by signing an agreement with such a ISP. The Internet access service will be sold to the customer as a new operator's service and the related bill integrated in the new operator's overall bill.

The example thus foresees two different interactions for the new operator, respectively with the incumbent operator and the ISP. To further analyse these interactions we will make some realistic assumptions based on the current situation in Italy and some other European Union countries.

Interconnection with the incumbent operator

To allow new operators to compete with incumbent operators, regulations and laws are defined in the European Union countries reflecting the 96/19/CE Directive. As the incumbent operators have been at the same time privatised, to defend the investors who bought the monopolist shares (often from the government, the former largest shareholder), trade-off solutions were found in each country. Such solutions balance the rights of both the newcomers (that is, the incumbent operator cannot refuse to rent some of its resources) and the incumbent operator (limiting the range of these resources and giving room for tariff negotiation).

Starting from the interconnection policies of Telecom Italia (and BT and France Telecom) we suppose here, to have a realistic example, that the incumbent operator:

- is forced to make available its resources only for telephony, while analogue or digital direct links (semi-permanent connections) as well as ISDN and connections to data networks are subject to free negotiation between the parties; and
- is offering three kinds of services for telephony:

–*call termination*, allowing telephone calls from other operators to terminate at the incumbent operator's customers, routed on the incumbent operator network starting from the relevant PoI;
–*call collection*, allowing the calls from the incumbent operator's customers to be routed and collected at the PoI where they are passed to the other operator; this means that the incumbent operator's customers can become customers also of the other operator, using the services it offers and paying it directly for these services; and
–*international routing*, allowing the calls originated by the customers of the other operator, received from it at the relevant PoI, to be routed to other countries.

The PoI could be, for instance, located at three different levels (this depends on the actual incumbent operator's network infrastructure) (see Figure 7):

- international central office (ICO),
- transit central office (TCO), and
- urban area central office (UCO).

In general, to guarantee a high level of availability and reliability, the new operator should use two PoIs at two different ICOs or TCOs and set-up two separate flows using the 'fair traffic load' criterion.

From a physical viewpoint the PoI could be either located at a new operator site or within an incumbent operator site. In the first case the incumbent operator takes care of (and asks payment for) the link between the two sites while in the second one this connection is to be provided by the new operator.

In Figure 8-A the connection is at the new operator premises and takes place between a new operator

Figure 7—Incumbent operator–new operator interconnection schemes (A: international routing, B: call termination via TCO, C: call collection at TCO, D: call termination via UCO, E call collection at UCO

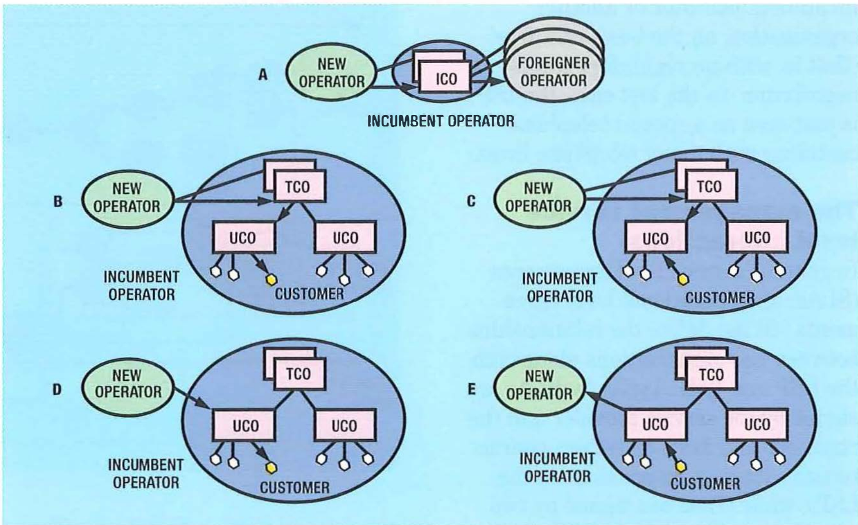
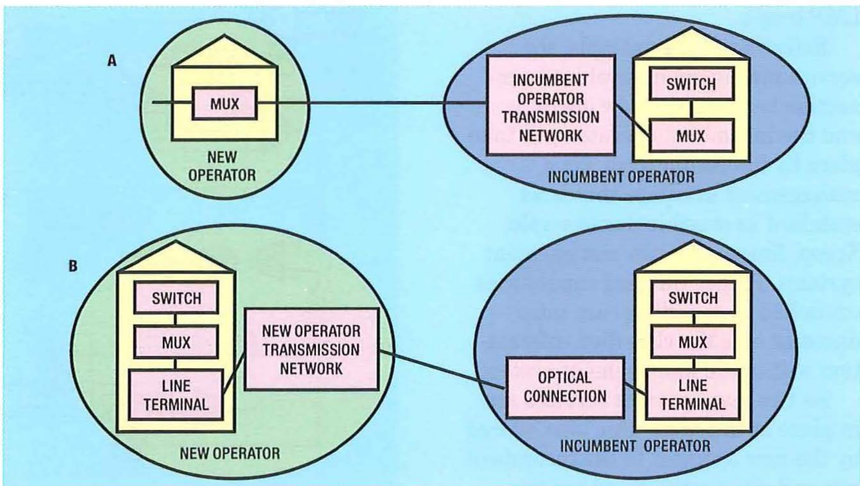


Figure 8—Possible physical location of PoI



multiplexer and the incumbent operator network (accessed at a transmission access point). In Figure 8-B the connection is a fibre splicing within a cabinet close to the incumbent operator premises.

Interconnection with the ISP

The connection with the ISP can take place in different ways depending on the relative location of the ISP site(s) and the new operator network. The following situations can occur:

- the ISP is directly connected to the new operator network,
- the ISP and the new operator are connected via third-party communication resources, and
- the end users are connected to the ISP server(s) via telephone calls, thus making use of the already described mix of new operator and incumbent operator resources.

In the following we will consider the first case. It should be noted that, in the second case, the connectivity could be provided by either the incumbent operator or another organisation, on the basis of a 'free' (that is, with no regulatory limits) negotiation. In the last case, the ISP is just seen as a special telephone customer with many telephone lines.

The management service level interactions

In general, service level agreements (SLAs) and operational level agreements (OPAs) define the relationships between two organisations along both the LSP and LMP. Typically, SLAs are signed by the service provider and the customer and focus on service characteristics (that is, interactions at the LSP), while OPAs are signed by two providers and consider both the service and the management aspects (that is, interactions at the LSP and LMP level).

Referring to the example, the service management level interconnection between the new operator and the incumbent operator will take place by interconnecting, via a management interface that is as standard as possible (for example, Xcoop, Xuser), the two management systems. Proper filtering capabilities (modelled by modifiers) are introduced to hide the classified information within the management system.

As two management services are in place at the same time (one offered by the new operator to the incumbent one and vice versa), there are two logical 'flows' of management-service-related value (from the new operator to the incumbent one and vice versa).

The service management level interconnection between the new operator and the ISP will typically exploit the management solutions adopted in the Internet environment. For example a CORBA bus can connect the management system of the ISP and the dedicated unit (within the management system) that the new operator will use to interact with the ISP.

The communication between the two management systems could make use of the new operator network, the incumbent operator communication resources or other solutions. Proper security mechanisms will be introduced to avoid the reading, deletion and modification of the information exchanged.

It should be noted that, again, two management services are in place at the same time (one offered by the new operator to the ISP and vice versa), and that there are two logical 'flows' of management-service-related value.

Model for the described example

The realistic interactions described above between the new operator and, respectively, the incumbent operator and the ISP can be modelled making use of the generic model introduced before. To summarise we assume that:

- the new operator only takes care of long-distance connectivity using the incumbent operator access network,
- the ISP is connected directly to the new operator,
- there are two management services in place for each of the two management interactions.

Figures 9, 10 and 11 show the LSP and LMP for the three organisa-

Figure 9 – LSP and LMP for the ISP

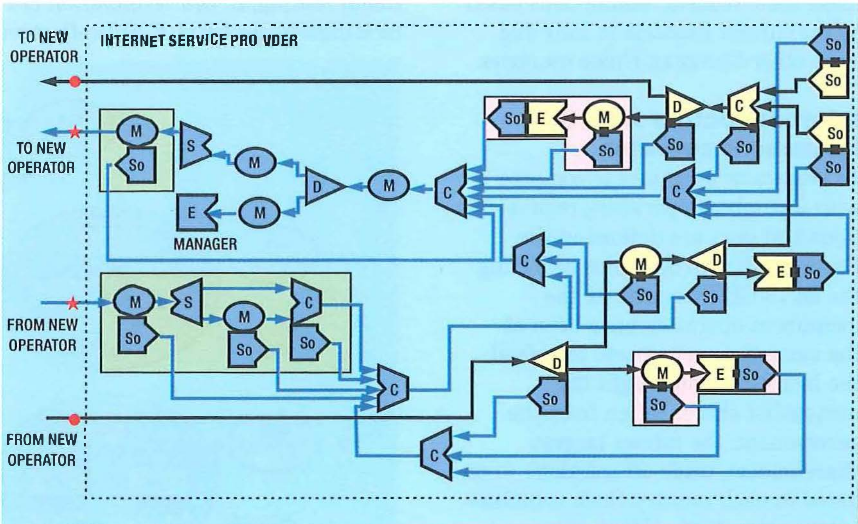
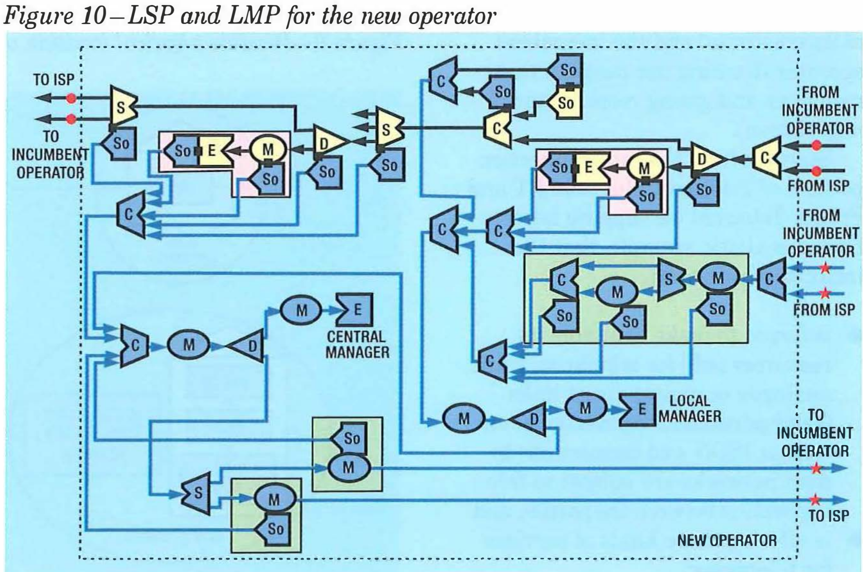


Figure 10 – LSP and LMP for the new operator



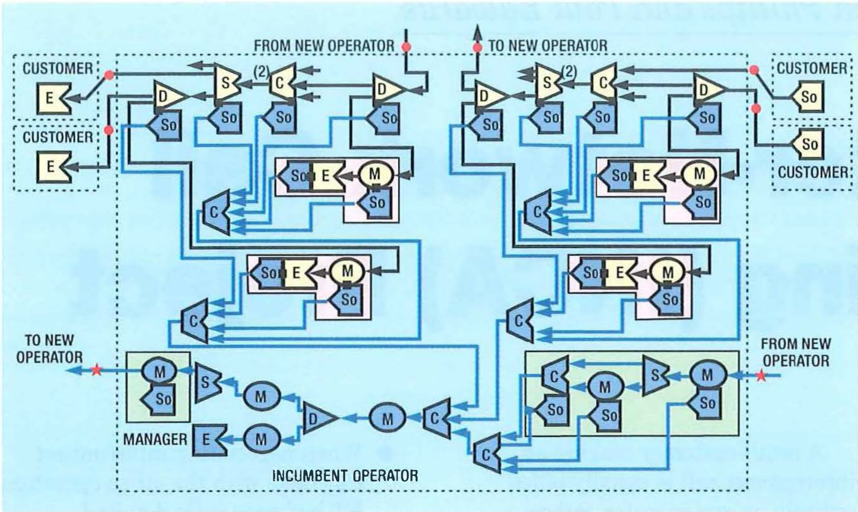


Figure 11 – LSP and LMP for the incumbent operator

tions involved (and for the telephony and Internet access services).

Conclusions

In the new scenario for telecommunications, services will, more and more, be jointly offered by a group of providers, with one of them being the service seller. Each of the providers feeds the service with 'value' that will be perceived by the user at the end.

As many different kinds of relationship can take place among the service co-providers, any analysis is rather difficult and risks being limited to a specific case. The first step to make analysis possible is to introduce a simple and generic model able to describe the way any possible service is generated and delivered. This model could then be used as a base for developing analytical procedures and tools as well as standardised criteria and solutions for setting-up and controlling interactions.

As competition and cooperation will take place at the same time among the service co-providers, it is in fact important that reference standards are defined to evaluate the 'quality' of what is exchanged, the way to measure it and how to actually pass it to each other (with reference to the signed SLA/OLA).

This paper has introduced a simplified model that, far from being a final solution, aims at stimulating the discussion about how to model the service provision chain and the interactions among co-providers at the service and management service level.

Biography

Roberto Vercelli
Sirti S.p.A.

Roberto Vercelli has a degree in Nuclear Engineering which he obtained from Politecnico di Milano in 1988. He spent one year at the nuclear electronics laboratories of CNR working on ultra-fast pulse lasers. He has been with Sirti since 1988, first in the Optical Technologies Department, and then responsible for the Business Networks unit of the Research and Development Division, where he covered areas such as broadband networks (DQDB MAN, ATM LAN and WAN, multimedia networks) and services (data, for example, SMSDS, and multimedia), and management systems (for network, service and system management). From 1996 he has been with the Systems Division, initially as bid manager and then as marketing manager for management systems and multimedia/Web services. He is the company's delegate at: ETSI NA5, ITU-T SG4, ITU SG7 and ESIG. He is project manager of two ESPRIT projects and one ACTS project, and is an author of more than 30 papers.

Eden Phillips and Paul Edwards

The Inter-Network Call Accounting (INCA) Project

A major challenge in a multi-operator environment is accurate billing and verification of interconnect traffic between operators. In the UK, which has some 150 operators, BT has developed the inter-network call accounting (INCA) system to tackle this problem. This article reviews the background behind the development of the system, provides an overview of the system requirements and its architecture, and shows what a major impact the system is having in the industry. The article goes on to describe the main system components.

Background

One of the consequences of opening up the UK telephony market is the large number of calls now made between customers of different network operators. One of BT's fastest growing areas of business is carrying these *interconnect* calls for other licensed operators (OLOs) in the UK. BT now carries arond 2 billion calls each month that either originate or terminate within OLO networks.

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A retail customer making an interconnect call is usually billed entirely by one operator. Subsequently, any other operator involved in carrying the call will bill the operator who collected the retail fee for use of its network to deliver the call. INCA is the system BT uses for billing and verifying interconnect telephony traffic between itself and the OLO in the UK.

Many telephony billing systems are based around *bulk counters* on exchanges which simply count the number of calls and total elapsed call times by certain categories. INCA is an *off-switch* system that processes itemised call detail records for every individual interconnect call that passes between BT and the OLOs. This allows more flexible charging and pricing regimes to be implemented and takes processing overhead off the exchanges. The system processes approximately 90 million call detail records (CDRs) per day.

The system was developed for the following reasons:

- Before developing INCA, BT was unable to produce accurate information with which to bill the OLOs for use of the BT network. The company relied on the OLOs themselves to declare how much they owed BT. Similarly BT was unable to verify, to any level of detail, the bills sent by the OLOs for interconnection to their network. This left BT lacking detailed and accurate evidence to put forward in cases where it wished to dispute an OLO's bill for example. Additionally some of the OLOs were considering charging BT for providing their own self-billing declaration.
- To help meet BT's audit requirements.
- This lack of a quality system undermined BT's image with the OLOs and OFTEL.
- When negotiating interconnect contracts with the other operators BT had very little detailed information on which to base its negotiating position in comparison with the OLO's negotiators.
- OFTEL was increasingly pushing BT to provide *accounting separation* between its various business units. One of the fundamental areas for accounting separation was to identify the costs for providing interconnect services. A more detailed, accurate and auditable system for billing interconnect charges helps BT demonstrate there is no cross-subsidisation between the retail and wholesale parts of the business and it is charging OLOs a 'fair' rate for use of the BT network.
- Strategically BT identified that interconnect telephony is a market in its own right. While not wanting to lose retail customers to OLOs in the UK, it saw that it could regain some of the revenue lost when customers defect by carrying the interconnect element of their calls. This is particularly true of geographically-based carriers such as the cable TV (CTV) operators who are dependent on a trunk carrier to deliver calls outside their operating region. These OLOs have a choice of trunk operator to carry their traffic and the accuracy of the trunk operator's billing system is important to them. A reliable system significantly reduces the amount of manpower an OLO has to use to verify and check their bills. A lot of information can be extracted from the raw call data that could be provided to the OLO for management information and marketing purposes. This includes information about customers and products and operational and routing information that could be

of use to a network planner who was looking for least-cost routing, for example. BT is, however, restricted in its ability to use that information. It is not allowed to pass any information about customers that has been gathered from its interconnect operations to its retail arm.

System Requirements

Once the decision to produce an interconnect billing system had been made the following high-level system requirements were determined:

- *Data Integrity* As BT is the incumbent operator in the UK market, a higher level of integrity and accuracy is expected. The end-to-end system and the business processes put in place to operate it, from capturing the records at the exchanges to producing the bills, had to be capable of processing the huge volume of data without losing any records. On top of this BT also has a far higher number of interconnect partners to deal with and more points of interconnect than any other operator.
- *Auditable* The quality of the system had to be demonstrable to an external auditor. There had to be clear and unambiguous audit trail through the system.
- *Accurate* The system must process the data correctly and accurately. This is particularly important to a company such as BT because of its position in the market. Disputes over the accuracy of the bills could make relationships extremely uncomfortable and give rise to accusations of deliberately making operations difficult for the new entrants. Long-running disputes could also delay the payment of very large bills with the associated impact on cash flow.
- *Robust* Because of the huge volume of data and the critical importance of the system to BT the system had to be robust and reliable. The system processes data 24 hours a day, every day of the year, and has been designed with resilience in mind.
- *Flexible* Interconnect billing is a fast changing area and the system had to be designed so that it could be enhanced and updated quickly in line with the changes in the business environment. The flexibility requirements are reflected in the modular design of the system, the structure of the database and application and the choice of hardware and software tools.
- *Scalable* Because of the difficulty in forecasting future interconnect volumes it was important to design a system that would not be limited by its own capacity to process CDRs.
- *Operable* From a computing perspective the system had to be easy to operate.
- *Maintainable* Given the large amounts of reference data that need to be held to support all of the various interconnect contracts in the UK, the data storage structures and the data entry mechanisms had to be built in such a manner that the end users can maintain the system with the minimum possible effort and staff.
- *Ease of use* The system had to be easy to use and intuitive for the end users to pick up. It had to have the same kind of look and feel as the other desktop applications they run on their PCs.

High-Level Design Decisions

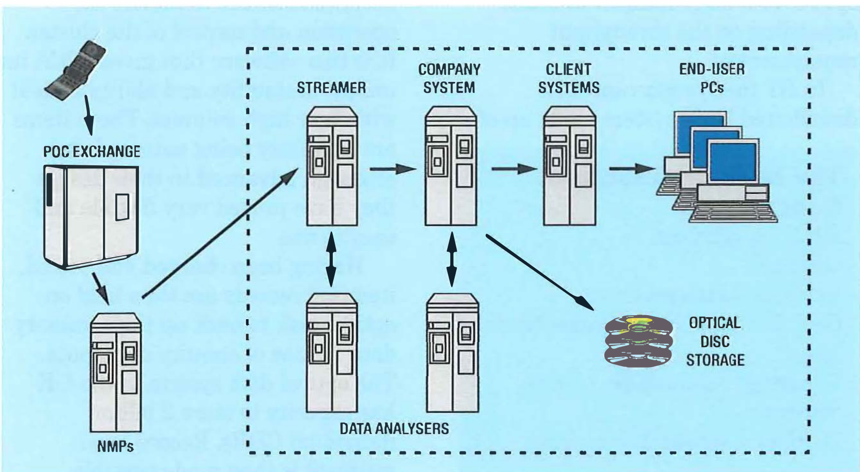
As a result the following high-level design decisions were made:

- *Itemised records* To allow for maximum flexibility and accuracy the system is an 'off-switch' billing system based on itemised CDRs.
- *Modular design* The design of the system was to be modular, making it more flexible and adaptable. When changes were necessary they could be fitted into the system with minimum impact. The various modules could also be individually customised, thereby optimising the system as a whole.
- *Open systems* To escape from the rigidity imposed by mainframe computers and to enable BT to customise a solution to the problem rather than make the problem fit the solution it was decided that the architecture should be Unix-based. This was also far more cost-effective.
- *CASE development* To speed the development up, to ensure integrity of the system and to make the system more maintainable in the future it was decided to utilise computer-aided software engineering (CASE) tools for development.
- *Easy-to-use interfaces* Where possible the end users were to be given graphical user interfaces (GUIs) to the system, similar to those used by the Windows applications on their PCs. The on-line screens have been updated with this in mind and the users have been provided with sophisticated reporting tools through which they are able to produce their own information.
- *Itemised call storage* It was decided that facility would be provided to store the individual CDRs after they had been processed for management information system (MIS) purposes and to back up the bills in case of any dispute.

Processing and Technical Architecture Overview

For every call that passes between BT and an OLO's network a CDR is produced by the exchange at the

Figure 1 – Logical overview



point of connection (POC) between the two networks. These CDRs are sent from the exchanges via a *network mediation processor* (NMP) to the INCA *streamer* (Figure 1). The streamer uses information contained in a *routing reference model* (RRM) to deduce which OLO the call was from or to. Amended records are then sent to the INCA *company system*, where each CDR is charged and priced and the results summarised into reporting tables. The INCA users use these summaries:

- to bill OLOs for use of the BT network for calls originating in their network and terminating in or passing through BT's,
- to verify bills sent out by OLOs for calls that travel in the opposite direction, and
- to produce MIS reports.

The main challenge has been to design a highly scaleable system, capable of coping with the huge volume of data every day and rapid growth of the market, that is flexible enough to cater for a fast-changing and evolving business area. The final architecture of the system is a specialised and innovative integrated solution.

The application software is a major CASE development utilising Sterling Software's Cool:Gen tool combined with an advanced GUI-based report generation package, Business Objects. Some of the later on-line transactions utilise advanced three-tier client-server techniques to enter large amounts of data quickly directly from a spreadsheet but with no loss of integrity.

It is important to note that Figure 1 is a logical view of the architecture. Physically the sub-systems shown can be impemented across one or two smaller boxes or split over a large number of boxes depending on the throughput requirements.

In BT the system runs on a distributed Unix system made up of 50 separate Hewlett Packard machines. At the heart of the charging system is a configuration of machines called a *cluster* comprising one master machine and a number of slave machines (38 slaves in the UK system). A copy of the main charging and pricing process runs on each of the slaves allowing many files of CDRs to be processed in parallel. This provides a highly resilient and scaleable solution. As call volumes rise the capacity of the system can be increased by simply adding additional slave processors.

The Main Architectural Components
HP Unix platform
Oracle/C
Cool:Gen batch routines
Cool:Gen and Oracle Forms for on-line
Reporting via business objects
Windows 3.1
Dorokey—optical disk storage

Recent architectural changes have meant that the cluster is now capable of running slave machines with an SMP architecture (that is, multi-processor machines) and the 38 single processor machines will be replaced by six or seven boxes with between four and six processors running on each giving a processing capacity of around 200 million CDRs per day. These architectural changes also mean that the system could run on just one box if necessary. This gives tremendous scalability for a new entrant, such as one of BT's joint ventures, who could start with a minimal solution and have knowledge that the system can be expanded to hundreds of millions of CDRs per day simply by adding processors and/or hardware with no application changes required.

In early versions of the system, BT used standard Unix file handling facilities and Hewlett Packard's Taskbroker product to manage the operation of the cluster. However, as volumes rose, problems with these prevented the system from being scaled up to meet the additional load. As a result, BT has now developed special file-storage systems between the streamer and company systems to cope with the high volume of data passing through the system and bespoke software to handle the operation and control of the cluster. It is this software that gives INCA its unique scalability and ability to deal with very high volumes. These items are currently being patented and although advanced in their design they have proved very flexible and easy to use.

Having been charged and priced, itemised records are then held on optical disk to back up the summary data in case of enquiry or dispute. The optical disk system in the UK has capacity to store 2 billion individual CDRs. Record-level retrieval is then made possible through a highly-customised version of Dorotech's Dorokey software.

INCA has been implemented over the last four years in a phased manner to meet the fast-evolving business area and to exploit the latest leading-edge technology.

Project Impact

The system has allowed BT to process accurately over 1·3 billion individual call records every month and produce bills in a fast changing market for over 150 OLOs in the UK. Because of its accuracy BT has been able to identify millions of pounds of previously under-declared payments, thus benefiting both itself and the rest of the industry.

The accuracy of the system is demonstrated by the fact that the system has quickly become the standard against which OLOs' interconnect systems are measured in the UK and by the issue of a Certificate of Competence by Price Waterhouse following a detailed and extended external audit of the system and its processes.

The benefits of the project for BT are:

- the ability to bill accurately the OLOs and verify their bills,
- the ability to meet its regulatory requirements quickly such as the introduction of a new charging mechanism (element-based conveyance) and number portability in short timescales,
- the capability to add value for its wholesale customers (the OLOs) through the billing system,
- the provision of valuable marketing and MIS information,
- reduction in the number of disputes between BT and the OLOs and OFTEL, and
- improved image for BT, both in the UK and in the worldwide market, where INCA is seen as a world leader.

The client for the INCA system in the UK is BT's Finance, Billing and Receivable group. The main users of the INCA system are BT's Carrier Services group who are effectively the account managers for the OLOs and the Financial Analysis Interconnect (FAI) group who are responsible for the actual billing of the OLOs.

Commercial implications

A whole new market has grown up in providing interconnect which has resulted in making major competitors major customers too. This requires new organisations, new systems and a new way of thinking:

- new processes and procedures need to be put in place,
- new products and services now have both a retail and interconnect perspective,
- regulatory issues also affect the market, combining with competition and product development to make the interconnect arena very dynamic,
- the regulator can have a major effect on market development and interconnect can be a major area for his consideration.

Globalisation of telecommunications

Over the past year, BT Systems Engineering has been successful in providing the skills to support partners and joint venture partners in other countries in pursuit of their requirements for interconnect, specifically through the adaptation of INCA for this purpose. This has successfully spawned a number of commercial deals for the product:

- In the early days of INCA, BT provided CELLNET with the base system from which their interconnect accounting system (CAMS) was developed.
- During early-1998, BT won a competitive tender to provide a version of INCA to TELENOR of Norway. The system (BICO) is now operating successfully within the Norwegian telecommunications arena.
- Over the course of the past year, a number of BT's joint venture partners in Europe (for example, VIAG (Germany), Telfort (Holland), Telenordia (Sweden), Albecom/Picienne (Italy), Sunrise (Switzerland) etc) have expressed considerable interest in taking on INCA as their system to support interconnect within their own marketplaces, and a number of detailed negotiations have ensued. BT has recently provided INCA as a bureau service to provide a relatively 'low-cost' option for the JV partners, and firm plans have been agreed with Telfort and VIAG for provision of service through the bureau. Albacom has additionally signed a letter of intent to use the bureau and Telenordia is currently considering it. In addition to the bureau service, BT also offers the following services to the JV partners:

—systems experience and consultancy,
—reduction of start-up costs,
—risk sharing,
—guidance/help,
—leveraging BT's experience in the field, and
—competitive advantage from a proven supplier.

External interest

BT's experience in the interconnect market and the INCA system has been featured in several press articles and presented at a number of international conferences and BT and the INCA system are now regarded as world leaders in their field. BT's suppliers also use the INCA system as a worldwide reference site to demonstrate the use of their technologies on a high-volume, strategic commercial system.

The system is of interest for the following reasons:

- it is the result of a close relationship between both the business and IT groups within BT and has delivered considerable benefits;
- in developing INCA, BT has harnessed leading-edge technology in a fully operational commercial system capable of processing vast amounts of data every day;
- the INCA development is an excellent example of a company working with its suppliers to produce an integrated and successful system;
- the quality and integrity of the system is excellent as demonstrated by the Price Waterhouse certification;
- the system has quickly become the industry standard in the UK; and
- the system has developed a world wide reputation as a leader both for its functionality and for its design and has attracted much interest from both telecommunications and non-telecommunications companies alike.

The system has now been adopted by other companies.

Details of the Main System Components

INCA has been designed in a modular fashion. The process of collecting call records from the NMPs through to finally producing the billing process has been broken down into a number of steps. These steps make up six logical components of the overall INCA system. The design of the applications is as far as possible hardware independent, thus these components and the steps that make them up are configurable allowing them all to be run on a few small Unix machines or expanded out to run over a large number of boxes, like BT's system, depending on the volume of data and processing requirements at an installation site.

Streamer

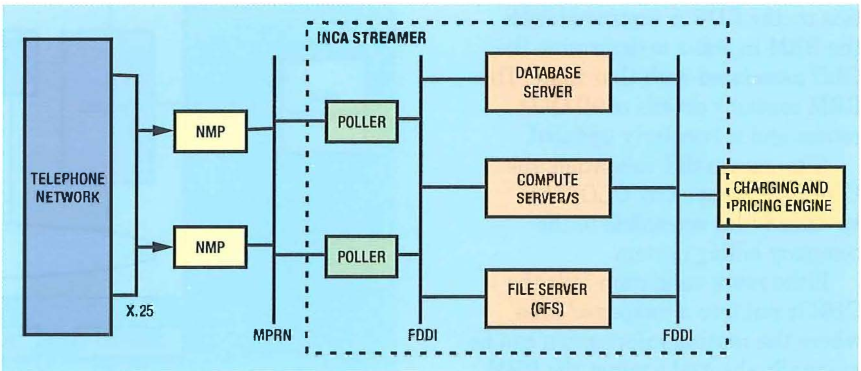
Introduction

The INCA streamer (Figure 2) is the sub-system responsible for collating and validating call-accounting data on a per OLO basis and making this information available to the INCA company system for use in billing calculations.

The NMP (sometimes known as the *data mediators* (DMs)) collect binary CDR files from the network switches. Each file contains between 500 and 16 500 CDRs. The INCA streamer collects the CDR files from the DMs, validates them and allocates the individual CDRs to an OLO.

Each CDR holds the interconnect route identifier and direction which

Figure 2—Logical view of the streamer architecture



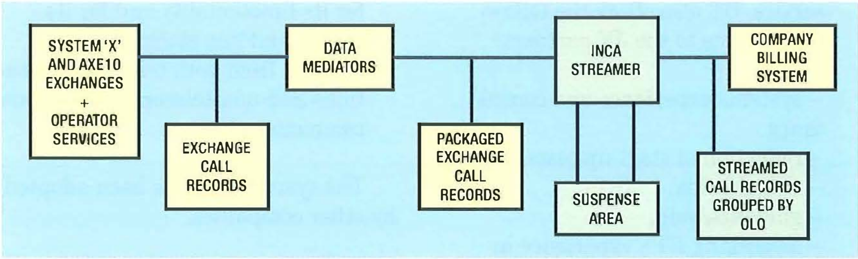


Figure 3 – Company billing system

is used to determine the OLO. The CDRs are grouped by OLO and made available to the company system. If validation fails an exception handling process is invoked.

The company system retrieves the validated 'streamed' files and calculates a price for each call record in the file. When the company system has finished processing the file, it updates the file information held on the streamer, and the streamed file is deleted.

Processes

The INCA streamer is the interface between the NMPs and the company billing system (Figure 3).

The INCA streamer retrieves a list of CDR files from the NMPs and transfers ('polls') all the files referenced in the list to its own on-line storage, deleting the original file on the NMP.

Files polled from the NMPs are validated to ensure that their structure and header information is correct. If header information or the structure is incorrect and cannot be fixed automatically by the process the file is sent to a 'sump' area where it can be manually analysed.

CDRs are converted to an internal standard format and are individually validated using a set of predefined rules. Any non-billing related data failing validation can be 'fixed' automatically by substitution with default values. Billing-related data failing validation must not be fixed and the CDR is sent to the 'sump' area for analysis. The route information on the CDR is compared with the RRM in order to determine the OLO associated with that route. The RRM contains details of all OLO routes and is regularly updated.

After successful validation, the CDRs are grouped by OLO into streamed files accessible to the company billing system.

If the route validation fails the CDR is put into a 'suspense' area where the routing information can be manually checked against the RRM which can be then be updated as necessary.

The suspended data is then reprocessed by the streamer and grouped into the OLO streamed files.

A remotely sited fallback system mirrors the architecture of the live streamer; it has sufficient on-line storage capacity for 90 days of data at full live volumes. In the event of a major failure of the live streamer, the fallback streamer becomes operational.

Network connectivity

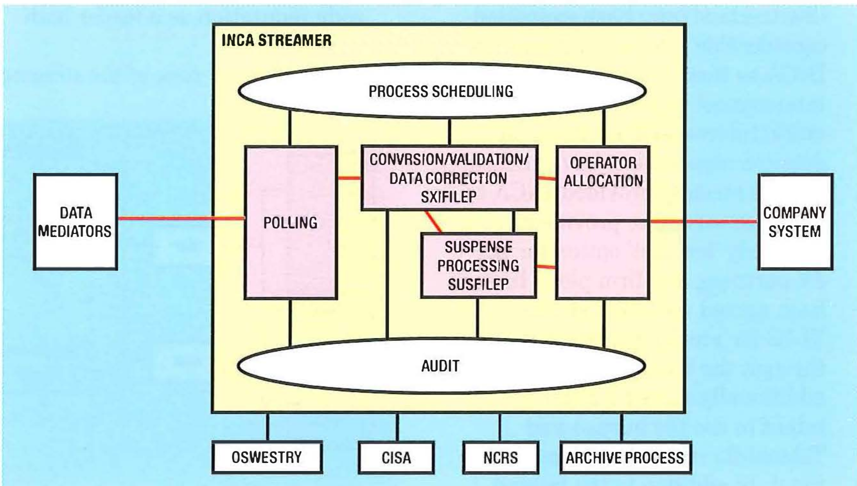
Connection to the company system from the streamer is via TCP/IP. The UNIX RCP (remote copy) command is used to copy files from the streamer. SQL*NET is used to read and update information in the streamer database.

Company system

The company system transfers all streamed files and calculates a price for each CDR in the file. The data is then grouped and added to summary tables held for the appropriate OLO. Selected call records are archived to optical disk storage.

Once the streamed file has been processed, the status of the file is updated in the streamer database, allowing the streamer to delete the file.

Figure 4 – The main INCA streamer processes



Software

Figure 4 shows the main INCA streamer processes. Much of the information used by the streamer is stored in Oracle tables, therefore, all the processes shown have access to Oracle.

Hardware and physical configuration

System implementation

The physical architecture of the INCA streamer is shown in Figure 5. The streamer is distributed across several Hewlett Packard UNIX workstations, process control being managed by the master scheduler.

Oracle configuration

Oracle is operated using a client-server architecture. The streamer database is hosted on machine 'B', the server. All other machines will operate as clients, connecting to the server via SQL*NET v1 and v2. The server is configured to use the multi-threaded server feature for these connections.

Development tools

Release 4.0 of the streamer will utilise the following products, technologies and protocols:

- Cool:Gen for structured design and automated source code generation;
- UNIX System V Release IV (HP/UX 9.0.4);
- POSIX (and ANSI) compliant 'C' code;
- T POSIX compliant Bourne Shell for UNIX shell scripts;
- HP Softbench as a 3GL development CASE tool;

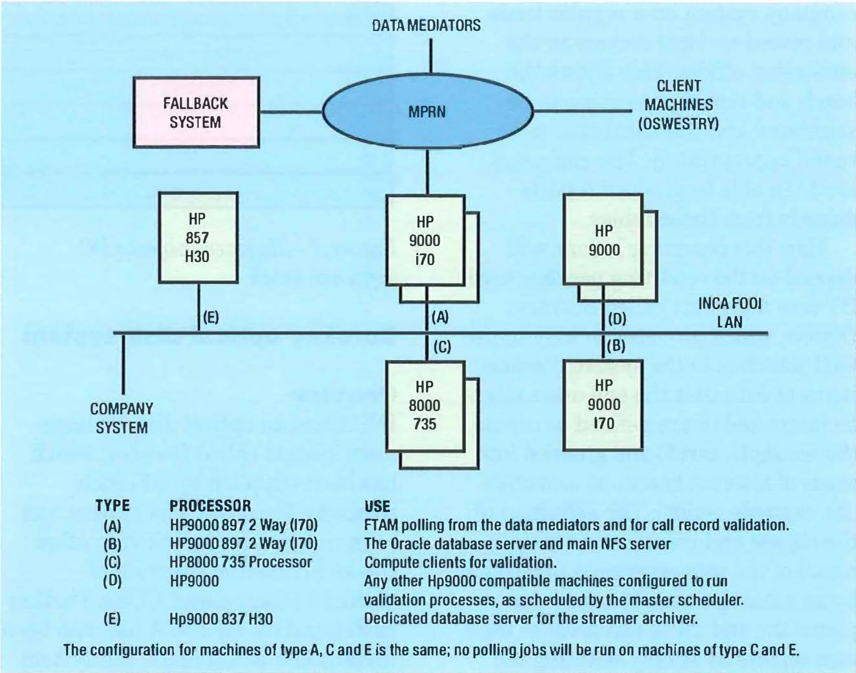


Figure 5—Physical architecture for INCA streamer version 4

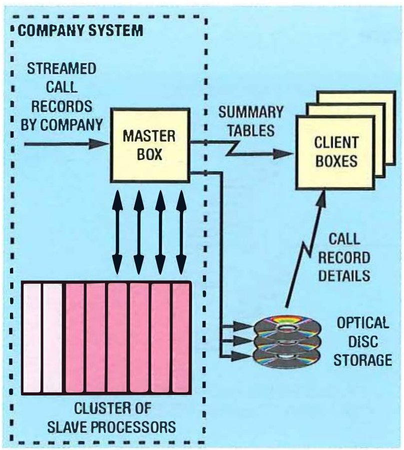
- Business Objects Version 3.0 or greater as a PC client for reports;
- Oracle Version 7.1.3, including:
  —PL/SQL Version 2.0,
  —PRO*C Version 1.5,
  —SQL*FORMS 4.5, and
  —SQL*NET TCP/IP Version 1.3 & Version 2.0;
- FTAM for NMP communications; and
- NFS and TCP/IP for all inter-INCA system communications.

Company system (charging and pricing engine)

Hardware architecture

At the heart of the charging and pricing engine is a hardware configuration called a *cluster* (Figure 6) comprising one master machine and a number of slave processors. Each slave holds its own copy of the main charging and pricing process allowing a large number of files containing CDRs to be processed in parallel. This provides a highly resilient and scaleable solution. As call volumes rise, the capacity of the system can be increased by simply increasing the size of the cluster.

Figure 6—Company system cluster architecture



To remove certain bottlenecks in Unix, BT has developed, in-house, a special file storage system on INCA and bespoke software to handle the operation of the cluster. These enable the system to process an average of 92 million itemised call records per day with strong audit integrity.

Processes

Receive calls from streamer

The company system continuously monitors the streamer to identify when there are new files of CDRs to process. When a file is available it is copied over to a free slave processor within the cluster (see Figure 6). The mechanism to do this has been developed internally by BT and is subject to a patent application. It replaces HP's Taskbroker product used on early versions of INCA.

Charging and pricing of individual call records

Once the file has been passed to the slave processor each record goes through a three-stage process.

Firstly, the CDR goes through a process of further validation. If for any reason the CDR cannot be charged and priced the CDR is rejected to a suspense area called the *company system INCA data analyser* (CIDA).

'Successful' records are then charged by categorising the call into an appropriate *chargeband.* There are two basic charging mechanisms available on INCA:

- *Distance-based charging* The country is split into several geographic zones, or *charge groups*. The originating charge group and the destination charge group are used to calculate the *chargeband* which will equate to a distance-based banding, such as local, less than 35 km, and over 35 km.
- *Element-based charging* This is different from distance-based charging in that the calls are categorised by the number of switches the call passes through in the BT network instead of the distance the call is carried.

Once a chargeband has been allocated to a call the CDR can then be priced. The pricing of a call is influenced by a number of factors. These include:

- the terms of the contract with the other operator;
- the day of the week (for example, week days and weekend rates);
- time of day (for example, day rate or evening rate);
- type of call traffic (for example, normal telephony, radiopaging, ISDN);
- chargeband (see above); and
- any special discounts.

Summarisation of results

Once the individual CDRs have been charged and priced the results are 'merged' into summary tables. These summary tables hold both daily summaries and monthly summaries and provide the basis from which the end users can produce the MIS and billing reports.

Error rejection to the CIDA

Records that cannot be processed by the charging and pricing algorithm are rejected, appended with an error message and an error code and sent to the CIDA system.

Write processed itemised records to Dorokey optical disk system

Processed itemised records with the chargeband and price of the call added are written out to the optical storage system where they can be held to provide information should a dispute arise or for other MIS purposes.

Feed Client System reporting information.
The summary tables are regularly copied from the company system to local servers in the end users' offices to enable them to produce their own reports. Reports can be produced directly from the company system itself but this gives the added advantage of separating out the batch and reporting processing requirements. This is particularly helpful when processing large volumes like BT's.

Software
The application software for the company system is written in C, generated by the Cool:Gen CASE tool from TI, running under Unix. There are several on-line GUI Windows for maintaining, authorising and auditing reference data. These include a specially designed Excel interface for entering and maintaining large amounts of tariff data. All data is time stamped with effective and ineffective dates to cope with the possibility of call data being received late or files being lost. Status checks are maintained on every file throughout processing, allowing strict audit of the data. The databases on both the master and slave machines are Oracle.

The main batch procedures are:

- *Load100*—the charging and pricing program (running on the slave processors);
- *Load101*—the 'merge', which loads charged and priced call information into the summary tables; and
- *CPS*—which manages the transfer of files from the streamer to company system and manages the communication between the master and slave processors.

Output files to the CIDA and Dorokey optical disk system are also produced.

The Client System

Processes
This is the end-user reporting environment for the INCA system. Reports could be run directly from the company system summary tables; however, in the UK, copies of the summary tables are taken from the company system on a regular basis and placed on local servers in the end-users' offices. This allows the batch and report processing to be separated and the databases to be tuned appropriately. The end users are then able to produce reports directly from these tables.

How this reporting is done will depend on the reporting package used. BT uses a product called *Business Objects*, which provides an easy-to-use GUI interface to the system. Various items of data that the end users might be interested in are defined as *objects* (for example, tariff) and grouped into areas of interest known as *universes* (for example, audit). The definition of the objects and creation and maintenance of the universes need to be done by an administrator, but once completed the end users can produce their own reports by simply selecting the objects they are interested in by clicking a mouse and then choosing what formats and styles they require. Once produced report formats can be easily amended, and the tool is OLE and DDE compliant, allowing data to be directly exported into other desktop tools such as Excel and Word.

Business Objects also provides security so that end users have views restricted only to objects and universes that they have been granted permission to view. This is another administration function.

Hardware
If reporting is to be done locally then a local server is required. The size of this depends on the size of the summary tables, the number of users and response times required. If using Business Objects the end users will require a minimum of a 486 PC with 16 Mbyte RAM.

Software
The server requires Oracle. The PC software stack is shown in Figure 7.

BUSINESS OBJECTS	OTHER APPLICATIONS (MS OFFICE)
PATHWAY TCP/IP	
WINDOWS 3.1	
DOS	
SQL*NET	
LAN SOFTWARE	

Figure 7—Business objects PC software stack

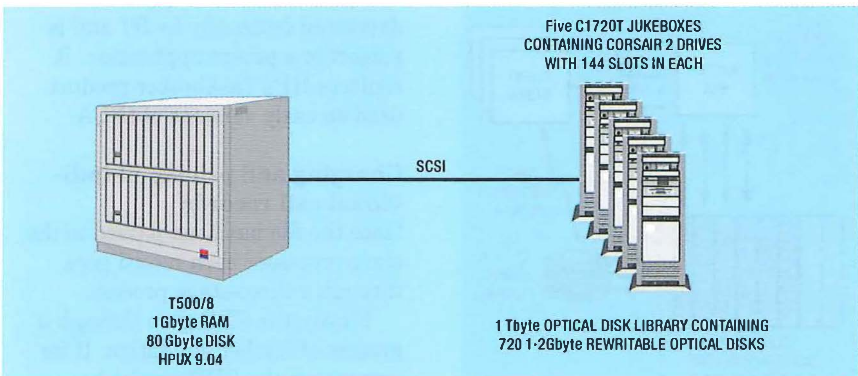
Dorokey optical disk system

Overview
INCA has an optical disk management system called *Dorokey*, which has been supplied by a French company, Dorotech. The system has been customised for INCA to allow the archiving and retrieval of itemised interconnect CDRs. Further customisation for INCA has also been undertaken to automate the system so that operator intervention is minimal. An example of this is when CDRs are no longer required: the optical disks are automatically recycled without operator intervention.

The current INCA system allows up to 4 billion CDRs to be held. Currently, the volumes written out to optical disk are between eight and 18 million CDRs per day. Retrieval times of CDRs from the INCA Dorokey system on average is between five minutes and one hour, depending on the query. The system is flexible and allows the storage of CDRs for 150 telecommunications operators or more with varying retention periods.

Hardware architecture
The hardware architecture to support the INCA Dorokey system in the UK is shown in Figure 8. However, the T500 machine driving the jukeboxes is the same machine as the master server in the company system cluster architecture (see

Figure 8—INCA Dorokey hardware architecture



above). The system consists of an HP T500 machine and five HP C1720T jukeboxes with four drives in each jukebox. The media used is re-writeable magneto optical disks with a capacity of 1·2 Gbytes for each disk.

Infeeds

Reference data needs to be entered into, and maintained on, both the streamer and company system modules of the INCA system. The streamer requires routing information to be maintained about the active POCs and routes between BT and the OLOs. The company system needs a variety of tariffing and chargeband items to be maintained. Within BT some of that data is fed from other systems within the company and some is manually input. It is therefore imperative that if the system is to be used within another organisation that the sources of this information are carefully analysed. Once this is done feeds from other systems or additional manual entry screens can be defined. This might be a significant amount of work.

Bill production

The actual final production of an invoice for interconnect traffic does not occur within the INCA system in the UK. There are a number of business reasons for this. However, billing information can be easily produced and fed into an invoice production package if required.

Glossary

CIDA Company systems INCA data analyser
CISA Charge information supply and audit, national charging database (NCDB) fasttrack interface
FDDI Fibre distributed data interface
FTAM File transfer, access and management
GFS Generic file system
INCA Inter-network call accounting
MIS Management information system
MPRN Multi-protocol router network. An internal BT network capable of routing TCP/IP traffic
NCRS Network change request system
NFS Network file system
NMP Network mediation processor.
OLO Other licensed operator
POC Point of connection
RCP Unix remote copy command for file copying between two different machines
Sump An INCA directory for files containing field level errors which cannot be altered to a defined default value.
Suspend An INCA directory for file containing routing errors
TCP/IP Transport control protocol/ Internet protocol

Biographies

Eden Phillips
British Telecommunications plc

Eden Phillips graduated from Portsmouth Polytechnic in 1986 with a degree in Mathematical Sciences. The same year he joined BT as an analyst/ programmer in BT's computer centre in Brighton. During this time he was involved in the implementation of BT's customer service system in South Downs District. He moved on to lead the development of a new finance system, FACET, within South Downs District. On completion the system was rolled-out to over 30 Districts and Eden moved to London to run a support and maintenance group looking after FACET and four other finance systems. In 1992, he joined the INCA development team and led a team gathering requirements for BT's interconnect billing system before taking over as project manager in 1993. Since then he has managed the full roll-out of the system to the point that it now accounts for interconnect traffic between BT and 150 OLO in the UK and processes over 100 million records per day. In 1996 the system was one of the winners of the prestigious British Computer Society award for its technical innovation and for the successful impact it had on BT's interconnect operations. He has presented at many international conferences on the subject of interconnect billing. He led the implementation in Norway which has just been formally accepted by Telenor. Eden and his team are now working on setting up an interconnect billing bureau service for BT's joint ventures as well as looking at a number of other opportunities. He successfully completed an MBA at Cranfield School of Management in 1991.

Paul Edwards
British Telecommunications plc

Paul Edwards graduated from the University of North Wales, Bangor, in 1969 with a degree in Mathematics and immediately joined BT (then the Post Office) as an analyst/programmer on BT's payroll system. He has remained in BT's IT department ever since, having been involved in a number of key technological developments including PRESTEL (BT's early videotext offering), CSS (BT's world-leading customer service system), MERIT (BT's personnel system), PROACT (BT's internal/ external works planning) and INCA. In 1988/9, he spent a year seconded to BT's Director Business Policy and Strategy, building a systems strategy to support BT's products and services and management information systems. He has been associated with the INCA development since 1994 and now has responsibility as principle systems engineer for the INCA programme in addition to his main role as people development manager for approximately 100 IT professionals.

Heike Felbecker-Janho

New IN-Services in Liberalised Telecommunications Markets: Potential and Technical Trends

How is competition going to start, develop and change liberalised intelligent-network (IN) markets?

Classification of Future IN Services

There is one class of IN services that mainly services the network operator to optimise internal processes. The other major class of IN services is directed to different groups of end-users. (See Figure 1)

IN services for network operators

Various internal processes at the network operator site can be supported by IN logic. Here are some examples: The best known IN service for operator use is the *number portability service*. It focuses on processes between competitive network operators. Its implementation was one of the main conditions of free competition.

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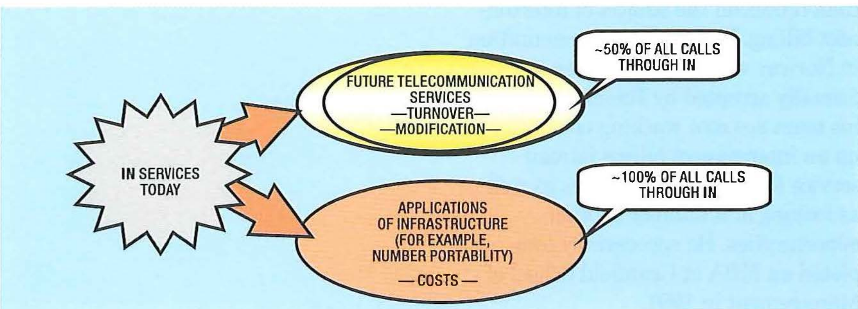
The number portability service hides real hardware addresses behind virtual hardware addresses of a predefined shape. As a result, all standard customer addresses look the same and there is no need to modify the address when changing operator.

Service number portability describes the same problem but this time concerning IN service numbers. The technical owner of any IN service number must not be visible to the customer site.

Some processes between the operator and the customer can also be supported by IN services. A closer look at the operator-customer relationship shows that not every operator might be willing to provide a service to each customer who tries to dial into the network. The operator's *call screening service*, for example, enables network operators to favour certain customers. Those operators, who only want to serve subscribed customers, will use *white list* screening. Customers with a bad credit rating are put on a *black list*. This makes it easy for the operator to stop providing services to blacklisted customers. Customers will not know about or pay for the service.

Figure 1 – Market development: services and applications of infrastructure



Operator internal use of IN services sometimes appears just to simplify handling of other technical devices; for example, voice mail systems. The customers will generally use the service without knowing it is IN. They may only be willing to pay for voice mail, but they might be willing to pay indirectly for comfortable voice mail usage.

This leads to the IN services which are sold directly to end-users.

IN services for end-users—market structures today

IN services may be directed to different groups of end-users. They may address the general needs of companies, freelancers or private people, but end-users will only pay for IN services when they see a clear desirable value in owning or using the service.

Therefore, it is important to consider the communication requirements (for example, the current problems or existing behaviour) of the particular customer group.

Popular IN services, like freephone, universal access number, or premium rate mainly focus on big companies with a high business interest in telephone or data communication. Virtual private networking (VPN) focuses on the same group of companies, but concentrates on internal use only.

In fact, apart from card-calling services, which sell but do not seem to produce significant traffic, only some problems of big companies are solved by IN services (Figure 2).

For instance, the monthly costs of the cheapest IN service in Germany are still above the costs for a normal telephone line, including the sub-

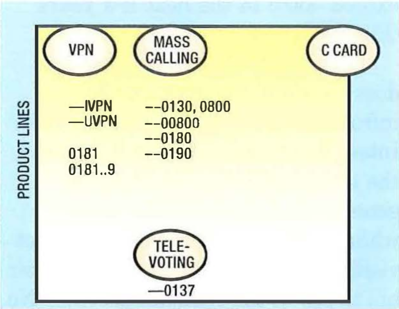


Figure 2—Current product portfolio (business customers only

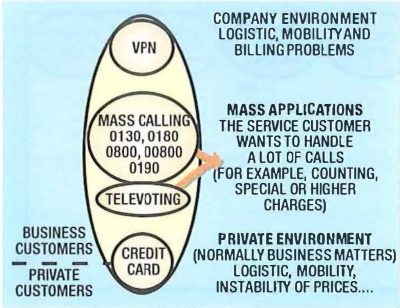


Figure 3—IN market currently addressed in Europe

scription fee, used units plus a service fee for changes. Therefore, at the moment, only big companies with a significant amount of traffic are able to profit from IN service numbers (Figure 3).

The quantity of IN service numbers in countries such as Germany is quite high and currently covers a significant amount of the top business segment at a high-price level—around 15–20% of those customers already owning IN numbers. In the whole business segment, including small and medium enterprises as well as SOHO (small office, home office), less than 5 per cent of the potential customers own or use IN numbers. This current market penetration is extremely small in comparison to the full IN scenario (Figure 4).

In this scenario, each call (either fixed or mobile, carrying data or speech, or successful or not) will consult the IN system at least once for additional information.

Competition will start to drive the cost of existing successful IN services down. This will lead to price wars in the same way as we currently see for call minutes (Figure 5).

Now is the time to define IN services that target the rest of the potential customers, especially small- and medium-sized companies and the public (households). This part of the market shows mass-market structures, which leads to successful new or different IN solutions that aim for a number of potential users at a much lower price level.

There is a risk of substitution when the feature content of new services is too close to the originals and yet still fulfils the needs of big companies.

At the beginning it will be possible to easily occupy niche market positions, at least for certain restricted time periods, just by approaching new customer groups (Figure 6). Customer needs will become increasingly more important, while new telecommunication products will look quite different from today's standard products; for example, subscription to network or IN numbers. Future products will be complete service packages including much more than just technical features; for example, service packages for freelancers, mobile companies, virtual companies, families, single females or senior citizens. These packages may contain different telephone lines for fixed, mobile and data purposes including suitable terminals, a time-dependant integration (if not subscribed), used terminals (for example, office telephones) plus special individual billing conditions, integration of other services, access to various facilities, plus many other features (Figure 7 and Figure 8)

Figure 4—Market situation in Germany fixed/mobile networks, 1997

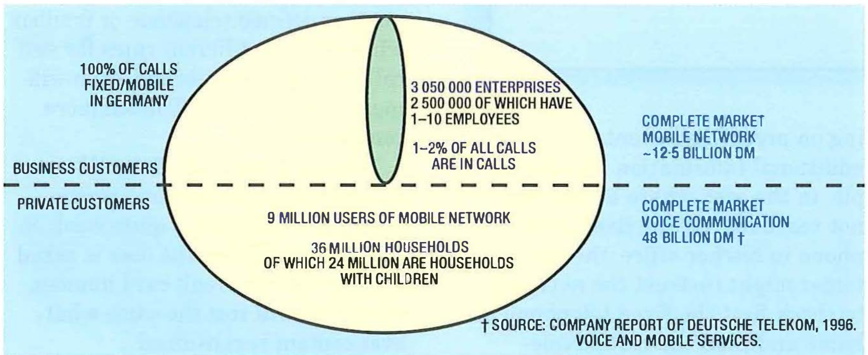


Figure 5—Mass calling in Germany

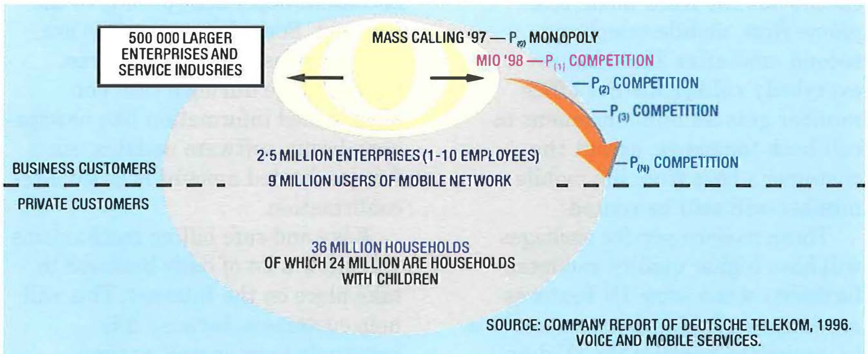
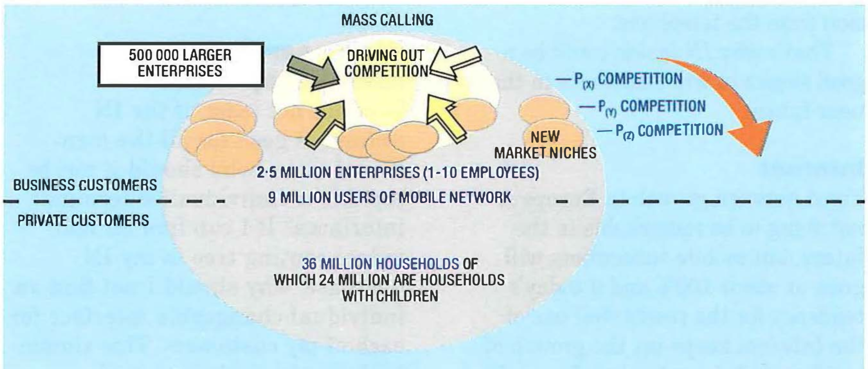


Figure 6—Market niches and driving out competition, 1998–99



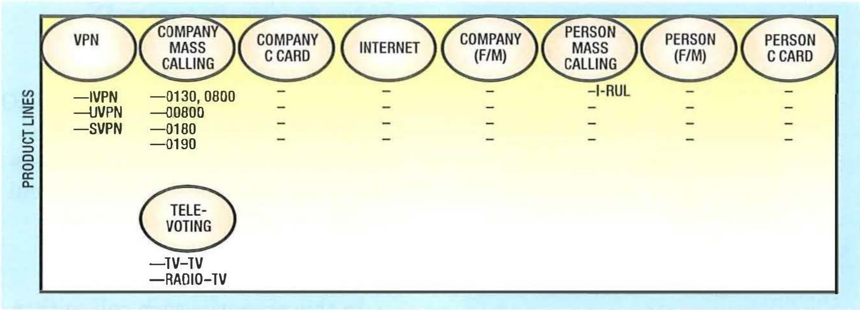


Figure 7 – Extended product portfolio (business customers)

Figure 8 – Extended product portfolio (private customers)

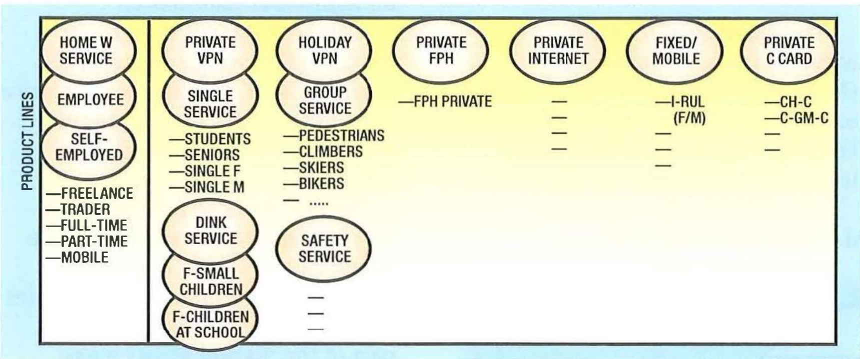
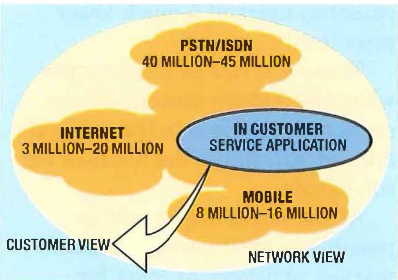


Figure 9 – Combined services 1



Modern service packages will need different launch, price, distribution and communication strategies.

Technical Trends

A big potential growth area of the IN industry is already visible today. Different technical directions are more and more evident. Integrated fixed-mobile services from a customer's point of view are practically available now. Further, a combination of IN and Internet offers an interesting prospective for new service definitions. Another visible trend is the very simple usage of telecommunication services. Also, following on from this, the IN concept offers a wide range of other possibilities.

Instead of ISDN—'IN inside'

The basic IN concept allows the switch to contact powerful database systems during call set up, depending on predefined events, to ask for additional information. For example, in the case where a customer is not reachable on the fixed telephone in his/her office, the customer might instruct the network, to check first the fixed telephone at home and then the mobile telephone, but only during day time. After 19.00 hours the network checks out the fixed home telephone first, mobile telephone second, and after 22.00 hours everybody calling his/her office number gets an announcement to call back tomorrow, except the customer's boss from his mobile number will still be routed.

These modern service packages will have higher quality and more flexibility when some IN Features are integrated. Management can be a lot easier too, because the IN database is accessible and can be changed from anywhere. There is no need to go home and remove the call diversion from the telephone.

That's why *IN inside* could be a good slogan to win customers in the near future.

Internet

Fixed network growth in Europe is not going to be remarkable in the future, but mobile subscribers will grow at about 100% and if today's tendency for the residential use of the Internet keeps up, the growth of residential Internet subscribers will exceed 300% in the next few years (Figure 9).

Each residential Internet access does use either fixed or mobile infrastructure. A part of the costs for Internet access is already shown on the telephone bill. Unluckily, in general the telephone line is busy while surfing, incoming mails are not visible anywhere and there is another bill to pay to the Internet provider. No integration on the customer site. On the other hand the IN database is easily accessible via Internet.

One of the above mentioned modern service packages can easily offer integrated communication solutions, including Internet access. The first advantage from a customer's point of view would be to receive only one bill. Features like diversion of private mails to a mobile telephone during certain periods of time, automatic diversion of calls to another defined telephone or mailbox while surfing, different rates for surf calls and speech calls and so on will make a customer's life much more comfortable.

A special strength of the IN concept are various billing mechanisms. The Internet is quite weak on this respect. Either the user is asked to enter his/her credit card number, or surfing will cost the same whatever content is consumed.

Using IN billing mechanisms, in the Internet will allow the possibility of content dependent pricing in the Internet. Some Internet pages are really expensive, others are free. Costs change during a call. For downloaded information like newspapers, books, software updates, etc. a fixed indicated amount is billed after confirmation.

Easy and safe billing mechanisms will allow a lot of daily business to take place on the Internet. This will help customers, because it is extremely easy as well as time saving, but it will also help operators because they will get a lot of new business opportunities.

IN like services for end users—easy to use

Last but not least, if the IN concept is good for all the mentioned ideas, why should it not be possible to individualise terminal interfaces? If I can find an individual routing tree in my IN database, why should I not find an individual changeable interface for each of my customers. This simple individual telephone interface

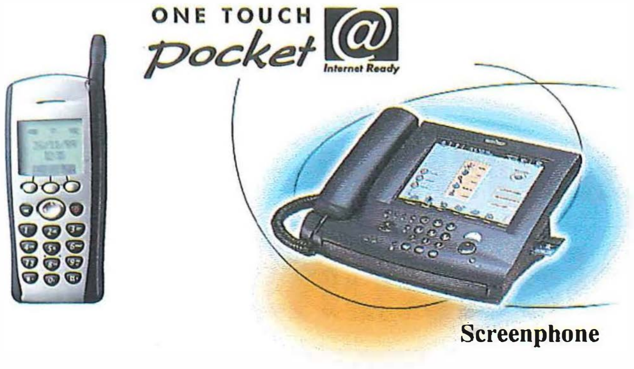


Figure 10 – Combined services 2

could contain a nice and easy to use integrated voice-mail function as well as an integrated 'new e-mails function' that at least displays sender and title of the new mails. Known calling numbers could be displayed as names and the telephone can offer certain functions like 'help', 'doctor', 'shopping service', where the customer or a service provider defines what should happen.

The more comfortable version of this telephone has a touch screen with a predefined Internet interface (Figure 10).

The technology behind this can be IN, but can also come from a smaller IN like server positioned on a lower level in the network.

Conclusion

The world is getting more and more complex, let us start making it easy for customers.

Biography

Heike Felbecker
Alcatel

Heike Felbecker, born 1965, studied economics in Bochum. She joined Alcatel in 1992 and started in the Business Systems department where she was in charge of product management for several telecommunication products. Since 1995, she has worked in the product management and business development areas of the Intelligent Networks department in Stuttgart, Germany.

Konstantinos Moustakas

Combating Telecommunications Fraud in the Multi-Vendor Environment

This paper on telecommunications fraud (TF) is aimed at the public at large. Therefore, neither technicalities nor details on types of TF, TF techniques or actual cases of TF are explained, but only business aspects and perspectives of TF and the possibility of controlling it, in connection with the multi-vendor environment. Consequently the operational and organisational aspects in order to combat TF are presented.

The New Environment

Telecommunications fraud (TF), estimated to cause a considerable loss of revenue to many telecommunications operators, is anticipated to expand in the multi-vendor market. Several factors support this:

- *The competitive environment does not favour anti-fraud procedures, measures or action which disturb the customer and put obstacles to achieving the sales goals.*

In the multi-vendor market each party is expected to work under higher pressure, lower profit margins and more demanding jobs. There is no luxury for screening customers, no time for running security procedures. It is natural that most competitors while hunting for new customers, when trying desperately to achieve their goals, may become easier victims of the fraudsters.

- *The interconnected networks consist more or less of different implementations and follow multiple standards, which may offer more chances to commit fraud and will certainly cause additional problems to investigate fraud cases.*

The rapid changes caused by technological development affect the infrastructure of every carrier, every PTO, even the best organised enterprises. All of us have experienced problems in everyday work, when the simplest actions are hindered because of incompatibilities between equipment of different generations and/or different standards.

It is obvious that, when having to deal with an interconnected network offering multiple new services under much more demanding standards, the problems are multiple. This technical 'commotion' creates the ideal circumstances for committing fraud, as well as all kinds of difficulties when trying to control it. In our experience a great deal of fraud cases involve more than one country and/or operator.

- *In the competitive environment, the players are no more trusting public entities. They are competitors trying to keep from each other both fraud cases and relevant action.*

Competition does have rules. Common understanding though, regarding anti-fraud action is not—at least not yet—among these rules. To inform competitors about lying traps or danger (for example, exchange black lists) is not yet regarded as normal behaviour.

More than that, in the open market it is hard to survive. In this respect we cannot reject the possibility that competitors could keep eyes closed when other parties are being damaged. Worse, but not impossible, would be the case that they had something to profit from fraud committed at the cost of competing enterprises; for example, in cases of fraud in premium rate or value-added services.

Consequently the open market situation is quite different from the old traditional trusted cooperation between the PTOs.

- *The varying procedures, methods and organization of each player will make cooperation on combating TF more difficult.*

Apart from differences in legislation or culture, suspicion, internal rules and relations, frequent changes, even linguistic difficulties play their important role and create further problems, delays and misunderstanding in combating fraud, as fraud is in many cases a complex or international conspiracy and/or involves more than one operator.

Furthermore TF is expected to expand because of new technological and social dimensions:

- *Most types of fraud are closely related to new product and*

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services and involve the use of high technology, while big money is involved.

Premium rate and value-added services are an excellent example of evolution attracting fraudsters' interest.

Such services, apart from one or more PTOs, involve third parties like service or content providers. This, together with the fact that payment is to be effected some time after service provision, makes a very attractive combination for some kind of people.

This brings us to the next point: who would be attracted to these new 'market' circumstances?

Together with the evolution in the technology, the business and the market rules, comes the change at the other side:

- *The profile of a fraudster is no longer simply a case of satisfying local needs, but appeals more to the portrait of a high-tech, business-oriented and well-organised gang, causing more losses and much more trouble to investigate.*

Such gangs are often constantly on the move, migrating and seeking new victims among operators which are less aware of new kinds of fraudulent activities.

It is quite difficult to make a case and prosecute such people, as a robust legal framework is not always in place while fast action at the international level is often required.

More than that it is no longer enough to arrest those committing fraud, because they are not always directly involved in this action. Nowadays, in many cases users committing fraud (for example, by buying falsified tele-cards) are found to be ignorant of this and are victim of such gangs making huge profits.

Motives for Action

Strong motives exist for the market players to take anti-fraud action:

Protect against loss of revenues
In the US an average 2% of the annual gross revenue of the telecommunications organisations is generally accepted to be lost because of fraud, while some would put this figure higher, between 3 and 5%. This is usually an estimate based on standard percentages of bad debt.

In fact, in several parts of the globe, rampant fraud on telephone networks has long been an established fact, with the cost to some national operators being in excess of 10% of net profits.

In addition to that, is the cost of network resources for traffic generated by fraudulent calls and the cost of handling fraud cases.

Finally, together with the PTOs, it is also private network operators that suffer at the hands of fraudsters, private enterprises (for example, some from those running PABXs), and residential customers.

Protect the image of the company
Each time a fraud case is disclosed the involved company image is severely damaged, in the eyes of both its customers and its shareholders, with obvious consequences. This explains why most fraud cases are not made public.

In the case of telecommunications operators, usually uncollected customer's bills are written off, while relevant out-payments on international or long-distance calls are made to other operators.

Interestingly, while demanding from the telecommunications operators utmost reliability, the general population's attitude favours the persecuted 'small one' fraudster instead of the big telecommunications operator', which is often perceived also as an arm of the government.

Enter the anti-fraud product and services market
As fraud becomes more profitable in the future free market, and telecommunications operators are deprived of considerable revenues, it is worth establishing anti-fraud or fraud-control mechanisms. Thus a new market is being created.

This rapidly growing and promising market is emerging just because of telecommunications fraud and in parallel to it, in the same way that the police are becoming more efficient in their efforts to cope with criminals.

Some of the most important products of the anti-fraud market will be consultation, protection and security services to the telecommunications operators, big customers and residential users.

These customers demand to be secure against fraudulent actions and will gladly carry the costs involved, if they know that much higher out-payments are at stake if they become fraud victims.

Anti-fraud systems, establishment of new procedures, training and installation of hardware and software to combat fraud are possible star products. For example, security devices are already broadly sold in the SOHO (small office, home office) market.

Furthermore, new anti-fraud services are already opening new strategic windows, such as accrediting private applications (network, servers, and terminals access and use authorisation, protection of data bases, encryption etc), traffic surveillance, relevant consultation and assurance services etc.

Training services will also need the police and juridical authorities to cope with the modern criminals using newest techniques and equipment.

In conclusion, fraud control is becoming a good business, in which it is evident that the telecommunications operators will have a major share.

Anti-Fraud Action

If all this motivation analysis has been adequately convincing, a next step would to think how telecommunications operators are to organise anti-fraud action.

Three possible levels of action against TF can be considered with reference to the prevailing situation:

At company level, where anti-fraud action should be planned, not as a separate unit but as a company-wide function
Each telecommunications organisation will need to organise the operation internally, coordinate the people and monitor the fraud control in a consistent way.

More specifically, in a future telecommunications organisation the fraud-control function will become everybody's business:

- The *technical* staff will need to secure the network and the services provision.
- The *sales* staff will have to compromise between customer satisfaction and anti-fraud precautions.
- The *commercial* staff will seek new opportunities and new products for the emerging anti-fraud markets.
- The *financial* staff will try to find the optimum solution between the fraud cost and the fraud control cost.

