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BRITISH TELECOMMUNICATIONS ENGINEERING

Included in this Issue

First of a new 'Perspectives' series

Voice and Data over Frame Relay

Intranets

35th European Telecommunications Congress

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BRITISH TELECOMMUNICATIONS ENGINEERING

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GUEST EDITORIAL

Chris Earnshaw

Leading Perspectives

Pulling together such an array of views and perspectives will help us to get a better understanding of the big picture

You would have to be leading a very sheltered life not to appreciate the sheer scale of impact the information age is having on our lives—the way we live, the way we work, the way we play. Change in our society is accelerating at such a rate as we approach the next millennium that virtually every aspect of our lives will change in some way—touched by new technology and the huge range of new opportunities that technology will offer.

Certainly our perspective of technology as a fundamental part of our lives is shifting, almost daily. And it is perhaps the key rationale behind a new series of articles beginning in this issue of *British Telecommunications Engineering*—'Perspectives' and, as President of the IBTE, I am delighted to be able to support it by acting as Guest Editor. In it, we intend to bring together challenging and insightful opinions from leading figures in and around our industry, each considering technology, its impact and influence on business and society, and the issues we face. Pulling together such an array of views and perspectives will help us to look at change from a number of different angles, and so get a better understanding of the bigger picture.

Chris Earnshaw
Managing Director
BT Networks and Systems

Sir Peter Bonfield

Managing Change—Building the Information Society

'Perspectives' is a new series of articles in which leading figures from within and around the communications industry share their opinions on today's industry issues. Opening the series, Sir Peter Bonfield, Chief Executive of BT, gives his view on the changes in today's roller-coaster world and the factors for success.

Age of Opportunity

As a relative 'new boy' in BT, it is no small challenge for me to write a 'learned' article for the IBTE journal. But I am delighted to have the opportunity of sharing my observations on the changes affecting our industry, and those around us, and offering some thoughts on what it is going to take to succeed in this turbulent roller-coaster world.

Two things strike me after nine months with BT—enormous change, and breathtaking opportunity. I recently saw a quote from Walter Mondale, written when he was US vice-president, nearly 20 years ago: 'If you are sure you understand everything that is going on, you are hopelessly confused.' This is an observation that appears to have stood the test of time, for if people were confused then, what state must they be in now, as we stand in the midst of arguably the greatest social revolution in modern history? The pace of change has continued to accelerate since vice-president Mondale wrote those words and, in the next decade or so, we are sure to see major changes in the established way of doing things. For many people, this is a daunting prospect.

I also think it's very exciting—the start of an age of opportunity. Some of the things we are seeing—the removal of many regulatory barriers in Europe on 1 January 1998, for example—will only happen once. There are huge gains to be made for those companies that are geared up to exploit the new business opportunities that will emerge. Perhaps I'm biased, but I think this industry is the most exciting place to be as the information age unfolds. There is no bigger game in town—and it's a game that we in BT are focused on winning.

Sir Peter Bonfield, Chief Executive, BT

Trends

To identify the strategies that are going to separate the winners and losers in the new industry, we need to understand the trends that are driving the change we see all around us. For the purposes of this article, I will concentrate on four: convergence, globalisation, technology and regulation

Convergence

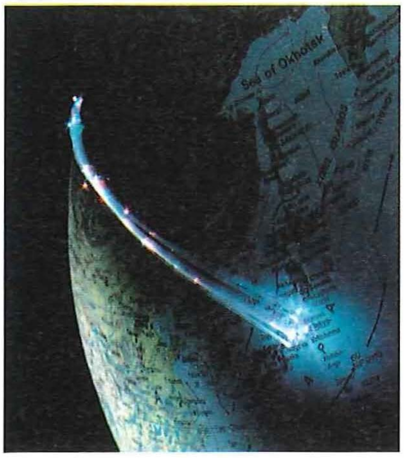
Since joining BT from the computing industry, I have had the opportunity to view the convergence trend from the inside. Many of the boundaries that were once clearly defined are now becoming hazy, and in some cases have disappeared completely. Cast your mind back just a few years to when life was so much simpler.

Banks were banks, and building societies were building societies. Telephones were telephones and computers were computers, and ne'er the twain would meet. How different it is now. Today, financial institutions overlap and constantly emulate one another, while computers are used to make telephone calls and telephones have built-in computers to manage your diary and send and receive e-mail. Companies that might once have been clearly labelled under 'hardware', 'software', 'content' and so on are constantly shifting and resisting classification. Our traditional switch suppliers, for example, now see much of their future revenue coming from software upgrades. And for a real example of change, you can look at Swatch, who revolutionised the traditional watchmaking industry and have since moved on to capture 28% of the German market for numeric pagers.

Convergence means we all need to think outside of the traditional boxes, and it forces us to rethink the commercial and social reality of tomorrow's world.

Globalisation

Globalisation is another key trend, one that affects all of the converging industries. In some senses telecommunications is already a global industry, with the international voice telephony network built up on the correspondent model over the last 100 years or so making global connectivity something we take for granted. At the market level however, it has been a very fragmented world, with the services that customers get and the prices they pay for them decided solely by their local PTT. Not for much longer.



Computing, on the other hand, is a much younger concern—although it has already achieved much. It has moved from huge mainframe computers to the stand-alone PC delivering ever-increasing processing power at decreasing costs. Now we are entering the next phase, with the emphasis changing from processing to communicating. People don't yet take global connectivity for granted in quite the same way, but it is there, and companies are exploiting this capability to give their people and their customers, wherever they might be, ever greater access to information.

Technology

The third trend is continuing improvements in technology, which are at the root of many of the changes, offering a world of more for less. Transmission costs are falling, and the cost of computing power is halving every 18 months. At the same time, networks are no longer dumb carriers, but have become intelligent; large, distributed networks with vast functionality and capability. We are also seeing rapid developments in digital technologies and techniques, in mobile, satellite and terrestrial broadcasting and in related areas such as compression and encryption.

Regulation

And finally we have the ever-changing regulatory position. In the UK we are, in the next few years, hopefully approaching a point where it is accepted that competition has made the need for comprehensive, industry-specific, regulation unnecessary. It should come as no surprise, in this world of change, that a regulatory model established in 1984 is inappropriate for today's business environment. Convergence poses a big challenge for regulatory authorities as well as industry players, as it calls into question the rationale behind single industry regulatory bodies. Likewise, globalisation raises some big questions. Who will be making the rules in Europe when the barriers come down at the start of 1998?

Changing Customer Behaviour

Having looked at the trends, let's now take a look at what all of this change means for customers. What are **they** doing that is different?

Well, one thing they are doing is making use of the broadband services that are starting to appear in the market. The opportunities are growing all the time—medical diagnostics using telepresence, collaborative working in real time over a wide area network, access to remote libraries and databases....the list is almost endless.

Then, of course, there is the ubiquitous and much-hyped Internet. This is a subject where even those who might otherwise lay claim to the total 'understanding' to which Walter Mondale referred would struggle to offer predictions. The impact of the data wave that we are starting to experience will be enormous, particularly with the surge of interest in intranets—the corporate Internet for closed user groups. The intranet business is already worth about $400 million in the US, and it is expected that this figure will grow to $8 billion within just two years. Globally, these figures leap from a value of around $4 billion in 1995 to $31 billion in 1998. That is a business that is doubling each year.

Then there is mobility, which will have an enormous impact in the next five to ten years. This is purely customer-driven, as the world's workforce is on the move and increasingly needs remote access to the information that is the lifeblood of today's businesses.

The impact of the 'information revolution' has, so far, been felt

Telepresence being used at a road accident

primarily in the workplace—facilities such as videoconferencing, networked computers, and electronic data interchange are already almost as familiar as the office furniture. But the next phase of the revolution will close the gap between information and entertainment and create a communications continuum between home, work and all points in between.

With virtual reality and other technologies, the experience of watching future Olympic Games will be almost as good at home as it is in the stadium. We will shop and bank from our armchairs, and keep in touch with friends and family via e-mail and video services. The whole world of learning will change, with a host of education services available at home to support children at school, students at college, or just those of us with an interest in life-long learning. The first versions of these services are in the market now, and the success of services such as CampusWorld and the Bristol Education On-line Network is immensely encouraging.

Engineering for Success

Clearly there are huge challenges facing us, as we try to decide what technology to invest in to take us into the next millennium and to allow us to meet our business vision. So what do we need to focus on?

Firstly, there is no one technological solution. Whether they are connected by fibre, radio or digital satellite, or using new technologies that squeeze huge performance out of traditional copper, customers will only really care about the applications. We can expect to see continued integration of hardware, from the television and personal computer to the radio, and both fixed and mobile telephones, but it will be the usability that counts, not which type of electronics makes it happen. We need to offer services that are intuitively easy to use, and that customers will want to try and repeatedly reuse.

Usability is often seen as a feature of equipment at the edge of the network, but as we move increasingly to network-based services, it will be provided by intelligence, the defining capability of the radically-simplified platform framework we are putting in place in the next few years. We, as telecommunications professionals, must exploit that intelligence to ensure that the ever-widening range of discrete applications and support systems we create are woven together to provide a service to the customer that is perceived as seamless.

Like other telecommunications operators, BT is putting in place an architecture that supports a multi-service network, with all the benefits of economies of scale, reuse and speedier delivery to the marketplace—and with enough flexibility to avoid the pitfalls of single, homogenised solutions. Architecture and integration will enable us to provide information, communication, and entertainment seamlessly—and to deliver it more speedily.

Indeed, with the right architecture in place, we can provide global services while moving from a mass market to an individual approach. A 'one size fits all' approach is simply unacceptable. 'One size fits one' is a better way of looking at market segments in the coming era of universal customisation, where communications will be tailored according to each customer's profile. We will also be able to let customers tailor the services themselves, building their own services from the options in their profile.

Customisation is also needed in information, as people are already facing an overload via a vast array of channels, and that will only increase. The tailoring of information according to market and demand will be critical—indeed, it could prove to be our unique selling point, an essential factor in any situation in which competition plays a part.

And finally, we need to be creative in identifying new things to do, not just better ways of doing the old things. This is often the greatest challenge, as while the applications of new technology look obvious with hindsight, the ability to spot the right ones at the outset is often what separates the winners from the losers.

Achieving Success

So what does this mean for engineers in the converging industries, the people who have helped to mobilise many of the forces for change? I would offer the following thoughts:

- A lot of what I have said is about harnessing innovation, doing things in radically new ways. That applies to the way each of us works as well as the things we produce.

- Time to market is critical. With product life-times shrinking and the speed of our competitors increasing, a six month delay in getting to the market can make the difference between success and failure. We need to be better at making the pragmatic judgement about what we need to start in the market, rather than what we need for a fully-engineered solution. Companies such as MCI have achieved much of their success in this way.

- Each of us needs to understand the commercial framework within which we operate, and the criteria for success and failure. We need to understand the value-add of our work and the structure of our costs, especially the role of capital. We will face continuing pressure on prices and, for many businesses, depreciation is becoming a bigger problem than labour costs. We need, therefore, to find new ways of delivering, without forever having to plough additional capital into our business.

- The future is about choice, interworking and flexibility, and therefore a much greater emphasis on open standards. In a similar vein we need to put more emphasis on reuse, integration and packaging rather than building everything ourselves. The winners are those who get a solution to market first, which is not necessarily those who take pride in building everything themselves.

- A lot of the success factors involve people skills. We need partnering skills to work with external suppliers. Likewise we need to work with customers to find the cheapest and quickest way of meeting their needs. We need people who excel at leading and working in multi-disciplinary and cross-divisional teams in environments of great pressure and short timescales.

Overall, a greater commercial awareness needs to show through in everything we do, and to guide every decision we make.

Thriving on Change

It is a great privilege and also great fun, to be working in the communications industry at such a time. Few other industries have the capacity to make such an impact on people's lives, or to contribute to national competitiveness. Provided we learn to thrive on change, rather than run for cover, we will seize those opportunities, and we will achieve BT's vision of being the most successful worldwide telecommunications group.

Biography

Sir Peter Bonfield joined BT as Chief Executive at the beginning of 1996, from ICL where his 15-year career spanned from Managing Director to Chairman and Chief Executive. He has also been Deputy Chief Executive of STC plc. His earlier career was with Texas Instruments Inc., where he established a wide experience base in semiconductors and computers in Europe, the USA and the Far East. Sir Peter, who was awarded the CBE in January 1989, is a Fellow of the Royal Academy of Engineering, the Institution of Electrical Engineers, the British Computer Society, the Chartered Institute of Marketing, and the Royal Society of Arts. He is also Deputy Chairman of the British Quality Foundation. In 1994, he was one of the high-level group established by the European Union to consider the creation of the information society, known as the *Bangemann Group*. Sir Peter is a member of the President's Committee of the Confederation of British Industry, a companion of the Institute of Management, a Member of Court at Cranfield University, a member of the Civil Service College Advisory Council, a member of the Trilateral Commission and a member of the Advisory Committee on Business and the Environment. He is a Liveryman of the Worshipful Company of Information Technologists and a Freeman of the City of London. He has also received honorary doctorates from the universities of Loughborough, Surrey and Mid-Glamorgan.

Paul Kearney

Voice and Data over Frame Relay

Voice and data over frame relay is an increasingly popular form of integrated access for intra-company communications. The main reasons behind its popularity are financial: the near-zero marginal cost of voice connections and the flat tariff nature of frame relay permanent virtual circuits. Against these financial benefits lie potential quality problems, due to factors such as the delays found in statistical multiplexed networks and the aggressive compression techniques used to keep down the bandwidth requirements.

Introduction

BT Telecomunicaciones SA (BT Tel), in Spain, launched its voice and data over frame relay service on the 30 January 1996, becoming the first public network to offer voice over frame relay as a managed service anywhere in the world.

Voice over Frame Relay

Frame relay is not the best technology to carry voice, but it is attractive for most companies as cost savings are possible when used as a form of integrated access with data traffic. Improvements in the compression algorithms and other developments in the latest generation of integrated frame relay access devices (IFRADs) have improved the voice quality to such an extent that it is acceptable to the average end user.

Two of the main reasons why the transport of voice over frame relay was generally thought not to be possible were:

- the sensitivity of voice signals to packet loss, and

- the delay introduced by the statistical multiplexing nature of frame relay.

Packet loss

Frame relay is a non-reliable form of data transport. To keep delays to a minimum, the network discards any corrupted data instead of carrying out any error correction. Also, where high traffic levels cause congestion, the network simply discards excess traffic. For voice connections this translates into short breaks in the voice signal that progressively worsen as the congestion increases.

Delay

There are two types of delay:

- *fixed delay*:
  - — voice encoding/decoding and voice compression, and
  - — transmission delay; and

- *variable delay*:
  - — queuing delay (both access and backbone).

Fixed delay depends on the design of the network (speed of access lines, frame relay network and number of hops) and the IFRAD used to process voice into frame relay packets. In this case, one important factor is the voice compression algorithm used.

Variable delay produces voice clipping. Queuing delay is affected by data traffic integrated in the same access line, the variable length nature of frame relay traffic, and congestion conditions in the frame relay network.

For reference purposes, the objective for end-to-end delay for a voice-over-frame-relay in-country circuit is that it should be less than 150 ms.

Voice and Data over Frame Relay

The big advantage of voice over frame relay is that voice traffic can be shared on the same frame relay access line that carries data, but this introduces the problem of mixing both types of traffic.

For data, throughput is critical so big packets (or frames) are preferred. For voice, delay is critical and therefore small packets are used. However, the packets for voice traffic are affected by the length of the data packets in the transmission queue as the larger the data packet is, the longer will be the queuing delay for the voice traffic. To solve this, the following techniques can be used:

- use of prioritisation for voice traffic in the output queue, and
- data packet fragmentation.

Voice interfaces

Customers want the service to connect their PBXs, telephones sets and key systems, but not all combinations are possible as the signalling must be compatible end-to-end. Different voice interfaces are currently available on IFRADs:

- *analogue*: foreign exchange station (FXS), foreign exchange office (FXO), ear and mouth (E&M); and
- *digital*: E1 (channel-associated signalling (CAS)).

Support for common-channel signalling (CCS) is still generally not available.

BT Telecomunicaciones Solution

BT Telecomunicaciones voice and data over frame relay is an integrated service of voice, fax and data

Frame relay

Frame relay is a technology that has been optimised for the transport of data in discrete units of information (normally referred to as *packets*). Frame relay is a successor to the widely used X.25 standard and incorporates the latter's bandwidth-sharing and efficiency characteristics while reducing the processing overhead associated with X.25.

Circuit switching versus packet switching

With traditional time-division multiplexing and circuit switching, each path (circuit) through the network has dedicated bandwidth allocated to that particular circuit on a static basis for the duration of the call. For example, in a traditional voice call, just as much bandwidth is used to transmit the silence (when listening and pausing between words and sentences) as the sounds when actually speaking.

Virtually all data has similar 'silence' between transmissions. In fact, data transmissions are typically much more sporadic in their nature than voice conversations with long periods of silence being followed by periods of intense activity (this is often referred to as *bursty*). Thus, when dedicated bandwidth is used, the transmission facilities are essentially idle for a large percentage of the time.

By contrast, packet switching (or statistical multiplexing) means that paths (virtual circuits) are defined through the network. However, no bandwidth is allocated to the paths until actual data (real information) needs to be transmitted. Then, the bandwidth within the network is dynamically allocated on a packet-by-packet basis. If, for a short period of time, more data needs to be transmitted than the transmission facilities can accommodate, the switches within the network will buffer (store) the data for later transmission. In the event that this oversubscription persists, congestion control mechanisms must be invoked.

Virtual circuits versus physical circuits

The frame relay interface specification provides a signalling and data transfer mechanism between endpoints and the network. This interface allows communication bandwidth to be shared among multiple users, creating instantaneous bandwidth allocation on demand. Each frame (or packet) contains header information that is used to determine the routeing of the data to the desired destination. This enables each endpoint to communicate with multiple destinations via a single access link to the network.

The mechanism by which the frames are addressed in frame relay is called a *virtual circuit*. Just as a typical telephone cable may contain multiple pairs of wires, one for each individual conversation, a single physical frame relay interface may contain many individual conversations. Each frame contains a data link connection identifier (DLCI) that denotes which conversation 'owns' that particular information.

Thus the end user device sends frames (packets) to the network, the network reads the DLCI and routes the frame to the proper destination.

Frame relay versus X.25

Frame relay also eliminates much of the processing done by the network, thereby reducing the portion of the transmission delay attributed to processing. The simplification of the processing focuses on the elimination of error recovery functions within the network. This is based on the assumption that with current digital networks the low error rates make such error recovery functions redundant. Instead, the element of the system that guarantees the error-free end-to-end transfer of frames are the end-station devices (for example, PCs), not the network itself. Frames that are in error are discarded. Unlike X.25 networks, protocols in the end stations must recognise the dropped frames and recover by reinitiating transmission.

Also, in the event of congestion in the network, X.25 will always ensure that the information gets through by using buffers and flow-control mechanisms, this results in the network slowing down when entering into overload conditions. Frame relay on the other hand will simply throw away any frames that are causing congestion in the network and leave it up to the end stations to re-transmit.

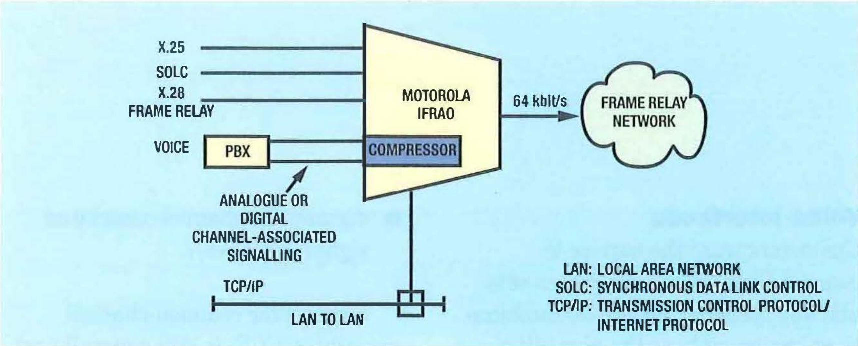


Figure 1—Integrated access using IFRADs

transmission over the company's frame relay network using a single frame relay access line for each customer site. It is an end-to-end managed service based on the use of Motorola 6520 IFRADs as customer premises equipment (CPE) (see Figure 1).

Data connections supported

The following types of connection are supported:

- A frame relay connection. If it is a Cisco router, a bundled service is offered. The other end of the connection does not need to be connected to a Motorola IFRAD.
- Up to five serial ports supporting legacy protocols such as X.25, asynchronous and synchronous data link control (SDLC) connections. In this case, the conversion to frame relay is done by the IFRAD. The permanent virtual circuits (PVCs) used are Annex_G type and so the other end of the connection must be connected to a Motorola IFRAD.

One of the characteristics of voice and data over frame relay as a form of integrated access is a much more complete support of data protocols than in more-traditional time-division multiplex (TDM) based solutions.

Voice interfaces and conversions

The voice interfaces and conversions supported are as follows:

E1 .... FXS
E1 .... FXO
E1 .... E&M
E&M .... E&M
FXS .... FXS
FXS .... FXO
E&M .... FXS

For FXS and E&M, an internal -48 V DC power supply and ringer are included in the IFRAD.

Voice encoding process and bandwidth allocation

Motorola IFRADs use voice compression techniques to reduce the bandwidth required; two voice compression algorithms are supported (both proprietary):

- 8 kbit/s codex vector sum excited linear prediction (CVSELP), and
- 16 kbit/s CVSELP (not used).

The voice compression algorithms can detect and demodulate a Group III fax signal and transmit it across the network as 4·8 kbit/s or 9·6 kbit/s data. This enables fax traffic to be supported without having to transmit pulse-code modulation (PCM) data across the network.

In addition to the compression algorithms, Motorola IFRADs support digital speech interpolation (DSI). Voice encoders do not use network bandwidth during the quiet periods of voice (only a small amount is used to keep the two ends synchronised). As during a normal conversation only one user is talking at a time, this frees up bandwidth that can be used by other data and voice sources in the node. Motorola IFRADs also have built-in echo cancellers that support up to 32 ms round trip tail circuit delay.

To determine the bandwidth required for a voice channel, the following must be taken into account:

- the bandwidth requirement of the compression algorithm,
- the voice header overhead, and
- the frame relay header/trailer.

Table 1 gives bandwidth requirements for different services.

The network designer can limit the amount of bandwidth on an IFRAD port that can be used for voice circuits via a configurable *maximum voice bandwidth* parameter in the port record. When a port receives a voice request, a check is done to determine if there is enough bandwidth (adding up all bandwidth requirements for all circuits already established and the requirement of the new one and comparing it with the configured maximum voice bandwidth) and then the new voice request is allowed or rejected.

Integrated access considerations

In the transmission queue in the access line to the frame relay network, voice and fax traffic have the same priority. Both forms of traffic have priority over data traffic. But this system is not good enough since, if a data packet is already in the queue, the voice/fax packet has to wait until the data packet has been completely

Table 1

Compression modes	Frame size*	Time between frames**	Bandwidth requirements**
8 kbit/s CVSELP	27 bytes	20 ms	10·8 kbit/s
16 kbit/s CVSELP	47 bytes	20 ms	18·8 kbit/s
4·8 kbit/s fax	44 bytes	60 ms	5·8 kbit/s
9·6 kbit/s fax	44 bytes	30 ms	11·7 kbit/s

* This includes one voice control byte, one-byte voice relay header, and the frame relay header and trailer for a total overhead of 6 bytes.
** This does not take into account any bandwidth savings from DSI.

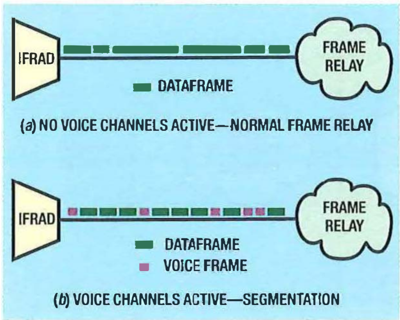


Figure 2—Data packet segmentation

sent. The bigger the data packet is, the more the delay to the voice/fax packet. To solve this, data packet segmentation (see Figure 2) is used with the following characteristics:

- Data packet segmentation length is configurable.
- The segmentation process is Motorola proprietary and so, the other end must be a Motorola IFRAD (this introduces an overhead of 2 bytes).
- When no voice circuits are established, no data packet segmentation is used.
- If the other end of the data connection is not a Motorola IFRAD, segmentation must be implemented by the end equipment (for example, reducing the message transfer unit (MTU) in IP).

A careful design of the network is also needed taking into account:

- access lines speed,
- number of hops,
- process and transit time in the IFRADs, and
- network delay.

With this information, it is possible to calculate:

- the maximum data-packet length when voice is present, and
- the voice smoothing delay which is a configurable delay that the destination IFRAD introduces to absorb the variable delay between two consecutive voice packets generated in the source IFRAD.

As far as the BT Tel frame relay network is concerned, the voice PVCs are given a committed information rate (CIR) of 12 kbit/s and, as explained below, these PVCs are given a higher priority than the data PVCs in order to control network introduced delays and avoid packet loss, especially in periods of congestion on the frame relay backbone network.

Prioritisation in the frame relay network

As mentioned earlier, two of the major potential problems in carrying voice over a frame relay network is the variable delay experienced in any type of statistical multiplexing network and the risk of packet loss due to the unreliable transport mechanisms used in frame relay.

Previous paragraphs have dealt with methods to control the variable delay in the access line through methods such as fragmentation of the data frames when voice traffic is present and the use of 'smoothing' delays at the destination end in order to play out the voice signal at a constant rate to the end user.

In the backbone network, based on frame switches from Hughes Network Systems, the prioritisation scheme inherent in these switches has been employed to give voice traffic a higher priority over the data traffic (both X.25 and frame relay). The use of prioritisation also helps to avoid packet loss under congestion conditions in the network.

Three priority levels are supported with a 10:1 preference between each queue type. For example, for every 10 frames transmitted from the high priority queue, one frame is transmitted from the medium priority queue; and, for every 10 frames transmitted from the medium priority queue, one frame is transmitted from the low priority queue. Currently, all data traffic types are assigned medium priority and voice traffic is assigned high priority.

In laboratory trials, BT Tel has loaded a reference model network with up to 800% over subscription on the backbone before voice quality degraded to unacceptable levels.

One of the side effects of using prioritisation to control the delay across the backbone network is that it is obligatory to use different PVCs for voice and data traffic although many users would prefer a single PVC as frame relay networks typically charge on a PVC basis (per PVC and CIR level). If all traffic was multiplexed over the same high priority PVC, then nothing would be high priority.

Management

Management of the IFRADs is done via the simple network management protocol (SNMP) and a network element management application based on HP OpenView. Direct connection to the IFRAD itself is possible via Telnet connections or a local attached terminal.

Customer experience

BT Tel now has 14 customers using the voice and data over frame relay service with more than 100 sites, including an important project (explained below in more detail) for a large Spanish investment bank. More installations are on the way with high-profile companies in the transport sector.