- The *legal* staff will ask for additional or special measures to the legal framework, in order to assure the fraudsters' prosecution.
- The *managerial* staff will need to connect, organise and control the losses caused by the fraud. Additional investment, relevant data banks, established procedures and training issues are also to be considered.
- Finally, the *administration* of each telecommunications organisation has to seek ways to cooperate and exchange information with competitors in order to manage the situation and catch up with the market evolution. Let us not forget that customers demand to be secure against fraudulent actions and will soon need to accredit their applications against fraudulent actions.

At national level, where a forum should be formed, possibly under the care of the national regulatory authority

In the multi-vendor market it is evident that operators should maintain a certain level of cooperation—not only regarding fraud control—since they all operate in the frame of an interconnected network.

This function should contribute to a better understanding and help handling fraud cases which involve or affect more than one operator.

It should be mentioned that some countries have already established such forums, like the UK (Telecommunications UK Fraud Forum—TUFF).

In view of the market liberalisation in the EU countries it should be expected that such measures are taken in other European countries, too, perhaps initiated by the national regulatory authorities.

At an international level, for relevant regulation to bilateral anti-fraud cooperation

There is already significant action with regard to this matter.

ETNO has established a working group to investigate telecommunications fraud, both technical and legal aspects (WG 94/02, which has done remarkable work).

FIINA (Forum for International Irregular Network Access), having already more than 90 members from more than 70 countries, is also doing a similar job.

EURESCOM has got pre-study P512 on the Prevention and Limitation of TF and project P660 on security risk assessment.

We can only hope that this effort can create an effective mechanism to confront telecommunications fraud; not to defeat it, because this battle never ends.

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Biography

Konstantinos Moustakas
Greek Telecommunications Organisation (OTE SA)

Konstantinos Moustakas has degrees in Electrical and Mechanical Engineering (1974) and Business Administration (1978) and a Masters degree in Operational Research and Informatics (1981). He has been an employee at the Greek Telecommunications Organisation (OTE SA) since 1977. Currently he is Head of the Development Division for the Telephone Directories Unit. Since 1996, he has been contact person to ETNO WG 94/02.

David J. Swift and Geoffrey Tooke

Number Portability—An Opportunity for Alternative Carriers

This paper looks at how regulators have taken different approaches to number portability and the benefits that can be gained by integrating the data and functions of number portability with other services and features.

Introduction

The arrival of network competition has brought with it new issues for the telephone users.

When they move their telephone service from the incumbent operator to a newcomer, how do they inform their customers and friends that their telephone number has changed?

This problem has been a worry for telephone users for as long as automated exchanges have existed.

The ideal solution is to give everyone a 'number for life'. However, for much of the history of telecommunications, this has been impossible. It is only recent developments in technology, and the rise of digitalisation, that have made this dream a reality.

Two solutions have been presented, one is personal numbering, whereby each individual customer hires a neutral number from a specific numbering range and special charges above the standard calling rate are made for incoming calls. The second technique, and the one which is linked intrinsically with competition is that of number portability.

This paper comes from a marketing point of view, looking at the realisation and the opportunities number portability offers operators in a liberalised telecommunications market.

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Operator Portability

Operator portability is often seen as the key to the new deregulated, competitive telecommunications market. It is currently much talked about, but few countries have yet applied the principle in practice. New York introduced operator portability for freephone numbers in 1993.

Since 1993 number portability has been introduced into the UK and Hong Kong in 1996. Before the introduction of portability in the UK, BT had 63% of the 66 000 freephone numbers, generating some 750 million calls annually, retaining its market share mainly because businesses regard a freephone number as a 'virtual front door' and have been reluctant to change to another number with another carrier.

With the introduction of non-geographic portability in the UK, telecommunication service providers expect this market to show explosive growth, with the fact that freephone 0800, local rate 0345, and national rate 0900 numbers now become the property of the user and not the operator and can be retained if companies switch to other network providers.

To illustrate this point in the UK more than one in four TV advertisements now carry an 0800 number, and it is predicted soon in the UK each of us will be spending an hour each year calling freephone numbers.

The European Union's requirement is for all member states to introduce number portability following telecommunications liberalisation in January this year. The Union's target date to have fixed line number portability in all major population centres in place is January 2003. There is pressure on the EU to bring its 2003 target date forward to 2000.

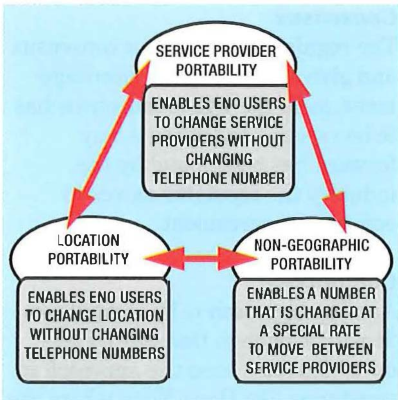
Within the Asia-Pacific region only Hong Kong has tackled the issue on a large scale, while Australia, Japan, New Zealand and Singapore are at various stages of tentative implementation; for example, allowing transfers between operators limited to certain types of line or geographic area as in the case of Singapore.

Digits on the Move

There are many types of portability enabling the users to take their different type of numbers with them.

Service provider portability enables the user to change operator while keeping the number allocated by the previous operator. This is sometimes called local number portability and geographic number portability.

Figure 1 – Types of portability



Location portability enables the user to move location while keeping the allocated number. This may or may not involve moving to a different charge area. Location portability is less popular due to the charging implications and the need to administer numbers that now occur outside of the old natural boundaries.

Non-geographic number portability enables a number that is charged at a special rate (freephone, local charge or premium rate) to move between service providers. In some territories this has been seen as the way to enable the growth in this sector.

Mobile portability is where the user can change cellular operators while keeping the number allocated by the previous cellular operator.

Important points

The important points with each of these types of portability are:

- The user can take the number, currently used in one operator's network, to another network and obtain service on that number.
- Service type should be the same as if the number belonged to the new network.
- The old network should not discriminate against numbers it has lost and ported to the recipient networks.
- Features like calling line identification (CLI) must work as normal, displaying the correct ported number.
- Procedures and data will need to be established between the networks both to effect the port of the number and to ensure correct call routing to the new destination.
- Callers should not have to know the number has been ported or perform any additional procedures in making a call to a ported number.

Number portability comes into play by:

Consensus

The regulator can look for consensus and give direction with encouragement, as in the UK. A consensus has to be reached and when a way forward has been found by the industry the regulator moves to enforce the agreement.

Compulsion

Another approach is by compulsion 'It will be done in this way by this date!' This has been the approach in territories like Hong Kong where the

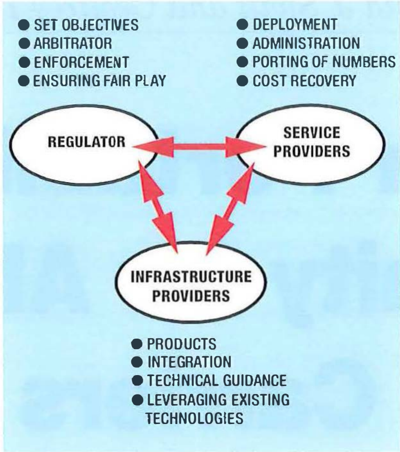


Figure 2 – The players

solution and the time scales were mandated by the regulator for the operators to meet. This is covered in more detail later.

Standards

These have been following some way behind the number portability band wagon, but ETSI is now pursuing solutions to geographic, non-geographic and mobile number portability and the ITU-T is too.

Porting in Britain

In the UK an arrangement has been developed to enable geographic portability using simple onward routing from the previous operator or donor and the recipient network by prefixing the number. This mechanism is the one that is currently being used.

Although this approach is easy as calls are routed using the information in the dialling prefix, there are issues concerning inefficiencies of this approach as the total operational ported numbers grows. Thus as the competitive service providers gain market share, there will be a higher proportion of calls being routed back and forth across local networks needlessly tying up switching and transmission resources.

One way to improve efficiencies would be to develop a database solution where, every time a number is dialled in a ported range on any network, reference is made to the master database. The look-up would check the current location and provide routing information. This scenario would logically be realised with intelligent network technology.

However, with non-geographic numbers a phased approach has been recommend by the UK Public Network Operators Interest Group (PNO-IG):

Phase 1: using onward routing which at present presents few problems as number ranges are allocated to specific service providers.

This approach is currently being used for freephone services, and it is expected to be extended to premium rate and split charging services early next year.

Phase 2: the network on which the call originated can provide intelligence to determine whether the call is destined for a subscriber on its own network before forwarding. If it is it can trap the call and pass it to its own subscriber.

With phases 1 and 2 only the original number range holder and the recipient of the port are required to know the number status

Phase 3: is where unique number ranges are no longer held by any one operator, and number information is held on a central database.

Hong Kong's Approach

The situation in Hong Kong is rather different. As well as the incumbent (Hong Kong Telecom), three new operators have entered the market (New world, New T&T and Hutchison Communications) and a general condition of their licences specifies that operator portability must be provided for fixed services with non-geographic, freephone and personal numbers (so far there appears to have been little porting of personal numbers). About 40 000 numbers have been ported so far.

The regulator OFTA, has since announced a study to investigate the feasibility of the introduction of mobile services.

OFTA had originally proposed that portability be introduced when the first new entrants were licensed, but the politics of the Hong Kong – China handover delayed this. At first, number portability, in Hong Kong was provided through simple onward routing, but this did, in fact, become an interim solution for, in 1995, a clear consensus directed the solution to evolve to a IN method being the preferred technique.

The method adopted in January 1997 was a distributed reference database system (rather than central) as no agreement could be found on the appropriate body to administer the database with the operators preferring a government authority, while neither OFTA nor any other official body was willing to accept responsibility.

Security reasons have been given as the justification for the distributed system, which consists of off-line and on-line databases with agreed standard protocols mediating between them. The result is four replicate databases linked by inter-operator data links.

Porting in Action

Customers are now free to choose the service provider of their choice and to review their choice as their needs and the telecommunication market and services evolve.

The barriers which up to now have stopped customers from moving to another operator have been removed. These can be in terms of:

- time lost through having to inform your contacts of the number change;
- inconvenience of having to compile a complete list (probably an impossible job!) and inform all of your contacts of the change to your telephone number; and
- cost involved in having to inform people of the change and the lost business that may occur because the previous number was well known.

Calling parties can carry on oblivious to the changing whims of the called party, saving:

- time when a number that used to connect now gets number unobtainable (NU) or a changed number announcement (The new number has to be obtained, used for this call and also recorded to prevent the cycle being repeated.);
- confusion when a tried and trusted number now connects to NU (has the business ceased, moved, not paid their bill?); and
- cost in obtaining the new number and keeping records up to date.

For service providers, number portability removes the barriers to winning new custom or old customers back.

They can provide new innovative services knowing that if they are attractive enough customers will change operator to obtain them. This can accelerate the growth of such services knowing that it is possible to attract enough customers to pay for them.

High-value services can be provided enabling the high-value users to switch operator to obtain them. No longer do such services have to be offered only to those potential customers that have yet to enter the market.

New entrants can now have, with number portability, a real possibility of gaining market share by being able to attract the customers of the established service providers (incumbent PTTs).

This creates for the first time a real new competitive environment in the telecommunications industry, both in price and functionality. New operators now have the opportunity to address vertical markets and therefore grow the market for a particular service (for example, freephone) by catering for specific industry needs.

Once a customer has moved operator, for whatever reason, there is no reason why that very same customer would not want to move back if the incentives are right. There is no barrier for customers to move and move again. The real market is out there to be fought for.

Number portability is a win-win situation:

- it stimulates growth in telecommunication services and in the features these services offer to the customers; and
- it stimulates competition for the telecommunication services and thereby gives the customer more choice and flexibility in meeting their own needs.

The increase in competition drives down the costs of the services to the customers and should drive down also the costs of providing the services in a competitive environment.

The competitive environment will lead to new innovative services being offered to customers in a drive to win market share and the high-value customers in the telecommunications marketplace.

Facts

Evidence based on the UK (from recent Ovum and OFTEL reports) indicates:

- 66% of residential fixed network customers would not change service provider if this meant changing their telephone number, and
- 96% of small and medium enterprises (SMEs) and 14% residential mobile customers anticipate problems if they change their telephone number.

Now fixed UK network service providers offer number portability, numerous customers are changing service providers on the UK network.

The Number Portability Problem

At the start, the number portability service is seen as a routing problem to enable the termination of calls to a ported number.

This is not the case. The routing of the call is in most cases trivial compared to the enormous hidden problem of the administration and procedures needed to first carry out a port of a number from one network to another. The next area is maintaining records and procedures for that customer on an ongoing basis.

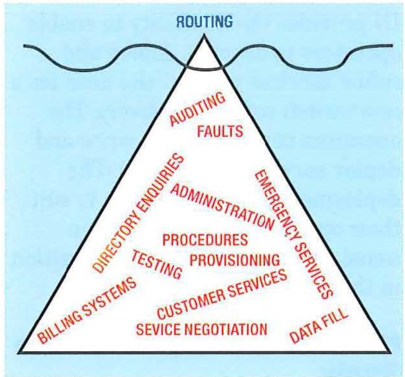


Figure 3 – The number portability iceberg

Many aspects of telephony use the relationship of the number to the termination:

- customer services front office systems,
- fault and diagnostic systems,
- Directory Enquiries, and
- emergency service, etc.

The list goes on. In the new paradigm of number portability these systems need to be able to cope with the break in the relationship between number and operator.

The procedures for effecting a port of a number in the first place needs to be agreed, set-up and tried. Fall back in case of failure must be accounted for. All aspects need to be considered

The Realisation

Traditionally services have been written and embedded in the switch architecture. The move now is to IN services, leaving the switch to deal with the basic service of setting up and dealing with the call. Number portability could logically be seen as a basic call set-up service, but this does not permit the service interactions that are necessary in a modern telecommunications environment.

Service interaction

A two-fold effect of an IN number portability service can clearly be seen. Firstly, the number portability functions can easily be defined and structured around the other services being offered from the service platform. Secondly, the efficiency of the switching and routing platform can be increased by always receiving back from the service layer a valid routing instruction, already having taken into account number portability.

The benefits of IN

IN provides the flexibility to enable operators to develop, deploy and refine services without the need for a new switch software delivery. The operators can, if desired, write and deploy services themselves. The deployment can be at a time to suit their operational needs and can assist in strengthening their position in the marketplace.

New World Telephone Case Study

Number portability is not just another switch feature but impacts upon the whole of the business of a telecommunications service provider. This includes sales activities; information technology systems such as customer care systems all the way through to billing; operational processes covering anything from the exchange to external field installation.

In Hong Kong, only New World Telephone (NWT) could project manage such an activity which requires specific company knowledge. NWT project managed all deliverables from all parties concerned—sales, customer engineering, network operations centre, switch centre, IN operations, field service, and IT systems.

NWT service creators used the GAIN INventor to create the number portability service which deals with:

- passing calls directly to ported number,
- call screening and translation,
- catering for activation/cessation at the nominated date and time,
- updating network databases and reporting of ported numbers to third-party operators, and
- adapting the personal number service for number portability.

NWT also implemented a coherent test strategy and plan which enabled the timely local test prior to inter-operator tests.

New World network

As mentioned earlier, the number portability databases are replicated and distributed in the four Hong Kong networks. Each holds its own master data and the slave copy of the other three. The databases are kept in step and communicate with each other using file transfer protocol (FTP). During the month the data is updated as numbers are ported. Cross-auditing of the data takes place during the first week of each month. The data is transferred to the real-time databases for IN access to determine call routing.

The NWT network consists of two System X switches and two GAIN *ACCELERATOR* SCPs. The number prefixes used to route calls to ported numbers terminating in the New World Telephone network are the same prefixes that are used to provide location portability within the New World Telephone network.

Information transfer

Exchange of information between operators that offer number portability is fundamental to the functioning of the service. In Hong Kong, local calls are free, and this is true also for calls to numbers that have been ported.

Number portability in Hong Kong does not affect in any way the existing mechanisms for inter-administration accounting and call charge transfer. Mechanisms have been put in place for the transfer of number portability data. The structure and fields of the data have been standardised and procedures are used to effect the correct and timely transfer of this data.

Data is transferred both when there is a request to port and routinely to ensure that the databases are kept in step.

How the NWT portability solution works

The solution to number portability requires consideration of calls which originate and terminate within the NWT network.

To implement the number portability, NWT elected to use the network number option allowed by OFTA. Network numbers are defined as 2xxx xxxx and 5xxx xxxx for PSTN, 8xxx xxxx for personal number, 800x xxxx for Freephone, 900x xxxx for Premium Rate and 9xxx xxxx for mobile services.

Calls originating within the NWT network

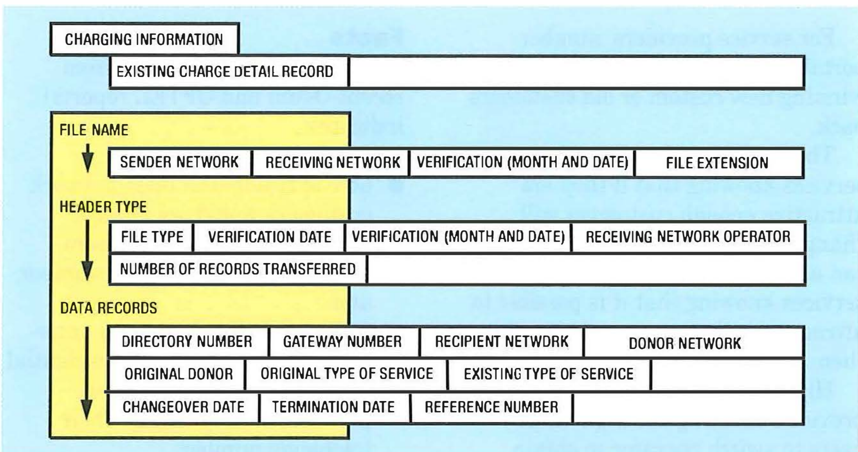
All calls that originate in the NWT network which are in the number ranges available for porting will trigger the number portability service. The application then refers to the number portability database.

If the number has not been ported, the service will prefix the number with either 197 or 198 (dependent upon which NWT switch is involved) and represent to the switch, this time not triggering the service but being routed on the original digits to the called number.

If the number has been ported the number will be prefixed with the appropriate digits and onward routed to another operator.

If the number has been ported within the New World Telephone network, the number would be prefixed with either 197 or 198 depending on the switch involved.

Figure 4—Data transfer format



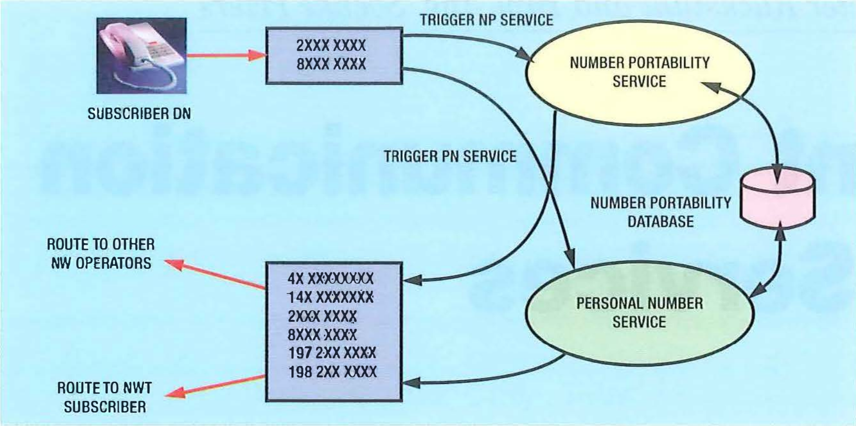


Figure 5 – Calls originated in the NWT network

Enhancement created by NWT—Personal numbers are translated in the IN to the correct terminating number that the personal number subscriber has set. However, the terminating number may be ported. This scenario could lead to the ported terminated number being delivered to the switched network only to be re-triggered back to the IN for analysis. New World Telephone stopped the double interaction by integrating the number portability functionality together with the personal number service functionality.

Calls originating outside the NWT network

For handling incoming calls to the NWT network (only calls which have been routed to NWT from other networks) which have the NWT allocated 40x prefix where x is a 2 will trigger the number portability service or a 8 will trigger the personal number service. Incoming ported calls are passed to the number portability application to be looked up in the number portability database.

If the number terminates in the NWT network the service prefixes the number with either 197 or 198 (dependant upon which NWT switch the called number resides) and then re-presents the number to the switch, this time not triggering the service but being routed on the ported number.

If the number has been ported to another network: the number is prefixed with the appropriate digits and onward routed to another operator.

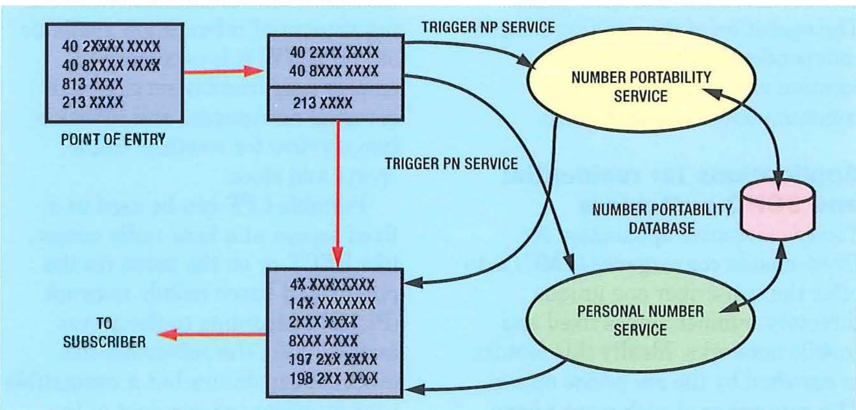
Enhancement created by NWT—Incoming calls to ported personal numbers (408xxx xxxx) will trigger the personal number service which will return the destination number personal number after reference has been made to the number portability database. This may be in the form of a NWT network number or a ported number to another operator.

In summary

Without this enhancement to personal numbering a situation could arise that the ported terminated number being delivered to the NWT switched network would be re-triggered back to the IN for analysis. New World Telephone stopped the double interaction by integrating the number portability functionality together with the personal number service, functionality thus improving network efficiency. When integrated, if a terminating number is ported, then the only result given back to the switched network is that of the correct routing to the recipient network. From beginning to end, the NWT number portability service was created and ready to be deployed in four months. This included inter-operator testing, which is so important for the smooth running of a number portability service.

New World Telephone decided to create the number portability service themselves using the GPT GAIN *ACCELERATOR* INventor service creation tool environment. To date, the number portability service in Hong Kong has been very successful with 10 out of every 1000 subscribers porting their numbers. This is only the beginning, the popularity of the service will mean that an ever increasing number of Hong Kong subscribers will be porting their numbers to suit their needs in the future.

Figure 6 – Calls originated outside the NWT network



Biographies

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David Swift is Marketing Manager for IN Solutions and Applications at GPT. He has 14 years of experience in the telecommunications industry working within fixed and mobile environments. Throughout his career he has worked with several telcos worldwide in the identification of new business opportunities and realisation through the delivery of new revenue-earning services to meet the telcos' business objectives.

Geoffrey Tooke
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Geoffrey Tooke works in the Network Vision department of the Intelligent Switched Networks division of GPT. He has over 20 years experience of telecommunications within the UK. He has a wide range of switching experience, having worked on fixed, mobile and IN systems. He is active in the UK industry fora on number portability and the ETSI and ITU standards bodies for number portability.

[*Editorial Note*: GPT is becoming Marconi Communications.]

Dipl.-Ing. Hanspeter Ruckstuhl and Dipl.-Ing. Soenke Peters

Convergent Communication Services

Convergent communication services are important to operators and end users. They provide end users with commercial viable and user-friendly applications. They allow operators to market their services to more users. This paper takes a closer look at the key applications for convergent communication services. The provisioning of such services today using intelligent network systems is described. Then, the additional requirements of the convergence of fixed and mobile and voice and data are analysed. Possible evolution scenarios for the core-network technology to facilitate advanced converged services are shown.

Introduction

The traditional telecommunications companies are facing many new or changing challenges. Among the most important ones are the deregulated market and the appearance of the information technology on the telecommunications scene. In combination with the rapid technological developments we see a huge number of new requirements but also opportunities for marketing new value-added services by the telcos. Convergent services can be the main service offering to keep or even extend the market share of traditional telecommunications companies. In the following, important convergent service applications are identified and discussed. The technological provision in today's networks is described and evolutionary network scenarios are depicted accounting for tomorrow's capabilities.

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Convergent Communication Services

Today's telecommunication and information technologies offer end users tremendous new and fascinating possibilities and opportunities. But the handling of all these services and features is becoming more and more complicated. So many features are not used by the 'normal' subscriber. Even if a feature is used in some environments it is not used in another. This has a negative impact on the results of the telecommunications operators: the return on investment is not as high as expected.

As a result, applications not technologies must be provided. A subscriber should not have to learn different ways to activate and deactivate services in different environments. The subscriber should be given one unique subscriber address (number) that will be THE contact ANYtime and ANYwhere. The operation of the services becomes independent of the end user's location only governed by the communicator's user interface.

Applications for residential and SOHO customers

Today's favourite application for fixed–mobile convergence (FMC) is to offer the subscriber one unique directory number across fixed and mobile networks. Ideally this feature is enriched by the *one phone* option. The subscriber of such a one phone service is always and anywhere reachable via one number and enjoys a set of compatible features in the fixed and mobile network. The degree of service convergence that can be experienced by end users is dependent on the FMC capabilities provided by the involved networks and the end-user equipment (mobile terminal, wireline phone, etc.).

Another group of services with fast growth rates is personal information/data services. Assuming the customer premises equipment (CPE) provides a comfortable user interface and the network offers data connections on an attractive cost-per-bit basis, these new information services can be an attractive alternative to the traditional magazines and newspapers. Today's World Wide Web (WWW) servers and services for information retrieval and personalisation show only the first steps of a new age of information distribution. Professional subscribers make intensive use of these new types of services. Many companies supply their information mainly via the Internet today. Almost all publishers of newspapers and magazines are providing on-line pilot services to prepare for the new information age.

In additional to these *pull* technologies, *push* technologies are getting increasingly important. Because of the dramatically increasing amount of information available on the WWW, it is necessary to employ user-friendly services like personal newspapers and information services for weather, traffic, sports and stock.

Portable CPE can be used at a fixed access, at a local radio access, like DECT, or on the move via the public land-based mobile network (PLMN). According to the access method used, the subscriber has different capabilites but a compatible user interface independent of the

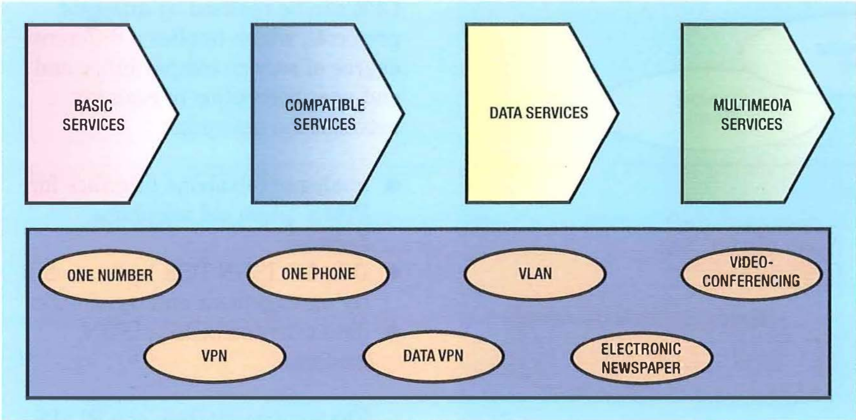

Figure 1 – Convergent service evolution

location. The use of fixed access offers high data rates; local radio access allows the subscriber to move freely inside his home. PLMN coverage enables people to be in touch everywhere but at the expense of lower data rates and higher tariffs.

Applications for corporate customers

Today's corporations have to deal with a huge amount of organisational overhead concerning the information and communication infrastructure. This opens up a wide range of services on top of plain telephony that can be offered by telcos.

Corporations can be characterised by the growing number of employees using mobile telephones. This implies that these people always have to communicate at least two numbers to ensure their reachability. Of course call forwarding is a first step to increase the reachability but the decentralised administration (at the CPE) makes it difficult to handle. A growing number of employees want to be home workers. To address these requirements a more centralised approach is necessary. Convergent virtual private networks, ideally combined with one number services, are the appropriate means to solve this communication needs.

Companies have a growing number of mobile workers (*nomadic managers*). Their workforce and a growing number of home workers need access to data stored on the corporate servers. Additional to today's voice-based virtual private networks (VPNs), now virtual local area networks (LANs) are required by these customers. Today's solutions are mainly based on circuit switched remote LAN access. This leads to high costs for the user. A packet switching approach would be a solution to save considerable amounts of money.

The business opportunities for the telecommunication companies are to provide reliable and flexible solutions to solve the specific needs of corporate customers and add a customised service concept to fulfill the increasing demand for 'one stop shopping'. Personal number and information services have the potential for real mass-deployment services that may change the way we communicate and obtain information in the future.

The telecommunication companies have all the necessary assets to play an important role in the information age but they have to take care to implement the right technologies today—technologies that allow easy integration which is the basis for convergent services.

There are many ways of providing convergent services to the subscribers. In the following part we will have a closer look at today's and future network scenarios and architectures that will enable the network operators to fulfill the fast growing demands of their customers.

What kind of technologies are required to realise the above mentioned applications and user scenarios? How can a network operator ensure today that it will also provide an attractive platform tomorrow?

Two main approaches can be chosen to accommodate the requirements of a specific convergent communication service.

- IN-based overlay network, and
- extending the core network functionality.

These approaches are not contradictory. The combination results in a network architecture that is able to provide evolutionary convergent services today and in the future.

Provisioning of Convergent Services Today

The capabilities and features of the chosen platform to provide the convergent service is one main issue. The availability and smooth network integration is the other main issue. INXpress is the Siemens intelligent network platform, ready to support convergent services today. It allows the provision of convergent services without requiring any structural changes of the underlying fixed and mobile network.

Looking at the actual networks today, we see mobile and fixed networks strictly divided. They are only connected via gateways. Services are different, specialised according to the main purposes of each network type.

By implementing a central service control point (SCP) it is possible to deliver compatible services for both networks. Due to the capability of simultaneously handling several different protocols the SCP can serve service switching points (SSPs) from the fixed and mobile network and supply convergent services to subscribers in both networks. Fixed–mobile convergence at service level is therefore available now and is a viable solution for both multivendor and multinetwork environments.

This is an ideal platform for one number/one phone services described above. Convergent VPNs provide company-wide private numbering plans including fixed and mobile users.

The IN-based service provisioning has the following main advantages:

- flexible service provisioning due to service-independent building block based service design,
- centralised administration,
- short time to market, and
- independent of specialised CPE.

Today the IN-based convergent services give the operator the chance to reduce the churn rate and to maintain top corporate customers by providing customised services fitting exactly their communication needs.

To increase the benefits of IN-based services in the future some new features can be realised, like CAMEL and MAP (ATI)†. These

† CAMEL: Customised Applications for Mobile networks Enhanced Logic
MAP: Mobile application part
ATI: Any-time interrogation

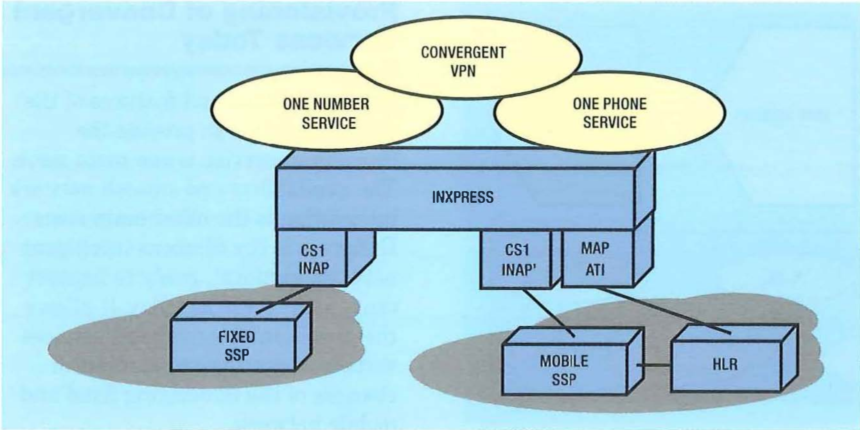

Figure 2 – Convergent service provisioning via IN technology

building blocks improve the way convergent services can be implemented by the IN architecture. CAMEL allows the provisioning of IN services across network borders and makes multi-mobile and fixed network VPNs and one phone services possible. This can be used to realise VPNs for multinational companies or to get more flexibility in adapting the existing infrastructure of corporate customers which may have different providers for their mobile telephones. MAP (ATI) allows any time interrogation of the home location register (HLR) by the SCP. The HLR and SCP share the same location information and automatic roaming services between the fixed and mobile network are possible. This enables the provision of enhanced one number services.

Network Evolution for Convergent Services

In the future even more users will use mobile communication for both voice and data. Data will gain an increasingly bigger share of the total communication volume. Data exceeds voice already in some regions of the USA; for example, Silicon Valley. Applications like Internet and voice over IP will even intensify this trend. The first steps are already taken by many network operators. ISDN and xDSL provide scaleable bandwidth pipes to the customer. However, the complexity of services increases with each new technology implemented in the networks. In the future, even more, rather than less, networks will be in operation; for example, second- and third-generation PLMN, fixed circuit switched, IP-based, ATM multiservice networks and a growing number of LANs in corporate, but also increasingly in residential, environments. It is necessary to use various networks to obtain the highest benefits and lowest costs for the user. This implies that convergence will play a major role to make efficient use of all these technologies and that it is addressed with every new technology provided. High penetration, economies and scalability require that convergence is built into the networks in a way which ensures support for today's and tomorrow's technologies and services.

To fulfill the network requirements for mass deployment of services like:

- one number/one phone services,
- personal information and communication services, and
- virtual LANs,

some vital improvements of today's fixed networks are necessary:

- *mobility management* to provide automatic roaming and high security which integrates naturally with mobile networks,
- *integrated points of presence (POPs)* to control the Internet access, and
- *bandwidth enhancement in the access network* to enable high-speed data applications.

To provide mobility inside the fixed network, the well proven and successful GSM technology sets the standard. The mobility management is implemented by the partial integration of the visitor location register (VLR) into the local exchange (LE). The mobile application part (MAP) connection is used for HLR interrogation according to the GSM procedures. The access to the CPE can be realised by different protocols, which implies a different degree of service compatibility and end-user perception of roaming between the networks:

- analogue telephone interface for POTS (plain old telephone service);
- DSS.1+ (ISDN DSS.1 plus mobility management enhancements);
- data oriented (xDSL, ISDN, modem).

The implementation of a PLMN-based mobility management into the fixed network enables automatic roaming between PLMN and PSTN. But to unleash the real power of convergence, data communication has to be included. For the provisioning of such services, an integrated POP (IPOP) inside the local exchange (for example, EWSD InterNode) with remote access server (RAS client) functionality is a key requirement.

Data communications can be realised on different access networks. However, it is only through using xDSL that the local access can offer sufficient high bandwidth to enable the provision of multimedia services. This offers a smooth migration of circuit-switched remote LAN access (RLA) to real virtual LAN applications.

As mentioned above, efficient and secure mobility management should be based on the PLMN functionality. Depending on the chosen access type, different local identification and authentication procedures are possible. To serve a wide range of access types a flexible local identification and authentication centre (LIAC) must be implemented inside the LE. Depending on the supported local identification and authentication function (LIAF) of the connected CPE the appropriate LIAF will be executed inside the LIAC. The supported feature set and user interface vary according to the LIAF capabilities of the CPE.

Analogue access

Using a standard analogue telephone interface requires the termination of mobility management procedures inside the LE. The local authentication is realised via a service call and PIN entry by the subscriber. The functionality and user interface is comparable with today's IN-based implementations of one number/one phone concepts.

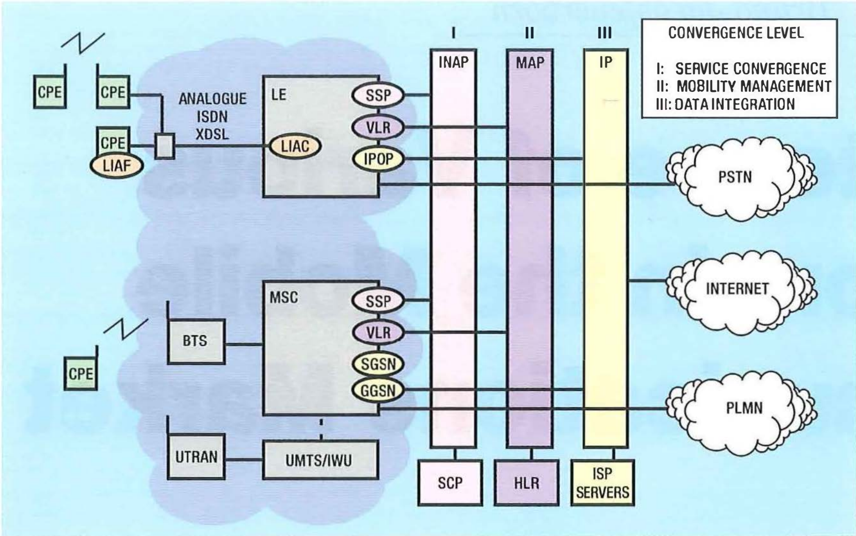

Figure 3 – State-of-the-art LE and MSC, like EWSD, are the platforms for the integration of fixed–mobile and voice–data convergence

ISDN DSS.1+
This digital subscriber access offers a wide range of service interworking of ISDN and GSM. The so called *a-Interface* adds mobility management functions to the standard ISDN interface. The mobility management information can be mapped into the appropriate fields of the DSS.1+. The mobile part could be realised either as dual mode (DECT/GSM) or as single mode (GSM-CTS).

Data-oriented modem, ISDN, xDSL
If a data-oriented connection is established between the LE and CPE, a wide variety of local identification and authentication procedures are possible. Appropriate CPEs are personal digital assistants (PDAs), notebooks or VoIP terminals. The LIAC inside the LE maps the mobility management information into the LIAF provided by the actual connected CPE. As transport pipe analogue modems, ISDN and xDSL connections can be used.

The final configuration shown in Figure 3 consists of a combination of PLMN-based mobility management and integrated voice/data communication. This leads to an integrated and thus future-proof approach for fixed/mobile and voice/data convergence in any environment.

Conclusion

Convergent service concepts should not aim only at a compatible set of network-based features because this would limit the feature spectrum that can be provided to the end user by the involved networks. A successful concept for convergence should combine the advantages of each network to result in a greater benefit for the user than the parallel use of the different networks.

Today's choice of technology to provide convergent services are intelligent networks. In the future we see the need to upgrade the capabilities of the fixed network to keep pace with rapid development of the mobile network and the requirements for supplying convergent services to the subscribers. Mobility management as an inherent part of the fixed networks will serve all of the above access techniques; that is, is future proof. Also, the local exchange is the focal point that can easily integrate the key technologies (mobility, broadband data, voice, multimedia) which are the fixed network's contribution to the convergent service offering.

Biographies

Soenke Peters
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Soenke Peters received his degree Dipl.-Ing. in technical information processing at Hochschule fuer Wirtschaft und Technik, Flensburg, Germany in 1992. Than he worked at the Linotype-Hell AG. In the Product Engineering department he was responsible for project management and software development for computer-based test equipment. Later on his task as project manager was the implementation of the production processes for new products. In October 1997, he joined Siemens, Public Communication Networks. The wide area of fixed mobile convergence is his scope as project leader in the business development department.

Hanspeter Ruckstuhl
System Engineering
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Hanspeter Ruckstuhl received a masters (Dipl.-Ing.) in Electrical Engineering from the Federal Institute of Technology (ETH) of Zurich, Switzerland, in 1982 and a masters in Business Administration from the Florida Atlantic University of Boca Raton, USA, in 1989. He joined Siemens in 1982 and has worked in software development and system engineering in Switzerland, USA and Germany. Since 1994 he has been responsible for a system engineering department in the Public Communication Switching Network Division. His main interests are in the areas of telecommunication application software with a special focus on fixed mobile convergence.

Bruno Jacobfeuerborn

Coexistence of Various Operators in the Mobile Telecommunications Market

The paper discusses the present and presumable future of the telecommunications market with special emphasis on the mobile sector. The first part of the paper outlines recent changes in regulation and the rapid progress in technology, especially in the domains of GSM, broadband transmission, satellite transmission and the Internet. New technologies change the spectrum of services offered to the user by offering substitutes for existing services or enhancing existing ones. The convergence of all forms of communication is today the biggest challenge and the biggest opportunity for future expansion for the operators. The opening of the telecommunications markets, combined with the progressive internationalisation of service, and the scope of operation, is leading to new alliances of operators. At the same time the obvious future extension of the Internet is the single biggest threat to the current market position of all operators. The second part of the paper discusses the likely development of the situation based on examples taken mainly from Germany and the US. The conclusion discusses convergence between mobile and fixed telephony, the impact of the Internet (this medium can be a direct competitor or supporter for the currently used communications infrastructure) and the fulfilling of the idea of one personal number and one bill for all forms of telecommunication services.

Introduction

The global telecommunications market is undergoing changes which can be called, without too much exaggeration, revolutionary. There is no doubt that in a few years all segments of the market will look entirely different—including of course the mobile sector.

Let us start with a short sketch of the current situation. The telecommunications market is rather specific—it differs from other markets in several aspects; to mention just the main ones:

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- physical limitations (for example radio frequencies),
- very expensive infrastructure, and
- profitability achieved in the long-run.

All these factors have direct implications on legislation and on attempts to steer the market by governments. Often these factors are the real reasons behind governments' strategic decisions. To illustrate the point: one of the reasons for the widespread privatisation of telecommunications (from China to Australia, not to mention practically the whole of Europe) is the need to raise capital to improve the very expensive infrastructure.

Companies competing in the telecommunications market must also coexist: either because they understand that it is their only way to survive in this specific market or because they are forced to do so by law. The truth is that the competition is, in the long run, a possible helper, and sometimes a future ally. At the same time we can observe convergence of main operators—every major company is trying to offer the whole spectrum of services. Furthermore, new technologies are creating substitutes for existing services or enhancing them radically.

The goal of this paper is to outline the current situation and possible future development of the telecommunications market, with special emphasis on the mobile sector.

Main Trends

The main processes now causing the changes in the telecommunications market are:

- regulatory changes,
- internationalisation, and
- technological advances.

Let us discuss these trends.

Regulatory changes

Stripping down the legal talk, regulatory reforms in the whole of Europe and the United States have opened wide telecommunications markets which were until now restricted. The core of these reforms is demonopolisation and privatisation of telecommunications. The European Union introduced new regulations in January 1998—their impact is yet to be seen. Similar changes have recently occurred in the United States. Probably because of much more aggressive marketing in the US (compared with Europe) the effects are more visible for the ordinary customer who is attacked by commercials comparing rates of various operators or enticed by free tickets to the cinema (Sprint) or the lottery with new cars (AT&T) as the reward for switching to a different operator.

Telecommunications has also accepted the World Trade Organization agreement on basic services—guaranteeing nondiscrimination, transparency and free market access. It means that all current accounting rate systems between European countries, which are secretive, quite often discriminatory and based on bilaterally negotiated arrangements, will have to be changed. It is easy to say, but let us not forget that in some cases these rates were the guarantees for huge investments achieved in tough negotiations. Legal changes can be especially difficult for GSM operators who, during the last few years, have built from scratch, the very modern and very expensive infrastructure covering in practice the whole of Europe.

In many European countries (especially in Eastern Europe) privatisation has one aspect worth mentioning: state-owned telecommunications companies have usually some concealed privileges granted to them by government agencies. In other words they have a slightly different treatment as the 'national operator'. Privatisation makes them equal to other operators.

Internationalisation

When we are talking about internationalisation in fact we are thinking of a number of ideas:

- telecommunications companies are extending their markets across the borders of countries and continents, and
- services supported and demanded by users are crossing the borders.

The first point does not need any comment: all major European companies are trying to invest in other countries; some of them are investing in American companies (for example, BT). To make the picture complete: most of the big American companies perceive Europe as the future market to conquer—so they treat investing in Europe as the natural expansion of their current operation.

To comment on the second point: the best example of ordinary users wanting to have cheap international access is the success of Internet. Part of the Internet's enormous popularity lies in the fact that the Internet has no borders; users can access information from any point of the globe for exactly the same price. Most of us probably still remember the excitement accompanying first connections with distant Internet sites for the price of a local connection (plus of course the Internet supplier's fee). Probably this flat price structure causes the effect which is quite surprising: people usually think that using the Internet is a lot cheaper than telephone connections. Comparing local connections, it is usually more expensive; but the situation that connections across continents are affordable for everybody lets the user forget that the bill paid for Internet access is usually bigger than the one for telephone calls.

The growing expectations of users coincide with the increasing competitive pressures which most operators are facing today. This, in turn, forces them to look for change in the accounting rate system. Adding to this, the problem of unbalanced traffic (especially difficult for developing countries)—and we can see why the ITU's recent World Telecommunication Policy Forum in Geneva once again focused attention on reform of the international accounting rate system. Although no real solutions were found, it is a clear indication that in the near future the rate system must be changed completely. We will return to this problem later when discussing the influence of the Internet.

New technologies

The fact that today's telecommunications market differs completely from the one which existed some 5–10 years ago is caused mainly by new technologies. Let us review perhaps not the hottest technologies on the market, but the technologies which are either promising the most spectacular effects in the near future or have showed their significance for the future of telecommunications:

- the global system for mobile communications (GSM),
- broadband transmission,
- satellite transmission, and
- the Internet.

GSM

The expansion of GSM does not need too many comments: it is enough to take a look at the streets of European cities—mobile telephones are everywhere. Current projections for the next five years estimate that the mobile revenues will grow at an average annual rate of over 30 per cent while the fixed network revenues are projected to grow at the rate of nine per cent per year. The number of mobile telephones (in Europe) should grow from over 52 million at the end of 1997 to over 125 million by the year 2001, with market penetration exceeding 30–40%. Such quick expansion has been accelerated recently by two trends:

- the benefits of mobile telephones (like 'staying in touch' or 'using dead time') have been accepted by the mass-market users (previously it belonged to the privileges of corporate upper-level management), and
- young people find mobile telephones more attractive than the fixed telephones and quite often their first telephone is mobile.

Of course these trends would not be possible without the basic factor of falling rates of connections—mobile telephones are affordable for young people (opposite to satellite telephones for instance). The examples of countries (like Israel) show the future of GSM telephones—quite soon it will be unusual not to have a mobile telephone. In the autumn of 1998, Italian operators are planning to introduce special mobile telephones for children between four and 14 years old. This rather controversial expansion of the market illustrates the total propagation of mobile telephones. In the situation when practically everyone has a mobile telephone there is a need for new services which will integrate it with other forms of communication (fixed telephones, e-mail). On the contrary, there is a need for services which will enable people to have some privacy or simply time for uninterrupted work like voice mailboxes, screening or transferring calls, etc.

Satellite transmission

Planned satellite systems which will become operational in 1998–2002 will provide new global telecommunications infrastructures for all kinds of media: Internet, fixed and mobile telephony. The four key satellite consortia are:

- ICO Global Communications,
- Iridium,
- Globalstar, and
- Teledesic.

Details of these enterprises are not discussed here. It will take some time before these enterprises will affect the mass market we are talking about, perhaps with the exception of ICO's network which aims to support inexpensive telephone services to 3 billion users who currently have no telephone connection at all. Such massive increase in the worldwide telecommunications market will be one of more interesting changes in the near future.

Broadband transmission
Broadband transmission has been, up to this year, rather a prospective vision than reality. But from the beginning of this year all over Europe radio regulatory agencies have started seriously to evaluate and allocate specific frequencies for broadband wireless access (for example, four licenses in the UK to stimulate expansion of ISDN; also licenses have been granted in Germany, France, Romania and Russia). The target for the investments is mainly the business customers. Planned usage is mainly for high-speed Internet and leased-line services, although there are some plans for reviving the idea of video-on-demand (direct transmission of movies to customers' homes). Although not so spectacular as satellite transmission, this medium can enable the fast transmission of data to private customers—up to now this service has been available only to corporate users.

Internet

Finally we look at the topic which probably will have the biggest impact on the telecommunications market. We do not have to see figures showing how quickly the Internet is expanding—it doubles very year. In fact the number of hosts on the Internet is actually quite small compared to telephone connections. But what has already happened justifies the common belief that the Internet is the single biggest competitor for traditional technology. The threat comes from the fact that the Internet is supporting services that replace traditional telephones—fixed or mobile.

Recently, telephony over the Internet has been the subject of great interest and a great deal of investment (rather in the US than in Europe). Although common Internet telephony is still far from reality, it is not something that can be ignored simply as the press noise. Packet-switched telephony as an industry was non-existent five years ago, yet now it generates about US$100 million in annual revenue. According to projections by market analysts Frost and Sullivan, this market will grow to US$2 billion in annual revenues by 2001. Indeed, Bell Canada's recent reorganisation assumes the present telephone network will be swallowed by the Internet. The Denver-based start-up Qwest Communications is based on the same assumption. The examples are taken from the US because in this respect Europe is still lagging behind the US.

Comparing the Internet with traditional telephony we can see that there are more similarities than differences. On the technical side, both forms of communications share the same local and international infrastructure (leased lines, fibre-optic cables, satellite links). The computers used for switching (or *routing* as it is called in the Internet) are also quite similar. The main difference is of course that telephone service is circuit-switched while the Internet is packet-switched.

From the users' point of view the most importance difference is the flat-rate pricing compared to usage-based pricing used by telecommunications. Less visible, but having a big impact on pricing and quality of service is the fact that the Internet is self-regulated while traditional telephony is ruled by the mighty telecommunications companies.

Because of the general similarities, it is rather difficult to treat the Internet as the hostile competitor for the traditional forms of communication, especially if we observe how much traffic is generated today by users calling Internet providers or if we take a look at the growing popularity of ISDN telephones boosted exclusively by Internet access. How the Internet will replace or support the existing services is still the open question.

Conclusion—Future of the Market

According to Mr. Klaus Hummel, managing director of technology in T-Mobil, fixed and mobile convergence will be key to the company's future. Deutsche Telekom, together with its daughter company T-Mobil, plans to merge fixed and mobile into one network, and to offer dual-mode devices for both residential and business markets. Current plans include the introduction of HomeZone pricing on GSM networks, adoption of dual-band telephones, and the further development of personal numbering and other convergent services. The company has already integrated applications from its D1 digital cellular service within company fixed-network PABXs. Competitors in the German market, E-Plus and Viag, are considering similar plans.

Another change in traditional telephony will be increasing substitution for voice traffic by data traffic. The American company MCI projects that data traffic volume will be greater than that of voice traffic on global fixed networks within three years (in the US, Internet traffic has increased by a factor of almost eight in the past two years). Internet access and the growth of corporate intranets are driving massive growth in network volumes in this country with data traffic as a whole growing by 30–35 per cent per year (voice traffic is growing by around five per cent per year).

The experience of mobile data is much less encouraging for the development of a significant mobile multimedia market. So far, GSM's data communication capabilities do not appear to act as a major factor in volume or revenues. Though operators have developed a variety of applications such as unified messaging and Web access, beyond specialist applications for particular users (for example, road transport), there has been a consistent lack of demand. In reality, everything available on the Internet can be made available on the wireless side, including electronic commerce, and e-mail. The introduction of third-generation cellular devices in 2002 and the GSM-2 standard will change the situation. So-called *handtops* will combine cellular telephones with laptops and videophones, opening the way for real multimedia service applications.

The convergence of various forms of communication is becoming a reality. In June, Sprint announced its plans for the *integrated on-demand network* (ION). Existing connections from users to the nearest switching centre will be used to establish a communication link supporting all forms of communication (fixed telephone, fax, Internet access, video on demand, videoconferences and others) at the same time. Users will get a unified telephone bill for the real usage of the line regardless of the devices used during connection. The predicted speed of the link—over 3 Mbit/s—guarantees access speed, changing Internet services from being interesting toys to working solutions. Other major US companies have already confirmed their plans for introducing similar solutions.

Supported by efficient infrastructure (satellite and broadband transmission) telephones and the Internet will provide for the common user services combining most of today's possibilities plus many more. Although bandwidth and used technologies will be different for different services, providers must integrate various devices and the processes must be invisible to the user. European operators will increasingly offer fixed and mobile packages based on partnerships and integrated network build. Already in the UK, Vodafone has signed agreements offering customers fixed line services via the networks of Energis and Racal Telecom. In the quite near future, combined mobile/fixed networks will provide one telephone number and one telephone bill for all their telecommunications services. Probably the most important question today is if this combined telephone number is also the e-mail address, and the mobile/fixed voicebox is also the Internet mailbox. I personally believe that traditional telephony will coexist with the Internet. On the technical level they will merge together, being supported by the same infrastructure. Internet telephony will be less attractive if the pricing structures of the fixed/mobile telephony change (and, as we can see, all regulatory changes are leading in that direction). Besides, I think that convenient small mobile telephones will not by eliminated by computer terminals—exactly in the same way as daily newspaper will not by killed by Internet news channels. After all, these changes must be accepted by a common user—and this is always the unknown factor.

Biography

Bruno Jacobfeuerborn
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Bruno Jacobfeuerborn graduated from the University of Paderborn in 1989. From 1989–1993 he was Head of the Operation and Maintenance Section of Deutsche Telekom GmbH. Since 1994, he has been Managing Director of T-Mobil, head of the Hannover branch office. His area of special interest is GSM technology and usage.

Robert Arnott, Seshaiah Ponnekanti and Carl Taylor

Smart Antennas for UMTS

With increasing mobile penetration and limited spectrum, there is a strong demand for techniques to increase capacity. Smart antenna schemes can mitigate the effects of interference and fading and increase the spectral efficiency. All of the air interface proposals for third-generation systems submitted to ETSI recommended the optional deployment of smart antennas in the network infrastructure to maximise the system capacity while retaining the required quality of service. The spectral efficiency achieved by smart antennas may be extended if the array can operate on more than one air interface. In this paper, we outline the issues related to system design of adaptive antenna candidate architectures for third-generation systems. The paper examines the use of high-speed digital signal processing (DSP) technology and software reconfigurable modules to support both TD-CDMA and W-CDMA schemes. The paper goes on to state the requirements for flexible data processing in a multi-mode base station and describes the partitioning of algorithms between parallel-processing DSP engines for the selected air interface schemes. Finally, a methodology is given for the complexity analysis of a sample demodulator and equaliser block implemented in flexible DSP, followed by extrapolation of the methodology to the dimensioning of a complete TD-CDMA receiver suitable for a smart antenna array.

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Introduction

Universal Mobile Telecommunication Systems (UMTS) is the European third-generation mobile communication system working towards the aim of integration and convergence of fixed and mobile communications. Conceptually, UMTS is expected to offer bit rates up to 2 Mbit/s for a broad spectrum of applications ranging from speech to high-speed interactive multimedia. All the standardisation issues surrounding the UMTS are decided by various subgroups in the European Telecommunication Standards Institute (ETSI). Recently, SMG in ETSI reached a consensus on the UMTS radio interface amounting to wideband code-division multiple access (W-CDMA) in the paired band with frequency-division duplex (FDD) and time-division code-division multiple access (TD-CDMA) in the unpaired band with time division duplex (TDD). This agreement may effectively be seen as the recommendation to deploy W-CDMA for macro and microcells, and TD-CDMA for picocell applications. Although it is not clear at this stage, it may be natural to assume that variations to this guideline may emerge, particularly, deployment of W-CDMA to offer high data rates within a reduced cell, which is tantamount to a picocell architecture. Both the air-interface evaluation reports perceived smart antennas as one of the technical features for UMTS. Moreover, there is a desire to incorporate flexibility into the base station primarily driven by the fact that any third-generation technology will have to co-exist in a world of multiple standards with different kinds of service provision per user. It is the purpose of this paper to present some system design choices to acquaint the reader with some of the basic trade-offs available for both CDMA and TDMA radio-access systems. In particular, we focus on air interfaces selected by ETSI for UMTS for third-generation systems, with an emphasis on software reconfigurability.

In the following sections, a candidate architecture for the TD-CDMA radio interface recommended by ETSI is proposed, and the issues surrounding the dependency of the radio interface for adaptive antennas are briefly discussed. The final section deals with the requirements for flexible data processing and concludes with a methodology for estimating the computational complexity of a TD-CDMA receiver suitable for an adaptive antenna array.

Candidate Adaptive Antenna Architecture for UMTS

This section develops an adaptive antenna architecture suitable for implementation in a UMTS base station, based on the TD-CDMA mode proposed by ETSI.

Figure 1 shows a block diagram of a multi-carrier TD-CDMA UMTS BTS with an adaptive antenna array capability. For simplicity only the FDD mode is considered. The base station supports several TD-CDMA carriers with a carrier spacing of 1·6 MHz. The architecture uses multi-carrier down-conversion in order to avoid the necessity of one down-converter per carrier per array element. The carriers are simultaneously down-converted to a low intermediate frequency (IF), digitised together and then separated by digital filtering.

The digital down-converters perform a quadrature down-conversion and filtering operation on the A/D output to extract the carrier signals. Once this down-conversion and filtering has been performed the complex baseband signals representing each carrier may be decimated to a lower sample rate, for example 5·2 MHz for TDMA signals and 4·33 MHz for TD-CDMA. The baseband signals from all of the array elements are distributed to processing modules over a high-speed data transport bus.

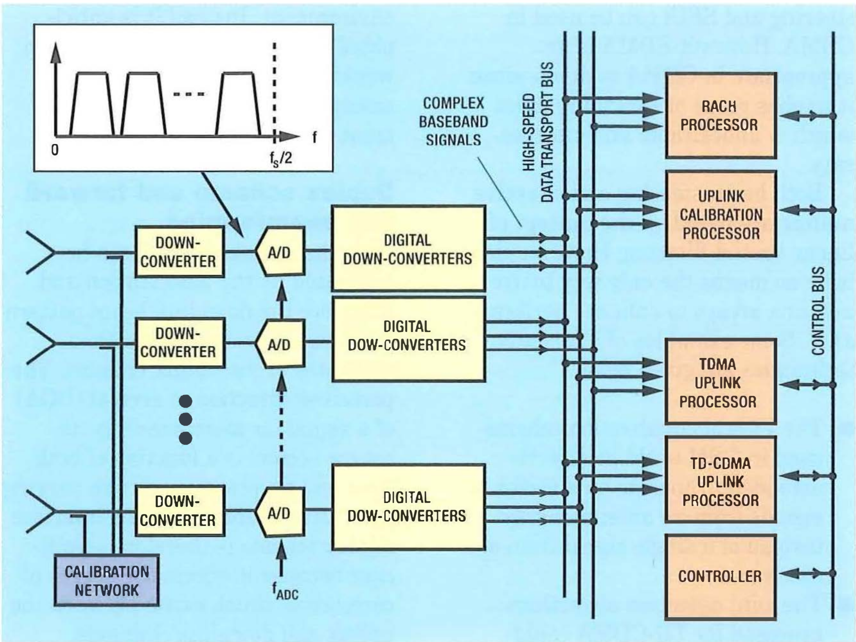


Figure 1 – TD-CDMA multi-carrier adaptive antenna BTS architecture (uplink)

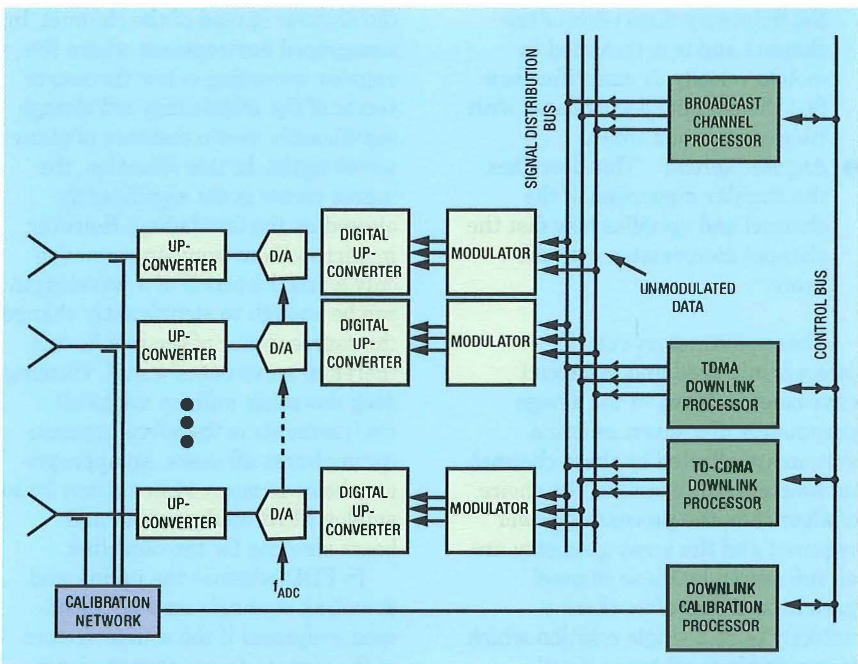
A number of processing modules are connected to the high-speed data transport bus. These modules have access to the signals from all carriers, timeslots and array elements and extract the ones they require for processing. A RACH processor is provided to detect and process random access attempts from mobiles. The demodulation of traffic and dedicated control channels is handled by a TDMA uplink processor module and a TD-CDMA uplink processor module. It is possible that common reconfigurable hardware modules could be used to implement both the TDMA and TD-CDMA processors. This provides the most flexible solution, allowing hardware and software resources to be dynamically allocated to TDMA or TD-CDMA demodulation tasks across any of the carriers.

In the downlink direction, shown in Figure 2, the unmodulated data to be transmitted on all the carriers is distributed to all array elements. Each array element has a modulator which performs pulse shaping (and spreading in the case of TD-CDMA). Each modulator outputs complex baseband modulated signals which are passed to a digital up-converter. The digital up-converter performs a frequency translation on each signal to a low IF, after which the carriers are digitally summed and the resulting composite signal is then converted from digital to analogue and up-converted to RF. The digital up-converter can also apply a different phase shift to each carrier signal on each element to implement the transmit beam-forming function.

The processor modules are also connected to a base-station controller which is responsible for their configuration and resource management. This connection may be over a separate control bus (as shown in Figure 2) or possibly multiplexed onto the high-speed data transport bus.

Calibration networks are provided to measure the transfer functions of both the receive and transmit paths so that mismatches can be compensated in the array processing function. Typically the receive paths would be calibrated by injection of a narrowband calibration signal during idle time-slots. An uplink calibration processor collects the resulting baseband signals and uses them to compute the calibration coefficients. The transfer functions of the transmit paths can be measured by RF sampling of the transmitted signals.

Figure 2 – TD-CDMA multi-carrier adaptive antenna BTS architecture (downlink)



Air Interface Issues for Smart Antennas

Smart antennas are a complex technology and their interaction with the air interface design and propagation environment is often complicated. Successful deployment of smart antennas in UMTS will involve careful choices which can only be made with a thorough understanding of the technology. The scope of this article does not allow us to address all of the relevant issues, so this section focuses on some of the most important aspects.

Beamsteering, adaptive nulling and beyond

There are many ways in which smart antennas can be used in a mobile system allowing performance to be traded against complexity of implementation. Indeed in some cases simpler techniques give better performance because they are more robust in difficult propagation environments.

Beam-steering refers to the class of algorithms which attempts to direct a beam towards the wanted mobile but make no attempt to null co-channel interference signals. The interference reduction effectiveness of beam-steering may be enhanced by combining it with other techniques such as frequency hopping.

Adaptive nulling can be used to further reduce co-channel interference in both uplink and downlink in order to improve the overall capacity of the system. In TDMA systems there are two principal ways in which adaptive nulling can be used.

- *Spatial filtering for interference reduction (SFIR)* In this scheme nulls are formed in the direction of interference sources in the uplink and downlink. This improves the carrier-to-interference (C/I) ratio and allows the frequency reuse pattern to be tightened, thus increasing capacity. This technique is also sometimes called *reduced cluster size* (RCS).
- *Spatial division multiple access (SDMA).* This involves the use of adaptive nulling to allow two or more mobiles in the same cell to share the same frequency and time slot. One beam is formed for each mobile with nulls in the direction of the other mobiles. This technique is also sometimes referred to as *same cell frequency reuse (SCFR).*

SDMA requires better nulling performance than SFIR because the high dynamic range of uplink signals within a cell means that the C/I of the wanted signal can be far below 0 dB. In the SFIR case the C/I is positive on average. However SDMA has the advantage that it can be implemented in isolation in single cells (for example, traffic hot spots), whereas SFIR must be implemented across whole clusters of cells. Of course SDMA also requires the establishment of new procedures to manage the air interface resources within each cell. For example this may involve intra-cell handovers.

In CDMA systems an improvement in C/I leads in principle to a proportional improvement in capacity, and smart antennas may be seen as a direct extension of the sectorisation techniques used in existing CDMA systems. Both beam-steering and SFIR can be used in CDMA. However SDMA is not appropriate in CDMA systems, since it implies reuse of spreading codes which is undesirable and unnecessary.

Both beam-steering and adaptive nulling are based on the concept of linear spatial filtering. However this is by no means the only way to use antenna arrays to enhance performance. Some examples of alternative techniques are given below.

- The Viterbi equalisation scheme used in GSM could be directly extended to operate on a vector of signals from an antenna array instead of a single signal from one receiver.
- The joint detection algorithms proposed for TD-CDMA could likewise be extended for vector operation.
- The use of spatial transmit diversity, which involves the transmission of copies of the downlink signal from two or more transmit antennas in order to exploit the spatial diversity of these antennas.

Influence of the propagation environment

A mobile-radio channel may be characterised in terms of three basic parameters as follows.

- *Delay spread* This describes the time dispersion of the channel, and specifies how fast the channel decorrelates with frequency (correlation bandwidth).
- *Doppler spread* This describes the frequency dispersion of the channel and is determined by mobile velocity. It quantifies how fast the channel decorrelates with time (correlation time).
- *Angular spread* This describes the angular dispersion of the channel and specifies how fast the channel decorrelates with distance.

These parameters vary for picocell, microcell and macrocell enviroments. Many of the design parameters of a smart antenna system are effected by these channel parameters. For example, the choice of algorithm, the processing power required and the array geometry are all influenced by these channel parameters. Therefore there is unlikely to be a single solution which is applicable to all types of cell environment. Instead it is anticipated that a smart antenna system would be designed based on an assumption of the type of environment in which it is to operate.

Duplex scheme and forward link beamforming

Only the uplink channel can be estimated by the base station and therefore the downlink beam pattern must somehow be derived from estimates of the uplink channel. The perceived direction of arrival (DOA) of a signal (or more precisely its source vector) is a function of both time and frequency in a time-varying dispersive channel. The air interface duplex scheme is therefore significant because it effects the degree of correlation which exists between the uplink and downlink channels.

The performance improvement obtainable from the smart antenna system is not symmetrical between uplink and downlink for this reason. The degree of asymmetry depends on the class of algorithm being employed. The direction of a beam maximum is less sensitive to time and frequency translation than the direction of a null. Therefore the asymmetry is particularly evident when it is necessary to form deep nulls in the downlink beam pattern, which is a requirement for SDMA.

In TDD schemes the uplink and downlink channels may be considered reciprocal if the source vectors of the signals do not change significantly in the time between the transmit and receive time-slots. The rate of change of the source vector is controlled by the mobile velocity and the angular spread of the channel. In a macrocell environment where the angular spreading is low the source vector of the mobile may not change significantly over a distance of many wavelengths. In this situation, the source vector is not significantly altered by the fast fading. However, in microcell environments, moving only a small fraction of a wavelength can be enough to significantly change the source vector of the mobile and therefore move out of a null. Forming deep downlink nulls in microcell environments is therefore impractical in almost all cases. An appropriate choice in many systems may be to employ SFIR on the uplink and beam-steering for the downlink.

In FDD schemes the uplink and downlink channels may be considered reciprocal if the source vectors of the signals do not change significantly between the transmit and receive frequencies. Typically the uplink and downlink bands are separated by much more that the coherence bandwidth of the channel and the source vectors at the two frequencies differ significantly. An exception to this is the open macrocell case with little or no delay spread or angular spread.

Broadcast control and pilot channels

In some second-generation systems the implementation of broadcast control and pilot channels causes unnecessary difficulties for smart antenna implementations.

For example, it is difficult to use smart antennas for downlink range extension in GSM. This is because the size of the cell on the downlink is fixed by the broadcast control channel (BCCH) which is measured by the mobiles in neighbouring cells. Since the BCCH is a broadcast channel it must be transmitted omni-directionally. The BCCH must therefore be transmitted at a higher power than the traffic channels to take account of the fact that once a traffic channel is established the beam-former gain will improve the link budget.

In the IS-95 downlink, a pilot channel is used which is broadcast to all mobiles for synchronisation purposes. This pilot signal must pass through the same channel as the traffic signal in order for the RAKE receiver in the mobile to function correctly. If individual downlink beams are used for each user then this is clearly no longer the case and therefore the current IS-95 air interface is unsuitable for downlink beam forming. UMTS overcomes this problem by providing a dedicated downlink pilot signal for each mobile.

Baseband Functions

The advent of fast DSP engines and bus architectures allowing fast memory access has led to an emerging technology area in mobile communications, termed *software radio*. By applying appropriate algorithms from a comprehensive algorithmic toolbox, the functionality of a radio transceiver can be vastly increased. The use of such flexible radio access techniques for base stations allows multiple air interfaces to be supported. An example of demand for this would be a base station architecture using reconfigurable DSP for dual second/third-generation system operation. This approach can be extended to the processing of adaptive antenna functions for different air-interfaces.

Flexible data processing

A critical feature is therefore the development of efficient DSP architectures that can support commonality in software functions. Correct planning of the DSP architecture can reduce production costs by the use of simpler and cheaper structures, simplify upgrade paths and enable more sophisticated performance, such as beam forming. An example of demand for this would be automatic selection of the most appropriate wireless communications scheme for a user's application in real time. This may typically involve switching between a packet switched protocol such as asynchronous transfer mode (ATM) and a circuit switched protocol, using network capacity only as required and minimising network resource requirements[8]. To support bandwidth-on-demand services to mobile users, the MS application drives the choice of air-interface, unless the available bandwidth becomes the limiting factor. In such an instance, the application must either reduce its bandwidth requirement, perhaps by reducing quality, lowering bit error rate (BER) or reducing video frame rate, or it must terminate. Therefore so long as adequate voice and data rate switching can be provided by the base station architecture, the specific MS application is transparent to the base station functionality unless the air-interface changes.

As an example of how the air-interface affects the DSP architecture, let us examine how the specific TD-CDMA and W-CDMA protocols may be accommodated by a single processing system:

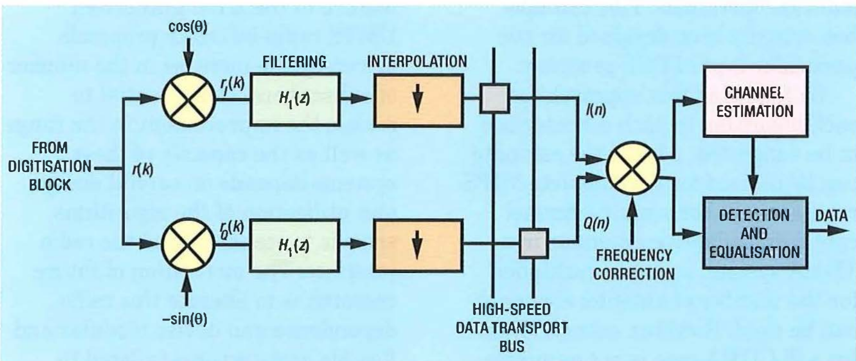
In a parallel-processing DSP system using a multiple instruction multiple data (MIMD) architecture configured for TD-CDMA, a single slot of data is ideally processed per frame. The processing is partitioned into a number of algorithmic elements that can be executed concurrently, implying no direct dependency between these elements[9]. The execution speed directly relates to the total delay from data input to processed data output (latency). Up to a limit, latency may be extended in TDMA systems to allow complex functions to be pipeline-processed by several DSP engines. In the case of a parallel-processing DSP system configured for W-CDMA, there are many more strands of algorithmic elements that must be processed directly in parallel, which implies a different DSP array architecture. This may take the form of a more conventional multi-element parallel array. Where beam-forming techniques are applied, these may be considered to form a subset of the algorithms for each air-interface, and are radically different for TDMA and CDMA cases. It can be seen therefore that the DSP array architecture is dependent on the type of air interface to be supported at that instant, and must be optimised as required.

DSP complexity analysis methodology

As a specific example, this section describes how the complexity of a joint-detection TD-CDMA demodulator and equaliser may be estimated in terms of the numbers of operations that a DSP processor must perform.

Figure 3 is a generalised block diagram of the digital baseband section of a TD-CDMA receiver, and

Figure 3—Generalised figure of a TD-CDMA receiver (digital base band)



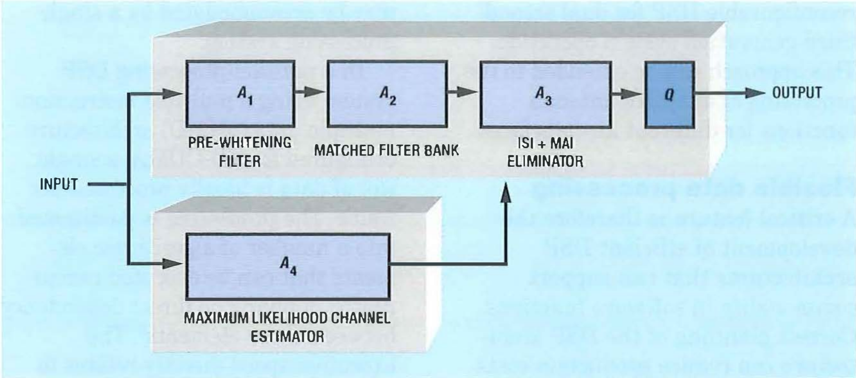


Figure 4—Joint detection and equalisation algorithm block

Table 1 Operations Required to Implement Detection and Equalisation Functions

Algorithmic function	Total MIPS per slot	Number of time-slots (example 8 slots)	Number of antenna elements (example 8)	Total (MIPS)
A_1	Σ_1	×8	8	$64\Sigma_1$
A_2	Σ_2	×8	8	$64\Sigma_2$
A_3	Σ_3	×8	8	$64\Sigma_3$
...	...	...	...	...
A_N	Σ_N	×8	8	$64\Sigma_N$
Total				$64(\Sigma_{1...N})$

Figure 4 shows a block diagram of the joint detection and equalisation algorithm block, where $A_1, A_2, \ldots A_N$ are the specific constituent algorithms for each function. These algorithmic functions that perform the detection and equalisation are extracted in Table 1 and listed in terms of the type of complex multiply and additions required at each computation. In such a TD-CDMA system, this can be parameterised in terms of the number of symbols per block, the channel length in chips and the instantaneous number of users and related directly to the number of millions of instructions per second (MIPS) needed to implement the complex multiply and addition operations. This example has actually been designed for one particular type of DSP processor.

By following this approach for each algorithm in each air-interface to be supported, a best-case estimate can be derived for the complete MIPS requirement. For a multi-channel case using adaptive antennas in a TDMA system, a simple multiplier for the number of antenna elements can be used. However, extrapolation for a W-CDMA case is not as simple, as best use of DSPs to implement complex functions such as RAKE receivers could be managed intelligently using traffic statistics. On top of this basic estimate, for both TD-CDMA and W-CDMA cases, an overhead must be added due to other factors such as non-ideal algorithm partitioning, less than 100% use of DSP resource and administration and control functions.

Conclusions

This paper has discussed the system issues related to the application of smart antennas to mobile communications in both TDMA and CDMA systems. The technology is a new feature in the ETSI authorised UMTS radio-interface proposals driven by the increase in the number of subscribers. The potential to realise the improvement in the range as well as the capacity of these systems depends on careful design and utilisation of the algorithms specific to scenarios and the radio interface. The motivation of future research is to liberate this radio dependence and devise modular and flexible architectures tailored to serve the generic set of scenarios. Towards this challenging objective, an architecture has been identified as a basic building block, in conjunction with a case study of its complexity. Efficient architectures for DSP systems have been identified as a critical component in mobile communications base stations, and a physical method has been described for estimating the DSP requirement for a TD-CDMA base station employing adaptive antennas.

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Robert Arnott joined ERA Technology Ltd in 1989 after graduating from the University of Birmingham, UK. In 1996 he was awarded a Ph.D. degree by Imperial College, University of London, under the Industrial Research Laboratories scheme for his thesis on array processing for digital mobile radio. He has been responsible for the development of several digital array processing systems including the TSUNAMI SDMA demonstrator. He also spent four months at the Centre for Wireless Communications, Singapore, as a consultant on adaptive antenna systems. He is currently a Consultant Engineer seconded to Telecom MODUS Ltd where he is involved in the development of UMTS base-station equipment.

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Seshaiah Ponnekanti received his doctorate in 1995 in electrical engineering from University of Newcastle, UK. He is currently a Principal Engineer in Telecom MODUS seconded from the Mobile Communications Department at ERA. Prior to joining ERA, he worked as a research fellow for two years in a project devising robust beam-forming algorithms and direction-finding schemes for electro-magnetically dense environments. He was the project manager of the ACTS TSUNAMI(II) Project that demonstrated the applicability of smart antennas to DCS-1800 mobile network. His current research interests include UMTS air interface related issues and interference suppression in European third-generation mobile systems and IMT-2000.

Carl Taylor
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Carl Taylor received the B.Sc.(Hons.) degree in Physics 1986, and his M.Sc. in RF Engineering in 1987. Working on CT2 handsets, BTS design and air-interface specification, he also designed narrowband VHF and UHF modulators, an antenna system for mobile DF and led a team to develop a channelised receiver for electronic warfare. Since 1995, he has studied software radio, adaptive array systems and the design of high dynamic range receivers. He was Project Manager of the ACTS FIRST software radio terminals project from 1995–1998 and is author of several papers on software radio techniques, multimedia and UMTS. From managing the Mobile Communications Department at ERA Technology he moved to Telecom MODUS Ltd in May 1998, where he is involved in the development of UMTS base-station equipment.

Andrei Constantinescu

NetSquare: A Multi-Purpose Tool for Telecommunications Business

This paper discusses the concept and use of multi-purpose telecommunications networks which were created for testing, training and demonstration purposes. NetSquare is introduced—Ascom's multi-functional area and environment for the telecommunications domain, situated in Berne, Switzerland. It shows how such a platform is used and the resulting benefits. Finally it looks at evolution scenarios moving towards an international net of such platforms, while a plea is made for an emerging telecollaboration.

Introduction

Today's telecommunications market is heavily in motion. Some keys to success in the battle for market shares are low costs, innovative services, a short response time to changing market needs and evolving technologies, as well as the awareness of the technically and commercially feasible. An elegant way to address these and related issues, is to establish an innovation and marketing platform.

For this purpose, Ascom created *NetSquare*, a multi-functional area and environment for the telecommunication domain. The NetSquare infrastructure, which is located in Berne, is a genuine and isolated telecommunication network with all typical elements from different manufacturers: digital switches, ATM-equipment, universal multiplexers, intelligent peripherals, telemanagement stations, PBXs, terminals, servers, backbone elements, etc. Figure 1 gives a snapshot impression of this continuously evolving network.

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NetSquare—Yet Another Products Showcase?

NetSquare is far more than the sum of its parts. The main purpose of such a platform is not to display isolated products, but to allow the visitor to interactively experience telecommunications as the interaction of all elements involved. Hence, this approach allows a company to show evidence of its telecommunications and IT competence—as Ascom does with NetSquare. However, if a visitor requires more technical details regarding some particular equipment or service incorporated in the network, he or she can ask the accompanying presentator to literally zoom in to that very system.

When creating NetSquare, particular attention was given to the thematic structure of the platform. In order to help visitors easily to find themselves and their needs, five rooms were defined:

- the welcome plaza, where the visitor is told where he/she is, what can be seen, and what NetSquare is about;
- the systems room, with the operator's typical transmission and switching equipment, including intelligent peripherals, Internet access platforms, etc.;
- the telemanagement room, with its network- and service-management facilities;
- the customer's cellar, where large business-customer or end-user accessing equipment can be seen, like PBXs; and
- the end user's area, where basic customer environments (home, small and middle size office and large company) are reproduced, connected and equipped with solutions according to their typical telecommunications/IT needs.

It should be also mentioned, that all systems and services shown in NetSquare are real, working solutions. Simulations would not conform to the philosophy of the platform.

NetSquare's primary mission, is to act as a communication or marketing interface. This *ShowSquare* character is meant to help one to experience the global view of today's telecommunication challenges, with focus on the visitor's particular interests, needs, business processes and business cases. Apart from that, NetSquare is used in different, complementary and coherent ways. One example is *LabSquare,* which, by fast prototyping and testing new services or network elements in this real-world scenario, enables a shorter innovation cycle to be achieved. Given the nature of this environment, it is possible to investigate not only the interaction of a telecommunications component or service with its typical future direct counterparts, but also to look into the more complex behaviour of network systems influenced by such elements.

NetSquare is perfectly suited for acquiring and updating one's know-how in the communications field. This *TrainSquare* facet comprises not only introductory and overview courses, but it can also offer speciali-

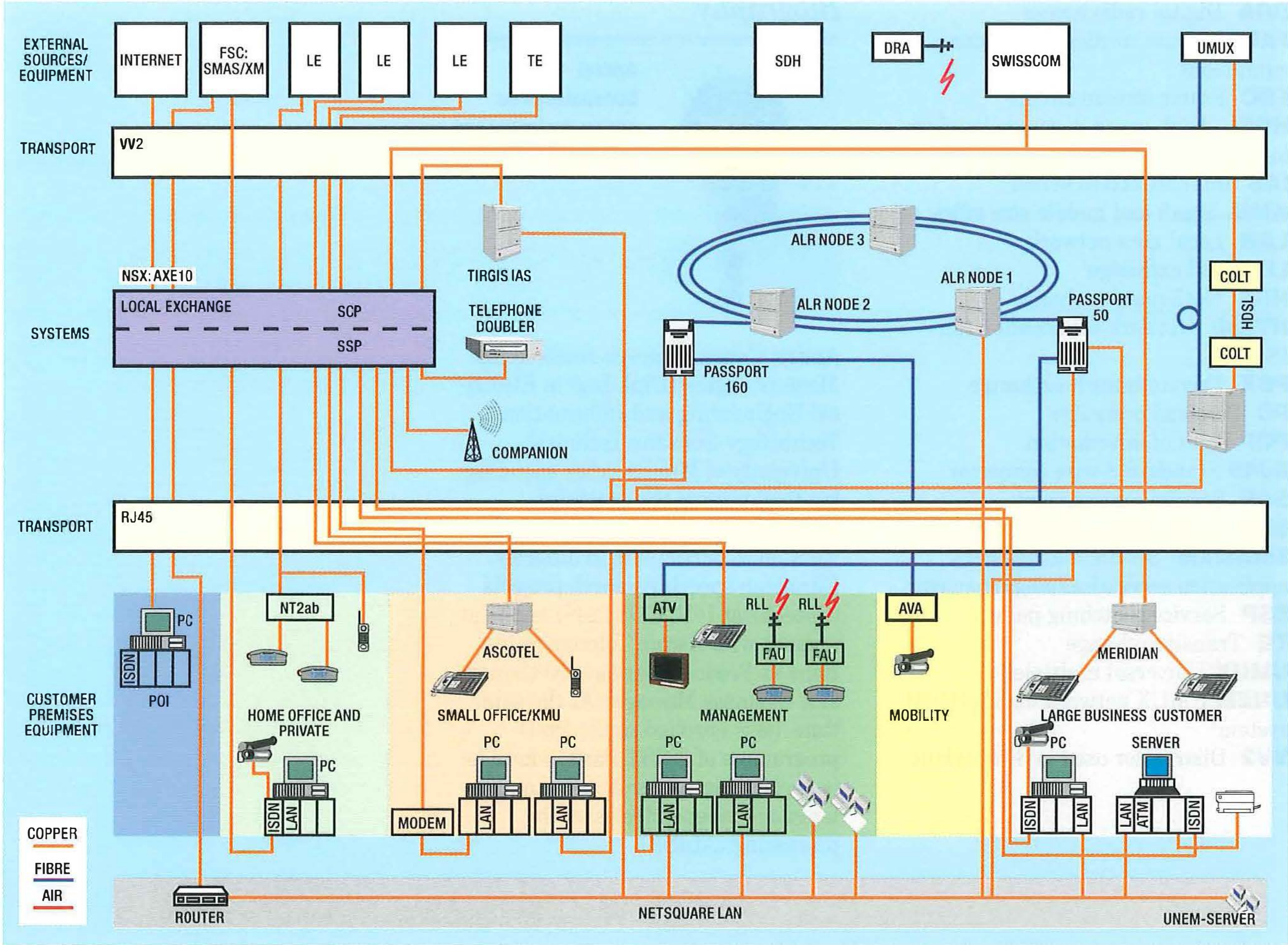

Figure 1 – The NetSquare configuration

sation classes for equipment and technologies.

A Sum of Benefits

A NetSquare-like platform acts as an innovation pool and business motor. It offers various advantages, among others:

- visitors not only see paper documentation of the systems or solutions they are interested in but can actually touch it, play with it, and see if it's real and that it works;
- the feedback from the market regarding acceptance of ideas or directions for services or solutions is very fast;
- prototyping and testing of own solutions in the existing and isolated complex network cuts down on costs and enhances reliability;
- offering the infrastructure to one's customers and partners generates direct and indirect turnover;
- it becomes possible to test typical telecommunications processes, from service provisioning to billing; and
- by concentrating system components, customer needs, research-and-development experts and business managers on such a platform, a critical mass is achieved which generates innovative ideas for efficient products and services.

A Vision

NetSquare, as presented here, is reality. The described platform exists and is operational. The challenge of taking it one step further is intriguing, and so are some possible scenarios for a future, international *WebSquare*. What if different NetSquare-like platforms from different locations are connected together? We can imagine the extremely heterogeneous international network that would result, and its possibilities. We would be able to use this worldwide network for testing, prototyping and demonstration purposes. By sharing the resources of such a WebSquare, this instrument could be regarded as a worldwide reference testbed for services or systems to be inserted in networks. A worldwide quality label 'WebSquare tested' would be in sight. The funding for such a platform could be provided by international organisations, like the European Community, or FITCE, or by the individual national telecommunications regulators. Of course, the equipment providers could also participate in the network, as well as the telecommunications operators. The end users could be made aware of the newest services or breakthroughs, thus encouraging them to use the new proposed telecommunication means.

The inter- and intra-disciplinary platform created would bring experts and users together, who could share their know-how for everybody's benefit. Thus, soon enough, telecommunication would become *telecollaboration*.

Glossary

ALR ATM light ring
ATM Asynchronous transfer mode
ATV Video encoder
AVA Video decoder
COLT Copper line terminal (HDSL)

DRA Digital radio access
FAU Inhouse cordless telephone equipment
FSC Frame stream circuit
HDSL High-speed digital subscriber loop
IAS Internet access server
KMU Small and middle size office
LAN Local area network
LE Local exchange
NSX NetSquare exchange
NT2ab Network termination (for ISDN)
PBX Private branch exchange
PC Personal computer
POI Point of information
RJ45 Standard 8-wire connector
SCP Service control point
SDH Synchronous digital hierarchy
SMAS/XM Service management application service/exchange manager
SSP Service switching point
TE Transit exchange
UMUX Universal multipler
UNEM UMUX network management system
VV2 Distributor used in Switzerland

Biography

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Andrei Constantinescu received his Masters degree (Dipl. Ing) in Electrical Engineering and Information Technology from the Technical University of Munich after spending his final year at the Artificial Intelligence Laboratory of MIT. He went on to participate in different European speech research projects (SpeechDat I+II, COST249) and is at present with Ascom Telecom Solutions as Product Manager NetSquare and Business Manager. At the same time, he is enrolled in the Ph.D programme of ENST Paris, where he is performing research on automatic language independent speech processing (ALISP).

Achilleas Kemos and Alcibiade Zaganiaris

Teleservice Business Cases

This paper presents comprehensive techno-economic evaluations of two multimedia business cases, illustrating their respective merits and pitfalls, allowing the definition of a reasonable investment policy. The scenarios considered reflect the point of view of dominant operators, as well as of new entrants. Techno-economic results are presented in terms of costs and revenues from the multimedia services, net present value (NPV), cash flows and pay-back periods. These results are completed by an extensive risk assessment. The business cases presented here were studied within the European Project ACTS 226/OPTIMUM†. They both concern the region of Brittany which was extensively studied within this project. The approach adopted emphasised the importance of the business market, especially taking into account needs of small and medium enterprises, as well as 'institutional' customers.

Introduction

The telecommunications market across Europe continues to liberalise according to the European Union (EU) directives and World Trade Organisation agreements. Forecasts for substantial returns, partly due to traditional telecommunications services, but primarily due to new information and communications technology (ICT) services encourage the entry of new players into the marketplace. Many new advanced services are increasingly being offered, yielding enormous implications and new business opportunities for both the user and the service providers.

The small and medium enterprise (SME) market is characterised by its diversity and attractive margins. Nevertheless, its evolution depends on the national regulators who are defining the roles and limits of traditional and new operators as well as service providers. According to Eurodata, companies with fewer than five employees spend four times as much per employee on telecommunications as companies with more than 50 employees. This reveals that the 'small professional' market is a captive one, as small companies do not have the specialised personnel and the large negotiation capacities of big companies. The SME market is expected to contribute significantly to growth in the telecommunications industry. The large majority of EU companies are SMEs, with a staff below 250. They employ 70% of the workforce and generate a similar proportion of turnover. The telecommunications SMEs represent a sizeable and potentially influential user group, covering the entire sector of manufacturing and services and ranging from small structures to larger multi-site companies.

The emergence of new actors and growing competition are creating new opportunities, generating new revenues. In a deregulated environment, various players are likely to interfere with the SMEs, either as their customers or as service providers: traditional and new operators, service providers, equipment suppliers, etc. Therefore, the approach of the SME marketplace is rather complex and requires ad hoc modelling tools as well as reliable market assessment for key user applications. A comprehensive analysis of costs and potential revenues from the SMEs in addition to the business market is of paramount importance for the introduction of multimedia services and infrastructures. Projects ACTS 226/OPTIMUM and AC364/TERA study business cases representing real field situations and taking into account emerging advanced residential and business applications, as well as users requirements.

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Methodology

The techno-economic evaluation of the business cases has been carried out with the methodology and the tool developed by the EU projects RACE* 2087/TITAN‡ and ACTS** 226/OPTIMUM. TITAN developed a model for predicting the cost evolution for the network components, which is based on a combination of the learning curves and the logistic model, and in addition for each network component has specified the prediction uncertainties as a function of time. The TITAN methodology and the tool have been further developed and enhanced within OPTIMUM to be able to cope with complex multimedia service and network structures. Risk assessment is carried out with the OPTIMUM tool by the use of an add-on simulation program.

Six business cases have been selected, covering key applications and important user communities and market segments:

- *SME industrial park*: Optimised use of advanced communications for a group of SMEs located in an industrial park.
- *SME sectorial multimedia services*: Optimised use of

† OPTIMUM: Optimised Network Archtectures for Multimedia Services.
* RACE: Research in Advanced Communications in Europe.
‡ TITAN: Tool for Introduction scenario and Techno-economic evaluation of Access Networks.
** ACTS: Advanced Communications Technologies and Services.

advanced communications for a group of SMEs spread in a wide geographical area and with a common sectorial profile.

- *Telemedicine*: Techno-economic merits of telemedicine.
- *Telelearning*: Economic analysis of telelearning as a means of promoting continuous technological education.
- *Competitive access provider*: The economic feasibility of full service provisioning by a competitive access provider in an Eastern-European country.
- *Multimedia service upgrades*: Economics of new multimedia services for residential and SOHO (small office/home office) customers, provided by telecommunications or cable operators.

The general framework for the business cases is a multimedia network model, including appropriate transport, switching and access network facilities. This particular end-to-end network model serves as a common reference for the business cases described above. The requirement of increased capacity demand on both the access and the core network was taken into account, through a comparative analysis of network dimensioning and economics. Case study analysis was performed according to the following steps:

- identification of key user and complementary user groups,
- identification of operating environment (services, demand, usage pattern, geographical constraints, regulatory environment, etc.),
- identification of suitable communications solutions (architectures, etc.), and
- techno-economic evaluation of the different communications solutions.

In this paper, two business cases are presented: the SME industrial park and telemedicine.

Optimised Use of Advanced Communications for a Group of SMEs Located in an Industrial Park

This business case is focused on telecommunications applications within an industrial park. A comprehensive analysis of costs and potential revenues is of paramount importance for the introduction of multimedia infrastructure and services in the dynamic SME sector. The timing and rate of the implementation of multi-service networks is crucial since sizeable investments will be needed, with risks of investing too early, of choosing the wrong alternative or even of not investing and losing opportunities.

The industrial park studied is *Pegase,* situated in Lannion, 450 km west of Paris in Brittany. Lannion is considered the birthplace of major technological achievements in telecommunications, such as time-switching and asynchronous transfer mode (ATM). The presence of the French PTT's research centre CNET attracted telecommunications companies. In the 1960s, many telecommunications manufacturers (ALCATEL, SAT, Lucent etc.,) settled production facilities in the area. This high-technology activity also gave birth to SMEs, acting as subcontractors of the production process of the main companies (metal and plastic workshop, cabling). The creation of SMEs acting as services providers to the main companies (software, documentation processing) took place at the beginning of the 1980s, with some of the SMEs starting to run businesses centred on their own products in the 1990s. From this industrial background has emerged an industry landscape devoted to telecommunications.

The techno-economic evaluation was performed from the telecommunications operator viewpoint. The core network was not modelled for this case, the architectures considered here were only different from each other up to the STM-1 interface reference point. Service connection, rental and usage charges have been derived from information provided by France Telecom/CNET. Service penetration figures were converted to penetration for the following bearer services: ISDN2, 2 Mbit/s (unstructured) and 2 Mbit/s (structured)/ ISDN30. The running costs include a minimum of operation/administration personnel cost and the maintenance cost related to equipment maintenance, calculated in accordance with the standard OPTIMUM methodology. The architectures studied are the digital multipoint system (DMS), the local multipoint distribution system (LMDS) and the high-speed digital subscriber loop system (HDSL).

Financial results are illustrated in Table 1. Most of the investments are made at the start of the study period. The investment is large, resulting in a long payback period and low net present value (NPV). For the LMDS architecture, most of the investments are done at start of the study period, as for DMS, but the size of the investment is not as large. Also, part of the investment is shared between the interactive services considered and the video-distribution service for the wider area. This leads to positive cash flows right from the start of the study period. The initial investment for HDSL architecture is higher than for the LMDS architecture, but the economics of this case are similar to LMDS.

Some basic data such as tariff inputs are country dependent whereas demand was derived from an ad-hoc survey based on questionnaires. Therefore the conclusions drawn reflect the field reality and cannot be directly extrapolated to other geographical areas. For instance, French tariffs are driven down by competition. In the case of peripheral countries, tariffs still correspond to a monopoly situation and may therefore be significantly higher.

All parameters involved related to tariff, demand or architecture have a major impact on the viability of a particular service. Geographical aspects, the availability of an existing network (twisted pair or coaxial) narrow down considerably the technological options, so the viability becomes mainly driven by the service-related aspects.

For SMEs clustered in an industrial park, HDSL and LMDS architectures are profitable and

Table 1 : The economic results for Pegase Industrial park

Architecture	NPV (ECU) (5 years)	Internal Rate of Return (IRR) %	Payback Period Years
DMS	18 800	Very low	5·2
LMDS	241 000	Very high	>1
HDSL	242 000	Very high	1·4

comparable. This implies that the traditional operators do not have a big advantage from ownership of the copper loop in the industrial park. A competitor has fair conditions and might even have advantage in applying LMDS by the additional revenues from TV distribution. DMS, at its present price level, is clearly more expensive than the LMDS and HDSL architectures and does not have the additional TV distribution properties.

Telemedicine

Telemedicine is considered as one of those applications which may be considered as a building block for the European information society, according to the Bangemann report. The European White Paper on Growth Competitiveness and Employment proposed to install, by the year 2000, multimedia links between various health and social security centres. National initiatives took over these recommendations but the applications differ depending on the topography and healthcare structure in the various countries. In some countries focus has been on bandwidth demanding telemedicine specific applications including second opinion on diagnostics in tele-pathology, tele-radiology and tele-endoscopy.

Telemedicine is defined as the investigation, monitoring and management of patients and the education of patients and staff using systems that allow ready access to expert advice and the patient no matter where the patient or relevant information is located. From a telecommunications point of view the activities involved in telemedicine are diverse and consequently span a wide range of bit rates and circuit usage patterns. The low density of the target audience (when compared with traditional telecommunications user groups) entails a large-area test bed in order to obtain information of sufficient statistical significance.

The telemedicine test bed is located in the French region of Brittany. This is a mainly rural area of 27 200 km² in north-western France. The population is 2·8 million and the regional capital is Rennes. The region exhibits a reasonably even distribution of population and settlements. There are several different types of site involved in the telemedicine test bed. The number of each type of site is known but not the specific locations. Consequently it has been assumed that the sites are distributed randomly throughout the area.

A wide range of medical activities was considered within the test bed, ranging from low-level patient monitoring to the exchange of high-definition graphics files. In order to estimate the traffic flowing between the various types of site, the likelihood of intercommunication has been weighted. The global traffic generated by each site type was then shared between the possible destinations. Telemedicine applications cover a wide range of services from POTS (plain old telephony service) modem bit rates to possibly 155 Mbit/s for the transfer of large high-definition graphic files. For bit rates greater than 2 Mbit/s the current and emerging charging structures for circuit bandwidth influence the adoption of cell-based services.

It is assumed that at the beginning of the trial all users will use the lower-rate service, but that during the trial a percentage of users will migrate to the higher bit rates as these become financially viable. This is a historic trend which has shown a reasonably constant bit-rate increase by a factor of 10 every decade. This *bit-rate drift* has been modelled by periodically moving a percentage of users from a given service to the next higher bit rate service. Service connection, rental and usage charges have been derived from information provided by France Telecom/CNET where available. In cases where tariff information for the French network is not available, charges derived from the UK network have been used.

Two interconnected STM-16 (2·5 Gbit/s) rings would connect main sites in the test bed area. The protected ring architecture has been proposed for availability reasons. At each main site a synchronous digital hierarchy (SDH) add-drop multiplexer (ADM) would extract local traffic. This local traffic would be routed via the site local area network (LAN). It is likely that any operator installing a network for this test bed would regard it as part of the general operator infrastructure and would allow it to carry other non-telemedicine traffic. This poses the question as to how much, if any, of the network costs should be attributed to the telemedicine test bed. The model allows this proportion to be varied. A default value of 3·3% of the infrastructure cost has been attributed to telemedicine. This represents the approximate proportion of 'telemedicine' traffic to the continuous throughput of an STM-1 ring. It is also assumed that all the relevant medical equipment is either already in the site or that it would be acquired through medical funding not associated with this telecommunications project.

The financial results are presented in Table 2. The encouraging financial results are, however, very sensitive to the proportion of infrastructure costs attributed to the project. For incumbent operators the tendency would be to use their existing infrastructure (if available) and treat infrastructure costs as incremental. For this scenario the default figure (3·3%) of infrastructure cost proportion is reasonable. For new operators the situation is radically different.

The financial viability of the telemedicine test bed is largely dependent on two sets of parameters: the proportion of any infrastructure costs attributable to the project and the scale of the annual tariffs, particularly the rise in tariff with bit rate and the continuation of the historic bitrate drift towards higher bit rates. Two opposing trends may be identified. On the one hand, a severe tariff increase with bit rate tends to dampen the rate at which bit rate is increased thus depriving the operators of the increased revenue from the higher tariffs. On the other hand, a slight tariff increase with bit rate means that operators do not gain particular financial benefit from offering higher bit rate services and so tend to decrease the rate at which they are introduced. It is important for the operators to strike the correct balance between these two extremes.

A further factor affecting the financial viability of the overall project is the view taken of potential national medical care savings by the introduction of telemedicine. Any savings derived from the decrease in transport of images, medical samples, files etc., or from the possible decrease in the number of medical sites could

Table 2 : The economic results for telemedicine

Architecture	NPV (ECU) (5 years)	Internal Rate of return (IRR) %	Payback Period Years
SDH/ADM/LAN	16000 000	28	4.7

be used to subsidise this heavy investment.

Risk Assessment

The risk assessment of broadband access network upgrade paths, encompassing the uncertainty in the market and technology evolution, in particular the cost development of critical network components costs, has been performed. The risk assessment shows how the uncertainty in the network components influences the investment risk for each network-upgrade alternative evaluated in the business cases. Economic criteria like NPV, installed first costs and payback period are used to evaluate the broadband architectures. The communications solutions or broadband architectures studied are fibre-to-the-building and fibre-to-the-node upgrade solutions for the network operators. The cost predictions and related uncertainties are defined for the most critical components: asymmetrical digital subscriber line (ADSL) and HDSL modems, ATM components, cable modems, amplifier, and civil work costs. It is shown for some of the cases studied that there is a risk (on 2·5% level) for reduction of the NPV of about 50%.

The most important risk factors in ranked order are:

1. Tariffs
2. Competition
3. Penetration and market share
4. Component costs

A combination of reasonably low tariffs and significant uncertainty of the tariffs gives a higher contribution to the risk than the other factors. The competition in the specific network area between operators will indirectly influence the tariff evolution. If the operators force each other to make high reductions of tariffs during a long competition period, then the tariffs will be the factor which creates the highest economical risk.

Other case studies analysed the risk of total market forecasts and the market share between the operators. The results showed that the uncertainty in the market forecasts contributes more to the risk than the uncertainty in the market share. A set of case studies analysed the impact of the cost evolution of network components. By using the same case studies for uncertainties in the market evolution and in the cost evolution, it is documented that the uncertainty in the market evolution creates higher risk than the uncertainty in the cost evolution. The result can be explained with the so-called *law of large numbers*. If we add up uncertainties from a large number of component costs, some components will have a deviation in one direction (for example, negative) while others will have a deviation in another direction (for example, positive). Parts of the deviations will cancel each other and not add up the total uncertainty. However, there will be a correlation between the cost evolution of a set of network components which in turn will increase the risk. Calculations have shown that the risk is still significantly lower than for the uncertainties in the market evolution. Further studies in this area will be carried out in the TERA project.

The civil work and the installation were an important part of the investment. However, their influences on risk were significantly reduced because there is less uncertainty connected to these factors since the technology used is old and well known. The uncertainty in cost by producing a new network is relatively higher.

Conclusions

The globalisation of the economy implies intense competition leading to a combination of growth and economic insecurity. Telecommunications is a key issue for business and trading and greatly impacts the strategic success of high-technology SMEs. Whereas big companies are looking for a wide range of integrated services, supplied by one service provider over a single network, SMEs need a variety of specific services closely adapted to their needs. Owing to limited resources, the SME's investment choices are extremely critical to their survival. Once a technology is adopted, there is no alternative; it has to work since the SME depends on it.

The business cases presented in this paper are from the region of Brittany in France. The TITAN/OPTIMUM methodology and tool were used for the techno-economic evaluation and risk assessment. The business cases range from traditional telecommunications network upgrade projects to the valuation of the economic value of the total telecommunications (and hence indication of price levels) for the health sector in a country.

The techno-economic evaluation has been carried out from a telecommunications operator's viewpoint. In AC364/TERA, a comprehensive cost-benefit analysis is under way. This study is expected to complete the overall economic outlook by tackling the user's point of view. Cost-benefit analyses, carried out in parallel with Delphi surveys, are likely to significantly improve demand assessment through more reliable modelling.

For SMEs clustered in a industrial park in a deregulated telecommunications market, the HDSL and LMDS architectures seem attractive solutions with similar cost structures. Therefore the incumbent operators may not have a big competitive advantage resulting from ownership of the copper infrastructure. This may lead to good business opportunity for a newcomer. DMS, is still more expensive than LMDS and HDSL.

The encouraging financial results of telemedicine are very sensitive to the proportion of infrastructure costs attributed to the project. For incumbent operators, the tendency would be to use their existing infrastructure and treat infrastructure costs as incremental. For new operators, the situation is less favourable. A further externality factor affecting the financial viability of the overall project is the potential cost benefit of national medical care savings by the introduction of telemedicine. Any savings derived from the decrease in transport of images, medical samples, files etc. or from the possible decrease in the number of medical sites could partly be used to subsidise the high cost of the services.

Active investigation of SMEs in European projects is a difficult yet rewarding exercise, promoting industry and technology watch, favouring the taking-up of research-and-development results into industrial applications and considerably enlarging the market horizon of the SMEs.

Aknowledgments

The application examples in this paper are part of the business cases studied within project ACTS226/OPTIMUM. They are based on real field situations and take into account emerging advanced residential and business applications as well as users' requirements. OPTIMUM and TERA are projects 226 and 364 of the ACTS programme. The authors wish to express their gratitute towards the European Commission for supporting this work.

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Biographies

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Achilleas Kemos graduated from the Electronic and Electrical Engineering Department of University College London. He then moved to France where he obtained two post-graduate degrees: Diplôme d'Études Supérieures Specialisées on 'Project Analysis for Industry and Agriculture' at the Université de Rennes I and a Mastère on 'European Business Engineering' at the École Nationale Supérieure des Télécommunications de Bretagne, where he is lecturing and carrying out research in the Economics Department. He is currently preparing his Ph.D. thesis on the liberalisation of Greek telecommunications. He is participating in the European Project ACTS 226 OPTIMUM. He has contributed to the general methodology and is monitoring four business cases involving SME participation. He has worked as a consultant for the European Union Directorate General XVI, evaluating the impact on cohesion of community policies for telecommunications.

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Alcibiade Zaganiaris graduated in mathematical physics from the University of Athens. He received a postgraduate certificate in telecommunications electronics and a doctor's degree from the University of Rennes, France, then a PhD in telecommunications economics from the University of Lyon. He joined the Centre National d'Etudes des Télécommunications (CNET), where he carried out research on optical materials and fibre properties, local networks and techno-economic studies. He is author of 75 publications, conferences and patents. Since 1981 he has been involved in European and International organisations in the field of optical communications: COST, RACE, EURESCOM, Optical Society of America, American Ceramic Society, International Telecommunications Society etc.

Simeon Coney

Implementing Service Management to Competitive Advantage for Operators

To be successful in the face of increasing competition and high customer expectations, an operator must be able to manage not only its infrastructure, but also the whole concept of service. This article considers how effective service management can be a practical means for service providers to retain control of the supplier/customer relationship. Service management describes the mechanisms for organising all aspects of the relationship between operator and customer. The article examines the choices open to operators, particularly either network- or service-oriented (NetCo and ServCo), the types of knowledge necessary for successful service management and considers five approaches, each applicable to different types of service and business criteria.

'*Knowledge itself is power*'—Francis Bacon (1561–1626) Religious Meditations—Of Heresies.

Introduction: Responding to Change

The annual report of almost every large organisation, irrespective of sector, stresses the significance of telecommunications and the services it supports to the success of the business. The provision of telecommunications and associated computing resources has a strategic impact on the future of the enterprise, which puts a service provider in a strong position—full of both challenges and opportunities.

Operators themselves must grapple with a series of trends that are affecting fundamentally the way they run their networks and offer services:

- *Deregulation*: opening a profusion of telecommunications services to competition.
- *Competition*: encouraged by new licensed operators (NLOs) differentiating themselves through price, responsiveness and service.
- *Technologies*: rapid advances in all areas of operator business, including transmission, access and service creation are changing expectations of operators and customers alike.
- *End users have become increasingly demanding*: shopping around for responsive service providers; insisting on stringent but cost-effective quality of service.

For today's customers, much of the complexity of the operator's multi-faceted business environment is both hidden and largely irrelevant. They want to concentrate on their core business and buy communications services in much the same may as they might purchase electricity. Looked at from the operator's perspective, however, its internal environment—the telecommunications systems themselves, from the transmission network to the voice and data services running on top of it—supports a plethora of internal departments, applications and services.

From sales to billing, consultancy to customer care, they are integral to the overall perception of service to the external customer. How that service—defined in all its intricacy—is managed is vital to the success of the operator's business.

What is Service?

Generically, in this context, 'service' is every part of the engagement between two business entities. It is not a marriage of equals, however: the customer has expectations of the operator and, with competition and innovative technology, those expectations are rising.

Whatever agreement regarding 'service' is struck between the two parties, how that agreement is implemented and controlled throughout its life—everything from service delivery to arrears counselling—is the purpose of 'service management'.

Traditionally, a customer places an order—for a telephone line, for example. It is delivered and payment follows. Today, operators are more likely to become involved with customers far beyond the single transaction, responding to requests for new or additional features or changing the customer profile—fostering a relationship beyond a contractual minimal of offer, acceptance and consideration.

Instead of customer Acme Ltd paying £X to Operator Telcom for a specific item, Acme Ltd is more likely to pay Operator Telcom an agreed sum for ongoing support up to an agreed limit of commitment as Acme Ltd's business needs demand.

For example, Nortel's telecommunications needs are elaborate and forever changing. It finds a general 'framework' agreement with an

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operator—in which both parties work within agreed parameters, rather like a 'burst' capacity for bandwidth. It is more cost-effective for both sides than individual agreements that keep lawyers in business. This agreement requires careful administering and monitoring to ensure that the commercial and technical checks and balances are maintained.

Two Sides of the Same Coin

For operators and those who provide know-how and services to them, an understanding of the concepts and demands of service management helps identify and isolate the most important driving forces—and corresponding pressures—of their particular type of business and so select the appropriate solutions and operational strategies.

There is therefore a growing pressure on operators to align their operations to both the aspects of customer-focused service management and of network orientated infrastructure support.

A useful description of these two aspects of its character is that of the 'NetCo' compared with the 'ServCo'. Unlike Dr Jekyll's nemesis Mr Hyde, both types have many redeeming features although, like their fictional counterparts, they both surface at different times and vary in intensity—that is, from operator to operator depending on each operator's chosen strategy—and will occasionally conflict.

The NetCo side of the operator's business focuses on saving money and maintaining quality within the network. In many respects, the resulting network integrity reflects the traditional monopoly telecommunications provider; irrespective of how efficient its administration, there would always be dial-tone and capacity come what may. What is supplied to a customer is related directly to the technology installed in the network rather than the express demands of a particular customer.

Return on Investment (ROI)—maximising the assets of the infrastructure—is a primary target for the NetCo along with remote management, performance management and other means of network optimisation. A goal is to make full and best use of employees, while reducing overheads wherever possible, such as outsourcing highly-specialised resources.

For the ServCo side of the business, the emphasis is on providing what the customer needs in the manner that the customer needs it. Service delivery must be fast and high-quality; profits must begin to flow as soon after deployment as possible, service level agreements must be maintained wherever possible. The overall goal is to make profits and achieve customer satisfaction, while increasing productivity and therefore revenue per employee.

In order to facilitate this orientation in operations, an operator needs effectively to decouple the physical network from the service network. This then permits a strategy to be defined to meet the desired business goals.

Flexible Strategies

These two perspectives are not either/or choices facing an operator, but are best represented as a sliding scale up and down which an operator can move depending on its circumstances at any particular time.

For example, a wholesaler of telecommunications services has little need for ServCo attributes delivering, as it may, exclusively to the retail channel. In contrast, the retail channel may have little or no NetCo component. A mobile network service provider owns the network, for example, but the subscriber perceives his/her provider to be the market channel such as Phones-R-Us in the High Street.

Moreover, the sliding NetCo/ServCo scale might be applicable in different ways to different areas of the operator's business and stacked in layers—applicable to the services given to NLOs and to the services they provide to their customers.

Operators will therefore slide up and down this NetCo/ServCo scale as their business evolves. This environ-

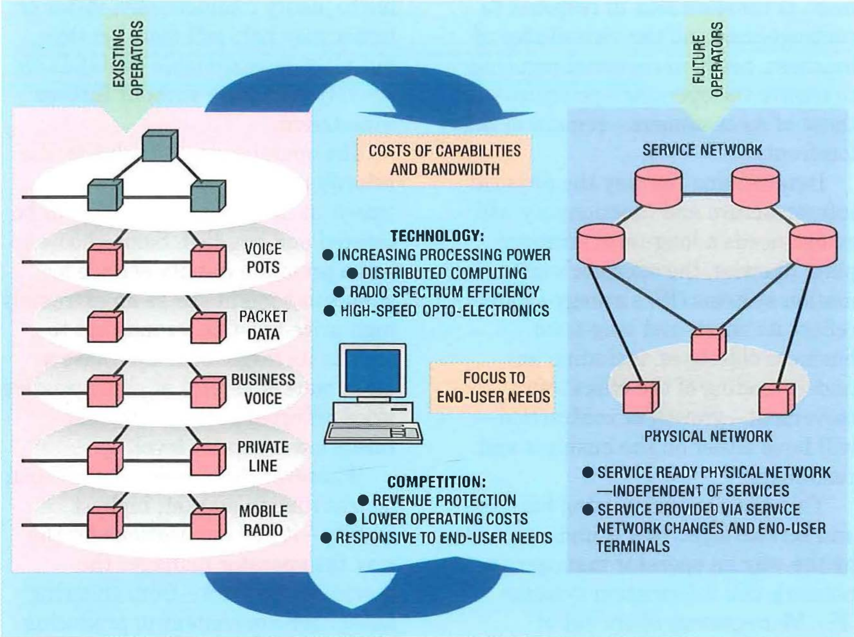
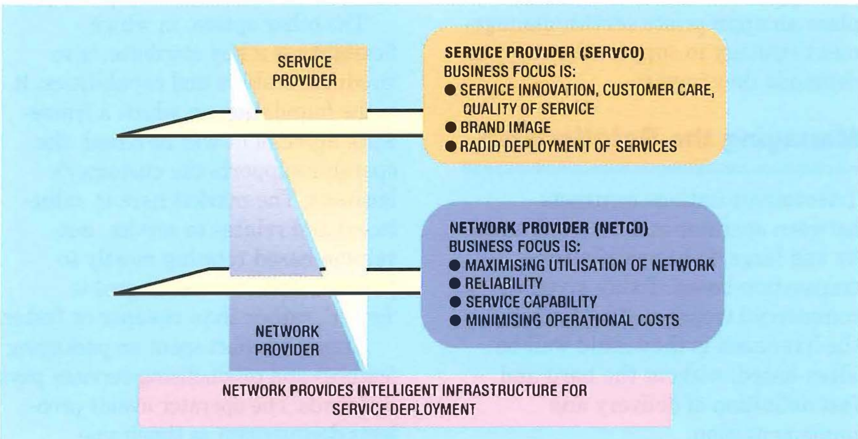


Figure 2—Trends in the network architecture

Figure 1—Operator types



ment of constant flux in response to contingencies and the vicissitudes of business, needs to reviewed regularly to ensure the operator's priorities—or those of its customers—remain in the forefront.

Determining the way the physical infrastructure and functionality will evolve needs a long-term strategic plan; likewise, the operator's information systems (IS) strategy should reflect its short- and long-term business objectives, including an understanding of the effect any movement—growth or contraction—will have either on the business and customers.

This process of reviewing business and service objectives is underpinned by the way an operator manages its network and information systems (IS). Management of one set of business segments influences directly the others.

The operational and IS strategies help define the processes leading to the types of service the operator chooses—the choice of which flavour of NetCo or ServCo—a choice that will fluctuate over time according to commercial and other parameters.

A watching brief on service management is essential to guide the operator to meet the operational goals. And, of all the pressures on an operator, it is competition that is creating change and competition that is demanding a customer-focused approach.

The subscriber or customer business looks for an operator who can best satisfy its needs, including offering rapid response, enthusiasm, knowledge and experience. The way the operator network is managed, such as service quality, customer information processing and problem-handling, affects directly this public sales and marketing, customer-facing visage. Because there is almost always an alternative ready to take the business, from now on in public telecommunications, first impressions count.

Cheaper, Faster or Better?

Just as operators vary and compete in their business objectives, an operator's objectives can conflict, internally, with its own operational strategy. The goals of cheaper, faster, better may be achieved individually fairly readily, but it is almost impossible to achieve all three simultaneously. Cheaper might well be acceptable operationally, but impossible to justify commercially; faster or better may help sell more services, but place unreasonable demands on the infrastructure without further investment.

The operator needs to decide the priority of each goal and how the 'space' in the market for each will be created and handled. Some choose to sell a premium quality service for what some might see as an extremely high price-tag. Others may opt to offer to its target customer base a mass market service at an aggressive price reflected in the commensurately lower service level.

Whatever the metric—lowest cost, fastest time to market, highest quality—it has implications for the way the operator manages the services it delivers—from ensuring subscriber are content to producing accurate traffic flow statistics.

Product Sell/Consultative Sell

The increasingly popular framework agreement has an inherent impact on the operator's processes and resources. It is a consultative 'sell', rather than a product 'sell', in which the customer explains, the operator listens, asks questions, listens some more, then effectively opens its suitcase to take out what is needed. Both types of sale have their value and commercial merit.

By analogy, a conventional restaurant chef prepares, to order, from the range of dishes displayed on the menu: a product sell, suitable for a mass market. A sushi chef, on the other hand, serves a course, watches how and what the customer eats. Taking those findings into account, the sushi chef then prepares the next course and onwards through the meal: the consultancy sell. The value of this service is high because it is customised.

An operator needs to respond to both types of request and have in place an appropriate service management strategy to support the varying demands they impose.

Managing the Relationship

Telecommunications contracts between operator and customer used, by and large, to be specific and transaction-based. Today, given the commercial trends outlined above, the likelihood is they could well be ideas-based, without the hard and fast definition of delivery and implementation.

This poses a challenge to an operator: how can he match what was agreed contractually as being needed by the customer into what is actually delivered, so as to make sufficient profit and give the customer what he wants?

The operator naturally wants to avoid becoming a hostage to fortune: the framework agreement must be sufficiently flexible to meet the customer's needs yet sufficiently rigid to prevent any form of operator exposure, either technical or commercial.

Of course, while the reason for entering into the agreement is because the operator can deliver what is agreed cheaper, faster or better than the competition, meeting the customers current and future needs, the operator also needs to be seen to be innovative and competitive as part of managing that relationship.

Other considerations to be managed include the primary point of contact with the customer—ensuring the account manager, for example, has the appropriate skill set—the quality of service matched to the bill, the charging and collection process and, most importantly, unequivocal proof of what is going on.

Packaging Features; Productising Capabilities

In understanding what it sells and how it sells it, namely the channel stream from bid to installation and maintenance, an operator can manage its resources accordingly. Specific features and functionalities, such as call waiting, calling line identification and ISDN, can be packaged—marketed as individual products—suitable for volume markets, such as residential. The operator cannot afford too much flexibility in these markets—cheaper and faster are the guiding principles.

The other option, in which flexibility is a key attribute, is to 'productise' skills and capabilities. It is the foundation on which a framework agreement will be based: the operator supports the customer's business. The market here is value-based and relates to service, not volume-based relating mostly to product, and the overall goal is 'better', rather than cheaper or faster.

Time and effort spent on packaging features and productising services pays dividends. The operator avoids problems downstream as timeframe agreements mature, having agreed clear 'products', such as the timescales for implementation, cost, quality of service and any level of guarantees of maintenance and commercial integrity. These potentially nebulous, unspecified people-based skills become quantifiable and can be assessed by both parties to the agreement.

One highly-successfully operator, for instance, that concentrates on market segments such as European financial centres will not agree to meet a customer's timescales if it would compromise its image of quality (covering level of service, ability to meet commitments and integrity), which is a particular selling point for this service provider.

Productising services enables the operator to manage its service offerings far more accurately. Regular defining and refining of capabilities ensures customers receive not only similar functionality but also higher quality of service due to that consistency. Potentially, too, services can be offered at a more attractive price and almost certainly with a higher perceived value compared with an operator without such controls.

The operator that does not balance what is technically achievable for a customer against what is best for its own business and who delivers service without managing the processes in this way, risks over-stretching resources and under-performing in the eyes of customers. This is not a fear without precedent—it has happened to major service providers.

It is far more prudent to assess the productised service and be willing, on occasions, to hold back or request further discussions with the customer—perhaps the service is still undergoing trials; perhaps a charging mechanism has yet to be applied to it—than to deliver services in a vacuum just to placate a customer's short-term concerns.

Who is 'driving the taxi' in a relationship based on timeframe agreements, productised services and mature service management? The operator decides the route taken and the speed of travel; the customer chooses the destination.

Tacit and Explicit

Just as NetCo and ServCo are intertwined, cheaper, faster and better are not mutually exclusive, but moving towards any one has consequences for the operator. Promoting fast time to market to the exclusion of all else may well affect service functionality; if an in-depth consultative sales process is preferred, the number of new customers won may be limited due to lack of resources.

One of the biggest limitations for an operator seeking to balance and manage its customer-facing resources is the lack of people with the appropriate skills. The aim is to have effective, trained staff across all aspects of the business. Any long-term shortfall is bound to have an adverse effect on how the operator approaches service delivery and therefore service management.

In the early 1990s, swathes were cut through middle management. Along with the headcount, a particular and useful form of knowledge went out of the door: 'tacit' knowledge that is excellent for successful service management. Whereas its counterpart, 'explicit' knowledge describes rules and procedures—knowledge that is definitive and can be looked up—tacit knowledge is that little bit extra. It is instinctive and intuitive, based more on experience and gut feel.

Together, they make a formidable team—good chess players exemplify the successful mix of the two. Without that little extra something when dealing with customers, the explicit knowledge of products functionality and service delivery counts for little. Effective service management relies on this special blend.

Approaches to Service Management

Operators can assess which approach to service management is most appropriate for their resources, their customers and the nature of the service on offer. There are many systems available in the marketplace today that support the various approaches to service management and can be broadly categorised into the five following groups:

1. Managing element technology

This couples management of network elements closely to the technology—the physical network devices—itself; as such it supports all or most of the capability of the elements. However, being technology-focused, rather than on the service under consideration, it demands an in-depth knowledge of the physical elements.

By analogy, I can bring up Microsoft Word to edit my *win.ini* file, but then I still need to know what the contents of the file are and the parameter options to effect the correct changes. This approach is best suited to a network in which the services being delivered in a semi-static service environment, such as extensions to existing services. An example might be additions to a PSTN dial-plan such as national code changes. It is not, strictly speaking, service management, but more an enhancement of existing explicit knowledge.

2. Managing a simple service

Service management links the physical and service networks. A customer service representative needs the tacit knowledge necessary to handle the customer, but has limited explicit knowledge. It works well for operators wanting to improve responsiveness and quality of service, perhaps an initial service which the operator wants to ensure works really well.

This solution applies when offering one or two specific services or sets of services, but doing them well. Typically the service is created to perform a particular task, which it carries out effectively. By analogy: I can use an individual control panel application in Windows 95 to change my system set-up (without needing to understand the underlying configuration) but am restricted to a particular set of variables such as mouse, screen or modem in each application.

3. Managing the service layer

This involves a system that allows the operator to enter the commands for activating complex services and to manage the information flow surrounding that service throughout and within the operator's organisation.

It will not activate that service automatically within the operator network, so avoiding the potential problem of different order versions existing simultaneously or sales staff committing the operator to delivering unrealistic levels of service. However, it has no explicit knowledge about how the service can be activated in the network—it has no link to the technology layer. It is useful for a network that needs to establish a front office—a sales arm—but whose resources are limited. It can achieve a good fit with the business/sales process and the way services are defined and provides a good interface into customer care environments.

Considering this approach, a particular Scott Adams cartoon springs to mind in which an engineer is saying to his sales colleague: 'Stan, you promised the customer things that engineering can't possibly deliver. Do you know what that means?' His colleague replies: 'It means I'm a great salesman and you're a *!@?*!* engineer.'

4. Service to network layer mediation

This approach supplements the above approach well, in that it provides that missing link between the order capture and the network activation.

For instance, this back-end component may mediate between the order capture system and the network. It takes commands from the order management system, analyses them and despatches the relevant commands to the operator's actual network to activate the service. This system of toolkits gives an operator flexibility to define new services and introduce new technology into the network, while updating the order capture and the mediation component through scripting.

A limitation of this approach is its need for highly-skilled personnel to support it, who have an understanding of the possible impact on the network. For instance, existing service A will have a script for adding and removing it; the operator decides also to sell service B. A script is needed to sell A and B, to remove them both, to add B on its own, remove B on its own...

This complexity can be expressed as an equation: $X!$ where X = the number of features. With complex capability offerings, it is not unusual to have upwards of 100 service features, or 100!. Most electronic calculators cannot cope with more than 65!.

It is ideal for a network operator attempting to implement and integrate a new technology without imposing a burden or having a big impact on existing management, such as resources or timescales to deployment. It suits operators who like to manage the network by well-defined processes without involving the underlying technology.

5. Managing through controlled autonomy

The final approach models all aspects of the service offering: the rules needed to implement it in the network and the business rules particular to the operator deploying the service. As such it is suitable for productised capabilities, where a commercial framework can be established that nonetheless allows complete flexibility within that detailed framework.

This considers a broad segment of service, such as virtual private network (VPN) or Centrex and provides a high level of functionality while simplifying service management. It incorporates modelling of service, business processes and technology and is well-suited to complex service management.

The system helps with service definition, before the operator works with the customer on implementation and achieving the customer's aims. The operator's customer account manager using such a solution will have the terms of the framework agreement automatically checked to ensure their actions remain within its terms; beyond that they are free to choose how best to achieve what the customer is paying the operator to deliver.

It suits tacit knowledge because the checks and balances of the framework take the strain of the explicit knowledge that would otherwise be necessary for the operator to achieve its goals under the contract. By analogy, the operator driver can concentrate on driving; the framework car sorts out how best to manage the road and weather conditions.

A Multi-Faceted Phenomenon

Operators need to examine a number a models, choosing the appropriate one for each particular service segment. Transmission service, for instance, has relatively little service complexity—an order for a circuit between A and B, for instance—so the first approach outlined above suits it well.

Mass-market residential services could best be supported by models two, three or four, while voice services for the large corporate market involves providing services that suit particular business needs—productised capability, rather than a packaged product—tending towards the fifth approach.

There is a danger for operators in over-simplifying the impact of service management; it is a multi-faceted phenomenon:

- Market drivers are forcing operators to consider new approaches to the traditional supplier/customer engagement.
- The effects of competition have increased the complexity of the services operators are supplying.
- Systems now come from a wide variety of sources, from operators themselves to workflow management experts, process consultants and equipment manufacturers, so a wide variety of models are needed to manage the commercial and technical lifecycle of the services.

Francis Bacon's adage that 'Knowledge itself is power' certainly holds true for service management. The customer that outsources its service management to an operator, has little incentive to retain that knowledge within the organisation. As the customer network evolves, the necessary detailed understanding of what infrastructure the customer owns and needs to run and support its business is gradually displaced to the outsourcing partner.

Service management is therefore a valuable and significant tool for encouraging customer retention—an effective 'lock-in' by default.

It is often not appreciated fully how strategic this knowledge is. The bonds between a customer and an operator chosen to take responsibility for its service management become tight and binding. The challenge for the operator is to ensure those bonds neither shackle nor suffocate either party; the opportunity is that, through effective service management enabling an operator to deliver the highest levels of service quality, such partnerships with customers can be profitable, mutually beneficial and enduring.

Biography

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Simeon Coney is Senior Product Manager, Operations Management Solutions, for Public Carrier Networks Europe at Nortel plc. Since graduating in Computer Engineering from Manchester University, He has worked exclusively in the telecommunications systems industry. His eight years of telecommunications experience encompasses many disciplines (from customer services, marketing, product management and portfolio management), and work with developers, suppliers and operators in the UK, Europe and the US. He currently has responsibility for defining and marketing operational support systems solutions tailored to the needs of Nortel's European public network customers.

Fred Gillet and Stefan De Beule

Management of Intelligent Networks

Personalised services are a key differentiator for operators in a liberalised telecommunications market. Intelligent networks (INs) offer these services with speed and flexibility. The rapidly growing number of services, subscribers and users requires an adequate solution at all levels of management. This paper presents a management strategy which will retain the speed and flexibility for which IN is known, while assuring easy integration within the operator's existing management infrastructure.

Introduction

Market liberalisation and the demand for newer, faster and more versatile services, like calling card services, carrier selection, virtual private networks and number portability, mean that network operators and service providers are becoming much more interested in supplying intelligent network (IN) services.

Until recently, there was a widespread debate in many operating organisations as to whether IN management should be integrated within the existing management system, or be completely separate. However, today there is a clear move to integrate both as seamlessly as possible. Indeed, IN has become a basic component of most fixed and mobile networks, and should therefore no longer be considered solely as an add-on to the existing infrastructure.

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IN services are considerably more complex than the existing plain old telephone services (POTS) and therefore require adequate solutions both at the level of IN service provisioning and management and at the level of IN infrastructure management.

Integration of IN management with existing management information systems (MIS) and within the telecommunications management network (TMN) architecture, based on *de facto* standards, brings important benefits to telecommunications service providers. First it reduces costs because IN nodes can be managed within the same architecture as other switching equipment. Second, the TMN mechanisms provide effective answers to the needs for quality of service, high availability and consistency.

Management domains

An IN structure can be considered to consist of:

- *IN service intelligence*: This hosts the service logic function and the service data function. It is managed by the operators that offer IN services—network providers, service providers and service subscribers.
- *IN infrastructure domain*: This is split into an *IN internal domain*, including all the distributed IN service elements like the service management point (SMP), service control point (SCP), service data point (SDP) and intelligent peripherals (IPs), and into an *IN shared domain*, including the service switching points (SSPs) in the switching network and signal transfer points (STPs) in the CCSS7 network, as well as connections to the higher level operations support system (OSS). The IN infrastructure domain is managed by pools of infrastructure management operators.

The architecture of Alcatel's IN management systems clearly separates IN service provisioning and management from IN infrastructure management (Figure 1). However, the separation between infrastructure management operators and service management operators is not absolute since they will need to exchange management information, keeping in mind the allowed tasks of these operators.

A strong advantage of this architectural split lies in the difference between the speeds of development of IN services and IN network elements. In addition, it is possible to take advantage of service evolution based on the Alcatel service creation environment, which automatically generates all the service provisioning and management tools when a service is created.

Consequently, the two types of operators—IN service management operators and IN infrastructure management operators—can always be equipped with the best tools to manage their respective domains, thereby guaranteeing optimal performance of the IN at all times.

It is felt that such an architecture not only makes the operational room more effective in the way management tasks are handled, but also that specific management functions can be tailored better to the systems to be managed and to the organisation and qualifications of the operating staff.

Service Provisioning and Management

General concept

Because of the availability of complex new services, the IN service management environment needs to be more

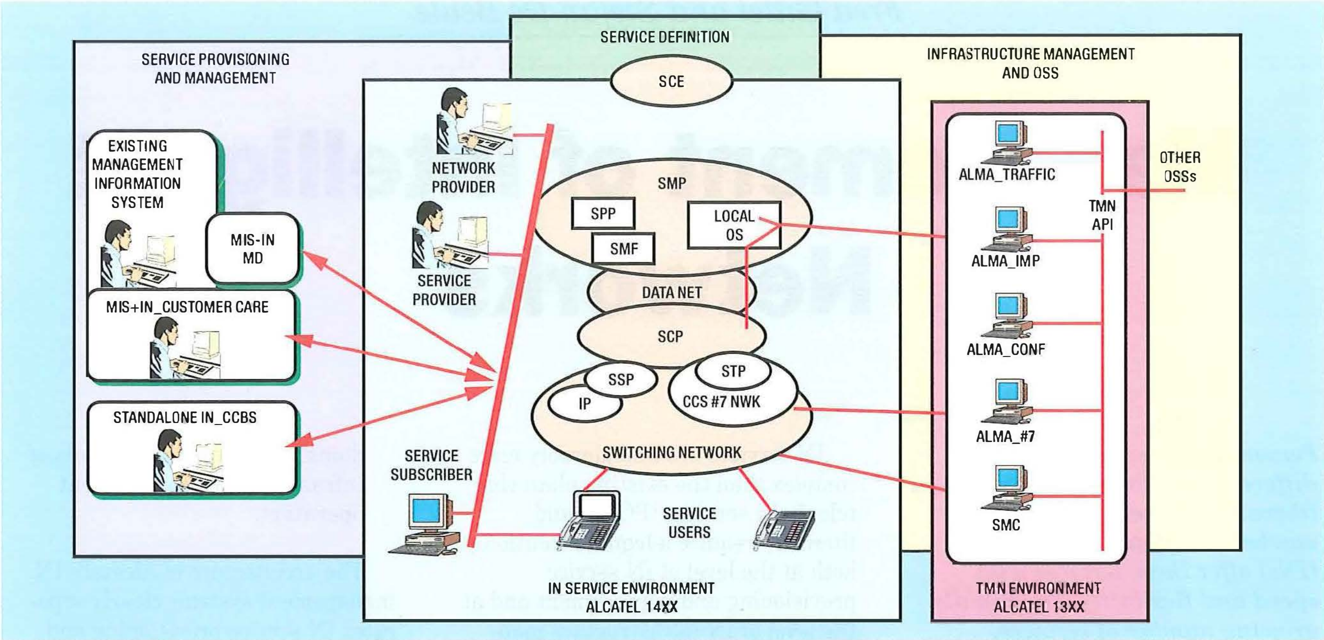

Figure 1 – Overview of management domains

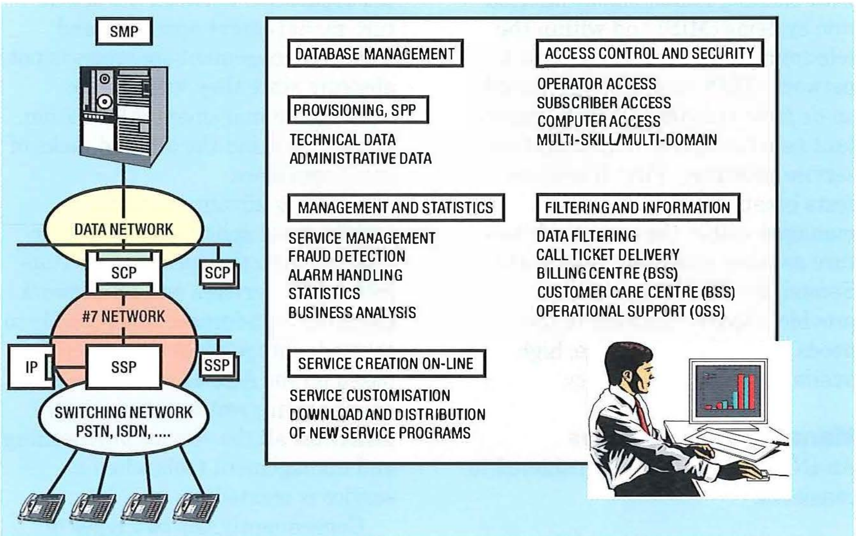

Figure 2 – SMP management

and more customer-oriented. It must enable businesses to utilise and manage new enhanced services. In addition, it must supply all the information required by a business to control the use and behaviour of its services. Despite its internal complexity, IN management operations must be simple and user-friendly. Users should enjoy a rapid response and the high availability of reliable, up-to-date information.

These new services require an adequate solution at the levels of:

- *Provisioning* Provisioning of such complex services to the users has to be performed within all the areas of the service chain, including:
  – intelligent network environment;
  – switching network environment;
  – customer care and billing centre; and
  – facilities associated with the services, like the production of calling cards and service manuals, as well as marketing and promotional campaigns.

- *Management* Management of complex services, together with the management of subscribers and their related data, poses real challenges for a number of reasons:

  – services are provided for 'users' (not to 'connection numbers');
  – each subscriber has a unique 'service profile' which will have to accommodate a real increase in the number of service attributes;
  – IN service subscribers also use basic telephone services and therefore also have existing customer data;
  – reuse of existing systems, like customer care facilities, billing centres and business management systems;
  – reuse of prior investment in operator pools and call centre infrastructures, as well as in operating procedures, work flow procedures, management, etc; and
  – existing operators already managing basic telephonic services within the existing network will also have to manage the new IN services.

- *Rapid piloting and introduction* of new or modified IN services prior to the operational phase.
- *Keeping ahead of rapidly changing market requirements.* INs must evolve and grow rapidly to keep up with changing requirements and with competitors.

The solution must guarantee a sound investment and, above all, a system that will enable the service operator to continue to manage services so that they are better than those offered by the competition.

Alcatel has addressed the challenges of service provisioning and service management by introducing the Alcatel SMP, a management environment dedicated to IN service intelligence. It is able to operate within the following modes:

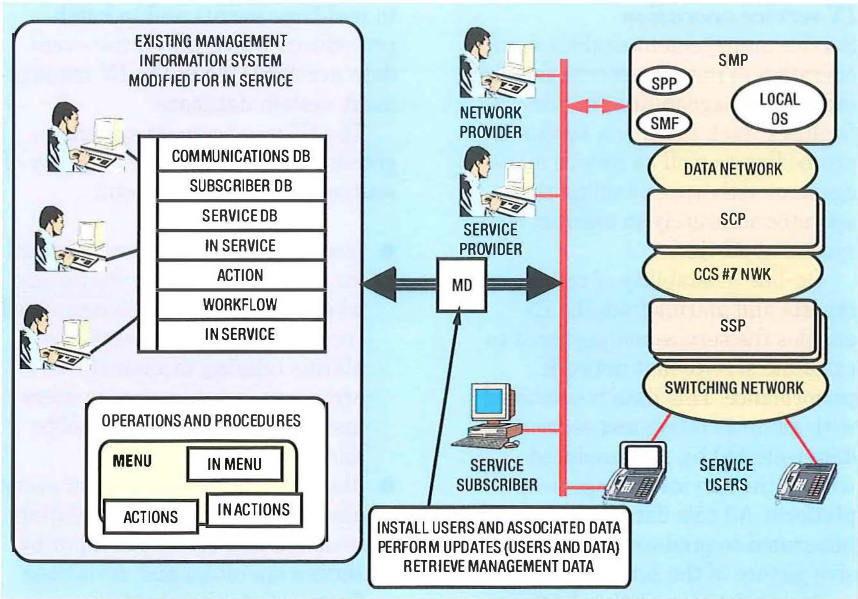

Figure 3—SMP integration with the management information system

- *Standalone SMP* In this case, the SMP provides, within its environment, all the management functions required for IN service provisioning and management (Figure 2). To optimise management responsibilities, management operators are organised in a hierarchical structure in which an operator's rights are a subset of the rights of his/her immediate superior. Operators access the management applications via a user-friendly graphical user interface running in two alternative environments:

  —PC running Microsoft Windows; and
  —Web-browser supporting Java 1.1.

  The Web-based interface offers maximum flexibility for network providers, service providers and service subscribers as regards the choice of platform and physical location for the operators.
- *SMP integrated with an existing MIS* In this case, the SMP interacts with an external MIS, which can be one of the following types:

  —existing MIS systems or legacy systems which have been extended or adapted to manage IN services.
  —dedicated IN management systems which are placed in front of an existing MIS to integrate IN service management between the SMP and the existing MIS.
  —dedicated new IN management systems, including all the management facilities and features required to manage new IN services.

MIS–SMP interface adaptation/mediation will have to be included at the following levels (Figure 3):

- Alignment between the MIS and SMP in the way they handle customers and treat services (for example, mapping of MIS actions, not all related to IN services, to SMP actions).
- Adaptation of the interface in the area of provisioning (for example, passing to the SMP details of a block of users with their associated parameters—extracted from a marketing databasc—and the recovery procedure in the event of a single fault in the list).
- Adaptation/mediation between the MIS data model and the data model required by the service and used by the SMP (this IN service data model is automatically generated by the SCE at service creation time).

Access management and security functions

Prior to the logical IN service management operation, the basic IN management system functions offer the access management and security functions which are applied to all operators to protect the system against malicious actions.

The system incorporates advanced data security procedures for defining and controlling user authorisation and access to the service management environment. It monitors users' activities and prevents unauthorised users from accessing and modifying system data.

Service provisioning

The customer care system (single point-of-contact/one face to the customer) for IN service management performs the following functions:

- reception of applications for service subscriber registration either by telephone, fax, in writing or via e-mail;
- ordering and distributing of related facilities like calling cards and PIN numbers, as well as allocation of network facilities like line service attributes;
- dealing with customer/user appeals, billing queries, etc.; and
- telephone assistance to service users:

  —information service (for example, how to use certain facilities/attributes); and
  —call-connection services (for example, connecting inexperienced users).

Customer registration

Customers may register for one or more services utilising a variety of unique service attributes that meet their needs. These attributes incorporate the service profiles associated with each customer. Service attributes can be inherited by service users belonging to the customer. Each instance of a user profile can also be made unique. Customers can define the service profile for each service, and might determine how the bills for their services should be handled.

The registration process verifies and authorises customer details and ascertains that the customer is not barred from receiving the service either because it is incompatible with other services to which the customer subscribes, or for administrative reasons (for example, non-payment).

Customer data management

Intelligent networks offer telecommunications users a wide range of services and service attributes. Services can be tailored to the needs of each customer, whether large or small, whether a commercial organisation or a private user. Operators need to be able to manage all these customers and their complex service attributes as efficiently as possible.

Each customer, whether an individual, or a small or large organisation, can be registered with a variety of services. The customer care system maintains information about the customers and the system's users. This information includes customer details (administrative and commercial) and billing data.

For each service to which the customer subscribes, there are customer service profiles, a customer security profile, a list of service facilities, service billing parameters and payment data. In addition, the following data is maintained for each service user:

- relationship to the customer;
- user detail;
- user service profile;
- user service facilities (for example, calling cards, lines); and
- service usage data.

Customer appeals

Customer care registers each customer appeal in the customer's application database where it is assigned a status. Follow-up procedures track the status and date of each appeal in order to identify those that have to be handled by particular customer care officers. Certain types of appeal (for example, billing inquiries, security related complaints) can be diverted to a suitable group of customer care officers who are trained to handle them.

Service management

Service management provides the means to control service activation/ deactivation either at the service level (all the customer's users for a particular service), at the customer level (all services related to the customer and all its users) and at the user level (a particular user belonging to the customer).

Service management provides user-friendly means to update global service parameters and thresholds, enabling the operator to tune the service environment according to service traffic, market constraints, customers' behaviour, and so on.

In addition, service management provides the operating company with a better view of service trends and growth, customer usage profiles and behaviour, as well as powerful tools to adapt the complex service management parameters to its own requirements.

IN service operation

Service management enables service operators to improve service monitoring and manageability. On-line facilities track the way a service is proceeding as well as service management activities, enabling the operator accurately to monitor the system at all times.

On-line availability of call records, reports and alarms from the IN enables the service management to calculate service and network performance. This data is combined with administrative and security data collected by, and produced within, the service management platform. All this data is then integrated to produce a comprehensive picture of the service behaviour.

Accumulated operational data is invaluable to the operator when designing marketing and promotional campaigns, and when planning to expand services or introduce new ones.

Service activation or deactivation can be initiated either at the request of the customer or by the service operator for administrative or security reasons. Service activation and deactivation is carried out manually or automatically, depending on the requested implementation.

Reports and statistics for IN services

Service management produces a wide range of reports and statistics covering all aspects of providing services. These reports and statistics are embedded within the SMP implementation. Access to these reports and statistics is granted to authorised users.

A graphical report generator is available to enable the operator to produce on-demand reports and statistics. It can present complex data views and graphical charts employing a variety of database intersections.

Service management can be configured to generate very large numbers of reports and statistics with little or no effect on service provisioning and management.

Security centre and fraud detection

One of the keys to a successful service is that it should be protected against fraud during provisioning and use. The key point is to trace and eliminate fraudulent events before they can be included in a customer's bill.

Fraud detection tools incorporate on-line procedures that correspond to real-time events and to batch procedures which act on the event data accumulated in the IN management system database.

The IN management system gathers information from a variety of sources to obtain data about:

- *service usage*—it receives a record for each service access indicating whether it failed or was completed successfully, together with any alarms relating to anomalies, erroneous input by service users and deviations from thresholds; and
- *platform access* with a log of every operator activity, alarms relating to anomalies, erroneous input by service operators and deviations from various thresholds.

Infrastructure management

The proposed infrastructure management solution contains all the basic applications for fault management, configuration management, accounting, performance management and security management (FCAPS). It is emphasised that this solution can be used to address management systems in line with the general TMN principles as well as those based on various *de facto* standards.