Application—large Spanish investment bank

The investment bank in question has a nationwide network of 31 branch offices spread around the major cities in Spain, a central office in Madrid, and an international presence on all of the major continents. Since 1994, the national branch offices have been connected to the central office in Madrid using the X.25 variant of the local area network (LAN) interconnect service of BT Tel. Late last year, two

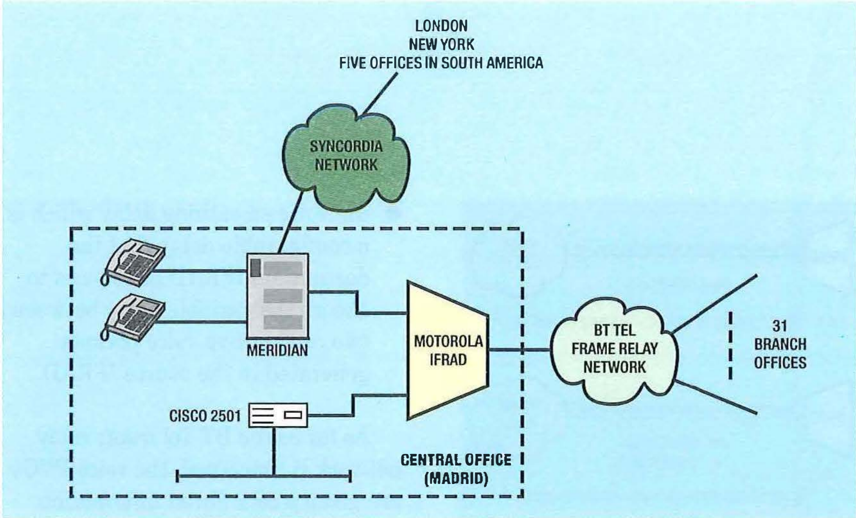


Figure 3 – Top-level network topology

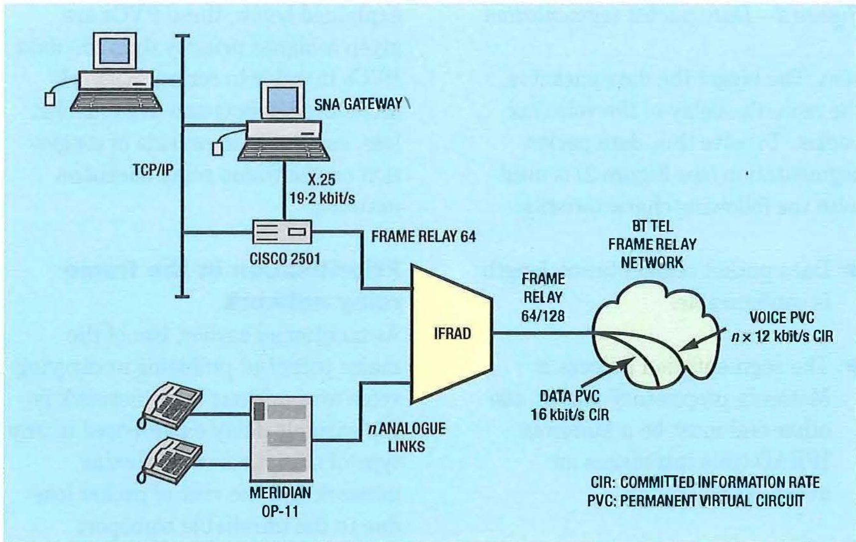


Figure 4 – Typical branch office configuration

projects were won: an international private network based on Newbridge technology to be installed by Syncordia and the conversion of the national network to frame relay with the inclusion of voice and fax. The supply and support of Nortel Meridian PBXs was also part of the project.

The overall configuration of the network is shown in Figure 3. For the connection of the national branch offices, access is provided via the BT Tel network with 8 kbit/s voice being used.

For the international connections 4:1 compression is used on most routes, although some of the South American offices use 8:1 on the links back to New York.

The typical configuration of a branch office is shown in Figure 4.

In use, the voice quality is acceptable even when multiple compression hops are being used and the call is transiting the central PBX. The quality achieved caused some surprise, even when the two types of compression were mixed, as this was not supposed to work!

So far, the customers seem satisfied with the voice quality and, in fact, most of the problems come in the installation process. This takes a long time as there is not generally very much experience among the users on how to configure their PBXs, and supervision signalling is not exactly the same from one vendor to the other. Fortunately, Motorola IFRADs are quite flexible in their configuration and allow connections to be customised and adapted to almost every kind of PBX.

Future developments

At the time of writing, BT Tel is field testing phase II of its voice and data over frame relay service with a phase III planned for the fourth quarter of 1996. The principal features to be included are as follows:

Voice switching

This allows the IFRADs to route calls between themselves without having to transit a PBX. The dialled digits are used to route the calls and, apart from the savings in the PVCs, voice quality is significantly improved because of the voice signal only being subjected to one compression hop regardless of destination.

Hunt groups

This feature allows major cost savings where a significant number of small sites connect to a single large central site; for example, the investment bank mentioned earlier. This feature allows BT Tel to break the 1:1 relationship between the channels available at the remote (small) sites and the central PBX.

Taking the example of the investment bank, we see the following:

The 31 branch offices have a total of 69 channels which therefore need another 69 channels to be provisioned at the central PBX if the 1:1 relationship is to be preserved.

However, the traffic generated by these branch comes to only 11 erlangs as most of the branch offices have only two or three channels. If the channels are dynamically allocated at the central site, then only 19 channels need to be provided (assuming a grade of service of 1% blocking).

The saving, therefore, at the central PBX and IFRAD is more than 72% of the hardware needed to implement the service at the central site.

Dynamic selection of compression rate based on dialled digits

To support different quality levels, higher-speed fax or simply fax machines that do not work with the fax demodulation system used, this feature allows the IFRADs to switch dynamically between different compression rates depending on the dialled digits.

Integrated router

Apart from the obvious cost savings from having the router internal to the

IFRAD rather than having to pay extra for a stand-alone box, this also gives one possible solution to one of the major problems with this type of service for data connections—serialisation delays.

The effect of the delays across a 64 kbit/s connection from an external router into the IFRAD followed by the added delays across another 64 kbit/s line into the core network means that the overall delays to the end systems exceed standard service description parameters.

Evolution to ATM Voice Switching?

In the information technology world, so called 'interim' solutions have a nasty habit of becoming permanent while the standardised solutions get delayed in their development and/or in their deployment in the real world. Frame relay itself started out as an interim step along the road to asynchrononous transfer mode (ATM) but has now established itself so firmly that it is not likely to disappear, even when ATM services become widely available and affordable.

The 'adaptation' carried out by the IFRADs, although designed to work over frame relay networks, gives a possible evolution path/model to ATM voice switching, especially for smaller sites where a direct ATM connection is unlikely to be justified for several years to come.

In the near future, the use of frame relay switched virtual circuits (SVCs) (now available on BT Tel's network although further testing is required) can give the current voice over frame relay projects more flexibility and open possibilities for other developments in areas such as billing. Further developments are still required from the IFRAD manufacturers so as to make this a reality, but several of the major players have already announced an intention to implement frame relay SVCs in late 1996 or early 1997.

Acknowledgements

The author acknowledges Miguel Angel Martínez and Claudio Moran, both of Service Development and Integration, of Network Engineering, BT Tel, who have contributed to this article and who were deeply involved in developing and implementing the voice and data over frame relay service; and Isabel Arranz of the Network Systems Group, Network Engineering, for her work on high priority PVCs.

Glossary

ATM Asynchronous transfer mode
CAS Channel-associated signalling
CCS Common-channel signalling
CIR Committed information rate
CPE Customer premises equipment
CVSELP Codex vector sum excited linear prediction
DSI Digital speech interpolation
FR Frame relay
FXO Foreign exchange office
FXS Foreign exchange station
IFRAD Integrated frame relay access device
IP Internet protocol
LAN Local area network
MTU Message transfer unit
PBX Private branch exchange
PSTN Public switched telephone network
PVC Permanent virtual circuit
SDLC Synchronous data link control
SNMP Simple network management protocol
SVC Switched virtual circuit

Biography

Paul Kearney
BT Telecomunicaciones SA

Paul Kearney is an electronics engineer who graduated in Ireland in 1983. From 1984 to 1990 he worked in South East England on a number of projects principally in the financial sector in London, including two years in the IT Infrastructure Development Group of the London Stock Exchange. Moving to Spain in 1990, he worked for Telefónica Sistemas (the engineering arm of Telefónica) before joining BT Telecomunicaciones as Network Engineering Manager in February 1994.

Malcolm Paterson

FeatureNet—A Network Perspective

This article describes the history of FeatureNet, from its inception to the present day, and outlines the network configuration and services offered. In its current form, FeatureNet offers a wide mix of managed Centrex, virtual private networks and bureau services. FeatureNet has evolved over the last six years, to the point where, as a service platform, it is ideally placed to offer managed service via centralised intelligent network technology and offer to customers enhanced bureau service through the functions of computer supported telephony.

Introduction

In 1991, BT launched its first commercial virtual private network (VPN) service followed, in 1992, by the launch of Centrex. This service was, and still is, delivered by the DMS-100 switch procured from Northern Telecom (NORTEL). This VPN/Centrex combination formed what is known as *FeatureNet* providing BT with its first managed VPN and Centrex service.

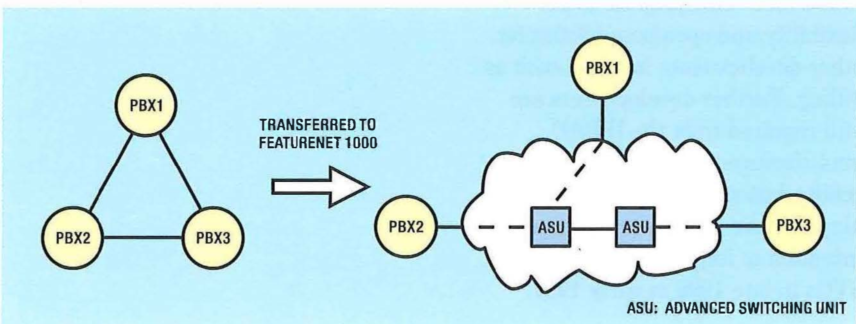
History

In the mid- to late 1980s, BT had considered the delivery of a Centrex and VPN service via the core network, but there were significant difficulties in terms of the time, cost and complexity of developing a robust and suitable service management domain. This meant that an overlay network had to be deployed if BT was to realise the launch of a VPN/Centrex service. During the tendering process, a firm requirement was set that the successful supplier had to provide a full service management platform together with billing and network management elements.

The network was launched in 1991 with two nodes. FeatureNet now has 25 fully inter-connected DMS-100 switches, a tribute to the success of the service providing a full managed VPN, Centrex and hybrid facility. The DMS-100 switches employed for FeatureNet are also known as *advanced switching units* (ASUs). This article explains the basic technical network elements of the service from a network perspective. The significant complexity of the support systems is worthy of a separate article.

FeatureNet offers customers the option of BT taking over all or part of their private network and incorporating it within the FeatureNet architecture. All FeatureNet elements of customers' networks are fully managed by BT as part of the resulting contract. Where a customer elects to retain their existing network in the form of a PBX environment; the resultant configuration is known as *FeatureNet 1000*. FeatureNet 1000 comprises various types of PBX, which will be connected, via the Digital Private Network Signalling System Number 1 (DPNSS1) or the Signalling System Number 15a, (SSAC15a), to the DMS-100 network as shown in Figure 1. They form what is known as a *virtual private network* (VPN).

Figure 1—Migration of a private network to FeatureNet 1000



Virtual Private Network (VPN)

A VPN, in its purest form, is the ability of the controlling network to emulate customers' private network transmission medium. To achieve this simple task the network must support, in full, the signalling systems appropriate to the private network and the private numbering plans. The numbering plan comprises an access digit(s), a site location code (SLC) and an extension number; or the SLC and extension number; or just the extension number. In some large networks, the customer's number or dial plan may comprise all three variants within its numbering structure. It is important to provide, as close as possible, the feature transparency supported by the original private network environment. (Feature transparency is the ability of a multi-node network to support all the available networked features; for example, ring back when free.) Unless otherwise requested by the customer, the original configuration provided by the private network must be reflected into the VPN domain as accurately as possible with minimal, or no impact upon the PBX software or its data configuration.

Feature transparency must be maintained for both intra- and inter-node call routeing environments. As stated, the VPN signalling systems supported by FeatureNet are DPNSS1 and SSAC15a. In a pure VPN supported by a DPNSS1 network, the services supported by British Telecommunications Network Requirements 188, (BTNR 188) are available with some minor exceptions, (see Services Supported). Hence, services such as ring back when free, call diversion (in all its forms), and three party calling, are supported as in a private network application.

In a private network environment, PBXs that use SSAC15a (which is an analogue signalling system) must rely on the gateway PBX to act as the software bridge for SSAC15a to DPNSS1 calls. This bridge maps the two very dissimilar signalling systems and permits a logical interchange of information between them. The software bridge will correctly process any DPNSS1 service not supported by SSAC15a. The gateway PBX will hence support, where possible, any services which are deemed applicable to a gateway function; for example, drop-back messages which contain a diverting number, (see Services Supported). In a VPN, it is seen as the VPN's duty to perform this gateway function, the DMS-100 node supporting the SSAC15a connection performing the function of the gateway PBX (Figure 2).

Centrex and Hybrid Applications

Centrex is the generic name for PBX features and services provided by a local exchange. When a customer asks that some or all of their private network PBXs are replaced and handled as a part of a Centrex environment, this requirement can be met by FeatureNet. This service is known as *FeatureNet 5000*. The extensions that were supported by the replaced PBXs are connected to remote concentrators, which in turn are connected to the DMS-100 in the same manner as connections to a System X remote concentrator unit within the core network. Centrex is thus the provision of a managed voice service, with the host DMS-100 providing the call-control and service process medium previously supported by the original PBX.

The DMS-100 remote concentrator units are available in two sizes, the small remote unit (SRU) which can support up to 240 lines and the larger remote switching centre (RSC) which can support up to 4000 lines, (messaging and traffic loading would restrict this number to less than 2000). The two-wire station based CPE will be as for the AXE 10 and System X core network with the addition of a proprietary signalling interface, specific to the DMS-100 and NORTEL technology, which utilises outband signalling techniques and supports the very popular *Featurephone* used as part of the FeatureNet 5000 service.

Customers connected to FeatureNet may use FeatureNet 1000 or FeatureNet 5000 or, as many customer do, employ a mix of the two services known as a *hybrid network*. The service offered in terms of features supported does differ in each case. Again see the section on Services Supported.

Centrex Numbering

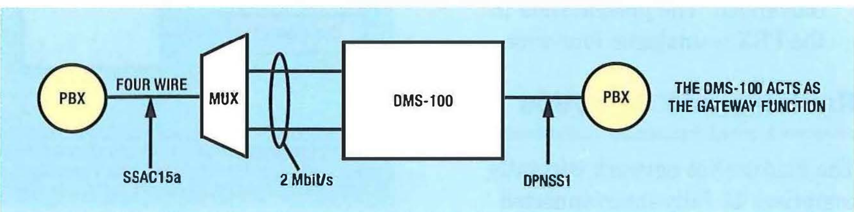
When a customer transfers to FeatureNet 5000, a change of public number will be required. The new Centrex extensions will have a number range allocated from a block of public numbers. Wherever possible the numbers allocated will reflect the customers' wishes and the new number may incorporate part or all of the 'old' PBX extension numbers; for example,

old number range—3XXX,
new allocated number range—0171 123 3XXX.

Current FeatureNet Network

Figure 3 shows the current network employed for FeatureNet, depicting the various network elements and

Figure 2—FeatureNet analogue VPN connection



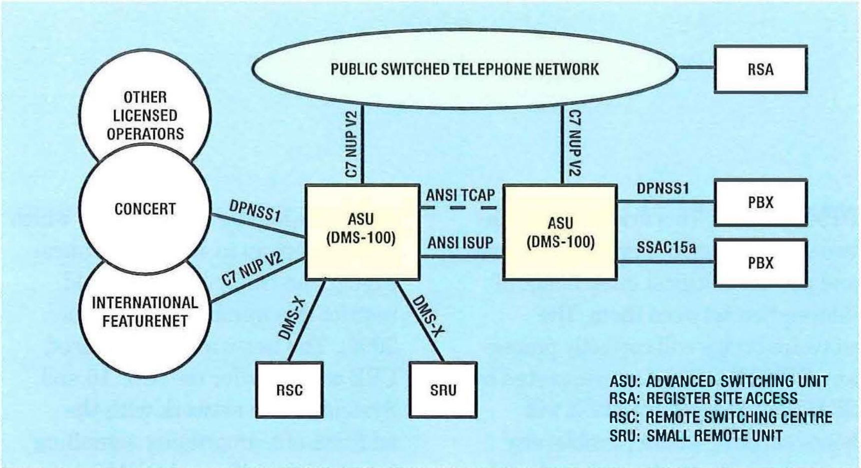


Figure 3 – FeatureNet network

the signalling systems appropriate to each of them. The following aspects of the network should be noted:

- access to the public switched telephone network (PSTN) is always at the digital main switching unit (DMSU) level, no direct access to local digital exchanges is used, the signalling employed is C7 NUP V2;
- international FeatureNet (IFN) is supported by a DMS-100;
- access to other licensed operators (OLOs) is currently via DPNSS1;
- the signalling between the FeatureNet host exchanges and their remotes (SRUs and RSCs) uses NORTEL's proprietary signalling system, known as *DMS-X*;
- inter-node signalling capability is supported by a variant of C7, the American National Standards Institute, Integrated Services User Part (ANSI ISUP) with transaction capability (TCAP) for the support of, for example, non-circuit related virtual calls; and
- connection into the FeatureNet node for analogue VPN via SSAC15a is at the 2 Mbit/s level, a multiplexor being used to provide the analogue/digital conversion. The presentation to the PBX is analogue four-wire.

Routeing and Selection

The FeatureNet network currently comprises 25 fully-interconnected DMS-100 nodes which provide the VPN/Centrex base for a significant number of customers. Two customers could have identical numbering schemes and thus calls to a specific extension whose number is common to both customers must access the correct extension. Therefore, it is important that the customers remain separate from each other in terms of their own specific call routeing requirements. To this end, FeatureNet ensures that the correct routeing takes place by;

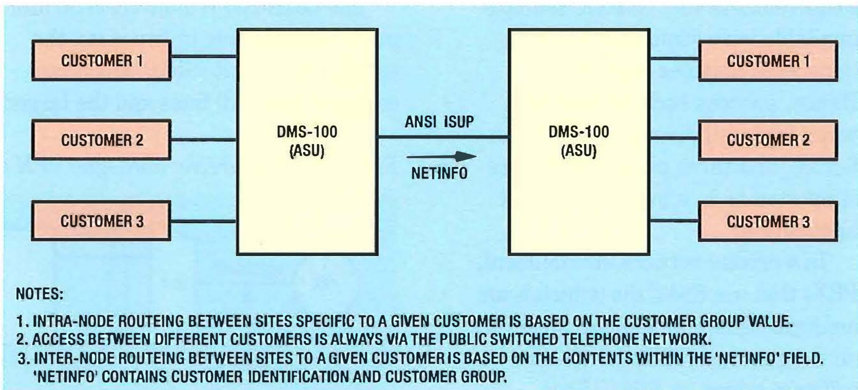
- reflecting the origin of the call; and,
- providing a secure customer partitioning scheme.

For intra-node calls the correct routeing is enabled by the *customer group* value allocated to the line or the trunk group (for DPNSS1/ SSAC15a). Customer group is a DMS-100 software attribute which is used to identify a specific customer. This effectively constrains the call to use only the customer's own data structures. For inter-node situations where common ANSI ISUP routes are employed, the received destination address (that is, the dialled number) at the terminating node is likely to be ambiguous in terms of presentation to the correct customer. Hence, a parameter range of network information (NETINFO) held within the initial address message (IAM) containing information about the customer identity and the customer group is used to fan into the correct data tables applicable to the customer. Access between two FeatureNet customers is always via the PSTN (Figure 4).

Call Types and Capacity Throughput

From Figure 3, it can be seen that there are a significant number of origins (for example, Centrex, C7 NUP V2, ANSI ISUP, DPNSS1) which are all capable of generating calls for both on-net and off-net applications. If Centrex is subdivided into its service capabilities and line types, the total number of call types becomes significant; over sixty variants are currently possible. These call types are important for FeatureNet in determining the amount of core and peripheral processor loading a DMS-100 can support for any given software build. The average work time (the amount of processing time specific to each call type) of all the call types are factored into the throughput analysis for each new software build to be loaded onto the FeatureNet platform. The work

Figure 4 – Customer partitioning on FeatureNet



time for any call type varies with each new build and in this way capacity checks can be undertaken prior to an upgrade to ensure that processor capacity is not compromised.

Tariffs

FeatureNet currently supports two tariff variants, a usage-based charging (UBC) tariff and a national-networking channel (NNC) tariff. The usage-based tariff is simply the raising of a call charge and the generating of a billing record for each answered on-net inter-site call, and for off-net calls. Intra-site calls are not billed.

The NNC tariff allows customers to nominate, for inter-charge-group calls, the number of simultaneous calls they wish to carry between two sites. The system software and related data design ensure that the customer-specific software attributes (used to reflect the customer's wishes) are decremented and incremented, according to the traffic level, up to the maximum nominated value. Where the two sites are associated with different nodes, the speech channels contained within the ANSI ISUP route are common for all customers and are not specific to a given customer. Route partitioning is not employed, instead customer partitioning methods used are sufficient to ensure that the relevant software attributes are correctly modified.

Services Supported

FeatureNet supports a large number of features covering the various elements listed previously. The following lists the feature set for each of the areas.

VPN

Where the point-to-point application is DPNSS1 based, the feature set of BTNR 188 is available for use by the PBXs, with the exception of channel maintenance, single channel working, and loop avoidance. Thus the feature transparency is almost total; the limiting factor being the functionality supported by the PBXs.

Where an analogue SSAC15a gateway is encountered, the feature set will be substantially less. Only basic calls with either loop disconnect or MF4 signalling are supported to and from SSAC15a. Auxiliary signals are not supported by the DMS-100 and hence features which could be activated by a recall signal cannot be used. For the gateway function within the DMS-100 the following features will be supported: diversion, three party, hold, and redirection.

Other services, such as executive intrusion, are not directly supported as end-to-end features but are treated correctly by the DMS-100 in a manner compliant with BTNR 189 (Interworking between DPNSS1 and other Signalling Systems); for example, for the executive intrusion feature the gateway can provide a common intrusion protection level for the SSAC15a trunks.

Centrex

Centrex services maybe divided into two main blocks: base Centrex with operator console (known also as *attendant console*) applications, and bureau services.

Base Centrex (FeatureNet 5000) supports an extensive range of features which are available for customer use. Centrex extension features include:

- for extension users—call pick up, call waiting, do not disturb, last number redial, hold, multiple appearance directory numbers (MADN), speed call, network ring again, conferencing, call forward, call transfer, voice messaging; and
- for operator console—automatic recall, call logging, call transfer, camp-on, call park, and call hold.

Bureau services

Automatic call distribution (ACD) is supported using the same hardware platform as for FeatureNet 5000. FeatureNet enables BT to offer customers a complete ACD bureau service capable of handling large volumes of incoming traffic and optimising the distribution of the calls via software queuing algorithms among group(s) of answering positions (known as *agents*). Coupled with ACD is the ability to provide a management information system which will provide near real-time displays and historical output reflecting the bureau and agent performance.

Hybrid services

Where a customer employs a mixed FeatureNet 1000/5000, the features that can be supported are less than those which can be supported in a pure DPNSS1 network. Full-feature transparency is not available due to the cost and complexity of the development required. However, a number of features are available for use by customers who have hybrid network; basic call with calling line identity, call back when free, executive intrusion, call diversion, busy information, hold, three party, call offer, and redirection.

Note that in addition to being available to FeatureNet 1000/5000 based extensions, this feature set also forms the main service set for the centralised operator service. For FeatureNet, this service is not fully symmetrical as it is only applicable where the centralised operator function is supported by a DPNSS1 connected PBX.

Future Developments

Two services currently being trialled with FeatureNet are register site access (RSA) and integrated services digital networks (ISDN).

RSA allows a customer to gain access to their FeatureNet-based corporate network from a public-network based site (figure 3). Access is typically via an 0800 number with validation, based upon the public site's calling line identity (CLI), being performed by a selected DMS-100. Successful CLI vetting will result in secondary dial tone being returned to the calling site who will then have access to any on-net and, where appropriate, off-net number. The call charges will be raised against the calling public site but will be incorporated into customers' corporate FeatureNet bill.

The ISDN service will, with appropriate hardware additions, such as line-card variants, be supported by customers' Centrex delivery mechanisms (SRUs and RSCs) and will be integrated into customers' Centrex networks. The standards supported will conform to those appropriate to the European Telecommunications Standards Institute Basic Rate Interface (ETSI BRI).

Acknowledgments

Acknowledgments for help in the production of this article are given to Mr. Clive Dellard and Mr. Peter Rogers.

Biography

Malcolm Paterson

Malcolm Paterson joined the Post Office in 1965 on installation and maintenance. In 1975, he moved to headquarters to work on software and data planning standards for TXE4 exchanges. From 1985 to 1989, his responsibilities covered the requirements and acceptance of AXE10 digital local exchanges. In 1989 until his retirement from BT in 1996, Malcolm worked on the network design for FeatureNet.

Graham Walker, Doug Traill, Mike Hinds, Alison Coe and Matthew Polaine

VisionDome: A Collaborative Virtual Environment

For three weeks in March 1996, visitors to the Learning Resource Centre at BT Laboratories could have been excused for thinking that aliens had landed in Suffolk (Figure 1). The UFO was in fact the VisionDome, an interactive digital virtual-reality environment, which enables group interaction around common data or a shared application. This article reports on some of the technical challenges faced in developing content for the VisionDome, reviews the response of the many visitors, and considers potential applications.

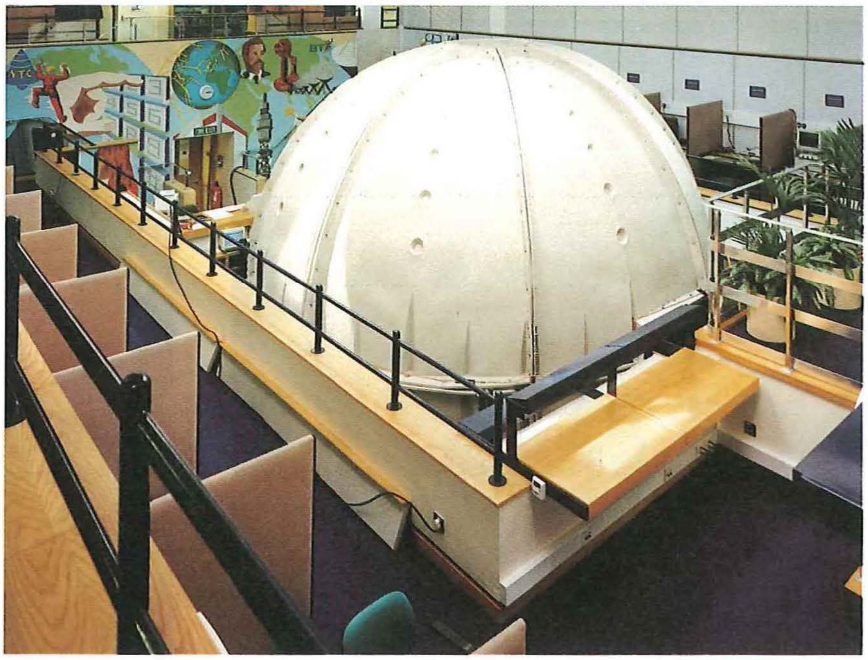
Introduction

Creating an effective human interface to ever-increasing volumes of complex information is a critical challenge for many future telecommunications services. Imagine a *shared space*[1] in which:

- the public, planners and politicians could walk through a proposed urban development, experiencing the environmental impact;
- engineers from around the globe could meet to review a virtual product design, exploring options in form and function;
- military commanders or commercial managers could be immersed in information, and collaborate on complex time-critical decisions;
- scientists could travel through their data, interacting in real-time with the underlying instruments or experiment; and
- students could be transported in time and space, collaborating with tutors and colleagues in an unfamiliar environment.