Industry is moving towards an open-management architecture which will enable all resources to be accessed through well defined, easy-to-use interfaces. Alcatel is in a leading position with its integrated switching management solution (ISMS), which provides functional blocks and, most importantly, the TMN-API, which gives an overall view of all network resources. This TMN-API, which has already been implemented, will be extended in two ways: first to support more objects, and second to support more technologies to access these models.

A key component of open networks is the network database, which stores all the relevant network information, such as links or trunks and connections, subscriber profiles, and service capabilities.

ALMA_IMP, with its associated pools of infrastructure management operators, manages the IN infrastructure domain. Its main functions are:

- management of the IN internal domain, including all the distributed IN service elements, like the SMP, SCP, SDP and IP, each with its local management point;

- supervision of the IN shared domain, including the service switching points from the switching network, which are managed by the switching management system, and the signal transfer points, which are managed via the CCSS7 management system;
- monitoring of external alarms and events; and
- interface to the higher level operations support system.

The ALMA_IMP solution is based on ALMAP, Alcatel's state-of-the-art platform for providing advanced, integrated telecommunication network management. It includes a range of standard (*de facto* and *de jure*) interfaces which enable it to be connected to a wide variety of external systems.

Not only does ALMA_IMP work with different external systems, but it has also been developed to function as an 'operator assistant', not simply as an IN element manager. This role as an operator assistant is of the utmost importance as the network operator's IN will grow and evolve over time. Consequently the management solution must be able to handle not only the increased capacity of the IN, but also to cope with changes in the network operator's internal organisation, which is reflected in the way the operators have to perform their tasks.

Conclusion

We strongly believe that, within the constraints of the rapidly changing market for IN services, the approach outlined here offers the opportunity to create the best possible telecommunications management applications for IN services while providing the necessary cooperative interfaces for further integration with other management systems.

The unique features of this solution guarantee a sound investment and, above all, a system that will allow operators to manage services up to the level needed to be better than their competitors.

The offered IN management-system solution is thus a reflection of the functionality that can be derived from evaluating existing implementations and analysing future requirements.

Alexandros Sarantellis

INXpress—Adding Service Management to the Greek Telecommunications Network

Increased competition in today's deregulated markets forces the network operators to seek new methods for rapid service deployment. The intelligent network (IN) platform provides a network architecture which enables network operators/service providers to introduce and manage new services efficiently.

This article focuses on the introduction of IN to the Greek telecommunications network. It is based on Siemens' INXpress product which conforms to the ETSI and ITU standards.

The article summarises the underlying IN philosophy, briefly describes the Greek fixed telecommunication network and outlines the major trends governing the Greek market until liberalisation. The article goes on to present the technical solution for the Greek fixed network. Finally, the plans for future enhancements are outlined by taking into consideration the current trends in converging network types; that is, the integration of IN into the wireline, wireless and private networks.

Introduction

Intelligent network services are constantly penetrating the market and create an ever-increasing percentage of the operator's traffic volume in the network. For value-adding telephone services, IN is becoming more and more popular in both business and residential market segments. Depending on the particular application, these value-adding services provide various benefits for the network operator or service provider as well as for the users of such applications:

- increase the provider's revenue based on higher traffic rates (like voting or mass-calling services);
- increase the provider's revenue based on higher call-completion rates (for example, typical for routing services with optimised call distribution and call-event handling);
- provide new sophisticated tariff and billing options (like virtual card calling or prepaid services, least cost routing services or local zone billing); and
- enhance the existing PBX networks of mid-size to large companies with attractive tariff options or provide an alternative to PBX networks for the low-end business segment (virtual private networks).

Depending on the marketing approach and feature mix chosen, some services are specifically used for business subscribers (for example, large companies with several locations) while other services target individual customer groups or even residentials.

Intelligence in the network will be an important differentiating factor for operators as global competition in the telecommunications markets becomes ever more aggressive. The IN architecture turns into a strategic necessity for operators, allowing:

- flexible engineering and rapid deployment of services,
- easy provision of new and customised services, and
- smooth introduction of 'new technology' into the network.

The differences between a monopoly and a competitive market are illustrated in Table 1.

However, even in a non-competitive environment the IN-services can

Table 1 Comparison of monopoly and competitive markets

Monopoly market	Competitive market
No competition, market share = 100%	Highly competitive, market share = dynamic
Services based on technological capabilities ⇒ technology driven	Services based on customers' needs ⇒ market driven
No competitive pull for new services	New services as main driver to secure and increase market share

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evolve into an extra source of revenues leading on the same time to customer satisfaction.

The Drive for Intelligent Networks

The fixed telecommunications in Greece are considered to be a monopoly market operated by a state-owned organisation (OTE). Greece has lagged behind its European partners in liberalising its telecommunications infrastructure and implementing EU directives. The data services have not been long liberalised whereas the voice services will be liberalised on 1 January 2001. This fact has been the main driving force behind the Greek PTT's fast-track programme and its successor, the five-year frame contract which started in 1998, both aiming at securing OTE's dominance of the market. The targets of this programme can be divided into two categories. The first category concerns the digitalisation of the network (digital exchanges, ISDN user part (ISUP), integrated services digital network (ISDN), synchronous digital hierarchy (SDH), signalling transfer point (STP), telecommunications management network (TMN) etc.). The second category concerns, among others, the provision of new services via a software upgrade at the switch level and the introduction of an intelligent network architecture which will be used to provide the customers with innovative services in a flexible and rapid way. For the intelligent network, the Siemens' INXpress product has been selected. INXpress is a world leader in the intelligent network market with approximately 7·9 million subscribers in 28 countries creating a load of 6·5 million BHCA. Moreover, Siemens has been long involved in the intelligent network area and the experience gained can be valuable to the customer. The milestones below emphasise this.

1985 Siemens participates in the first RFI for IN (Ameritech) worldwide.

1986 EWSD (Electronische Waehl System Digital) provides switch-board freephone service.

1988–90 Leading role in the definition of IN/AIN architecture (RBOCs, Bellcore, ETSI, CCITT).

1992 Siemens supplies Deutsche Telekom AG, with an IN solution for
—advanced freephone (FPH),
—universal access number (UAN),
—advanced premium rate (PRM),
—televoting (VOT).
Siemens first supplier of Customer Service Control (CSC).
Siemens first supplier of AIN 0.1 SSP-functionality.

1994–95 Siemens first supplier supporting the ETSI core INAP specification.

1996 Siemens winner of The European IT Prize, 1996, awarded by the ESPRIT programme of the European Commission, for innovative service design.

1996 Siemens first supplier of IN products for GSM-based mobile networks.

1997 Siemens first supplier of network convergence solution between fixed and mobile networks.

1997 Siemens and Microsoft announced cooperation dedicated to the delivery of IN solutions on Windows NT server.

Network Status

To date the network is almost 60% digitalised with some 230 digital exchanges out of a total of 500. All transit exchanges are digital and they are being interconnected with Signalling System No. 7 trunks (ISUP). Additionally, the Athens area is served by a digital ring, called the *Attika* ring, which enhances the network reliability. By the end of 1998, the major Athens area will be almost 98% digitalised. The primary target for OTE is to reach a nationwide digitalisation of 96% by the year 2001. It would then be in a strong market position to accommodate new entrants.

The INXpress Solution

The classic ITU solution has been utilised for the Greek intelligent network. The IN implementation consists of one service management point (SMP) and one service control point (SCP). Both are located in Athens. These are connected to seven service switching points (SSPs) throughout Greece (all EWSDs). For handling IN traffic, the rest of the switches (both analogue and digital) must be through connected to the nearest SSP. The nationwide distribution of the SSPs is shown in Figure 1.

Figure 1—SSP distribution in Greece

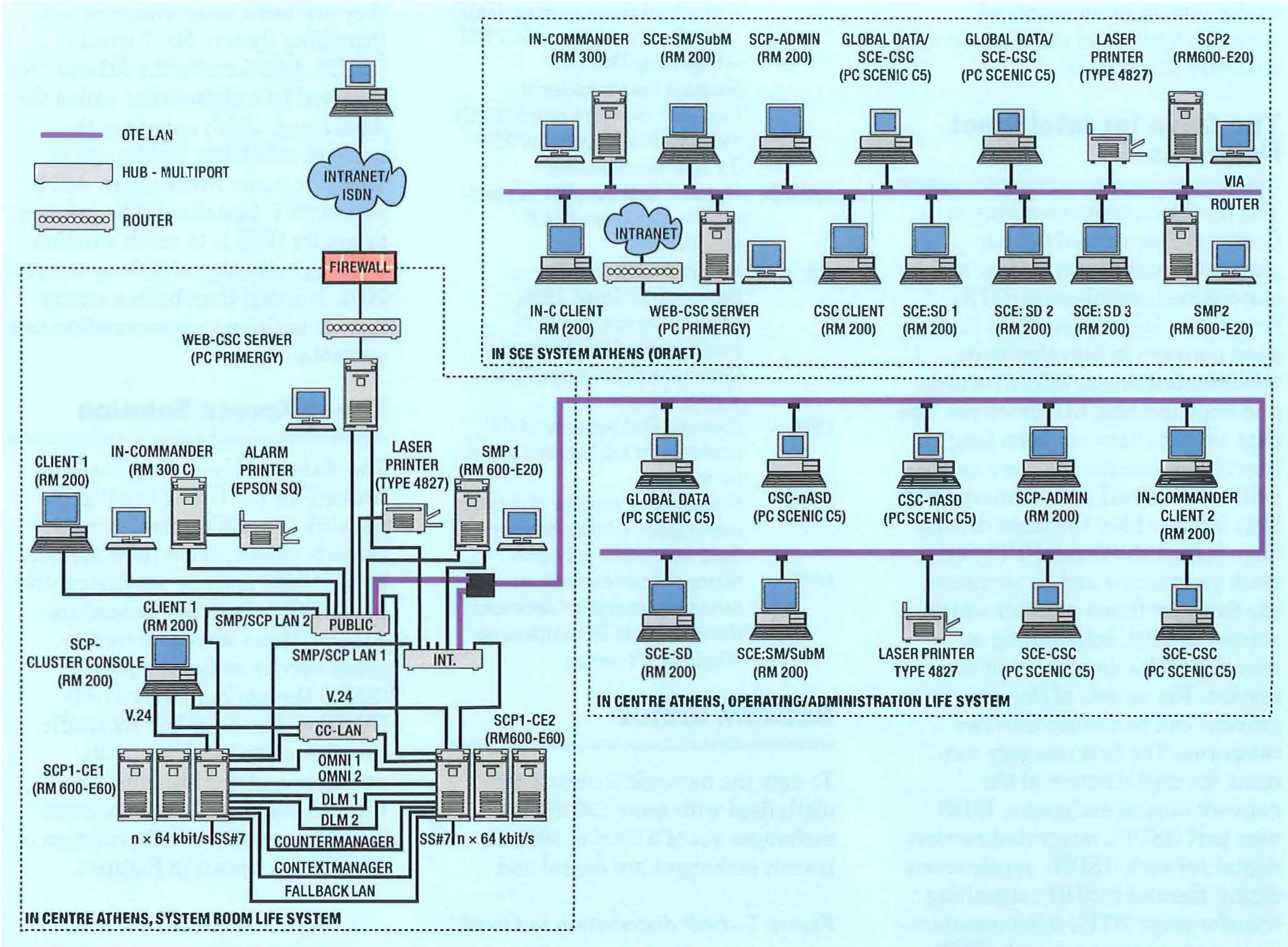


Figure 2—OTE intelligent network

The SMP is a UNIX-based platform consisting of a Siemens Nixdorf RM600-E20 model. It can handle a maximum of six SCPs although only one will be deployed in the beginning.

The SCP is also a UNIX-based platform consisting of a Siemens Nixdorf RM600 E60 model. It can handle from 240 000 to 2 million BHCA. The initial configuration utilises two processors with a main memory of 2816 Mbyte and a hard disk capacity of 145·6 Gbyte, which can handle an estimated traffic of 250 000 busy hour call attempts (BHCAs).

The service creation environment (SCE) will be exclusively operated by the OTE personnel. The Greek PTT intends to be the sole service provider in the market. For this reason an SCE team will be set up with the task of creating new services and tailoring the existing ones to the specific needs of the customers. The Siemens regional development centre in Athens locally supports the OTE's IN activities.

The SCP and the SSPs are interconnected via an INAP protocol based on the ITU Capability Set-1 (CS-1). The SCP, being a multivendor platform, can support several intelligent network application part (INAP) protocols in parallel. This would enable SSPs from different vendors to be interconnected in the same IN platform.

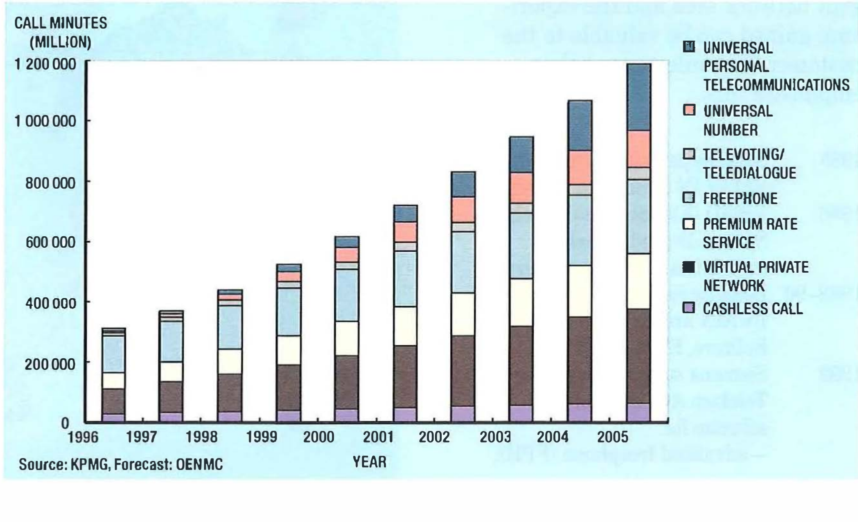
The current configuration, as is shown in Figure 2, was fully functional on 20 August 1998.

Initially, the services to be deployed are:

- freephone,
- premium rate,
- televoting,
- universal access number,
- universal personal communications,
- virtual card calling, and
- virtual private networks.

These are estimated to be the ones attracting a considerable interest in the upcoming years as is illustrated in Figure 3.

Figure 3—Forecast of world market for classical IN services



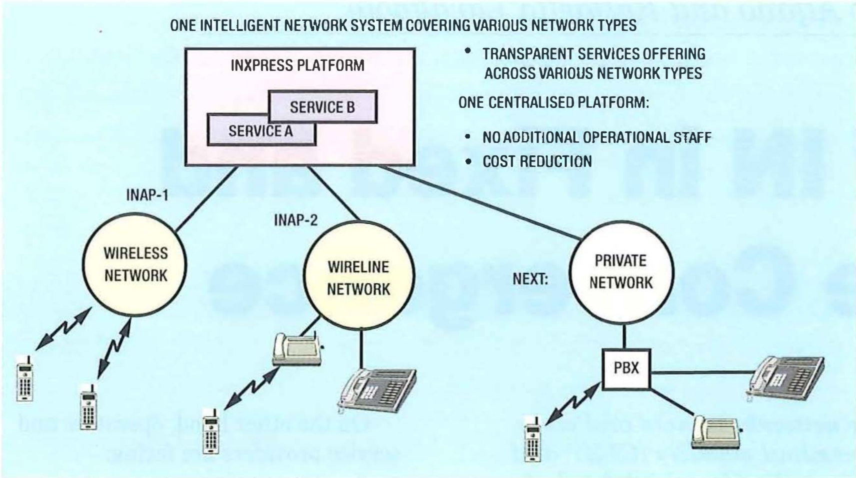


Figure 4 – Converging network types

The existing hardware of the SSPs will be extended with an intelligent periphery for enhancing the creation of valued-added services.

Future targets

During 1999, further digital exchanges will be given an SSP functionality thus enabling direct interconnection to the IN network. The number of intelligent periphery (IP) modules will also grow. It is intended that the IP should assist sophisticated value-added services such as voice recognition for the Greek language.

The SCP installed is a multivendor platform. This would enable the Greek PTT to connect other types of networks via different INAP protocols to the same intelligent network platform. It is believed that in the future a convergence of network types will take place. In that sense the IN will play a major role. This is illustrated in Figure 4.

Biographies

Alexandros Sarantellis
Siemens

Alexandros Sarantellis was born in Athens, Greece, in 1967. He graduated from the National Technical University of Athens in 1990. He joined Siemens Greece in 1991 as a telecommunications software engineer and worked for the first two years in Germany. In 1996 he was transferred to the sales department at the headquarters in Munich. From April 1998 he has been located in Athens and has been responsible for the IN project.

Gennaro Alfano and Raffaella Lavagnolo

Role of IN in Fixed and Mobile Convergence

The boundary between fixed and mobile networks is more and more blurring. The development of cordless terminal mobility (CTM)[1] and intelligent network (IN) services is characterised by a high level of integration of both environments and services. In the near future it should be possible to combine the possibilities offered by cordless, cellular, fixed and private networks and add more advanced services to this scenario. IN provides a means to realise this 'convergence' efficiently being suitable to handle basic mobility procedures and supporting the capabilities of providing value added services in a flexible way.

Although the current IN standard does not yet fulfil all the mobility requirements, it provides a means to add functionality in a modular way which opens up the possibility to reach a complete convergence in different environments: in a mobile network offering IN services to mobile users and in a fixed network by adding terminal mobility to users.

In particular, the use of IN-based architectures allows the network providers to offer value-added services on top of basic services on user base, and hence to distinguish user's collection of services.

These mean that in a competitive environment IN is quite attractive as a facilitator to fixed and mobile convergence.

This paper describes the approach, followed in an extended technical trial carried out by Telecom Italia, CSELT and Italtel in the town of Turin, to experience an enhanced service profile combining digital enhanced cordless telephony) (DECT) radio access for terminal mobility and IN functions to emulate PABX features in a public environment (cordless mobility for business customers).

Introduction

Several elements anticipate convergence issues, and some of them are already implemented in the telecommunication context. The term *convergence* is more and more associated to the fixed and mobile network relation. Besides, depending on the viewpoint, different and sometimes controversial meanings are assigned to the term *convergence*.

The basic objectives leading to, or at least influencing, convergence must take into account the customer aims related to:

- the service level from a quality viewpoint (for example, overhead duties normally associated to the service itself such as payments, service profile changes, administrative requirements, service outage management);
- the set of available services and their accessibility, ease of possible upgrading of the personal service conditions;
- service usability, in terms of low service price, under well-defined and user-tailored pricing configurations; and
- the usability of terminals.

On the other hand, operators and service providers are facing:

- stronger and stronger competition;
- a decrease in monthly average revenues per subscriber (mainly in the mobile context);
- an increasing need for access deployment, service creation capability and time to market efficiency; and
- an increasing sensitivity of network infrastructure and network operations costs.

Fixed network operators are already implementing wireless access (possibly with limited mobility) or personal mobility services, based on IN solutions. This is done in order to enlarge (or maintain) their market penetration towards users asking for high-quality, local services offered at low prices (typically very close to the classical fixed network tariffs).

Mobile operators, on the other hand, are more and more adopting IN-like solutions in order to increase their service-creation capability and the relevant time to market features.

The above trends can be fulfilled from a network and commercial organisation viewpoint through different approaches.

Cordless Mobility for Business Customers

Telecom Italia is offering local mobility to residential users with the Fido[2] service and is now moving towards business customer with an enhanced service profile combining DECT radio access for terminal mobility and IN functions to emulate PABX features in a public environment (cordless mobility for business customers).

Due to the complexity of all network improvements, an experimental approach is needed for an appropriate analysis of all technical implications; therefore an extended

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technical trial has been carried out by Telecom Italia, CSELT and Italtel in the town of Turin.

The trial objectives were identified as follows:

- to verify the validity of a real network reference solution based on improvements of the public switched telephone network (PSTN) exchanges, including the private PABX environment, and IN infrastructure incorporating enriched capabilities for service management;
- to explore DECT radio coverage in complex indoor environment in order to optimise the criteria of radio base station planning;
- to verify the customer facility in using the terminal and service procedures; and
- to evaluate the quality of service as perceived by customer and measured by tester.

The cordless mobility service for business customers, conceived for the trial, integrates PABX services with terminal mobility in a public environment.

The basic service features are summarised as follows:

- the ability to identify business customers in the local public environment (through DECT radio access to the network) by the same number they normally use in their private environment (office PABX wireline);
- the ability to switch from office PABX wireline to DECT terminal, and vice versa, by menu-driven procedures;
- the ability to maintain the short PABX numbering plan in the public environment, including attendant position call;
- DECT terminal call transfer to other users (PABX internal or external);
- call forwarding to a centralised voice mail (CVM) system for calls received on roaming DECT terminal when busy, not reachable, no answer; and
- call forwarding to a dynamic back-up number (fixed or mobile) for calls received on roaming DECT terminal when busy, not reachable, no answer.

As shown in Figure 1, the DECT cordless terminal is supplied to the users in addition/substitution to their fixed PABX wireline, by maintaining

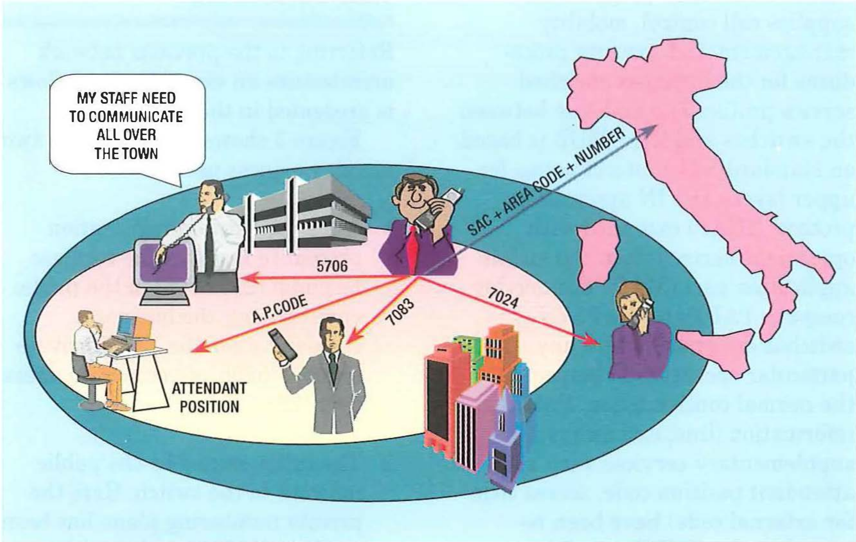


Figure 1 – Cordless mobility for business users

the same service features. Customers can roam inside company buildings and in outdoor environment, both covered by DECT radio base stations.

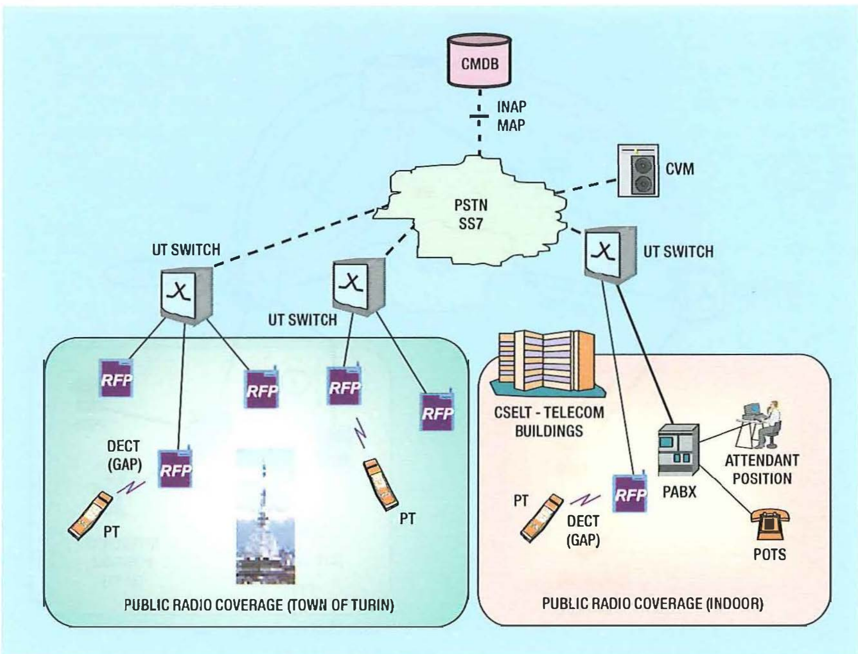
Network Architecture

The trial started in October 1997 with system integration activities to prepare and tune appropriately all network elements. An experiment is currently running, involving more than 100 users chosen from Telecom Italia and CSELT employees. Public coverage has been provided inside the three buildings where the offices of the users are located. Outside the offices the radio coverage is provided by the public DECT stations which cover all the urban area of Turin (about 5000 stations).

The core network architecture for technical trial (Figure 2) is based on N-ISDN while mobility support is provided by dedicated IN.

The implementation is based on the UT switching platforms, supplied by Italtel and deployed in the Telecom Italia network, supporting the business features and the radio access and on the intelligent node cordless mobility database (CMDB). The CMDB, placed in the National Intelligent Network Centre of Rome,

Figure 2 – Trial network architecture



contains customer profiles and supplies call control, mobility management and security procedures for the business enriched service profile. The dialogue between the switches and the CMDB is based on standard SS7 protocol using, for upper layers, the IN application protocol (INAP) extended with operations derived from the mobile application part (MAP). Connecting company PABXs to the PSTN switches does not require any particular operation in respect to the normal configuration. PABX information (line, extensions, supplementary services such as attendant position code, access code for external code) have been reported on the CMDB customer records.

Customers can define different routing options for incoming calls treatment when the terminal is out of coverage or switched off. Possible options are a CVM mailbox or a telephone number dynamically set up by the user via DTMF procedure controlled by IN.

The indoor radio coverage of the CSELT building has been planned with a simulation tool developed in CSELT; the results of the simulations have been integrated with radio field measurements and finally some 50 radio base stations have been installed. The radio coverage of the Turin town consists of about 5000 radio base stations, assuring contiguous radio coverage and offering the possibility to do bearer, connection and external handover.

Call Scenarios

Referring to the previous network architecture an example of call flows is presented in the following.

Figure 3 shows a call between two mobile business users:

1 After the location registration procedure made by the cordless terminal (228.5706) in the public environment, the business customer dials the PABX private number '5205' of another business user (228.5205).

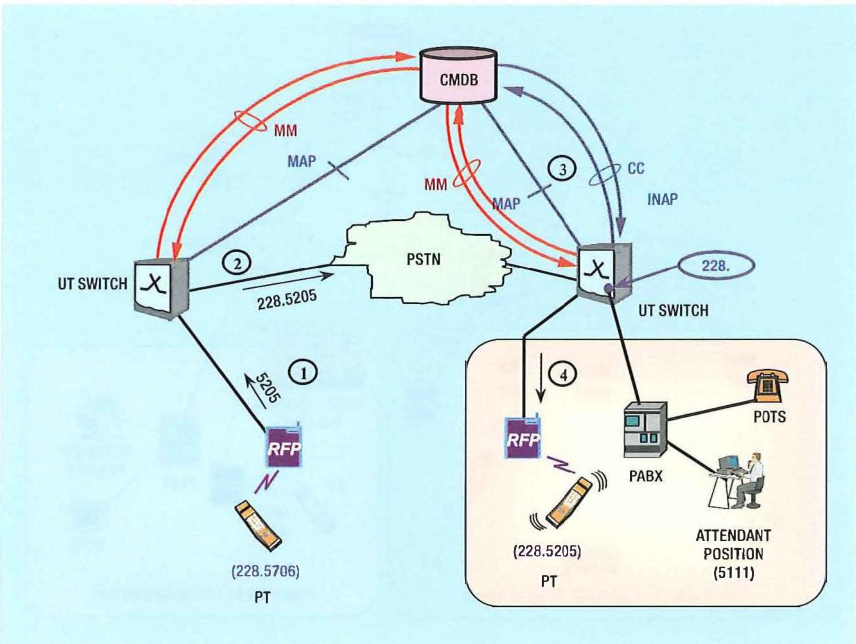
2 The call is routed by the public network to the switch. Here the private numbering plane has been configured (228.) and the corresponding PABX is connected. This operation is driven by the information contained in the customer profile downloaded from the CMDB during the location registration procedure.

3 The terminating switch recognising the called subscriber as a business user, triggers the CMDB and obtains the roaming number in order to reach the DECT cordless terminal; in the example the called user is under the indoor public radio coverage area.

4 The paging procedure is activated and finally the called business user answers.

If the paging procedure fails (the called business user is busy, not reachable or does not answer), the UT switch queries the CMDB in order to obtain an alternative destination for the incoming call. For example the IN node can return the CVM mailbox number. In this case the call is routed to the CVM mailbox, where the calling user can leave a speech message.

Figure 3—Mobile-to-mobile business user call



Conclusions

The flexibility offered by IN provides a means to add functionality in a modular way which opens up the possibility to reach a complete convergence in different environments: in a mobile network offering IN services to mobile users and in a fixed network by adding terminal mobility to users.

In particular, the use of enhanced cordless mobility profiles for business users within IN, including PABX information and services, may help integrating public and private environments by local mobility features that allow the user to roam between the office and the public covered areas while maintaining PABX features.

This paper has described the technical trial carried out by Telecom Italia, CSELT and Italtel in the Turin, to experience an enhanced service profile combining DECT radio access for terminal mobility and IN functions.

The trial is still running and the first feedback received by the users indicates that the service profile is adequate for the users' needs of local mobility. The service has been widely used for indoor and outdoor mobility and associated with advanced service features. In particular, the option of having all the calls diverted to another number (dynamically chosen by the user) has been considered useful when the terminal is out of coverage or switched off.

IN is playing a key role in the development of new services and will certainly be a platform which will be a common base to build and provide services in the field of mobile and fixed network convergence.

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Biographies

Gennaro Alfano
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Gennaro Alfano graduated in Electrical Engineering in 1989, and received his M.S. in Electrical Engineering from Polytechnic University of Brooklyn, New York, in 1990. In December 1989 he joined the R&D department of SIP (now Telecom Italia) Headquarters where he has been involved in the development of new telecommunication services (IN and centralised services). From the end of 1994, he has been working in the PCS Project of the Network Division of Telecom Italia. He has participated in the service definition and the network development of the Fido project. He is now in charge of technical trials in the switching sector of the Network Direction of Telecom Italia.

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CSELT

Raffaella Lavagnolo joined the CSELT Intelligent Network Department in 1989 and was involved in specifying the Italian IN project. She specified the Italian IN protocol and SSP funcionality. Her present activity concerns personal communication services in relation to both long-term definition and short-term implementation in the IN context. She participated in several EURESCOM projects and in ETSI on CTM and CS2 Core INAP standards. She is also involved in the Italian CTM project with the responsibility of specifying the extension to IN protocols with MAP-based operations for mobility management.

Julien De Praetere, Philippe Maricau and Marc Van Droogenbroeck

Data Networks Integration

This paper discusses the role of data networks integration on an asynchronous transfer mode (ATM) core and compares the advantages achieved by the usage of ATM with those given by emerging technologies such as Internet protocol (IP) over synchronous digital hierarchy (SDH) (giga-routers).

Data Networks Integration

A few years ago, most public network operators (PNOs) were confronted, for historical reasons, with many separated networks (voice, X.25, FR, IP, GSM, LL,etc.). Deregulation dramatically changed this situation: competition caused deep rationalisation processes aimed at cost efficiency, standard solutions and service excellence. At the same time, the push also came from the emergence of asynchronous transfer mode (ATM)—a standard technology designed to integrate the legacy networks.

ATM allows, by the integration of existing networks on an ATM core, economies of scale and economy of scope. A certain critical size, beyond which the cost/benefit ratio leads to profitable growth, must be achieved for any service to be successful. It is also important to integrate multiple services on to common networks and to provide a smooth evolution path for the customers.

This led to a vision in which multiple network technologies must co-exist, which implies that certain issues are very important:

- support for multiple service functionality on the network equipment;
- network-level interworking to interconnect customer sites having a mix of interfaces (frame relay, ATM, IP, etc.); and
- service interworking.

Today, the situation has changed again, mainly because of the evolution of the traffic pattern—ever more IP. Today's networking environment is becoming increasingly driven by Internet and intranet services: Internet doubles every six months and the old 80/20 rule, which stated (in former LAN and campus networks) that only 20 per cent of network traffic went over the backbone, has been scrapped. This results from the combination of intranet traffic and the increasing use of multicast applications.

As the telecommunications companies move up the Internet value chain by providing ATM-based IP backbones and speed up the access, perhaps using xDSL, the Internet service provider (ISP) role may in future be taken over by the telco—thus generating more IP traffic.

Mainstream data network services are fundamentally driven by the market and applications, not technology. It is now more than likely that IP will be the best service for use by end-system applications, while ATM will (currently) be provided as the underlying transport for it.

The same economical considerations that led us to integration a few years ago when ATM was considered as the ideal federating technology will now lead, due to this new imbalance, to a disintegration: separate networks again. One network would be optimised for IP transport and the other one would still be an ATM network, integrating all non-IP networks. Both could run on the same physical network.

Integration Benefits

The integration benefits include:

- reduction of transmission costs (suppression of redundant leased lines, better utilisation of backbone capacity),
- reduction of switching costs (reutilisation of existing switches, less ports wasted on the switches),
- savings on exploitation costs (scale savings, less equipment to manage, easier to upgrade, reduced stocks, etc.),
- shorter cycle time for provisioning and roll-out of new services,
- network management enhancements (networks are managed on the same platforms, allowing easier configuration and fault detection),
- performance/quality enhancements (switching hops saved—ATM is faster and more reliable),
- ATM quality of service (QoS) differentiation, and
- optimise assets utilisation.

Integrating the data networks and providing service interworking also allows a smooth evolution path to the customers between the different data protocols. A customer can mix the different technologies (ATM, FR, X.25) and interconnect them on the same network, and thus have coexisting ATM, FR, IP and X.25 sites. This allows the operator to offer a full range of differentiated services.

If we consider that 95 per cent of the traffic carried over the data network is IPv4 traffic, efficient transport of IP is one of the most important decision factors. The next section compares the several IP over ATM models with the IP over SDH technology.

IP over ATM

Strenuous efforts were made to map the fundamentally incompatible IPv4 on to ATM. The main problems that are encountered when transporting (TCP/)IP over ATM are:

- The inadequacy of TCP for ATM transport (window management, efficiency, sequence number wrap, MTU, etc.).

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- The huge gap between ATM throughput and IP goodput.
- How does the IP service model, with certain service classes and associated styles of traffic and QoS characterisation, map on to the ATM service model?
- How does the IP reservation model (whatever it turns out to be) map onto ATM signalling (especially when dealing with hybrid networks) and how is the address problem resolved?
- How does IP over ATM routing (QoS routing, broadcast and multicast routing, mobile routing) work when service quality is added to the picture? (ATM computes a route or path at connection setup time and leaves the path in place until the connection is terminated or there is a failure in the path.)

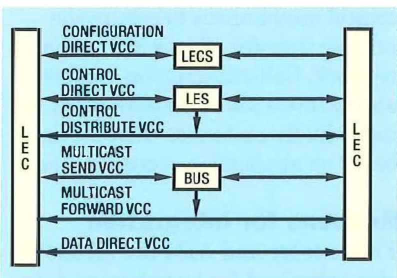
Edge routing over the ATM backbone

This approach to internetworking partly alleviates the performance bottleneck of router-based networks by equipping conventional routers with a fully configured set of ATM network links. But it is clear that as the number of locations and routers increase, the cost of maintaining the fully-provisioned mesh of virtual channels becomes costly as well as complicated to manage. Furthermore, ATM QoS capabilities are not utilised if the edge routers continue to treat ATM as just another highpeed link.

Classical IP over ATM

Classical IP over ATM is an approach that uses the power of ATM to forward IP traffic. It is used to connect subnets or workgroups that use only IP as the transport protocol. As in edge routing over ATM, QoS capabilities of ATM are ignored. It is possible to have multiple subnets on the same network, but at present each subnet must operate independently of the others and routers are required to provide communications between subnets. In complex environments, with multiple subnets, the router latency continues to be an issue.

Figure 1 – LAN emulation



LAN emulation (LANE)

LANE is used as a service that emulates the services of existing LANs across an ATM-network running the LANE protocol; that is, the shared medium of a traditional LAN has been replaced by an ATM network. In fact, it is a way of mapping the connectionless LAN service to the connection-oriented ATM service. Due to this mapping based on OSI-layer 2 with MAC-to ATM-address resolution (this address resolution is done by the LAN emulation server (LES)), all ATM attributes will be hidden by the LANE protocol for the LANE users, with its most important impact that the quality of service offered by ATM cannot be accessed by the LANE user (Figure 1).

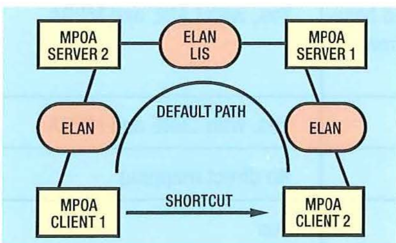
Depending on the implementation in equipment, LANE will support the Ethernet, IEEE 802.3 and IEEE 802.5 standards and higher layer protocols as IP, IPX, etc.

The broadcast and unknown server (BUS) handles all broadcast and multicast traffic. Moreover, data traffic, whose destination (ATM-address) is unknown until address resolution is performed and a data direct connection is set-up to another LAN emulation client (LEC) is also handled by the BUS.

Enhancement of LANE service will provide new features as ATM QoS support, enhanced multicast, multiprotocol over ATM (MPOA) support, LANE network node interface (LNNI), multiple and redundant server elements per emulated local area network (ELAN), logical link control (LLC) multiplexing for virtual channel connection (VCC) sharing.

Because LANE service requires the ATM-Forum ATM-transfer capability unspecified bit rate (UBR) the equipment used produces bursty output at link rate. Due to this fact shaping of the bursty ATM-traffic **must** be applied before the traffic can be transferred over an ATM-network using the VP-bearer service.

Figure 2 – The MPOA model



MPOA

The MPOA model distributes routing among edge devices and ATM attached hosts with MPOA clients (MPCs), that forward packets, and MPOA servers, which supply routing information. MPCs examine the destination address of packets received on legacy LAN segments in order to make the correct forwarding decision. If the packet is to be routed, it will contain the destination MAC address of the MPOA router interface. If so, the MPC will look at the destination network layer address of the packet, and resolve this to the correct ATM address based on information received from the MPOA server or use information in its cache. The MPC will then establish a direct virtual channel connection to the appropriate destination.

If the packet is destined to a host in the same subnet so that it can be bridged, the MPC will use LANE to resolve the ATM address and establish a virtual-channel connection to the destination.

If the local MPOA server does not know the appropriate ATM address, it can propagate the query to other MPOA servers or routers using next-hop routing protocol (NHRP) functionality. The destination ATM address from the MPOA server can be the address of the host (if the host is ATM-attached), or the address of the appropriate edge device to which the packets should be forwarded.

IP over SDH

Routed networks topologies evolved during the last 20 years using emerging technologies in order to enhance the cost, the management and the scalability of the networks.

The growth of the Internet and intranet (IP) traffic is seen today as the driving force for the deployment of data networks. The technologies built around IP will evolve in order to accommodate several requirements like low latency, quality of service, dynamic bandwidth, etc. However today there already is a strong pressure towards more bandwidth. In this regard, SDH is an excellent medium; it is reliable and widely

Figure 3—Paradigm shift between an ATM platform to an IP platform

implemented in large telecommunications infrastructures.

Until recently, ATM appeared to be the only viable method of aggregating voice, video and data traffic on high-speed networks. In this conception ATM is a platform for all services. In Figure 3, we compare the ATM concept to the situation where IP plays the central role. These new approaches, called *packets over SDH*, lead to new backbone architectures that preserve investments made in SDH and rely entirely on IP. The shift to IP instead of ATM is also observed in the LAN environment (gigabit Ethernet has been optimised for IP traffic).

Running IP on top of SDH eliminates the overhead needed to run IP over ATM. The issue is important because half of the packets on the Internet are around 60 bytes long. Moreover, several techniques are under development to provide QoS at the IP level; ATM QoS would not be further needed, which would solve the problem of mapping layered QoS into each other.

As data traffic continues to increase, SDH will carry more and more data packets. This event has impacted the existing SDH infrastructure in some countries. SDH transport backbones are being stressed by the exponential growth of Internet more than by any other information source.

It is expected that the platform of choice for IP will maintain low latency and resilience of SDH, and add dynamic throughput as well as performance based on differentiated quality of service in the network

Comparison

See Table 1 for a comparsion of gigabit Ethernet, ATM and IP over ATM.

QoS evolution?

- Efforts like QoS routing and RSVP really do pay off, and therefore ATM loses any of its advantages over packet-switched schemes, or
- RSVP does not work out as hoped, and ATM's circuit-based nature is an asset. In this latter case, if the drops to end users are on over-provisioned Ethernets, then you will probably have enough excess bandwidth to pretend you have QoS delivery.

ATM in LANs?

The cost and complexity of ATM to the desktop and the few rewards for the majority of users (due to lack of applications, drivers, spotty deployment, etc) made it a flop.

Conclusion IP/ATM

Finally, IP over SDH enables high-speed, packet-oriented, low-cost (lower level of services and functionality), IP-optimised WAN connections without the need to assemble/disassemble packets into cells for transmission over the WAN. The capabilities of Ethernet are increasing towards the current capabilities of ATM while preserving the compatibility with the installed LAN nodes (80 per cent of which are Ethernet) and installed protocols (which all operate over Ethernet).

ATM provides voice, data, and video integration, while gigabit Ethernet delivers high-speed data. Voice and video capabilities over gigabit Ethernet will depend on the success of video and voice over IP. Note that there is an application overlap between Gigabit Ethernet and ATM. Both will be used for backbone, server, and building riser applications. However, today (as no QoS enforcement is possible on a gigarouter based network until the arrival of MPLS) only ATM can today provide WAN services in situations where bandwidth is still a scarce resource.

In the future, both networks are likely to coexist—an integrated ATM network and an IP-optimised gigarouter-based network.

X.25/FR Integration

X.25

X.25 is an internationally accepted ITU-T standard that defines a communication protocol between data-terminal devices and packet-switched data networks. The X.25 protocol facilitates the interworking of packet-switched data services across geographically dispersed public and private networks.

X.25 is a virtual call service that allows network users to set up calls using standard X.121 and E.164 addresses. The network establishes calls over virtual circuits, which are logical connections between the originating and the destination addresses. Through the use of statistical multiplexing methods, X.25 can support multiple virtual circuits over a single physical circuit, thus providing port sharing and dynamic bandwidth allocation.

The X.25 protocol implements various error correction and flow control mechanisms to ensure the reliable transfer of data across the network. Call-subscription options and facilities allow network users to individually customise their service based on application requirements.

Reasons for integration

Frame relay and ATM are technologies optimised for transferring data

Table 1 Comparison

	Gigabit Ethernet	ATM
Bandwidth	Low cost	Moderate cost
QoS	Class of service (CoS) with 802.1Q, RSVP	Guaranteed QoS
Service integration	High-speed data, potential for voice/video over IP	Data, video, voice
	Gigabit Ethernet	**IP over ATM**
LAN protocols	Yes: leverage installed base of Ethernet, fast Ethernet, and LAN protocols	Yes, with LANE and MPOA
Scalability	Yes	Yes, with LANE and MPOA
QoS	Emerging—MPLS	No direct mapping
WAN	Emerging	Yes

over high-quality transmission facilities.

While such facilities exist in certain parts of the world, many countries lack the network infrastructure required to support these newer technologies. In these regions, data communications systems using X.25 are required. International business networks that span the globe need a combination of all of the above communications technologies to meet their requirements. Currently, typical X.25 access is low speed, within the 9·6–64 kbit/s range.

As X.25 subscribers require greater access speeds and demand newer technologies such as frame relay, existing network infrastructures are unable to handle the added capacity requirements. The integration with frame relay allows the provision of a smooth migration path from X.25 to FR. Some customer sites can continue working on X.25 while some others, requiring more bandwidth, are migrating to FR.

Finally, the integration of the X.25 and FR/ATM networks allows the reduction of transmission costs by multiplexing the traffic between X.25 switches on the existing FR/ATM trunks.

Methods of integration

There are two main methods to carry X.25 traffic over a frame relay network.

The X.25 encapsulation can be done according to the following standards:

- ANSI T1.617a Annex G—Encapsulation of ITU-T X.25/X.75 over FR. Annex G encapsulation provides a means of encapsulating LAPB frames using a 2-byte header. Because of the low overhead, this is the preferred encapsulation method.
- RFC 1490 or ANSI T1.617a Annex F—Multiprotocol encapsulation over FR. RFC 1490 defines a multi-protocol encapsulation method for carrying network interconnect traffic over a FR backbone.

All frames contain information necessary to identify the protocol carried within the information field of the frame. This method adds an 8-byte multiprotocol header in order to identify the LAPB frame. Because of the higher overhead, this encapsulation method tends to be less used by the equipment manufacturers.

Biographies

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Julien De Pratere graduated from the Catholic University of Leuven as a civil engineer in electronics with specialism in micro-electronics. He joined Belgacom in 1993 at the test laboratory for data equipment. Since 1994, he has been responsible for X.25, IP, FR and ATM network technology and planning.

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Marc Van Droogenbroeck receive his electrical engineering degree in 1990 and his Ph.D. degree in telecommunications in 1994, both from the University of Louvain-la-Neuve. Since 1994, he has been with Belgacom. His main interests include IP network/applications and image processing.

Elina Nikaki

Voice over ATM in the Corporate Network

The subject of voice and data integrated networks has occupied the telecommunications industry during the last decade. Many experts claim that it will happen soon. However, they share diverse opinions about what will be the technological vehicle for this multi-traffic merger. Among the several candidate technologies, asynchronous transfer mode (ATM) seems to be a strong candidate.

This paper focuses on the ATM deployment in the corporate network. It surveys the newest ATM products and defines the alternative network configurations. It identifies the various issues concerning ATM's ability to transport voice, and the parameters that will determine ATM's future positioning as the choice for the integrated network.

More specifically, the diverse subjects that are covered include:

- *An overview of the evolution of the corporate private networks from 1970 up to today: the infancy of the private PBX-based voice networks, the advancement of packet-switched data communications into the virtual networking of the broadband era, and the business requirements of the corporate networks of the future.*
- *An ATM technology overlook: what are the advantages and the disadvantages of ATM compared with alternative packet voice technologies.*
- *The ATM deployment scenarios in the corporate wide area network (WAN) for voice and data consolidated networks: an evaluation of the diverse types of ATM switches that can transmit voice.*
- *The ATM deployment scenarios in the corporate local area network (LAN) for voice and data consolidated networks: the concept of the ATM LAN PBX.*
- *An identification of the diverse voice-ATM configuration scenarios and the issues that they raise for the industry and the carriers.*
- *Conclusions about the future of ATM as the prevailing technology for the integrated network.*

The Evolution of Corporate Networks

The reasons the first private company networks were built, the technologies they deployed and the business needs that influenced their evolution throughout the years are valuable means to judge their future directions.

Phase I: 1975–1985. Private company networks

In the late-1970s–early-1980s, we had the emergence of what was called a *private company voice network*. The incentive for large companies with sites in different cities was the reduction of the extensive long-distance intra-company telephony costs. Private voice networks were built with dedicated lines† that interconnected the customer-owned switches (PBXs*) located at the various company sites.

At the same time, companies were implementing separately their private data networks. The first data networks were centralized star or hierarchical topologies, based on a mainframe host connected to a front-end processor that managed the communication between the host and several computer clusters. The end-user terminals were non-intelligent devices accessing the intelligent host or mainframe through the computer clusters. The transmission protocols used were IBM SNA and legacy BISYNC.

The ownership of a private network provided companies with cost savings‡, higher control over the network's performance and configuration**, and the flexibility to introduce additional features. Nevertheless, it also charged them with the responsibility and the costs of the network's operation and management, as well as the risk of reduced networks availability due to the lack of alternative routes in case of a link's failure.

Phase II: 1985–1990. Packet switching for data

By 1985, digital transmission facilities were deployed extensively and the private networks were built with T1 leased lines. Multiplexers were used at the corporate sites to reduce bandwidth cost by consolidating voice and data applications over common facilities. Both networks were sharing the same transmission lines.

Voice-related technologies did not change much. For data, the evolution was significant: packet switching, a technology introduced in the late-1970s was now widely deployed. In addition, data networks evolved, as mini computers replaced the

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† These are lines leased from the telecommunications carrier dedicated for the exclusive use of the company. The first dedicated lines were analog, but later digital leased lines prevailed.

* Private branch exchanges.

‡ Cost savings are derived from the difference of fixed pricing of the leased lines from the usage-based pricing of the public telephony in the case that a company's telephony traffic exceeds the fixed cost of leased lines.

** For example, flexibility to add, alter and transfer telephone numbers within the company.

mainframes and intelligence was moving to the terminals.

We observe a tendancy towards a more intelligent and important network. Packet switching was based on the idea of segmenting data in variable length packets and allocating the capacity of a network channel from one node to the next for the duration of the length of the packet. This way, a more efficient allocation of the channels' bandwidth was possible. Data networks became more important as they did not perform only plain data transfer; they intelligently allocated the resources and routed the traffic.

Phase III: 1990–1995. Broadband technologies and virtual data networking

In the 1990s, we witnessed the advent of broadband technologies, that brought along the concept of *bandwidth on demand*, and a new notion of virtual private networking. Along with the proliferation of the LANs, they set the ground for what we currently know as *modern communications*.

Broadband technologies (like frame relay (FR)) allowed *virtual data networking*; that is, sharing the public network switching and transmission resources across a large number of enterprise users, instead of dedicating communication facilities to each user.

The principles of *client-server architecture* and *distributed processing* implemented in the local area networks (LANs), have been major developments in data communications. They were a step towards decentralised networks: the intelligent end-devices (PCs) were interconnected and shared the processing load.

In a sense, the idea of virtual networking was already familiar from voice communications: a line was shared among several users, so that the same physical connection was part of different logical networks (*virtual*).

The private network over leased lines requires a dedicated connection between any two sites of the corporate network. While in the virtual private network (VPN), only the access lines to the public network are necessary. VPNs deliver simpler networking than the private time-division multiplex (TDM) network solutions since a lot of the sophisticated network functions† are performed by the broadband cloud. In this sense, 'intelligence' was shifted from the corporate end-devices to the public broadband network. Additionally, VPNs discharged the companies from the network management responsibilities; those were now assumed by the carriers. Therefore, considering the administrative and maintenance network costs, VPNs could provide lower-cost solutions than the dedicated networks.

Data communications were taking the lead over voice communications both in growth rate and the introduction of new services. They assumed a comparable position with voice networks in the company's budget considerations. This tendency continued during the following years as well.

Phase IV: The present

The present picture of corporate networks is as follows: legacy technologies co-exist with the newest solutions; data traffic is assuming an increasing importance and volume; and voice is separate from data regarding their technologies, physical networks and corporate administrations. Both private lines and virtual private networking are used in the same corporate network: leased lines to interconnect the largest sites and virtual private networking for the rest.

The most recent technological advancements include *cell switching*, the fast and multi-traffic switching fabric deployed in the ATM protocol.

Voice can also be now transmitted over broadband technologies. However, broadband packet technologies for voice imitate the traditional TDM multiplex lines*: constant bit rates and continuous allocation of bandwidth for the entire duration of a call.

Phase V: The future

The parameters determining the network technologies that will prevail in the future derive from the available technologies, their economics, and the combination of the current and future business needs that define the network requirements.

Technologically, several recent developments open the road to new network solutions: advancements in the voice compression techniques that result in releasing three-quarters of the current voice bandwidth‡; the use of switched virtual circuits (SVCs) in FR and ATM that translate into more switching flexibility and routing efficiency and result into enhanced bandwidth and cost savings; and the standardisation efforts for the H.323** protocol for the Internet protocol (IP) and the AAL2§ for ATM that set the ground for computer telephony integration.

Business-wise, the challenge of future networks will be to satisfy the following business needs:

- *Need for more bandwidth and higher speeds.* The increasingly flatter and 'distributed' corporate organisational structure is driving the need for each individual to communicate with more entities and requires a larger quantity of data.
- *Beneficial network economics.* Economical benefits are twofold: they derive from the network's ability either to support existing capabilities at a significantly lower price, or to enable new applications that were previously too expensive or unavailable. The networks' flexibility to accommodate the legacy technologies, protect investments already made, and migrate to new technologies and applications with minimum cost will be an essential economic factor. Voice and data consolidation can produce significant savings, by reducing the operational and management network costs and enhancing bandwidth management.
- *Ease of use / usability.* Companies would like, if possible, to integrate all current communication methods (fax, telephone, e-mail, videoconferencing) to a single one; a type of a multimedia call that would be as simple as a voice call or a World Wide Web (WWW) information access. On the other hand, it is equally important for their business to maintain the user choice and flexibility in the access of the network: locally or remotely, by desktop, laptop, or telephone.

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† Routing and redundancy considerations to provide alternative paths in the case of link failures or network congestion.

* With applications like CES (circuit emulation), for ATM.

‡ 8 kbit/s ADPCM dynamic compression with silence emulation can result in 4-to-1 compression.

** H.323 is the standard that enables telephony over IP networks.

§ AAL are the asynchronous transfer mode adaptation layers. They are a series of protocols that enable ATM to be made compatible with most of the commonly used standards for voice, data, image and video transport. AAL2 is the protocol appropriate for real-time, variable-bit-rate applications such as voice and video.

What though will be the best technology for the future networks that will satisfy all these requirements? The evaluation of the new technological solutions for the corporate networks will be based on any significant advantages over the currently available options. Such advantages should translate ultimately into economic and competitive benefit for the corporation.

ATM Technology

The ability of ATM to transport voice, and its benefits and disadvantages over alternative technologies, are crucial for its evaluation as the technological vehicle for the future voice and data consolidated network.

ATM Technology Overview

Asynchronous transfer mode (ATM) is a multiplexing and switching technology designed for great flexibility and ability to accommodate an unlimited range of different applications (all types of traffic) at very high speeds.

It is connection-oriented, and packet based with a major characteristic: all data is divided into fixed-size packets of 53 bytes (5 bytes header and 48 bytes payload) called *cells*. Because of this attribute, its switching functions can be implemented in hardware that makes it relatively easy to build high-speed networks†.

In addition, ATM was designed, from the start to support differential and 'guaranteed' quality of service (QoS) for different applications. This allows time-critical traffic such as live voice conversations to get priority over bulk file transfers. Several service categories are defined for this reason within the ATM layer; this is what makes ATM a multi-service, multi-rate fabric.

For any single application, it is usually possible to find a better data communications technique. However, ATM excels where it is desirable for applications with different performance, quality, and business requirements to be performed on the same computer, router, switch, and network. By its formalisation, ATM was intended to be the ultimate solution for integrating voice and data on high-speed networks.

The characteristics of ATM technology provide competitive advantages and disadvantages over alternative packet technologies for transporting voice. The fixed-size cell is the main reason for most of them. Combined with the prioritization of voice cells, it reduces voice traffic delays. The 'guaranteed QoS for voice' can not be provided by technologies that transport packets of varying length and where it may be necessary to wait for a long packet before the next transmission can begin. In addition, the fixed size of cells enables the integration of multiple traffic types for dynamic bandwidth management and efficient resource allocation. On the other hand, the packetisation overhead might be significant, because of the rather small size of the cells.

SVCs vs PVCs

An important feature of ATM is that it can provide either permanent virtual circuits (PVCs) or switched virtual circuits (SVCs).

PVCs are 'pre-provisioned' virtual circuits to the user on a continuous basis. This means that, the PVC connection between two nodes is predefined and can not be denied. Bandwidth is pre-allocated and the QoS requirements are predetermined as entries in the tables in the network nodes' databases. A PVC is static and it provides security of connection and QoS. Nevertheless, bandwidth may be allocated even when it is not used, as in the case of constant bit rate (CBR) and variable bit rate (VBR)*.

SVCs are not pre-provisioned virtual circuits. They allow direct connection to any node; connection is established via signalling that lets the user define the end points upon initiation of the call. So, connections are established 'on demand' through the connection request/accept/establish procedure. SVCs provide the benefit of flexibility since the user can select dynamically the receiving party and QoS features can be negotiated and determined on a call-by-call basis. Additionally, improved bandwidth efficiency is achieved since bandwidth is not permanently reserved.

Voice over ATM

The transport of voice over ATM is as follows. The synchronous voice signal is first segmented into fixed-sized cells, each with its own header. The cells are interleaved in the network with cells from other sources carrying different traffic types, until they are finally delivered to the destination.

At the destination, cells must be re-timed into a synchronous stream. For this reason, a re-timing buffer is used. Cells in the network are subject to different queuing delays depending on traffic levels and types, and therefore they arrive at different time intervals at the destination. The signal at the destination PBX must be played out as a synchronous stream, and that is why cells are held in a re-timing buffer to make sure that their variations in the arrival times are not going to be sustained in the output signal.

A major consideration for voice is delay and delay variation. Delay in packet voice is comprised of a fixed and a variable component. Fixed delay consists of:

- *Propagation delay.* It depends on the distance between source and sink.
- *Serialisation delay.* It is the time it takes to place the bits on the circuit, and it is inversely analogous to the circuit speed.
- *Processing delay.* It comprises of the coding, decoding, compression, decompression and packetisation delays, and it depends on the algorithms deployed.

The variable delay component is *queuing delay*. That is the time the packet waits in queue to get in the trunk. *Dejittering buffers* are used at the receiving end to smooth delay variation. Dejittering buffers cause additional delay according to their size.

Overall, the total delays in voice-over-ATM can be around 65 ms, while for alternative technologies, such as voice-over-FR, we experience delays of about 100 ms and more for the same distances‡.

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† Higher speeds than the ones achieved by the traditional routers designed for multiple sized packets (for example, IP), since extra time is needed in order for them to 'read' the length of each packet and process it accordingly.

* In PVC/VBR there is no allocation of bandwidth if not used.

‡ Based on Reference 5, pp. 16–17, for the calculations of voice-over-FR. For the ATM alternative, we assume an ATM OC3 private line from NY to LA, voice compression 16 kbit/s, 6 ms/km propagation delay, 0·00005 ms serialisation delay, packetisation delay 0·125 ms/byte, and dejitter buffer delay twice the coder delay. We notice that the circuit speeds of the two configurations are different (OC3 for ATM, and E1 for the FR), but they are justified by the different nature of the technologies.

Adaptation techniques for voice
Besides the standard voice compression additional techniques are used in ATM to increase the total rate of compression†, while maintaining voice at a 'toll' quality. Such features are the following*:

- *Dynamic voice compression.* Voice is transported at the minimum level defined, and whenever the voice traffic encounters congestion, the compression is increased dynamically to the maximum compression level.
- *Silence suppression.* Packetised voice allows‡ sending either nothing or background noise when the channel is idle or silent. This feature takes advantage of the fact that during a typical voice conversation a speaker talks during half the time and listens the other half.
- *Silence emulation.* Silence suppression can be enhanced with dynamic noise matching; that is, the insertion of comfort noise at the egress that matches the speaker's environment.
- *Dynamic bandwidth allocation.* Bandwidth is allocated for a voice call only when a voice call is in progress, otherwise idle bandwidth is available to other applications**.
- *Voice band data and fax detection.* Often it is not voice on the voice channel, but modem data or fax. Detection of the diverse voice traffic allows automatic adjustment of compression according to the type of traffic and its configured priority. Modem and fax traffic requires more transmission capacity than compressed voice, but is not delay sensitive.
- *Voice trunking.* It is an ATM standard that allows several calls to be multiplexed into a single virtual circuit, allowing multiple calls per one ATM cell. Therefore, it keeps the number of virtual circuits used to a minimum.

'Voice-wise' evolution of ATM
The first attempts at consolidating voice trunks over ATM networks used CBR quality of service over PVCs or AAL1 circuit emulation service at the T1/E1§ level. Consequently, 1·74 Mbit/s were consumed for a T1 line (1·5 Mbit/s) emulation, which is an ineffective use of bandwidth††. Additionally, voice channels were allocated during the entire duration of a telephone call, although they remained idle for 50% of the time.

An alternative way to transport voice is using the AAL2; that is, variable bit-rate (VBR) quality of service and voice adaptation techniques, such as voice compression and silence suppression. The transport of voice over AAL2 provides a way to put highly compressed speech into very small packets and put multiple packets into an ATM cell. This way, the bandwidth gains can be at a factor of 4:1, and more.

A further step in the ATM technology deployment was the use of SVCs instead of PVCs. Connections can be created 'on-demand' between virtually any two nodes, without having to predefine them. Improvements in terms of flexibility, network management, bandwidth and economics take place.

Overall, the evolution of voice-over-ATM implementations followed the following pattern; first the circuit emulation service (CES) using CBR/PVCs (AAL1 implementations), later VBR/PVCs using AAL2, then SVCs in AAL1, and finally AAL2 SVCs.

ATM was intended to be the ultimate solution for supporting mixed voice and data traffic. But it has not quite worked out that way so far. However, ATM technology is currently being deployed, by major service providers like MCI, as an integral part of the Internet backbone; a new series of products is being introduced by vendors, while SVC services are now being offered by providers. Does this mean that ATM has still the chance to become the most popular technological vehicle for the integrated network of the future?

Voice and Data Consolidation in the WAN

During the last few months, several vendors have been very active in the area of ATM, introducing in the market a new series of ATM switches that can transport voice implementing the SVC/VBR voice over ATM. Active in this direction are mainly the traditional voice vendors such as Lucent and Northern Telecom (Nortel), and a few mainly data vendors like CISCO.

Depending on the different levels of functionality, they come at various performance points and prices. Their major categorisation into *public* and *private* is based upon their capacity to support public traffic or not. Nevertheless, in some cases switches for private networks may be used for public traffic and vice versa§§.

Private network ATM switching systems can be further segmented into three distinct types based on their deployment scenarios and functionalities. They are found under several different names, such as:

- *workgroup* ATM switches,
- *access* ATM switches, and
- *core* ATM switches.

Workgroup ATM switches
Workgroup ATM switches are directly connected to the desktop; that is, they are the *ATM LAN switches* and are optimised for pure ATM desktop interfaces

Access ATM switches
Otherwise called *concentrator*, switches since they concentrate multiprotocol LAN and voice PBX traffic, convert it into ATM cells and sent it over to the corporate core ATM backbone. They are also referred to as *campus* switches, because they are usually deployed in the campus networks. Since they are the only ones that accept non-ATM traffic and transmit it to the ATM network, they serve as an 'access' to the corporate ATM WAN.

Access switches offer lower throughputs (usually less than 3 Gbit/s), a greater flexibility in the interfaces

† For example, 8-to-1 compression can be achieved by using 16 kbit/s ADPCM compression plus silence suppression and emulation.

* Reference 5, pp. 48–50

‡ Because the first operation the network performs is to segment the voice stream into cells, it is possible to examine the contents of each cell as it is generated. If the cell does not contain any speech—and about 50% of every conversation is silence—it can simply be suppressed and not sent across the network. At the destination, the missing cells can be identified, and their time interval replaced by a synthesised background noise signal. This feature is available on ATM switches that have speech detection abilities.

** That is a feature of ATM (VBR) in general, but now it is accentuated by the silence-compression technique. Bandwidth is allocated for a call only when somebody talks.

§ A T1 line is 1·544 Mbit/s and can carry 24 voice channels (at 64 kbit/s each).

†† The additional bandwidth required is due to the overhead of the ATM cells and the ATM AAL1 encoding for CBR.

§§ Enterprise private switches can be used by public network providers as the 'edge' of their network.

(often, a wide variety of low-speed interfaces at the ingress) and are usually smaller in physical size.

Core ATM switches

Core ATM switches are designed to form the core backbones of large, wide-area enterprise networks. For this reason, they are also named *enterprise* or *backbone* switches, since they are deployed in the enterprise backbones. They are used to interconnect ATM-interfaced devices, such as workgroup ATM switches, ATM access switches, and ATM routers.

Since they are also widely deployed at the 'edges' of the public networks providing multi-service integration onto the ATM infrastructures of the public carriers, they are also referred to as *edge* switches. They integrate all of the disparate services in the enterprise backbone.

Core switches have higher throughput (5–10 Gbit/s), and higher performance in terms of the total number of virtual connections they can establish, and the calls per second that they can support. They support higher bit-rate interfaces, and they have much higher reliability, provided by full redundancy of power supplies, switching and processing hardware, and failure recovery modules. They usually support more sophisticated routing, and they might provide additional features such as billing and statistical network management applications.

The ATM-compatible PBX

If the function of converting analogue voice into ATM cell streams is performed within the PBX, then no additional gateway is required for the corporate voice network to be connected to the ATM cloud.

Conclusions

Given the above benefits we would expect the market to jump into the integrated ATM networks. What hinders it? Extensive interviews with representative vendors provided us with some answers†.

- Most of the new ATM switches are going to be in the market by the third or fourth quarter of 1998. Corporate users are reluctant to try new products, while they wait to be 'tested' by the market.
- There are many administrative issues concerning the voice and data networks integration. Since the two networks are separate organisationally as well, the data and telephony corporate units are resisting to their merger.
- Moreover, such network integration requires retraining for the data and voice units of both the vendors and the corporate users. We are only at the beginning.

The full operational economic benefits can be achieved through the efficient deployment of SVCs; although the products are supporting SVCs, only a few carriers offer them. Most of the carriers offer today only PVCs, although several have announced they will support SVCs within the third or fourth quarter of 1998*. The pricing of SVCs is yet to be seen and it is going to affect the economics of ATM/SVCs implementations.

ATM within the Corporate LAN

The integration of voice and data in the corporate LAN is accompanied by a novice‡ concept of the PBX: a software-based PBX. Since the software PBX is actually an application in the LAN it is referred to as the *LAN PBX*. Depending on the underlying LAN technology, the LAN PBX can be either an Ethernet or an ATM LAN PBX. The existing ATM LAN PBX products, and their diverse configurations are examined in the following paragraphs.

Pure ATM to the desktop configuration

The most obvious case of ATM in the LAN is handsets or common analogue telephones connected to ATM-compatible-PCs. The functions of the traditional PBX are performed in the gatekeeper of the network server. Both data and voice are transmitted over the same wires, and switched by the ATM switch. Call management is coordinated by a server attached to the ATM LAN.

This is the only 'pure CTI', that expands all the way from the user desktop to the WAN backbone. The user can 'process' his/her telephone calls through the PC monitor. CTI permits integration of electronic mail, voice mail, intranet messaging and fax. The user can maintain only one address book for all his communications. Call forwarding is as simple as a drag and drop action. Call redirection can be done without even answering the call. The caller's identification (caller ID) is presented on the screen. A call history of all the incoming and outgoing calls with call durations is accessible by the user. Recent calls can be returned with a simple 'click' on the screen.

The ATM LAN PBX—CTI only from a user perspective

In the previous case, the user can still have the benefits of a CTI interface, if each analogue telephone is connected logically with a PC from the existing data network (ATM or other). The user has still a telephone and a PC on his/her desk, but he/she monitors his/her telephone calls on the desktop.

Here, voice is transmitted over a separate network from data, but the PBX functions run on the data LAN so the user can access it from his/her desktop. Traditional telephone wiring is used for transmitting voice and the networking wiring is used for transmitting data, so there are two wires drawn to the desktop. This implementation gives the impression of CTI from a user perspective. It lets users control telephony from the desktop via standard customisable applications.

The Diverse ATM Voice-Network Configuration Scenarios

Based on the preceding analysis of the newest ATM products, the diverse ATM voice-network configuration scenarios are examined in order to draw a few preliminary conclusions.

The traditional voice network (non ATM)

Before we jump into the ATM scenarios, we will take one more look at the traditional corporate voice network. Currently, most corporate PBXs are interconnected either through the public telephone lines, or by direct private lines; that is, pulse-code modulation (PCM) 64 kbit/s voice channels in both cases. In the public network a call is originated by the caller's local exchange carrier (LEC), transmitted by an interexchange carrier (IEC), and terminated by the receiver's LEC.

In the ATM world, there are three alternative configurations according to the existing ATM product options:

† The conclusions cited here are derived from discussions with the Lucent and Cisco representatives listed in the acknowledgements.

* AT&T offers currently SVCs, while Sprint and MCI have announced that they will offer in the third quarter of 1998.

‡ Contrasted with the traditional hardware-based PBX.

- PBX-to-PBX interconnection through a gateway (*hop on/off*),
- PBX-to-PBX direct interconnection, and
- PC-to-telephone interconnection.

We will attempt to analyse each one and draw conclusions for both the carriers and the corporate users.

The hop on/hop off configuration

In order to introduce ATM at the public voice backbone, gateways are required to convert PCM voice to ATM-cell streams. Gateways are owned by the carrier. The choice of technology used at the public backbone is transparent to the corporate user. Therefore, the carrier assumes any benefits from the economics of the network.

So far, we have not seen any carrier implementing such a solution. Given though that some carriers are just building their ATM backbones for data services, maybe voice will eventually follow, but it would certainly not happen soon. Furthermore, the public ATM switches for voice are also just appearing; cost savings can happen mainly by implementing VBR/SVC voice, which is new.

In the case of private networks, company-owned ATM gateways (the 'new' ATM enterprise switches) are replacing the public gateways, interconnected and private ATM links.

This configuration may present a window of economic opportunity depending on the prices of the ATM connections and the economics of the SVCs networks. In case the economics are beneficial, we should expect a situation similar to the one we are currently experiencing in the IP-telephony arena with the example of Qwest, where a private IP-based network offers long-distance telephony at half prices.

It is interesting to note that ATM is not currently considered as an *enhanced service*, as IP is, so there are no savings incurred because we avoid the access charges. It seems that there is a regulatory bias that favours IP against ATM. Therefore, the savings incurred in the above scenario might not be comparable to that of the IP equivalent. In the case that an alternative carrier implements an ATM gateway, the carrier still has to pay the access charges, whenever LECs are not bypassed.

Moreover, ATM products are just appearing in the market while the equivalent IP gateways have been around for quite some time.

PBX-to-PBX direct interconnection

A private voice corporate network can be realised by the ATM-compatible PBXs interconnected by ATM private lines. This network is similar to the previous ones. Its implementation might be a more economically beneficial solution given the existing corporate network infrastructure, size, and needs, and the prices of the different products. (Upgrading PBXs to support ATM might be less costly than buying gateways.)

The cost-savings here derive also from the eventual data and voice consolidation and the efficient allocation of bandwidth since voice is switched directly to the destination PBX, and voice is compressed and decompressed once.

PC-to-telephone direct connection

In this area, IP has undoubtfully won the market so far with wide deployment in the corporate LANs. A significant reason is that the H.323 'PC-to-gateway' standard was quickly defined, while the equivalent AAL2 is still being progressed.

The Economics of Voice over ATM

To draw some conclusions over the economics of voice over ATM, we have to look at the prices offered by the different carriers. A simple exercise provides us with some observations.

Pricing seems to be varying greatly from one carrier to the other. However, in most cases, ATM-connections pricing consists of three parts:

- *Access charges.* The access charges depend on the geographic area of initialization and termination of the call.
- *ATM port charges.* An estimation of ATM the port charges component on the voice_call_minute gives us: $0·001 voice_call_minute†. Assuming an average port cost of $6000 for a DS3 port, a 7:1 peak-to-average usage rate, and 1800 simultaneous calls per port at the peak hour.
- *The usage charges.* Here, pricing schemes are very different per carrier*:

  —Sprint's PVC/VBR connections are priced per megacell of usage. Assuming Sprint services, with ATM PVC/VBR connections we have usage component $0·0036 voice_call_minute‡; assuming an average of 19 kbit/s for a voice channel, after voice compression and silence suppression. Therefore, the total will be $0·0046 voice_call_minute.

  —AT&T's SVC/VBR pricing is usage-sensitive (on a per minute basis), depending on the sustained cell rate. Assuming AT&T's rate for 16 kbit/s SVC/VBR, the voice_call_minute is $0·01. Therefore, the total will be $0·011 voice_call_minute.

  —AT&T's PVC/VBR rates are fixed priced. The equivalent of a 16 kbit/s SVC** is the PVC that has 38 cells/s sustained cell rate. It is priced $29/mon, which is translated to $0·005 voice_call_minute for a 7:1 peak to average ratio. The total is $0·006 voice_call_minute.

In all three cases, usage costs are substantially lower than the market prices offered currently by the carriers§. In order to be able to make any comparisons, access charges should also be included††. Additionally, we should also have in mind that the prices proposed by the carriers do not necessarily reflect their costs. Therefore, they are prone to changes according to the existing market situation.

It is hard, though, to draw conclusions for the differences in costs that ATM SVCs vs ATM PVCs will incur. However, we observe that:

- The fact that just a few carriers are currently offering SVCs demonstrates that their prices are

† Reference 7.

* The sources for the prices are the AT&T and Sprint representatives listed in the references.

‡ Sprint rates are $0·70/megacell. So, $0·7/megacell × 2689cells/min = $0·0018/min.

** We assumed 16 kbit/s in the previous calculations of AT&T SVC/VBR prices.

§ Granted the large discounts that carriers offer to high volume customers, the current prices for VPNs are under $0·04/min, net of access charges, for a large company. (Source: Fred Goldstein. Posted in the <telecomreg@relay.doit> bboard, 7 May, 1998.) Federal government, which is the largest customer by magnitude of 10, is charged $0·015 voice_call_minute, net of local access charges, under the FTS contract. (Source: Frank Ferrande, presentation at the Kent Law School Symposium on Network Convergence.) Resellers are charged $0·02/min. (Source: Fred Goldstein. Posted in the the <telecomreg@relay.doit> bboard, 7 May, 1998.)

†† They depend on the local carrier of each geographic region.

to be determined in the future according the market demand.

- The existing pricing of SVCs from AT&T does not really favour it against PVCs.
- However, in comparing the economics of SVCs vs PVCs, we should take into account that the low costs of SVCs are virtually for any connection to any of the nodes connected to our ATM network. If it is the public network, the connection possibilities are numerous.

Conclusions

Following the evolution of corporate networks, the examination of ATM's capabilities and shortfalls, and the market overview of the newest ATM product solutions for the corporate network, there are only a few preliminary conclusions.

Technologically, ATM can be the right solution for voice and data consolidation, given its ability to accommodate diverse traffic with guaranteed quality of service for each traffic type. This is especially important for the delay-sensitive voice traffic. What will, though, determine the technology of choice for the integrated multi-traffic corporate network is its economics.

ATM is currently one of the many choices for the transport of data in the corporate WAN and it is estimated to increase its market share in the near future.

Within the corporate LAN, ATM does not seem to have a lot of chance. The fact that there are only a very few ATM product solutions offered in this category, underlines that assumption. IP's dominance in this area, suggests that probably ATM might make sense as the infrastructure for IP. Alternatively, ATM can have a future, here, simply as the tail of an all-ATM network, in an all-ATM world.

In the corporate WAN, news is more optimistic. This is the area where substantial economic gains can be achieved through voice and data consolidation. Vendors are just coming up with a series of new products, offering the latest voice adaptation techniques that benefit from ATM's inherent ability for bandwidth efficiency.

So overall, the technology seems to be mature. What about the market? Our survey revealed that the market response to the voice and data consolidation is rather slow. Vendors are just shipping the new products, the carriers are not yet offering the services that might support the largest economic gains, and clients are typically reluctant to accept the 'new'. Additionally, administrative issues concerning the traditional lack of communication between the corporate telecommunication and data departments seems to hinder further any efforts towards the integration.

In total, the parameters that can determine ATM's positioning in the future integrated corporate network, are: the pricing of the ATM services offered by the carriers, the regulatory decisions in terms of the access charges, the right timing for the definition of the ATM standards, and its integration with the current technologies in place.

In the case that all these parameter act favourably for the ATM economics, there will be a window of economic opportunity similar to the one we are experiencing now for IP: voice traffic transported over data networks for just a small portion of the current market price.

It seems that the ATM future is still to be determined, but it is definitely worthwhile watching it!

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Biography

Ekaterini (Elina) Nikaki

Ekaterini (Elina) Nikaki was born in 1972, in Athens. She graduated from the National Technical University of Athens, Greece, in 1995, with a degree in Electrical and Computer Engineering. She completed her graduate studies in Carnegie Mellon University, Pittsburgh, USA, in 1998, with a master's degree in Information Networking. Her work experience includes a variety of projects in telecommunications and systems integration. In summer 1993, she worked for Siemens, Munich, on the proposal for a mobile telecommunications system. She participated, in 1995, under the framework of her thesis, in the design and development of a geographic information system for the network of the Telecommunications Organization of Greece. She was a six-months trainee in the Statistical Office of the European Union, in Luxembourg, in the fall of 1995, where she was involved in a study of the statistical multimedia applications. In summer 1996, she designed and implemented a projects'portfolio database for Intrasoft, SA, Greece. She worked for US West, Colorado, USA, in summer 1997, in the strategic evaluation of the company's residential networks. In September 1998, she will join the Networking Group of Deloitte and Touche Consulting Group in New York.

Claire Ahern

The Euro Side of ATM—A Business Case!

Implementing a ubiquitous asynchronous transfer mode (ATM) network depends on the successful migration of voice services. An evolutionary process is discussed in this paper taking into consideration the established and capital intensive time-division multiplex (TDM) network. The stages outlined are evaluated from a business and operating perspective and enable the operator to build up voice traffic on the ATM core in a structured way utilising installed and new infrastructure to the maximum and obtaining immediate returns on investment.

Introduction

The telecommunications industry is a huge market and poised to become a US$1 trillion industry in 1998. As an industry it is ranked third in the world after banking and healthcare in terms of market capitalisation, and telecommunications service companies rank seventh in total revenues among the top 500 companies in the world[1]. Growth will continue with 43 million potential customers on official waiting lists and millions more waiting to be listed worldwide.

The beginning of 1998 brought a new set of operating parameters to European communications operators. In most countries telecommunication services are now deregulated and open to competition. However, not only are the operators faced with challenges and opportunities from competition, they are also faced with challenges and opportunities in technology deployment coupled with a shift in business drivers for service deployment.

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Attracting customers will focus operators on differentiation from competitors and this will be in the types of services offered, quality of service and price. Deployment of services will be crucial in both time to market and time to customer. One of the major shifts in planning is that customers, both business and residential, will demand and expect to receive large amounts of bandwidth. Networks will have to be planned to expect and cope with the increase in the volumes of traffic, have the ability to deploy new services quickly and be future proofed. Operators that invest now in efficient, scaleable network infrastructure will be best positioned for the future. Having a network in place today will also enable those operators to roll out services to the early adopters. Ensuring that early service adoption benefits the end user will generate positive publicity for the operator and therefore build brand awareness.

Voice traffic is core telecommunications business and accounts for over 90% of revenues for public telecommunications operators, and rides on an established network. Data has already overtaken voice in terms of traffic volume in the US and across the Atlantic and Pacific Oceans and is being carried on a variety of networks, Internet protocol (IP), frame relay, ATM etc. Consolidating these overlay networks and running all services over one backbone will result in substantial savings. As data traffic increases it will become increasingly apparent and necessary that voice must migrate to the data network.

Survival of the Leanest

Competition in Europe will result in an increase in the number and type of operators in the marketplace. All operators will want to maximise profits, reduce time to market for services, be in a position to offer new services and to differentiate their operations so as to attract targeted customers.

Large established telecommunication operators will have to rationalise their organisations and networks to gain the operational efficiency that newer operators have (as a consequence of deploying the latest technology in their networks and concentrating on particular markets). Their advantage is that they have networks that cover their country of operation, which is a valuable asset, but this could also be a hindrance as they will be required to lease interconnect capacity to new entrants, their competitors.

Encouraging the widespread adoption of ATM will benefit all operators as it reduces operational overhead, and is more efficient in terms of bandwidth and provisioning, but will also benefit interconnect arrangements and subsequently quality of service to customers as delay introduced as a result of multiple TDM/ATM conversions will be avoided. ATM networks will also serve as the foundation of third-generation mobile networks and so would make ATM the common technology between access and core networks for this service.

One For All and All For One

To date ATM is the only technology that can facilitate high-speed, resilient, standards-based backbone networks which are capable of scaling up and supporting future services with quality of service guaranteed.

Benefits of ATM include:

- *Statistical multiplexing* When a connection is not sending cells at the full rate the unused bandwidth can be used by other connections running over the same link.

- *Flexible bandwidth* Granularity, ATM connections can be from a few kilobits per second to hundreds of megabits per second which is more flexible than that offered by synchronous digital hierarchy (SDH) and TDM-based networks.
- *Dynamic connections* ATM signalling enables switched as well as management configured connections and also facilitates dynamic bandwidth provisioning in the event of network failure, assuming that the fibre and transmission capacity are available.
- *Asymmetric connections* Uplink and downlink bandwidth do not have to be equal.
- *Flexible mesh* Connections are set up with desired bandwidth enabling many destinations to be reached depending on total bandwidth available.

Subscribers can access communication networks and services using a variety of protocols for data and voice traffic, including the public switched telephone network, and are driving the demand for bandwidth. ATM is the only technology that can transport all protocols and traffic types, enabling network consolidation as illustrated in Figure 1.

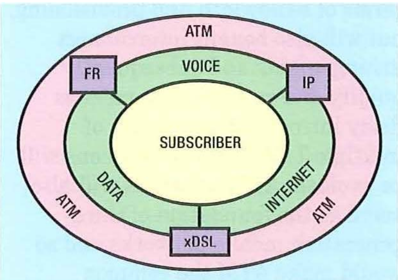


Figure 1—ATM provides ubiquitous transport

Networks Today

The extensive core TDM network is a hierarchical structure dimensioned, in 2 Mbit/s increments, to accommodate peak traffic volumes and over-dimensioned to allow for traffic surges. Resiliency is achieved by provisioning redundant equivalent bandwidth links in a mesh which is another significant contributor to cost and inefficiency. Traffic is lost if demand exceeds supply as provisioning additional trunks cannot be done dynamically. Building overlay networks for different services is bandwidth inefficient and expensive in cost, footprint and operation.

Tomorrow?

By consolidating voice and data services onto a single ATM network which is built for average traffic throughput using statistical multiplexing, carriers' costs could reduce by an order of magnitude[2]. Installing a core ATM network radically changes the planning paradigm which should be flexible to accommodate different physical and logical network designs and varying traffic parameters. Profit growth is the goal, it has a large influence on share price, hence the value of the company, and should fund the investment necessary for the network to grow and evolve. Given that the network absorbs most of the capital and operating costs and provides most of the services and hence revenue, it has a dominant impact on company profit. Network planning must therefore be aimed at maximising short- and long-term profit and competitiveness rather than the traditional objectives of cost optimisation. The capital intensive network infrastructure when installed is difficult and expensive to change[3].

Issues for consideration are:

- deployment phases, when and where to modernise;
- interconnecting, interworking and interoperability with legacy equipment;
- standards supported;
- network redundancy and resiliency;
- traffic mixing and forecasting;
- pricing;
- growth and churn in both the TDM and ATM networks;
- incremental growth and route planning; and
- signalling, PNNI, SS7/B-ISUP: PNNI is self configuring and offers automatic routing around failed links, SS7 requires manual configuration.

Voice Migration—Staged

The recommended approach for operators is to move in clearly defined stages towards the final goal of fully integrating narrowband voice and ISDN networks with broadband ATM networks. Two methods will be used for interworking narrowband traffic into an ATM network. In the beginning it will be predominantly network interworking, where narrowband services and signalling are transported transparently through the ATM network. As standards, equipment and management systems evolve service interworking will be deployed which involves the mapping of narrowband services and signalling into a native ATM environment.

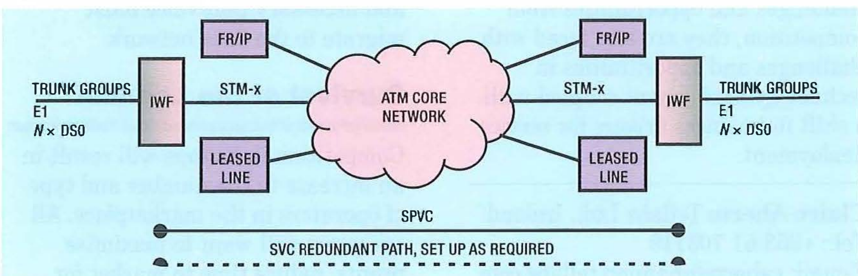
Operators have invested heavily in the installed PSTN and not only must this investment be protected but voice over ATM must also ensure that quality and reliability is maintained, all network elements guarantee QoS, that there is seamless interworking between the legacy and ATM networks and finally support of narrowband to broadband interworking[4].

Operators are investing in ATM networks, primarily for transport of frame relay and IP traffic. High-speed interfaces on ATM equipment mean that network upgrades are at STM-1 or higher, and generally traffic growth does not match these increments. Provisioning of leased-line services, while not optimising the ATM network, utilises this capacity, offering quicker return on investment and frees up capacity on the PSTN network, allowing short-term growth.

Stage 1: Migrating leased line services, CES (Figure 2)

In TDM networks provisioning of leased line services is inefficient as each network element must be

Figure 2—Migrating leased line services



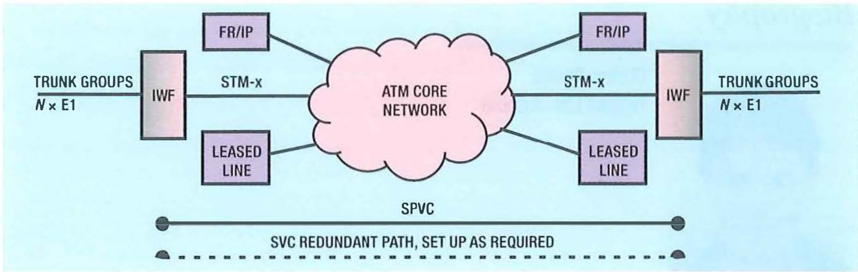


Figure 3 – Trunk group migration

provisioned individually and a comprehensive database of all internal connections within the network must be available to avoid duplication. Carriers have found cost reductions of greater than 50% for long-distance service when mixing leased line circuits with other services over a shared ATM backbone[2].

Leased line over ATM is established using permanent virtual circuits which are set up either by signalling or management control. SVC signalling is generated by the interworking function (IWF) that sets up a path through the ATM network and greatly reduces the complexity of configuring end-to-end service across an ATM core. Effectively the ATM core is being used as a virtual cross-connect and E1 or $N \times$ DS0 are carried as single ATM connections using AAL1. Fault management and performance monitoring is performed using ATM OAM cells.

Stage 2: Trunk group migration (Figure 3)

TDM backbone networks are typically configured using a mesh architecture for redundancy. Sizing of the trunk groups ($N \times$ E1) is complex and they are dimensioned for peak traffic, a significant contributor to bandwidth inefficiency. Also, each trunk group requires a signalling channel and setting up trunk groups and adding capacity is time inefficient.

Bandwidth savings are achieved using an ATM mesh consisting of virtual connections which can be dynamically sized and redundant paths that are also provisioned dynamically. Virtual connectivity is provided between every end point in the network and E1s are multiplexed into VPCs or VCCs. The E1s are mapped as CES, statistical gain is achieved if only active time-slots are sent. Control over the ATM connections is provided via management control of the IWF which in turn generates SVC signalling to control the core ATM switches.

Stage 3: Tandem switch migration (Figure 4)

The replacement of tandem switches in the network by ATM devices will overcome many of the shortcomings of TDM tandem switches such as low-speed interfaces (2 Mbit/s) and high cost per port. A client-server architecture is used where connection management and call processing are distinct. This gives operators increased control in terms of feature transparency and service implementation. It also provides transparency with narrowband switching services while at the same time allowing a smooth upgrade to an ATM switching/transport infrastructure.

The ATM tandem will provide higher speed interfaces to ATM switches. The call processing is performed by intelligent nodes, the local exchange, and connections are established by the ATM network.

Interworking Function

The interworking function is a logical function which communicates with peer IWFs on the ATM network edge and functionality depends on application. The logical and physical separation of switching from adaptation is beneficial as multiple adaptation devices can be rolled out depending on traffic and service. This architecture has many advantages in that the interface from the IWF to the switch is at high speed and so maximises the port utilisation and processing power on the switches.

Desirable features of the interworking function are:

- bulk termination of TDM traffic,
- redundant SDH interfaces at STM-1 or higher rates,
- echo cancellation capability,
- adaptation to ATM and aggregation of cells before presentation to an ATM switch,
- adaptation from ATM to TDM and allocation to time-slots,
- signalling support for dynamic services, and
- OSS interworking, EMS and NMS integration.

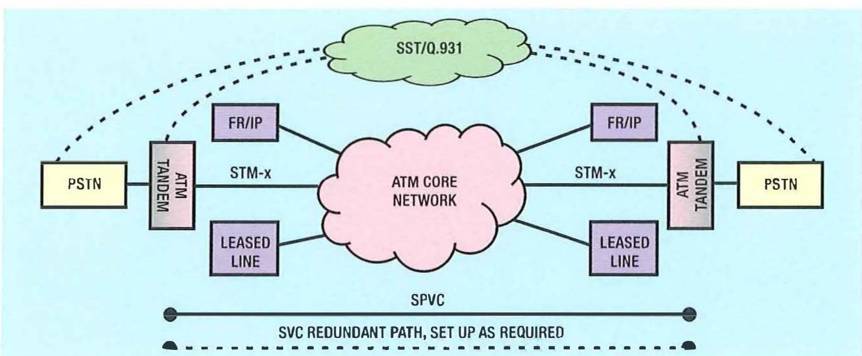
VoIP

Voice over IP (VoIP) could theoretically challenge voice over ATM in terms of network consolidation. However, issues such as quality and connection guarantees will limit the rollout of VoIP and it is unlikely that it will be used in the core or as a replacement for the PSTN.

Roll-out in Europe

Most European operators have installed ATM in their networks and they are using the capacity to serve as a unified backbone for other service networks such as Internet and Frame Relay traffic and native ATM services. The above staged path would enable them to maximise their investment and progressively increase the volume of traffic on the ATM core and continue to invest in a future-proofed architecture.

Figure 4 – ATM tandem switch



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Acknowledgements

Thanks to my colleagues in Tellabs and University College London, and in particular David Wells and Keith Ward, for their help.

Biography

Claire Ahern
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Claire Ahern graduated from UCL with a B.Eng. in Electrical and Electronic Engineering with Optoelectronics in 1994 and is currently completing an M.Sc. in Telecommunications, also at UCL. Initially she worked for Videotron planning transmission and switching networks and is now employed by Tellabs as a marketing engineer focusing on ATM.

Paul Excell

BT's Multi-Service Platform— The Customer Benefits

This paper discusses the benefits to customers and network operators of deploying a multi-service platform (MSP) to support existing and new data services. This paper covers the commercial and market drivers for an MSP, discussing the marketplace trends and growth of data services for applications such as local area network interconnect, World Wide Web, remote server access, e-mail and joint team working. The technical and operational aspects of an MSP are discussed.

The paper concludes by providing some practical deployment strategies for an MSP and discusses future trends for user services/applications and the technical options to meet these customer requirements.

Introduction

The desire to extend business/customer applications over the wide and/or metropolitan area, for business, research, entertainment etc. is fuelling enormous growth in data traffic. It is not a matter of **if** data traffic will outstrip voice traffic in today's telecommunications networks, it is a matter of **when**.

This paper discusses the service provider/network operator opportunities and engineering challenges from this enormous growth in data services/solutions (sometimes referred to as the *datawave*). In particular, the paper focuses on the benefits to customers of an integrated multi-service platform (MSP) capable of:

- supporting all existing data services/solutions/applications;
- bringing new services/solutions/applications to market very quickly; and
- growing the platform both cost-effectively and without service 'downtime'.

The paper covers the concept/drivers for an MSP, the MSP architecture, the MSP evolution and future plans and how customers benefit from an MSP.

MSP Drivers

We live in exciting times...... The technological revolution we are living through at present is probably greater than that caused by the introduction of the printing press or the industrial revolution in the last century.

Other trends back up the claim that our industry, and society in general, is undergoing a revolution ...

- globalisation of our industry (the Internet paradigm is not aware of national borders);
- the constant innovation and availability of new technology (Moore's law *et al*);
- merging of the telecommunications world (*Bell-heads*) and the IT world (*Net-heads*); and
- customers using data services/solutions for innovative and mission critical applications—to give them a business edge/lead in their own increasingly competitive, global marketplace.

Is this an exciting industry to work in? Absolutely!

We are already seeing early signs of the revolution. Many of us have more e-mail messages than telephone calls today. Few TV programmes or commercials end now without giving their Wew site address. School children have been brought up to communicate and search for information electronically. President Clinton and Prime Minister Blair have held question-and-answer sessions on the Web.

Everybody has their favourite statistics on the growth of the Internet, mine are:

- In 1992 there were 100 World Wide Web sites; now there are more than 200 000.
- The Web grows by 300 000 pages every day.
- Every 30 minutes another network is connected.
- The transaction value in the year 2000 is expected to be some $1 trillion.

Other customer applications driving MSP growth are:

- Internet protocol (IP) virtual private networks (*intranets*) and extending to customers/suppliers (*extranets*),
- file transfer and video streaming,
- data visualisation,
- videoconferencing,
- e-commerce, and
- e-mail + attachments.

'Market Driven'—MSP Design Objectives

In designing an MSP to meet customer needs, a number of requirements have to be taken into account:

- *Flexibility and scaleability*
  Forecasting data service growth and requirements is notoriously difficult so any technical solution has to be able to 'flex and scale' cost-effectively:

  —to meet actual customer demand, whether this is higher or lower than actual, to match investment to revenue generation; and

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–to reduce time to market for new features and services.

- *Existing multi-service support* BT offers a wide range of data services/solutions to meet customer needs:

  –IP (for example, IP (Layer 3) transport service, IP virtual private networks, etc.);
  –frame relay (FrameStream™);
  –cell relay (CellStream™) nationally, internationally and in metropolitan areas;
  –switched multi-megabit data services (SMDS), offering a connectionless service capability with virtual private network (VPN) and security features; and
  –private circuits.

  Note: Voice as an application can be supported by the MSP platform via the services above; for example, on CellStream using a constant bit rate (CBR) virtual path or virtual connection (VC).

- *New multi-service capabilities* An MSP must be designed to support existing data services (see above), but its underlying technology (network and systems) must be flexible to support 'new' applications or 'mixes' of applications as required by customers in any particular market segment; that is, the opportunity is there to 'customise' solutions to the specific customer requirement/market segment.
- *Residential and wholesale markets* An MSP must be designed to recognise the whole range of market sectors that represent an opportunity for MSP, including residential markets and wholesale customers.
- *'Telco' strength platform* The data world is very different to the telephony. There is an adage that data years are like 'dog' years; that is, each 'data' year is equal to seven normal years. Sometimes the pace seems a lot quicker than that!

  However, there are many lessons to learn from the engineering of plain old telephone service (POTS) networks. Some key strengths of existing telephony networks are:

  –**resilience** (I am writing this paper during a power cut and my computer has 'hung' up 2–3 times. On the other hand I have been able to download information and e-mail over the POTS network during the power cut and phone business contacts, friends and family!
  –**scaleability** (millions/billions of customers are served on the global POTS network); and
  –**ubiquity** (direct dial is possible to virtually every country—I have been able to e-mail and use the Internet in every country I have visited or worked in across the globe).

  Data services are already used to support mission critical business applications and this trend is set to continue. Furthermore, data services are intolerant to information loss, even if non real-time services are tolerant to some delay.

  So while an MSP must be designed with the flexibility to allow new and exciting applications to be introduced very quickly, the MSP must also be designed, specified and built:

  –to the 'bedrock' objective of minimum customer-service downtime; and
  –to allow high volume, residential and global markets (via gateways) to be addressed.

MSP Architecture

Traditionally each data service has been supported on a separate platform (*platform* equates to network and operational management systems and processes) focused on delivering the detail of that particular service. Each data service platform would typically have its own separate operational centre, management systems and processes and normally use different vendor's equipment (see Figure 1).

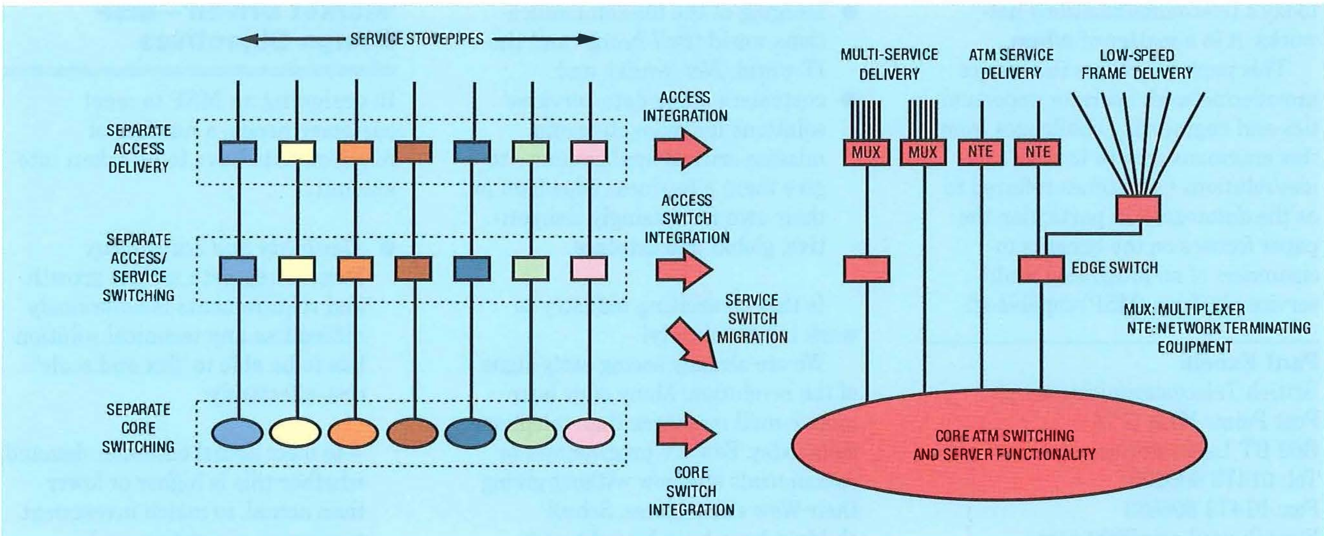
While data services were serving low volume niche markets, this was probably an acceptable, arguably optimum, approach. However, this 'stovepipe' approach does meet the market-driven design criteria outlined earlier in the paper

In order to deliver a platform solution that meets the needs of the market, BT has designed and deployed an MSP as illustrated in Figures 1 and 2.

The main components of the BT MSP platform are a two-tiered switch architecture and associated support systems:

- *Core node*: A large, scaleable high-capacity asynchronous transfer mode (ATM) switch to 'trunk' traffic capable of scaling from ~40 Gbit/s to 500 Gbit/s and

Figure 1—Multi-service platform integration and migration vision



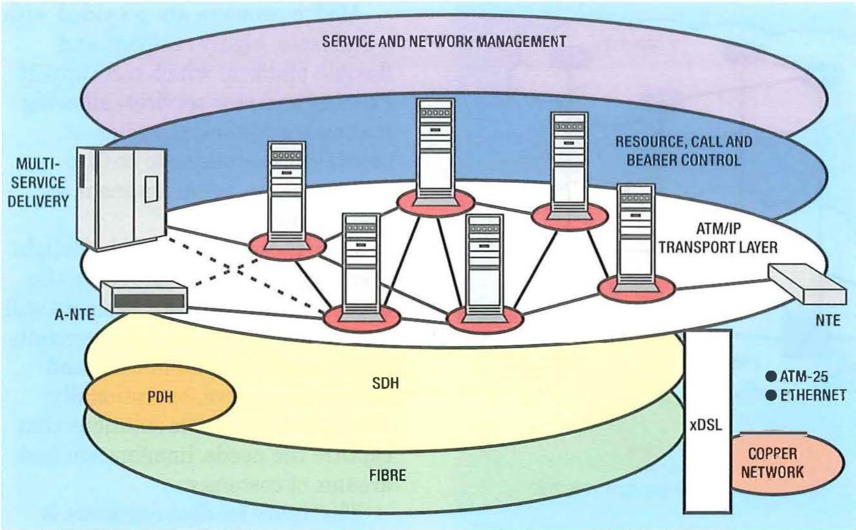


Figure 2—BT's multi-service platform—not showing dial access

above. Core routing equipment will also be part of the core node.

Note: An industry debate has been raging over the merits of IP and ATM as a multi-service technology. This debate has concluded that ATM does provide a universal Layer 2 capability and equipment/standards allow large, cost-effective ATM platforms to be built today. Given IP is likely to be the dominant (data transport) service in the future, a key part of the MSP evolution discussed later in this paper is the volume support of IP in the future.

- *Access node*: A multi-service edge switch at key points of presence (PoP) across the UK. The edge switch provides:

  —all the service interfaces (see below);
  —ATM service adaptation (for example, mapping to an ATM virtual path (VP) or virtual channels (VCs);
  —grooming and consolidation; and
  —local/metro switching if necessary/required.

  Each edge switch is dual-parented back to two core nodes for network resilience.

  'Edge' routing equipment is being considered as part of the MSP future evolution (see Figure 3).

- *Customer-located equipment*: Depending on the requirements of the customer/customer's sites (now and in the future) this can be:

  —ATM-network terminating equipment (A-NTE) to manage the ATM flows on an end-to-end basis;
  —multi-service access solution (MAS)—a multi-service multiplexer providing managed multi-service delivery; and
  —small edge switch.

  Typical customer interfaces provided, or that are under consideration, include:

  —ATM user network interface at 2, 34, 155 Mbit/s;
  —frame relay at $n \times 64$ kbit/s up to 2 Mbit/s;
  —SMDS access capability (data exchange interface (DXI));
  —circuit emulation at $n \times 64$ kbit/s up to 2 Mbit/s;
  —IP at $n \times 64$ kbit/s and 2–34 Mbit/s; and
  —high-level data link control (HDLC) emulation to support frame forwarding.

- *Operational support systems*: The MSP plan includes scaleable management systems to allow:

  —volume automation of the operational processes (to plan, provide and operate services and networks);
  —services to be managed on an end-to-end basis; and
  —customers to move/add/mix further capabilities to their service contract in a managed way.

- *Control plane*: This allows the provision of switched services and resilience for services using switched permanent virtual channels (S-PVCs).
- *Core transport*: This is provided by resilient synchronous digital hierarchy (SDH) links at 155 Mbit/s with evolution to 622 Mbit/s and >2·4 Gbit/s planned.
- *Access transport*: The access network is a key cost and quality component for the MSP. In order to deliver services to a range of different customer sites (in terms of size/bandwidth) the proposal is to use:

  —**broadband access** for the largest sites using SDH or ATM over fibre;
  —**wideband access** for the medium/small sites using SDH and/or digital subscriber loop (DSL) technology; and
  —**narrowband access** for the small or remote sites using dial up or other techniques on copper (narrowband refers to up to 64 kbit/s 'calls', primarily public switched telephony network (PSTN) and integrated switched digital network (ISDN)).

Resilience

As resilience is a key requirement for customers, complementary resilience mechanisms have been built into the SDH transport layer (line system and multiplex protection) and ATM layers.

Roll-out

The plan is to have over 100 points of presence (PoPs) in place across the UK by the March 1999 and over 200 PoPs in place by March 2000. This means that 98% of business customers will be within 15 km of a BT PoP by the turn of the century.

MSP Evolution

Most forecasts are showing a dramatic growth in IP traffic, so the key design issue is how can IP traffic be carried in a managed way at best value for money, including quality of service options, both today and in the future?

ATM is a proven multi-service technology which can be used to transport all forms of traffic—IP, SMDS, frame relay, cell relay and real-time services. ATM is used in the core and access of the MSP offering service today.

In the future, it may be that IP technology (for example, high-speed routers) would make direct optical links within the core of the MSP, rather than going via an ATM layer (see Figure 3). ATM investment can continue to be re-used in the access/inner core, where grooming/management of services/traffic and multi-service support are key requirements.

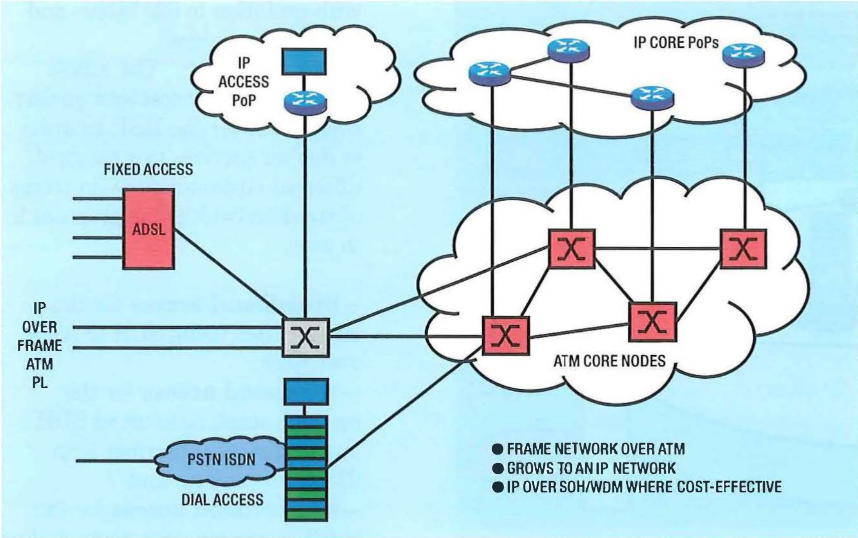


Figure 3—Possible MSP evolution

Other technology/service options being investigated for the MSP are:

- voice support (voice = data application), voice on IP (VoIP);
- optical-domain transport techniques (WDM/DWDM);
- IP QoS and multicast, leased line support;
- volume support of IP—multiprotocol;
- offload of data calls from the narrowband network;
- narrowband-to-broadband interworking;
- applications; for example, directory enabled services; and
- intelligent networking/services.

The vision is to provide customers a total solution right out to the desktop/home, including mobile access, mobility, Internet access, intranets, extranets, narrowband access/services, wideband/broadband access, narrowband/broadband service interworking and intelligent services/capabilities (see Figure 4).

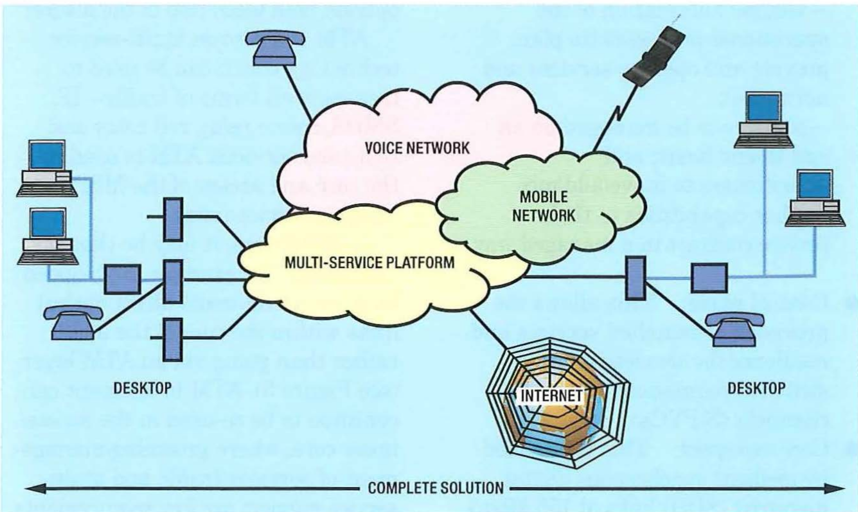
Conclusions

Our industry is taking part in a major and exciting revolution in technology and service provision which will radically change the world in which we live.

New applications, enabled by technological advances, are driving the need for a huge increase in the volume and range of services to offered by network operators—the datawave.

To meet customer demand for data, BT is deploying a scaleable and flexible MSP across the UK based on a two-tiered switching architecture. The MSP supports today's services of IP, cell relay and frame relay but has been designed to allow a smooth migration to an IP-dominant network with access to residential, business, wholesale and mobile customers.

Figure 4—BT's total MSP solution—voice, data, mobile



MSP customers are provided with a scaleable, highly resilient and flexible platform which can support existing and new services, allowing managed addition/migration of capabilities/solutions to ensure customers can be pre-eminent in their own markets.

Only those operators who delight their customers will survive in the new order. Delighting customers will largely depend on how commercially aware engineers can market and deliver innovative, operationally sound, and profitable solutions that capture the needs, imagination and dreams of customers.

The future for data engineers is challenging and competitive but will be tremendously exciting and rewarding.

Acknowledgement

The author acknowledges the work of colleagues in the BT MSP Programme, Broadband and Data and Market Driven Network teams, who have contributed to this paper.

Biography

Paul Excell
British Telecommunications plc

Paul Excell is Programme Director for BT's multi-service platform (MSP)—a key business initiative (£300M+ investment programme) to meet customer demand for new and existing data services (for example, IP, frame relay, cell relay). He started his career with BT in 1978. He has worked on submarine systems, satellite systems, echo control, LAN design, SDH and international performance standards. Before becoming Programme Director for the MSP, he succesfully launched the CellStream (ATM service) and the switched multi-megabit data services (SMDS) in the UK and internationally. He graduated with a B.Sc. (Hons.) in Electronic Engineering from the University of York in 1985. He gained a Masters of Science degree in Telecommunications and Information Systems from the University of Essex in 1990. In 1997, he was a finalist for the Hanson/*Sunday Telegraph* management award for his work on launching CellStream and the MSP design/vision. He is a Chartered Engineer and a Member of the Institution of Electrical Engineers.

Sean Abraham

Technology for the Fixed Access Network

The market in which telecommunications companies operate is increasingly competitive, deregulated and volatile. As the information revolution continues, customers will demand more services, higher bandwidth, better quality and lower charges. New broadband services, such as high-speed Internet access, telecommuting and video-on-demand (VOD), will require the upgrade of the local network, using technology-based solutions over copper and/or fibre. Technologies such as SDH, ADSL, VDSL and PONs will dramatically change the final link to the customer, while maximising the use of existing copper plant. Already newer entrants to telecommunications are using SDH/FAS solutions to compete for both the residential and business segments of the market. Partly in response to this competition, but also because of the inherent advantages of such solutions, existing telcos are deploying similar self-healing SDH rings to serve large businesses and business parks. However, deployment of broadband access in the local network will only occur when it is economically feasible to do so. Broadband access networks must offer existing services at the same price to the customer, and new services at an acceptable price. Currently, high-speed Internet access is seen as one of the main customer requirements for broadband access. Such a service is indicative of most interactive multimedia services to the home, as it is asymmetric in nature, requiring a large downstream channel (1.5–9 Mbit/s) with a smaller upstream channel (16–640 kbit/s). As it is unlikely that mass deployment of fibre-to-the-home (FTTH) will take place in the near future, xDSL will be an essential technology for mass deployment of broadband services in the next few years. Initially these services can be delivered directly over copper, using asymmetric digital subscriber line (ADSL). It is envisaged that a cost-effective combined optical distribution network (ODN)—very-high bit rate digital subscriber line (VDSL) solution will be possible in the future. ODN solutions can be either point-to-point or point-to-multipoint. The latter solution, realised through a tree-and-branch passive optical network (PON), is predicted to enable cost-effective mass distribution of asymmetric broadband services.

SDH and FAS Solutions

The large EU telecommunications market, combined with deregulation and consequent competition, has accelerated the use of synchronous digital hierarchy (SDH) in the local network. In the UK, where the telecommunications market is already highly deregulated, new entrants have focused on both the business sector and the residential sector. Cable operators have made real progress in winning residential customers. Indeed, residential penetration rates can be ahead of those for cable television and churn rates are lower[1]. As the markets are deregulated in the rest of Europe, competition for this market segment can only grow.

Increasingly, telecommunications is becoming the lifeblood of business. Greater customer awareness, and increased expectations, has generated a demand for increased service availability. The business strategy of some new entrants has been to focus on large-to-medium size businesses, using competitive pricing and SDH as a state-of-the-art technology. They have entered the market early to establish a customer base and to develop the necessary infrastructure prior to full competition.

Using SDH, resilience to failure is ensured by the inbuilt protection mechanisms at the equipment, path, synchronisation and management levels. Existing telecommunication operators can also use SDH to face competition and ring fence customers by improving speed and quality of service, integrate service provision and increase synergy between the core transmission and access networks.

Possible SDH/FAS solution

Figure 1 depicts a possible SDH/FAS (flexible access system) solution. The ring is composed of STM 1 ADMs, which would ideally have a cost-effective STM 4 upgrade option. Full STM 4 ADMs are not currently suitable or necessary for deployment in the local network. The ADMs and/or FAS can be located in the customer communications room, the frame rooms of large buildings in the business or financial district, or a cabinet on the side of the road.

As SDH equipment is designed for an exchange environment, care must be taken when locating the equipment away from the exchange. In order to ensure availability, power and thermal management may be critical, particularly in an enclosed environment such as a cabinet.

For business applications, subnetwork connection protection (SNCP) will be enabled allowing 63 or 252 protected 2 Mbit/s paths (STM 1 or STM 4 operation). A self-healing ring only provides protection across the ring. Resilience can be further improved by passing the ring through two exchanges, and dual homing customer traffic. This would normally be a competitive advantage to existing telcos due to their larger installed base of switches.

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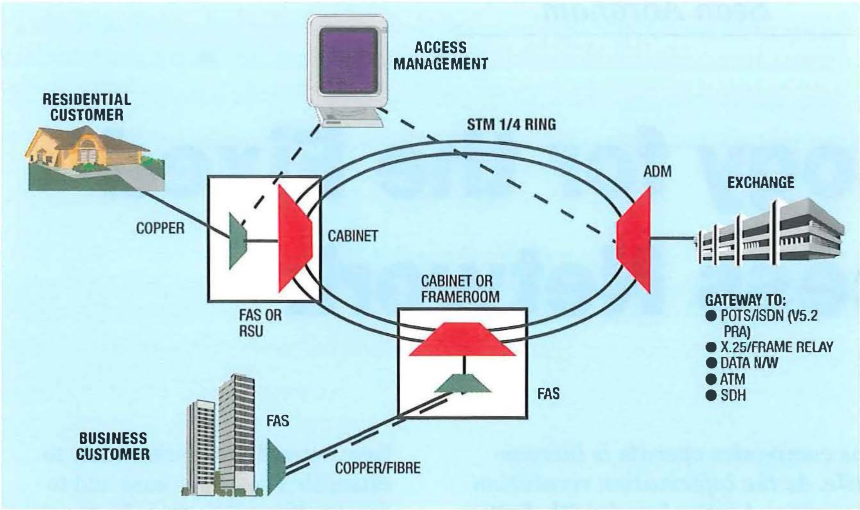


Figure 1—SDH/FAS solution for business and or residential markets

For residential applications (PSTN and ISDN), protection may be disabled to double the ring capacity and hence drop the cost per home passed. 3780 PSTN lines could be served on an unprotected STM 1 ring.

For a fully managed and flexible solution, the different components of the FAS equipment should be integrated at a mechanical, backplane and management level. The purpose of the FAS in this application is to:

- multiplex sub 2 Mbit/s services (PSTN, BRA, *N*× 64 kbit/s etc.);
- provide vendor interoperability between the FAS and the switch using a V 5.1 or V5.2 interface;
- connect the customer premises to the ADM using HDSL, 8 or 34 Mbit/s optical links, sub-STM 1 or STM 1 links; and
- allow optional protection between the customer connection and the ADM, if they are not collocated.

Network management and administration

An access network platform, managed end-to-end, would greatly increase network flexibility and service quality, while reducing operational overheads. This would require a fully integrated management solution for FAS and SDH equipment at both element and network management level.

In practice, FAS and SDH families of equipment from the one supplier will have evolved separately. While element and network management of SDH equipment is relatively mature at this stage, PDH/FAS legacy equipment may belong to several different equipment families which have only limited integration at the fault or element management level. The next generation of access equipment is moving towards full integration of FAS and SDH equipment.

Existing telcos will have to integrate the access network management system(s) with their existing core network management system(s). In a multi-vendor environment, this may not be fully realisable until TMN standards are complete. Management systems are primarily used for configuration, alarm and performance management of equipment. Hence, a separate administration system will be required to monitor resource utilisation (fibres, DDF, tributaries, capacity utilisation etc.) and to issue path provisioning information to the network management centre.

ADSL, VDSL and PONs

ADSL

Several enhancement technologies, collectively known as *xDSL* (digital subscriber line) have the potential to exploit the copper access network for the provision of broadband services. Asymmetric digital subscriber line (ADSL) is a modem technology that can provide up to 9 Mbit/s of bandwidth in the downstream direction from an exchange to a customer and up to 640 kbit/s in both directions over an existing telephone line. The technology allows simultaneous voice and data traffic over the same telephone line, and has been designed to make optimum use of the available bandwidth, by taking advantage of the asymmetric nature of interactive multimedia services (Figure 2).

Furthermore, Universal ADSL (ADSL lite or splitterless ADSL) was launched by the UADSL Working group (Microsoft, Intel, Compaq and telecommunication companies) to promote global acceptance of ADSL. It has reduced modem complexity at the expense of a lower maximum bit rate (1·5 Mbit/s). This bit rate is ideal for high-speed Internet access, as there is approximately 500 kbit/s throughput of traffic across the Web.

Future versions of Microsoft Windows will include Universal ADSL for ease of software setup. Another feature of UADSL is that no splitter is required in the customer premises, enabling simple plug and play.

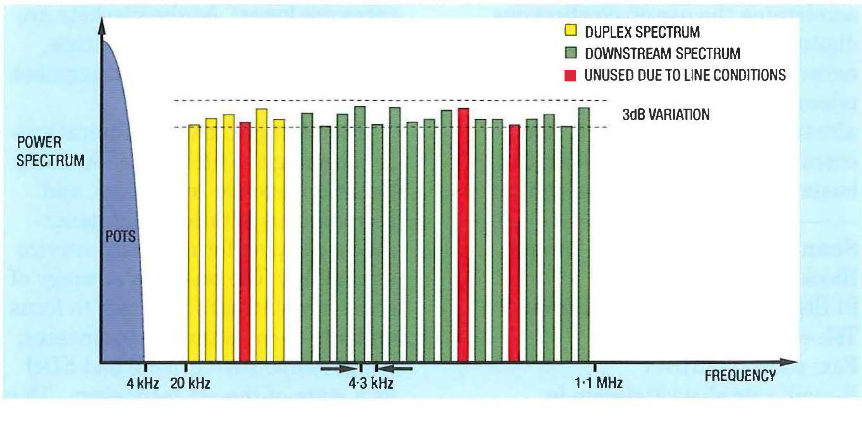
Typical broadband services available over ADSL are:

- high-speed Internet access,
- video-on-demand,
- switched video broadcast,
- telecommuting,
- videoconferencing,
- distance learning,
- telemedicine (X-rays etc.) and
- high-speed file transfer, etc.

The advantages of ADSL are:

- maximum use of existing copper plant,

Figure 2—DMT frequency spectrum for full ADSL



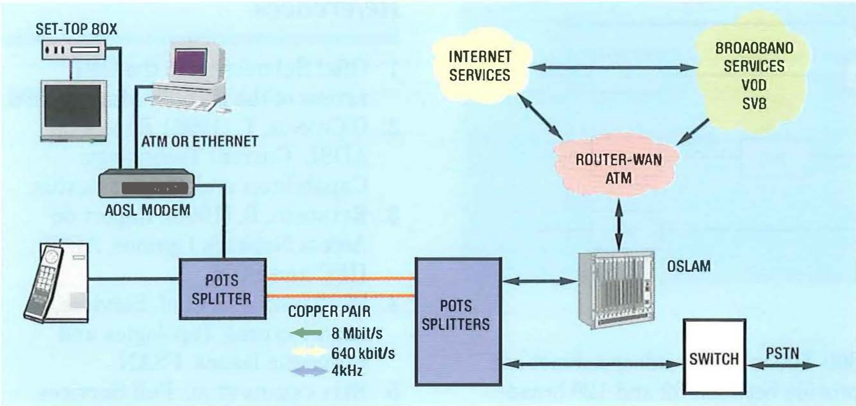


Figure 3 – Service provision over ADSL

- new revenue stream,
- frees switch from long sessions,
- always on line,
- asymmetric use matches requirements of interactive multimedia,
- telephone, PC and/or set-top box in use at same time, and
- more secure than cable modems.

How does ADSL work?

Discrete multitone (DMT) is the ADSL line standard adopted by ANSI and ETSI. DMT uses many narrowband carriers, all transmitting at once in parallel, and each sub channel can carry up to a maximum of 60 kbit/s, depending on line conditions. The available frequency spectrum is split into three information channels as follows:

- a high-speed downstream (to the customer) channel (1·5–9 Mbit/s)
- a medium-speed duplex (both directions) channel (16–640 kbit/s)
- a PSTN channel

Passive filters are used to separate the PSTN channel from the data channels, thus guaranteeing uninterrupted PSTN, even if the ADSL modem fails.

Figure 3 shows a typical ADSL implementation[2,3]. The customer equipment can be a PC or a set top box with an Ethernet or ATM access to an ADSL modem, which in turn connects to a single port on a digital subscriber line access multiplexor (DSLAM).

Most ADSL vendors are using the discrete multitone (DMT) standard with rate adaptation; that is, the ADSL modems automatically adapt their data rate according to the quality of the line. Installation is essentially plug and play, as the status of a single LED on the modem indicates correct or incorrect operation. The latest generation of DMT-based modems allows downstream/upstream rates to be programmed as fixed rates, in steps of 32 kbit/s. Furthermore, telecommunications operators and vendors have realised that a minimum of 1·5 Mbit/s downstream may be too high for commercial service. How do you tariff 1·5 Mbit/s to the home? Instead service bit rates, such as 384 kbit/s downstream and 64 kbit/s upstream could be offered.

DSLAM space and power requirements are currently too high and will need to be reduced before mass commercial roll out is possible. The DSLAM in the exchange can have:

- an Ethernet connection to a router, which in turn is connected to the traditional data network and over this to an Internet server (The disadvantage with this method is that there is no guaranteed quality of service (QOS). In this case the customer would only have an Ethernet connection.);

or

- A connection to the broadband ATM network. (This overcomes the QOS limitations in the traditional Ethernet access solution. In this case the customer would have an Ethernet and/or an ATM connection.)

The trend is for ADSL vendors to integrate ATM into their DSLAMs. In addition to QOS, the ATM solution has other advantages, such as:

- it can scale up to many users, which is not possible with traditional ADSL Ethernet solutions;
- the PPP protocol that ISPs use for authentication works over ATM, and is viewed as essential for the roll out of fast Internet; and
- it prepares the way for multimedia services, which require ATM signalling to work effectively.

Range of xDSL technologies

The downstream data rates depend on a number of factors, including the length of the copper line, its wire gauge, presence of bridged taps, and cross-coupled interference. Cross-coupled interference may be caused by several sources, such as other ADSL signals, HDSL, ISDN and PSTN signals or RFI in adjacent pairs within a cable. However, xDSL systems are designed to operate in the presence of pessimistic crosstalk noise; that is, real-world situations.

Table 1 Summary of xDSL Technologies over a Single Copper Pair (Source: NTC, October 1997)

Name	Meaning	Data Rate	Mode	Applications
SDSL	Single line digital subscriber line	2 × 2·048 Mbit/s Range: 3000 m	Duplex	Leased Line, ISDN, WAN, LAN access
ADSL	Asymmetric digital subscriber line	1·5–9 Mbit/s 16–640 kbit/s Range: 4800 m–2·048 Mbit/s 3600 m–6·312 Mbit/s 2700 m–8·448 Mbit/s	Downstream Upstream	Video- on-demand Internet access Remote LAN access Interactive Multimedia
VDSL	Very high data rate digital subscriber line	13–52 Mbit/s 1·6–2·3 Mbit/s Range: 1350 m–12·96 Mbit/s 900 m–25·82 Mbit/s 300 m–51·84 Mbit/s	Downstream Upstream	Same as ADSL plus symmetrical broadband services

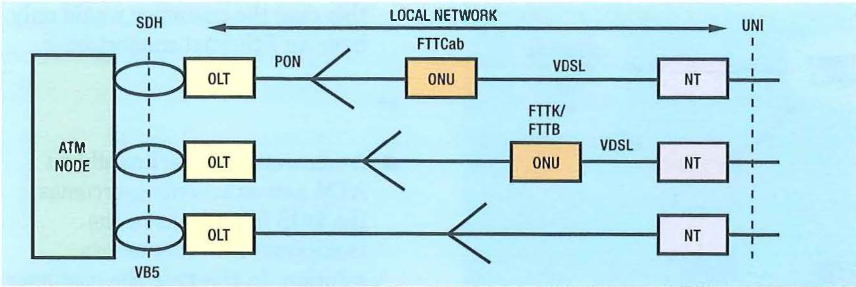


Figure 4–PON deployment scenarios

Passive Optical Networks

Work carried out by the full services access network (FSAN) operators and suppliers indicates a minimum set of specifications[4,5], which will allow PONs to meet a broad range of services and deployment scenarios. Such a network will enable the economic introduction of the following services:

- asymmetric broadband services (higher bit rates than ADSL), and
- symmetric broadband services (telecommunication services from 2 to at least 4x2 Mbit/s).

While not completely defined, a PON consists of a central optical line termination (OLT) serving a number of optical network units (ONU) via a passive tree-and-branch passive optical network (16–32 way split). The maximum possible distance between the OLT and ONU will be greater than 20 km (Figure 4).

As interactive broadband services are asymmetric, the line rates will typically be STM 4 (622 Mbit/s) downstream and STM 1 (155 Mbit/s) upstream. ATM is supported through a TDMA format, and traffic concentration is achieved with a dynamic bandwidth allocation scheme (VB5) controlled by the OLT. A medium access control mechanism ensures collisions are avoided in the upstream direction. The PON can extend as far as the cabinet (FTTCab), the kerb (FTTK), the building (FTTB) or the home (FTTH).

VDSL over existing copper pairs is seen as the likely transport mechanism for the final drop. VDSL[6], for which no firm standards exist yet, will use a less complicated modem technology, and run at higher line rates than ADSL. It should enable 6·5, 13 or 26 Mbit/s downstream and 2 Mbit/s upstream for a reach of 1–1·5 km, which should be sufficient for most residential and business customers. 13 and 26 Mbit/s symmetric transmission should be possible for 300–500 m. The outdoor cabinet can provide between 32 and 128 broadband accesses.

Conclusion

This paper has highlighted the advantages, applications and possible deployment scenarios for technology in the access network. All of these technologies are technically feasible, but customer demand, cost and competition will determine their implementation.

The demand for using SDH in the local network is apparent for both the residential and business market segments. New and existing telecommunication operators can make maximum competitive advantage of this managed and flexible technology, offering a premium quality of service to their customers for both narrowband and broadband services. This is particularly true for the medium-to-large business customer market.

ADSL will become available as a commercial service in many European countries this year. The main application will be high-speed Internet access, followed by teleworking. Universal ADSL will be a important catalyst for widespread awareness and implementation of ADSL technology. A very important issue will be the tariffs for this service, which will determine the take up for this service. Successful deployment of broadband services will require a significant upgrade of the core switching (ATM) and transmission (SDH) infrastructure.

FTTCab, FTTB and FTTH using PON/VDSL technology may enable economic mass deployment of broadband services. The exact timing of their implementation is hard to predict. Based on studies conducted by the FSAN group, the per line cost of producing a full service network will decrease with volume of production. Hence a critical mass, driven by broadband services and customer demand, will be required before such a solution is possible.

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Biography

Sean Abraham
Telecom Ireland

Sean Abraham was born in Dublin, Ireland in 1964. He joined Telecom Ireland (then PT&T) in 1982 as a trainee technician. Taking advantage of Telecom Ireland's engineering scholarship, he was awarded a B.Sc. Eng. from Trinity College, Dublin in 1992. He then entered the Technical Training Division, where he had responsibility for company-wide training on PDH and SDH systems, including three separate SDH network management systems. In 1997, he joined the Access Technology Division, which is charged with the implementation of technology in the access network. Sean has also lectured in the Dublin Institute of Technology since 1990.

Sandro Dionisi, Umberto Ferrero, Stefano Omiccioli and Adler Tofanelli

Development of a Full Service Access Network

Several concurrent drivers emerged during the last few years, stimulating the innovation of the access network. A mix of new services' demand, technical opportunities and regulatory changes has completely reshaped the telecommunication scenario. The paper outlines the rationale of the technical choices made by Telecom Italia to develop the full service network nationwide. The overall architecture description is complemented by the analysis of switched digital video services implementation and by the report of the first results of laboratory and field experiences.

Introduction

The access network is the part of the telecommunication infrastructure linking every single customer to the closest local exchange: traditionally dimensioned to deliver telephony, it now calls for a thorough upgrade to accommodate new midband and broadband services, exploiting the extensive range of available technologies. Telecom Italia has undertaken an innovative plan to upgrade the existing infrastructure.

During the last few years several network solutions have been trialled, and every single broadband access network implementation shows some specific advantages recommending its adoption under specific circumstances in terms of service acceptance, regulation and existing infrastructure[1]. Early implementation of broadband services offer the benefit of stimulating the acceptance of new communication media among customers.

Significant cost reduction, on the other hand, is achieved by the mass market of one (or few) solutions. Broadband passive optical networks (BPON), often referred to as *ATM PON*, have been identified as technology of choice for telecommunication operators some years ago, but only the increasing maturity of complementary technologies has stimulated coordinated actions to foster the development of this kind of system through comprehensive requirement specifications[2,3]. The development of FTTO architecture is oriented to business customers.

FTTx architectures support the effective implementation of both overlay, broadband only access networks, and full service network option. Market uncertainty and competitive pressure tend to favour overlay options for immediate roll-out, while strategic considerations give a key role to integrated platform following an appropriately phased and focused deployment.

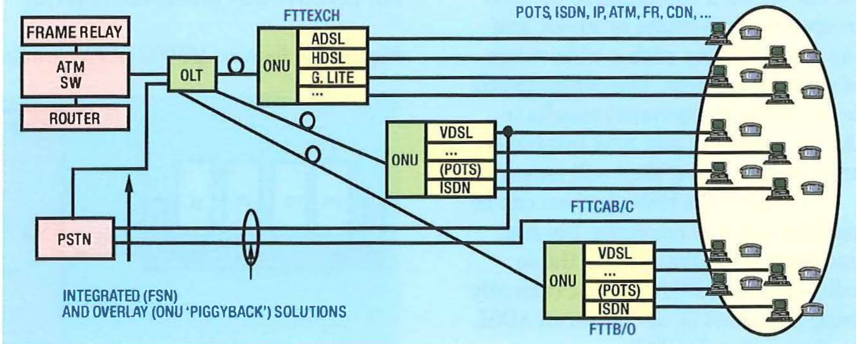
Flexibility of FTTx Architectures

Historically, the deployment of new telecommunications services has taken years of effort and large amounts of investment. Predicting market acceptance before taking the business risk is also a difficult task. FTTx systems offer suitable solutions to cope with the wide geographic diversity (urbanisation, customer density, etc.) and mix of service demand (type, expected growth, bandwidth, etc.). FTTx systems may be deployed as overlay networks, supporting new services only, or as real 'full service' platforms. The fibre penetration can be optimised to fulfil service and investment constraints, as depicted in Figure 1. The flexibility of the FTTx solution can also solve the problem of the fast provisioning of services, when they are required, thereby circumventing the uncertainties of market demand.

In the near future, strict efficiency and flexibility requirements will tend to favour integrated network solutions able to manage a wide range of services, both broadband (for example, broadcast video, on-line, IMM, native ATM) and narrowband (for example, POTS, ISDN, data, cordless mobility), for residential and professional/business customers.

All FTTx implementations offer the advantages of baseband optical transmission in the access network, allowing for the extension of the primary/feeder network and, therefore, the overall network rationalisation through node consolidation. The

Figure 1 – Flexibility of the FTTx solutions



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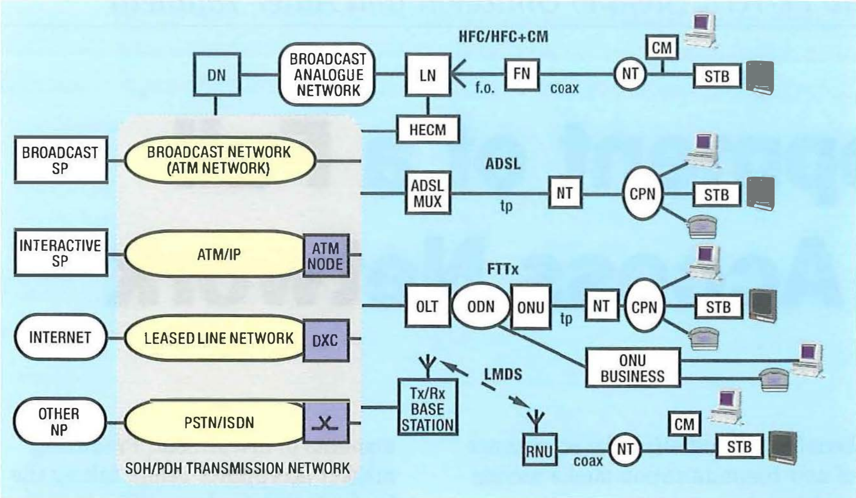


Figure 2—Overall network architecture

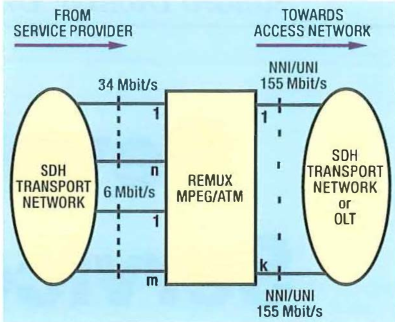


Figure 3—Remux MPEG/ATM interfaces

selection of alternative FTTx implementations will be influenced by several factors such as dwelling distribution, expected service penetration, quality of the existing copper network, together with the achievements of the permanent technical evolution.

The development of a full service network provides the platform able to support both the emerging midband applications (that is, few hundreds of kbit/s per user) as well as bandwidth intensive services like those required by business customers and broadcast video services.

Specification of the Full Service Network (FSN)

Telecom Italia elaborated detailed functional and technical specifications of the FSN, defining performance and characteristics of broadband access network equipment based on PON technology and FTTx configuration. The specifications rely on main international standardisation bodies such as the ITU-T and ETSI, industrial interest group like ATM and ADSL Forum, and the FSAN initiative.

One of the main challenges faced by the specification authors has been interoperability with alternative access network solutions, to be used in specific time-frame or areas, and the compatibility with a wide range of existing services. The commitment to the network openness results in the possibility to add new interfaces and services when they will emerge.

If required, the FSN platform can be complemented by emerging, low-cost, mid-band DSL solutions like the so called *consumer DSL* (CDSL), currently being addressed by the universal ADSL working group (UAWG).

Figure 2 shows the overall architecture of the targeted network, featuring legacy HFC, early ADSL multiplexer and FTTx systems together with wireless solutions for broadband (LMDS).

Switched Video Delivery as a Competitive Advantage

The full service network target requires the introduction of the switched digital-video broadcasting (SDVB) technique beside the high-speed data and telephony transmission. SDVB refers to broadcast service delivery with network channel selection; video formats comply with the DVB standard.

The integration of bandwidth-intensive video application will disclose new opportunities for real convergence between data, Internet-based applications, telephone-based traditional services together with TV.

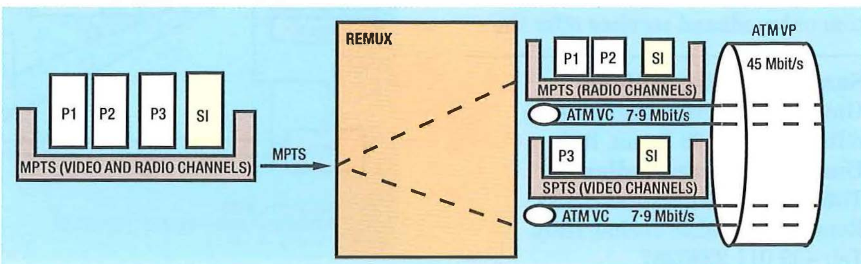
Overall, SDVB architecture has been designed with the target of assuring the compatibility between the legacy HFC network and the new FTTx platform, both from a network point of view (that is, in the core and transport layers) and from a user point of view; that is, users should not perceive any difference in terms of quality, number of channels and ease of use.

The compatibility is achieved by introducing MPEG/ATM remuxes; these split MPEG multiprogram transport streams received from service providers into smaller MPEG single-channel transport streams, and adapt them to ATM. The remux assures the appropriate interface between MPEG streams supplied by service providers with the SDH transport network, as shown in Figure 3. The remux and OLT can be connected directly or through the SDH network.

The video streams generated by the remux are transported over ATM VC links within VP towards the OLT, where the broadcast control unit activates the access network distribution handling the users' requests. Some streams may be permanently delivered to the ONU. In particular, the remux extracts from the multi-program transport stream (MPTS) received, both single streams and their aggregation in MPTS/SPTS (multi/single-program transport stream) with a suitable bandwidth for the transport on the copper network and ADSL/VDSL systems.

The output streams are coded in video formats and comply with the DVB standard. Moreover, the remux extracts from the MPTS received the service information (SI) (for example, electronic program guide (EPG)) and makes the right association to every program extracted.

Figure 4—Remux MPEG/ATM functionalities.



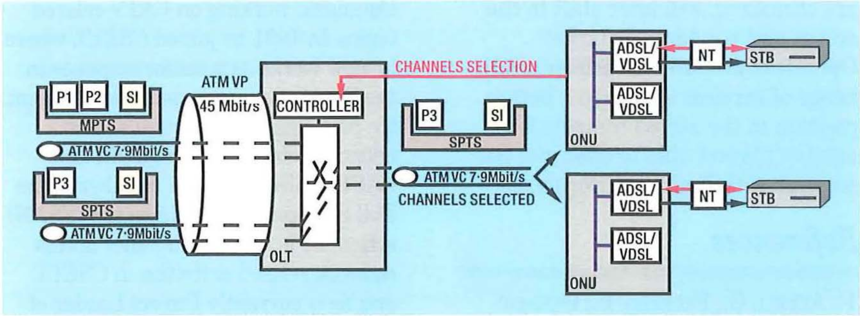


Figure 5—Selection point in the OLT

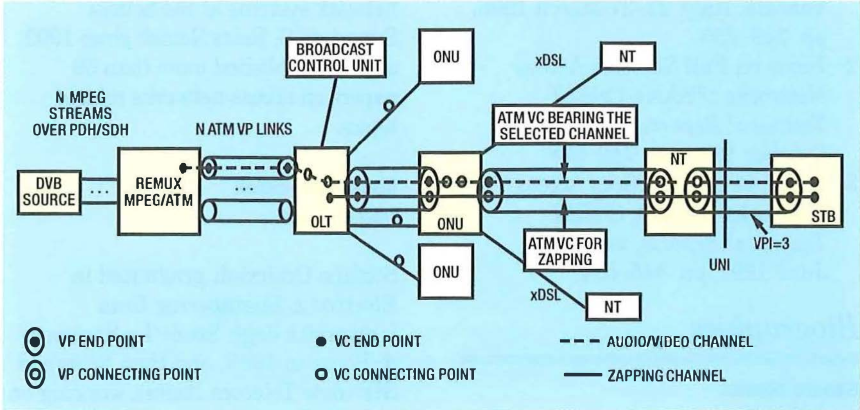


Figure 6 - Reference architecture and ATM VP/VC allocation for SDVB, case 1

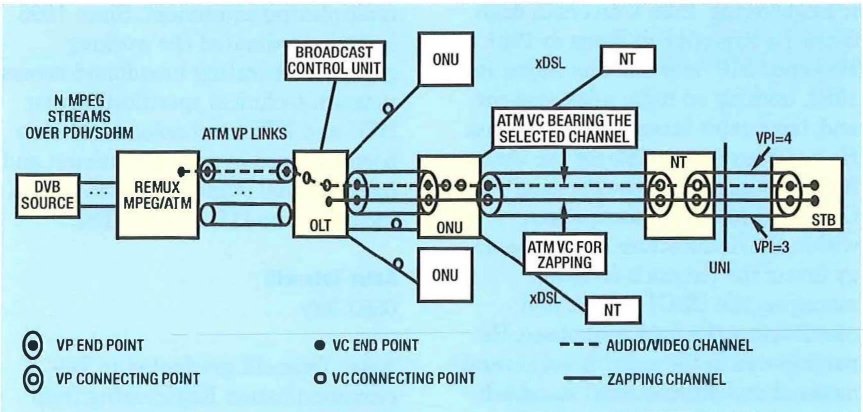


Figure 7—Reference architecture and ATM VP/VC allocation for SDVB, case 2

Finally, the remux transmits every MPTS/SPTS produced over single VC/ATM connections (Figure 4).

End users access SDVB services via a set-top box (STB) equipped with ATM Forum 25 Mbit/s interface. The network termination is able to support up to two STBs, if connected via VDSL.

ONUs provide the replication functions of the received streams to all the users watching the same program. Then, the ONU sends only the MPEG stream selected by the customer (one VC/ATM connection) to the STB. Further replication may be supported by the NT.

Every PON system has a reserved band of 475 Mbit/s for the broadcast services transport to the ONUs, and at least 60 VC/ATM connections.

If the channels transported to the OLT have a bandwidth greater than the reserved band, it is possible to give the customers a group of all the channels introducing a selection point in the OLT (Figure 5).

Two ATM user-network connection are possible:

- a single bidirectional ATM VP, CBR type, per STB (Figure 6). Two ATM links are provided: a bidirectional 16 kbit/s ATM VC, CBR type, with zapping information and a unidirectional ATM VC, CBR type, with bandwidth up to 7·9 Mbit/s per STB. The VP/VC end-point user-side is located in the STB, while the network side is located in the remux.
- two ATM VP connections per STB, as shown in Figure 7: one 16 kbit/s bidirectional ATM VP/VC, CBR type, with zapping information and one unidirectional ATM VP, CBR type, with bandwidth up to 7·9 Mbit/s per STB, carrying the video stream.

As an option to provide more STB per NT or picture-in-picture functionalities, user can be given a single ATM VP connection for video services with double bandwidth (15·8 Mbit/s).

The initial service offer will be based on semipermanent ATM connections, via a management system. In a second phase ATM call set-up upon request will free bandwidth to be used by other services while customers are not using the SDVB service.

Considering ATM fault management, VP and VC end point and connecting point for ATM connections are shown in Figure 4 and 5. The zapping channel can also be terminated in the ONU.

Segment loop back on zapping connections is activated at VP level in the downstream direction, from the OLT and ONU or NT, and can be performed periodically or upon request.

Segment loop back at the VC level are activated by the OLT and terminated in the ONU (network or user side) and eventually in the NT, only after checking customer activity of the selected channel.

Laboratory and Field Experiences

Telecom Italia started trials of narrowband PON technology in 1993 and of ADSL technology in 1994. The effort of Telecom Italia to trial state-of-the-art access technology is now expressed in several activities[1].

Early testing of FTTx-BPON has been started, using both commercial and prototype systems. Full service access networks (that is, integrated access networks able to support all kind of services) are being trialled in field and under laboratory conditions.

A laboratory demonstration is currently in progress in CSELT premises (Turin). The system, based on Broadband Technologies equipment and 52 Mbit/s VDSL, delivers switched digital video broadcasting, high-speed IP access and POTS services. The current system set-up represents an FTTB implementation; new VDSL releases will demonstrate FTTCab architectures. The systems are currently managed in TL1 language, and the video services are managed via a video administration module, implementing network and service management separation. Several home network solutions have been tested in the laboratory, and new optical drops are now being developed to verify the viability of this solution.

A field trial was started in Telecom Italia premises in Milan at the end of 1997. The current system set-up represents an FTTB implementation, based on Italtel equipment (UT-Medianet) and 52 Mbit/s VDSL systems, and delivers POTS/ISDN and high-speed IP access.

The next challenge is the field deployment of the selected architectures and the offer of broadband services to end-users. For the first step, FTTE architectures, relying on ADSL technologies, will be deployed to deliver SDVB and high-speed IP services. Then FTTCab architecture, relying on VDSL technologies, will be deployed on the basis of techno-economic evaluations, depending on the copper network status and services development.