The VisionDome (Figure 1), an interactive, digital virtual-reality environment, provides a collaborative space in which such applications may shortly be realised. Through a collaboration with the dome developers, Alternate Realities Corporation (ARC), a VisionDome was installed at BT Laboratories in March 1996. New content was developed over the preceding months, and experienced by nearly 1000 visitors. This article records the experiences and explores the potential for future applications.

Figure 1 – VisionDome at BT Laboratories



VisionDome™ is a trademark of Alternate Realities Corporation

Linked with compelling audio, the dome can temporarily suspend belief in the physical world and transport the audience into a virtual space.

Background

Displaying pictures on domes is far from new. Cyclorama panoramic paintings were first created in the 1700s to depict historic events, and modern planetariums[2] were opened in the 1920s. The VisionDome takes such environments one step further by giving the audience the ability to interact with a three-dimensional world, creating a walk-in virtual-reality experience.

The VisionDome delivers a full-colour raster-based interactive display, with 360 degree projection and a 180 degree field of view. The tilted hemi-spherical screen is positioned to fill the field-of-view of the participants, creating a sense of immersion in the same way that large-screen cinemas draw the audience into the scene. The observer loses the normal depth cues, such as edges, and perceives three-dimensional objects beyond the surface of the screen. The dome itself allows freedom of head motion, so that observers can change their direction of view, and yet still have their vision fully encompassed by the image (Figure 2).

In contrast with the large-format analogue film used for entertainment in domed cinemas, the VisionDome is driven by digital media, either pre-recorded or generated in real-time from a computer or high-definition TV camera. Linked with compelling audio, the dome can temporarily suspend belief in the physical world and transport the audience into a virtual space. This provides the group equivalent of a virtual-reality headset but without personally-inhibiting hardware, and opens up a range of potential standalone and networked applications:

- *Product presentation* Perhaps the most immediate opportunity is as a portable virtual-reality environment for trade shows and exhibitions. The dome is ideally suited for presenting products that are too large (such as the excavator in Figure 3) or too delicate to transport.

- *Telepresence* It is possible to project live or pre-recorded video onto the dome. Since this involves image manipulation rather than transformed projection of a true three-dimensional world, it does not give the full three-dimensional effect. Nevertheless, it can create a compelling sense of immersion within the environment. To record footage, a fish-eye lens is used on the camera, and composition and shooting angles must be adjusted to take account of the greatly expanded field of view. Telepresence applications could include remote real-time projection of sporting events and concerts, immersive video-conferencing, and recreation of inaccessible locations, which might be geographically remote or environmentally hostile. This technology offers a significant step forward in the realisation of the virtual business.

- *'Edutainment'* The dome could be used to immerse a class in an informative and entertaining manner which they are unlikely to forget. Buildings, extinct creatures and historic events could be created. Imagine being transported back to the age of the dinosaurs or to ancient Egypt. Not only are the events or images viewed at the correct scale, but the environment offers interaction, which is essential to effective learning. Figure 2 is an image from a fly-through of

Figure 2—Interior of the VisionDome

Figure 3—Product visualisation

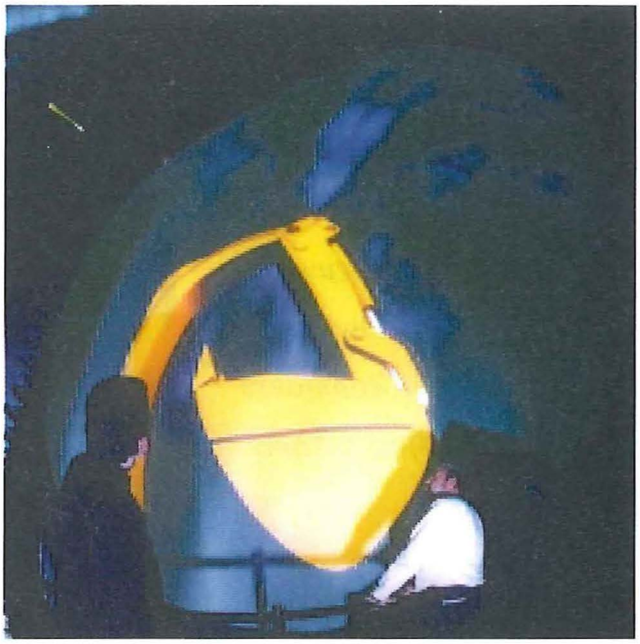
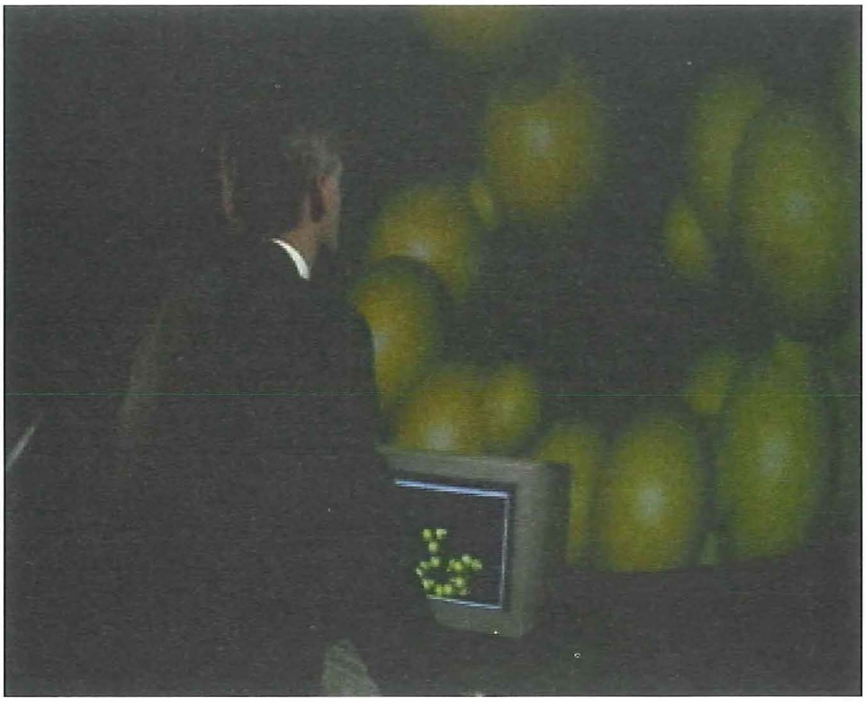


Figure 4 – Molecular visualisation



an Egyptian tomb: imagine meeting your virtual classmates in the Tomb of the Kings.

- *Design* Extending the initial concept of portable product presentation, the dome is also suitable as a fixed installation for product design, development and testing. The dome provides an immersive environment which can display life-size images or at least provide an appropriate sense of perspective. The developers could use the environment linked to real-time computer-generated graphics to gain feedback on new products through focus groups, or for collaborative working and design reviews. Applications might include architectural walk-throughs, safety reviews and training, or molecular visualisation for the pharmaceutical industry (Figure 4).

Content Creation

The VisionDome provides a unique three-dimensional viewing environment, enabling innovative applications. However, it also presents severe challenges to both creative designers and technical developers. Attempting to visualise the curved immersive space on a flat desktop monitor proved to be a mind-bending, or at least head-turning, experience for those involved.

Content can be pre-rendered computer animation, live or recorded video, or interactive computer-generated material. The material for the VisionDome was developed around the concept of *community information networks*, virtual private networks which support the communications needs of an extended enterprise. To open the presentation, eight minutes of computer-generated animation introduced the basic ideas. A prototype interactive environment for community network design in the financial sector was then demonstrated. Finally, pre-recorded video clips were shown to suggest a range of potential multimedia services.

Storyboard, models and animation

Pre-rendering the content allows more ambitious material to be tried, experimenting with different techniques to create a compelling three-dimensional space. Initially, animation was created in a conventional manner. The theme, content and style of the presentation were established, and storyboards produced outlining the animation sequence. The storyboards show keyframes of the presentation at various points in time (Figure 5). This provided the basic sequence and timing for the computer animation, script and soundtrack.

The animation was created by building three-dimensional computer models of the virtual world. A virtual camera (in effect the observer's viewpoint) was then moved along a path, to give the impression of moving through the three-dimensional space.

Creating effective animation for the VisionDome required mental visualisation of the computer monitor view when projected onto the curved surface of the dome. This was easier when moving through a physical environment, such as the BT Laboratories site, since the spatial effects in the dome should match real-world experience. However, with more abstract content, it could be very difficult to predict the final effect in the dome. These problems were partially alleviated by using the metaphor of a 'room' in which all objects were placed. This helped in understanding where objects would actually appear with respect to the

Figure 5 – Extract from the final VisionDome storyboard

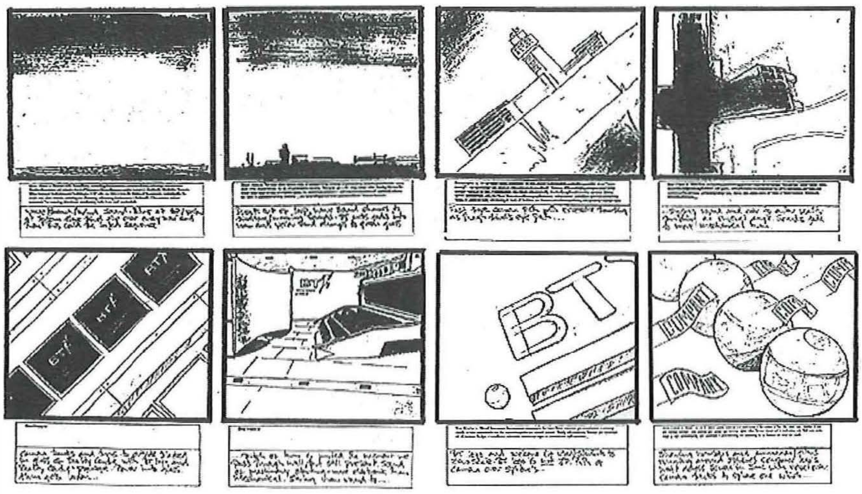


Figure 6—Rendered image of BT Laboratories

Figure 7—Rendered image after application of the virtual lens

viewer in the VisionDome. For example, objects above the camera appear at the top of the dome, above the viewer's head.

Image distortion

Once the animation sequence had been created, with materials and textures assigned to the objects in the world, the animation frames were rendered. Figure 6 shows a rendered frame with a conventional camera set-up. However, if a normal planar image is projected onto the dome, the image is simply 'stretched' to fit the curved surface. This stretched image is distorted and appears unnatural to the observer. To provide the spherical perspective that matches our spatial perception, corresponding distortion of the camera view is required.

The required distortion was achieved using a computer model of the proprietary VisionDome physical lens. In the rendering process, the entire view of the virtual camera was captured by this virtual lens. The lens was tilted at 45 degrees to align with the final angle of projection, and when a distorted frame was subsequently displayed in the dome, the resulting image appeared with the correct perspective. Figure 7 shows a 'golf-ball' shaped image generated by rendering the scene shown in Figure 6.

Rendering

The rendering method used to generate the image is known as *ray tracing*. Ray tracing is a mathematical technique which accurately calculates the visibility of surfaces by tracing virtual rays of light from the camera to the objects in a scene. This technique gives a realistic simulation of the reflection and refraction of light, and of shadows within the scene.

Ray tracing is computationally demanding, particularly with the additional demands of the virtual lens in our application. Each image was rendered at high resolution to provide a clear image when finally projected, and a single frame could take several minutes of rendering time. For eight minutes of animation at 30 frames per second, the render time at five minutes per frame would be 50 days! In order to reduce the overall time, it was therefore essential to optimise all the models, using polygon reduction, rendering only the front faces and deleting models when not in the current field of view of the camera. Such techniques are standard practice for real-time virtual-reality applications in which there is a critical trade-off between visual-realism and interactivity. The challenge in this case was to maintain the very high-level of image quality required for the large screen area of the dome.

The highest resolution available for the dome is 1920 × 1035 lines (HDTV). For comparison, normal PAL TV resolution is 720 × 560 lines. Time was available to render the images at only half of the maximum quality (1035 × 960). Since the images were projected over such a large surface area, the final image appeared blurred or out of focus. To reduce this effect, the images were edge-enhanced before the final transfer to HDTV tape.

Audio

An important consideration in maximising the overall impact is reinforcing the visual material with audio cues. It is believed that this is an essential component of the 'total-experience' necessary for many of the applications outlined. The challenging dilemma was to maintain a balance between the scripted voice-over and supporting sound-track. The voice-over tells the story, but the soundtrack is needed to reinforce the visual effects. The final soundtrack was a compromise, and one area for improvement was direct audio reinforcement of visual cues such as scene transitions, motion and collisions.

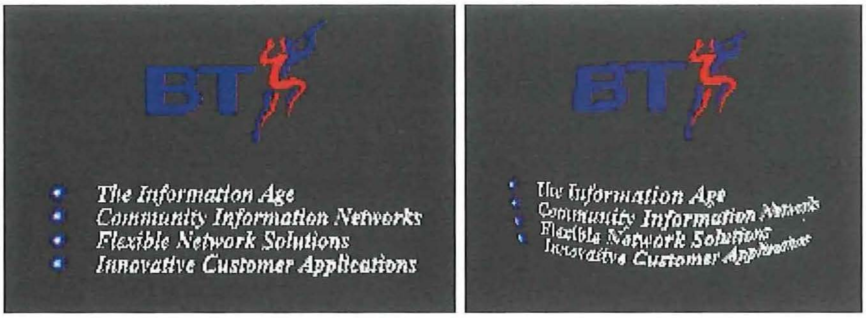
An experiment was conducted with spatialised audio in the dome, with the aim of prompting the audience to turn and look at a particular area of the screen. Owing to the shape of the dome and the hard reflective screen, this was very difficult to achieve, with effects comparable to the whispering gallery in St Paul's cathedral.

Interactive Environments

For real-time display and manipulation of three-dimensional models, the computational overhead of ray tracing each scene is uneconomic. Instead scenes must be generated 'on the fly' as we interact and move freely within the virtual space.

To achieve interactive performance requires use of the underlying graphics hardware. As with the animation, a distorting transformation must be introduced into the rendering of the objects in the three-dimensional scene (Figure 8). Hardware graphics accelerators can then be used, which are optimised for flat-screen projection.

Figure 8—Three-dimensional text: undistorted (left), and distorted for projection in the dome (right)



A key issue is deciding how to implement the distorting transformation with reasonable performance. Figure 9 illustrates one potential problem, caused by the standard practice of culling objects that lie outside the defined field of view. In flat-screen projection (left), objects A and C do not appear in the rendered scene, and hence they can be ignored very early in processing by a hardware graphics accelerator. However, when projected onto a dome (right) they will be visible, and must not be culled. This suggests problems in fully exploiting the 'flat screen' design goal of many of today's graphics accelerators.

One consideration is that we do not want the user to be responsible for implementing the required transformations. Working in the user code would require rewriting and recompilation of every element of scene-creation code. Fortunately, the VisionDome developers provide a three-dimensional graphics library binding that hides the complexity of these issues underneath an industry-standard programming interface.

In practice, we used a modified version of OpenGL™ which Alternate Realities Corporation implemented with testing and debugging assistance from BT for this project. With the assistance of Silicon Graphics Inc. (SGI), a special debugging version of OpenGL was installed on a SGI Onyx RealityEngine at BT. The library was installed via the system administrator account and literally displaced the standard system version of this same library. The library was installed as a shared library meaning that applications need not be recompiled to take advantage of this newly installed modified library. The SGI system was now 'dome enabled' thus providing a means of running standard applications with dome distortion-correcting transformations transparent to the user. This is a simplistic description and in reality the user must pay attention to OpenGL calls and arguments which by definition have a different context. For example, the 'fovy' (that is, field of view) parameter in the gluPerspective() subroutine no longer has meaning since the VisionDome field-of-view is fixed at 180 degrees. The user must also pay attention to tilting the camera up 45 degrees for reasons discussed previously. These are just two of many examples.

Another technical challenge is referred to as *object subdivision*. This causes distortion of large objects that have a low number of vertex points. Consider the simple example in Figure 10, where a straight line is to be transformed. In the left image, just the end points have been transformed, with the result that, when the straight line is rendered onto the dome, it is badly distorted. The longer the line, the worse the distortion becomes. To correct this distortion, the object can be broken up into smaller shapes ensuring a more faithful transformation of each component part. This is shown for the straight line in the right image.

Object subdivision helps to reduce distortions on large objects but is computationally expensive to perform in real-time and yields little advantage for small objects. The size of a rendered object depends on the viewpoint and, since this changes, it is not possible to pre-compute the optimum level of subdivision. Calculating the required level of subdivision on the fly requires information that is deep within the scene graph, and hence is difficult for an applications developer to access.

A solution to the object subdivision problem is still pending. For our demonstrations we used an empirical approach involving some subdivision and avoiding moving too close to small objects. A longer-term solution would be to introduce some feedback from the low-level graphics renderer, which is actually aware of the length of rendered lines. Such feedback could inform the higher levels in the graphics pipeline that object X was being drawn with 'long' lines. Object X would then be subdivided in subsequent frames. Under this approach, only the required objects would be subdivided, and the solution could be included within the graphics hardware.

Figure 9—Object culling: flat screen (left), and dome projection (right)

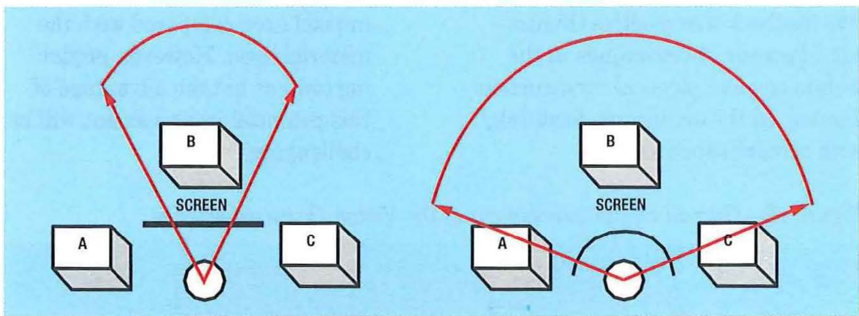
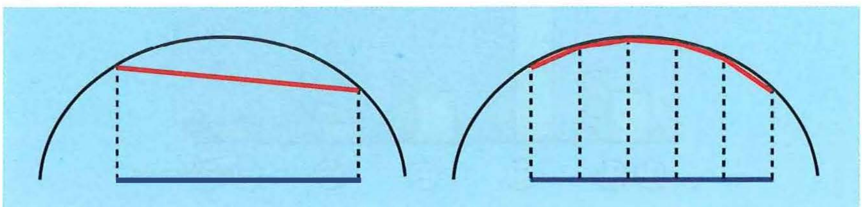


Figure 10—Distortion of large objects (left) and with object sub-division (right)



the visitors to the VisionDome accepted a long-term vision of interactive immersive environments for a range of business and entertainment applications

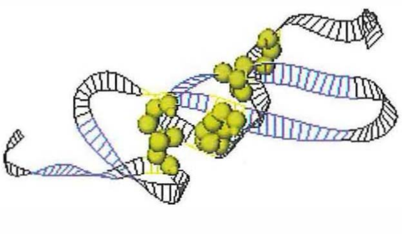


Figure 11—Molecular model distorted for projection in the dome

Our demonstrations used a wide variety of interactive material, including standard Silicon Graphics demonstrations, a range of Virtual Reality Modelling Language (VRML) models, a customised scenario from the financial services industry developed in OpenInventor and a molecular modelling application (Figure 11). Object manipulation or scene navigation was achieved using a spaceball, and in some environments the sense of three-dimensional presence could be powerful. However, advances in interaction hardware will be important in achieving a compelling sense of immersion.

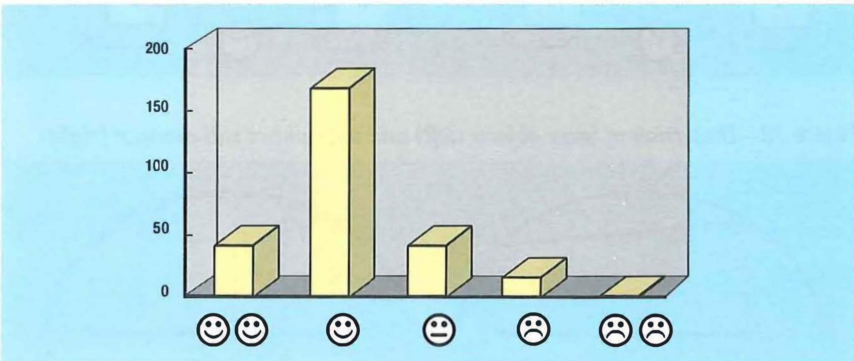
User Reaction

Overall, the visitors to the VisionDome received a long-term vision of interactive immersive environments for a range of business and entertainment applications. They enjoyed the experience and quantitative feedback was positive (Figure 12). However, shortcomings in the technology and physical construction dominated the qualitative feedback, with remarks such as:

- 'mediocre resolution compared with normal screens';
- 'contrast was too low—background light level was too high';
- 'projector very intrusive';
- 'other people obscure view and distract from immersion'; and
- 'uncomfortable standing/neck position'.

Such comments are to be expected in response to embryonic technologies and a prototype product, particularly when comparisons are based on experience of theme parks and other mass-market entertainment applications. Graphical environments will always be judged against such demanding standards, and developers must respond to customer expectations.

Figure 12—Overall visitor assessment of the Vision Dome experience



Future Developments

A number of developments are planned to address limitations in underlying technologies and acknowledged shortcomings in the current VisionDome implementation:

- The resolution of the projection system will increase to 2000 × 2000—a four-fold reduction in pixel area compared with the material used. However, producing content to take advantage of this potential improvement will be challenging.
- A fabric version of the dome will be developed. This will offer much greater portability than the current plastic construction, with set-up time reduced to just a few hours. Portability offers access to events and markets which would not warrant a semi-permanent installation. The acoustics will also be greatly improved, with scope to conceal speakers and damping materials behind the screen.
- Introduction of light-pipe technology within the projector will allow much of the bulky and visually intrusive electronics (Figure 2) to be recessed into the floor of the dome.
- New transformation libraries with increasing capabilities to support a range of standard environments within the dome will be used, greatly reducing development time for interactive applications.
- A spatial audio system will be used to ensure that the visual environment is maximally reinforced by acoustic cues.

These developments address user concerns, and deliver the original vision of an immersive shared space.

Conclusions

Advances in computing power and display technology are enabling real-time generation and presentation of sophisticated graphical environments, with increasingly complex user interaction. Such environments might be proposals for a real physical space, replication of a geographically remote location or an entirely abstract information landscape. The aim is to create a sense of immersion and collaborative presence in the computer-generated world, and projection in a dome is one potential solution.

There are challenging issues in areas such as pre-rendered content generation and real-time graphics transformations, but our work with the VisionDome confirms the opportunities afforded by such developments. Shared spaces will be an important component of future networked services, and developing an in-depth understanding of both customer requirements and network implications ensures that we will be able to grasp early opportunities for commercial services.

Acknowledgements

The work described was collaborative research with Alternate Realties Corporation (ARC), and the contributions of Ray Idazak, Rick Zobel and David Bennett are gratefully acknowledged. Hosting the VisionDome at BT Laboratories involved a substantial extended team, and the authors would like to express their thanks to all those involved.

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Biographies

Graham Walker
BT Networks and Systems

Graham Walker manages the Shared Spaces project at BT Laboratories. The project team is exploring early opportunities for commercial shared spaces, and is working collaboratively to advance the under-pinning technologies. Graham joined BT as a sponsored student and, after graduating from Oxford University in 1986, spent six years researching into coherent optical transmission systems. This work resulted in numerous publications, and the award of a Ph.D. from Cambridge University in 1992. More recently, he has been leading a group within Advanced Applications and Technologies, working on information visualisation and shared information environments. He has an MBA from Cranfield School of Management and is a Member of the IEE.
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Doug Traill joined BT from the University of Glasgow in 1990, after gaining a B.Eng. in Electronics Systems and Microcomputer Engineering. He initially worked in the Transmission Performance section, investigating in-service non-intrusive network monitoring equipment. He has represented BT at ITU-T and ETSI standards meetings. He is currently working in Advanced Applications and Technologies on the media environments project, looking at large-screen projection systems to create collaborative virtual environments.
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Mike Hinds received B.Sc. and M.Sc. degrees in Computer Science from the University of East Anglia in 1987 and 1991. Since joining BT in 1991 he has worked in Advanced Applications and Technologies on information visualisation, developing concept demonstrators showing applications to network data and call records. Currently, he is working on shared spaces, designing and prototyping highly scalable server architectures.
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Alison Coe
BT Networks and Systems

Alison Coe joined BT Human Factors in 1995 after graduating from Brunel University with a BSc in Industrial Design. The VisionDome, for which she created the computer-generated animation, was one of her first projects, and she has since become involved in the design and development of interactive applications for virtual environments. Her main interests are in the human interface and social interaction issues of distributed virtual worlds.
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Matthew Polaine
Freelance

Matthew Polaine graduated from Leicester Polytechnic (now DeMonfort University) in 1989 as an Industrial Designer. Plunging immediately into freelance status, he has worked on a wide range of telecommunications related projects. He designed desks for the London Underground Jubilee Line Extension control room, built the first engine diagnostics housing for ATP, and has just completed the casing design and production of eight pub videophone teledating game prototypes. His work for BT includes product development on PICA, PC2000, OTIAN and TWSF. On the Shared Spaces team, he has been generating novel interface concepts and designing virtual worlds.
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James Callaghan and Phil Flavin

Intranets

Corporate Nirvana—The End of the Traditional Organisation?

Intranet technology is revolutionising the way businesses operate. This article considers the background to this revolution and speculates that intranet technology will mark the end of traditional organisations as they move to a state of corporate nirvana.

Introduction

In November 1995, the *Wall Street Journal* coined the term *intranet* to describe the use of Internet technologies by businesses to revolutionise their information technology (IT) strategy. The development of corporate intranet solutions is now fuelling the most significant change in corporate infrastructure since the development of the PC in the early-1980s. Its impact is likely to be even greater and could herald a radical change in the way organisations operate.