Conclusions

Broadband access deployment has been widely discussed in the last few years, and is now about to be deployed under the pressure of customer needs for high-speed data services and competition. Telecom Italia is initiating the roll-out of new technologies in the access network: the phased approach will see the early support of data services for small business customers and later extension to the residential market.

The overlay deployment preferred at a first stage will then turn into more integrated platforms, namely the full service network concept. Such systems are likely to be deployed in the near future to refurbish old parts of the network and to provide users in new growth areas.

And finally, a provocative statement to highlight a different point of view: is access becoming a commodity? The increasing number of access solutions exploiting existing infrastructures (copper pairs, CATV network, power distribution), coupled to wireless solutions stimulates tough competition.

This statement stimulates a new vision of access network evolution: the initial competition in the transport network and in the business market segment, where the margins are shrinking, will later shift to the access and residential market. Operators prepared to deliver a full range of services will be in a better position in the access competition against players able to offer just few services with limited performance.

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Biographies

Sandro Dionisi
Telecom Italia

Sandro Dionisi graduated in Electronic Engineering from Università degli Studi 'La Sapienza' di Roma in 1981. He joined SIP (now Telecom Italia) in 1983, working on radio relay systems and, later, cable transmission systems. He has been responsible for the Radio Relay group, and for the Personal Communication Services project, within the Architecture and Technology line of the Network division, managing the DECT Project and coordinating the field trial phase. He participated in the activities of several national and international standardisation bodies; from 1990 to 1994 he chaired ETSI TM4 (Radio Relays) and has been a member of the Board of the DECT Forum. He has published several technical papers. He is head of Technology and industrialisation of equipment and radio relay in the network division.

Umberto Ferrero
CSELT, Italy

Umberto Ferrero graduated in Telecommunication Engineering from the Politecnico di Torino in 1992. In 1990 he worked at Telestyrelsen, in Denmark, working on CATV related topics. In 1991 he joined CSELT, where he now works as a senior engineer in the Transmission Systems department. He participated in several access network related EURESCOM and RACE projects. He is a member of the Full Services Access Networks (FSAN) action, he is involved in other access network related activities in CSELT, and he is currently Project Leader of EURESCOM P614 'Implementation strategies for advanced access networks'. He has lectured on access network systems at the Scuola Superiore G. Reiss Romoli since 1992, and has published more than 50 papers on access networks related topics.

Stefano Omiccioli
Telecom Italia

Stefano Omiccioli graduated in Electronic Engineering from Università degli Studi 'La Sapienza' di Roma in 1988, and then he joined SIP (now Telecom Italia), working on technical specifications and design guidelines of access and transport network transmission and multiplexing equipment. Since 1995 he has coordinated the working groups elaborating broadband access network technical specifications for HFC and FTTx technologies. He has been involved in several national and international standardisation bodies, including the ITU-T and ETSI.

Adler Tofanelli
CSELT, Italy

Adler Tofanelli graduated in Telecommunication Engineering from the Politecnico di Torino in 1973. He joined CSELT in 1975. His main interests have been ISDN and high-speed copper-based transmission systems. He has lead the Access Network Architecture group since 1991. He has published several technical papers and he has been involved in national and international standardisation bodies, including ITU-T and ETSI. He is a member of the FSAN initiative.

Fernand Hollevoet

The Any-Media Call Centre

Call centres have traditionally handled voice calls via the public switched telephony network. With the advent of modern technologies such as the Internet and multimedia, call centres have the opportunity to move into these areas. This paper looks at how call centres can handle the modern communications media.

The Call Centre and Business Strategy

Operators today face the increasingly complex challenge of attracting and maintaining loyal customers. In a booming economy, new service providers enter the marketplace to compete with each other and with older, more-established operators for the same customer base. In a static economy, consumers are more cautious and difficult to 'sell' on a new company, product, or idea—or they are just looking for the lowest prices on the market, moving from one company to another based on price difference and often without regard to quality.

A powerful market differentiation, in good times and bad, is the level of service that a company provides. The service provider that offers personalised service in tune with individual buying preferences, habits, and style achieves a competitive advantage, and is more likely to attract and retain customers.

Delivering personal service through face-to-face interaction is a luxury that few businesses are able to afford due to the high labour costs in their markets. In addition, customers are looking for flexibility and convenience in when, where and how they perform transactions.

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So, for many service providers, the call centre plays an increasingly strategic role in delivering superior levels of customer service, cost-effectively. The call centre is used to provide maximum availability—24 hours a day, seven days a week—using the latest technology to provide the best service and performance with skills-based routing using a minimum number of agents.

Moreover, by connecting its data environment to the call centre using computer-telephony integration (CTI), a company can further tailor the calling experience to individual consumer's needs, tapping into account information, buying history, and other customer-related information.

Customers are Using Different Media in the Relationship with their Service Providers

In addition to recognising the overall strategic value of the call centre in providing service, service providers have come to realise the importance of accommodating mixed media communications—voice, data, fax, e-mail, and video, in any combination, simultaneously. As a result, many service providers are beginning to embrace mixed media technologies, both in internal business applications that allow employees to collaborate more effectively using an array of communications tools, and in external applications that support multiple access channels, allowing customers to communicate in the media of their choice.

The enormous growth of the Internet coupled with the availability of more standards-based technologies has the potential to revolutionise business communications, allowing service providers to utilise the Internet cost-effectively for telephony, fax, and videoconferencing in addition to data transfer, file sharing, and e-mail.

At the same time, the business domain (.com) is the largest and fastest growing segment of the Internet, with nearly 25 percent of hosts worldwide, according to Network Wizards. The Internet is one of the fastest growing marketing and distribution channels. The International Data Corporation estimates that consumers will spend $16 billion on-line by the year 2000 (*The Economist*). With the growth of Internet telephony adding to this general explosion of Internet commerce, it is obvious that linking the Web with the call centre resources is the right choice if service providers want to offer to their customers personalised service and a choice of communications media via the Internet.

This so-called *Internet Call Centre* allows customers to be offered a direct-access channel into the call centre from the business Web site. It enables maximum access, call management, transaction processing, and call centre functionality within a single sales and service environment—effectively turning the call centre into a contact centre that supports all media and allows consumers to do business the way they prefer.

The Internet Call Centre is a complete, reliable solution, making use of Internet capabilities based on industry standards: voice over IP, 'text chat', escorted browsing, call-back; and—with the *Message Care Call Centre* software—e-mail and fax.

Another technology that is mature enough, and can be integrated in an existing call centre environment today, is video communication over the ISDN public network. Face-to-face interaction while carrying out transactions in the business world is most valued by customers. This mode of communication provides a sense of comfort and security that is not found in most of today's automated solutions for customer service. Conversely, there are transactions that the business prefers to have performed in a face-to-face environment; for example, first-time financial transactions.

From the business's point of view, face-to-face communication is the most costly avenue to pursue, since it requires dedicated resources at all locations, including people and information technology. At the crossroads is the *Video Multimedia Call Centre*.

The Video Multimedia Call Centre delivers a business solution that offers face-to-face communication and data collaboration between customers and call centre agents, with no limitation on geography.

The best voice-based call centres are highly effective and efficient organisations that can handle potentially thousands of calls an hour. The audio call centre work group is carefully managed through the use of specialised skill assignments to agents, advanced call routing algorithms, and comprehensive tracking of customer call history and related agent activity. All of the power of the audio call centre can be extended to universal call centre agents. In this context, the term *universal* refers to voice, video and data collaboration.

The Internet Call Centre and the Video Call Centre strategies integrate advanced technologies and support mechanisms with existing business applications, resources, and goals to create a universal contact centre—a state-of-the-art tool for delivering outstanding customer service in real time and with maximum cost-efficiency—generating greater revenue for the business bottom line.

Internet Call Centre System Architecture

The Internet Call Centre allows businesses to offer customers self-help capabilities at the Web site and to create direct links from pages within the site to the call centre, making live agents available to assist customers as needed. It makes use of existing call centre and Web site infrastructures, increasing the value of the investment in each.

The Internet Call Centre provides two-way communication between the customer and the agent over the same telephone line being used for the Internet connection. Queuing and intelligent routing of voice calls, text chat, e-mail, and fax messages are supported, as are call-back requests. In addition, live videoconferencing over the Internet will soon be supported.

Consumer Environment

To take advantage of the voice and text chat capabilities of the Internet Call Centre, the consumer PC must be equipped with Internet access via an Internet service provider (ISP) and utilise a Java-enabled Web browser.

To use the Internet for voice calling, the PC must be multimedia-equipped, with an H.323-compliant telephony application such as *Microsoft NetMeeting* and a high-speed connection to the Internet (minimum 28·8 kbit/s).

To support text chat and call back only, a minimum Internet connection speed of 14·4 kbit/s is required.

Call Centre Environment

At the business premises, a Bell Labs developed Internet telephony gateway (ITG) and a Java server are closing the gap between the Internet and the call centre automatic call distribution (ACD) switch to accept calls from the consumer to the call centre agent across the Internet. Queuing and routing support for non-real-time transactions with e-mail and fax requires additional *Message Care* software, and a POP-3 compliant mail server with Internet Messaging.

In addition, CTI links to the call centre ACD switch are providing synchronisation between the responding agent and the right web-pages displayed on his/her PC.

The call centre agent desktop must be equipped with a PC and the appropriate 32-bit operating system—for example, Windows 95 or Windows NT—and a Java-enabled Web browser. No desktop speakers, microphone, or telephony application are needed,because the voice portion of the call is delivered through the telephone of the call centre ACD switch.

A Closer Look at a Typical Internet Telephony Call

Internet Call Centre facilitates electronic commerce between consumers and businesses by combining, in real time, the interactivity, rich content (that is, graphics, images, text), and spontaneity of the World Wide Web (WWW) with the personalism and flexibility of the traditional call centre.

In a scenario where the end-user is equipped with a multimedia-enabled PC, the customer uses a Java-enabled browser to access the WWW. While browsing a Web site, the customer simply clicks a button on the Web page to talk to a customer representative. There is no need for the customer to end the browsing session and wait for a call back. The customer simply uses the Web page interface to request the type of call he/she wants—an Internet voice call, a text chat, or even a call back on an ordinary telephone using the public switched telephone network (PSTN).

The application initiates a call across the Internet to the call centre ITG, using the same telephone line used to connect to the ISP. The ITG starts the Internet telephony application on the customer's PC. The call control software provides the customer with call status messages as well as the interface through which the customer drops the call, conducts text chat, or types in data to collaborate with a call centre agent.

As the call control software is downloaded to the customer's browser, the ITG launches the call across the PRI facility to the call centre ACD switch, where it is queued according to its destination specified in the initiating Web page. Meanwhile, the customer continues to surf the Web site, and/or the Web site pushes pages of interest to the customer.

The call is routed to the first available agent with the proper skill level; this can be achieved by advanced ACD software like the Expert Agent Selection developed in the Bell Labs. An agent can handle ordinary voice calls as well as Internet voice calls using the same equipment; both call-delivery processes are transparent to the agent. When the call is delivered to the agent's voice terminal, the CTI server simultaneously sends a 'call answered' message to the ITG, which in turn delivers a URL to the agent's PC to display a screen 'pop' of the Web page the customer initiated the call from. If the customer is surfing the Web site at the time, he/she is returned to the same Web page.

While the customer and agent converse via voice or text chat, Web page collaboration takes place. The agent follows along as the customer surfs the Web site, answering questions or helping the customer place an order, and receives data entered on the customer's page. The agent leads the customer to related pages, to provide more information, show a product photograph, and cross-sell or upgrade sell.

The agent also uses information passed via the CTI link to review account status and other customer-specific information that is already present in the business database, which further helps the agent understand the customer's needs and provide more personalised service.

Additional Flexibility for Electronic Messaging

The Message Care software gives the universal contact centre greater control in managing electronic messages, while giving customers more access choices. This application, when integrated with Internet Call Centre, helps businesses manage:

- e-mail generated directly from the Web site (for example, customer responses to 'Write to us now' links created for specific Web pages and routed to skilled agents);
- e-mail sent to a specific address and routed based on a corresponding destination; and
- faxes forwarded to an 'electronic mailbox' and stored in a POP-3 compliant mail server.

In a typical scenario, a customer sends an e-mail to the service centre, either through a typical e-mail channel or by filling out a form on the Web site (accessed, for example, through a 'Write to us' link). The message travels over the Internet to the premises mail server, where it is accessed by the ITG. The ITG initiates a phantom call through the call centre ACD switch creating a virtual message call that is treated like an ordinary voice call, and queued and routed according to the destination and skills set specified by the application.

When an agent becomes available, the e-mail 'call' is delivered to the agent's voice terminal and the call-answered status is delivered to the ITG. The ITG in turn delivers the message URL to the agent's PC to display a screen 'pop' of the e-mail. For the duration of the message call, the agent's busy status is indicated as for a normal voice call, allowing the management system to track the e-mail responses as well as the voice calls, the Internet calls and the video calls.

The application can include several built-in message-handling tools, including the ability for the agent to create an e-mail response, place the message on hold to consult with other agents within the call centre, or forward/transfer the message for handling by another agent—for example, a subject matter expert—via e-mail. The ITG can also link the message to the platform's call-back capability—either by including the option on the Web site form or by retrieving information from existing customer records via CTI.

In addition, depending on the business's needs, the Internet Call Centre can independently integrate other application software into the message-handling capabilities; for example, order entry and processing.

Choice of Access Through the Internet

Internet Call Centre enables customers to interact with a call centre agent using whichever method of access meets their needs, preferences, or equipment capabilities. Internet telephony allows voice calls to be sent across the Internet, effectively utilising a single telephone line to handle both voice and data.

Text chat is implemented as part of the call control software that is downloaded to the customer's PC when a call is initiated. It supports the voice session between the customer and the agent, or it replaces the voice session for customers who do not have a multimedia-equipped PC. For example, the software provides a convenient means of accurately transmitting strings of digits, such as account codes or serial numbers, and of verifying spoken communications—'Did you say "B" or "P"?'—as well as a method of access for the hearing impaired.

Customers choosing e-mail as their preferred means of communication with a business via the Web typically wait long periods of time (several days to several weeks) before receiving responses, leading to dissatisfaction. Internet Call Centre provides these customers with direct access to call centres, ensuring a guaranteed response. A customer simply clicks on an e-mail link on a business Web site, then submits his/her request using a form provided by the site. The request arrives at the desktop of the first available, appropriately skilled agent via a screen 'pop'. The agent composes the response, preferably with the help of a database of frequently asked questions, then sends an e-mail message back to the customer.

Message Care software supports free-formatted e-mail, allowing the call centre to support general inquiries from customers who contact the business using a standard Internet address—not just the hot links to a Web site. For greater flexibility, Message Care software can also route customer faxes to an electronic mailbox via an e-mail server's fax interface, where the fax messages can be accessed and routed just like Internet calls or e-mail.

In addition, for those customers who have a second telephone line, Internet Call Centre allows businesses to accommodate call-back requests. The customer simply indicates this preference and his/her telephone number. The request is queued and routed just like any other call coming into the call centre. The first available, appropriately skilled agent will then automatically return the customer's call using the PSTN. The agent is provided with the customer's telephone number within a pop-up window, allowing the agent to verify the number. The agent then selects 'Call' to signal the call centre ACD switch to dial automatically the number and connect the call.

For the customer who has a firewall that will not permit Internet telephony access to the desktop, Internet Call Centre pushes a page that prompts the customer to enter call-back information. The customer submission is routed to the first available, appropriately skilled agent for call back.

In the near future, Internet Call Centre will support additional access choices—such as videoconferencing—further enhancing a business's ability to provide immediate, responsive, high-tech service. In addition, Internet Call Centre will route customer requests to the best available agent anywhere in a global call centre network.

Video Call Centre System Architecture

The Video Call Centre can be built on top of the H.320 standard for videoconferencing and uses the ISDN public infrastructure for transporting the video, audio and data portions of the communication. Once this call enters the Call Centre ACD switch these portions are separated and processed independently. This results in the audio portion being delivered immediately to the agent's telephone while the video portion is delivered on the agent PC also equipped with H.320 video. Answer, Out Calling, Transfer and Conference are initiated trough the normal telephone. Due to the multimedia call handling software in the call centre ACD switch, this solution today only needs some extra video-enabled agent PCs and standard H320 endpoints—using BA lines—connected to the public network.

Interesting Applications for the Video Call Centre

Retail sales

Customers connect to a service that can provide on-camera presentations of the items on sale. Goods are inspected without making a trip to the distant store. Agents provide various angles of display to customers and even zoom in on certain details. A customer may simply want to collect as much information as possible to start the decision making process. To provide the customer with detailed information, an agent traditionally mails documentation and follows-up with telephone calls to ensure the customer received and evaluated the information. With the Video Call Centre, customers can be provided with all the information online while their confidence is kept by sending a real-time smiling friendly and familiar face.

Customer service

Service providers use video and data collaboration to demonstrate feature usage of new software, to send upgrades directly to specific machines, to troubleshoot customer complaints about applications, or to provide billable training to specific customers.

Business alliances

Service providers can place video kiosks in public places or in the offices of their partners, where customers interact directly with sales associates to complete sales transactions.

Enhanced Ability to Collaborate

The Universal Contact Centre (Internet Call Centre and Video Call Centre) delivers an effective way for agents to collaborate with customers, by combining real-time Internet interactivity with existing CTI applications and standard call centre functionality. In turn, this allows agents to access all the technologies and resources available to the call centre to enhance the customer experience.

For example, in addition to providing a screen 'pop' of the specific Web page that a customer was viewing when he/she initiated an Internet call, the Web application is configured to present the agent with enhanced information—such as account information drawn from the company database, a special offer related to the page being viewed, or another page that is linked to the original page. These links are based on data that the customer provides when initiating the call—such as a name, telephone number, account code, or registration number.

Internet Call Centre links are also configured to present automatically the customer with additional pages (such as a 'thank you for calling' page) or information that is linked to the original page he/she was viewing, to help further enhance the experience.

Escorted browsing allows the agent and customer to surf the Web site independently and then, with the click of a synchronise button on the call control (software), synchronise their browsers to view the same page simultaneously. Security functions built into Internet Call Centre allow the agent and customer to browse synchronously and control what information is sent to each other—ensuring that neither party will view inappropriate, confidential, or inaccessible pages.

In the Video Call Centre, the agent can use an extra camera for showing documents or objects which are not available in an electronic form. On the other hand the agent can show live video clips to the customer or activate a video conference with other colleagues. The application sharing can provide data and presentations for the caller and even offer the use of a white-board function during the conversation.

Maximising Call Centre Capabilities

Calls that are received by the Internet Call Centre are converted into circuit-switched calls, sent across a PRI facility, while video calls immediately use the ISDN technology. These calls are then routed using the same queuing and call routing capabilities already present in the call centre ACD switch. Call Vectoring, developed in the Bell Labs, is one of the best examples on the market today. The call centre simply needs to modify the expert agent selection criteria by adding some new skills necessary to handle calls generated from the Web site. Expert agents continue to handle ordinary voice calls as well as Internet calls, based on their skills.

The Internet Call Centre can be configured to provide customers with Web pages that present reassuring messages in addition to the messages seen while calls are in queue. If a call cannot be queued because all ITG resources are in use, the application presents a Web page that apologises for the delay and asks the customer to try again later or to call the company's normal number as an alternative.

Internet and video calls that pass through the call centre are delivered to specific agent destinations, similar to traditional incoming voice calls. Internet call statistics such as average talk time, queue time, the numbers of calls, and so on, are collected by the call management system (CMS) and reported the same way as other call statistics. CMS tracks e-mail message handling, starting when the phantom call is launched within the call centre ACD switch and including the entire time the agent takes to process the message.

The CMS also gathers data on how many times an Internet Call Centre-enabled Web page is hit, as a basis for analysing how often page hits result in customers actually accessing the call centre. In addition, the Internet Call Centre detects and sends to the CMS information on calls that could not be delivered to the ACD due to insufficient ITG resources or because no agents were staffed/logged into the Internet Call Centre.

These reporting capabilities allow a business to consolidate data from various media—gathered via the standard call centre as well as the Internet—into a single call report tool that reveals information pertinent to market analysis and sales and service strategies, as well as to the effective management of the call centre and Web site.

Professional Services Support

The Internet Call Centre services that must be included for a successful implementation are:

- Internet Call Centre server design;
- network application integration;
- application integration services;
- database integration;
- Internet seminars;
- business consulting;
- Web outsourcing;
- customer acceptance assessment;
- customised computer telephony integration;
- Internet security audit; and
- firewall design and implementation.

It becomes more and more important that these kind of solutions are supported by comprehensive services designed to relieve the complexity of integrating state-of-the-art technologies for service providers—allowing them to instead concentrate their efforts on creating new business opportunities and generating revenue. These services result in an offer that is a total-solution approach, with an array of end-to-end support choices and options based on each unique business's specific requirements.

Biography

Fernand Hollevoet
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As country leader and managing director of Lucent Technologies in Belgium, Fernand Hollevoet is responsible for all Lucent operations in Belgium and Luxembourg, and holds the responsibility over all NATO and related accounts. His duties include commercial strategies, general management and representation of Lucent Technologies in Belgium. He is also responsible for promoting new business development, directing personnel management, and strategic planning. Prior to joining Lucent Technologies, he worked at Lernout & Hauspie Speech Products (1990–1992), and moved on as General Manager of Kreutler Belgium (1992–1995) and then as General Manager of Ericam NV (1995–1996). He began his professional career as Captain in the Gendarmerie overseeing telecommunications systems investments within the national Police. He has an MBA from the University of Leuven.

Paschalis Bouchoris

Strategic Positioning and Market Opportunities for Telecommunications Operators in the Internet Market

As the Internet paradigm prevails, telecommunications operators (TOs) face a need to re-assess their strategy with regard to it. The paper discusses opportunities and threats for TOs in the following market segments: Internet service provision, Internet telephony, IP-based data services, Intranets—extranets, electronic commerce services, Internet directory services, Internet media and content business, and Internet advertising. In brief, it is suggested that Internet telephony, the spread of intranets and packet-switched platforms might well erode the competitive positioning of traditional telecommunication companies. IP-based data services and electronic commerce seem to be large but highly competitive markets while TOs are found to have few competitive advantages in exploiting emerging opportunities related to Internet media and content provision or Internet advertising. The paper outlines market and technology trends and provides a number of strategic recommendations to TOs to maintain their competitiveness in the Internet landscape.

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Introduction

The rapid growth of the Internet represents both an opportunity and a threat for telecommunications operators (TOs). By the end of 1997, well over 60 million people were connected to the Internet and this number is growing at more than 50% per year. These numbers should also compare to a total of almost 750 million traditional telephone users growing at less than 10% per year.

This frenetic growth has driven analysts to the conclusion that 'one Internet year equals three PC years'. It took the world 15 years to go from 1 million PC users to 150 million (1980–1995), while according to estimates Internet users will reach 150 million from less than 1 million in only 5 years (1995–2000).

Moreover, the impact that the Internet has on their business seems to be the single most important question TOs have to answer.

Internet and Telecommunications: Convergence or Collision?

In a striking contrast to the generic trend towards network 'convergence' there is an obvious clash between the worlds of telecommunications and the Internet. Most evidently:

- telephony is circuit-switched while Internet packet-switched;
- telephony has been usage-priced while Internet charges have been flat-rate;
- telephony charges have been relatively high, especially the long-distance ones, while the use of the Internet has been extremely cheap; and
- telephony has been monopolistic and highly regulated, while the Internet is self-regulated.

In fact, the Internet has been 'bad news' for many established TOs. If nothing else, it has forced them to carry the burden of multimedia-intensive, heavy data transmission and thus obliged them to keep upgrading their infrastructure to meet the ever-insatiable demand.

Nowadays, established telecommunications operators face an assault against the core of their profits: international telephone calls. Despite the rapid fall in the cost of international calls over the last few decades the charges have remained high much to the benefit of TOs. These profits have traditionally allowed TOs to finance investment in less lucrative areas—most notably the local loop. However, this situation is changing rapidly. The key drivers of this change are:

- the growing spread of international simple resale (ISR) rights worldwide,
- the ongoing move from the accounting-rates system to

schemes based on call-termination charges,
- the prevalence of practices such as refile and call-back, and
- the intensification of competition with the explosion of a resellers' market and the availability of tools such as least-cost routing software or even Internet-based spot markets for international telephone capacity.

The Internet seems to be the ultimate and most drastic catalyst in this transformation of the telecommunications industry towards a new fragmented structure with highly differentiated players ranging from commodity wholesalers through resellers and intermediaries to retailers.

In the paragraphs that follow, the new opportunities that are being created by the Internet are being grouped in the following categories:

- Internet service provision,
- Internet telephony,
- IP-based data services,
- Intranets—extranets,
- electronic commerce services,
- Internet directory services,
- Internet media and content business, and
- Internet advertising.

At first sight, it might seem that established TOs can offer most of these services at a competitive advantage, namely because of their ability to offer bundled services on one bill and become an one-stop shop for telecommunications and Internet-related services. This is only half-true because of:

- conflicts of interest they face when trying to offer both traditional services of the 'old-telecoms world' and new ones from the 'Internet world';
- lack of trained personnel, skills and an overall sales mechanism with the capacity to sell the whole range of services from simple voice to electronic commerce applications and intranet solutions; and
- existence of legacy billing systems which are not able to adjust easily to the new services offered.

To make things even worse, in most cases Internet service providers (ISPs) enjoy some competitive advantages on their own as they are by definition closer to the market, more flexible and aggressive and they also lack some of the burdens that TOs are obliged to carry, namely they are exempt from the telephone companies' charge to the local network, universal service obligations etc.

Internet Service Provision

Despite early 'snobbism' most telcos are already active as ISPs.

In fact, most TOs enjoy market leadership positions in the ISP market while many pioneering ISPs have been the targets of acquisitions completed by traditional TOs.

As soon as they understood the Internet market, established TOs demonstrated some strong competitive advantages. To name a few:

- their strong brand recognition and existing wide customer base;
- their ability to offer Internet bundled with other services achieving customer retention;
- their 'financial muscle' to build and keep upgrading their ISP infrastructure to keep up with rapidly increasing demand especially in the consumer dial-up segment of the market;
- their capacity to offer low-priced Internet connections to eliminate early entrants or use Internet connection as a loss leader for more profitable offerings such as their leased lines and data services.

Internet Telephony

Although it is still unclear whether voice calls will finally shift to the Internet, research studies underline the threat for established TOs.

A few indicative market forecasts for Internet telephony are as follows:

- The telecommunications consultancy Analysys forecasts that by 2003, over 25% of international call minutes will be carried over the Internet, by which time the Internet protocol (IP) telephony market will be worth at least $7 billion.
- Forrester estimates that by 2004 more than 4% of the revenue of American telephone companies may shift to the Internet.
- An MCI projection shows that by 2010, 50% of all telephony will be through what is called today *Internet telephony*.
- According to Frost & Sullivan, the Internet telephony market will be worth some $600 million by the end of 1999 when there will be more than 16 million users. It will increase to $1·89 billion by the end of 2001, following a five year compound annual growth rate of 149%.
- According to Forrester Research, Internet telephony is expected to reach $2 billion by 2004.

Starting as PC-to-PC communications only, IP telephony has been gaining a wider acceptance since IP telephony gateways were introduced. Now all possible combinations among telephones, PCs and fax machines are supported.

Although packet-switching has clearly not been conceived for voice and quality remains an issue, there is such a huge cost difference that IP telephony often takes the lead from traditional telephony. In addition to cost savings, the possibility to make multimedia-enriched real-time communication seems to be a key growth driver of IP telephony. Desktop videoconferencing utilising audiovisual communication is expected to be a fast-growing market segment. Other related segments which have already gained market momentum are Internet fax and voice mail.

Furthermore, it should be noticed that although IP telephony might account for only a small share of the total telephony market, as is the case for the resale and callback markets as well, it is still a major market in itself. As a matter of comparison, the international telephony market is estimated at $78·5 billion. Gaining even a thin slice of the pie matters a lot!

No wonder we have already seen traditional TOs such as AT&T, Deutsche Telecom, MCI, GTE and NTT entering the IP telephony market. The question remains how established telephone operators will shift long-distance and international voice calls to Internet without cannibalising their own core revenues. The position is more difficult for the international carriers as opposed to many local operators who, after the liberalisation, just happen to enter the long-distance market and chose to build their networks on IP.

Emerging players such as WorldCom, QWEST, IDT and Delta Three claim a large share of this growing market.

IP-Based Data Services

In Europe, total telecommunications traffic today is roughly 80% voice to 20% data. The trend is towards a reverse in the next 5–7 years. This fact shows the importance of a decision by TOs on the platform their data services are going to use.

The Internet is clearly a winner in this market segment as a market consensus has been reached that most data services will soon become IP-based. This means that many TOs have to come to terms with the fact that most of the legacy data services they offer will become obsolete before 2000.

It also seems that there is not enough time for TOs to compete against strong competitors such as systems integrators, IT vendors and consultants which have already been aggressively pursuing fast rising market opportunities such as virtual private networks (VPNs), value-added services and wide area networking.

Intranets—Extranets

This will definitely be a significant and quite lucrative TCP/IP market. However, early evidence shows that TOs are being seriously beaten by competition from:

- the customer's in-house development staff,
- IT service providers,
- technology consultants,
- hardware and software vendors and support providers,
- ISPs, and
- business consultants.

After all, building intranets lies mostly in developing applications and integrating equipment rather than transmission issues in which TOs excel. At the same time only a few TOs have dedicated divisions for this line of business.

The weak competitive position of TOs in this market segment may also reflect upon other segments as the party who will manage to control the corporate networks will also be the one having the greatest influence on the client, possibly leading to overall account control.

Electronic Commerce Services

Market research companies seem to reach a consensus on the total size of Web-based sales in 1996 was around $2–3 billion. This market is expected to show an explosive growth, with predictions varying from 110% to 157% per annum by 2001. IDC projects $220 billion, Active Media $314 billion, Forrester $327 billion.

The revenue will go not only to the people who provide the on-line shops but also the ones who enable the commercial transactions, namely software providers, clearing houses, financial intermediaries and so on.

Once again, it is unclear what share of this market segment TOs will manage to maintain.

Internet Directory Services

The omnipresence of WEB-based directories has caught most TOs by surprise as they saw at risk products they have been offering profitably for decades, often as monopolies. Yellow Pages and Minitel-like directory services have been outperformed by rich Web catalogues, and powerful search engines. A number of traditional reference publishers and, more importantly, numerous new, 'Internet-only', entrants (indexers, information re-packagers, etc.) have entered the arena wining against traditional TOs in:

- conceiving and developing new, superior products, tailor-made to market needs unmet before;
- attracting advertising revenue; and
- attracting media attention to promote themselves to customers and advertisers and sometimes even investors achieving to upgrade into media businesses (for example, Yahoo!)

In effect, Internet directory services have proven to be a sizeable market attracting a large share of the total Internet advertising revenue and, so far, a missed opportunity for TOs.

Internet Media and Content Business

The Internet could well become the next mass medium as users seem to embrace it faster than any prior media (newspapers, magazines, radio, broadcast and cable TV). It is amazing to consider that it took 38 years for radio to reach 50 million users, 13 years for the broadcast TV, 10 years for cable while only 5 years for the Internet!

As an indication of what comes next, it is noted that the PC industry expects to have shipped 30 million TV-ready digital-PC devices by 2000.

TOs were never good at the media and content business. Essentially telephone companies, TOs, find themselves in the middle of a complex web of relationships between broadcasters, cable TV networks, producers and advertisers still not being able to achieve a noticeable presence for themselves in this market segment.

Internet Advertising

According to estimates by Jupiter Communications, Internet-based advertising was nearly $311 million in 1996. This is still a small number comparing to the mainstream media. As a comparison, it is noted that media advertising for the same year in US only exceeded $100 billion.

However, estimates for the advertising revenue in the year 2000 range from $1·7 billion to as high as $5 billion—the high end implying an average per-user advertising expenditure of $33, which compares to almost $340 for broadcast TV household, $83 per cable TV household, and $116 per radio household (according to Morgan Stanley data.)

Despite the overall growth of the market, traditional media will certainly lose revenue to the Internet. Forrester Research estimates the loss by 2001 to 10·5% for newspapers, 0·3% for TV, 0·8% for radio, 5·1% for yellow pages—overall a 6·8% of advertising revenue will be lost by mainstream media to the Internet.

The top beneficiaries of advertising revenues on the net have so far been companies such as Netscape, search engines Yahoo!, Infoseek, Excite, Lycos, and WebCrawler, and mainstream or emerging content providers such as CNET, ZD Net, ESPNET, WSJ, USA Today, CNN Interactive, HotWired etc. The top 10 sites seem to concentrate more than half of the advertising revenues. Search engines and directories account for 40% of it, computer-related sites 18%, entry portals 14%, news media 12%, general interests 8%, men's and sports 4% (according to data by Jupiter Communications).

TOs are of course nowhere in the picture. And to make things even worse, there are many who believe that the advertising model of the media/broadcasting markets will prevail as the standard funding mechanism of the Internet. It is hard to imagine how per-usage charging TOs will adjust to a marketplace similar to the one of the mainstream media where broadcast TV and radio are 100% funded by advertising, newspapers 80%, cable TV 50% and magazines 63%.

The only choices left seem to be becoming popular entry portals or just facilitating the hosting of Internet sites.

Conclusions and Strategic Recommendations

The Internet phenomenon with its far-reaching impact could not leave TOs unaffected. On the contrary, it will have a serious influence on the competitiveness and business strategy of TOs which have to take immediate decisions and re-evaluate their positioning in an IP-dominated world.

When it comes to bandwidth and provision of capacity, telecommunication companies might have to re-invent themselves in order to remain competitive in what seems to become 'a packet-switched world'.

Internet telephony, the spread of intranets and availability of alternative terminal options (for example, set-top boxes) might well erode the competitive positioning of traditional telecommunications companies. IP-based data services and electronic commerce will be large but highly competitive markets. TOs have few competitive advantages in exploiting opportunities related to Internet media and content provision or Internet advertising.

TOs will be obliged to reposition themselves in a highly differentiated marketplace. The Internet will be the final catalyst for the clarification of each TO's role. The most evident alternative options include:

- remain an end-to-end all-telecommunications operator trying to exploit competitive advantages in all fronts,
- become an efficient provider of raw bandwidth (although increasingly commoditised),
- become a customer-oriented 'retailer' bundling services oriented towards targeted market segments, regardless of control of own facilities, and
- become a niche player.

TOs that choose to adopt IP telephony have to:

- consider the threats of cannibalising their long-distance line of revenues—otherwise not enter it before the competitive situation obliges them to do so;
- expect a serious investment in educational and consultative promotion of IP telephony;
- identify and quantify the potential savings of IP telephony and be ready to demonstrate it to potential buyers; and
- treat quality of service (QoS) issues and be able to explain differences of IP telephony from PSTN to potential customers.

On the other hand, inter-exchange carriers that choose to stay away from IP telephony will have to emphasise the quality and reliability of their service as opposed to voice-over-IP services and underline the lack of standards in the IP telephony world.

Biography

Paschalis Bouchoris
European Dynamics S. A.

Mr Paschalis Bouchoris works as an Assistant Managing Director at European Dynamics, a fast-growing European systems integrator based in Athens, Greece. The company's affiliate Telecom Dynamics is Greece's leading private telecommunications operator developing a state-of-the-art alternative telecommunications network in the South East Europe region. He is an electrical and computer engineer and an MBA graduate from Rotterdam School of Management at Erasmus Graduate School of Business in the Netherlands. In the past, he worked as a management consultant and also as a research director for IDC. In his current position he is responsible for international business development, investment strategy and corporate planning.

Frederic Lagacherie and Ann Matthews

Pushing Opportunities on the Internet

In today's competitive environment, customer-driven (one-to-one) strategies seem more likely to restore brand loyalty than product-centric approaches. With its interactive and open architecture, the Internet embraces the one-to-one model and arises as the right vehicle to engage each customer in a personalised relationship. Opportunities exist now for telecommunications companies to develop on-line customer-centric services to provide their own end-customers with personalised services or to position themselves as a conduit for third parties to trade with their individual customers.

Introduction

In the *now* culture of the information age, customer satisfaction has become increasingly hard to achieve. By raising their requirements in terms of choice, speed of provision and quality of services, customers are stressing the need for a new kind of buyer/seller relationship. An increasing number of companies now recognise in customer-driven strategies, also called *one-to-one* or *relationship* marketing, a key success factor to their business. In essence, the concept relies on treating each customer differently by engaging her/him in a personalisation process based on a one-to-one dialogue.

Concurrently, thanks to its open standards and its level of interactivity, the Internet has experienced exponential growth and is identified as a promising line of revenue. Despite the current criticisms and misunderstandings that grow with its development, the Internet is a trigger for the development of new multimedia technologies and a powerful channel for cultural change. As a result, both small and multinational organisations are exploring the Internet as a new means of delivering their products and services to a wider audience at a lower cost.

But what is more fundamental, is that the Internet is a radically different paradigm to traditional media. The Internet can shape a new business environment centred on customers as active participators rather than passive receptors. With that in mind, it is proposed that the Internet should serve as the conduit for one-to-one strategies. This paper is divided into three sections to highlight how the Internet is emerging as a powerful interactive tool to sustain the one-to-one marketing process. It identifies which, among the raft of current technologies are likely to serve the personalisation flow of information, and assesses the role that telcos might play and the benefits that they can derive from participating in the Internet value chain.

The Working Principle Behind Internet Marketing

The Internet is increasingly viewed as the interface for worldwide commercial applications. However, reducing its usage to a simple commercial window fails to recognise the value of the Internet as a powerful medium to sustain a dynamic marketing model. In this section, the synergies that arise between the one-to-one business process and the Internet will be assessed.

Aggregate markets versus individual customers

In today's world of increased competition and increased customer expectations, marketers face strong resistance in meeting customers' needs and achieving brand loyalty. From a marketing point of view, it is questionable whether a traditional marketing approach can keep up with customer needs and competition pressure[2, 3]. Increasingly, marketing gurus recognise that today's business environment requires marketing concepts and operations to be revised. With the shortening of most product life cycles, especially in the telecommunications market, product differentiation† strategies cannot be stand-alone options because of the high cost they incur. In the new business era, the focus has shifted from product-centric to customer-centric approaches.

Traditionally, marketing as a discipline was created for a non-addressable, non-interactive world. This was a world in which a marketer had to think about customers in aggregates and groups. The resulting strategy was to mass market a standardised product. At its heart, one-to-one marketing considers each customer individually in an attempt to sell, to one customer at a time, as many products as identified from that person's characteristics[4]. The one-to-one process consists of capturing expressed and implied information regarding individual customers' interests. The aim is then to engage the customer in a unique relationship, developed from the personal informa-

† Product differentiation is the strategy whereby a company decides to differentiate from its competitors by providing a product that will be unique due to one or more of its functionality, performance, style, design, life time, etc.

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tion, and to deliver customised products targeted at the individual's needs. The resulting offer should increase brand loyalty by making it extremely difficult for a customer to match the level of services and satisfaction with any of the competitors.

One-to-one marketing is therefore not another refinement of a traditional business process but a new paradigm to deal with individual customers in an attempt to reinforce brand loyalty. This is an even more viable option since traditional figures reveal a 1:6 cost ratio in favour of keeping an existing customer rather than attracting a new one.

The one-to-one process and the need for information technologies

Developing one-to-one strategies clearly involves different marketing processes, both in terms of techniques and skills to be used. Marketers have to process large quantities of information to learn about customers and target them individually. This necessitates high levels of automation as well as a means to interact and disseminate information in real-time. This would have been an incredibly tedious task prior to the invention of the microchip[2]. To be competitively viable, the whole concept relies on the use of automated tasks provided within the technological sphere. Engaging true one-to-one relationships lies in three important computer capabilities, which respectively support one stage of the personalisation process:

- *Create dialogue with the customer base*: Interactive dialogue is now available, in a variety of interactive media, all sharing the capability of two-way, individual communications.
- *Collect customer information and extract strategic knowledge*: Marketers can keep track of numerous and complex individual interactions with their customers through relational databases. A business can remember its ongoing relationship with each one of them by monitoring, over time, a large range of variables. For instance, supermarket loyalty cards successfully demonstrate how to monitor customers' purchases to adapt display and pricing policies.
- *Take action for each individual, based on the customer's profile:* Mass customisation† of products and services is now enabled via computer-controlled machinery, modularised production and distribution processes. The potential now exists to customise efficiently and cost-effectively a wide range of products. This can be achieved either by manufacturing it differently (for example, Levis's stores can now produce customised pairs of jeans given the customers' measurements), or by delivering it in conjunction with a totally customised array of services, (for example, some car dealers provide insurance and banking facilities tailored to each car buyer).

Taken together, these computer-enhanced capabilities not only make one-to-one marketing possible, but competitively essential in building a customer-driven framework.

The emergence of this new marketing paradigm is thus a combination of advances in computer technology and information systems and the competitive environment. The implementation of one-to-one strategies is therefore about understanding the emerging business model so as to develop and use the technology accordingly[5].

Internet as the matchmaker

In the one-to-one process, described below, there now exists a variety of interactive media to manage the interactive dialogue part of the relationship. These media include voice-mail, fax-on-demand, electronic data interchange (EDI), interactive kiosks, voice-mail, touch-tone telephone, and interactive cable television. Although each of these media shares the capability of a two-way individual communication, the Internet is powerful in both enabling individual dialogue and providing a unique information channel to track user data. This allows the personalisation of information and services via:

- *Monitoring users' information*: By taking advantage of the Open Database Connectivity (ODBC) standards, (which allow an easy interaction with a relational database), marketers can collect the data originating from customer interactions and add value to this raw data to support decision-making.
- *Enhancing interaction with customers*: Even though we are still far from a face-to-face interaction, Internet users can combine e-mail and Web usage to interact directly with the company to express their needs and to provide feedback on the quality of services.
- *Mass customising information and services*: The Internet client/server architecture enables the generation of personalised Web pages on the fly* in response to customers' inputs and behaviours. This is particularly efficient in targeting advertising banners, (DoubleClick's business is based on inserting a banner ad on a template Web page for a targeted customer), and pushing information to a particular user, (BackWeb uses push technologies‡ to deliver real-time information to a user's Web site according to her/his expressed interests).
- *Processing on-line transactions*: The Internet covers the entire cycle of the purchasing process, from information provision to transaction processing. On-line sales are handled through credit card, cheque or even micropayment systems along protocols such as Secure Electronic Transaction (SET).

So far, most companies have failed to recognise the interactive power of the Web. As a result, many commercial Web sites bear a strong resemblance to the company's print brochure. The Internet should not be thought of as a traditional mass marketing vehicle (one-to-many). The strong value of an interactive, one-to-one communications medium is that it transforms the nature of the relationship by granting and providing customers with control over the flow of the marketing information.

Since the key concept in relationship marketing is customer empowerment, the challenge is to provide an interactive platform through which users will be able to communicate and marketers will be able to

† Mass customisation occurs when the process of customising products or services is engineered into a routine.

* 'On the fly'; that is, in real-time given a customer's direct inputs. A typical example is to include the user's name on top of the page once this one has been registered.

‡ Push technologies drive the content that meets the user's requirements when, and only when, new information content becomes available on the server. The user does not have to 'pull' anymore to upgrade specific information.

monitor the sets of data gained from the interaction itself [6,7]. With the Internet, customers have the means to drive individually their relationship with a company, and marketers can rely on a single medium to cover the entire one-to-one process.

Implementing one-to-one Internet solutions is a matter of upgrading the marketing processes with the matching technology and changing the marketers' philosophy to endow customers more power than they have ever had before.

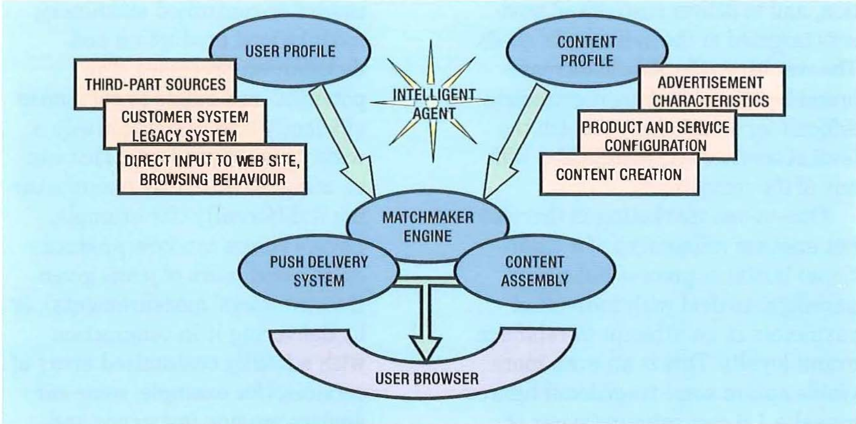


Figure 1 – The personalisation of information flow

An Insight into the One-to-One Internet Architecture

Although the idea behind one-to-one marketing is not new *per se*, implementing the right technology is not a straightforward process. This section focuses on the technologies involved in the matching of individuals and content, and the development of an open architecture dedicated to a business usage.

The core of the customisation process

The first level of the process is to establish a simultaneous knowledge of both customer needs and content availability. This is shown in Figure 1.

Providing one-to-one services is based on the ability to figure out and act upon the preferences of a user in order to target him/her as a unique customer. Establishing an accurate *user profile*—the repository of personal information, (see Figure 1)—is therefore vital to the design of a relevant personalised solution.

Currently, there are no winning techniques for providing an accurate user profile, and applying a number of different information collection techniques seems highly valuable. However, the variety and complexity of the information required in the user profile depends on the degree of customisation that needs to be achieved. Hence, basic demographic information should already be available from the existing customer and financial systems. To build a more detailed profile, demographic data will need to be complemented by more 'personal' information. This is when the interactive channel provided by the Internet becomes extremely valuable. Besides the monitoring of the data gathered from Web forms and feedback e-mail, the Internet has a unique ability to offer an extended method to encapsulate psychographic† data. Internet servers have built-in facilities to monitor the clickstream and file downloads of every user's session and capture this data in a dedicated file, namely a log or cookie* file. This data provides an insight into the user's on-line behaviour from which it is possible to extract implied interests.

Simultaneously, content needs to be profiled in an equally accurate manner for the right information to be provided to the right individual. To avoid the burden of manually indexing the content, multi-dimensional scaling and natural language engines can be used for the automatic storage and categorisation in a central *content profile*. Companies like Aptex, Autonomy and Excalibur deliver dynamic content categorisation tools to increase the flexibility in designing personalised solutions. As topics and interests vary over time, constant adjustments are made to reflect the customer dynamics.

Matchmaker engines will complete the personalisation loop by matching individuals and content. *Explicit rules servers* run the rules, established by marketers, by linking indexed content and user profile. *Filtering tools*, especially collaborative ones, compare users' likes and dislikes between various users to deduce the most logical need that an individual might have, given the inputs of like-minded persons. For example, Firefly tools and networks make extensive use of this community knowledge to advise people about CDs and videos likely to suit them. Eventually, successful matchmaker engines will integrate several technologies. In that respect, the development of *intelligent agent*‡ systems will provide the appropriate platform to achieve different degrees of personalisation[8].

A personal agent framework could provide every user with a personal Web assistant whereby all the transactions between the personalisation entities would be handled by agents. Sophisticated agents can learn on their own by following a user's behaviour. They can monitor browser sessions, discover user interests and tailor their behaviour accordingly. As agents come of age, highly personalised content for entertainment, news, products, and other links will appear automatically on users' favourite Web sites with much reduced user input. This should enable marketers to focus on feedback retrieval and service narrowing. From a technological perspective, the future lies in merging complementary mechanisms. For instance, push technologies and intelligent agents may act collaboratively in the customer's best interest. The agent will have the responsibility for profiling and matching, while the push engine will provide the information in an agreed format and time scale.

The need for an open architecture

To be efficient, the core of the personalisation process, as depicted above, needs to be encompassed within an integrated architecture. This will enable marketers to

† The psychographic approach consists of measuring attitudes and lifestyle characteristics to feed a personal profile.

* Cookie files are tokens of information, such as preferences, passwords, browsed pages within a site, that Web servers collect from the clients that access them. This data is stored on the user's own hard disk. On the next visit, the server checks on the hard drive for previously recorded information to identify the user and upgrade the data.

‡ An agent is a piece of software capable of acting intelligently on behalf of a user in order to accomplish a pre-set task.

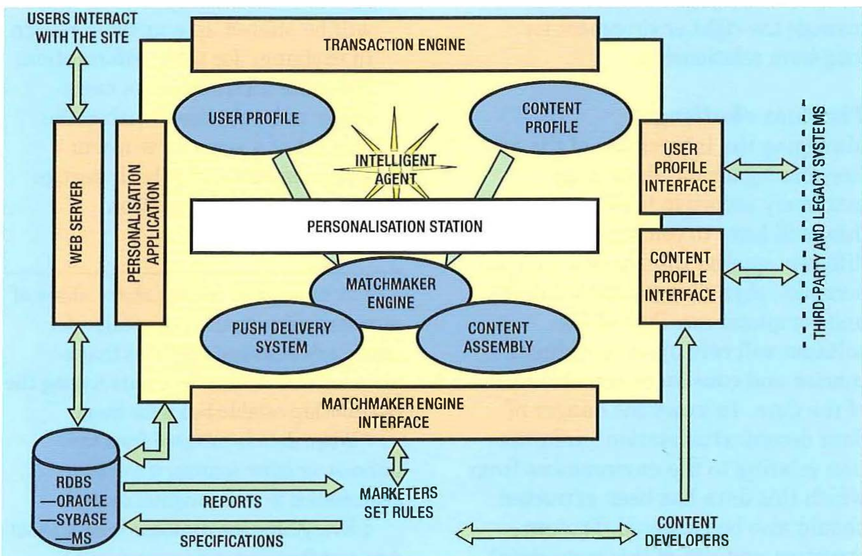
implement their relationship process, from data tracking through to transaction processing.

The architectural design needs to allow non-technical people access to the platform so as to permit real-time and dynamic content management. Engaging customers in true one-to-one relationships should be simply a matter of providing marketers with a set of easy-to-use point-and-click programmer-free tools. Once marketers have hands-on control of the one-to-one system they can dynamically set up the marketing and selling rules of the matchmaker engine. Next, the system must provide an early insight into how customers respond to a particular incentive or service. These reports are essential to monitor the effectiveness of the strategy. In response, the system must also provide some easy mechanisms to modify content in real-time.

On the technical side, the one-to-one toolkit must support an RDBS†. Simply storing clickstream or psychographic data in a RDBS is of limited interest until the raw data is processed into value-added information for marketers. Database marketing systems are deployed to gain some better and faster statistical information about one customer, and to supply decision-makers with value-added knowledge gathered from the community of Web users. From the whole demographic and psychographic cohorts, data mining* techniques can differentiate purchasing and navigation behaviours, and provide an insight into why and how particular individuals make a purchasing decision[9].

Accordingly, the relevant solution must be integrated with the Internet server and designed for easy upgradability, (to include Object Oriented Design through Java and CORBA tools, legacy systems and third party inputs), and flexibility, (to adjust content and services in real-time). Figure 2 is the actual translation of those requirements into one integrated structure.

Figure 2 – The one-to-one architecture



Opportunities at Stake for Telcos

Telecommunications companies are constantly dealing with new opportunities resulting from deregulation policies and the emergence of technologies that fully integrate telecommunications features. Among those, the Internet offers a multi-layer model to enter the on-line market. This section considers the role that telcos should seek when entering the on-line business chain, together with the strategic value that they can derive from personalisation.

Seizing the Internet value chain

As providers of global telephony services, telecommunications companies have naturally emerged in the Internet value chain as access and network providers. As they become more aware, Internet companies expect that the technology will meet their particular needs and not simply to achieve basic automation of services. For that reason, most telcos have now opted for a vertical integration of the Internet value chain (as shown in Figure 3), whereby they can provide more flexible and tailored solutions to their customers. The integration of downstream activities allows telecommunications actors to deliver value-added solutions conducted by cross-disciplinary teams.

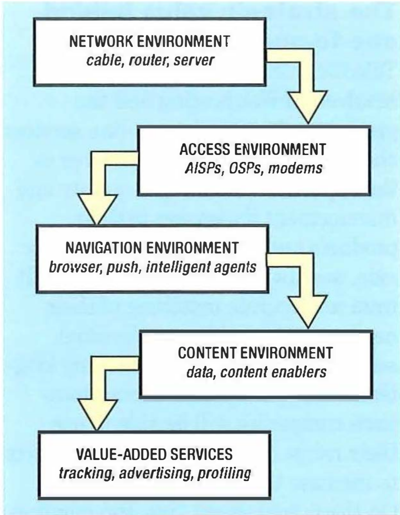


Figure 3 – The Internet value chain

The purpose of vertical strategies is to allow differentiation on a service rather than on a product basis. Product-driven strategies have resulted in price wars and cuts in margin. Moreover, price incentives only guarantee to attract highly volatile customers. In contrast, quality and value-added services generally account for more-in-depth relationships. In the ISP market, where this phenomenon is highly observable, the provision of new services based on technological leadership is likely to create a strong competitive advantage. However, the Internet market cannot be locked-up by a technology but rather by the development of a matured service package together with that technology. For instance, the on-line tracking technology used by Federal Express to monitor the shipment, in real time, of personal parcels around the world is a strategic differentiator technology since it leverages the value of the parcel delivery service. Customer-driven solutions offer telcos the opportunity to get involved along the entire Internet value chain, not as software producers, but as providers of value-added services that integrate parts of the navigation and content environments.

† RDBS stands for relational database system. The relational model relies on the mathematics of set theory, thereby providing a solid theoretical base for the management of data.

* Data mining is the extraction of global patterns that exist in large volumes of data via an established algorithm.

The strategic value behind one-to-one solutions

Telecommunications operators involved in Web hosting and the provision of Internet or on-line services should regard one-to-one services as the opportunity to bring a quality and management dimension to their products and services. On the quality side, worldwide customers can benefit from an accurate matching of their needs together with an individual service attention. By establishing long-term relationships, telecommunications companies will be able to use their range of complementary products to increase their share of customer†. On the management side, the monitoring of Web site usage, advertising campaigns, and the impact of new strategies can all provide significant real-time measurement tools to achieve cost-benefit analysis.

From an internal point of view, the information overload syndrome, emphasised by the extensive use of e-mail, is one of the organisational problems that can be easily attenuated by the filtering and targeting of information. Simultaneously, the very process of implementing the technology internally will set up the basis for knowledge management and a better monitoring of the information content. The extension of such services to the supplier and customer chain is another way to coordinate and optimise the flow of resources within the extranet.

Implementing customer-driven approaches

Building a true customer relationship system on the Internet requires an equal focus on three sensitive areas; namely, the integration of the technology, the people and the data within the legacy infrastructure of the company.

The information system challenge

Existing off-the-shelf software packages, currently available from companies such as BroadVision or ATG, encompass a great deal of personalisation. However, the outsourcing of the whole solution might create some unexpected technical dependencies. Telecommunications companies might benefit from their internal resources and expertise by keeping parts of the core personalisation process internally and by outsourcing the front-end technology, which should be available from diverse vendors.

The challenge for IT professionals relies upon the selection of the right Web server among the tens of existing ones. On their own, Web servers provide a wide range of tools and philosophies for database integration and dynamic management. The choice of a Web server will eventually depend on the problems it has to solve. Unfortunately, the level of comprehension about what marketing is trying to achieve is extremely low. In the future, both in-house and outsourced solutions will need to be justified through a set of marketing specifications concerning the objectives of the process and the typical outputs expected.

The organisational challenge

The high rate of technological evolution is likely to benefit the marketing activity if it is integrated alongside the existing technology and if the resulting information system is adopted by the other centres within the company. The benefits of an open technology are enhanced if it is also integrated across the different functions of the company. For instance, marketing, sales and finance need to co-ordinate their efforts by using the new system as a core component of their respective business process. Gaining cross-departmental cohesion to the one-to-one system is likely to leverage the company's value by optimising the use of existing information resources.

However, the first and probably the most important step remains to integrate the marketing and IT process into one business function. By bridging the two through a common set of objectives, the customer-driven system should faithfully respect marketers' requirements while reducing the effect of the technological constraints. The 'hybrid manager' will ultimately fuse data processing and marketing into a one-profit-making entity, to create and manage the right environment for long-term relationships.

The data challenge

Managing the integration of the on-line and legacy database is an extremely sensitive task where all data will have to comply with different quality dimensions such as accuracy, objectivity, interpretability, and completeness. Part of the solution will rely upon providing a concise and consistent representation of the data. To avoid the danger of data decontextualisation*, information relating to the environment from which this data has been extracted, should also be gathered. The construction and use of this *meta data*‡ is a vital prerequisite to the use and transformation of raw data into consistent information.

The efficiency of customer-driven approaches depends on the consistency of data but equally on the quality and nature of the information released by the customer. For that reason, privacy issues are depicted as the key to unlock the personalisation process. While 80% of respondents in an Internet surfers survey acknowledged they had declined to give personal information at some point, two-thirds said they would probably have released this information if they had been given a deeper insight into the usage of this data. The success of one-to-one strategies relies on establishing a true level of trust between the company and the user. To make this trusted environment a reality and to guarantee the protection of information privacy, it is necessary to build a framework characterised by three complementary levels:

- Recent European Union directives on data protection offer a framework for the legal use of private data. It is also likely that this should be encouraged as a 'code of practice' for non-EU states to guarantee consistency on a worldwide scale.
- The Internet industry itself is developing, under the lead of the W3C, technical systems to allow Internet sites to declare their data collection policies, while allowing users to monitor which personal details they are willing to release. Such systems include the Platform for Privacy Preferences (P3P) and the Open Profiling Standard (OPS).
- Finally, Internet companies must establish a social contract with their users whereby individuals will be offered an equitable return in exchange for their information. Valuable information is more likely to be obtained within the context of a secured win-win environment where both parties gain from the interaction.

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† In contrast to market share, share of customer refers to the percentage of a customer's/business' expenses that a company will be able to acquire during the relationship established with them.

* When data is collected from the Internet, or other sources, it can be disembodied from its original context.

‡ Everything the database knows about data and the computing environment.

Conclusion

Relationship marketing is, in essence, an attempt to bring marketers and customers closer together within a long term collaborative framework. In that context, the relevancy and value of the information that is processed between the two parties will largely be accountable for the efficiency and quality of the service. The technology and the philosophy behind it must therefore encompass the necessary mechanism to respect information privacy. The resulting framework is as much about securing information transactions and access as monitoring the flow of information itself.

For telecommunications companies involved in connecting people and businesses with flexible solutions, the relevance of one-to-one approaches is not difficult to prove. In the chaotic business environment they have to face, relationship marketing provides a more adequate framework for connecting people when, how, and in the way they want. The Internet is a true opportunity for them to become key players in the information market, by delivering value-added services and providing information management mechanisms, internally as well as externally. Seizing those opportunities *now* can trigger telecommunications companies to lead the market and prepare the organisation for entering the personalisation wave.

Increasingly, the design of customer-oriented solutions will need to empower the customer in terms of interaction and participation. For this reason, it is vital to use the Internet as an experimental platform to drive and manage the customer-driven culture across the different centres and processes of the organisation. Joining the personalisation industry, while the market is still in its infancy, should set the basis to produce and distribute new interactive and multimedia services, supported by more advanced telecommunications infrastructure and applications. Whether it relies on the internet, interactive TV or some other similar media, the one-to-one paradigm encompasses a broad range of events that will surely affect the way companies do business.

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Biographies

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Frederic Lagacherie joined BT in 1997 having obtained a Master's in Management from CERAM Business School, France, and an M.Sc. in Information Systems from the London School of Economics. He is working for the Business Modelling Group, where his task is to build techno-economic models of future multimedia services. As an input to his modelling work, he is continuing his M.Sc. research on the commercial uses of the Internet. He is now responsible for developing dynamic business simulations to assess the impact of on-line personalisation services and IP telephony applications.

Ann Matthews
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Ann Matthews joined BT in 1985 with a B.Sc. in Physics and Mathematics (Hons) and an M.Sc. in Modern and Applied Optics, from the University of Reading. She designed and analysed theoretical and practical optical telecommunications systems until 1992, obtaining her Ph.D. in Novel Optical Design Theory from the University of Reading in 1988. In 1992, she began business case modelling for proposed telecommunications networks and their services. She led a team in the development of techno-economic models which have been used in the analysis of several BT network proposals, and collaborative European projects. She now leads a team continuing this research, and provides competitor analysis on a consultancy basis within BT.

Victoria E. Skoularidou and Konstantinos I. Tzelepis

Opportunities in E-Commerce: Advertising and Commerce in a Virtual Enterprise

The purpose of this paper is to present INTRACOM's approach for building a global electronic commerce service which will support integrated retail services, providing an intelligent interface upon which the involved players (retailers, suppliers and consumers) will establish a tied and trusted relationship. The meaning of terms used and service actors roles are explained and the key components for building such an environment are identified. The business objectives for the proposition of such a service are defined and the description of the system is given in detail. The overall architecture of the proposed global electronic commerce service and the main components of the application are identified and analysed in depth.

Introduction

An important factor in the growth of the Web is *electronic commerce (e-commerce)*: the ability to buy, sell, and advertise goods and services to customers and consumers. This ability to conduct business via electronic networks such as the Internet and the World Wide Web is currently one of the fastest growing and most practically relevant application areas of distributed systems technologies; it is a total new way of doing business[1]. It is based on the economic aspects of commercial trading patterns combined with distributed computing systems technology. It is a market environment characterised by low transaction costs, a large number of market participants, and simple on-line access to services and goods offered. It also implies a set of rules and policies for the successful organisation of business transactions.

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Although e-commerce is based on the principles of *electronic data interchange* (EDI), it goes far beyond EDI in that it aims at supporting the complete external business process, including the information stage (electronic marketing, networking), the negotiation stage (electronic markets), the fulfilment (order process, electronic payment) and the satisfaction stage (after-sales support).

Present e-commerce implementations automate only a small portion of the electronic transaction process, such as: order processing, shipment scheduling, customer service support, and so on. Moreover, e-commerce is hampered by closed (self-contained) markets that cannot use each other's services, incompatible frameworks that cannot interoperate or build upon each other, and a bewildering collection of security and payment protocols. In general, e-commerce applications do not yet provide the robust transaction, messaging and data-access services typical of contemporary client–server applications. While there is considerable interest in developing robust Internet applications, protection of significant investments in client–server technology and interoperation with mainframe transaction servers and legacy systems is a serious requirement.

Other issues that need to be considered are: the increasing demand of consumers for automated and improved services, the need for suppliers to measure and identify consumer preferences in a more efficient and cost-effective manner and the emerging exploitation of technology developments.

Thus, there is a strong demand by the retailers to define new methods of differentiation. Differentiation comes in the form of additional services and support for new business models and, of course, requires highly technical solutions. Major retailers have also realised that profit increase should occur from the exploitation of new avenues and opportunities instead of putting pressure on the supplier's side. We should also mention that the volume of US electronic 'home shopping' retail business already reached US$2·6 billion in 1993, although this included all on-line services and interactive television[2].

In this paper we present INTRACOM's approach for building a global electronic commerce service which will support integrated retail services, providing an intelligent interface upon which the involved players (retailers, suppliers and consumers) establish a tied-and-trusted relationship. This platform's intention is to provide a new sales channel which will reduce cost in the interest of all involved parties and will support tied collaboration in order to unify retailer and supplier market objectives.

The rest of this paper is structured as follows: in the next section a general description of the global electronic commerce service along with the corresponding objectives of this system are presented. The following section defines the general architecture of the proposed system. Finally, a discussion summarising the main points of our approach is given.

Objectives and General Description

The proposed global electronic commerce service will establish a multi-agent electronic marketplace that will transform the on-line advertising, promotion and shopping experience by leveraging the unique features of the Internet, electronic commerce and software intelligent agent technologies, as, today, the agent paradigm and agent technology is considered to represent a key technology for implementing solutions for the emerging open services market[3].

The main goal is to allow *advertising and commerce through the Internet in the context of virtual enterprise.* Issues that will be addressed include distributed marketplaces, open agent and marketplace communication standards, open multimedia database schemas and digital libraries for describing goods and services, visualisation of marketplace data and activities (focusing on numerous user interface issues), alternative market models, and issues of trust, security[5], law, payments[6,7] and intermediaries.

This platform is very close to real retail-oriented services as it is based on the evolution and the integration of advanced technologies, operates over public infrastructures and involves real actors from the retail industry (retailers, suppliers and customers). In addition, provided that appropriate adaptations take place, several retailers in parallel could also adopt it to facilitate the establishment of a *virtual mall.*

The main objective of the proposed system is the provision of an adaptive platform for electronic retailing, depending on each user's requirements.

The platform presented in this paper is going to realise a fundamental transformation in the way people transact goods and companies promote products, to satisfy the following business objectives:

- Provide efficient, customised and supportive 24 hour shopping channels between consumers and retailers (and respective suppliers) that will maximise sales and subsequent profits (for all parties involved).
- Provide efficient **physical** inventory and **virtual** sales management methods and tools that will exploit information to optimise stock, establish continuous replenishment environments and apply sophisticated promotion techniques (that is, personalised marketing).
- Provide efficient marketing and advertising models that will support especially small-to-medium enterprises (SMEs) and will go along with the Internet retailers' requirements.
- Establish tied relationships between all parties involved where information and products flow efficiently along the virtual and the physical value chain respectively.

The establishment of this global electronic commerce platform, which intends to support integrated retail services, will produce a number of important technical results. These results, that are analysed in the next section, include the following:

- A *tool for secure home shopping* which will provide consumers with an agent-based support for product filtering and recommendation based on consumer habits, while at the same time act as a point of sales (POS) for order and payment, integrated with the retailers' legacy systems, where the consumer can opt for a preferred virtual store environment.
- A *tool which will monitor consumer behaviour and define consumer profiles* that will support providers to apply targeted promotion techniques such as couponing, e-mail discount alerts, direct compensation for advertisement viewers, and sweepstakes, while at the same time applying direct market research through electronic questionnaires and complaint boxes.
- A *tool which will provide alternative advertising schemes* that will guide providers to display product information based on standard presentation templates (that is, yellow pages) or use specific Internet advertising techniques (Web site navigation, video display, etc.) in a cost-scaleable way, based on multimedia and electronic forms technologies.

The above described tools comprise several sub-components (described in the next section) and will be later referred to as the *home-shopping tool*, the *consumer-behaviour tool* and the *advertising tool*, respectively.

Specific exploitable results, which will occur by the commercialisation of INTRACOM's proposed global electronic commerce service, include:

- *Sales increase* Sales will be increased in total numbers by the provision of new supportive channels, which will attract old and new customers. Sales per customer (consumer basket) will also increase as a result of product cost reduction, 24 hour shopping and support during the buying process.
- *Accelerated information delivery* Electronic links among partners will accelerate information flow, taking into consideration the high volume of paper, which is currently exchanged in the retail sector.
- *High quality of information* Data on consumer behaviour, critical for efficient marketing plans, is hard to obtain. The proposed system will provide a means for gathering and processing information in real time.
- *Improved inventory auditing* Automated sales systems like the one proposed optimise inventory levels by reducing out-of-stock and over-stocking cases.
- *Efficient product promotion and introduction* New cost-effective marketing channels and practices that will occur in conjunction with extensive forecasting analysis on the collected data will provide an efficient means of evaluating promotion and introduction activities and update them based on consumer characteristics.
- *Improved corporate image* The introduction of advanced technologies and services has proved to be a valuable business asset in influencing consumers.

From the above mentioned points it is obvious that, all business processes involved in the virtual value chain such as sales, marketing, logistics management, customer support, after-sales support, information-system management, executive decision making, business network management, etc. are going to be improved.

In order to achieve these objectives, extensive market research will be carried out to identify user requirements in relation to future market trends and alternative technical considerations. Following the implementation of the final prototype system, two large-scale pilot systems, with the involvement of real actors, will be launched to validate the system's viability and objectives while an exploitation plan will be adapted in order to define properly market positioning and commercialisation strategy. In addition, a best practice guide will be developed which will provide the framework for the integration of the prototype system into the existing business practices and internal applications.

Global Electronic Commerce Service Architecture

System architecture

A preliminary system overall architecture view of the proposed global electronic commerce service is depicted in Figure 1. As can be seen, the proposed system is based on a layered architecture. Each layer contains certain components that are described in the following:

Technology infrastructure layer

E-commerce platform The e-commerce platform will provide us with basic electronic commerce transaction services based on Open Trading Protocol (OTP) specification[4], certificate[5] and payment services[6,7], upon which the basic functionality of the home shopping tool will be delivered. Platforms that are to be considered, among others, include Microsoft Site Server Commerce Edition, Sun Java Electronic Commerce Framework (JECF), IBM NetCommerce platform, and Netscape SuiteSpot server.

Agent platform This component denotes the platform used to deliver distributed secure services for the implementation of the agent services. Agent platforms that will be considered include IBM's Aglets, Mitsubishi's Concordia, General Magic's Odyssey, ObjectSpace's Voyager, and Grasshopper from IKV++. Emphasis will be given on the functionality covered in connection to the Object Management Group Mobile Agent System Interoperability Facility (OMG MASIF) specification[8]. All these platforms are implemented in Java and the agents are transferred via Java Remote Method Invocation (RMI)[9], OMG Common Object Request Broker Architecture (CORBA)[10] or Microsoft's Distributed Component Object Model (DCOM)[11].

Multimedia database This is used for storing and retrieving product and consumer data. The information stored in the database might include text data, video and audio. Relational databases to be taken into account include, among others, Oracle, SQL server, and Informix.

Supporting services

These components denote the supporting services that need to be developed in order to realise the tools of the proposed global electronic commerce service:

Message handler This component is responsible for dispatching HTTP messages from the home shopping tool to the various sub-components of the e-commerce platform, legacy systems and databases.

Virtual catalogue service This component provides information about product data residing on the electronic catalogues of the suppliers. Extensible mark-up language (XML) is going to be a critical technology to be adopted. XML[12] is an extensible language and it is to content what HTML is to presentation; it became a World Wide Web Consortium (W3C) standard recently. Furthermore, we plan to use the Information and Content Exchange (ICE) standard to describe products and merchant offering[13]. The ICE protocol builds upon the XML feature of using tags in order to define data fields within a document and having those fields correctly interpreted by a 'reader' application.

Agent services This component will deliver application specific services for the agent-based tools of the proposed system. The type of services that might be implemented depends on the capabilities of the selected platform. Thus, we might need some sort of registry services that will point the right consumer to the right merchant or product offering, or events subscription, etc.

Profile manager This component will provide structured personal profile information to offer individuals tailored content, goods and services that match their personal preferences, while protecting their privacy. The user profiling is going to be based on the Open Profiling Standard (OPS) to provide secure, private and personalised experiences. The OPS specification has been submitted to the W3C recently[14].

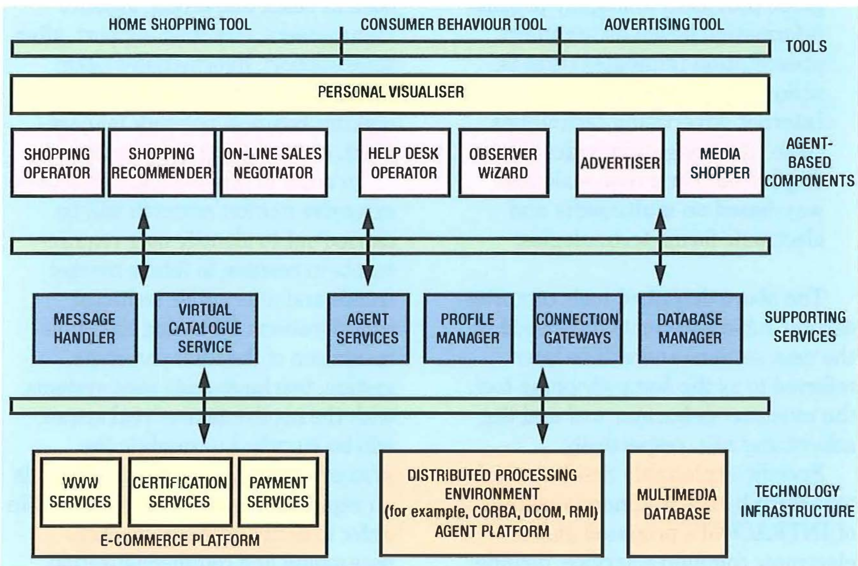
Connection gateways This component will cater for information exchange between the proposed system and the legacy ones. Thus, depending on the nature of the legacy systems, it might be necessary to have some kind of protocol translation between Internet and legacy systems; for example, HTTP message translation to bar code messages, EDI messages for inventory update, order processing, etc.