So what is an intranet? Essentially it is a closed area of the Internet with added security and guaranteed quality of service. It enables low-cost access to information in a wide variety of forms without unnecessary restrictions upon location.

This article looks at the development of the use of an intranet within an organisation and considers its strategic role. The opportunities offered by the use of an intranet will be so far-reaching that the traditional organisation and ways of doing business will be replaced by a focus on the information flows within, and external to, the organisation.

Just as an intranet can be viewed as a virtual network, organisations that use them to exploit fully the potential of new information flows and business processes can be viewed as virtual organisations. It will become increasingly difficult to draw the boundary of such an organisation since it will be 'tied' to its strategic business partners by mutual information flows. This state can be viewed as a form of *corporate nirvana*, where organisations will attain the blissful condition of having optimum information flows and optimum business processes.

Ultimately, intranets are about moving from an organisational culture based around the idea of the fixed office to a culture based on the dynamics of business so that work truly becomes an activity not a place.

Overview of Current Use of IT in Organisations

Let us start by considering briefly the current use of IT systems and their key shortcomings, and discuss how, in moving to an integrated solution, the task of ensuring that IT fully supports corporate strategy becomes achievable.

Most organisations currently use a mixture of the following IT solutions:

- mainframe-based highly-centralised processing and central storage of data;
- client-server approach, supporting a move towards distributed processing and decentralisation of data; and
- networked (or stand-alone) PCs.

An assessment of the current situation is summarised in Table 1.

The main problem with current IT solutions and implementations is that they tend to focus on a particular business activity. In many companies, this results in a prolifera-

Table 1 Baseline Assessment of Current IT Solutions

IT Structures	Typical Characteristics	Skill Levels Required	IT Tools	Examples in BT
Mainframe	Very expensive to purchase, maintain and support. Data stored, maintained and updated centrally	Applications developed and managed by experts	Hardware and software is proprietary. Lack of open systems approach. Few standards	Customer support system (CSS)—one of the largest mainframe systems in Europe
Client-Server	Compared to mainframes, this approach is significantly less expensive. Also has a higher degree of flexibility. Some data still stored centrally but this approach also supports decentralisation of data storage	Applications developed by experts but often customisable by end user	Still strongly based on proprietry hardware and software, although there is a move towards a standardised architecture. Standards are developing but still not a true open systems approach	Internal purchasing requisition system—based on DEC's All-in-One system. Uses customised clients to access a central server
Networked PCs	Relatively cheap to purchase, maintain and support. Supports both centralised and decentralised data storage and management	Applications are typically off-the-shelf and easily customisable by end users	Open systems approach predominates	Office automation systems—typically standard PCs running Microsoft Office

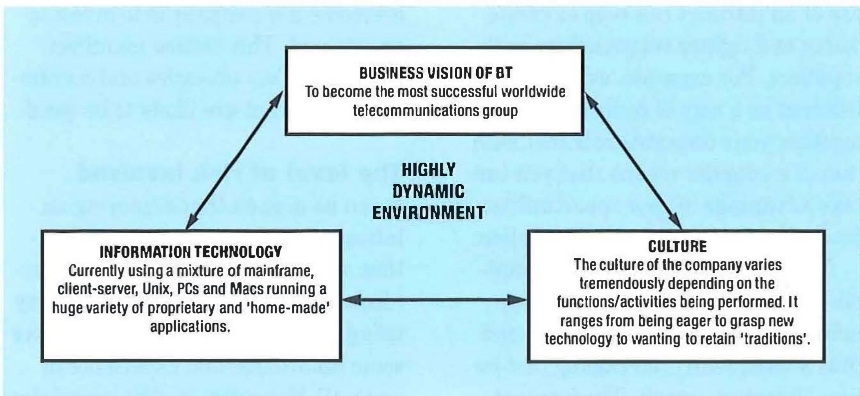
tion of solutions, each targeted on a specific part of a business process or activity. In essence, each solution performs the same functions of storing, allowing access to and manipulating data. However, in practice, multiple solutions, as opposed to a single 'universal' solution, result in increased costs for IT system design, procurement, installation, maintenance and training. The intranet provides an opportunity for organisations to realise such a 'universal' IT solution.

Balancing behaviour and tools to accomplish objectives

The absence of a universal IT solution and the proliferation of 'point' solutions often mean that companies do not receive the optimum benefit from their investments in information technology and information systems. The model shown in Figure 1 provides a useful framework for assessing the extent to which the IT can support what a business is trying to achieve. It also accounts for the organisational culture and behaviour required in order for IT to be used optimally in pursuit of the business vision. The essence of the model is that the business vision, the IT and the organisational culture should be balanced.

The use of this model can provide a first-cut assessment of the balance between the three elements. However, as the size of the company under consideration increases, the use of the model becomes rather difficult. For example, using a relatively simple value chain as a way of representing the business processes or vision is likely to reveal that each individual activity performed in the company is currently based on a tailored IT system. Each of these will have its own 'subculture' in the organisation. The problem then is how to ensure that all of the various subsystems and subcultures work together in such a way as to provide optimal support in achieving the objectives of the company.

Figure 1—Balancing behaviour, tools and objectives



If a single IT solution was possible throughout an organisation, then the task of balancing IT and organisational culture in order to meet the business vision would be substantially easier. Thus senior managers could better focus their efforts on achieving the corporate objectives. Furthermore, the speed of change in IT is ever-increasing and the sheer difficulty in trying to keep pace has seen many companies outsourcing their IT function. Unfortunately, outsourcing does not always deliver the benefits it promises. However, the use of an intranet provides the opportunity for organisations to implement an enterprise-wide IT system that is essentially universal; in other words, an IT system that, using the same technology and systems infrastructure, can support all the functions of the organisation.

Intranets

As stated earlier, the term *intranet* is used to describe a corporate Internet protocol (IP) network. In essence, it is an Internet deployed within the confines of an organisation. The intranet differs from the Internet in that it is based on private company-controlled servers and is shielded

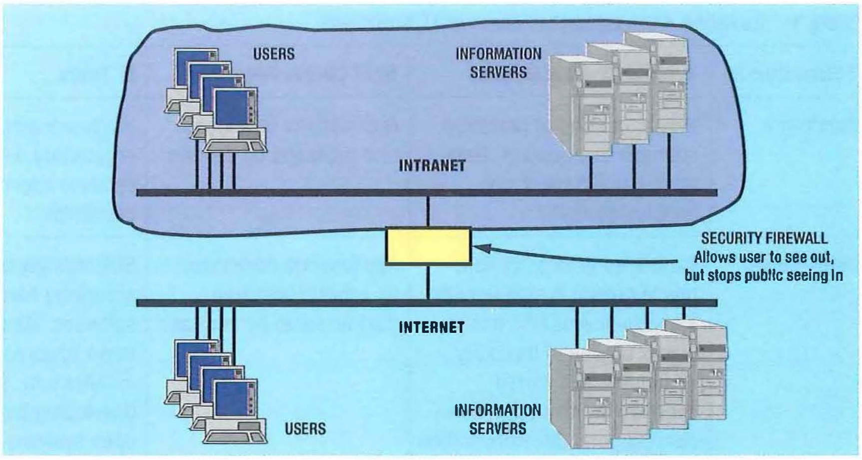


Figure 2—A simple intranet

from the public Internet by a security firewall as shown in Figure 2.

Intranets are typically based on standard Internet technology with open standards and multiple hardware and software platforms. Having a standard technology platform has a number of benefits. It is both cheaper and easier to implement than some existing technologies used for information publishing and distribution. Furthermore, the advent of IPng—the next generation of the Internet protocol—will offer additional benefits and advantages. For most organisations, intranets will be their main entry to, and manifestation of, the rapidly developing multimedia industry, where the disparate disciplines of telecommunications, information content, and computing are merging rapidly.

Opportunities—Strategic Impact of Intranets

The use of the intranet can revolutionise the use of IT in the corporate environment. It can replace existing technology at a much lower operating cost and has a significant number of additional advantages. It offers companies new opportunities for sharing and distributing information both internally and externally with customers and suppliers.

Key benefits and opportunities

An intranet offers the following key benefits and opportunities:

- Communications are better, both internally and with key business partners—e-mail, mailing lists, bulletin boards, internal 'usenet' type newsgroups, audioconferencing, videoconferencing, and audio and video broadcasting.
- Use of information on customers, competitors, and market research is better resulting from the sharing of data.
- Publishing and distribution of information within an organisation are more effective. Most companies have several internal publications—employee handbooks, quality management systems, company reports etc. These have the attendant problems of version control and cost of printing and distribution. Intranets solve these problems by having a copy of the documents available on a server.
- Business processes can be re-engineered to take full advantage of the increased access to, and flow of, information. An intranet permits many new information flows that previously were impossible or prohibitively expensive. An analysis of the new information flows may identify ways of gaining strategic advantages as a result of parts of the company having access not only to more information but also more timely information about markets and competitors.

Relationships with strategic partners

The use of an intranet that spans the whole of the company gives a greater bargaining power owing to the sheer size of the network and the amount of equipment involved. Conversely, the use of an intranet can help to create better and tighter relationships with suppliers. For example, using the Internet as a way of connecting together your corporate intranet with that of a supplier means that you can take advantage of new opportunities for accessing and sharing information.

Toyota revolutionised the automobile industry by sharing production information with their suppliers and thus subsequently developing just-in-time inventory supply. The intranet can similarly revolutionise most industries. The ease with which an intranet can support information sharing between a company and its suppliers and the impact this is likely to have on an organisation's business processes will contribute to the demise of the traditional 'stand-alone' organisation.

An Information Architecture for the Intranet

Having identified the potential impact of the intranet and explored some of the possibilities and opportunities that it offers, it is useful to have a framework on which to base decisions about the deployment of the intranet. One such framework is an information architecture which helps to focus on how the software, hardware and data should be used in order to support the business processes. This framework takes account of the culture of the organisation in terms of the actual or desired way of working. Table 2 illustrates some of the issues that require consideration.

Obstacles

As with any investment in IT, there are several obstacles that need to be overcome if a company is to invest in an intranet. This section identifies some of the key obstacles and counterarguments that are likely to be faced.

The level of risk involved

It can be argued that deploying an intranet involves a lower risk than that associated with deploying other (disparate) IT systems. Any company using networked computers will have some knowledge and experience of using IP. However, specific knowledge

Table 2 An Information Architecture for an Intranet

	Business Processes	The Way We Work	Location
Software	Each part of the individual business processes should continue to use existing software if it is deemed to have advantages over intranet software. This is likely to change with the advent of Java applications which will offer a much higher degree of flexibility than current application software	Support and develop the use of groupware. Encourage sharing and reuse of information rather than regeneration of information already available	Basic software platform is IP. Applications currently being developed using Java and Virtual Reality Modelling Language (VRML) will offer many new opportunities
Hardware	Migrate from the current range of hardware to a common base of hardware that will support the development of an intranet	Support mobile access to data using laptops and GSM phones	Intranet servers distributed throughout the company
Data	Identify the information requirements for organisational effectiveness. Highlight the data and information flows between, and within, the business processes	Support individual access to the data based on the requirements of the individual's role	Distributed globally

of setting up and maintaining Intranet servers will be required.

We believe that risk involved in building an intranet is relatively low. Indeed it could be argued that the biggest risk involved is the **risk of not doing so.**

Investment in 'legacy' technology

A second obstacle to investing in an intranet is 'legacy' systems. However, relatively simple macros are available that will generate intranet pages direct from Microsoft Word documents. Similarly, tools are available for converting Lotus Notes documents into intranet pages. This 'backward-compatibility' offers the opportunity to develop a strategy of coexistence so that there is a benefit from existing investment.

Cost of implementing an intranet

The cost of implementing an intranet and development of applications is also likely to be perceived as an obstacle. However, when compared to other IT systems, the costs turn out to be substantially less. For example, initial intranet start-up costs and commitment are very low, with a minimal up-front investment and training. Furthermore, it is relatively easy to migrate existing content to intranet format (HyperText Markup Language (HTML)). Also, intranet applications can be fully developed and deployed relatively inexpensively. Moreover, intranets can be easily adapted to support multimedia applications. For example, video is an easy extension to the basic intranet platform. Also, using publicly available free or inexpensive utilities (CU SEE ME, Internet Phone, Real Audio etc.), a corporation can deploy bidirectional desktop videoconferencing relatively inexpensively.

Availability of skills required

The final major obstacle likely to be encountered is the availability of skills and people. While they may be in short supply within a company, they are readily available. The skills that may be more difficult to acquire are likely to be those relating to setting up and establishing the intranet servers and infrastructure. However, many companies can provide assistance and guidance with the start-up phase. Once the initial infrastructure has been set up, the job of maintaining and updating the intranet is fairly straightforward.

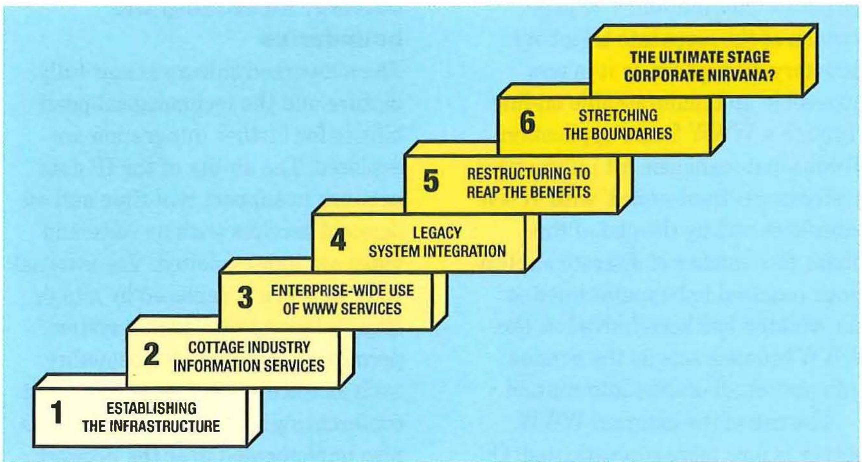
Building the Future Organisation—Six Steps to Nirvana?

In moving towards this goal of corporate nirvana it is useful to consider the stages in which this might happen. We have called these the *six steps to corporate nirvana* based on the likely process that most organisations will follow. Figure 3 illustrates the six steps.

Step 1—Establishing the infrastructure

Basic IP data networking is in place and users can communicate by e-mail, swap files with each other and have access to remote systems. Key IT users have a desktop PC. External connections to information services are established as is basic firewall technology for security. An Internet connection of modest capacity is provided enabling users to receive e-mail from the outside world and experimental use of the World Wide Web (WWW) is established but restricted to one or two specialists. There is likely to be general suspicion of the Internet at senior management levels because of its perceived potential for wasting time, usurping management levels, breeding

Figure 3—The steps to corporate nirvana



By the time the organisation has reached the sixth stage, many of its traditional structures and edifices have been swept away by the new technology.

anarchy, and compromising corporate security.

Step 2—Cottage industry information services

Small groups of users access simple forms of information such as personnel lists, top-level project plans, missions statements etc. Some experiment with WWW authoring and add their own 'home pages'. Simple navigation aids to corporate information begin to appear. Senior managers gain their first exposure to the technology and quickly grasp its potential.

Step 3—Enterprise-wide use of WWW services

There is now support for the company-wide use of the technology at 'functional director' level and working groups are established to define a roll-out plan for corporate information. Some regular reporting functions are migrated from e-mail to WWW as the company begins to move from a 'push' to a 'pull' culture. In other words, less information is sent unsolicited as more information is available on-line. The chief executive officer (CEO) has a WWW browser on his/her desktop PC. The company commissions its first presence on the Internet outside of the firewall by publishing information on products and services.

Step 4—Legacy system integration

The working groups have established a myriad of opportunities for simplifying access to a wide variety of corporate information. The paper version of the corporate telephone directory disappears as it is now accessible and maintainable on-line through a WWW forms application. Traditional management information systems are 'front-ended' with WWW interfaces and by the end of this phase the number of discrete applications required to be maintained at the desktop has been halved as the WWW browser acts as the window into almost all on-line information.

The use of the external WWW server is now more sophisticated. On-line trading is initiated as the potential of the medium as a new channel to market is realised. Also, on-line recruiting and closed user group access to some key suppliers is permitted, heralding the beginnings of an electronic trading culture.

Step 5—Restructuring to reap the benefits

Dependency on the corporate intranet is now high and many traditional processes have changed significantly. Security is improved as key operational systems are integrated. The use of encryption technology for secure messaging both within the company and with partner organisations is commonplace. Confidence in firewall technology is now high and the external Internet is used routinely for 'tunnelling' between different parts of the extended organisation. Encryption technology is also implemented to enable digital signatures to be used for key financial and operational processes. A highly secure trusted third-party system is implemented for authenticating electronic documents enabling most paper-based sign-off processes to be replaced.

The organisation has now reached a point where there is a high degree of flexibility possible in the organisational structure and several middle management layers are removed as simple chains of command are implemented electronically.

Step 6—Mature networking culture: stretching the boundaries

The networked culture is now fully mature and the technological possibilities for further integration are explored. The ability of the IP data network to support real-time and on-demand services such as voice and video are now exploited. The internal voice network is replaced by a high-quality Internet telephone system, permitting advanced functionality such as voice control and automated conferencing. Video to the desktop is also implemented over the network, which now features advanced asynchronous transfer mode (ATM) and guaranteed quality-of-service protocols. Automated user tracking and intelligent information agents begin to appear as does some use of virtual-reality technologies for information navigation.

By this stage, most users have on-line connections from their homes and cars. Work patterns change with many users now able to give up a permanent desk at the office in favour of a much more flexible working environment. Fully-equipped multimedia conference rooms are provided for meetings between geographically separated parts of the organisation.

The ultimate stage—corporate nirvana?

By the time the organisation has reached the sixth stage, many of its traditional structures and edifices have been swept away by the new technology. Flexibility of action is the keynote. Information workers are contracted for limited duration projects. The ability for the best to work for any organisation in the world is no longer restricted by geography. Head office can be downsized as many of today's functions are no longer required in their current form. The corporate network infrastructure is completely outsourced to advanced IT/ communications companies who provide and maintain a highly-secure infrastructure. These organisations are key as they are now responsible for the bulk of the assets of these new virtual organisations. They have a similar role to the banks of the 19th and 20th centuries who were responsible for the fiscal assets of the traditional organisation.

It is now possible for a company to exist in electronic form only. It has no tangible assets. It exists purely on-line with its workers, suppliers and customers interacting through the electronic medium. The company's board and its shareholders are able to monitor its performance at almost any level of detail. Decisions can be taken and communicated in an instant without the inertia that the old-style organisation endured. The organisation has now reached corporate nirvana; it only exists because of the network. Without the network it has no meaning.

Conclusions

Intranets offer new opportunities for organisations, ranging from increasing the degree to which information is shared and distributed, through to re-engineering into an informated entity. Being able to exploit the opportunities offered by the intranet will give many companies a strategic competitive advantage.

In comparison to other IT systems, the start-up, training, ongoing management, and updating of intranet applications cost significantly less. The benefits offered by Intranets include cost savings, minimal training, single source of data, links to outside data sources, and easy management and delivery of information.

Intranets will not only change the way companies do business, they will also radically alter the structure of industries. Having lived through the impact and opportunities offered by an intranet, we believe firmly that those who invest in an intranet solution will not be disappointed. Rather they will likely be overwhelmed by the benefits and opportunities that it will offer them. Nirvana will come to mean more than nonexistence.

However, attaining corporate nirvana will not be an easy process. Many (if not all) current systems, processes, and procedures will be undermined. Corporate nirvana will also lead to new human resource management issues as a result of organisations moving from the traditional 'command-and-control' approach to being information-based. However, as with all breakpoints in technology, the companies that grasp the opportunities will survive. Those companies that dismiss the intranet as another fad will be sadly mistaken.

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Biographies

James Callaghan
BT Networks and Systems

James Callaghan joined BT in 1986, after graduating from the University of Dublin (Trinity College) with a first-class honours degree in Electrical Engineering. He subsequently gained an MA from the University of Dublin, an M.Sc. from the University of Essex, and a Diploma in Marketing and an MBA from Henley Management College. His work in BT has primarily been in network management research. He spent several years working on, and leading, projects in the European RACE programme. He has also investigated the application of artificial-intelligence techniques to network and service management. Current interests include intranets and the likely impact of new technologies on the way companies conduct their business. He is a Chartered Engineer and is a Member of the IEEE.

Phil Flavin
BT Networks and Systems

Phil Flavin joined BT Laboratories in 1971. He successfuly completed the CEI pt II examinations in Electrical and Electronic Engineering, Computing and Control in 1977. Until 1986, he worked in microelectronics including advanced device development for TAT-8 and 565 Mbit/s transmission systems. He published several papers on the fabrication of sub-micron structures by electron-beam lithography. In 1986, he became a group leader responsible for development of computer-aided engineering and, later, for PABX development. In 1989, he became a section manager in the IT department and built what became the Decision Support Systems Section, focusing its activities around the application of information technology to business decision making. He is now manager of new services in the on-line and multimedia sector of Design and Build. He is a Chartered Engineer and Member of the IEE.

Mike Burt

Quantum Dots—Designer Atoms

Quantum dots are crystals so small that one can almost count the number of atoms they contain. This emerging low-cost materials technology could revolutionise the way materials are designed for hardware that will play a key role in providing affordable broadband networks for the future.

Introduction

The optical fibres that have revolutionised telecommunications over the past 20 years use glasses so pure that someone could see through a 22 mile block, just as if looking out of a window. Even so, fibre manufacturers are quite used to the idea of manipulating these remarkable materials to make them even better at solving particular problems.

To take one example, how does one trap the light in a fibre, stopping it getting weaker as the light leaks out from the sides of the glass strand? The answer is to mix two slightly different glasses, and arrange the core to have a higher refractive index than the outer cladding. Total internal reflection at the boundary between the two glasses keeps the light in the central core of the fibre.

Taking a second example, how can one stop the light getting weaker after it has travelled a few hundred miles? Here, a very sophisticated technology provides the answer—the erbium-doped fibre amplifier. Erbium atoms are mixed into the glass, and the fibre is pumped from a special light source which makes the electrons of the erbium atoms go into excited (higher energy) states. When the telecommunications light signal goes down the fibre, it stimulates the erbium electrons to give out more light at the same frequency, effectively amplifying the stream. It is thus a self-amplifying optical fibre, which allows wideband communications to go for hundreds or thousands of miles entirely in fibre without electronic processing.

The technology needed for doping is very sophisticated, but even so it leaves a few problems in its wake. Optical fibre passes light at wavelengths around 1·55 μm and 1·3 μm, these being the two optical windows that are exploited in telecommunications. The trouble is that erbium atoms can amplify light only corresponding to the energy jumps between the fixed energy levels of the electrons, and in no way do these cover the whole of the 1·55 μm window, which is about 0·1 μm wide, let alone the 1·3 μm window as well. Furthermore, the wavelengths within the 0·03 μm-wide band that the erbium atoms can amplify easily are not amplified equally, and sophisticated engineering is needed to obtain near-uniform amplification over even this restricted wavelength range. To amplify signals in the window at 1·3 μm praseodymium atoms are required, and a similar problem with the range of wavelengths they will amplify and the uniformity of the amplification is encountered.

Though we might seek other atoms to come to the rescue, we find there are simply no other more suitable atoms that operate in the right bands. The fact that the best solutions to the fibre amplifier problem so far use such exotic elements as erbium and praseodymium means that we are really scraping the bottom of the barrel in our search through the periodic table. Clearly a radically different approach is needed to move away from the restrictions of the periodic table and achieve uniform amplification easily across the whole of both the 1·3 μm and 1·55 μm windows.

This broadband uniform amplification would be highly desirable for future high-capacity networks. It would greatly increase the quantity of traffic a fibre could carry via

Figure 1—Quantum dots in the making—Dr Oleg Salata at work in his laboratory in the Engineering Department, Oxford University

wavelength division multiplex by increasing the number of possible channels and at the same time increasing the wavelength difference between the neighbouring channels, thereby making the multiplex and demultiplex processes that much easier and less expensive.

Designing and Making 'Atoms'

The radical solution to the problem of not being able to find a suitable atom is to make your own! This is not as fanciful as it first sounds thanks to recent advances in chemistry. The 'atoms' are very tiny crystals of semiconductor, less than 0·01 µm across, and are often referred to as *quantum dots*. Electrons inside a quantum dot are constrained to move inside the dot and so can take on only discrete energies, just like electrons in an atom. So a quantum dot is an artificial atom, but an atom that can be tailor-made because the energy levels available to the electrons depend on the size of the dot.

The cheapest and most flexible way of making quantum dots is to use colloidal chemistry. This is a bit like those school chemistry experiments where one obtained an insoluble salt by precipitation from a mixture of soluble salts in solution. Now, to stop children getting bored, the reactions have to be quite fast so that there is soon something to see. The insoluble salt crystals grow by molecules coming together into quantum dots, and then the dots aggregating to form visible crystals.

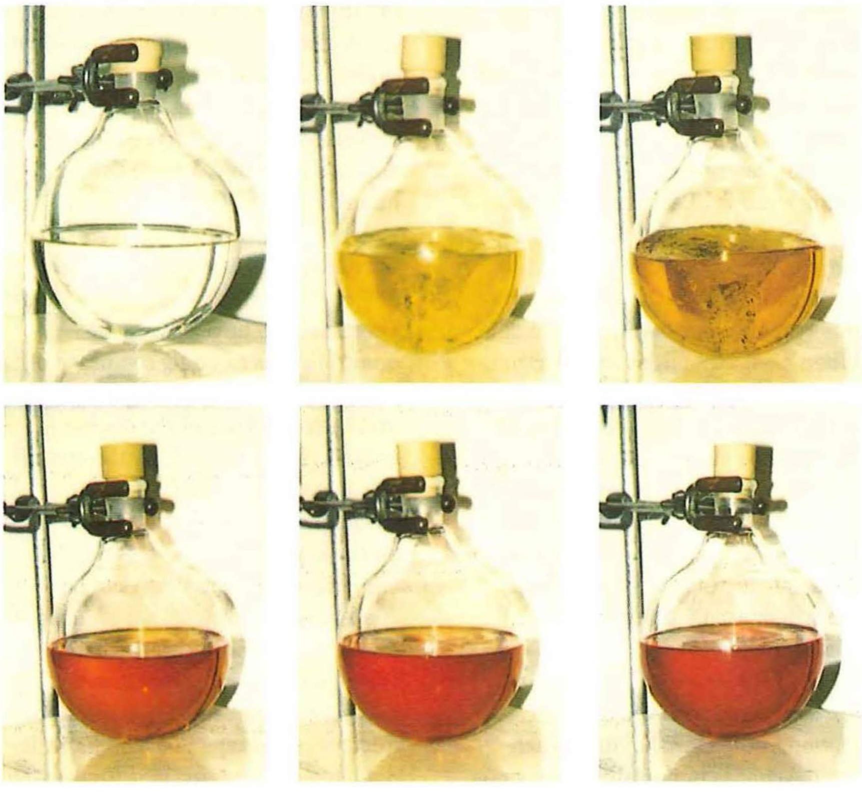
To make quantum dots, it is necessary to slow the reaction down, and stop it at the 'dot' stage. By adding particular reagents, a chemist can slow reactions down so that the quantum dots grow slowly, and there is then time to stop the growth by adding another reagent that may, for instance, form another compound on the surface of the quantum dot that does not favour any further aggregation though there are many variations on this theme. The trick is to find the right reagents, and this is the subject of leading-edge research in university chemistry departments. The quantum dots (see Figure 1) can be extracted in the form of a powder by using a centrifuge and drying them. They can be incorporated in a fibre as an alternative to erbium or praseodymium to make an amplifier.

The size of the dots depends on when the reaction is stopped. The size of the dot determines the wavelength of light it amplifies. By making a number of samples containing different dot sizes and putting them in the same fibre, an amplifier can be made with any required gain spectrum. One device could amplify signals over the whole of both 1·3 µm and 1·55 µm windows.

Figure 2 illustrates the growth of quantum dots made from the semiconductor cadmium selenide. Originally, the flask contains only the original colourless reagents (top left picture). As the reaction proceeds, the cadmium selenide quantum dots form and grow in size. As the dots grow, the electronic energy levels change and this influences the wavelengths of the light that the solution absorbs and emits, so influencing its colour. The photographs show the solution changing colour from yellow via orange eventually to red as the dots grow. This is a dramatic demonstration of the power of this low-cost chemical engineering.

While the expertise needed to make these quantum dots by using colloidal chemistry is indeed sophisticated in terms of the concepts used,

Figure 2—Formation of CdSe quantum dots in colloidal solution (photographs show growth of dots with sequential addition of Cd and Se precursors. Size range of dots isolated from this sequence is about 2–5 nm)



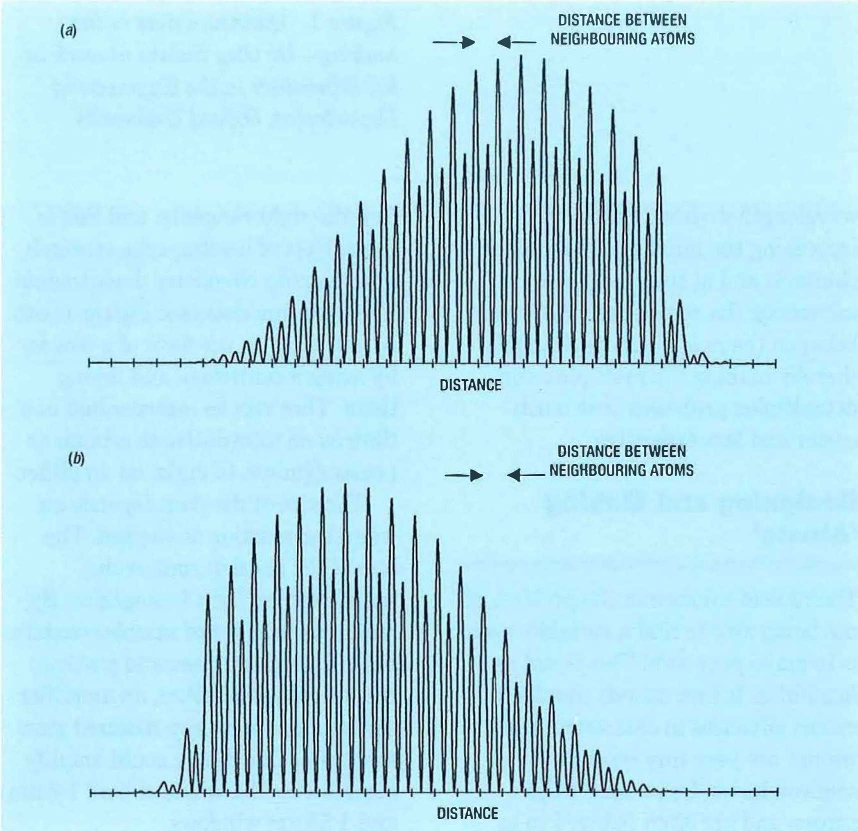


Figure 3—Distribution of electrons over a quantum dot—plot of probability density versus distance

making them is by no means expensive. For instance, the equipment needed to make a colloidal suspension of quantum dots is widely available at modest cost in most chemistry laboratories.

Why Are They So Good?

The ability of quantum dot technology to provide an amplifier with any required gain spectrum might well be regarded as a significant enough advantage on its own, but there are other ways in which quantum dot amplifiers would be much better than the conventional erbium- or praseodymium-doped fibre amplifier. Because the quantum dots are much bigger than erbium and praseodymium atoms, they are much more responsive to the incoming light because some of the electrons are not tied to their parent atoms, but can move throughout the dot even though they have discrete energy levels. This responsiveness is similar to the way a large aerial or satellite dish is more sensitive to radio signals than their small equivalents: they can absorb more energy from the stream. By the same token, because the electrons can move further (about a thousandth of a micrometre) within a dot than in an atom (about a ten thousandth of a micrometre), they radiate out their energy more efficiently. The comparison is like a giant antenna versus a small aerial: they make more powerful emitters.

A model calculation can illustrate this responsiveness of quantum dots. When exposed to light, the electron oscillates back and forth within the dot, and snapshots can be taken of the way the electron is distributed over the dot at the two extremes of the oscillation. Figure 3 shows how the electron is spread over a quantum dot some 20 atoms across at maximum displacement to the right (*a*) and to the left (*b*).

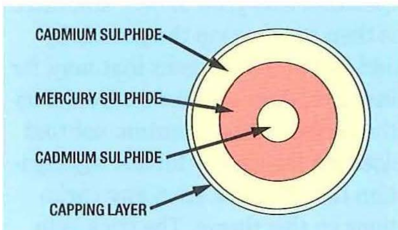
The rapid variations in each plot are connected with the detailed motion of the electron about each atom. What is important, however, is the difference in the 'centre of gravity' of the two distributions shown in (*a*) and (*b*) and this is about six atomic spacings in this example. For an isolated single atom, the corresponding oscillation would be 10 times smaller even for the most favourable case just because of the much smaller size of an atom compared with a quantum dot. Discovering this true extent of the electronic oscillation in a quantum dot requires sophisticated analysis and it is not uncommon to find incorrect analyses published implying that quantum dots are no better than individual atoms.

Scotch Eggs and Crystals

Up to now we have envisaged quantum dots as being composed of just one semiconductor crystal type and the properties of the dot being engineered by controlling the size of the dots. This already gives a lot of freedom to make what is required since, as well as the size of the dot, the chemical composition can be chosen from a large range of semiconductor crystals. But even greater freedom is possible since it is not necessary to have just one semiconductor crystal type in each quantum dot. One can imagine (see Figure 4) a quantum dot with a 'scotch egg' type structure with the yolk representing a semiconductor crystal of one type, say cadmium sulphide, a layer corresponding to the white of the egg, perhaps only a few atoms thick, of a second semiconductor crystal type, say mercury sulphide, and finally a third semiconductor crystal layer corresponding to the sausage meat, which in the simplest case could just be of the same composition as the semiconductor occupying the yolk region. Such structures have been made and clearly open up a whole new degree of freedom in the engineering of these 'atoms'.

Does the 'scotch egg' structure and obvious variants represent the limit of quantum dot technology? By no means. It was mentioned earlier that one can stop the growth of a quantum dot by adding a reagent that forms a layer of another compound on the surface of the quantum dot that does

Figure 4—'Scotch egg' structure



not favour any further aggregation. This outer or capping layer may only be one molecule thick, and in the 'scotch egg' structure it corresponds to the layer of bread crumbs, but its chemical composition can profoundly influence its solubility in the medium that supports the quantum dots. By choosing this layer wisely a very high density of dots can be achieved in various liquids and polymers so that devices such as amplifiers would only be millimetres or centimetres long. Contrast this with the very low solubility of erbium atoms in glass, a quantity over which there is virtually no control, resulting in fibre amplifiers several metres long.

Early in our education we learn that atoms are the very building blocks of all matter and later on we learn that in crystals the atoms are arranged in a periodic lattice. Silicon is a famous example in which the atoms are arranged in the same way as carbon atoms are arranged in a diamond. If quantum dots are truly artificial atoms, then should they not bond together to form crystals? Indeed they should and within the last year or so the first demonstrations of these new crystals have been reported in scientific journals. In one example, cadmium sulphide quantum dots in the shape of pyramids were made to crystallise to form a diamond type lattice. Clearly a whole new aspect to materials science is just opening up.

Concluding Comments

Advances in materials science such as the development of ultra-low-loss glass for optical fibres and the semiconductor alloy crystal technology to make high-speed lasers and photodetectors have revolutionised telecommunications networks over the last two decades. In particular, developments in making semiconductor alloy crystals based on indium phosphide, rather than staying with the established compound semiconductor gallium arsenide, have enabled the telecommunications industry to start exploiting optical communications in the windows corresponding to minimum dispersion at 1·3 μm and minimum loss at 1·55 μm and create the high-capacity networks we have today. However, if we are to make the most of optical fibres in future broadband networks ways must be found of getting amplification over the whole of the available windows at minimum cost. It can be seen how quantum dot technology could give us a way of doing this. But the very power of the technology suggests it will have much wider application. For instance, the potential ability of the technology to provide dots that give out light at a range of colours just by changing their size and the flexibility of the technology to incorporate them in a number of hosts means that they may make their biggest impact in low-cost large-area displays that would make a huge impact on the viability of visual communications.

Biography

Mike Burt
BT Networks and Systems

Mike Burt received his undergraduate and postgraduate degrees from Oxford in 1968 and 1971. He then spent 2 years working at the University of Utrecht in the Netherlands as part of the Royal Society's European Programme. From 1973–79, he was a Research Associate at the Cavendish Laboratory, Cambridge, sponsored by the Ministry of Defence working on a new generation of night vision devices. In 1979, he joined BT Laboratories and has worked on a variety of projects involving quantum electronics and optoelectronic devices. In 1993, his contribution to research in these topics was recognised by Oxford University with the award of the prestigious Doctor of Science degree. In 1995, he was appointed Visiting Professor at the University of Durham.

Simon Pyzer, Philip Williams and Diane Richards

Applying the BT Operational Support Systems Architecture

There are currently around a thousand computer systems supporting BT's operational processes. This article describes how the operational support systems (OSS) architecture is being used to help rationalise and reduce this portfolio into a more manageable set by ensuring maximum reuse of functionality and minimum replication of data. This will lead to lower maintenance and development costs as well as speedier delivery of new solutions.

Introduction

A previous article in *British Telecommunications Engineering*† has set out the reasons for the development and the method adopted in the production of the *BT OSS architecture* for the management of operational support systems (OSS). This article reviews the salient parts of the architecture, describes the value of it and how BT uses it in the design, development, procurement and deployment of computer systems.

Background

The BT OSS architecture is just one of the components of the *BT OSS framework.*

The current scope of the OSS architecture comprises three main areas:

- selling and billing of services,
- maintenance of service quality, and
- the management of the BT portfolio of services and its network platforms.

This OSS architecture evolves as the requirements of the business change, as functionality is enhanced and as further detail is added. Work is currently in hand to increase the scope to encompass other business areas of BT and its activities outside the UK.

The complete OSS framework consists of the following components:

- *The BT OSS architecture* This is described in the previous *British Telecommunications Engineering* article† (see Figure 1).
- *The data architecture* This comprises data areas, data models, data flows, data standards, the interfaces between data areas and key business drivers. This is encapsulated in what is known as the *Data Architecture Manual.*
- *The portfolio of BT's computer systems* Details of these are held in the *BT Systems Encyclopaedia.*
- *System evolution plans* These consist of a set of plans for the further development of each of BT's key systems over the next five years.
- *Reference solution designs* These are a set of designs that collectively provide up to 80% of the solution for new products. They are based on BT's key systems and are compiled from a set of tables of preferred software.
- *Solution designs* These are produced to meet specific requirements.

Figure 2 demonstrates how these various components are related and

† Furley, Nick. The BT Operational Support Systems Architecture Framework. *Br. Telecommun. Eng.*, July 1996, **15**, p.114.

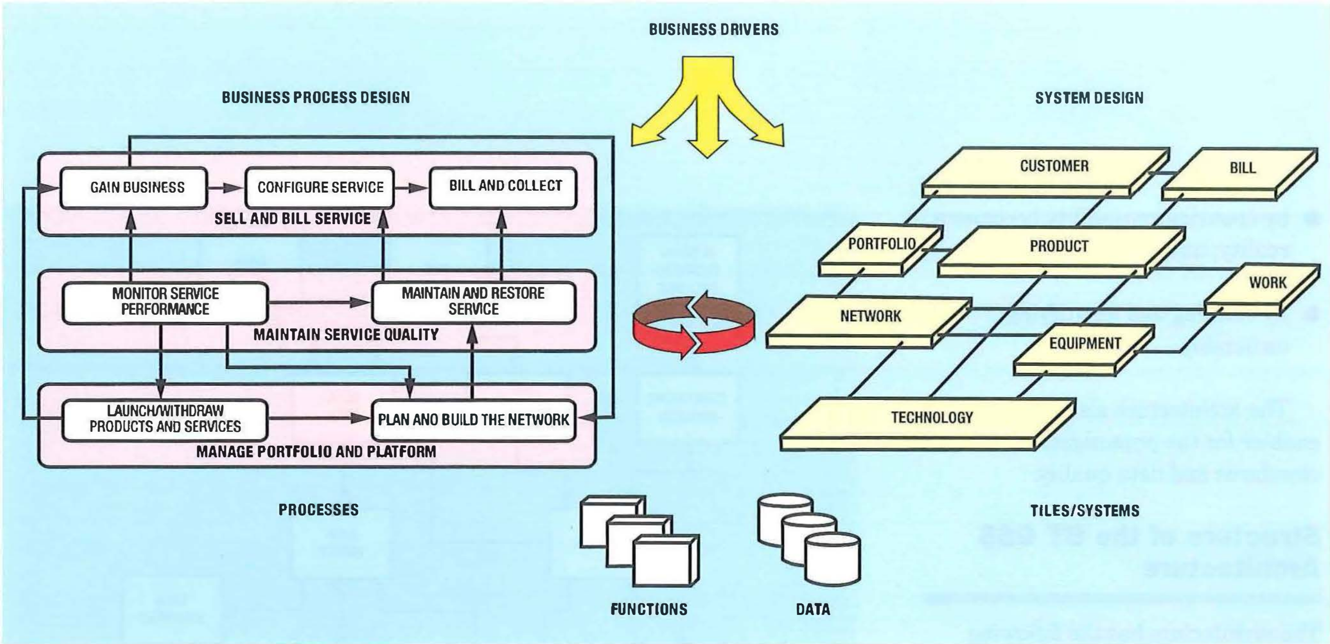


Figure 1—The BT OSS architecture

work together to provide the complete framework within which OSS developments are managed.

Context

The purpose of computer systems is to serve the needs of the business and to respond to the pressures and drivers on the organisation. Computer systems need to automate processes, provide accurate information in time and be able to support the mix of products in order to deliver timely customer solutions both in the UK and globally. Also, at a time of change in the telecommunications market, the computer systems must be flexible, not constrained to any particular organisational model and support the need for continuous improvement.

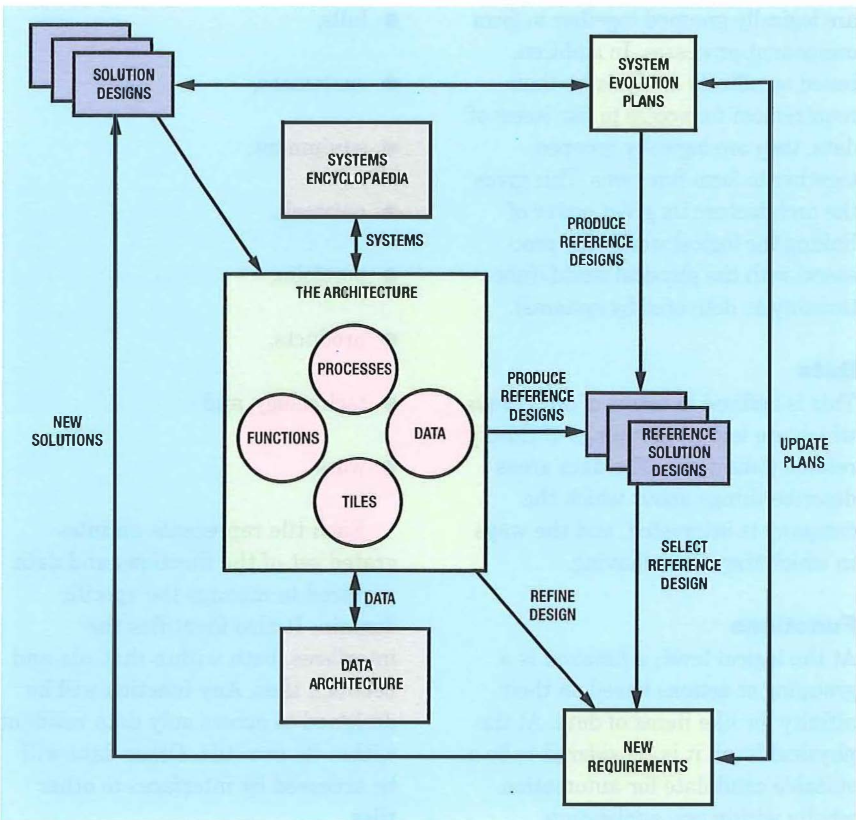
BT has a portfolio of computer systems which must be managed. These systems support the business processes by encompassing the required functionality, appropriate data and data access. This portfolio depends on a technical architecture where data is well managed, secure and accurate, with one master source, and where interfaces are clearly defined, effective and managed.

The OSS architecture is a structure which helps the roles and relationships of the computer systems to be understood. It is required because of the sheer complexity of modern telecommunications and information networks and the number and scale of BT's systems.

The architecture will aid the company:

- by improving the quality of software development;
- by improving data management capabilities—availability, accuracy, and controlled replication;
- by increasing the speed of systems development;
- by assisting in the handling, assessment and delivery of required changes;
- by allowing for greater management control of the portfolio;

Figure 2—Components of the OSS framework



- by ensuring reusability becomes a reality; and
- by defining and identifying ownership.

The architecture also acts as an enabler for the promulgation of standards and data quality.

Structure of the BT OSS Architecture

The architecture has the following parts: generic business processes, component processes, actions, data, functions, tiles, and all their associated interfaces. Figure 3 shows the interrelationships of these parts of the architecture and the relationships with their physical implementations.

Generic business processes

The OSS architecture has identified three *key business processes* which, in turn, have been broken down into seven *generic business processes*:

- Sell and Bill Service:
  —Bill and Collect
  —Configure Service
  —Gain Business
- Maintain Service Quality:
  —Maintain and Restore Service
  —Monitor Service Performance
- Manage Portfolio and Platform:
  —Launch and Withdraw Products and Services
  —Plan and Build the Network

Component processes

Each generic business process has been broken down into a set of *component processes* which have been linked together with their required data. Each component process performs an activity carried out by the company in the performance of its day-to-day operations and consists of all the actions needed to operate that process.

Actions

Both a function and a component process consist of *actions*. An action is in effect a lower-level process and can be considered as the basic reusable building block for realising both component processes and functions. Based on the business context, they are logically grouped together to form component processes. In addition, based on affinity analysis for their requirement for access to like items of data, they are logically grouped together to form functions. This gives the architecture its great power of linking the logical world (the processes) with the physical world (functionality as delivered by systems).

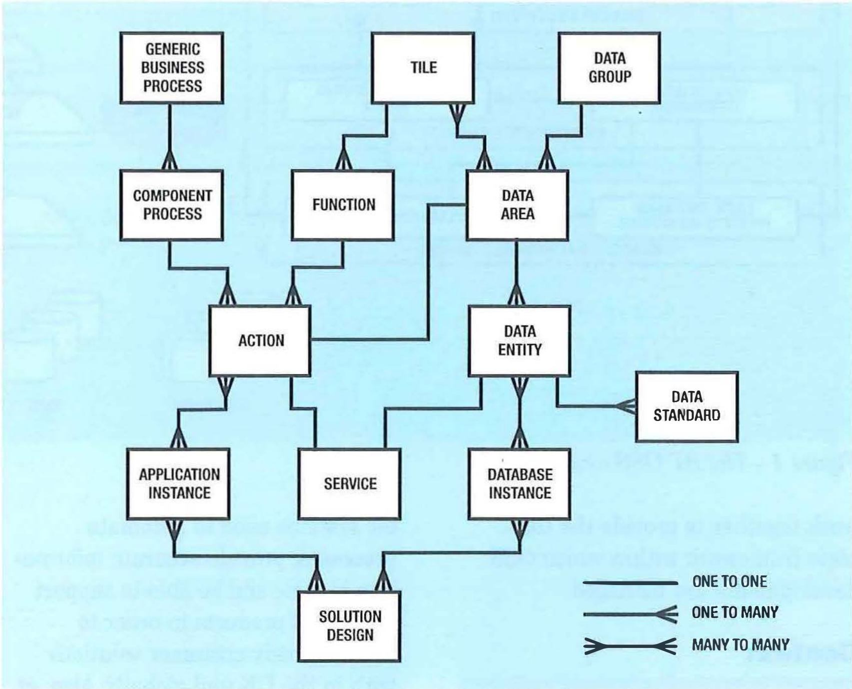


Figure 3—The OSS framework information relationships

Data

This is defined in terms of *data areas* which are logical groupings of closely related data items. The data areas describe things about which the company is interested, and the ways in which they are behaving.

Functions

At the logical level, a *function* is a grouping of actions based on their affinity for like items of data. At the physical level, it is considered to be a suitable candidate for automation wholly within one application.

Tiles

The architecture identifies eight specific management domains which have been called *tiles*:

- bills,
- customers,
- equipment,
- network,
- portfolio,
- products,
- technology, and
- work.

Each tile represents an integrated set of the functions and data required to manage the specific domain. It also identifies the interfaces, both within that tile and between tiles. Any function will be designed to access only data resident within its own tile. Other data will be accessed by interfaces to other tiles.

Value of the Architecture

A major role played by the OSS architecture is the tight linkage it provides between the logical process world and the physical world of people and computer systems.

It provides a structure for the effective management of data and computer systems to serve BT's large and complex business. The use of the architecture enables consistency within the design and development processes. It ensures the production of designs which take a company-wide view, rather than being restricted to a particular product, service, process, technology, or geographical area. It also makes it clear where a focused design fits into the broader picture, exposing the relationships and dependencies.

The advantages to the company of using the architecture include:

- a common understanding which is gained through using standard process and function design,
- consistency of presentation of the computer systems solutions,
- the enabling of ownership for data and functions,
- the clear definition of the scope of solutions and associated responsibilities, and
- the provision of a common language or terminology to encourage consistency in understanding and expression of designs.

The OSS architecture also gives a structure in which issues can be examined. For example, whether software solutions should be acquired from external suppliers as opposed to being developed in-house and whether a proposed solution for one business requirement is consistent and fitting compared to existing applications and proposed solutions in other areas. When using the same structure for all designs, the probability of reusing the same or existing components for many solutions will increase.

The OSS architecture allows BT to model the operations of other administrations, other licensed operators and service providers without being concerned with the detail of their operational processes and computer systems.

How the OSS Architecture Helps the Design Process

The role that the OSS Architecture plays in the delivery of systems is to assist in the production of solution designs and evolution plans. Solution designs need to be produced to support new business objectives and initiatives. Evolution plans need to be developed for existing systems.

For existing systems, the architecture assists in the analysis by characterising these systems in terms of the functions they perform and the data which they hold or use. This enables designers to place the system on the appropriate tile(s). The overall design policy that BT is following is to concentrate design and development effort on key systems with clearly defined and delimited functionality. It is intended that the functionality provided by any one system should be wholly contained within one tile. As existing systems were designed and developed prior to the introduction of the architecture, it is not necessarily expected that they will align with this view, and it is often found that an existing system has an appearance on more than one tile.

For new applications, the OSS architecture helps solution designers to ensure consistency between solutions. Its scope covers the whole of service and network management and thus enables designers to produce designs for specific requirements with a knowledge of the broader context. A checklist of all the issues which need to be taken into consideration in producing a design is also included in the architecture.

Design takes place within the context of key systems. All current key systems have been analysed for the functionality delivered. This functionality has been considered from different business perspectives, such as technology (for example, integrated services digital network (ISDN)), geography (for example, Pacific Rim, UK), products and services (for example, FeatureNet, public switched telephone network (PSTN)). Thus a complete picture has been built up of what each of the key systems delivers within various categories.

Guidelines/principles

A basic set of principles has been created to guide the design of new systems and the evolution planning of current systems. The architecture provides valuable input and further guidance in the implementation of these principles. The following paragraphs give the authors' views as to how the architecture will contribute to this process.

- *Proven components will be used in preference to new development (reuse of key systems).*

  These 'proven components' will increasingly be the functions as defined within the architecture.

- *Solutions should reduce the number of manual interventions required in the company's processes, thereby reducing the cost of failure.*

  The close linkage of the logical and physical views in the architecture provide designers with a clear view of where there are gaps in automation.

- *Modular solutions will be built with clear boundaries and interfaces.*

  The architecture provides very clearly scoped and unambiguously defined functions, together with their interfaces. These modular solutions will be the physical implementation of those functions.

- *The model for system deployment is the three-tier architecture.*
  One of the major criteria behind the development of the OSS architecture has been to keep the functionality and the data separate. Therefore, the architecture fully supports the three-tier requirement of user access, applications and data layers (see section entitled 'Deployment').

- *New system developments will only be instigated if the need cannot be met by an existing key system.*
  The architecture includes a mapping of all key systems to the functionality supported by them, together with information on the business perspective. Reference to this gives a quick guide as to the areas where a current system has the potential of meeting the requirements.

- *The scope and complexity (in terms of functionality and data) of existing systems will not be increased.*
  The architecture is playing a major role in the scoping of systems. Evolution plans have been created for all of BT's key systems. Based on the architecture, these rationalise the functionality provided by each system such that, ultimately, no system provides functionality spanning more than one tile.

- *All new functional interfaces will be based on TMN (telecommunications management network) standards.*
  This guideline, together with the tight and clear scoping of functionality of the modules as defined within the architecture, enhances the opportunities to buy-in components.

- *Key BT reference databases will be used directly as sources of data.*
- *Data replication will be minimised and fully controlled.*
- *Data should be obtained directly from identified master sources of data. If performance considerations require the use of copies of such data, the replication must be under strict control.*
  The architecture clearly defines the data access requirements of the individual functions. This identifies all functionality that requires direct access to the master sources of data and others that can be provided by a controlled copy (for read access only).

Procurement

Single components or whole computer systems may be bought in from suppliers external to the company. These systems must then be integrated with other systems in terms of both functionality and data. The architecture is a useful tool for checking that a purchased solution meets the functional and data requirements of the business.

The procurement process should use any key business drivers identified within the architecture as a checklist in determining whether a package meets all or part of the requirements.

Deployment

The OSS framework is not prescriptive concerning the deployment of applications and systems on a particular kind of hardware architecture. However, BT has adopted a three-tier model for its computer systems, known as the *three-tier architecture*.