Database manager This component will provide the necessary structured query language (SQL) drivers for the information exchange between the databases and the proposed system. The information will include stock data, product data, promotion material, user profiles, etc. The implementation of the drivers will depend upon the type of the data warehouse; for example, relational database management systems, proprietary databases, files, etc.

Agent based sub-components

These are the agent-based components to be delivered on the basis of the proposed global electronic

Figure 1 – System architecture for the global electronic commerce service



commerce service. It is a decomposition of the three main tools of the proposed system—that is, the home shopping tool (the first four sub-components), the consumer behaviour tool (the next two sub-components) and the advertising tool (the latest two sub-components), that were described in the previous section.

Virtual shopping operator This sub-component is responsible for the provision of basic purchasing services such as, electronic baskets, which will host the selected products, access to product information through electronic catalogues and point-of-sales (POS) types of services (for example, secure order processing and payment). Integration with the retailers' legacy systems will also be considered, while the *product information model* will provide product information.

Shopping recommender This sub-component will provide recommendations to the users regarding products purchasing—that is, discounts, special offers, new products, contests and lotteries, etc.—taking into account the consumer's profile, which will be registered in the *consumer information model*. In addition, recommendations will take place, based on other consumers' comments.

On-line sales negotiator This sub-component will find, based on agent technologies, negotiate and purchase products on behalf of the shoppers and retailers, based on a set of user-specified constraints such as, desired price, a highest (or lowest) acceptable price, technical specification, a date by which to sell (or buy), etc. Launching of agents will be optional depending on consumer or retailer requests. In addition, the wizard will disseminate smart queries along electronic catalogues that will be connected to the system under a *virtual catalogue scheme*.

Personalised retail store visualiser This sub-component is responsible for the virtual store customisation. It will provde an interface based on consumer preferences; that is consumers may wish to see only products they are interested in or they may wish to use a virtual reality interface with human salespeople instead of catalogue navigation. So, this sub-component will provide a personalised view of the virtual store based on user profiles and on advanced presentation schemes.

Help desk operator This sub-component, enabled through electronic forms technology, will be responsible for the direct elicitation of consumer behaviour data through questionnaires and e-mail boxes.

More specifically, electronic questionnaires will be presented to the users according to their navigation within the virtual store in specific time intervals (that is, 'resting spaces', on entrance or exit, etc.). The questionnaires will refer to existing products or brands evaluation, new product introduction, consumer needs for new products or services, even suggested product specifications, etc. The consumers will also participate in virtual contests or lotteries.

On the other hand, complaint boxes will be supported by this sub-component for expressing comments on the service, products or the virtual retail store itself. This data will be also registered in the *consumer information model*.

Observer wizard This sub-component, based on agent technology, will be responsible for the recording of consumer navigation in the system while he/she selects and purchases products. The collected data will refer to the consumer habits (that is, which products are visited or selected first, how much time is spent for information on a specific product or watching a specific video commercial), consumer needs (which products are more commonly selected or viewed) and shopping behaviour (how the consumer uses the system, how much time he/she spends inside the virtual store, etc.) and will be stored in the *consumer information model*.

This data will be used by suppliers for marketing policy definition including product evaluation and support for targeted 'narrow-casting' promotion techniques such as couponing, e-mail discount alerts, direct compensation for advertisement viewers, and sweepstakes. We should point out that this function will take into account individual privacy protection.

Advertiser This sub-component is responsible for target advertising of products (directory advertising) through the provision of a rich set of advertising templates (with different size, quantity of information, type of data, etc.). The content providing and the template selection will depend on the suppliers' preferences. The advertisement will be presented when the consumer clicks on the selected product for more information, at the time he/she visits electronic product catalogues. The related information will be stored in the *product information model*.

Media shopper This sub-component will be responsible for the negotiation and provision of TV advertising policies in terms of time zones, pricing, best time view, etc. The video commercials, displayed on specific parts of the screen, will follow these policies. This service will be provided taking into account best space allocation, based on dynamic programming algorithms, and proposed display time for each product category, by combining data on product purchase time data and consumer profiles.

Tools

The system is comprised of the three above-mentioned tools, namely the home-shopping tool, the consumer-behaviour tool and the advertising tool.

Figure 2 illustrates the proposed environment of the *personalised virtual store* in terms of interconnectivity and interdependence of the system's components as well as their interaction with the retailer, supplier and consumer entities.

An issue of great importance is the extensibility of the system. That is, the proposed global electronic commerce service is based on an open, scaleable and extensible architecture, which will allow seamless interoperation among its main components and will, furthermore, permit the integration of additional individual system components and product hierarchies into the whole system in a plug-and-play-manner. Thus, the whole architectural design of the system allows it to remain, as much as possible, independent of particular technology and platform choices.

Conclusions

This paper has presented a system which aims at producing a global electronic commerce platform for the support of integrated retail services, establishing a new advertising, promotion and purchasing medium. In addition, it will provide for customer convenience and facilitation of the product seeking and purchasing function. Thus, the proposed system offers a full elec-

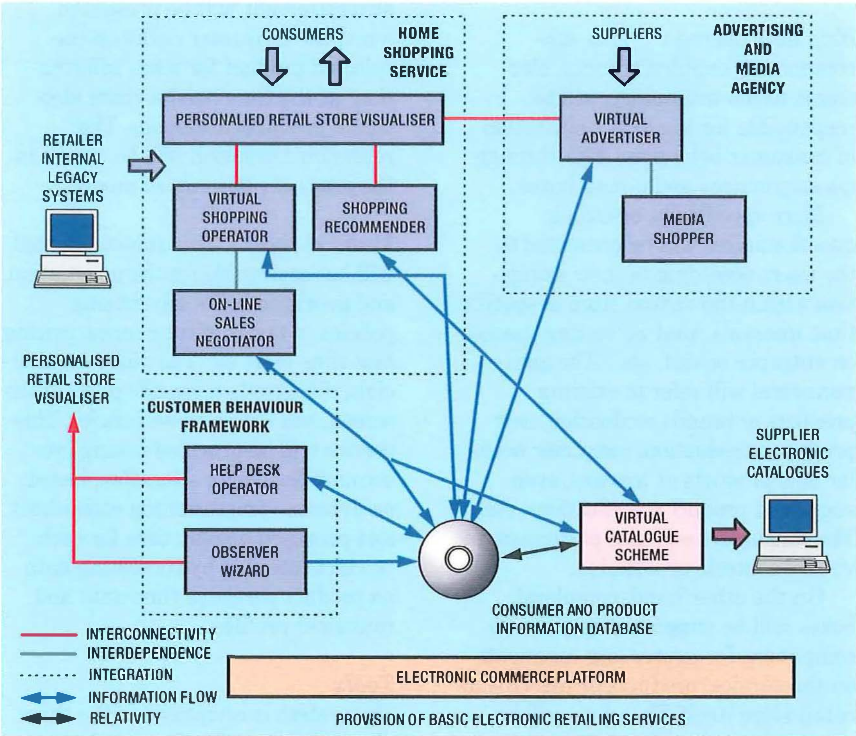


Figure 2 – The proposed environment for the global electronic commerce service

tronic commerce platform capable of providing for retailers', suppliers' and customers' needs.

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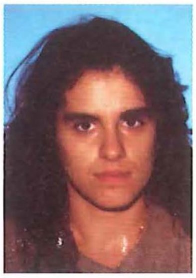
Biographies



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Dr. Constantine A. Papandreou and Dionisis X. Adamopoulos

Design of an Interactive Teletraining System

New information and telecommunication technologies create many great challenges and opportunities for growth, generating a strong demand for more efficient and expedient ways to distribute knowledge. The challenge is for innovative technological systems that can reach great numbers of people with vast amounts of information under a variety of conditions. In this paper an attempt is made to conceptualise how such systems might work by considering the new instructional paradigm of interactive teletraining. An architecture is proposed and analysed, and the development of a TINA-C multimedia conferencing service for education and training is examined.

Introduction

Rapid technological developments are taking place in both information and telecommunication technologies. An evolving synergy between these, termed *telematics*, is gradually gaining momentum, providing a wide range of opportunities for the delivery of new advanced multimedia telecommunications services (telematic services) in a liberalised global market. In addition, privatisation and competition are expected to create the economic incentives for the construction of a telecommunications infrastructure capable of delivering broadband connectivity to all subscribers. National information infrastructures will be interconnected to form the global information infrastructure (GII) extending broadband connectivity throughout the world (information superhighway)[13].

In this environment, training centres, universities, and other educational establishments are encouraged to adopt a new educational and training paradigm, where teaching and learning are constrained by neither time nor distance, but where interactivity is a key component in the learning process[15]. Teletraining provides a platform for the effective and efficient realisation of this new paradigm. Its objective is to enable and facilitate people in the emerging information society, to learn what they like (by improving access to learning facilities), when they like (by providing flexible methods of delivery), where they like or can (at home, at work, in rural areas), at their own pace[11, 22].

This paper examines the efficient support of teletraining activities through the use of new telecommunications services. It proposes an architecture, which, in combination with the service engineering framework of TINA-C, facilitates the design of interactive teletraining systems suitable to address a wide variety of emerging educational and training needs.

The Concept of Teletraining

Within a context of rapid technological change and shifting market conditions, the movement and management of information is critical to the growth of a business. As corporations expand their operations at an international level, they are faced with geographical and cultural constraints that require innovative solutions. Moreover, corporations (especially those with an international presence) have complex training requirements in order to keep their (distributed) work force fully up-to-date. Additionally, in the field of education there is a growing demand for programmes which can provide adults with a second chance at a college education, and reach those disadvantaged by limited time, distance or physical disability. To meet these needs, companies and individuals have turned to the use of teletraining.

Teletraining is an integrated system for the planning, design, delivery, and management of training programmes through the use of advanced telecommunications services. It allows organisations to deliver training from an instructor-led location to students/trainees at remote sites located anywhere in the world. The students can interact with the instructors and with each other as if they were together in the same classroom[7, 12, 21].

The following types of teletraining can be identified[3,10]:

- *Audio teletraining:* This supports two-way audio communications between the instructor and learners at remote sites (audioconferencing). It utilises the public telephone network, while for large groups of trainees additional devices are used to reduce noise and interference. Technical components of audio teletraining might include telephone handsets, speaker phones or microphones, an audio bridge that interconnects multiple telephone lines and controls noise,

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and a speaker device to facilitate multiple interactions.

- *Audiographic teletraining:* This is audio teletraining supported by enhanced image or data transmissions (audiographic conferencing). While voice remains the principal communication medium, audiographic peripherals provide a visual component. Examples of such peripheral devices are an electronic blackboard, a facsimile machine, still video technology, and a personal computer.
- *Multimedia teletraining:* This supports two-way video and audio communication between multiple locations using sophisticated computer technology (computer-based interactive video-conferencing)[6]. The presence of computers also permits the (simultaneous) interchange of data, text, vector graphics, and pixel-oriented images. This type of teletraining utilises (as well as computers), codecs, modems, monitors, pre-recorded video, microphones and cameras, and can be implemented in the following ways:

  –*Small room videoconferencing:* This is designed primarily for small groups (1–12 trainees) seated around a conference table.
  –*Classroom videoconferencing:* This usually uses high-quality audio video (AV) components and an interface that allows all participants to be seen on the monitors.
  –*Desktop videoconferencing:* This utilises a personal computer and videoconferencing software, and is strongly advocated for individuals. All participants in a training session should have the same software and hardware in order to ensure equal opportunities on computer interaction and feedback.

All three types of teletraining enable organisations to train in a timely manner, reduce expenses, minimise disruptions, and increase productivity. However, teletraining is also a better alternative to other innovative training strategies, such as computer-based training (CBT), computer-assisted instruction (CAI), computer-managed instruction (CMI), instructional audio, and instructional television. All of these innovative technologies satisfy, to varying degrees, the following requirements: timely training of employees, decreasing travel costs, and increasing the productivity of existing training resources.

Teletraining is able to go beyond these requirements and meet additional client needs because it is an instructor-led technology. The other training strategies are only interactive in a highly structured, preprogrammed sense. The only feedback and responses the trainee can receive are those that are already built in. However, teletraining has a 'live' real-time character which can be adapted quickly in response to trainee input or changes in the training environment.

The benefits of teletraining include: increased flexibility in the delivery of learning, increased training to more employees without increased training resources, increased access to subject matter experts, increased sharing of information among staff at dispersed locations, and improved coordination and cooperation among employees[12]. Research comparing teletraining to traditional face-to-face instruction indicates that teaching and studying at a distance can be as effective as traditional instruction, when the method and technologies used are appropriate to the instructional tasks, there is student-to-student interaction, and timely teacher-to-student feedback[11, 21].

Teletraining facilitates training centres to offer seminars and courses at a distance, which have, in the past, been provided exclusively within a traditional educational structure. Widely dispersed groups of trainees, or trainees who are located at considerable distances from training centres, can be offered virtually all the facilities which would be available to them if they were to attend a traditional training centre. Therefore, training centres have the facility to add virtual components to their provision, or, alternatively, training centres may, themselves, be virtual organisations[8]. The proposed architecture for an interactive teletraining system, which is presented in the following section, aims to lead training centres in this direction.

The Proposed Architecture

In order to design and implement successfully an effective and efficient multimedia communication system for education and training, an integrated and systematic approach is required. For this reason, an architecture for an interactive teletraining system is proposed. The main aims of this architecture are to support efficiently teletraining applications, to provide communication capabilities to students / trainees as widely as possible (even worldwide), and to operate in an unproblematic and cost-effective manner by utilising standardised components. It can be considered as a part of a more general framework for the application of distributed broadband multimedia communication services in education and training, which assists in an organised and concise way the composition of a set of specifications that ensures the creation of teletraining systems able to accomplish their objective today and in the future[19].

The constituent parts of the proposed architecture can be seen in Figure 1. Training centres (or other educational establishments) are responsible not only for the production of the training material, but also for the management of all the training activities. They deliver teletraining to both organisations / enterprises and individuals through the use of a suitable network infrastructure. With reference to this infrastructure, several fixed and mobile technologies may be employed in the physical layer. High-speed performance, flexibility, and efficient support of continuous media should characterise all of them[13].

Multimedia teletraining (as defined earlier) is considered to be the most promising type of teletraining[19]. For this reason, training centres offer it by providing enhanced classrooms with state-of-the-art AV and computing equipment[6]. More specifically, training centres offer all three variants of multimedia teletraining. In an enhanced classroom, trainees interact with a trainer, who can be either present in the classroom or located in a remote classroom at another training centre. They can also interact with other trainees in remote classrooms. In the same manner, trainers use the facilities of the enhanced classrooms to establish teletraining sessions with remote trainees. These trainees can be either individuals, located at home or their place of work, or employees of a specific organisation. In the latter case, training can take place in enhanced classrooms (if possessed by the client organisation) or at the offices of the employees utilising the (local area) networking resources of the organisation.

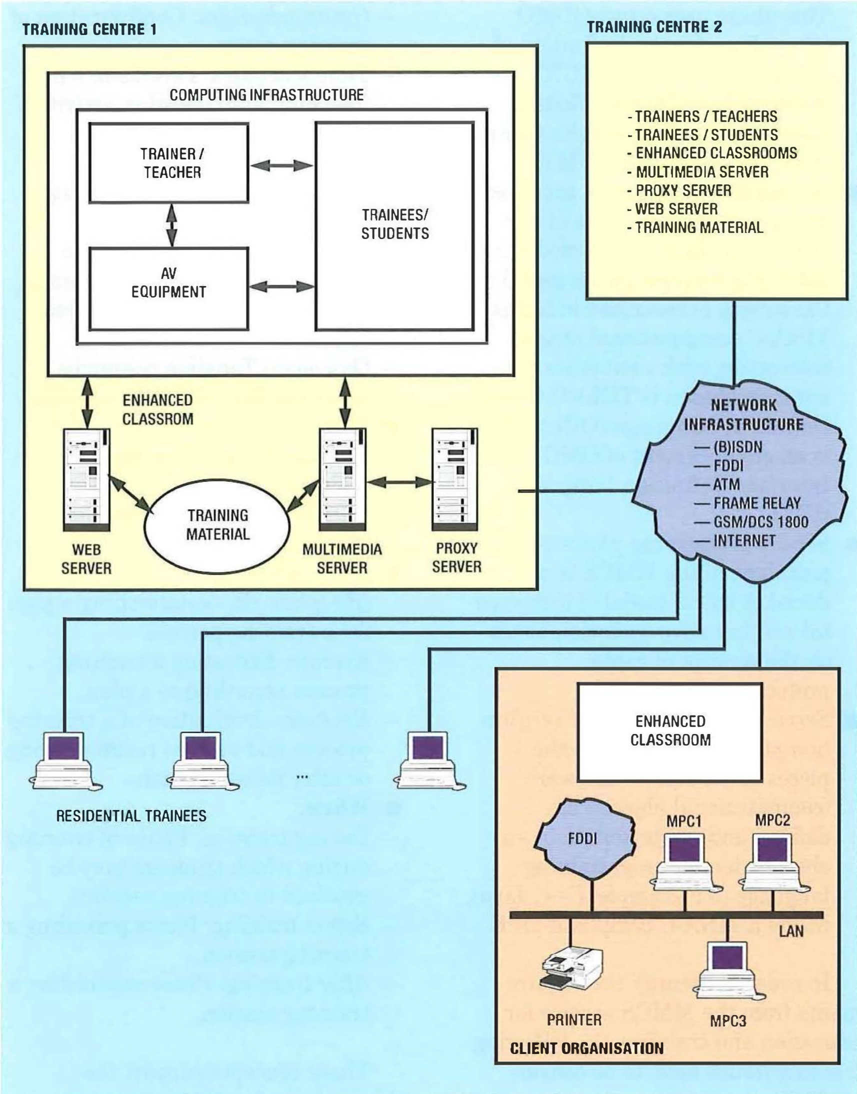


Figure 1 – The proposed architecture for an interactive teletraining system

As can be seen in Figure 1, it is suggested that at least two servers should be installed solely for the purpose of interactive teletraining. The first server (multimedia server) is used mainly as a store-and-forward device. Video signals are captured by the video camera of an enhanced classroom, converted from analogue to digital, compressed and stored. Then they are used to update the video stream to the trainee's site. Reaction from the trainee is also transmitted to this server to be forwarded to the correct enhanced classroom screen. The second server (proxy server) is primarily used for security considerations. Only trainees/students enrolled in the offered seminars/courses should be allowed access to the resources. This server monitors the network traffic allocated to each location of service request ensuring that only one stream of data is sent to a location where multiple requests are received (for example, a client organisation). It also oversees the overall traffic volume in the network and limits the number of users as deemed fit. Finally, it allows authentication of the trainees and is responsible for the encryption of data streams.

From the description of the proposed architecture, is evident that a multimedia conferencing service (MMCS) for education and training has a central role in an interactive teletraining system[9], and thus it will be examined in more detail. In order to realise such a telematic service in a deregulated environment open to competition and open to changes in market and technology, developments in the areas of intelligent networks (INs) and telecommunication management network (TMN) must be taken into account in an integrated and unified manner. Additionally, the approach used should support the following principles:

- object-orientation,
- reusability,
- precise service semantics,
- accommodation of legacy services and systems,
- accommodation of standards,
- industrial applicability,
- openness to all types of end-users,
- openness to all types of applications, and
- openness to change of service software and hardware.

Therefore, there is a need for an innovative architectural framework addressing in an integrated manner both service control and service management. For this reason, the framework defined by the Telecommunication Information Networking Architecture Consortium (TINA-C) is proposed to be used for the development of the multimedia conferencing service for education and training. TINA-C encompasses the long term objectives of both IN and TMN, applies open distributed processing (ODP) standards and object-oriented design principles, facilitates the efficient design and provision of services in a heterogeneous system and network environment with different domains of ownership, and ensures the introduction of new and enhanced services and their management, much faster and more efficiently than with current approaches[5, 17].

It has to be noted that the selection of TINA-C does not exclude the Internet from the proposed architecture. On the contrary, it is suggested that the Internet should be used to supplement and enhance the training process. Although it is not best suited for real-time communication, it can efficiently support interactions which take place with time latency. Students may e-mail questions to their instructors or fellow students. Teachers and peers, in turn, may respond at their convenience. Additionally, the ubiquitous World Wide Web (WWW) infrastructure can greatly facilitate student access to instructional material at both scheduled and unscheduled times[14], and this is reflected in Figure 1, where a Web server is proposed for each training centre. However, the further exploitation of the Internet for teletraining is hindered by its non-deterministic nature. Its integration and interoperation with formal distributed processing environments, such as OMG's CORBA and Microsoft's COM/DCOM, is envisaged to result in globally interconnected interacting objects[2, 4]. This 'web of objects' will be able to provide issues like on-line reliable information retrieval, authentication, confidentiality, security, accounting, and customisation, which are necessary for teletraining applications[22].

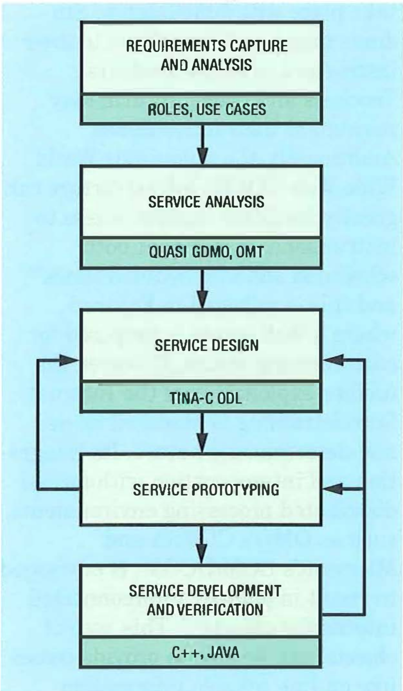
In the following paragraphs the development of a multimedia communication service for education and training using TINA-C will be examined. Additionally, alternative network technologies and important design considerations for interactive teletraining systems will be identified.

A Multimedia Conferencing Service for Education and Training

For the development of the MMCS for education and training TINA-C is used as the target platform. The service creation methodology which is proposed to be used for the MMCS under examination can be seen in Figure 2[1].

- *Requirements capture and analysis phase:* It identifies the MMCS requirements (together with a number of roles), and presents them in a structured way. The use case concept is applied for this purpose.
- *Service analysis phase:* It describes the semantics of the problem domain that the MMCS is designed for. Thus, it identifies the objects that comprise the service (service objects), their types, and their relationships.

Figure 2 – The proposed methodology for the development of the MMCS for education and training



This phase uses quasi-GDMO (Guidelines for the Definition of Managed Objects) with GRM (General Relationship Model), together with Rumbaugh's Object Modelling Technique (OMT).

- *Service design phase:* It produces the design specifications of the MMCS. Computational modelling takes place in this phase and thus the service is described in terms of TINA-C computational objects interacting with each other. The notation chosen is TINA-C Object Definition Language (ODL), which is an enhancement of OMG Interface Definition Language (IDL).
- *Service prototyping phase:* A prototype of the MMCS is produced. A spiral model of incremental and iterative evolution based on the concept of rapid prototyping is adopted.
- *Service development and verification phase:* In this phase the pieces of the service software (computational objects) are defined and implemented in an object-oriented programming language (for example, C++, Java), inside a TINA-C compliant DPE.

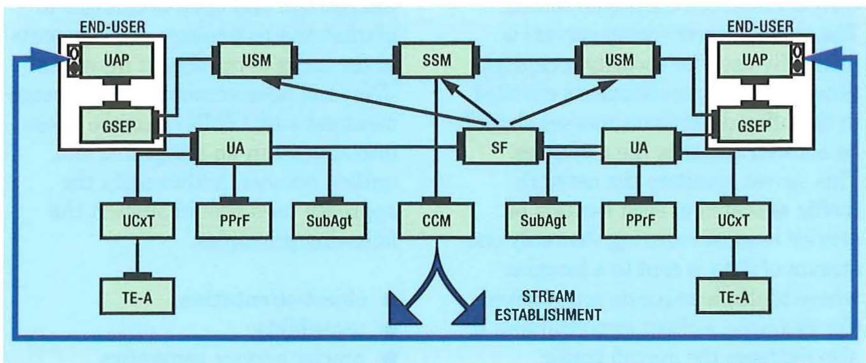
In order to identify the requirements from the MMCS service for education and training, the following training issues have to be considered[16, 20]:

- ***What:***
  - *Training objectives:* Expected outcome of, or deliverable produced by, a training process.
  - *Entry conditions:* Prerequisite skills and knowledge of students.
  - *Activities:* Training activities facilitating achievement of training objectives.
  - *Learning content:* Non-human, passive information resources.
  - *Group schedules:* Configuration of training actors.
  - *Time schedules:* Periods in which (teaching and) learning activities are expected to occur.
  - *Activity schedules:* Ordering relationships between training activities.
  - *Media and tools:* Non-human resources for production, storage, retrieval or transfer of information.
  - *Outcomes:* Tangible resources resulting from training activities.
- ***Who:***
  - *Teacher / trainer:* Principal training provider.
  - *Student / trainee:* Educational consumer.
- ***Meta-activity:***
  - *(Re-)plan:* (Re-)establishing a plan for a training process.
  - *Execute:* Executing a training process according to a plan.
  - *Evaluate:* Evaluation of a training process and process results during or after its completion.
- ***When:***
  - *During training:* Phase of training during which students may be involved (a training session).
  - *Before training:* Phase preceding a training session.
  - *After training:* Phase succeeding a training session.

These concepts support the description of training processes. More specifically, they specify 'what' training processes involve and 'who' is involved in them. Additionally, they consider three meta-activities, as training processes are subsumed to plan-do-evaluate cycles, and indicate also 'when' a plan-do-evaluate cycle can occur.

The computational view of the MMCS for education and training can be seen in Figure 3. Assume that a teacher wishes to establish a

Figure 3 – Main TINA-C computational objects involved in the MMCS for education and training



multimedia conference with a student. First, the user application (UAP) at the teacher's site contacts a generic session end point (GSEP) asking for an invocation of the specific service. The GSEP forwards the request to the teacher's user agent (UA) including authentication data. The UA performs an authentication proof by querying a subscription agent (SubAgt) to check if the teacher is authorised to use the MMCS. The SubAgt returns either a non-authorisation notification or an authorisation. In the latter case, it delivers the MMCS profile containing associated service capabilities and an object reference of a service factory (SF) with the capability of creating MMCS session components. Then, the UA asks the usage context (UCxt) for an appropriate terminal associated with the teacher, that satisfies the requirements expressed by the service profile. The UCxt consults terminal equipment agents (TE-As) to obtain capabilities and states of registered terminals in order to perform the selection task, and returns the terminal and network access point. Having succeeded in the authorisation and capability checks, the UA queries the personal profile (PPrf) for the teacher's constraints and preferences for individual service execution.

After the reception of the personal service settings the UA creates the MMCS session. More specifically, it asks the SF to create a user service session manager (USM) and a service session manager (SSM). The *UA* relays the creation result and the USM reference to the GSEP. The GSEP forwards the USM reference to the UAP and the MMCS session components start their interaction. Having established the service session, the teacher can invite a specific student to join it. Then, its UAP relays the request to the SSM, which contacts the UA of the invited student. The student *UA* first queries the subscription agent in order to check the subscription characteristics of the student with respect to the required service. If the invited student is authorised, the UA finds the terminal at which the student can be reached, and alerts the student through the appropriate GSEP and UAP. If the student accepts the invitation, his/her UA initiates a join phase asking an SF to instantiate a (student) USM. This USM is then linked to the SSM and the accepted student invitation is signalled to the teacher's UAP. Finally, the SSM requests via connection management (that is, the communication session manager (CSM)), the establishment of a stream between the UAPs of the teacher and the student, and the interaction between them begins.

Table 1 Network Technologies for Teletraining Systems

Network Technologies		Access Speed (Mbit/s)	Isochronism	Bandwidth Guarantees	Stream Multicasting
Packet LAN/MAN					
Ethernet	Standard	10	No	No	Yes
	Switched	10	Yes/No (1)	Yes/No (1)	Yes
	100Base-T	100	No	No	Yes
	100VG-AnyLan	100	Approached	Allocated	Yes
Token Ring	Priority	4,16	Approached	Allocated	Yes
FDDI	Standard	100	No	No	Yes
	Synchronous	100	Approached	Allocated	Yes
FDDI-II		100	Yes	Dedicated	Yes
ATM LAN		34–622	Yes	Dedicated/ Allocated	Yes/No (2)
Packet WAN					
IP	Standard	0·001-100	No	No	Yes
	with RSVP	0·001-100	Approached	Reserved	Yes
ST-II		0·06–2 (3)	Approached	Reserved/ Allocated (3)	Yes
Circuit WAN					
PSTN		10^{-3}–0·0336	Yes	Dedicated	No
Leased circuit	Analogue	10^{-3}–10^{-2}	Yes	Dedicated	No
	Digital	0·064–45	Yes	Dedicated	No
ISDN		0·064–2 (3)	No (3)	Reserved (3)	No
SMDS		1–34	-	Mean bit rate	Yes

(1) Depends on the interswitch capacity
(2) Yes at switch level, not yet at network level
(3) Implementation dependent

The Network Infrastructure

Interactive teletraining requires the real-time transmission of continuous media information (audio and video). For this reason, the network selected for the proposed architecture of Figure 1, whether local or wide area, should support high transmission rates and have a range of protocols suitable for dealing with multimedia traffic[9, 13].

In the local/metropolitan area, the central network technologies for teletraining are Ethernet, priority token ring, fibre distributed data interface (FDDI), and asynchronous transfer mode (ATM) (Table 1). Ethernet and priority token ring use the principle of sharing a medium among several stations. Evolution of the Ethernet is the 100 Mbit/s Ethernet which has two variants: the 100Base-T fast Ethernet and the 100VG-AnyLAN. FDDI is an ANSI standardised 100 Mbit/s token ring-based metropolitan area network able to support about 500 workstations over a distance of 200 km. The more recent FDDI-II standard explicitly supports continuous media data by partitioning the available bandwidth into *isochronous* (for continuous media) and *non-isochronous* (for conventional data) parts. Finally, ATM switches fixed-length frames called *cells* and allows variable numbers and capacities of connections, each with a particular throughput, latency, and cell loss properties.

In the wide area, a teletraining system can utilise, either a packet-based, or a circuit-oriented wide area network (WAN). In the former case, candidate technologies are the Internet protocol (IP) and ST-II (Table 1). IP is a connectionless best-effort delivery protocol, operating at layer 3 of the ISO hierarchy. The fact that IP can operate over virtually any underlying transport mechanism, at bit rates ranging from 300 bit/s to 100 Mbit/s, makes it capable of supporting a wide range of teletraining applications. With the addition of RSVP (resource reservation protocol), IP can satisfy even demanding real-time videoconferencing requirements. Finally, ST-II is a connection-oriented packet protocol designed for continuous media streams. ST-II can also support demanding teletraining applications, as it exhibits good performance in the transmission of real-time packet audio and video streams.

In the case of circuit-oriented WANs, the main alternative technologies can be seen in Table 1. However, the most prominent technology for the economic and effective realisation of teletraining is the integrated services digital network (ISDN). ISDN is a digital network standard, intended to replace current telephone networks, which supports a wide range of voice and multimedia services that users access through a limited set of standard multi-purpose user-to-network interfaces. Broadband ISDN (B-ISDN) is an evolution of ISDN, which is expected to become the key network for demanding teletraining applications. The channel rates envisaged for B-ISDN are H21 (32·768 Mbit/s), H22 (an integer multiple of 64 kbit/s in the range 5–43 Mbit/s), and H4 (an integer multiple of 64 kbit/s in the range 8–132 Mbit/s). Proposed B-ISDN networks are in either synchronous transfer mode (STM), or asynchronous transfer mode (ATM), to handle both constant and variable bit-rate traffic applications. Other promising technologies in the wide area for the future are frame relay and the switched multimegabit data service (SMDS) (Table 1), which both can be implemented on top of a number of other network technologies.

Finally, in wide area mobile teletraining systems, cellular radio based systems are becoming prevalent. The most important cellular-based network at the present time is the second generation pan-European digital service commonly referred to as GSM (global system for mobile communications). This is used by trainees, not only for voice, but also for data communications, as it has an acceptable (for simple mobile teletraining applications) raw data rate of 13·8 kbit/s (9·6 kbit/s with error checking). Mobile multimedia teletraining is expected to be supported gradually by third-generation mobile systems, such as DCS 1800. However, it must be noted that currently for such systems, very small aperture terminals (VSATs) are used in special cases.

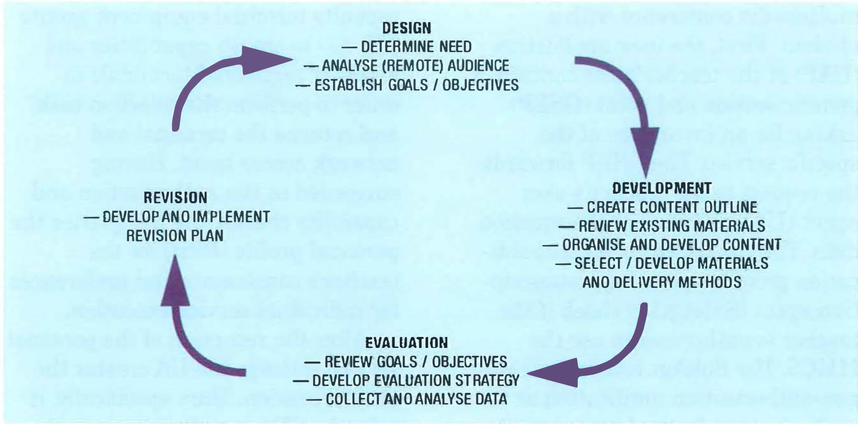


Figure 4—A teletraining instructional development process

Other Important Design Considerations

The realisation of the full potential of teletraining is more than a simple matter of providing the technologies and putting students and tutors online. Important issues which need to be addressed are not only the technological ones, but also issues of communication and coordination, pedagogy, and management[11]. Effective implementation involves thoughtful construction of the virtual learning environment, careful design of the learning materials, thorough training of tutors, and the adaptation of organisational and management structures to accommodate a new paradigm[8, 15].

Without exception, successful teletraining begins with careful planning and a focusing on content requirements and student needs[18]. Appropriate technology can be selected only once these elements are understood in detail. As there is no one best use of technology, there is no one best way of teaching with technology. Flexibility should be encouraged, allowing teachers to develop their personal teaching approach utilising the variety of options offered by technology.

An instructional development process is essential in teletraining, because the teacher and students may share limited common background and typically have minimal face-to-face contact. Such a process provides a framework for systematically planning, developing, and adapting training based on identifiable learner needs and content requirements. An instructional development process that can be used in a teletraining environment consists of the stages of design, development, evaluation and revision, and can be seen in Figure 4[21].

Conclusions

Teletraining is a cost-effective method for delivering teaching and learning with significant potential. Benefits, in addition to cost-efficiency, include the ability to reach remote, low density locations which are too difficult and time consuming to reach through conventional travel arrangements, the ability to add multiple locations to a training session when needed, the flexibility to increase the number of students who can be reached at one time, the ability to disseminate information quickly to an entire work force, and the ability to share limited instructor resources[3]. However, caution is necessary as organisational and management structures need to be adapted along with this new mode of delivery, course design needs to be carefully structured, and appropriate pedagogical methods thoughtfully chosen.

The architecture proposed in this paper, in combination with TINA-C, which, as a service engineering architectural framework, ensures the fast and successful evolution of the telecommunications market in a broadband environment, promises to make teletraining an integral part of the emerging open integrated broadband telematic service infrastructure. In this environment, interactive teletraining systems will quickly mature and support in a more active, flexible and economic way, highly individualised, just-in-time, and on-demand training processes.

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J.W. Meijer and J.M.G. Geraads

Convergence and Divergence in Business Communications

Bandwidth has become a primary need. Fortunately the bandwidth provided for by communications equipment doubles roughly every 2·5 years. The forces that drive this doubling are Moore's Laws. According to Metcalfe's Law a network becomes more valuable as it reaches more users. We will discuss some ways in which networks are affected by this law. These laws lead to convergence in the marketplace. The opposite effect is achieved by the current explosion of new applications. We will give some examples of this phenomenon, which leads to divergence in the marketplace.

Introduction

Where would Abraham Maslow have placed bandwidth in his hierarchy of needs today? Most probably at the same level as physical needs like food, drink, sleep and sex. The need for bandwidth starts manifesting itself early in the morning when we log in at home or at the office to collect our e-mail, and it ends at three o'clock the next morning when the information highway is free of traffic jams and we are finally able to transfer large files. Bandwidth (that is, the number of bits that can be transmitted per second through a given channel) has most definitely become a primary need.

But the information highway is fog-bound. This leads to the paradoxical situation where we all want to cruise the highway despite receiving warnings from all sides that we will be able to advance only very slowly. Purchasing a new vehicle to cruise even faster is something night owls would do. Some time ago, seeing the fog, a number of alchemists started seeking the philosopher's stone. 'Turn copper into gold' was what one of them proposed at the FITCE congress in 1996 in Vienna. Interesting, but then you are still on the information superfootpath, was the comment given by Peter Cochrane, the keynote speaker in Vienna[1]. He told us that we need optical fibres for an information superhighway, and that we should not amplify, switch and route signals electronically but optically. In order to look your partner deep in the eyes you need to transmit information at a rate of at least one gigabit per second. Today we are still living in the Stone Age and we have to satisfy ourselves with postage-stamp-sized televisions.

In the following sections we will explore the forces that have given rise to our need for bandwidth, discuss certain convergent network effects, and finish with some examples of divergent application trends.

More about Moore's Law

In 1965, Gordon Moore wrote that: 'Integrated circuits will lead to such wonders as home computers—or at least terminals connected to a central computer—automatic control for automobiles, and personal portable communications equipment.'[2]. In 1959, year zero, the year that Moore co-founded Fairchild Semiconductor, the number of components on an integrated circuit was only one. In 1962, it was eight. By 1963, it had increased to 16, in 1964 to 32, and in 1965, it reached 64. At that point, Moore predicted that: 'With unit costs falling as the number of components per circuit rises, economics may dictate squeezing as many as 65 000 components on a single chip by 1975.' Moore predicted that the number of components on a chip would double every year. Let us see what happened (see Figure 1 and Table 1)

For the past 25 years the number of transistors on a chip has doubled with almost clockwork precision roughly every 2·2 years (R^2=0·99], instead of every year as Moore predicted in 1965. We call this Moore's First Law.

Due to both the increase in clock frequency and the number of transistors on a chip, the processing power in MIPS, expressed in millions of instructions per second, has doubled

Fig. 1. Moore's First and Second Laws

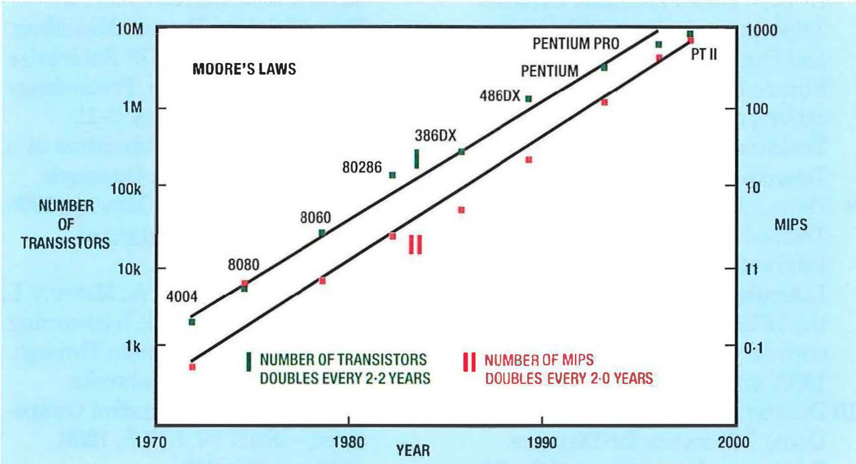

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Table 1 Intel Microprocessor Data

Year	Procesor	Number of Transistors	MIPS	Clock Freq (MHz)
Nov 71	4004	2300	0·06	0·108
Apr 74	8080	6000	0·64	2
Jun 78	8086	29 000	0·75	10
Feb 82	80286	134 000	2·66	12
Oct 85	386DX	275 000	5–6	16
Apr 89	486DX	1 200 000	20	25
Mar 93	Pentium	3 100 000	112	66
Nov 95	Pentium Pro	5 500 000	(428)	200
May 97	Pentium II	7 500 000	(632)	300

roughly every 2 years for the past 25 years (R^2=0·97). We call this Moore's Second Law.

If we limit ourselves to the past 13 years, the doubling period of Moore's Second Law is roughly 1·6 years (R^2=0·99). In the press, the doubling period of Moore's First Law is mostly given as 2 years and that of Moore's Second Law as 1·5 years.

Gordon Moore observed recently that his law 'has become a self-fulfilling prophecy'. Companies literally plan on it. The computer you buy four years after you bought your current one will have internal and external memories that are four times larger and it will be six times more powerful. This moved Steve Steinberg to write in *Wired* that progress today is all too predictable[3]. Change has become routine and uneventful. Progress has become automated. Convergence is everywhere.

Speed Isn't Everything. It's the Only Thing

Moore's First and Second Laws are well-known. What is less well-known is that they are the major driving factors behind our bandwidth needs.

Moore wrote in 1965 that integrated circuits would lead to such wonders as home computers—or at least terminals connected to a central computer. He could have added modems. Our need for more bandwidth (that is, more information bits per second) has led to an ever-increasing need for both memory capacity and processing power. Hence we expected that the market introduction of modems would follow the rhythm of Moore's Laws. Ken Polsson's *Timeline of Microcomputers* on the Internet provides us with the relevant data on modems (Table 2).

The doubling time of modem speed was roughly every 2·5 years in the PSTN era (Figure 2). Between 1978 and 1996 modem costs were all important while PSTN transmission costs were a transparent factor. We observe that only now are we really beginning to enter the ISDN era.

Extrapolation suggests that in April 2003 the market will be ready for video communication at speeds of 384 kbit/s if we assume a level of transmission costs acceptable to the customer.

What about speeds of 1·5 Mbit/s and higher? When will copper finally turn into gold? We expect that widespread introduction of asynchronous digital subscriber loop (ADSL) and xDSL-based services will be problematic for some time to come. Probably just as problematic as the introduction of ISDN in the mid-eighties proved to be.

Does the data community follow a different path? Let us take a look at the introduction data of local area networks (LANs). The first experimental Ethernet LAN was built by Metcalfe and Boggs at Xerox Parc in 1976. Ethernet (10 Mbit/s) hit the market in 1982, fast Ethernet (100 Mbit/s) in 1990 and gigabit Ethernet (1000 Mbit/s) in 1998. So LAN speeds have been doubling roughly every 2·4 years.

What about wide area networks (WANs)? KPN Telecom introduced packet switching (X.25; 64 kbit/s) in the Netherlands in 1982. Frame-relay followed in 1992 (2 Mbit/s) and in 1998 (34 Mbit/s). This gives a doubling period of approximately 1·8 years.

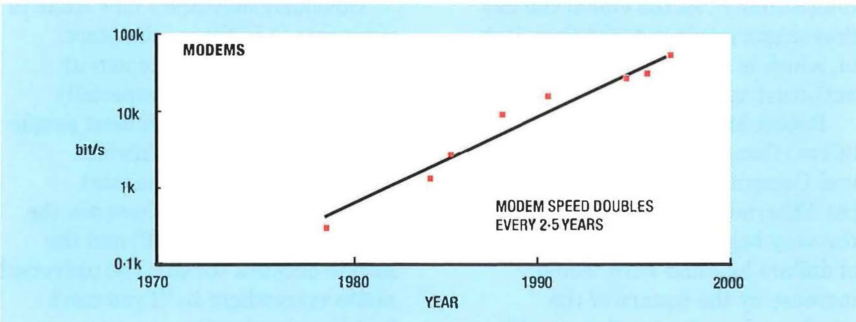
Clearly Moore's Laws rule supreme in the systems needed for LAN and WAN alike.

Finally let us have a look at carrier networks. What path was followed by the systems needed to build these networks? A plesiochronous digital hierarchy (PDH) network was built in the Netherlands by KPN Telecom in the mid-eighties, and an asynchronous transfer mode (ATM)/synchronous digital hierarchy (SDH) network is being built today. Carrier speeds, see

Table 2 Market introduction data for modems

Year	Standard	Speed (bit/s)	Company
Jun 78	V.21	300	Hayes
Jan 84	V.22	1200	Apple
Dec 84	V.22bis	2400	Several
Jan 88	V.32	9600	Hayes
Jun 90	V32.bis	14 400	US Robotics
Jul 94	V.34	28 800	US Robotics
Jul 95	V.34+	33 600	US Robotics
Dec 96	X2	56,000	US Robotics

Figure 2—Modem speed



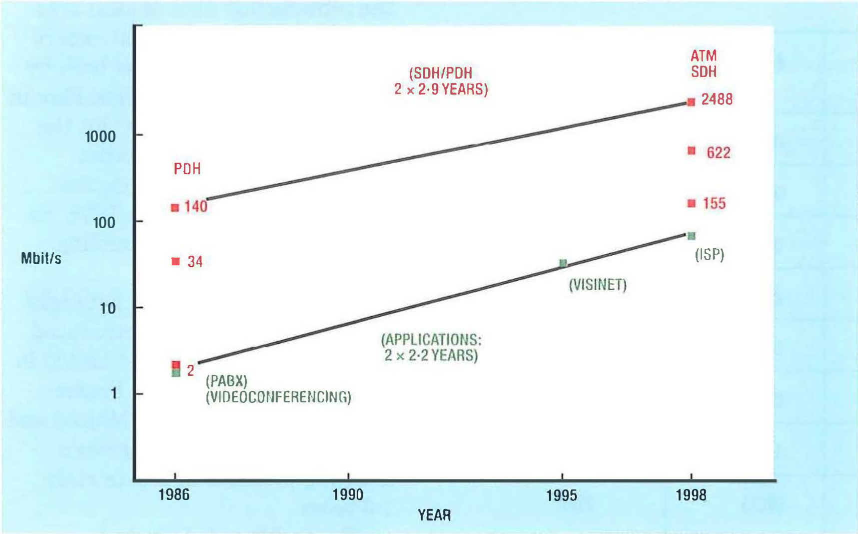


Figure 3 – Carrier networks

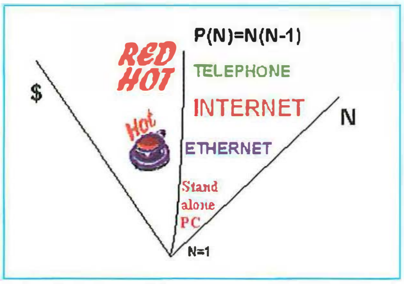


Fig. 4. Metcalfe's Law

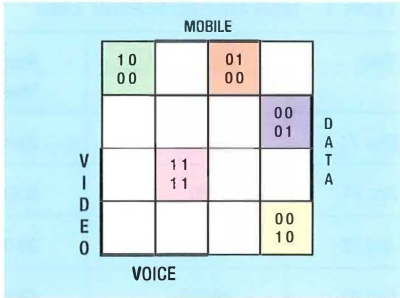


Figure 5 – The telecommunication atlas

Figure 3, follow the rhythm of Moore's Laws once again doubling every 2·9 years. It is interesting to note that the same is true for the bandwidth required by early adapters of high-speed applications which double every 2·2 years.

The data presented here leads to an interesting corollary to Moore's Laws. We observe that the bandwidth provided for by communications equipment doubled roughly every 2·5 years for the past twenty years. Something we expect to continue for at least the next 10 years[4].

The Effects on Networks of Metcalfe's Law

Metcalfe's Law states that a network becomes more valuable as it reaches more users[5]. An increase by a factor thousand of the number of users makes a network a million times more valuable. This of course takes time. After a certain point in time however it becomes difficult for competing technologies to survive or to enter the market – a phenomenon known as *network effects*. Following ideas of the economist Paul David, Steve Weinberg observed that network effects put a premium on compatibility[3]. At the end of the day they might result in technology lock-in, which is something regulators and anti-trust agencies fear.

Robert Metcalfe, who founded 3Com (Computers, Communication and Compatibility) and marketed the Ethernet LAN, understood from the very beginning that the number of dollars he could earn would increase by the square of the number of companies that would embrace this standard (Figure 4). He succeeded beyond his wildest dreams. Of course he had his moment of doubt when he thought that ATM would supersede Ethernet. So far however network effects deserve a lot of the credit for defeating ATM as a LAN solution.

What about the battle between Bellheads and Netheads? Given the sizes of these networks we would be surprised if either one would be able to emulate the other any time soon. The costs that carriers and customers alike have sunk in their respective networks are enormous. Between dream and deed stand laws and practical objections. Bellheads might become Netheads someday or vice versa but network effects will delay this from happening for some time to come.

Obviously Metcalfe's Law leads to convergence in the marketplace. There is a strong urge to join up existing networks and especially those networks to which most people are connected. The worldwide telephone network is the most prominent example. Others are the Internet (TCP/IP; HTTP) and the mobile network (GSM). The universal motto everywhere is: 'If you can't beat 'em, join 'em!'

The Theory of Everything

In the business communications environment there were once four clearly distinguishable regions on the telecommunications atlas (Figure 5). The oldest was data (Samuel Morse; 1836), next came voice (Alexander Graham Bell; 1876), followed on its heels by mobile (Guglielmo Marconi; 1895) and finally by video (John Logie Baird; 1925).

Today the situation has become rather complex. We seem to have reached the point that almost every day somebody somewhere announces a new application as a result of combining and splitting the original regions.

The ultimate combination seems to be the multimedia handheld (voice, video and data), which can be reached anywhere (mobile) on earth, in this context also called the *global village*. Physical meetings will soon be replaced by meetings in virtual meeting rooms and exciting worldwide searches in virtual databases. We are entering the postmodern world in which the recommendation of the French philosopher Jean-François Lyotard that everyone should have access to all databases will finally materialise.

What also becomes clear is that where until recently everybody stayed in their own spot on the telecommunication atlas, nowadays everybody is moving everywhere. The field of play has become larger than ever before. Until recently our main preoccupation was keeping up with the pace of Moore's Laws and transforming ourselves into digital beings[6]. Nowadays we are discovering others territories and adding new functions to existing applications – voice to data, data to mobile, video to data, voice and video to data, and so on.

The only way to create some order in the existing application chaos is by using set theory. Major application sets include voice, video, data and mobile. We can define subsets, for example data subsets like LANs, WANs, Message Handling and so on. In this way we not only bring some order into the chaos but also identify interesting new applications that we were unaware of.

Application-Oriented Marketing

The AIDA marketing model, which stands for 'from Attention to Interest to Desire to Action', describes the steps through which customers pass before they end up in the buy 'mode'. More advertising induces or seduces consumers to buy more. An ever growing number of 'old' and 'new' media can be used for this purpose thanks to the divergent trend in applications. Let us explore this a little further.

Almost unnoticed our market has evolved in the past decade from a market of 'simple box movers' to one of 'application-oriented thinkers'. Sometimes the box even seems superfluous. What really matters to customers is that we are knowledgeable about their applications. The Dutch police once told us that catching a criminal is less important than finding the information to get a conviction in the first place.

Go Everywhere, Young Man

We will show below how applications diverge from the voice only [0; 0; 0; Vo] perspective. Similar stories can be told from the data [Da; 0; 0; 0], video [0; 0; Vi; 0] and mobile [0; Mo; 0; 0] points of view.

Old gold: the private branch exchange

[0; 0; 0; Vo]: The private branch exchange or PBX has always been and will remain for some time to come the workhorse of voice communications in the business environment.

In the early eighties stand-alone PBXs connected to a PTT infrastructure were the rule. Sometimes PBXs were connected to each other by analogue leased lines to provide low-level networking. In the mid-eighties digital PBXs were the talk of the town and digital PBX networks took off. Digital PBX networks with 2 Mbit/s leased lines provided a high level of functionality. A representative of a PBX supplier once argued quite convincingly that with the 'automatic ring-back' function alone one could justify the entire investment in a digital PBX network. Unfortunately, such investment costs were out-of-pocket costs while the others were hidden costs. So not everybody bought this argument.

The issue of how to provide companies with a 'bandwidth-on-demand' PBX network has risen in recent years—years during which virtual private networks (VPNs) based on ISDN have been getting hotter. These have been followed in the Netherlands by our national VPN (NVPN) service that allows companies to integrate any PBX from any supplier into their network. Now companies can also let their people work from home since they can be easily integrated in the NVPN. And as a network becomes more valuable as it reaches more users, so does a PBX network.

Reach out and I'll be there!

[0; Mo; 0; Vo]: How can you get in touch with one of your road warriors while you are in your office? The classical way used to be to dial a multi-digit mobile number. Now you just dial the person's five-digit PBX extension number and thanks to KPN Telecom's GRIP service you get them on the telephone whether they are in the office or on the road. And if your road warrior is busy with a

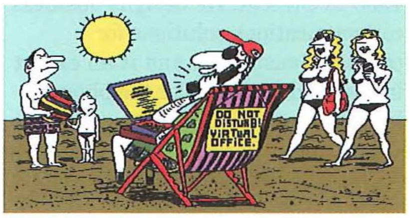


Figure 6—The virtual office of a road warrior[7]

customer you can leave a voicemail message. GRIP also gives ICT managers a much better insight into the use of mobile telecommunications services and, last but not least, a lower bill. We point out that in this case the fixed-mobile network becomes more valuable as it reaches more users more easily.

Electronic traders tell it with flowers

[Da; 0; 0; Vo]: 'How can traders buy flowers from a remote location?' was the question one of our customers wanted us to answer. ISDN provided the answer. Thanks to ISDN, traders can now stay at home instead of leaving the house at four o'clock in the morning. They can log in, receive pictures of the flowers on sale on their PC monitor, follow the auction clock and strike a deal by hitting the space bar. An ISDN voice connection allows them to talk to the auction people to discuss details of deals. Special provisions in the KPN infrastructure provide the required high level of voice-data connectivity between the auction and the network.

From call centre to contact centre

[Da; 0; Vi; Vo]: Customers can decide when and how they will communicate with companies, whether it be by phone, fax, e-mail, post, video or the Internet. Every call centre that wants to succeed in the marketplace must become a contact centre. It is obvious that the systems used in a call centre must facilitate call centre agents, given the new ways that customers can approach them. Multimedia servers are becoming the prime enablers of contact centres.

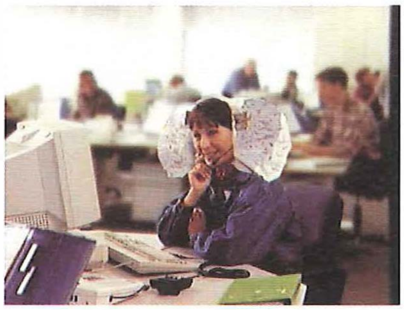


Figure 7—A Dutch call centre

Conclusions

The real optimists among us like George Gilder are already living in the future[8]. According to them, today's paradigm of *scarce bandwidth, free transistors and free watts* will be replaced tomorrow by the *free bandwidth, free transistors and scarce watts* paradigm—one that reminds us of the Paulinian paradox 'as having nothing, yet possessing all things'. But suppose Gilder is right and that tomorrow we will have 'free bandwidth' for all our applications; for example, enough bandwidth to be able to look our partner deep in the eyes. We should not underestimate this possibility because technically nothing is standing in the way. The need for information, and thus, according to Shannon's Law, bandwidth, is growing exponentially. So we think it would be wise to go back to the future as quickly as possible.

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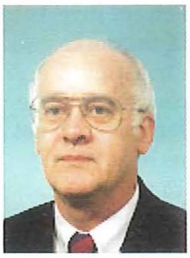

J. W. (Hans) Meijer
KPN Telecom

J. W. (Hans) Meijer started work at KPN Research, where he specialised in transmission networks. Prior to that he worked in Bolivia and in Yemen. In 1986, he joined KPN Telecom, initially working as a manager of a consultancy group in Amsterdam and after 1989 in The Hague. He is currently responsible for research activities relating to the business communications portfolio.

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Dr. Nikolaos Golias

Internet Telephony

Interconnect Issues, Impact on PNOs and Regulatory Implications

Internet telephony is currently, one of the biggest buzzwords in the telecommunications sector. Internet telephony, or Internet protocol (IP) telephony, encompasses any kind of real-time audio communications that use the Internet or any other IP network as the transport medium. In this respect it is fundamentally different from the traditional circuit-switched based voice telephony. Internet telephony is revolutionising the telecommunications industry and spreading shock waves in the telecommunications landscape. Internet telephony offers an alternative to traditional voice telephony, circumventing the international and long-distance accounting rate system.

The adoption of the new technology raises many issues related to interconnection and regulation and is going to have a profound effect on the services the telecommunication operators offer. Public network operators (PNOs) should change mentality and consider the new technology as an opportunity, rather than as a threat, and elaborate on how to exploit this new technology for the provision of better and more advanced services. PNOs have all the advantages of competing in the new technology, and should embrace it. In this respect excessive regulation should be avoided and any imposed regulation should take into account its applicability, regarding the global nature of the Internet, and the impact it is going to have, so that it is not proved obsolete or a hindrance to further developments. Further it should be based upon the principle of imposing the same rules to all players.

Internet Telephony

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In traditional circuit-switched based voice telephony, a telephone call is transmitted along a set of copper wires that sustain a constant circuit between the originating and terminating ends of the call. A channel with a given bandwidth is allocated on the sustained circuit, regardless of the amount of information that is being transmitted between the two ends. In this way, a fixed bandwidth is allocated and the voice signal is transmitted along with information about the initiating and terminating telephone number. The global telephone system is built around this concept.

The transmission of voice over IP networks is based on a totally different concept. Since voice is an analogue signal, it must be transformed into a digital signal in order to be transmitted over an IP network. Voice/data packets are routed dynamically over the IP network using a completely different transport mechanism. As each voice signal is digitised, compressed and packetised it is sent over the IP network with the IP transport mechanisms. The data packets are routed over the available bandwidth dynamically. Each packet carries the delivery information. At the terminating end the packets are assembled, the voice signal is reconstructed and transformed to the analogue voice signal. IP as a transport network is very flexible, in that it uses the amount of bandwidth it needs, instead of consuming a given pre-specified bandwidth.

The original appearance of IP telephony was with the use of proprietary software between two multimedia PCs, both connected to the Internet. However, owing to recent progress in technology, the interface between the PSTN and IP networks has been greatly improved, enabling the routing of calls from a multimedia PC to the PSTN network. This interface is called an *Internet telephony IP gateway*. In a similar way telephone calls that originate from, and terminate on, traditional analogue telephone terminal equipment can be routed via the Internet with the use of Internet telephony IP gateways at both ends.

This is accomplished with the use of special access servers. Calls from ordinary telephones are routed to the service provider's access server via a local call. Then the analogue telephone signal is digitised and transmitted via the Internet or data lines to the service provider's computer server in the destination. There the signal is transformed into analogue and is dialled-out to the destination telephone number with a local call. With this technology, service providers—including local and inter-exchange carriers, Internet service providers (ISPs), cable companies or alternative access providers—can offer an alternative to long-distance or international calling.

Various commercial examples of telephone-to-telephone Internet

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telephony have appeared in the market. Major telecommunication manufacturing companies are offering Internet telephony servers to ISPs that enable telephone-to-telephone and fax-to-fax communication via the Internet. These servers can work in any public switched network to route telephone calls over data networks. Further, these servers offer real-time communication.

Features and Interconnect Issues

The wide adoption and use of Internet voice telephony will depend on a variety of technological, pricing and regulatory issues.

The major advantage of Internet telephony is going to be price. International and long-distance calls can be routed through the Internet at the cost of a local call and typical ISP charges that are usually flat monthly fees. In this way a user can circumvent the expensive traditional accounting rate system for international and long-distance calls while routing his/her voice signals over the Internet at a very low price.

Compatibility is going to be another major factor for the widespread use of Internet telephony. The original appearance of Internet telephony was based on proprietary software. Users at both ends of the connection had to use the same proprietary software and be connected to the Internet at the same time, that is be online. However the use of standards is beginning to prevail and in the near future it is likely that there will be two or three products on the market, supporting common standards such as H.323, and G.723.1 for voice transmission with typical delays of about 10–30 ms.

Efficient use of bandwidth is another advantage of Internet telephony. The routing of voice packets over an IP network does not require the allocation of a pre-specified bandwidth, resulting in more efficient use of the channel. Further advanced compression schemes allow 5–10 times more traffic to be carried over the same telephone channel. On the other hand, increased traffic may result in reduced voice quality, packet delay, echo etc. and this is one of the disadvantages of IP telephony. Research for the use of more efficient protocols is under way for solving problems associated with quality issues.

The interoperability of Internet telephones with the conventional (PSTN) telephone network requires the so-called Internet telephony gateway. The Internet telephony gateway bridges the gap between the PSTN and IP networks, allowing voice traffic from traditional circuit-switched networks to be routed over IP networks. The voice from a conventional PSTN telephone will be digitised and packetised in the gateway, so that it can be transmitted through the data network. At the other end of the link, the recipient's gateway, will transform the digitised signal into an audio signal so that it can be transmitted through the PSTN network to the termination terminal. This allows calls between regular telephones to take advantage of all of the benefits of packet switched data transmission, including increased efficiency in the use of the bandwidth, advanced services and decreased costs.

The Impact of Internet Telephony on PNOs

The increasing use and wide adoption of Internet telephony will inevitably have a profound impact on PNOs. It is clear that IP telephony will become a viable alternative for large and significant segments of consumer and corporate voice and fax traffic. IP telephony will fundamentally change the telecommunications landscape. Although there isn't any consensus on when this change is going to happen, it is widely admitted that voice and fax traffic carried over IP networks will slice away a large bite in revenues from the traditional circuit-switched telephony.

The low price of Internet telephony will appeal to the majority of the telecommunication users, especially individual customers. Although quality and network congestion issues are going to be a disadvantage, the large discount, especially for international and long-distance telephone calls (it is mentioned that Internet telephony can offer discounts of as much as 90%) will seem attractive to many users, who are willing to sacrifice quality for the much lower price. At such discount prices it is certain that many users will adopt the new service, tolerating possible shortcomings associated with decreased quality.

However, the global expansion of the Internet and the need for the transport of more and more data, growing exponentially, seems to indicate that in the future the capacity of the Internet for the offer of advanced data services high-bandwidth multimedia) will be at least capable for transporting narrowband voice signals. In addition, the development of new protocols and routing mechanisms that guarantee a certain quality will mean that quality and congestion issues may be less important in the future.

This will have a profound effect on the structure of the traditional accounting rate system and settlement rates for international telephony, since Internet telephony circumvents the problem, offering communication at the cost of a local call. As a result, there is going to be a significant decrease in revenues for traditional international and long-distance telephony.

Also, it is anticipated that the explosion of the Internet and IP telephony will have a profound effect on fax traffic. It is anticipated that a large chunk of fax traffic will be transited swiftly to the IP network. Fax traffic accounts for a significant part in the pie of international and long-distance traffic. The routing of fax traffic over IP networks or the use of alternative mechanisms for transporting information (e-mail etc.) will result in a significant decrease in revenues for traditional telephony. The routing of fax traffic over IP does not present the shortcomings of voice traffic and it is expected that it will expand quickly. Further, fax traffic belongs to a data network and does not suit a circuit-switched network.

Despite the shortcomings in revenues associated with the transition from circuit-switched to IP switched telephony, the telecommunications operators must see the new developments as an opportunity rather, than as a threat. It is anticipated that traffic overall will increase and this will offset the part of the losses caused by the increasing use of Internet telephony by leasing more private circuits to ISPs, who will require increased capacity to handle the extra traffic. This will have as a result higher revenues from providing more network capacity (a traditional telecommunications provider's product).

Some operators have already embraced the new developments and offer IP telephony services. It is very likely, that in the future, the telecommunication operators will offer two kinds of services:

- better quality and higher price telephony on the existing circuit-switched network, and
- non-guaranteed quality and lower price telephony over the IP network.

Regulatory Implications

In many countries the provision of telecommunication services is regulated. A few countries do not allow any voice telephony services over the Internet. In other countries, although their voice market is not yet fully open to liberalisation, voice services over the Internet are allowed. One reason for this is the innovative character of the service and its small impact at the moment on traditional voice telephony.

However, there are some issues that should be thoroughly examined. Such an issue is the provision of voice telephony services over the Internet, through common telephony terminals to the public. As was explained, voice telephony services can be offered between two common telephone terminals with the use of specialised servers that act as Internet gateways, so that the voice traffic is routed through the IP network. In such a case the Internet is used as the transmission medium, while calls originate and terminate at the PSTN network. It is realised that commercial providers of this service should be subject to the same rules as traditional telephony service providers (licensing, authorisation, requirements).

Some countries charge VAT on communication services. However, owing to the global nature of the Internet, Internet telephony services can be provided by businesses in countries with a favourable taxation legislation. As a result, businesses based on these countries will have a significant advantage and this will result in losses for the national public revenue systems and, unfair competition with respect to the national telecommunication service providers. The taxation issue is difficult to resolve, and needs thorough study.

Conclusions

Internet telephony is revolutionising the telecommunications industry and spreading shock waves in the telecommunications landscape. Internet telephony offers an alternative to traditional voice telephony, circumventing the international and long-distance accounting rate system.

The new technology is going to have a profound effect on the services the telecommunication operators offer. PNOs should change mentality and consider the new technology as an opportunity, rather than as a threat and elaborate on how to exploit this new technology for the provision of better and more advanced services. PNOs have all the advantages of competing in the new technology, and should embrace it.

Excessive regulation should be avoided and any imposed regulation should take into account its applicability, regarding the global nature of the Internet, and the impact it is going to have, so that it is not proved obsolete or a hindrance to further developments. Further it should be based upon the principle of imposing the same rules to all players.

Biography

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Nikolaos Golias is currently with the International Strategy and Investments Department of the Hellenic Telecommunications Organization, Athens, Greece. He has also held positions at Intel Corporation, Santa Clara, California, as a consulting engineer, and at Stanford University, as research associate. He has worked extensively in several fields of telecommunications and electrical engineering. His research topics include optical, microwave and wireless communications, parallel and distributed systems, computational prototyping and integration and research in telecommunications and information systems. He has participated in a large number of research projects of the European Community, Stanford University, ARPA and Intel Corporation. Current interests include digital broadband communications, computer communication networks and integration of advanced technologies in the information infrastructure. He has taught courses and given lectures at various institutions. In addition, he has attained extensive experience in the evolution of new technologies and especially the new technological breakthroughs and their implementation for practical applications. In this context, he has gained experience in equity research of high technology growth companies, potential upstarts and venture capital entrepreneurships.

Luca Cipriani

Architectural and Technological Evolution in the Telecommunication Market: Trends and Innovations Towards 2000s

All over the world the new trend for the liberalisation of the telecommunications market together with the new technological developments are dramatically changing the traditional telecommunications order. New needs together with possibilities like those offered by Internet, are demanding new requirements to the contents and architecture of the traditional telephony networks. Starting from the new concept of service, this paper analyses first the main technological innovations and then tries to define the network evolution path towards 2000s.

Introduction

All over the world the new trend for the liberalisation of the telecommunications market, contrasting with the old monopolistic trend, has given rise to intense competition and to the proliferation of service providers and network operators. The market now involves multiple competing and cooperating players, providing services that can substitute or supplement each other. In such a scenario, services from one provider could be used by other providers as components of their own services. On the other hand, the technological development (ATM, SONET/SDH), with its high speed transport rate capabilities, supports new and greatly enhanced services compared with those traditionally offered by existing narrowband networks. The combination of multimedia and inter-activity concepts, as well as the need for a more personal and universal communication, is yielding a large variety of services transforming 'tomorrow's dream' into reality. It is clear that all these changes require a revision of the traditional view of what a telecommunications service is, how it is created provided and used. Figure 1 shows four emerging key players in the renewed global 'infocom' market emphasising that, the provision of new services, depends considerably on the global system performances, requiring strong interaction between each of the components[1].

In this context, in order to gain new market shares, strategic cross-industry partnerships are bringing traditionally distinguished sectors, like telecommunications, audio-visual media and information technology, towards a unique communication

Figure 1 – Key players in the renewed global market

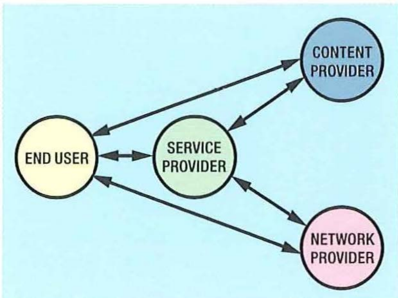
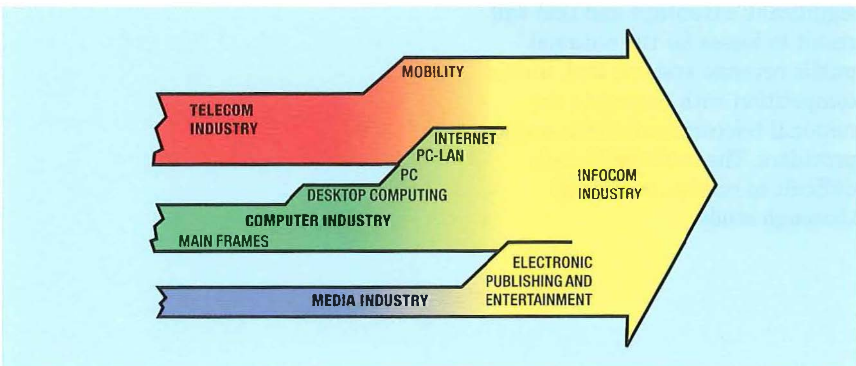


Figure 2 – Evolution scenario toward Infocom vision



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landscape, well aligned with the political view of the information society (see Figure 2).

Because of the valuable stake, a basic element in the transition towards the liberalised market will be the introduction and observation of regulations that creates the conditions for innovation and investment, ensuring fair competition and adequate protection of public interest. Within the European Union, the legislation setting the timetable for 1998 has come into force, together with rules that allow the use, today, of alternative networks for the provision of currently liberalised telecommunications services and mobile communications[2]. This paper, starting from an overview of the new emerging services (Internet, interactive multimedia applications, etc.) and technological innovations (xDSL, LMDS, DECT, etc.), highlights the need of a seamless network, achievable through the concepts of interoperability and internetworking. In particular, it focuses on the middleware as a good platform to realise the previous needs. Finally it analyses the possible network evolution (both at the access and core side) toward the 2000s communication platform. Medium and long-term solutions will be shown taking into account major requirements coming from users (for example, mobility), recent standards (ITU-T, ETSI) and the real current network infrastructure (cabled, fibre or radio based).

New Emerging Services

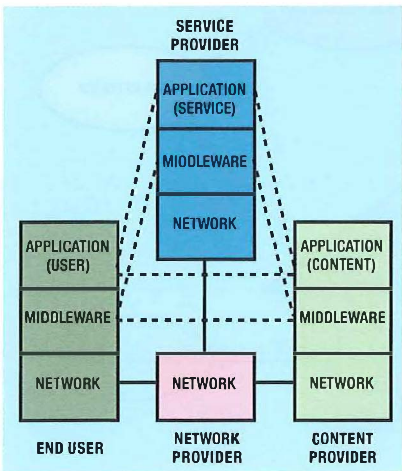
The users' demand for high-speed multimedia communication, together with the already mentioned technical and social justifications, has brought telecommunications market to distinguish two basic classes of users, respectively with regard to *business* (multimedia conferencing, computer supported cooperative work, etc.) and *residential* applications (video-on-demand, tele-shopping, travel services, etc.). New services, requiring the use of specialised resources (for example, bridge, routers, and multicast units) as well as a clear definition of the service logic to take into account all the possible sequence of actions needed to provide the service, will impose extra-requirements on the network in terms of functionality and control. These needs have to be conjugate with the real current infrastructures, namely many different technological networks, which converge towards a unique information international infrastructure, the so-called 'triple-I vision'. In this context interconnectivity, be it at network level or between terminals and networks, as well as interoperability of services and of distributed applications, becomes a mandatory requirement. It is clear that such requirements will imply a growth of the functions of intelligence, both in the terminal and in the network. From a technical point of view, this means placing management and processing functions in each of the systems related to the involved players, that is to say in the end-user equipment and in the service, content and network provider (Figure 3). Currently the most sound and flexible approach, to fulfil the previous requests, is represented by the middleware layer[3]

This layer, enabling the interworking of management functions and distributed intelligence (for instance, through client-server based architectures), can overcome problems deriving from the heterogeneity of distributed entities when designing and using customer services and applications. Many features characterise middleware, in particular those to manage:

- service creation and activation;
- session, call and connection control;
- numbering and addressing;
- brokering and billing; and
- security.