The term *three-tier architecture* may be used to classify the logic within an application—a logical three-tier architecture—and is also often applied to three physical classes of machines (workstations, mid-range servers and mainframe systems)—a physical three-tier architecture.

The OSS architecture is a logical framework within which computer systems are to be developed. It does not make any recommendations as to the exact physical architecture to be employed. However, it can be seen to fit in very neatly within this three-tier approach. Figure 4 is a diagrammatic representation of the three-tier architecture, with the tile architecture overlaid. The OSS architecture has not concerned itself with the presentation layer, but it can be seen that the tile architecture spans the mid-tier layer (the reusable functions representing the business logic) and the data layer (the data areas representing the physical databases to be employed).

Rationalisation

Aside from the design and development of solutions, the OSS framework is used as a base for the creation of evolution plans with a view to rationalising BT's current systems into a more manageable set.

Overall, the approach to rationalisation is:

- to partition the existing systems into two categories: key and non-key systems; then

- taking into account each product and service, to produce evolution plans for key systems which support the business processes; and then

- to identify candidate systems where there is scope for rationalisation because of data and functional duplication.

The framework provides the process, data and function structure which enables the above analysis.

Key systems are those which form the core of the company's computing power. They are the systems that support the main processes, tend to be the larger systems, and the ones on which most of the computer systems budget is spent.

Key systems are characterised in terms of the functionality and data held or used. When the key systems are considered as a set, it is possible to identify overlaps in function-

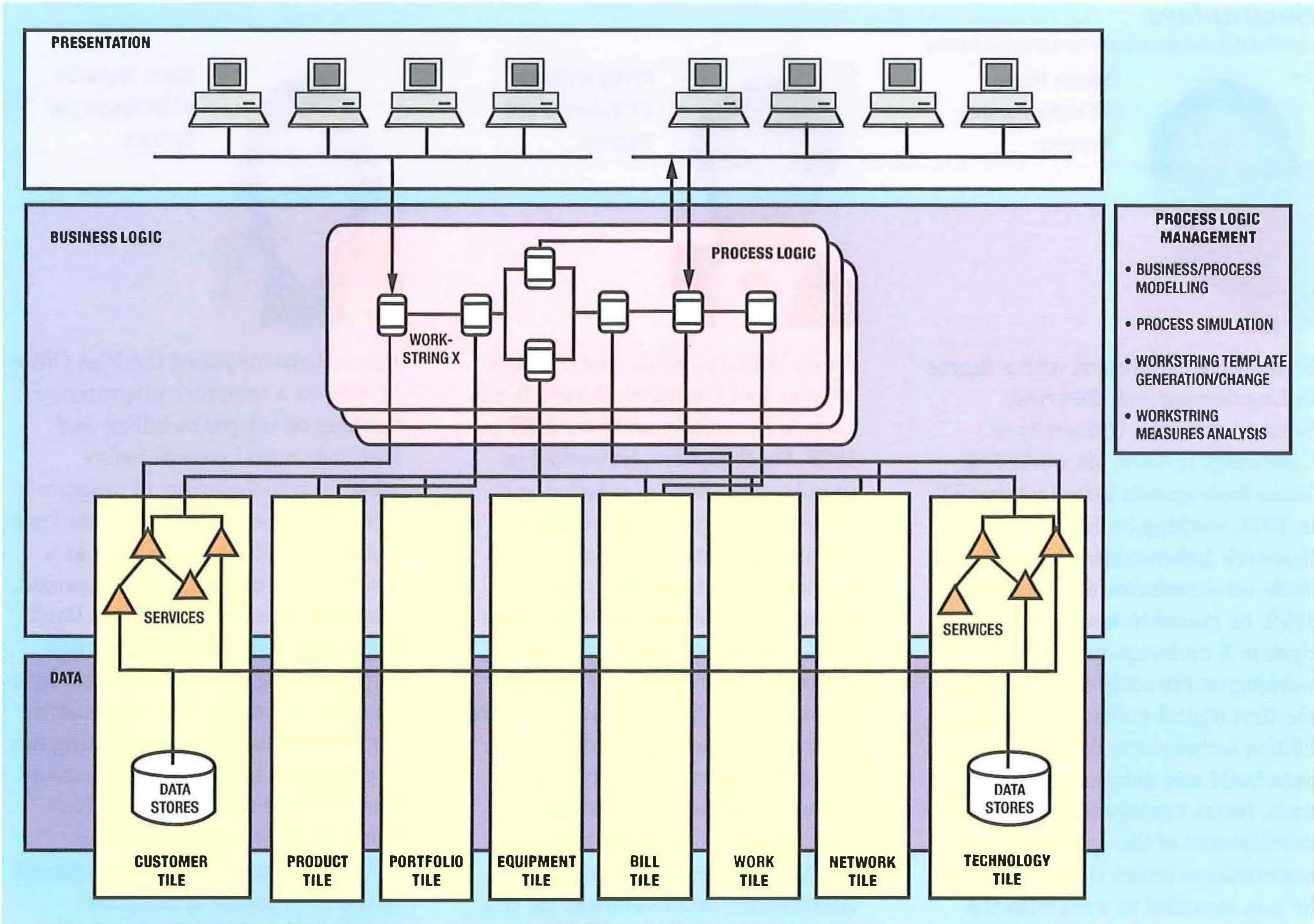


Figure 4—Relationship of the three-tier architecture with the OSS architecture

ality, having taken account of factors such as geographical coverage, network coverage, support of products and services, and network technology.

The changes over time to key systems are shown in the form of tile evolution plans. It is then possible to plot the evolution of the key systems and plan to rationalise them by bringing functionality together on these systems.

For non-key systems, a similar characterisation can be made of the functionality and data. Consideration can then be given to determine whether key systems can supply the functionality and data manipulation required. Redundant and duplicate functionality and the transfer of functionality need to be considered on a case-by-case basis within the context of the product and service.

As functionality is moved from non-key systems, they can be gradually phased out.

Conclusions

This article has described how the OSS architecture is helping BT in its quest to rationalise its many computer systems into a manageable quantity. It has also described how the architecture is part of a larger framework that provides the company with the means to manage future developments in a more controlled and flexible way.

It is envisaged that use of the architecture will lead to:

- a reduction in the number of operational systems and their interfaces,
- a reduction in data replication,
- increased control of data,
- increased reuse of functionality,
- standardised interfaces,
- lower costs,
- quicker delivery, and
- higher quality.

Acknowledgements

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Simon Pyzer
BT Networks and Systems

Simon Pyzer graduated with a degree in Engineering and Electrical Sciences from the University of Cambridge in 1973. He worked for Texas Instruments before joining BT in 1974, working initially at the BT Research Laboratories on metal-oxide semiconductor development. In 1979, he moved to work on the System X exchange programme, working on the early data builds for the first digital exchanges. Responsibilities included the development of data-build and data-management tools, frame management and early development of the operations and maintenance centre (OMC). In 1991, he was seconded to work with the Network Operations team within the Strategic Systems Plan unit, later becoming the Process Management unit, developing a model of BT's operations. He was then seconded to the Breakout project in 1994, where he was a member of the team that developed the OSS architecture. He is now responsible for the management and application of the OSS architecture described in this article.

Philip Williams
BT Networks and Systems

Philip Williams graduated in Mathematics and Computer Science from London University and joined BT in 1986. For five years, he worked on the planning, implementation and support of computer-based systems for the international telephone service. He gained a Diploma in Management Studies in 1990. Since 1991 he has been involved in the planning and evolution of computer systems, initially concerning network control and operations, later for the broader support of activities in customer, service and product management. Currently, he is an analyst in Computing Systems Architecture and Evolution. He is a Chartered Engineer and a Member of the British Computer Society.

Diane Richards
BT Networks and Systems

Diane Richards joined the Post Office in 1969 as a computer programmer working on telephone billing and customer rental records before moving on to lecturing on programming. She then worked for Real Time Control and Rank Xerox both as a programmer/analyst and as a project manager. Much of her time at Rank Xerox was spent in producing and implementing the results of strategic studies within the data administration area with a view to assisting the development of information systems. She returned to BT National Networks in 1984 and worked as a project manager for the development of the lines planning computer system before becoming involved with Total Quality Management as a facilitator and trainer. Since then she has been involved with data management in the company, managing various projects relating to the identification of master reference data sources, data security, production of manuals about data management and the development of the data architecture. She has acted as an advisor on several boards which were responsible for data management in various business areas. In addition, she was seconded to Breakout for work on custodianship of data, and the responsibilities involved, and data quality. She is now responsible for the BT data architecture, its application and the use of the data quality process.

Lorraine Margherita, Mike Parry and Mick Saunders

35th European Telecommunications Congress

'Multimedia Services on the Telecommunications Networks of Europe' was the theme for the stimulating 1996 FITCE Congress in Vienna. This article, which summarises the congress programme, serves as an introduction to a small selection of articles based on papers from the congress.

Introduction

'Multimedia Services on the Telecommunications Networks of Europe' was the theme for the 1996 congress of the Federation of Telecommunications Engineers of the European Community (FITCE), held from 27 August to 1 September 1996 in the beautiful and historic city of Vienna. The congress was hosted by the Austrian telecommunications industry and the Association of Austrian Telecommunication Engineers (VAPT) and attracted some 450 delegates from all over Europe.

Technical Sessions

The congress theme stimulated a wide range of papers covering various aspects of the service, technology, application and regulation opportunities being addressed by telecommunications companies throughout Europe.

Introduction to multimedia

The first session, chaired by Andy Valdar of the UK, included a number of papers which helped delegates understand a common definition of multimedia services. Professor Peter Cochrane from BT opened the session with a keynote speech in which he discussed the confusing definitions of the 'Information Superhighway', and defined the technical needs and the fields of application for telecommunications in the future. Klaus Dieter Eckert (Alcatel SEL AG) showed that PCs seem to be bound to replace TV in the next few years, because of the development of Internet. Regarding market orientations, closed solutions provided to homes prevail, and users favour information about their local community. John O'Sullivan (Telecom Eireann) stressed the various factors in the commercial success of interactive services combining several media; he mentioned the methods to address competition, market demand, technological development and standardisation issues.

Leonardo Chiariglione (CSELT) introduced the notion of *middlemen*, defined as organisations operating information technologies. The evolution of technologies should reduce the influence of these middlemen, and allow direct communications, producers and consumers of information are bound to be actors in the information value chain, and allow the global information infrastructure to be driven by the users' needs. Demosthenes Soulis (OTE) distinguished three types of multimedia services: communications comprising voice and image, data retrieval services and messaging services. Technical and commercial factors will influence the development of technologies and services, providing opportunities for each segment of the telecommunications industry. Finally, Inma Rodríguez Serrano (Telefónica) shared her experience in the development of multimedia services through a hybrid fibre coaxial (HFC) network. This allows analogue and digital cable TV and on-line services, and may be adapted to provide video-on-demand (VOD) or telephony services. The implementation of fibre-to-the-curb switched digital video (FTTC/SDV) architectures is an alternative to the upgrading of HFC networks.

Lorraine Margherita is a research associate of Prométhée, a Paris-based organisation.

Mike Parry, BT, is publicity secretary for FITCE UK.

Mick Saunders, BT, is membership secretary for FITCE UK.

Field trials

The issue of field trials tackled in later presentations of the first session introduced the second session, chaired by Anton Greiner of Austria, which was dedicated to trials of multimedia solutions and services launched in several European countries. Emilio Cancer (Telecom Italia) introduced Italy's interactive multimedia trial, while Marco de Grandis (Telecom Italia) explained the specificities of the SOCRATE project; that is, the 'Optical-Coaxial Development of Telecom Italia Access Network'. Alec Livingstone (BT Laboratories) described the British interactive television trial launched in October 1995. Christian de Rubercy (France Télécom) explained the 13 year story of the French videotex, Minitel. Geert de Jonghe (Belgacom) explained Belgium's Tectris project; that is, the 'Technical Trial for Interactive Services'. Alexander Ristic (Siemens AG Österreich) showed the Austrian cooperation between network operators, manufacturers, information technology suppliers, software companies and end users from various industries, in the ground project named 'Computer-Supported Collaborative Work' (CSCW).

Applications and implications

Applications and implementations were featured in the papers presented in the third session, chaired by Herbert Schneider of Germany. Helmut Leopold (Alcatel Austria AG) stressed that multimedia services should not only target households, but also corporations and institutions, be they public or private. The results of such an action come faster than on the private markets. F. J. Moreno (Clínica Puerta de Hierro) introduced two medical applications of the Cph_Hypermed system: one is clinical, the other is educational. Both are based on the creation and exchange of interactive electronic documents. Fofy Setaki (Intracom) emphasised the news delivery system of a personalised news-on-demand service implemented by his company in Greece. Cooperation with news providers is all the more relevant to such a customised service. Francisco Fernandez Masaguer (University of Vigo, Spain) analysed the systems attempting to offer secure electronic payment for the delivery of linear or interactive information services: digital cash, credit debit, credit card systems are possible. Their requirements (authentication, etc.) are the conditions of their specificities and protocols. M. Marcon (CSELT) showed how Telecom Italia has seized the opportunity to play the role of network provider for multimedia developments, by explaining the target architecture it has designed, as well as the first two steps of implementation of its network management. Illustrations are provided with the synchronous digital hierarchy (SDH) transport network and the HFC access network cases. Nikos Pronios (Intracom) ended the session by stressing the work on standardisation in broadband services. The thinking involved several viewpoints, especially in the definition of accurate services. Infrastructures and access networks also enclose various solutions.

Multimedia strategies of the European PTOs

The multimedia strategies of European incumbent operators was the subject of the next session, chaired by Antonio Como of Italy. Guillermo Villarino Martín (Telefónica) showed that the HFC network architecture of the Spanish operator encounters two questions: the return channel is a condition to the development of interactive services, and to the integration of traditional services, while the set-top box is the key to the adaptation to one or several markets. Nico Baken (PTT Telecom) stressed that the existing telephony or cable TV networks are available for new services. He explained the implementation of fibre in the local loop, as well as the development of asynchronous transfer mode (ATM) and broadband services. He described *Plantool*, which helps design the number and location of primary access network (PAN) nodes, the service area of PAN nodes, as well as the fibre routeing and the number of fibres per node, in a given location. Anton Greiner (Post und Telekom Austria) also argued that telephone and cable operators should develop multimedia services by using their existing infrastructures, and by converging. PTA has chosen to be a service provider, and will launch a trial involving 'friendly customers' and employees in order to design costs and services for the future.

Stephan Breide (Deutsche Telekom) described the activities of DT in multimedia services and interactive television: business applications, on-line services with T-Online, interactive video services pilot projects, as well as research and development work. He stressed that technical specificities will not attract consumers: those will choose relevant applications and services. João Carlos Carvalho (Portugal Telecom) summarised the risks and opportunities to enter multimedia activities, and presented his company's experience; a trial will be launched in May of 1997 in order to test the operator's ability and position in multimedia services and applications. TVCabo Portugal will contribute through the use of its fibre/coaxial network. VOD and Internet access will thus be tested in the first stage, then more households will be involved, and then a wider range of services will be tried. Finally, Isabel Tibbitts (Arthur D. Little) provided insights into the market forecast and evolution. Cost issues will drive the development of various multimedia and communications systems. Moreover, too many actors and actions are involved in the development of the information superhighway to allow a revolution; multimedia will rather evolve through the observation of the markets, the cooperation and the competition between the actors involved.

Trends in regulation and standards

Opening the next session on regulation and standardisation trends, chaired by Niko Manassis of Greece, Konstantine Moustakas (OTE) presented the content and impact of the regulation on telecommunications in Europe and in Greece, and emphasised the social role of the incumbent operators. Gerard Braam (IBM Europe) argued that regulations should evolve along with the technological and commercial trends driving telecommunications, and be 'technique independant' as techniques and industrialists converge. Rob Koenen (KPN Research) shared his experience of MPEG standards, as MPEG 4 is being prepared. It is based on the Syntatic Description Language, able to deal with audio and video contents in an interactive way. MPEG 4 will be launched in 1998.

Preparing the access network for multimedia

The next session, chaired by Herbert Philipp of Austria, dealt with the access network issue. Hans-Erhard Reiter (Ericsson Austria) said he believed that telecommunications operators have to get ready to provide multimedia services, and thus to think twice about their access network possibilities—and 'turn copper into gold'. P. di Martino (Sirti) discussed the various technical solutions for access network architectures: the integrated HFC architecture, the hybrid fibre to the building (HFTTB) architecture, and the fibre to the building (FTTB) architecture are compared technically and economically. Fibre appears to be the most strategic solution. Jürgen Rahn (AT&T Deutschland) explained how to implement a flexible and economic broadband network. ATM path routeing is used along with an SDH-based backbone.

Mobility in the multimedia world

Mobility in the multimedia world was the subject of another session chaired by Niko Manassis of Greece. Berndt Eylert (MobilNet) defined the relevant criteria to take into account as the mobile market is developing at a fantastic pace in Europe. David Podmore (BT) explained and illustrated the on-line virtual classroom, using multimedia services to train employees. Francesco Franci (Interproductions Association) brought an Italian example of the same idea, and discussed learning on the Internet.

Internet—a challenger

The Internet was the central issue of the final session, chaired by Herbert Philipp of Austria. Gerd Schnaars (Siemens) explained the ATM network architecture for the Internet and its specificity: virtual routing. Johan Pirot (Alcatel) discussed the keys to the development of on-line services (OLS): the marketplace, multimedia applications, network requirements. He discussed the role of the Internet as a future OLS network. Ciarán Treanor (Broadcom Eireann Research) shared his thinking about the Internet, its applications and its protocols. As a conclusion, he stated that Internet protocols will be independant from transport technologies.

Closing panel

The paper sessions were concluded by a closing panel of distinguished representatives from a wide range of telecommunications backgrounds: Eugenio Triana Garcia (European Commission, DGXIII), Jos Gerrese (Unisource), Fabio Bigi (ITU), Bob Foster (BT), Jean-François Latour (France Telecom) and Volker Steiner (Deutsche Telekom). The panel reviewed the week's technical sessions and discussed how the growth in multimedia technologies and services presented both challenges and opportunities for the telecommunications companies in the global marketplace particularly from a customer perspective of 'one-stop' shopping.

Congress Awards

As recognition of the high standard of technical papers and presentation by the delegates, two congress awards were made at the end of the proceedings. The Best Paper Award 1996 went to Dr Nico Baken of PTT Telecom Netherlands for his paper 'From Copper to Fibre, from PDH to SDH/ ATM, from POTS to Interactive Multimedia Services'. The award for the Most Promising Young Engineer 1996 went to Inma Rodríguez Serrano of Telefónica Spain for her paper 'Evolution of a HFC Network to Offer Multimedia Interactive Services'.

Study Commission

A report back to the congress on the progress of the study commission investigating the personal development of telecommunication engineers was given by Mike Saunders at the General Assembly on the last day of proceedings. The study commission chaired by Les Brand of FITCE UK is investigating how FITCE can better serve and add value to its membership within the context of a rapidly changing European telecommunications market. The study commission had completed its first year of study from which a number of opportunities were identified for further development.

Conclusion

The 35th FITCE congress provided a stimulating and thought provoking venue for focusing attention on multimedia and the impact it is having on the traditional telecommunications market. As well as the technical presentations, delegates also had the opportunity to enjoy a programme of technical visits and social and cultural events.

The 1997 FITCE congress will be held in Thessaloniki, in Greece, the theme being 'Emerging Opportunities in Telecommunications at the Dawn of the New Millenium' (see inside back cover). In 1998, the congress will be held in the UK and it is expected that the 1998 opening of European telecommunications markets will form the basis of the conference theme.

Nico Baken

From POTS to Interactive Multimedia Services

While many interactive multimedia applications can be realised by using existing copper networks, a full range of services requires the use of fibre, and synchronous digital hierarchy and asynchronous transfer mode technologies. This article examines the strategy adopted by PTT Telecom in the Netherlands.

Overview

A range of interactive multimedia applications can be realised using existing networks. To access these applications, the current access network of the telecommunications or CATV operator is available. The transport medium is mostly copper—twisted pair and coaxial; the transfer modes in general are plesiochronous digital hierarchy (PDH) and analogue techniques such as amplitude-modulated vestigial sideband (AM VSB). However, to deploy a full range of interactive multimedia services (narrowband as well as broadband), fibre must be deployed with synchronous digital hierarchy (SDH) and asynchronous transfer mode (ATM) as the transfer modes. This certainly does not imply fibre to the curb/home and SDH/ATM in all parts of the access network as the solutions for today. This paper presents both the roll-out of fibre in the local loop by PTT Telecom and the stepwise roll-out of ATM and broadband services as a coordinated action, paving the way for the migration from separate public network operators (PNO)s for POTS (plain old telephony service) towards an AT&T Unisource Alliance full service provider.

Fibre In The Local Loop

Summary

An optical-fibre access network, comprising *fibre city rings*, has been introduced in the Netherlands as an optical overlay network in the primary part of the access network. The rings are rolled out using blueprints in which market information and topographic data are incorporated. The timing of implementation of the blueprints is market driven. Today the triggers for roll-out are mainly determined by business customers, but the blueprints are such that residential customers can benefit when multimedia services come to penetrate this market segment. Following the vision, strategy, policy and design stages, the actual roll-out started in 1995. The guidelines used to design the blueprints of the primary access network are implemented in a sophisticated computer tool. The architecture consists of 3–5 optical-fibre rings per local exchange area (LEA) with enlarged availability through *dual routeing*. These fibre city rings of different LEAs are coupled if the market requires the *dual parenting* feature. Currently, blueprints are available covering all major cities in the Netherlands. Thus, PTT Telecom is bringing fibre close to both business and residential customers.

Introduction

In 1991, within the strategy department of the Network Services Business Unit of the Dutch PTT Telecom, the first draft of a strategy for the introduction of fibre in the local loop was developed. Because fibre to the home was still an unrealistic goal, the target was to install fibre in the primary access network (PAN) according to market demand. This resulted in a master plan in 1992 stating that optical-fibre solutions in the access network needed to be found that served the changing needs of business customers from 1995 onward. This would create a basis for providing residential customers with new multimedia services from 2000 onward. The PAN

This article is based on a paper presented by the author at the 35th European Telecommunications (FITCE) Congress, 27 August–1 September 1996, Vienna. The paper won the Best Paper award.

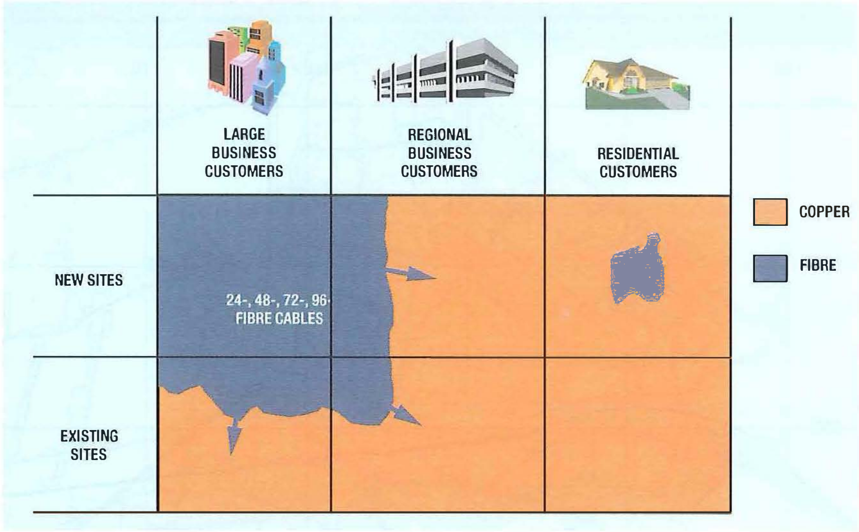


Figure 1 – Market-driven roll-out with focus on large business customers

project started in 1992; commercial, technical and operational guidelines were designed within some 14 project groups by 1993. In 1994, on the basis of the guidelines, the blueprints of the optical-fibre rings for the primary access network were produced using a sophisticated computer tool, pilots were executed and the guidelines expanded and tuned to the findings in the pilots. Thus, all preparations were in place for a major roll-out in 1995.

However, the large-scale introduction of fibre in the access network is having a major impact on all parts of the organisation. Firstly, the position of PTT Telecom on the Dutch market is rapidly changing through liberalisation and competition so that broadband services for business customers are becoming cheaper, better quality and easily available. These factors obviously affect the commercial departments. Secondly, the technical structure is completely new for the technical departments, although the local exchange service areas are (as yet) not affected. For over a century, these departments have used a copper vocabulary for thinking, planning and working. The new network structure is a fibre ring, not a star structure, with access nodes for 500–4000 (future) customers. Thirdly, all major processes (administration, maintenance and provisioning) are affected by commercial and technical changes. By involving people from the operational districts in every stage of the project, the organisational/operational change has been anticipated and accommodated. These commercial, technical and operational aspects have all had equal attention in the planning process to ensure a smooth roll-out; they are considered further below.

Commercial aspects

PAN is a market-driven concept. Within the blueprints, all current market information and market prognoses are incorporated; the local marketing departments collect the market data and present the data in a certain format to the planning departments of the telecom district. The actual implementation of a PAN network, that is, the transformation from blueprint into an existing optical-fibre network is predominantly triggered by the market demands of large business customers (Figure 1). PAN is able to cope with present and future demands of all business customers. However, its design allows the addition of new generations of transmission equipment so that residential customers can be served as well. Currently, residential customers are connected only under specific conditions.

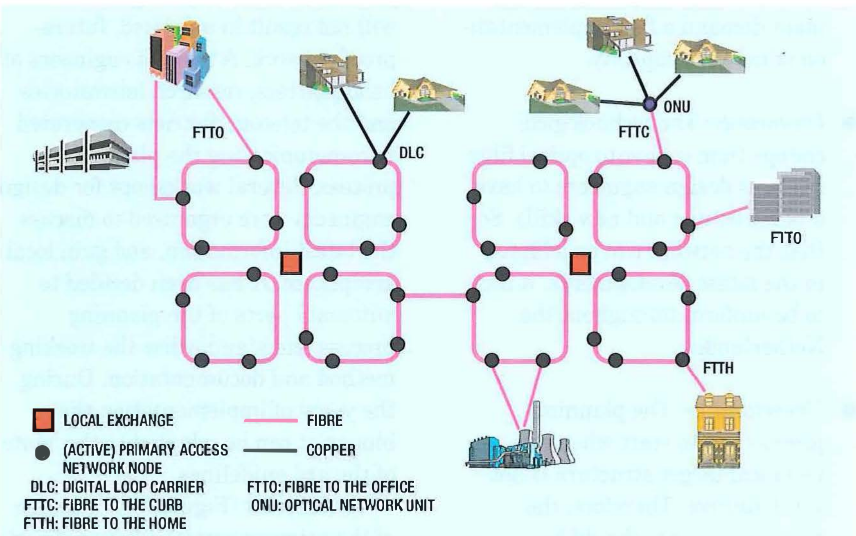
Technical aspects

The following technical aspects are considered: the network architecture, the planning and designing, the outside plant and housings, the construction guidelines, the selected (transmission) equipment and powering.

Network architecture

Many network architectures have been studied. The principal criteria for the architecture were the demands for availability, flexibility and costs. Importantly, the network had to be future-proof and able to serve any future multimedia service both for business and residential customers. Finally, ring structures were chosen, with 3–5 rings in each LEA (Figure 2); a fibre-poor concept was adopted which provided sufficient fibres for today's needs but also the flexibility to upgrade. Each ring can comprise up to 200 fibres. In each ring, 5–7 access nodes are installed where the secondary network starts to connect to the customers. With the ring architecture, enlarged availability is ensured through dual routeing; the rings of different LEAs are coupled if

Figure 2 – PAN network architecture



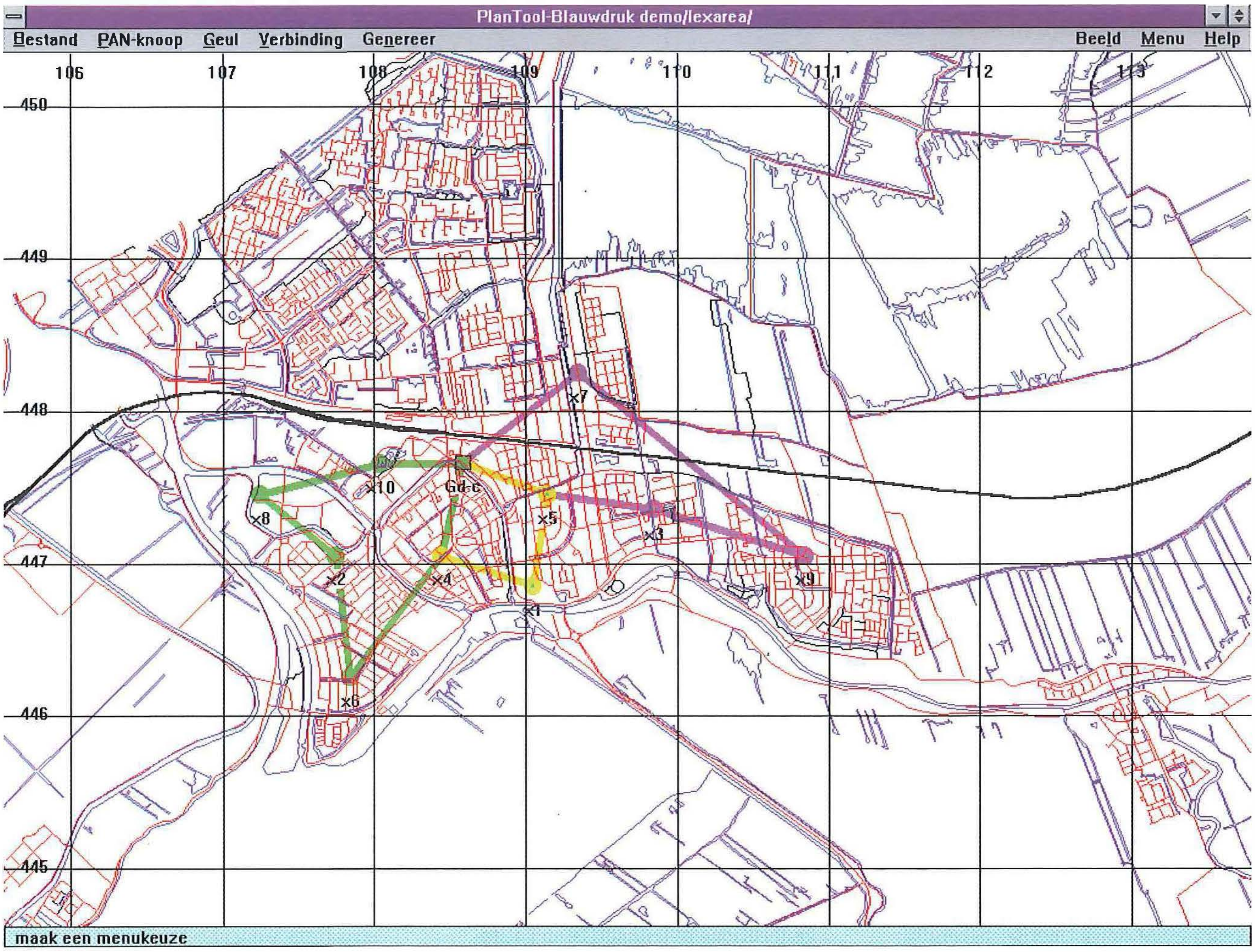


Figure 3—Blueprint of a local exchange area

the market requires the feature of dual parenting.

Planning and design process

For several reasons, the PAN-project requires changes in the planning process:

- *Time to market*: New services (for example, multimedia, distributive services) in a competing environment demand a fast implementation of network capacity.
- *Uniformity*: The technological change from copper to optical fibre requires design engineers to have a new attitude and new skills. So that the network can be adapted to the latest developments, it has to be uniform throughout the Netherlands.
- *Uncertainties*: The planning process has to start when the technical target structure is not yet definitive. Therefore, the planning process should be flexible and the use of outdated information is a real threat.
- *Costs*: Both the investments and the operational costs of the network will be high. Design errors can have substantial financial consequences for the life cycle costs of the network.

The points stated above show that just communicating the guidelines will not result in a desired, future-proof network. A team of engineers at headquarters, research laboratories and the telecom districts cooperated in communicating the planning process. Several workshops for design engineers were organised to discuss the latest information, and gain local acceptance. It has been decided to automate parts of the planning process and standardise the working method and documentation. During the years of implementation the blueprint can be adapted to the 'state of the art' guidelines.

A blueprint (Figure 3) is a design of the primary optical access network in a local exchange area. It serves as a basic architecture to realise individual projects. To support design, *PLANTOOL* has been developed. PLANTOOL is a computer tool which couples general guidelines and actual design. It contains:

- a geographical background;
- cost optimisation, using local market and technical information; and
- structure editing facilities.

The outside plant and housings

The average length of a ring is just over 7000 m. Optical-fibre cables with 24, 48, 72 or 96 fibres are used depending on the market demand. For more details see Reference 1.

The transmission devices and powering

The PAN nodes can be 'passive' if they are used only as a manipulation point for fibre connections, as is the

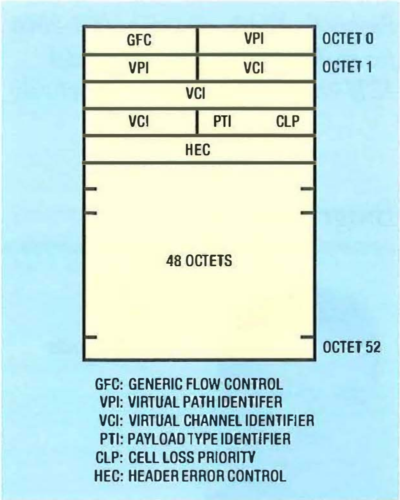


Figure 4—The ATM cell

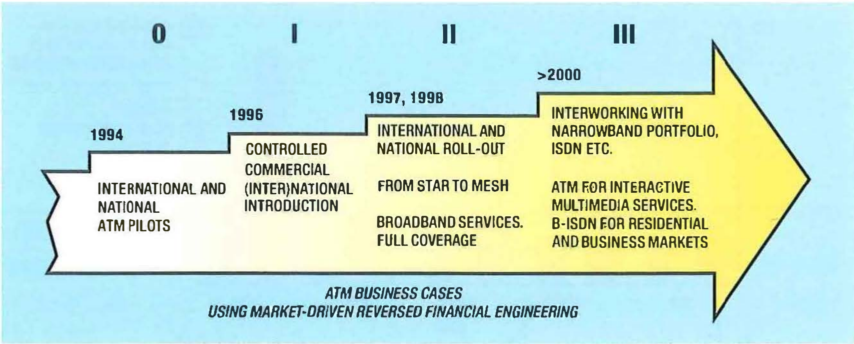


Figure 5—Four phases of ATM

case with fibre to the office (FTTO). In other cases, devices such as access multiplexers and line sytems are installed. In each node, the primary powering is provided using the facilities of the regional power company; for more details see Reference 1.

Operational aspects

Among the operational aspects included are education of the workforces, organisation, administration, network management, provisioning and maintenance. For details see Reference 1.

ATM and Broadband Services

Introduction

Asynchronous transfer mode (ATM) is a cell-switched connection-oriented technology that has been selected worldwide to enable the broadband integrated services digital network (B-ISDN). Standardisation of ATM is taking place within the International Telecommunications Union (ITU), the ATM-forum and European Telecommunications Standards Institute. The asynchronous character of ATM removed the need for specific time-slots for each user. This is made possible through the use of ATM cells, which contain 53 octets, five of which build the cell header (see Figure 4).

ATM has been designed to enable full service providers to support transparently present and future services. Interactive multimedia services comprising voice, data and video are integrated within a single network. Although today no big revenues are expected and no real killer application exists, customer expectations of ATM are high; especially, large business customers who expect that this technology will provide cheaper solutions for flexible provisioning of bandwidth and interoperability. These customers are demanding that network operators have ATM technology in their portfolio to guarantee future-proof solutions. This is why the Unisource Alliance feels it is compulsory to plan the introduction of seamless ATM-based services, especially since the competition is moving forward quickly. To speed up the implementation, it is necessary to study whether an already existing platform can be used and combined with other ATM developments. Simultaneously, a stepwise roll-out is planned of a common ATM platform and broadband services as a coordinated action within the Unisource Alliance, paving the way for the migration from four separate public network operators (PNOs) for POTS towards an Unisource Alliance full service provider. Obviously, national plans must be in line with this migration.

Evolution of ATM and ATM-based services

In 1991, several European operators assessed the feasibility of trialing ATM technology and the available ATM standards. Their goal was to accelerate the development of the technology and see whether ATM-based services could be offered in a multi-vendor situation and internationally in a multi-operator environment. In the end, 17 operators from 16 countries participated. The pilot ended in December 1995. As a derivative of the international European pilot, national pilots were conducted. This was also the case for the four operators of the Unisource Alliance. In addition, PTT Telecom set the goals to obtain practical experience with ATM technology and understanding the market. With the ending of the pilot, phase 0 of ATM has been finalised and a commercial first phase of ATM-based services started. In phase I, the motivation to roll ATM as a technology is triggered by the business market, requiring ATM broadband services like high-speed inter-LAN, circuit emulation and frame relay interworking; a basis for these services is formed by ATM virtual path bearer services. With the installation of an ATM overlay network in the coming five years for the introduction of broadband services for business customers, the operators will quickly discover the high efficiency of ATM on their trunk network. Thus, in addition to a market-driven roll-out, the roll-out will be accelerated by a need for cost reductions. This can be regarded as phase II: market and technology driven roll-out to generate new revenue streams and reduce the costs respectively. As such, the ATM network will gradually bear a substantial part of the traffic and impact upon the existing infrastructure. It is then that phase III will emerge. The ATM platform will become the B-ISDN platform and interworking with narrowband services will occur. The four phases of ATM are depicted in Figure 5. The speed with which each step is taken must be motivated by both strategic motivations and business cases.

Phase II, Cost Reduction

It is well known that through the synchronous digital hierarchy (SDH),

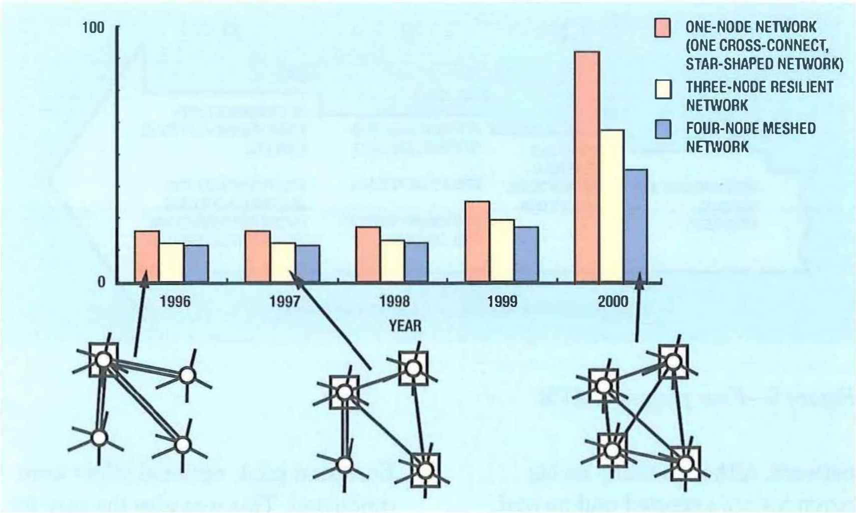


Figure 6—Yearly costs for 1996–2000 for an ATM trunk with 1,3, and 4 ATM cross-connect nodes respectively

large cost reductions can be obtained in both trunk and access networks compared to the plesiochronous digital hierarchy (PDH). This is in addition to increased management capabilities and quality improvements. It has been proven that, under the assumption of a certain increasing demand, the roll-out of an ATM overlay network using SDH for transmission is cost efficient, see Figure 6.

Conclusions

A range of interactive multimedia applications can be realised by using existing networks. To access these applications, the current access network of the telecommunications or CATV operator is available. To deploy a full range of interactive multimedia services (narrow as well as broadband) however, fibre must be deployed with SDH and ATM as the transfer modes. This certainly does not imply fibre to the curb/home and SDH/ATM in all parts of the access network as the solutions for today; in the last mile, several solutions will be implemented depending on the local commercial (market), technological and operational situation. This article presents both the stepwise roll-out of fibre in the local loop by PTT Telecom (starting with a fibre-to-the-zone concept), and the stepwise roll-out of ATM and broadband services as a coordinated action paving the way for the migration from separate PNOs for POTS towards an AT&T Unisource Alliance full service provider.

Acknowledgement

The author wishes to thank and acknowledge all collegues who contributed directly or indirectly to this article, especially C. Lavrijsen, A. van Uitert, M. Hooijkaas, L. Glimmerveen, the KGTS-, IPSB-ATM, ATM-UTN and ATM-workteam members.

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Biography

Nico Baken
PTT Telecom
The Netherlands

Nico Baken obtained an M.Sc. degree in Mathematics from the Technical University of Eindhoven in 1981. In 1982, he joined the PTT Research Neher Laboratories, where his main research interest concerned the propagation characteristics of integrated-optical waveguides embedded in stratified media. He was involved in the European research project COST 216—'Optical Switching and Routeing Devices', and the project RACE 1019—'Polymeric Optical Switching'. Since April 1991, he has been working at PTT Telecom and is the project manager for the development and implementation of a fibre-in-the-loop scenario in the Netherlands. In 1995, he was asked to prepare the introduction of ATM through organising the ATM programme. He is also responsible for coordinating ATM activities within the Unisource Alliance. He has been a member of the Integrated Network Architecture task force that developed a portfolio model for PTT Telecom, and was also involved in the Vision Access Network taskforce. Within Unisource (Telia, Swiss Telecom and PTT Telecom), he was responsible for the Access Network project.

Inma Rodríguez Serrano

Evolution of a Hybrid Fibre Coaxial Network for Multimedia Interactive Services

This article describes the evolutionary stages that a hybrid fibre coaxial cable television (CATV) network may undergo to become a multimedia network, offering a wider choice of services. A network that offers analogue TV can be upgraded to offer digital near video on demand (NVOD) and VOD, on-line services and telephony. As a final target a fibre-to-the-curb (FTTC) switched digital video (SDV) network is proposed.

This article is based on a paper presented by the author at the 35th European Telecommunications (FITCE) Congress, 27 August–1 September 1996, Vienna. The author won the Most Promising Young Engineer award.

HFC Network for Analogue CATV Transmission

Figure 1 presents a typical hybrid fibre coaxial (HFC) network, with a fibre star point-to-multipoint subnetwork and a tree-and-branch coaxial subnetwork. The headend receives, modulates and transmits the cable television (CATV) channels towards the optical network units (ONUs), where they are converted back to the electrical domain and sent to customers over the coaxial network.

Some intermediate points (the access nodes or distribution hubs) between the headend and the ONUs have been introduced. These are equivalent to the local exchanges of the telephone companies and will probably be the points where new equipment for the transmission of new services will be placed.

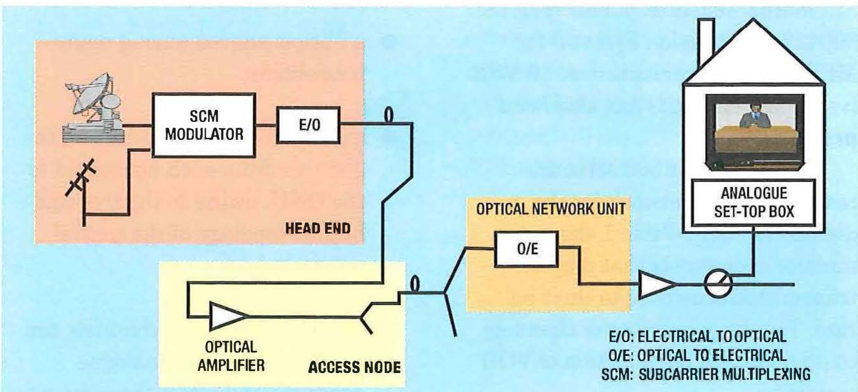
Channel transmission is made using analogue subcarrier multiplexing (SCM): each TV channel is modulated on a different radio-frequency (RF) carrier, usually between 50 and 550 MHz, though we shall here consider a 862 MHz network. A return path with limited bandwidth will be available. We shall take as an example a 1550 nm network where optical amplification can be used.

During network planning and design, the extent to which fibre is deployed within the network is extremely important. The closer to customers' homes that fibre reaches, the greater the number of services that can be offered, as the analogue bandwidth available will be shared among fewer subscribers. Network operators are choosing 500 homes served per ONU as the most cost-effective option that at the same time allows for the introduction of new services.

HFC Networks for Digital Video Services

The type of HFC networks previously described have been designed for the transmission of a limited number of analogue channels, offering CATV services and, in some cases, pay per

Figure 1—HFC network for analogue CATV



view (PPV) and limited near video on demand (NVOD) (in analogue format).

If the operator wants to increase the number of channels offered, the bandwidth is soon exhausted. Converting the signals to digital and using compression algorithms to eliminate redundant information allows a greater number of channels to be transmitted in the same bandwidth, so that new services like NVOD and video on demand (VOD) can be introduced.

The International Standards Organisation (ISO) has adopted MPEG2 (Moving Picture Experts Group) as the standard for video signal compression. These techniques achieve compression ratios ranging between 10:1 and 200:1, depending on the image quality required. They reduce the bit rate to typically 1·5 Mbit/s or 2 Mbit/s for VHS quality, 6 Mbit/s for broadcast quality and 20 Mbit/s for high-definition TV (HDTV) quality. The compressed digital channels are modulated on RF carriers placed in free spectrum left by the analogue channels; for example, between 550 MHz and 860 MHz.

The number of digital channels that can be transmitted within a 8 MHz analogue channel depends on the modulation used and on the bit rate at which the channels have been compressed. The modulation technique that is most commonly used is quadrature amplitude modulation (QAM) (usually 64 QAM), that has been selected by the European Telecommunications Standards Institute (ETSI) (prETS 300429, Multivision System) for MPEG2 video transmission. 16 VSB (vestigial sideband) has also been proposed.

For example, if 300 MHz are reserved in the network for the digital channels, Table 1 shows the number of channels that may be transmitted according to their bit rate. This large number of channels could allow the introduction of VOD services.

Table 1

MPEG	64 QAM (no. channels)	16 VSB (no. channels)
1·5 Mbit/s	850	1150
3 Mbit/s	450	600
4 Mbit/s	300	450

Broadcast digital CATV can be easily added to the network using MPEG encoders and QAM or VSB modulators at the headend and transmitting them on free RF carriers.

Interactive video services can also be provided. To analyse the upgrades needed in the HFC access network, a VOD service will be taken as an example. The films in MPEG2 are stored in a video server and retrieved through the HFC access network only when a customer selects one of them. Databases will keep customers' access authorisation, usage patterns, etc. An access service controller will receive requests from users, retrieve films from the server and send them to the appropiate access node. It also receives and handles the rewind, pause and fast-forward orders.

Upgrades on the HFC network to offer VOD

HFC networks were originally designed to offer broadcast services, and the goal is to adapt them to become interactive bidirectional broadband networks. This adaptation presents some problems:

- limited bandwidth, especially on the return path;
- a fibre is shared among many households;
- quality of service depends on the distance from each household to the ONU, owing to the tree-and-branch topology of the coaxial network; and
- the digital MPEG2 channels can interfere with the analogue channels and affect the carrier-to-noise ratio (CNR) at the coaxial subnetwork.

The following upgrades will be necessary in the network:

Upgrades on fibre network:
The HFC network has a passive optical network (PON), with two active fibres, one for each direction of transmission. When adding new services, two options are possible:

- full integration, using the same fibres; and
- using one of the dark fibres for the transmission of the new services downstream.

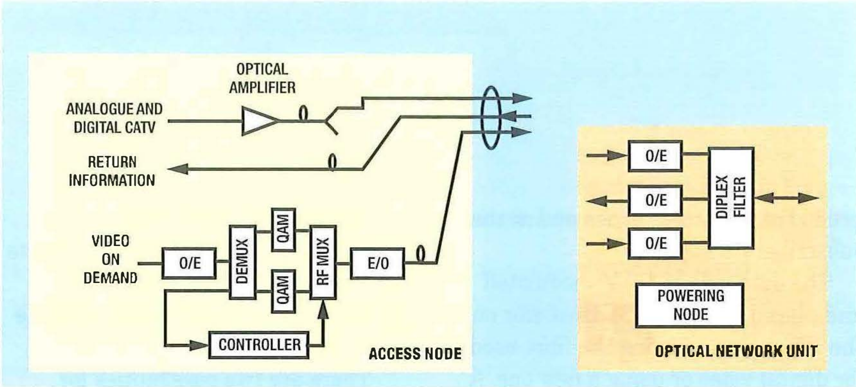
Though it is a question not yet resolved, the second option is the best positioned now, as it does not oblige the operator to use high-bandwidth lasers and multiplexers from the beginning. It also avoids the problems that the addition of digital channels produce on the analogue ones, like interference and problems related with a too high optical modulation index (OMI). Using a separate fibre to reach the ONU also means that the available bandwidth for interactive services is only shared among the homes passed by this ONU. Traffic calculations show that the traffic for an ONU serving 500 homes can be handled within the available bandwidth.

Upgrades on coaxial network
If the coaxial network was not designed to transmit the bandwidth that is now needed (862 MHz), some of its elements might have to be replaced or upgraded.

Because of the limited coaxial bandwidth, traffic calculations must be made to find how many simultaneous requests can be met. The new services might make it necessary to extend the fibre closer to the subscribers and modify the coaxial network.

To calculate the number of simultaneous requests (number of

Figure 2—VOD on HFC networks



simultaneous downstream signals), Erlang-B can be used. As an example, we shall consider an HFC network where 200 MHz has been assigned for the downstream transmission of VOD movies, and where these 3 Mbit/s movies are 64 QAM modulated. Each 8 MHz channel will then contain 13 videostreams, so that in the 200 MHz a maximum of around 260 streams will be transmitted.

The data to be used for the traffic calculations are:

- Blocking probability = 1%.
- Films are 2 hours long.
- Each home orders an average of 1·5 films per week.
- The service is offered only 7 hours per week.

With these assumptions we find that with a maximum of 260 'circuits' (videostreams), the maximum number of households that can be served simultaneously is 530 (we are assuming that the fibre network has a point-to-point topology). If we have a HFC network with 500 homes per ONU, and taking into account that only a small percentage of them will subscribe to the service, 530 simultaneous videostreams will be adequate.

New network elements

We shall assume that we have a basic HFC access network as shown in Figure 2, where the digital VOD channels reach the access node using a fibre transport network. To handle the new services, some new elements must be added at the access nodes, at the ONU and at the homes. We shall consider the case where a separate fibre is used for the digital interactive channels in the downstream and the upstream fibre is shared for all services.

Also, we shall assume that the new channels come from the access service controller time multiplexed in baseband using a transport network based on synchronous digital hierarchy (SDH) and asynchronous transfer mode (ATM) technologies. At the access node, the SDH signal is demultiplexed and the ATM cells are converted back to the MPEG format (adaptation layers AAL5 or AAL2), to enter the QAM or VSB modulators. The access service controller also sends information about assignment of the VOD channels within the available bandwidth, so that each set-top box (STB) will know the RF carrier and the channel that has to be decoded.

To the CATV ONU we shall add new optoelectronics for the fibre that transmits the digital VOD and introduce the electrical signals into a diplex filter for their transmission towards the coaxial network.

Each customer will need a digital STB, capable of decompressing and demodulating the digital channels.

Return channel for HFC networks

The following upstream signals must be transmitted:

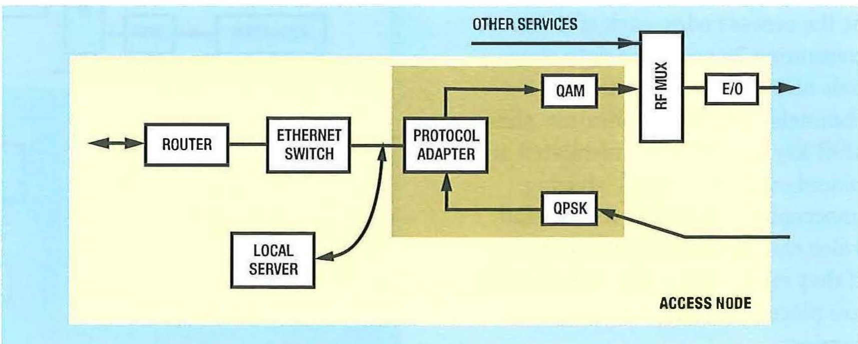
- alarms, supervision signals (coming from the ONUs and access nodes to the access service controller); and
- control signals for VOD/PPV services (requests of services, interactive orders for VCR functionality: rewind, fast forward and pause).

The upstream band occupies 5–40 MHz, and the topology of the fibre that is used for the upstream transmission must at best be point-to-point. The upstream signals have a smaller bandwidth than the downstream video, but they are affected by noise and ingress much more. The modulation techniques proposed are 16 QAM, quadrature phase-shift keying (QPSK), and binary phase-shift keying (BPSK). The methods used for multiple access can be time division multiple access (TDMA), frequency division multiple access (FDMA) or code division multiple access (CDMA). Reference 1 considers a combination of TDMA and FDMA or a FDMA system as the most suitable considering the noise present on the return channel and the bandwidth of the transmitted channels.

On-Line Services over HFC

High-speed data services can be offered through an HFC network. Figure 3 shows the network elements

Figure 3—Access node for on-line services



needed at the access nodes and at the subscribers' homes.

The data will be QAM modulated and placed within a 8 MHz carrier on the RF stream, sharing the fibre used for digital video or using a new one. A cable modem will be necessary at each home; they are now being implemented by many manufacturers and offer up to 30 Mbit/s downstream and 768 kbit/s upstream (asymmetric modems) or 10 Mbit/s in symmetrical ones (much faster than the access now available using the public telephone network (PTN) or the integrated services digital network (ISDN). A router will connect the service provider with the data networks including Internet.