Normally, middleware offers previous capabilities via a user-oriented application programming interface (API).

Figure 3 – Service provisioning based on the middleware model



Apart from such considerations, it is obvious that the end-users want assistance in solving their professional problems and not specific technologies. They will see, hear and ultimately judge a system by the way such a system offers versatility, simplicity and transparency. For this *look-and-feel*, *plug-and-play*, *point-and-click* seem to be the slogans, which contain the next technological keys. The growing success of the Internet phenomena and its spin-offs, the intranet and the extranet, can be partially explained in this sense. Moreover Internet currently provides the exciting possibility to offer voice over IP. Thanks to the digital signal processor (DSP), a special kind of microprocessor that allows voice, video and fax and other analogue signals to be processed into a variety of digital formats, the voice/fax traffic can ride for free over data network. On the other hand DSPs have fallen in price by over a hundred-fold, allowing the development of a new type of hybrid networking and voice/data integrated networks. With the right software, the DSP (generally ITU-T Rec. H.323 compliant) can convert analogue voice and fax into digital data for transport over data networks. The latter are already paid for and usually have enough extra carrying capacity to accommodate voice/fax traffic at no extra charge. Of course, not all the data networking technologies have suitable features to realise such a service. The key characteristics a data network must have to carry voice well are: low delay, predictable delivery of the voice information, a means of prioritising the voice traffic ahead of data and high enough efficiency to carry the extra voice traffic. Frame relay and ATM (especially TCP/IP along with proprietary solutions) are the technologies which fulfil these requirements. They achieve their high-efficiency ratings by collecting the data to be transmitted into packets (like envelopes) and only sending them when they are reasonably full. Not sending empty, or nearly empty packets, minimises waste.

Today however, the traditional IP routers represent one of the main obstacles to the growing IP traffic support. These routers, built to face completely different traffic loads (the faster ones process about 10^5 packets per second) are becoming classical bottlenecks. Gigabit routers technology, as well as IP switching techniques, are the ready reply to such a drawback; the former provides the next high-performance routers generation, while the latter couples the IP routing to fast hardware switching (typically ATM). IP switching techniques allow processing up to 10^6 packets per second.

Innovative Technologies

In order to realise broadband Internet access, huge investments are being made in both terrestrial media and via satellite links. In the former the access may be achieved using one of the following:

- telephone twisted-pair with an aysnchronous digital subscriber loop (ADSL) modem;
- coaxial cable with a cable modem;
- Hertzian carriers with local multipoint distribution system (LMDS) modems;
- passive optical fibre to the building with very high-rate digital subscriber loop (VDSL) modems.

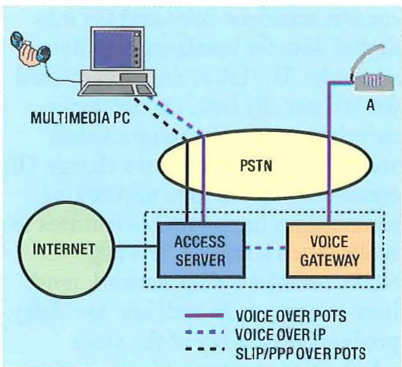
In the case of Internet via satellite links, the access is realised via interactive and diffusive connections in the K_u-K_a band (20–30 GHz).

In particular, in order to assure network interworking between POTS and IP, voice over IP gateway functionality will be developed to allow seamless coexistence of POTS and IP services (Figure 4).

Supporting interactive-broadband services on the Internet platform normally requires a bidirectional asymmetric channel, with 8 Mbit/s and 2 Mbit/s respectively in the down- and up-links. To this aim, as ADSL connections well satisfy such requirements and given the wide diffusion of the twisted pair, it is foreseeable that such a technology will be widely employed (Figure 5).

On the other hand coaxial cable allows sharing of the interactive band by more than 100 people, offering 20 Mbit/s down-link channels. Today coax finds its major use in the United States, where many buildings are connected by cabled access systems. A different scenario exists in Japan where the dominant technology is the optical fibre which, thanks to the current rate of 25 Mbit/s which can be extended to 100 Mbit/s in the next few years, has reached an high-penetration level allowing fibre-to-the-home (FTTH) links. In Europe such links are limited only to the great metropolitan residential and business areas and their extensive use is not foreseen in short term.

Figure 4 — Voice over IP technology for data-phone residential access

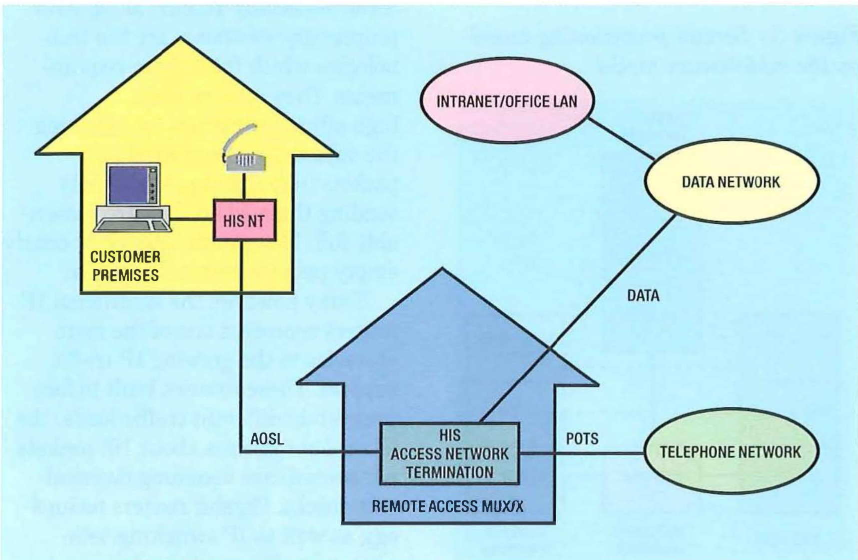


However much of the access network evolution will depend on the way network termination will be realised. Today, terminals can be provided with either asynchronous transfer mode (ATM) or Ethernet cards which can both support IP interfaces. In particular the ATM solution, conjugated or with ADSL or with WCDMA technology, is gaining considerable credentials.

The uncertain scenario in the access-network area requires further clarifications, at least in the wire-line access context. The access network can be split into two portions, each with its own functional requirements as well as technological and standardisation needs. The first access portion, known as the primary distribution network, is usually realised with SONET/SDH devices. The second, known as the secondary distribution network, connects the primary distribution points (corresponding to remote distribution centres to the last drop) to the connection between the distribution cabinet and the customer premises. The requirements of new multimedia services will mainly impact the secondary distribution network and the last drop, which will turn out the most cost-sensitive components in the frame of an eventual network upgrading. While both the portions are presently based on twisted pairs or coaxial cable, the secondary distribution network will be replaced by an optical infrastructure, known as the *optical distribution network* (ODN). Avoiding a detailed description of the various proposals, it is worth citing the major implementations alternatives, where the optical network unit (ONU), is placed closer and closer to the customer premises, producing the well-known solutions—fibre to the cabinet/curl/building/home (FTTCab/FTTC/FTTB/FTTH). It has to be remembered the flexibility of such solutions (designed to accommodate multi-wavelength advancement) support future-service requirements.

Finally, in order to complete the outline of new emerging technologies, it is worth citing the recent LMDS and DECT technologies. The former is a radio cellular network using the highest frequency, which is able to offer 2–8 Mbit/s channels for user. The latter, although it does not allow broadband access, permits the operators to share the same band without requiring a specific band allocation. The release of radio

Figure 5—ADSL for home Internet solution (HIS) service provisioning



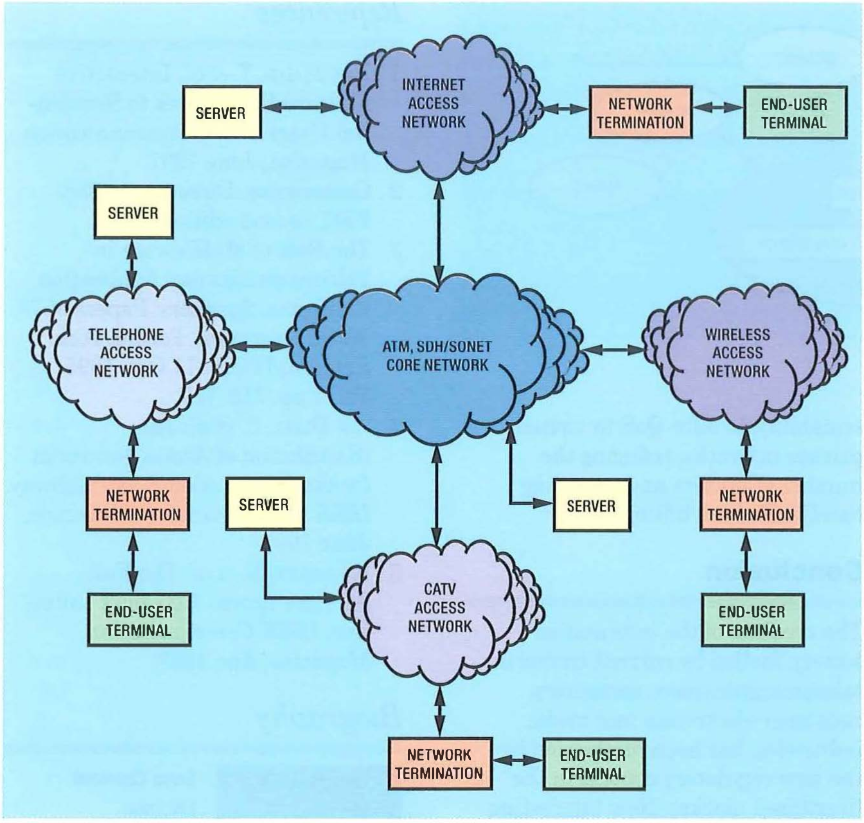


Figure 6 – Interconnectivity model between different access network

bandwidth in the higher frequency range (>5 GHz) will allow wireless loop to support broadband applications.

It is very probable that LMDS and DECT will coexist in the same scenario to realise bidirectional communication. In fact, the high costs of an LMDS transmitter device does not make it suitable for a wide-scale employment at customer premises. LMDS technology could be limited to the down-link direction, providing the users with LMDS receivers while for the up-link direction DECT transmitters could cost-effectively replace LMDS transmitters.

Network Evolution Scenario

According to a quite common idea, the modern network infrastructure will support rather than provide the variety of conceivable multimedia applications, realising in most cases an inter-connectivity and interworking web between different local networks. The scenario shown in Figure 6 sums up the current overview, stressing the need for a seamless model between different access technologies[4].

From a logical point of view the previous scenario equals that of a unique broadband integrated service digital network, namely the B-ISDN and it is known that ITU-T has chosen the ATM as transfer mode for implementing B-ISDN. However, today it is not rash to say that the original idea of B-ISDN is going to die although ATM will continue to exist, limiting its role to a pure transport mechanism, probably as IP support. On the other hand, the physical ATM support can be realised in native way (cell based) or by encapsulation in SDH/SONET frames (SDH based).

While in the core network the replacement of the analogue transmission and switching equipment with the digital ones may be reasonably easy to justify in term of cost for single user, at the access the technological choice is not yet clear as many factors such as costs, standards, capillarity of terminal infrastructures, still influence the final decision. The consequence is that different paths will characterise access and core network evolution.

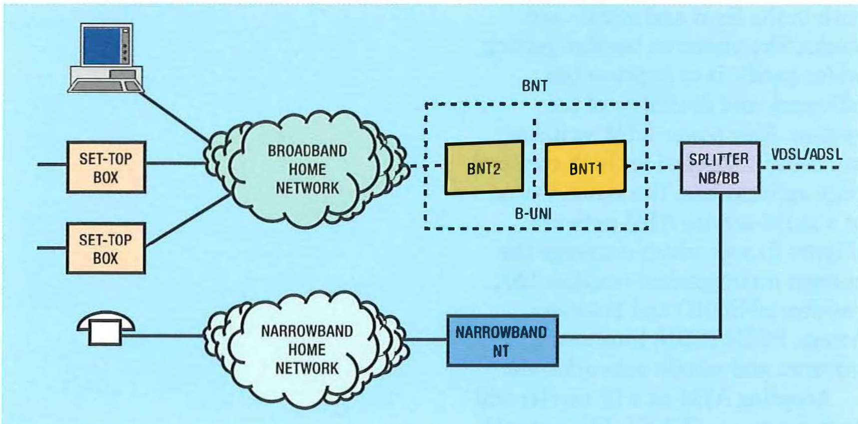
Access network evolution

In spite of the appearance of new operators and of market liberalisation, the access network is certainly the most critical area of the whole telecommunications network, traditionally representing the operator's monopolistic power domain. Unless a new operator chooses to lease lines from an already existing operator, any actions aiming at enlarging the access-area segment will be characterised by high costs and long installation periods. Access wireless networks can be a sound answer to this problem. Of course increasing high-bandwidth requirements need new efficient compression algorithms. Current mobile networks based on the GSM standard are being improved to provide adequate bandwidth for video and data services and ETSI has just defined the 2 Mbit/s WCDMA access.

There is also the need for most of the current access networks to support the traditional telephone services as well as the residential and business services (Figure 7). In such a scenario[5] a splitter, whose nature will depend on the distribution system, will assure the coexistence of broadband and narrowband services.

From a standard point of view, ideally ATM and B-ISDN access systems should be synonymous, although a distinction exists because

Figure 7 – Broadband and narrow-band services support in a intermediate evolution phase



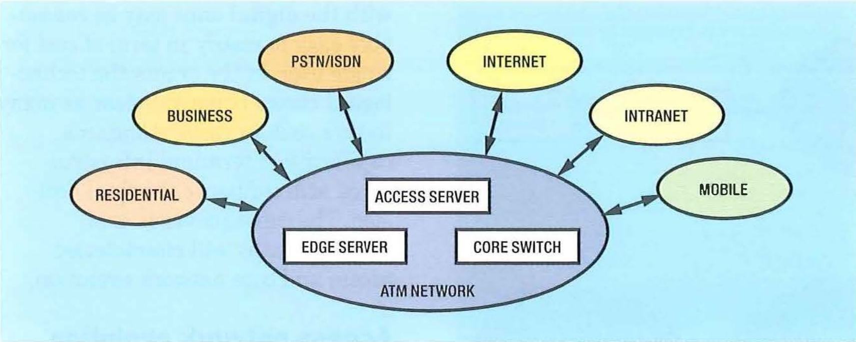


Figure 8 – Multi-service ATM networks

the B-ISDN standards do not yet comprise a full set of suitable user-to-network interfaces (UNIs), including asymmetric and low-speed interfaces. To this aim it is easy to verify that recent standardised fibre interfaces at 155 or 622 Mbit/s (ITU-T I.432-1 and I.432-2) are not suited to wide-scale deployment via access networks. On the other hand the symmetric 1·5 or 2 Mbit/s UNIs (ITU-T G.804) are not able to provide enough bandwidth in the downstream direction. Even the 51 Mbit/s carrierless amplitude/phase (CAP) mdulation-based interface (ITU-T I.432-3), recently introduced into the ITU-T, following work in the ATM Forum, requiring a twisted pair for each transmission direction, is able to operate over an unshielded twisted pair span of not more than 100 m, while existing drop facilities mostly consist of a single twisted pair per customer.

Core network evolution

As already stated, the convergence of the telecommunications and datacom worlds toward a unique infocom vision represents the basic point to trace the technological and architectural evolution in the telecommunication world. At the end, fast, reliable interfacing highway should be ready to support new services. The progress in the backbone network foresees the introduction of the ATM technology both in the fixed and mobile networks. The objective, besides getting wider bands, is to improve the efficiency and flexibility of the system. New power ATM switches are being developed for both core and edge applications. The vision is that of a multi-service ATM network (Figure 8) over which converge the current distinguished realities like, residential/SOHO and business access, PSTN/ISDN, Internet, intranet and mobile networks, etc.

Adopting ATM as a IP carrier will open many possibilities like network scalability, to offer QoS in virtual private networks, reducing the number of routers and providing bandwidth base billing.

Conclusion

The creation of the information society, fuelled by current trends in telecommunications, computers, consumer electronics and media industries, has been further fed by the new regulatory context in the liberalised market. New interesting prospects are attracting both manufacturers and network operators. The rapidly evolving telecommunications and datacom scenario makes it difficult to trace a sharp profile of the next years although the convergence of the two worlds towards a single Infocom vision seems to be the only certainty. Under this assumption, this paper began from a review of the traditional concept of service, first describing the new market scenario and its players, then an overview of the current promising technologies, describing the network evolution both at the access and the core side. The need for a seamless connectivity model between various existing networks seems to be a satisfactory solution although an ambitious target could be that of a single pure transport ATM network, gradually replacing all the other infrastructure, over which IP could run fast.

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Biography

Luca Cipriani
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Luca Cipriani was born in Portoferraio in 1963. He received his degree in electronic engineering from University of Rome 'Tor Vergata' in 1991. Since 1992 he has been working for Ericsson in the Research and Development Department, where he was involved in the RACE II MAGIC project and in the MULTICUBE ACTS project, gaining experience in the areas of network architecture and signalling protocol specification. Since 1995 he has carried on his research studies in Telecom Research Consortium (CORITEL), focusing his interest on the description and the realisation of network architectures for the provision of interactive multimedia services, as well as on the integration of IP and ATM and IP switching paradigms. He is a co-author of several papers on these topics. Currently his interest is focused on voice over IP.

Luigi Rocchi and Stefano Teodori

Digital Video Broadcasting—Terrestrial: An Opportunity For The Broadcasting Market

This paper illustrates a hypothetical scenario which envisages the beginning and growth of digital terrestrial television broadcasting. It briefly summarises the reasons urging us to extend the 'digital revolution' in Europe and in the United States, from the world of telecommunications to that of television broadcasting. It goes on to describe a hypothetical project for the introduction of DVB-T in Italy, which proposes the closure of analogue television services in the year 2010.

Introduction

The transition of television broadcasting services from analogue to digital has brought about a strategic revision of the television business in most industrialised countries aimed at furthering the following long-term objectives:

- a rationalisation of the uses and efficiency of resources;
- a wider and more client-oriented television offering;
- an increase in consumption and in returns for the industry; and
- the acquisition of competitive advantages.

This process was triggered in the US by the FCC's decision to close analogue TV services by 2006 and certain European countries, such as the United Kingdom, Sweden and Spain, have followed this example by proposing projects for the transition to digital television which will come to fruition in the period between 2008 and 2013[1].

Luigi Rocchi and **Stefano Teodori:** RAI Radiotelevisione Italiana, Rome–Via Teulada, 66-00195

A debate is underway in Italy about the proposal to fix 2010 as the time limit for the transformation from analogue to digital broadcasting on terrestrial frequencies, preceded (by 1 January 2002) by the transfer of analogue pay-TV to digital technology (via cable, satellite and/or terrestrial).

Starting from this hypothesis this paper illustrates a hypothetical scenario which envisages the beginning and growth of digital terrestrial television broadcasting.

In particular, the analysis considers a 'short-term period' dedicated to experimentation, a 'medium-term period' which is a window of time when the analogue and digital systems will have to co-exist, and a 'long-term period' in which the move to a 'completely digital' system will take place.

DVB-T in Italy

There are many broadcasters in Italy who offer a great variety of programmes both at national and local level. This has brought the saturation of the radio spectrum making it difficult to find free frequencies to assign to digital television and has resulted in the poor penetration of satellite and cable broadcasting.

The successful introduction of DVB-T in Italy, therefore, needs to satisfy the following critical factors and final service objectives:

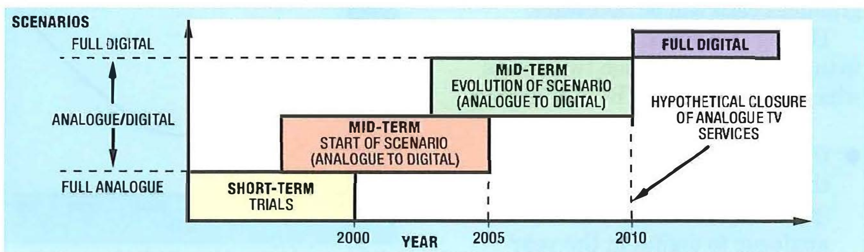
- *Rapid coverage of the population:* Coverage of the main cities will be especially important in order to reach an interested potential audience for producers of programmes, advertising and receivers.
- *Availability of receivers:* The presence, at a reasonable price, of the set-top boxes on the market, preferably integrated with various technologies, is fundamental to allow rapid penetration of DVB-T into Italian families.
- *Provision of quality programmes:* For the new technology to be attractive to the public it is necessary to guarantee a critical mass of interesting and innovative services right from the beginning (theme programs, HDTV, supply of data and software).
- *Consensus on the part of the broadcasters:* Agreement to the plan of introducing DVB-T by all operators is an essential condition to achieve the objective of closing down the analogue system.

Plan of action

One possible realisation of the phases of a complete transition from analogue to full digital could be the one shown in Figure 1.

The various phases which should characterise the transition from a 'full analogue' scenario to a 'full digital' scenario are described below.

Figure 1 – The introduction of DVB-T in Italy



Short-term: Experimentation
Whatever the choices adopted in the mixed analogue/digital scenario, we will be able to take advantage of the experience resulting from the DVB-T experiment which RAI will carry out in the three-year period (1998–2000[2]) reaching a coverage of 60% of the population by the end of this period. Such a percentage is considered sufficient both to develop fully the necessary trend for the research and to arouse the interest and consensus of all the economic categories who may be interested in DVB-T (from the operators to the public). Taking into account the present use of the spectrum in Italy, the following hypothesis for the identification of the necessary frequencies for experimentation and broadcasting of digital bouquets were formulated:

- transformation of Band III from Italian channelling to European channelling. This procedure, would allow the freeing of the European channel 9 over the whole of the national territory; and
- revision of the plan for the allocation of TV frequencies on the part of the Public Administration: the rationalisation of the system should allow the freeing of a series of resources successively re-usable for the DVB-T with a multi-frequency network (MFN).

Medium-term: Beginning of the mixed analogue-digital scenario
In order to make the DVB-T service immediately attractive, it seems reasonable to assume that the average subscriber should receive a number of programmes comparable to those received on average in analogue today. It is therefore necessary to allow for an offer comprising of:

- 10 national programmes
- five regional/local programmes
- five programmes with a high-innovative interest.

Allowing, therefore, for the broadcasting of 20 programmes overall, at least five 'bouquets' of four programmes each will be necessary.

During this period it is necessary to take into consideration two events which may 'trigger' DVB-T's takeover:

- the hypothesis of transition for the Italian terrestrial pay-TVs (presently two channels) from analogue to digital in the year 2002: by this date a conversion of the decoding devices (which are presently estimated at around 1 million units) should take place;
- the completion of the RAI experimental phase with coverage of 60% of the population: such a network could provide a carrier service for televisions presently codified in analogue.

In this way the industry could start the production of receivers already able to count on a sufficient demand to guarantee the growth of economies of scale, while pay-TV subscribers would not have to modify their reception equipment (which is required for satellite and cable TV).

Consequently, the release process of the terrestrial frequencies by the pay-TVs would free two channels to be immediately destined to the introduction of two new bouquets in which both commercial programmes and innovative services could be accommodated.

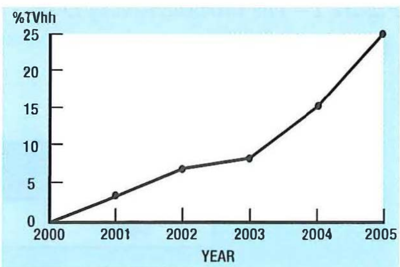
It is precisely the increased offering of digital TV services that would give a strong impulse to the distribution of the set-top boxes, thus triggering a process which will ensure that medium and short-term coverage objectives are reached.

To boost distribution of the digital reception devices, a series of measures to sustain the sector should be identified contextually at the beginning of the prospected scenario.

The graph in Figure 2 shows a hypothesis of the trend (over the five-year period between 2000–2005) for the percentage of families owning a decoder for digital TV reception.

Even if in the year 2000 the number of decoders will be limited to the 'friendly users' included in the RAI experiment, in 2001 it is estimated that about 50% of pay-TV subscribers will have to own a set-top box in order to ensure service for all subscribers by 2002. In the period immediately following (2002–2003) it is presumed that the increase in distribution of the DVB-T reception decoders will not be particularly relevant (comparable to the present yearly increase of the distribution of analogue decoders).

Figure 2—Estimate of the distribution of digital set-top boxes in Italy



From 2004 to 2005, thanks to the increase in services on offer to the public, linked to the availability of new bouquets and to the promotional policy for the purchase of digital decoders, a significant increase in penetration of the market, in line with European forecasts, can be hoped for.

A study commissioned by a number of European broadcasters—Nozema (Holland), Deutsche Telekom (Germany), ReteVision (Spain), TDF (France) and Teracom (Sweden)—from Convergent Decisions Group[1] (CDG[1] on the penetration of the various digital television broadcasting technologies (cable, satellite and terrestrial) claims that in 2005, 26 million families out of more than 100 million (data relative to United Kingdom, Germany, France, Sweden, Holland and Spain) will have abandoned analogue television.

Of these 26 million, only a small number will own integrated digital televisions (IDTVs), which, it is estimated, will only be on the market at an attractive price from 2002 onwards.

From such data one can glean that the growth of digital broadcasting will be closely linked to the availability of the set-top box, expected in the near future, and possibly to its being integrated with various broadcasting technologies, since the closure of terrestrial analogue services may require the creation of simulcast between them.

Long term: Evolution of the mixed analogue-digital scenario
The presence of a wider availability of digital TV services would give a strong boost to the distribution of set-top boxes, which would be concentrated in areas of high commercial interest. As a natural consequence, starting in these areas, the relinquishing of frequencies on the part of analogue services in favour of digital services would begin.

Next a long-term plan will lead to digital TV broadcasting definitively substituting analogue TV broadcasting.

The gradual substitution of analogue broadcasting with digital broadcasting will trigger a process which, in the final phase, will render a broadcasting capacity of about 200 television programmes of the present quality available on bands IV and V alone. There will, therefore, be ample space available for new free and pay services.

Such a transition, however, will be, as already stated, strongly conditioned by the users' interest in digital services, which will be demonstrated by the speed of diffusion of the set-top boxes.

The problem of frequencies and coverage strategies

The present use of the spectrum in Italy presents the following characteristics:

- a great number of broadcasting stations which are not always rationally distributed;
- systems of considerable power; and
- a not always adequate service due to reciprocally-provoked disturbances.

Starting from the present situation of congestion of the spectrum and considering the hypothesis above illustrated for the identification of resources to be destined to experimentation, it is easily understood that, initially, it will be necessary to operate various coverage strategies for the single DVB-T networks.

The network used for experimentation will be gradually extended in order to provide universal service.

Such a service, in order to reach more or less the whole of the population by the year 2010, allowing for the period necessary for the development of the network and for the necessity, at the same time, of extending the others, must cover about 90% of the population by 2005.

The remaining networks will reach a reasonably inferior coverage percentage (for example, 80% of the population) with different territorial directions of coverage and different commercial targets.

In Table 1 and Figure 3 the possible levels of coverage for the various bouquets are shown.

Conclusions

The present document describes the periods of time which will lead to 'full digital' terrestrial broadcasting in Italy.

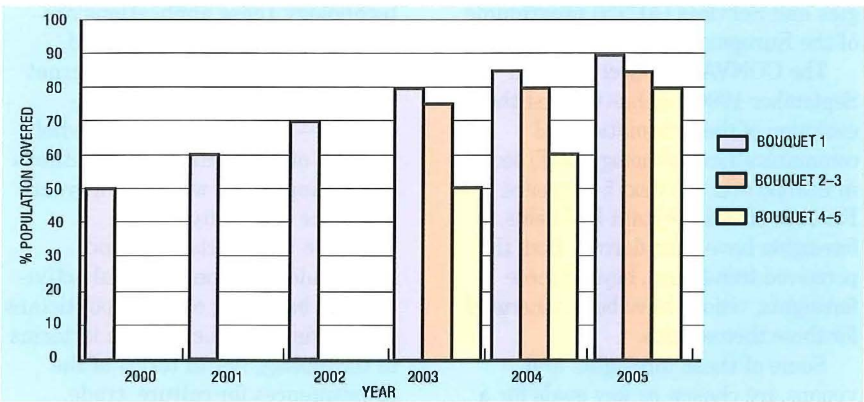
Particular emphasis is given to that which is called 'the start of the mixed analogue/digital scenario', that is, to that period which will follow the preparatory phase of experimentation, devoid of economic returns, and for which the broadcasting of five bouquets is already foreseen, with coverage strategies of the country which take into account the availability of frequencies and the interests of the broadcasters and of the public.

Despite the intense use of the frequencies spectrum in Italy, transformation of the networks from analogue to digital appears to be an unstoppable process. The thrust comes, in fact, from all the interested economic categories; from the production industry and that of broadcasting equipment to that of consumer products, and from the enterprises providing services to the public to the administrations, who see in the introduction of the DVB-T, a unique medium for the efficient use of frequencies.

Table 1: Coverage objectives for the DVB-T service (% of population)

Year	Bouquet 1	Bouquets 2 and 3	Bouquets 4 and 5
2000	50%	—	—
2001	60%	—	—
2002	70%	—	—
2003	80%	75%	50%
2004	85%	80%	60%
2005	90%	85%	80%
...	...	...	...
2010	100%	95%	80%

Figure 3 – Coverage of bouquets



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Biographies

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Stefano Teodori graduated in Electronical Engineering at Rome University 'La Sapienza' in 1991. The same year he joined Telesoft S.p.A. as a software designer. In 1993 he moved to RAI (Radio Televisione Italiana) where he works as a broadcasting network designer. He is a member of the Italian Association of Telecommunications Engineers.

Pietro Polese and Muryel Wehr

Telecommunications for the Forthcoming Information Society

Evolutionary Perspectives from the CONVAIR Project in the ACTS Programme

The goal set in Europe for the next decade is the realisation of the information and communication society[1]. Many new applications will become possible throughout Europe and will result in new business opportunities for all European citizens and enterprises. This will also produce new opportunities for telecommunications service providers, network operators, and equipment manufacturers. Existing services and network infrastructures are however inadequate to support the new emerging applications and must evolve to meet the challenge of the next century.

Several European telecommunications manufacturers and operators are involved in the CONVAIR[2] project within the ACTS European Programme[3]. Results emerging from CONVAIR lead to the conclusion that a real development of the information society is impossible without a suitable communications infrastructure.

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Introduction

Europe is moving towards an information society, which promises to bring benefits to virtually all sectors of the economy as well as to the majority of European citizens. The telecommunications sector is bound to play a decisive part in this development by providing key-enabling technologies for the new services and applications, which are forming the backbone of the information society.

Although it is impossible to forecast all the new services and applications that will come about, it is recognised that the existing infrastructure is already inadequate for many of the services and applications being contemplated. In order to remove the technological obstacles as soon as possible, several European telecommunications manufacturers and operators have combined their expertise in CONVAIR, a pre-competitive research-and-development project operated under the Advanced Communications Technologies and Services (ACTS) programme of the European Commission.

The CONVAIR project began in September 1996 and has forecast the evolution of the information and communication technology (ICT) sector in Europe over the next 5–10 years. For each of 10 important ICT fields, foresights have been derived from the perceived trends and, beyond these foresights, visions have been generated for these theme fields.

Some of these foresights and visions are chosen as key goals for a sustainable information economy and society, and critical issues are identified which are seen as factors preventing or delaying the accomplishment of these goals.

In this paper, the evolution of the network infrastructure anticipated by CONVAIR is outlined first, followed by an overview of the approach followed by the project and a discussion of the major project findings available to date.

The Market Forces of the Information Society

The main driving forces at work are the application pull and technology push, which influence the strategic planning of all high-technology products, including information communication networks. These forces need to be in balance, although this was not always the case in the past. For example, narrowband ISDN has been around for some 20 years, and although we are now seeing a modest applications pull for this technology, these applications are very different from the original vision. On the other hand, Internet technology was made available cheaply—and has spawned a whole new set of applications and methods of working which will have a great influence on society.

While the effects of IT and communications on all social activities are becoming obvious, politicians do not view social evolution in terms of technology, but in terms of the consequences for culture, trade,

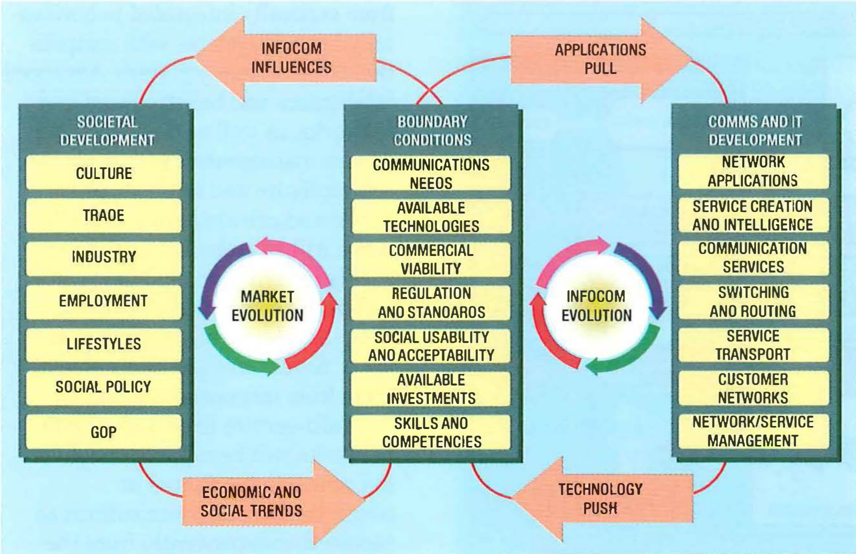

Figure 1—Societal and infocom evolution

industry, employment, lifestyles and social policies. This in turn is reflected by a nation's gross domestic product (GDP) and a major political objective is to grow (or at least maintain) the GDP statistic.

Currently many politicians and economists are convinced that the world has entered an information revolution, which could be more significant than the industrial revolution. The new technologies and infocom networks becoming gradually available will have an impact on employment and will strengthen the role of small businesses.

Statistical research shows that the economic growth created by societal development eventually leads to an increased demand for communication services, an application pull that drives the development of communication infrastructures, as shown in Figure 1.

The boundary conditions are enablers and inhibitors, which influence both societal and network evolution far beyond networks and technologies, making the demand for new products or services very difficult to predict. Commercial viability is emerging as the most dominant boundary condition, because business models for the emerging multi-operator, multi-vendor environment have yet to be developed.

The Role of Telecommunications in the Information Society

Investments in infrastructure produce a technology push that flows out from the communication networks to the end users in the form of access expansion, new access developments or new services. This creates a surge in new communicating applications providing a catalyst for more societal developments, leading to more innovations in communication services, and then in networks, in an ever-increasing supply and demand spiral. User needs, therefore, are dynamic and continue to increase in sophistication as lifestyles change and access to new services, via new 'communicating appliances', become more readily available.

The evolution of communication networks will therefore play a pivotal role in the creation of the future information society, such that the competitiveness of nations and the quality of life of their citizens could well depend upon the state of their information and communication networks.

CONVAIR has developed visions, described in reference 4, on the evolution of communication networks over the next 10 or more years, with the corresponding issues, drivers and regulators that influence this evolution. This also helps to bring into perspective other visions, which are being promoted under the banners of the *Information Superhighway* (USA) or the *Information Society* (EU).

To study and model the relevant aspects, CONVAIR has developed an *Infocom Conceptual Framework*. In this framework, the geographic topology of infocom networks is represented on the horizontal axis. The primary segments are public networks (core and access) and private networks (including customer premises networks and terminals).

The functionality is represented by a series of layers on the vertical axis. At the bottom are the infrastructure layers, which provide the physical means by which information is accessed or delivered, and the switching/routing nodes of multi-service networks. On top of these infrastructure layers are the communication services, which provide the basic methods by which people communicate using voice, data or video media. An agent and application layer contains hybrids of advanced services and application-support functions. Over all of these run the applications themselves, combining the basic services and presenting the result to the end-user. Together, these applications and their environment can be thought of as making public *cyber markets*, virtual meeting and trading places for individuals and cyber businesses.

Figure 2 shows this conceptual framework as used within CONVAIR to summarise the evolution towards a long-term scenario, including the developments in management systems, essential to bring order and stability to this complex scene, in which private and public players select combinations of roles to perform.

In the future, the rapid data-driven growth and increased competition is expected to cause a metamorphosis of the current datacommunications and telecommunications network models. As industries converge, the focus will shift from vertically integrated, service-specific architectures towards horizontally layered structures. This will promote soundly-based competition between new players filling selected roles in the provision of applications, services, etc., through access and core infrastructure.

As new networking business models begin to emerge, many current distinctions will disappear in the realignment of industry sectors including communications, IT, broadcasting and even banking. The basic enablers will continue to be network access and the availability of attractive content and applications. However, to deliver this vision of information communications evolution, major advances in the supporting roles including network and service management as well as application and communications services middleware are required. These will provide easy-to-use 'agent' functions to assist the user in

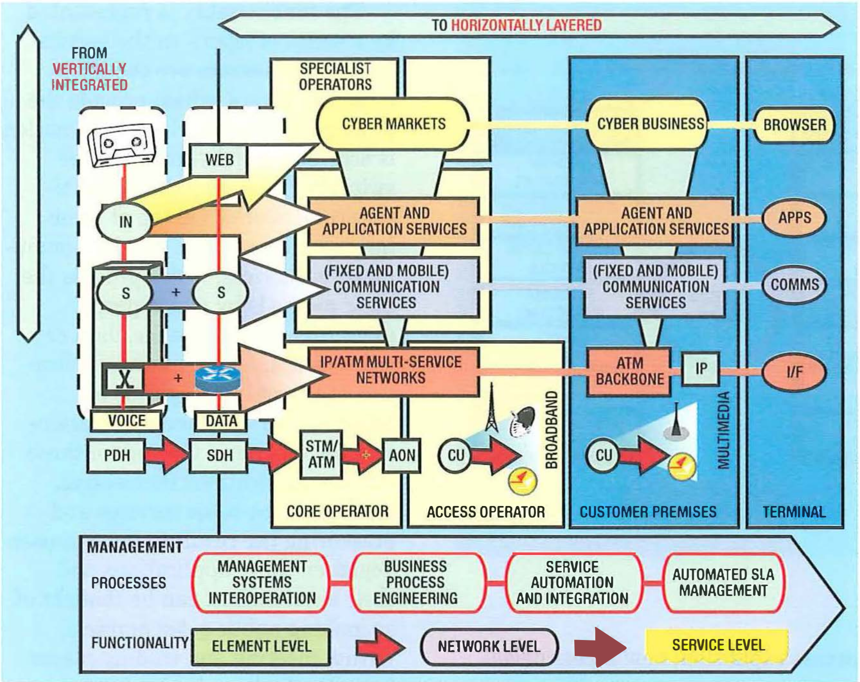

Figure 2 – Evolution towards a long-term scenario developed with CONVAIR

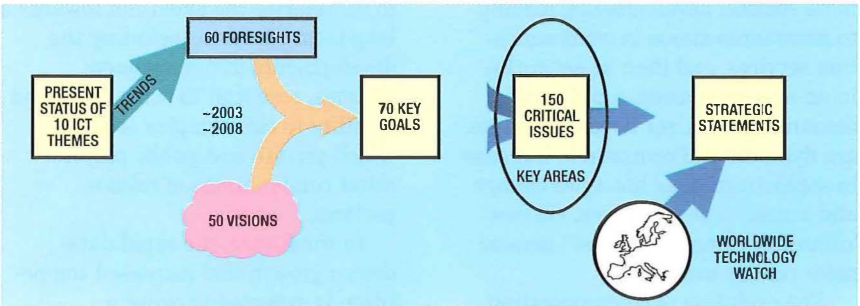

Figure 3 – CONVAIR methodology and results

locating people, services or information while simultaneously protecting the user's own information, personal privacy and identity.

Evolution of European Telecommunications

The CONVAIR project focused on 10 ICT themes:

- basic enabling technologies,
- access networks,
- connection-oriented (CO) versus connectionless (CL) communications,
- communications intelligence,
- mobile communications,
- core networks,
- customer-premises networks,
- network and service management,
- service-creation platforms, and
- application platforms.

In addition, the environment to which ICT is to contribute, and in which it is to serve, includes the following aspects: information society, user environment and user needs, enterprises in the ICT sector, and regulation. CONVAIR further selected four of these themes for special attention, considering them to be particularly topical: intelligence, mobile communication, CO versus CL communications and the access network.

The methodology used by CONVAIR to establish visions, foresights, critical issues and statements on the selected themes is shown in Figure 3. This work was complemented by a technology watch on worldwide work on network evolution and the potential emergence of new technologies.

The analysis of the statements leads to key recommendations for actions, which will allow the industrial society evolution towards the information society. Some foresights/visions concerning information communication network evolution are reported here following.

In the field of information communication networking for the next five to ten years, there will be a transition from vertically integrated to horizontally layered systems with competition between many players. Advanced intelligence will be introduced and networks, as well as the associated service management, will be able to self-configure and self-heal. Much public and private network intelligence will be embodied as software agents in terminals, and in private and public computing platforms. These will be highly responsive to users' needs and essentially shield them from increasing complexity.

Multi-service fixed and mobile networks will be capable of delivering connection-oriented or connectionless communications as required, independently from the underlying infrastructure and will support services, interworking from smart cards, through terminals and customer-premises servers to public and third-party service providers. The critical issues for the rapid creation of such interoperable mobile multimedia services lie in the interworking between telecommunications and datacommunications, requiring convergence from today's different platforms on to common architectural structures.

The information society will require rapid delivery of application solutions. Already IT-based applications tend not to be bound to specific infrastructures, instead, multivendor networks carry traffic between application hosts and intelligent terminals. Service-specific networks are expected to be replaced by application-tailored virtual networks (cyber markets); for example, finance, retail, education, transport, health, etc., all accessed through browser-like interfaces.

The work carried out so far within CONVAIR has led to the identification of a number of issues which are critical and need to be addressed, and to the formulation of statements on how to proceed[5]. These statements are of different types and include technology items for further research and development as well as other items concerning political and regulatory aspects.

Considerations and Conclusions

In conclusion, research shows correlations between societal development and the development of indigenous infocom platforms indicating that economic and social trends created by societal development lead to an increased demand for infocom services. This drives the development infocom platforms and networks, which in turn influences the direction of societal development.

The evolution of infocom networks will play a pivotal role in the creation of the information society such that the competitiveness of nations and the quality of life of its citizens could well depend upon the status of their infocom networks. While new technology will play an important part in infocom evolution there will be many other equally important forces including social and political, which influence through the boundary conditions.

The CONVAIR Project is expected to conclude its activities in February 1999 when the final report will be released. All the public results of CONVAIR are available for downloading from the project web site[6].

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Disclaimer

The views contained in this article do not necessarily reflect those of the partner companies involved in the CONVAIR Project. The CONVAIR partners are:

European Telecommunications Industrial Consortium (ETIC[7] coordinating partner grouping—*Alcatel, Bosch, Ericsson, GPT, Italtel, Lucent Technologies, Nokia, Siemens, Thomson*), BT, France Telecom, Deutsche Telekom, Telecom Italia, CSELT, Deutsche Telekom Berkom. EUREL[8] and ECTUA also participate in the project as associated partners to ETIC.

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6 More information is available at http://www.cselt.it/webhost/convair

7 More information is available at http://www.cselt.it/webhost/etic

8 More information is available at http://linux.etec.polimi.it/eurel

Biographies

Pietro Polese
ETIC

Pietro Polese completed his studies in Industrial Technologies in 1973 at ISTIM, Milan. During his career, he has been Assistant to the Technical Director, responsible for electronics components and technologies planning and FACE, and then Alcatel Italia, representative to the ETSI Technical Assembly and several ETSI Technical Committees. He has managed important horizontal projects within the RACE I and II EU Programmes. Since 1996 he has been Secretary General of ETIC (European Telecommunication Industrial Consortium). He is Deputy Director of FERT (Forum for European Collaborative R&D in Telecommunication) and Project Manager of the ACTS Project AC234 CONVAIR and of the Telematics Project SU2104 CONCORDIA.

Muryel Wehr
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Dr. Muryel Wehr, who has a Ph.D. in nuclear physics 1978, Lyon, France, started working on integrated circuits for switching by Ericsson. She held research on optical fibres for 5 years at Thomson-CSF and Alcatel. She spent three years as a professor assistant at Osaka University and at the Mitsubishi research centre in Japan. Returning to Alcatel in France, she was a sales manager of opto-electronic components, a project manager of SDH transmission networks and a product manager of WDM submarine networks. She is presently involved in strategies for future telecommunications research and development activities and in charge of the external affairs of the optical department of the Alcatel Corporate Research Center. She is the deputy manager of the CONVAIR project.

Jerry Foss

Brokering the Info-Underworld

Information brokerage is a range of intermediary services between consumers and info-sources in an increasingly commercial trading environment. In this scenario automated on-line businesses emerge to provide information services. Their construction, deployment and management is considered as net-centric component-ware: they continually re-assess their market and self-organise to fulfil their optimal business development. This process is likely to involve increasingly active intelligent elements in the global net. The global interactions of large masses of information may bring about some interesting consequences.

Global Informisation

Most aspects and commodities in society are becoming represented as information stored and accessible in the world's networks: business, entertainment, human activities, organisational activities; activities of the world's communication and information networks themselves; information about information. There appear to be two main families of information services evolving: (*i*) information trading and processing, and (*ii*) group activities... (and probably (*iii*) the ones we don't yet know about)[1]. As more people are empowered with computing and communications capabilities, new and unforeseen services and applications will emerge. The Internet will evolve beyond our current imagination and expectations, so the growth of the Global Net is unpredictable.

A number of services are required for the administration of info-businesses, and to guide users/customers through info-transactions. One of the mechanisms envisaged to provide these services in an integrated manner is the concept of the information broker. A number of broker services are appearing on the World Wide Web (WWW). Many of these are 'shopping' agents (especially for compact discs), like the Andersen Bargain Finder[2]; Firefly[3], based on Massachusetts Institute of Technology's HOMR, the Helpful On-line Music Recommendation service, compares similar client profiles to deduce its recommendations to the enquirer. The Firefly site then added a CD 'shopping trolley service', and now also offers communal media services. This is an example of the way in which 'new media' services can quickly diversify. (Firefly has been an established part of net-culture, and has recently been acquired by Microsoft). Many Web sites now offer services which blur the boundaries between a number of services—news, publishing, entertainment, shopping and other services are seamlessly bundled into entrepreneurial on-line malls. The significant trend is the speed at which these sites can redefine their service and reorganise their site accordingly.

Extending the Concept of Information Brokerage

In this paper, scenarios are described that extend the concept of brokerage. Here, a broker is considered to be a managed on-line collaboration of a range of functions (examples are given below) and acting as an intermediary between the customer and a range of information sources. Brokers are not entities which can be rigidly defined—they organically evolve and operate in a free market of networked services and service components (component-ware); for example, applications, macros and agents configured into the best-fit for the current task or business phase, independently created and managed by third parties. The broker's position in the trading model (between client and service) is suitable for administering the legal functions. Networked services may also be constructed as separate components which are brokered—traded by virtue of their availability, cost, affiliations, licenses, etc, and constructed on-line, probably (self-) organised into information networks (info-nets), creating an info-underworld of federated distributed heterogeneous information networks.

Current views of information brokerage seem to be limited to search and retrieval functions. However, in the context of the maturing information services and deployment of network resources, there is an increasing range of intermediary services which need to be applied between the suppliers, *information warehouses,* and (enquiring) customers. A brokerage:

- offers an intermediary range of functions to aid the customer with on-line services;
- can bridge the gap between what is available and what consumers want (for example, librarians for entertainments (games, video or audio); travel agents; insurance-brokers, etc.);
- can undertake a global trawl of potential information services and suppliers, and assess the suitability of a selection of information products for the customer;
- negotiate payment schedules for the service—per performance, per usage of application, etc. (A broker role may be employed at a corporate gateway to the network for information service exchanges. Brokers are in a position to reassess continually the market to maintain awareness of future potential user requirements for infoware.); and
- may take on other functions managing the info-traffic flow between suppliers and customers (for example, be able to build up service packages for clients, customising and integrating applications according to the client's needs, perform marketing and promotion and carry out

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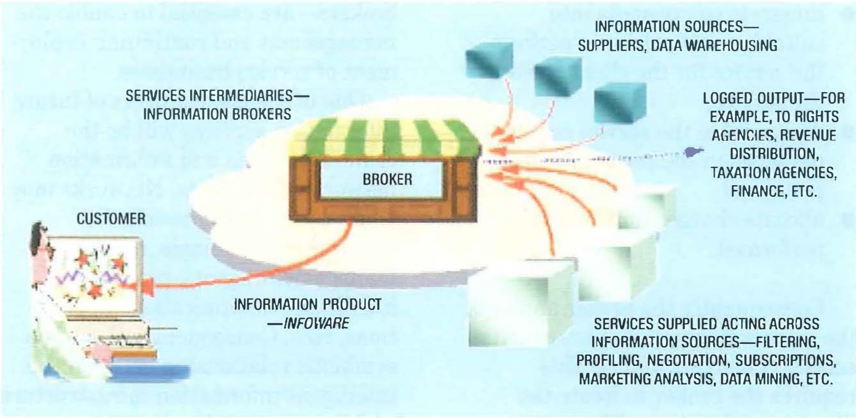

Figure 1—Basic model for information brokerage

market research for their own use or on behalf of clients or Infoware suppliers).

It is likely that the evolution of brokerage services will result in the provision of complex on-line information releationship management between clients and partners in on-line collaborative ventures.

This is not a proposal for a standardised hierarchy: it is a description of the commercial trading relationships already existing in real life. These roles will often be independent, organically evolving businesses, manned or automated. However, if we consider that information is continually sold, re-sold, repackaged and reworked, the roles of customer, supplier and broker become blurred. So we see that each user and each business can have elements of each role—a client who obtains information can rework it, and sell it, thus becoming a supplier.

Information brokerage—services and functions

Brokers may specialise in a number of sectors—corporate information networks, public sector information services (for example, local authority information services)—however, the largest brokerage sector will almost certainly be commercial information businesses. Brokers serving a specific sector of industry or commerce may provide services that are specialised to that sector. Some of these services may be permanently resident within the broker configuration, or available from external sources and bought/rented-in as and when necessary.

Functions offered by a brokerage may include:

- information search retrieval and processing (may also coordinate the subsequent processing of the information);
- maintenance of a *self-learning infobase* about (and on behalf of) the user (the information base grows with the user's business experience and may be incremented on a per-transaction basis);
- profiling of users;
- monitoring for items of interest to the user;
- protecting the user from intrusive access from other users or agents;
- filtering of incoming information;
- intelligent prediction of user requirements;
- commercial negotiation between customers and the providers to attain a contracted agreement including costings of sources and services (this may also include rights of future usage of information)
- technical negotiation—to match the customers' installation to the required network-services interface;
- access, procurement and integration of third party services and applications into the user's working environment;
- communications services management—administration, management and invocation of services (for example, diversion, conferencing facilities, access and user group integrity, etc. (*c.f.* intelligent network));
- subscription to nets and Webs—independent commercial information services may require contracted subscription access (the broker may provide a negotiated temporary subscription or proxy subscription for non-subscribers to these services and networks);
- collaboration and federation with other brokers—a customer's view of the broker may be as a single front-end, but the services may actually be implemented by a federation of many brokers;
- administration of information rights and revenues (IRR) (Many interested parties are eagerly proposing schemes for protecting the rights of info-commodities. The issues related to copyright in an open information network are rather complex, however the broker is in a position to administer royalties and revenues distribution, and possibly info-rights.); and
- market research on behalf of the infoware suppliers. A broker is in a privileged position to accrue information on all transactions conducted, as well as monitoring which suppliers have (or haven't) various items. This may be a large source of revenue for many intermediary services. These functions may be provided by separate components; for example, applications and agents that are responsible for each of the functions—search engines, negotiation agents[4], trading models, etc.

So in this 'extended' concept of information brokerage a broker develops its core functionality and extends its repertoire as needed, as new market requirements arise. Brokerage, as with any business or service can cover a wide range of business-types—from large global comprehensive combines, down to small niche market services. However, there are many intermediary functions which have yet to be identified for future requirements, and the brokerage model serves as a generic architecture. The customers (and suppliers) may need a wide range of intermediary services, and so they must decide whether to employ a broker who can supply all of these specific requirements, or if such a broker is not available. it may be preferable (or necessary) to employ the services of a number of brokers. A broker may 'front' the collective services of a number of sub-contracted brokers.

Service Nodes; The Info-Underworld

One of the possible methods of implementing future service nodes is for the node to acquire its service functions (applications, agents, etc) as/when it needs them; that is, as a continual (re)assessment of the service's ongoing business trends and requirements. Service components are acquired from on-line suppliers and integrated to form a composite but self-contained service node. This is basically a virtual private network (VPN) configured into a suitable architecture to implement the required service. This method of service construction is applicable to many networked services, and brokerage services themselves may be utilised in this manner; however, the construction of services in this manner will also need brokerage services to identify and commercially acquire the service components. Now let us consider that the service providers, their customers and suppliers are all on-line automated businesses.

The constituent service functions may be independently provided from on-line applications vendors, agent vendors, etc; that is, applications software products for sale/rent from other independent retail outlets, or information warehouses. The service business needs to:

- identify the current task (who the client is, what he/she wants);
- identify the components and functions needed to perform the task (some of these may already be owned by the broker—others are additional, and need to be acquired);
- initiate the (global) search for the additional required components;
- negotiate and procure these components, including payments;
- integrate components into suitable architecture to perform the service for the client perform the service;
- disassemble the service components when the service is complete; and
- allocate charges for the service performed.

Consequently the broker analyses the requirements and constructs its service (Figures 2 and 3). This requires the broker to locate the distributed functions. This may result in the formation of networked businesses that provide the specialised business of *broker-support*; that is, brokers for brokers. The broker is also an end-user in its own right and would now be self-organising, automating its self-building process. The service business could be managed as continual self reassessment. In this case the service continually reassesses its business environment (for example, on-line marketing) and reconfigures its component services accordingly. This scenario continues by considering that service platforms are recursive. The service formed by a network of components would now link with other services to form a platform at a higher layer, and so on. Consequently services at any specific layer are composites of services of lower layers. Many/most/all of these networked services are constructed in a fluid, commercial self-organised manner from networked components. In this fully mature net-centric service environment, intermediaries—brokers—are essential to enable the management and continuing deployment of service businesses.

One of the biggest users of future information services will be the communications and information networks themselves. Networks may trade with other networks for resources (for example, network management agents, protocol handling, communications applications, etc.). Consequently, there is a symbiotic relationship between the intelligent information infrastructure and the services that it supports. Given the real-time information trawling, self-organisation and service platform creation, there will be a dramatic increase in transaction traffic within the network.

The functions and services acquired by the broker (including those for its own construction) may be subject to acquisition charges, application usage charges, etc. The broker building process thus acquires an information rights and revenues culture all of its own. These charges are of course either absorbed in the brokers' overall business, or are charged as part of the broker's service charge to the customer for this specific task. The broker can also raise revenues from advertising or market research and consultancy using derived information from the broker's business. These charges are the business of the broker in a free market.

Infonets, Intelligent Marketing

In the brokerage tasks described above, a broker can locate, retrieve and integrate the constituent services from suppliers (that is. information/content owners) and then integrate and customise, if necessary. The broker may have to

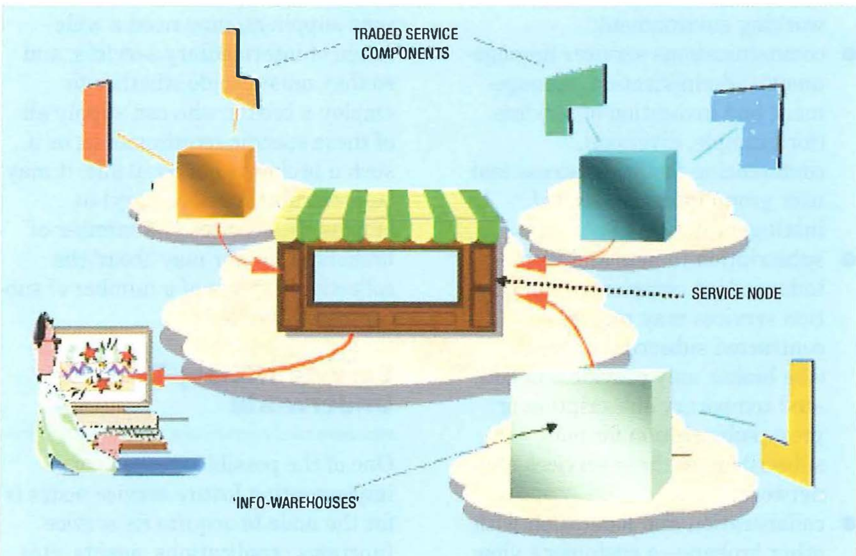

Figure 2—The service node assimilates requirements and acquires the necessary components to fulfil the task. This is a series of commercial deals with on-line warehouses that supply the components to build up the service node

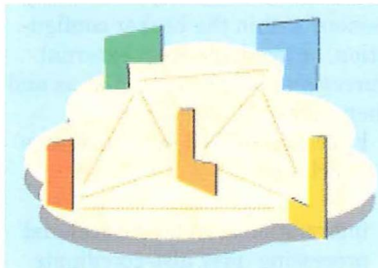

Figure 3—The service components are configured into a virtual organisation—*a* virtual private network. *This service architecture can now support the customer's requirements*

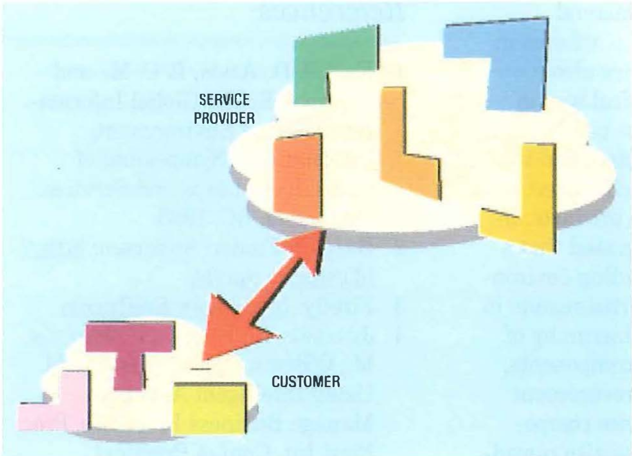

Figure 4—Now suppose the user/customer is another infonet (virtual organisation) service node...

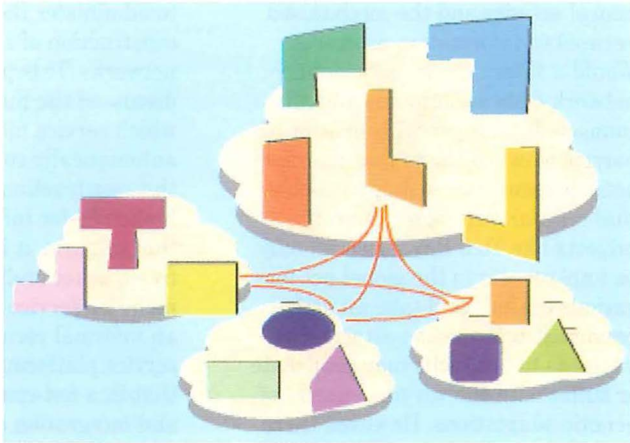

Figure 5—Agents from infonets take the initiative to browse other (hitherto unrelated) infonets. The infonets begin to learn about each other—opportunities, scavenging for general information about the common trading environment, marketing activities, etc.

search and retrieve other services, for example filters, negotiation functions, management devices to act across the accumulated 'raw' information content.

The information product (or service), the *infoware,* is constructed, probably specifically crafted and customised for the end-user. This may utilise the user's direct specifications (with his/her participation), or utilise a previously acquired profile of that user (or a mix of any or all of these options). Intelligent brokers can pre-empt these activities with intelligent marketing to predict their users' requirements in their evolving marketplace. A successful broker would reconfigure its own business to support these needs more efficiently and effectively to maintain a competitive business to its clients; it would also assist its clients to configure their on-line businesses to best advantage.

Figure 4 shows that a customer may be an automated business (similarly constructed of componentware) seeking the services from an automated service provider. In Figure 5, one (or more) agents takes the responsibility to break out and browse ad hoc with other agents representing other infonets, for a number of purposes; for example, trawling for information of potential interest to the user of the infonet represented by this agent; marketing the agent's infonet business to other infonets; serendipitous meetings with other agents (for future references). In these liaisons, agents can compare experiences, swap or trade information of other associates (subject to previous contractual agreements and security). Even at this level, agents may utilise other agents which assist locating other agents, assisting inter-agent functions, etc.

Such agents may take on a nomadic life, returning periodically to update their host. This type of mobile agent may be utilised for policing and monitoring activities in future information environments, checking for abuses of rights infringements, etc. Intelligent on-line marketing activities can be used to determine the degree and nature of self-organisation of an on-line business. Information businesses can fine-tune (or reconstruct their configuration) according to the findings of on-line marketing, including automated brokering businesses and intelligent agents; hence—the *underworld* of traded service components. There are inevitable issues about allegiances and loyalty in federated multi-agent systems. Some of the management issues are discussed in Reference 5. The service components (including agents) are tradable commodities in the lower layers of this service/agent-hierarchy.

From the complex informational activities described above it is likely that brokerage businesses evolve to provide relationship management services between businesses, their partners, their clients and their customers. This is an increasingly complex task as organisations continually form and re-form, and as partners drift in and out of virtual organisations. Full-time professional intermediation is needed with the ability to manage and contextualise vast interrelated fields of information swamping on-line enterprises.

Implications—Scaled Information Characteristics

There is a wide range of implications: What is the future status and role of the nation state as the global economy becomes increasingly on-line? How will national legal systems affect multi-national virtual organisations? How will global commerce accept cultural differences in trading, bartering, etc.? In this volatile info-underworld, will the latency of traditional monetary currencies be sufficient, or will information become its own global currency?

When large 'masses' of information become 'mobile' and interacting with each other in the global net, there could be significant and unpredictable results. Agents in the network are proxies of humans and serve to promote more-free communication between the information 'clusters' in the global net. These scenarios point to an automated information environment where information can, effectively, become 'aware' of other information; 'spatial' relationships between information clusters can be formed corresponding to similarities of content and potential interests. Informational groupings form affinities between each other, leading to natural clustering of informational groupings.

Information processing in a networked environment can be similar to human neural activity: non-centralised, self organised and integrated into overall activity. More efficient and effective interfaces (for example, prosthetics, MIT's 'wearable computers') of the future will allow a seamless continuum between human neural activity and the mechanised networked information processes. Would a future global information network embrace humans and all connected machines with little or no barrier between them; that is, *cyborg-nets*? It seems increasingly feasible that *cellular automata* (reference projects like Tom Ray's Tierra[6]) may be implanted into the global net for various reasons and take an active residence. Information attached as payloads to host-cells may propagate or suffer with the varying success of genetic adaptations. However, there is a symbiotic relationship between (*i*) the communications network which supports the information environment, and (*ii*) the information environment which carries (and even governs) the management processes for the underlying communications network. Is such an environment suitable for the evolution of info-species that can aggressively create an environment suitable for its own survival, evolution and proliferation? Would this disallow specific nodes access to the network, including some humans?

Summary

A series of scenarios has been presented for the evolution of the global information trading environment. The scale and commercial nature of this environment requires the use of information service intermediaries that administer the access and selection of a number of information sources which are the basis of infoware products for the user. At the same time there is a need to manage and administer information processing activities across the source material to produce the required information product for the customer.

This paper has presented brokerage in the context of a universal trading model in which brokerage is seen as necessary because of the sheer scaling problem as on-line commercial services drastically increase. This paper has also proposed that brokerage, as an intermediary, can administer the legal and commercial requirements of information trading in a number of market sectors—general public access to community information services; entertainment for domestic users; services for business users, etc.

Although the concept of information brokerage is not new, this paper has discussed an extension to the basic concept: the broker as a device to administer the commercial construction of service platforms in networks. This paper has also discussed the hierarchical way in which service platforms can be automatically constructed, and that this construction is itself subject to brokering for infoware products. In this scenario, it is suggested that a free market on-line trading environment for service platforms results in an informal recursive hierarchy of service platforms and components, that is, a net-centric procurement and integration of service components. This scenario has also considered brokerage as a commercial business, and the management of these businesses, and their continual redevelopment in the evolving on-line trading environment.

The scenarios have described the dynamic nature of information networks—infonets of information processing nodes that are self-organising, reconfiguring their operations as they respond to real-time marketing of the environment they operate in. These characteristics need to be considered for the development of communications services (for example, call and session processing), and in the development of the intelligent network, both technically, and commercially. One possible brokered commodity may be processing capability. Surplus processing capacity may be identified in idle resources and networked to tasks or businesses in immediate need of more processing power; for example, a brokered 'global grid' for processing power. Similarly, surplus bandwidth may be a brokered commodity, and network resources may also be traded as free-market commodities.

In the global information trading environment, the world is your hard disk, and information is the most marketable commodity. Perhaps much of the value of information is its relationship to other information. Intermediaries to manage these relationships and to broker information trading may be the biggest market sector of the future. On a global scale, interacting information masses have significant (if unknown) effects; probably information is the most dominant organism on the planet (and beyond). Our networks of computers and switches are merely the 'cells' of the organism.

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Biography

Jerry Foss
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Jerry Foss has worked for GPT (formally GEC Telecommunications) since graduating from Leicester Polytechnic in 1975. In recent years he has been involved in studies and collaborative projects for information networks and services, including commercial information brokering. Many of these studies have involved possible implementations using intelligent agents. Other studies and projects have included virtual organisations, computer supported cooperative working (CSCW), networked virtual reality, distributed virtual environments and virtual interfaces and metaphors. He has also been involved in a number of local authority information society initiatives, and public administration information services.

[*Editorial Note*: GPT is becoming Marconi Communications.]


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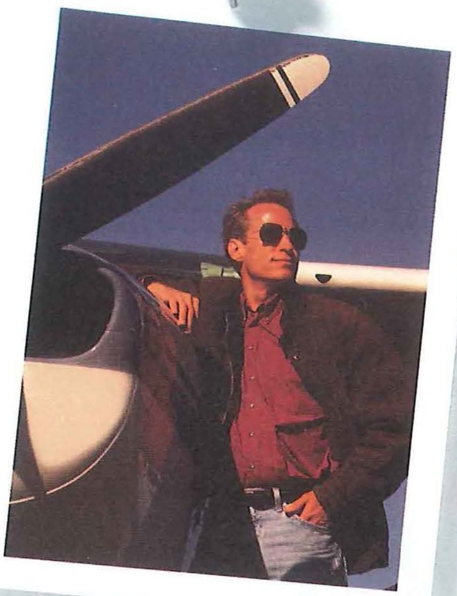

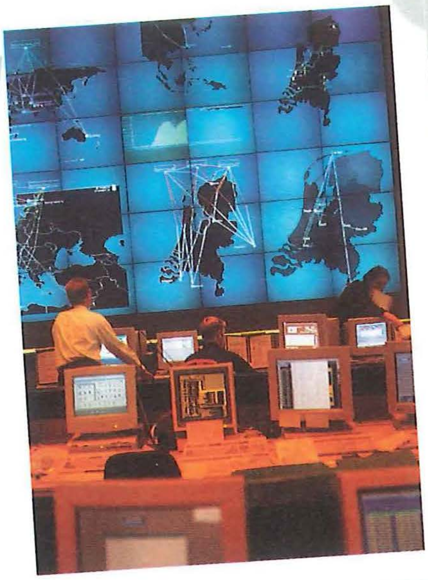

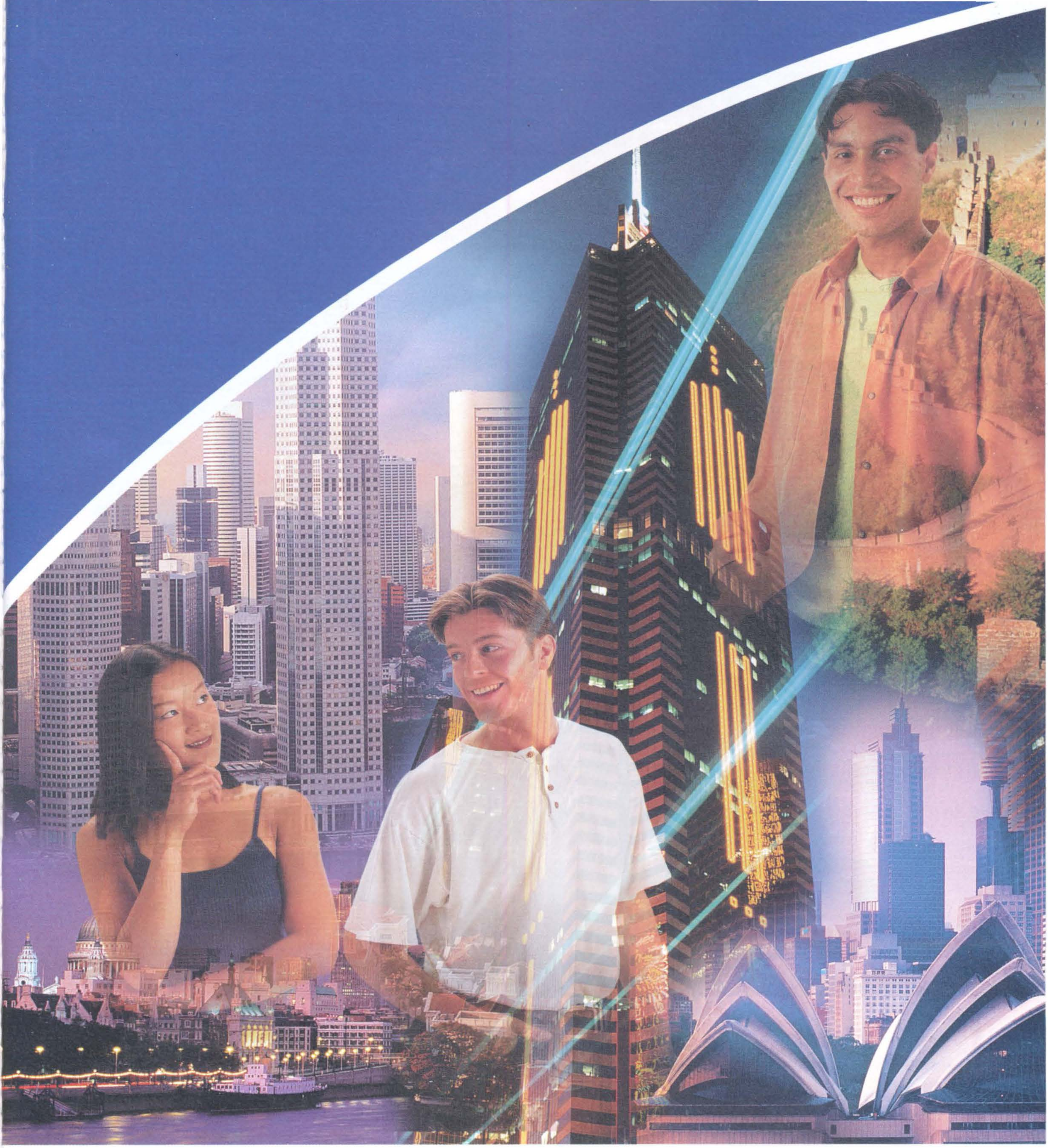

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