For the return path, phase-shift keying (PSK) or VSB modulations have been proposed, and carrier sense multiple access with collision detection (CSMA/CD) might be used, though some modifications over the Ethernet protocol are necessary.

Telephony over HFC Access Networks

British cable operators now offer telephony over their networks to get new revenues and to attract new customers to their cable service. This is offered using separate networks that run parallel to the CATV network using the same ducts.

However, telephony service integrated on HFC networks has been proposed by many manufacturers and there are plans for trials worldwide. A possible implementation of the service over the HFC network is now briefly described.

E1, 2 Mbit/s links will be received at the access nodes, each of them containing 30 voice and data channels at 64 kbit/s. Then, these E1 channels are offset quadrature phase-shift keying (OQPSK) modulated and placed over RF carriers (sharing unoccupied bandwidth with digital video channels, high-speed data, etc. if they exist). The upstream channels are placed within free 5–40 MHz carriers.

The system can have its own switches placed at the access nodes to provide switching for local calls between subscribers belonging to the same access node.

There are two possibilities for bidirectional transmission:

- Using fixed assignment, where each customer has a permanent time-slot within a RF carrier assigned. If the operator wants to transmit, for example, 16 E1 links (480 x 64 kbit/s channels) using QPSK, 24 MHz would be needed. 480 channels will be enough for an ONU serving 500 homes as not all the households will subscribe to the service.

- Concentration, where any free slot is reserved for each connection. This second method, though more complex, increases the number of subscribers that an ONU can serve.

Figure 4 shows the additional elements needed in the system.

Once again, depending on the grade of integration that is to be deployed using the downstream fibres, new active fibres might be needed. In some cases, the downstream telephony services will be inserted into the same fibre as that used for VOD.

In the coaxial network, between the tap and the subscriber's house, a new element is needed to extract the telephony signals and send them to the telephone through a twisted pair. This element is known as the *network interface unit* (NIU).

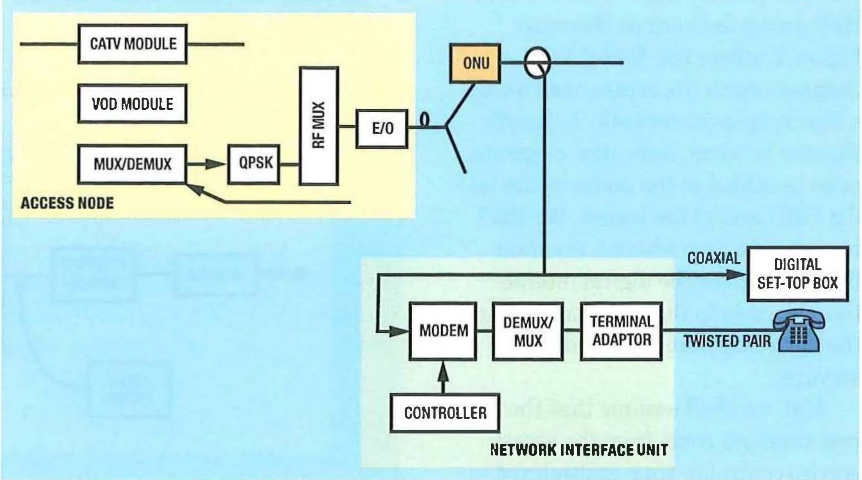
The NIU receives and transmits the composite RF signal, and extracts or inserts the narrowband channels from/to the twisted pair.

All the active elements in the coaxial networks need powering. These are the RF amplifiers and, in the case of integrated telephony, the NIU. The option described places a powering node at the ONU that powers all the elements of the coaxial subnetwork. Another option would be to power the NIUs from each house.

Fibre-to-the-Curb (FTTC) Switched Digital Video (SDV) Networks

The HFC access networks previously described used analogue transmission. It is possible to transmit multimedia services over a fibre-coaxial or fibre-copper network using digital transmission. The services will be time-division multiplexed (synchronously or asynchronously) and the fibre will be extended closer to the subscriber. Using very high bit-rate asymmetric digital subscriber line (VADSL) modems, the interactive video services and the telephony services are transmitted to the homes using

Figure 4—HFC network for telephony



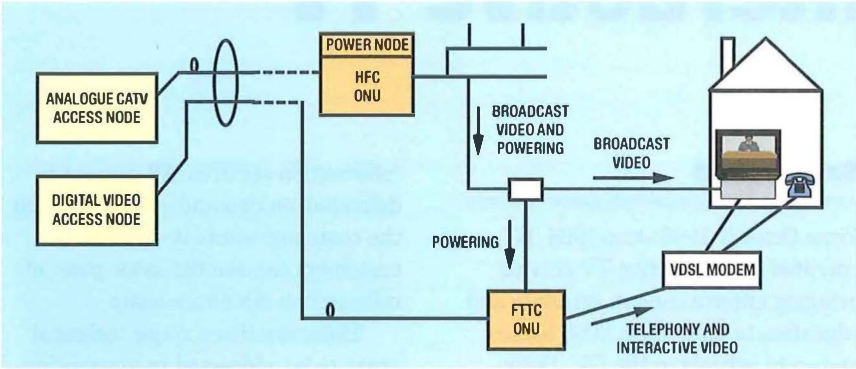


Figure 5—FTTC SDV network with HFC overlay

twisted pairs. The broadcast video will still use a coaxial cable.

For the powering of the ONUs (that are now placed very close to the subscriber) and for the transmission of the analogue CATV channels (for those subscribers not requiring any digital service), an analogue parallel HFC network will be needed[4] (see Figure 5).

The number of homes that a fibre-to-the-curb (FTTC) ONU can serve depends on the maximum distance to which a digital video signal can be transmitted over twisted pair. Using carrierless amplitude pulse (CAP) 16 or discret multitone (DMT), a reach of 150 m has been achieved in laboratory tests.

Conclusions

The final target is the so-called *full service network*, offering all type of bidirectional multimedia broadband services. As has been previously described, this can be achieved by upgrading HFC networks or deploying FTTC SDV architectures.

Evolution will depend on three main factors: demand for new services, regulation and technological advances. The technical advances include getting fibre closer to the subscriber, standardisation of STBs, servers and cable modems, real-time digital coding advances, cheaper equipment, etc.

Though a couple of years ago, VOD seemed to be the killer application that would pay for the expenses needed for the upgrades, today the high-speed data services (especially Internet access) seem to be the applications that will first be deployed.

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Biography

Inma Rodríguez Serrano
Telefónica

Inma Rodríguez Serrano graduated from Universidad Politécnica (Madrid) in 1995, with a degree in Telecommunications Engineering. In 1994, she joined the New Services Development Department at Telefónica, where she started working in the area of design and implementation of HFC networks. In 1995, she joined the Networks and Services Planning Department and she is currently involved in implementing multimedia services over broadband networks, prospecting new services for Telefónica, surveying available equipment and evaluating new business opportunities.

Alec Livingstone

BT Interactive TV

In the summer of 1994, BT demonstrated some of the key elements necessary for interactive home services—in particular the ability to transmit near-broadcast-quality TV pictures using 2 Mbit/s digital compression broadband transmission over normal telephone lines and subsequent reconstruction of the pictures in the home. As a result of that trial, from October 1995–June 1996, BT operated an interactive TV service bringing entertainment, retailing and education to more than 2000 homes and eight schools in the UK. Delivered across normal telephone lines, the system supported almost 150 content providers from Hollywood movie companies to UK charities.

Background

From October 1995–June1996, BT operated an interactive TV service bringing entertainment, retailing and education to more than 2000 homes and eight schools in the UK. Delivered across normal telephone lines, the system supported almost 150 content providers from Hollywood movie companies to UK charities. This article describes the principles of its operation, the system architecture and some of the details of the system development.

The basic principle of BT interactive TV is very simple (see Figure 1). Video content is digitised, compressed and stored on magnetic discs; ordered through a media server; and delivered to the home and reconstructed by a set-top box for display on a normal TV. The customer uses a normal VCR-type remote control to control the selection and display of content—normal motion controls in the case of movies, or function selection in the case of retail or information services. All content is delivered 'on demand'—that is, when the customer wants it—and no two customers can see the same piece of information simultaneously.

There are three major technical areas to be addressed in attempting to build such services:

- network capacity,
- server capability, and
- customer terminal equipment.

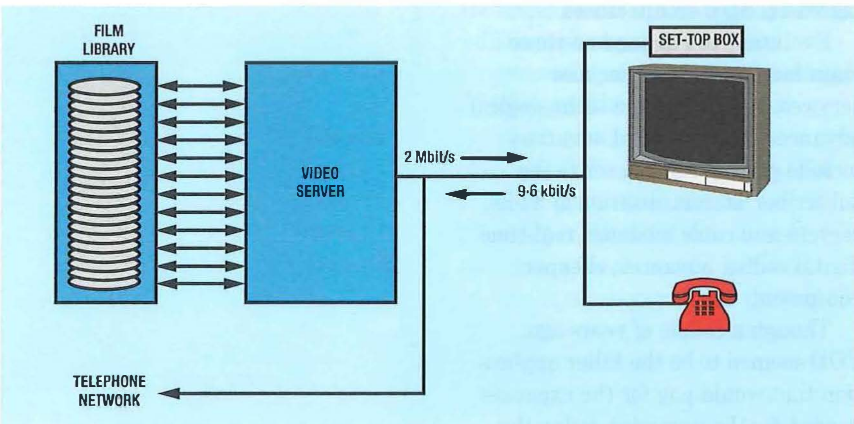
This article is based on a paper presented by the author at the 35th European Telecommunications (FITCE) Congress, 27 August–1 September 1996, Vienna.

Network capacity

For most telcos, the problem of delivering broadband services to the residential market is that few, if any, of their customers have optical-fibre access; a very small number may be connected by coaxial cable systems; but all are connected by normal copper telephone lines which have, historically, supported data rates no higher than the 64 kbit/s of the integrated services digital network (ISDN).

In the summer of 1993, the first 2 Mbit/s asymmetric digital subscribers loop (ADSL) equipment became commercially available. The technology has been described elsewhere, but, basically, by the addition of equipment at either end of a custom-

Figure 1—Simple video-on-demand system



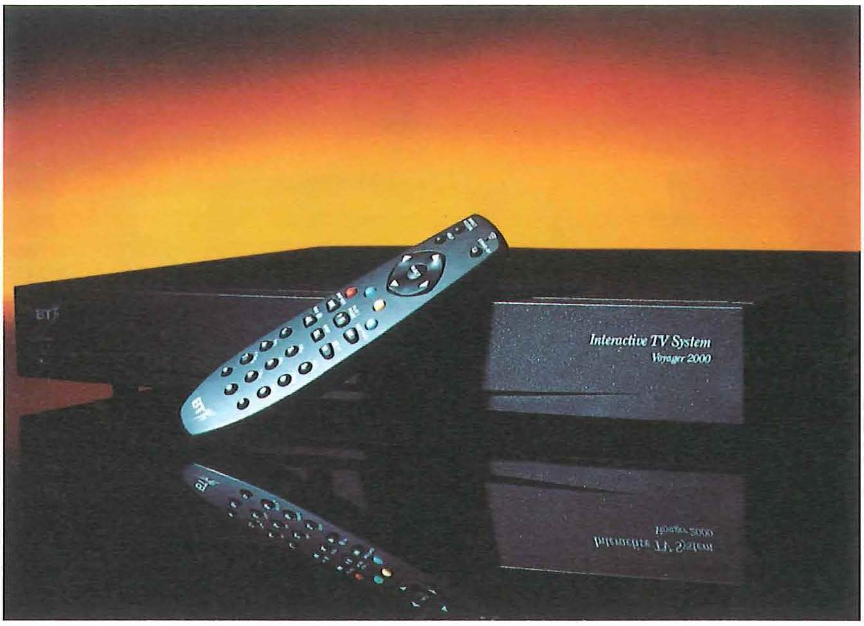


Figure 2—Apple set-top box and remote control

er's normal telephone line, that line is capable of delivering 2 Mbit/s towards the customer, a bidirectional 9·6 kbit/s data channel and normal analogue telephony for distances of up to 3 km.

The distribution of a number of video streams, and their corresponding control channels requires asynchronous transfer mode (ATM) technology. Although the transmission equipment had been available for some time, the necessary ATM ports to computer systems also became commercially available at around the same time as ADSL technology.

Server capability

The delivery of 'on-demand' services beyond mere video requires server capability beyond the simple description presented above. If movie content were installed on one magnetic disc, the number of customers who could independently access the data would be restricted to a very small number by the hardware constraints of the disc drive. Additional customers would require the movie content to be replicated.

Using the nCUBE massively parallel processing computer architecture, Oracle produced software which spreads the movie content across a large number of magnetic discs, which is then reconstructed in the nCUBE media server. This has two advantages. Firstly, for any reasonable number of customers, only one copy of any content is required, allowing maximum use to be made of available storage, and, secondly, applications such as shopping, which comprise a mix of text, still image and video clips, can be constructed on the same 'on-demand' basis.

Customer terminal equipment

The challenge for the set-top-box manufacturer was to construct a piece of equipment which looked like normal domestic electronic equipment and looked likely to be manufacturable in volume for a few hundred dollars. There were two possible approaches: take existing CDI player-type equipment and add intelligence, or take a personal computer and add intelligence.

The BT solution was to take the latter route with Apple. Not only did Apple deliver the product BT required, but the solution was a valuable enabler in achieving results quickly through the use of the embedded Apple tools. (See Figure 2.)

Equally important is the remote control, also developed with Apple. The remote control provided the simple VCR-type controls for navigating within video streams, as well as cursor and function keys. These, in conjunction with the menuing scheme, enabled navigation through a wide range of services in a way which was user-friendly and intuitive.

Technology Trial

In order to verify that the major technical pieces were in place, a technology trial was run from March to October 1994. The essence of the trial was to test all the components in as near operational circumstances as possible; this was not a laboratory experiment. The nCUBE server was placed in Kesgrave telephone exchange, a 25-year old building, still with much of its original cabling. There were 60 BT employees connected as customers and they were provided with around 50 hours of content. Apart from three lines delivered over 19 GHz line-of-sight radio, and two demonstration sites delivered over 2 Mbit/s MegaStream links, the customers were served equally by optical fibre direct to the home or by ADSL on their normal telephone lines. For the technology trial, there was no switching or concentration; that is, there was no need for ATM, and all the data was carried at E1 rates on 'nailed-up' lines.

All the major components of the trial worked satisfactorily and a small amount of operational information was gained. In particular, some of the elements of content churn were examined, and a very preliminary attempt was made to incorporate the service into BT's normal operational systems. This was particularly important, because any larger scale trial clearly would have to utilise, as far as possible, normal customer handling procedures and network management procedures.

The technology trial is widely acknowledged as having been the world's first interactive TV trial service.

Market Trial

As a result of that trial, the service in the towns of Ipswich and Colchester in the East of England, was instigated. The ambition was clearly to understand how customers would respond to a wide variety of services delivered to them on a one-to-one interactive basis. Thus from the outset it was necessary to design the system to support not only video on

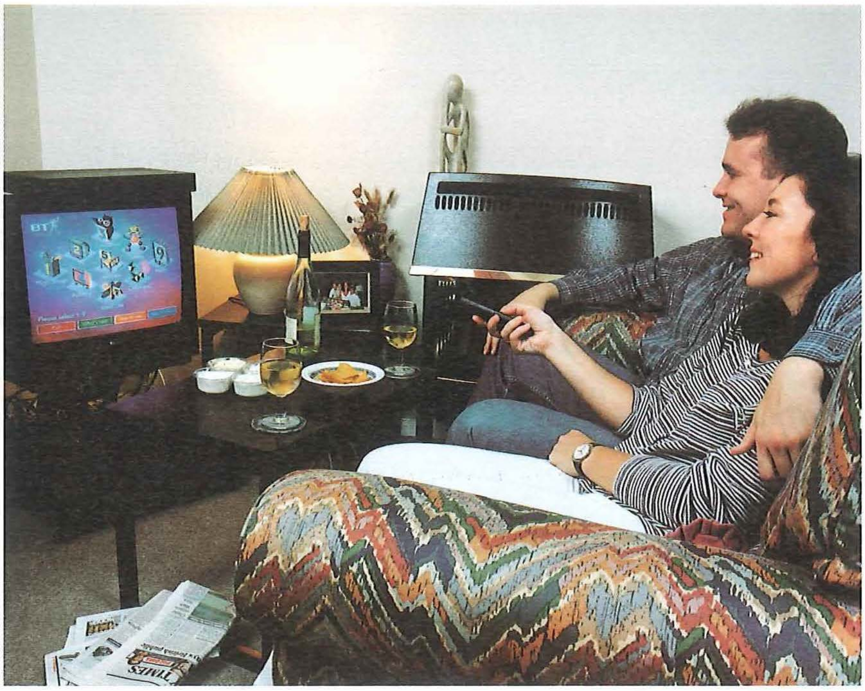


Figure 3 – The market trial has enabled customers' reactions to a wide range of services to be assessed

demand (VOD), but a range of entertainment, shopping and information services. In fact, the service comprised 11 applications, supporting almost 150 content providers, with the major applications being entertainment and shopping. The entertainment service featured content from all the Hollywood studios as well as the major UK and European movie and TV companies. In addition there was a music channel featuring jazz and classical content as well as rock and pop, and a children's channel.

The shopping mall supported a number of retailers and the banking service provided by National Westminster Bank not only allowed customers access to their accounts, but also provided a range of information on financial services. The education service was aimed at both the home and school with content provided by a number of educational establishments in the UK and geared around school age groups as well as further education.

System Design

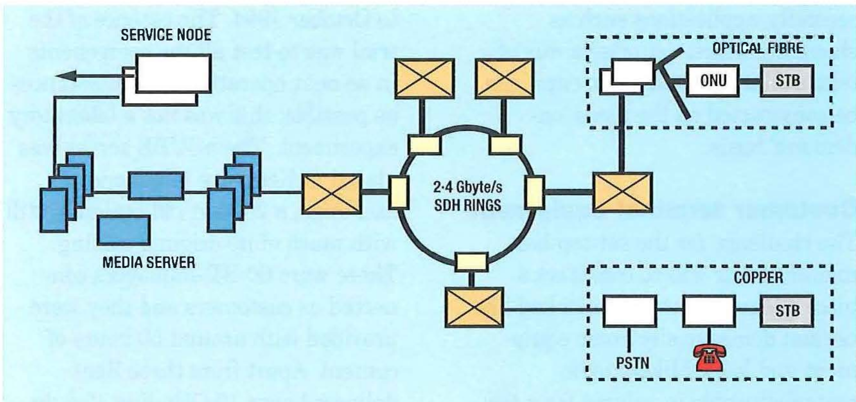
With the need to provide service to 2500 homes, the major enhancements to be made following the technology trial were:

- server scaling,
- switching and traffic concentration, and
- system management.

Server

The applications for the market trial required the equivalent of 2500 hours of content, although in practice a considerable amount of the information was still images and bit maps. The *server farm* to support the service comprised 600 × 4 Gbyte hard disc drives, or 2·4 Tbyte. The server was the same nCUBE M10 machine used in the technology trial, although scaled to support 1000 simultaneous 2 Mbit/s video streams. In addition, there was a stand-by machine to provide high availability. Both machines accessed the common disk store and fail-over time was around 15 minutes. Both media servers were controlled by independent Sequent computers hosting the enhanced Oracle applications, and these also operated in a main and stand-by mode.

Figure 4 – System architecture



In VOD mode, the media server provided the normal VCR-type controls; that is, pause, play, fast forward and fast rewind. Of course, on pause the image was a digital image without the smearing normally noticed on VCRs and the fast scan capability utilised the fact that discrete digital images were presented to the customer by allowing scanning at variable rates from ×2 to ×50.

Network

The major technical difference between the technology and the market trials was the inclusion of ATM technology to provide switching and concentration. The data from the media server was still MPEG1 coded, but carried in MPEG2 frames on the ATM bearer. By using Alcatel switching technology, the 155 Mbit/s ATM channels from the media server were combined and multiplexed up to be carried on two 2·4 Gbit/s synchronous digital hierarchy (SDH) rings, one serving Ipswich, the other serving Colchester (see Figure 4). Individual video signals were extracted from those rings at six remote exchange sites, where they were converted back to E1 and carried, as before, either on optical fibre all the way to the customer, or on their existing telephone lines using ADSL technology.

Management

From the outset, it was clear that the market trial had to fit as closely as

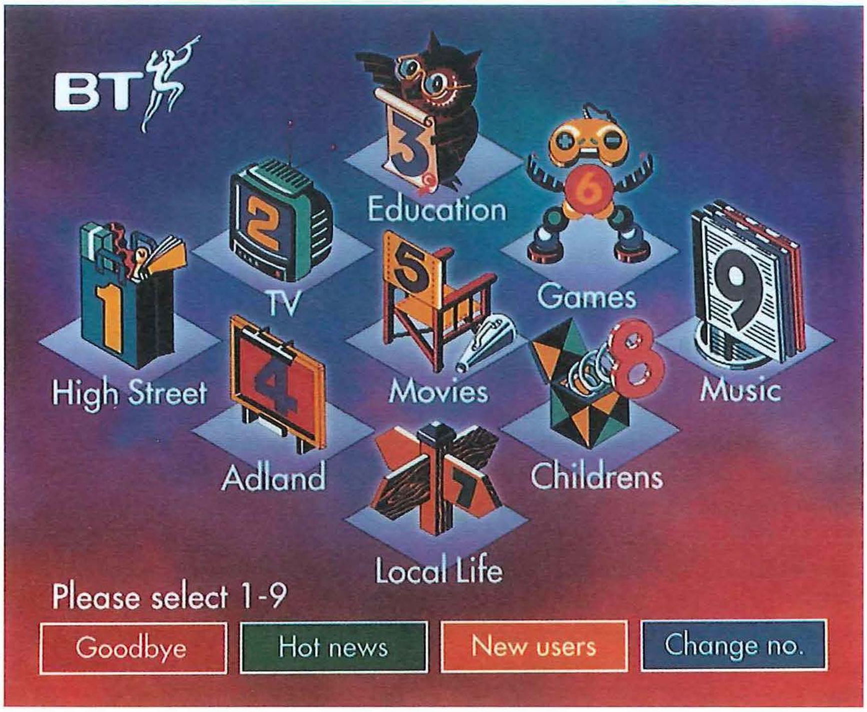


Figure 5 – Top-level menu

possible to BT's existing management infrastructure. As many as possible of the system elements were designed incorporating simple network management protocol (SNMP) standards. These included not only the media server and computing platform, but also individual ADSL components. This enabled BT's network operations unit to monitor the entire system all the way to individual customers. Although there was no SNMP capability in set-top-boxes, the network components in the customer's home were visible to the management centre.

Service Creation

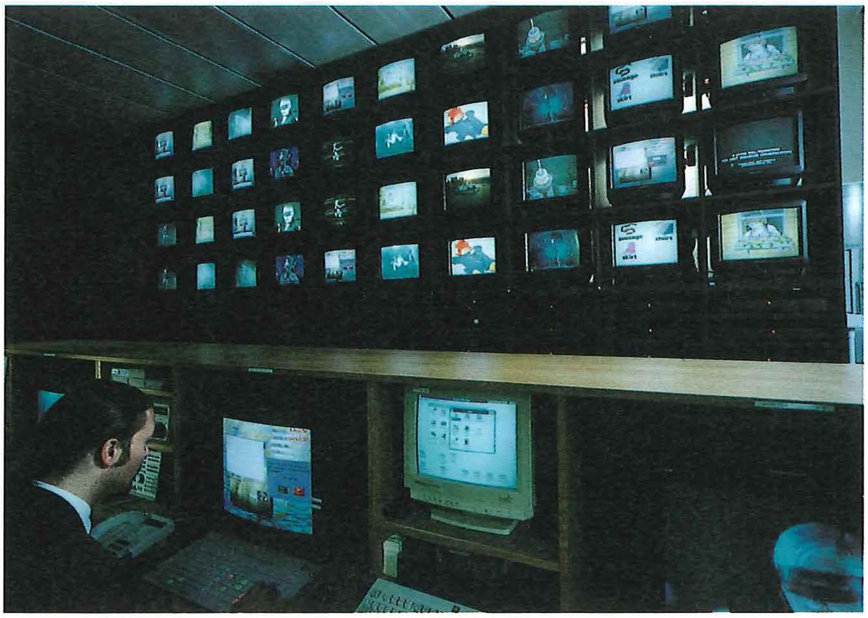
For the technology trial, BT built one of the world's first 2 Mbit/s real-time MPEG encoders. Clearly for a service on the scale of the market trial, BT could not code all the content, and two commercial organisations set up in the UK to code entertainment material. However, BT encoded the bulk of the short video clips used within the retail applications. These were built into applications in a service-creation bureau set up to assist content providers understand and utilise the technology available to them.

The essence of the service was its ease of use while providing quite difficult navigation using only the remote control, and the main navigation paradigm is to pick one of a set of numbered icons from the menu, additionally using four coloured function buttons to provide further information (see Figure 5). Essentially, these were the design rules provided to the service providers, along with a video tape that showed the sort of navigational capability which might be possible. The use of the four function buttons is also somewhat constrained. The red button is always on the bottom left-hand side of the screen and always moves backwards in navigation, the blue button is always in the bottom right-hand corner and always moves forward. The other two buttons essentially provided additional information. The same paradigm is clearly recognisable through all the applications including the top-level menu, despite the fact that every service provider has produced applications which have their own individual style. However, by using very simple guidance, the customer is never in any doubt as to how to navigate from individual screens.

The service-creation bureau consisted of a number of modules, each comprising a TV screen connected to a local server capability, a Mac-based design tool and the resource to take the service-provider storyboards and convert those into a real application.

The applications vary enormously in scale. The movie application comprised just over 200 movies, selectable through a number of categories including 'name'. Likewise, the retail services provide various selection categories leading to information on several thousand individual priced items. Each of these items had an associated 'detail' screen which carries textual information; they offered additional data through the function keys, and sometimes provided additional audio

Figure 6 – Test video wall



or video information. The system carried around 50 000 priced items, and some of the retail applications contained as many as 5000 video clips of around 10 seconds duration.

It is clear that content management is a major issue for this kind of service, with many thousands of video clips and tens of thousands of still images and bit maps. This is one of the major reasons why the trial stayed with MPEG1 coding. 2 Mbit/s MPEG1 coding provided excellent picture quality in the configuration and there has been no particular drive to move to MPEG2. Furthermore, the coding capability allows coding to be carried out not only in real time, but also without pre- or post-processing, although all content is validated prior to being made available to customers.

Development

The first internal trial customers were connected to the market trial in July 1995, one year after the development began. The first 'real' paying customers were connected in October 1995, and all homes were connected by the end of 1995. In order to build the system in such short timescales, there were four major development models built around the world to enable activities to be progressed in parallel. Oracle Consultants built the framework applications for entertainment and retail in Washington; Oracle's Multimedia Division had a development model using an nCUBE M10 driving a 40-screen video wall in California (see Figure 6) to develop the round-trip software between the media server and the set-top boxes. Alcatel had a similar arrangement in Belgium, where they did the ATM integration, and BT built a 40-screen reference model at BT Laboratories in the UK. That reference model was used for final integration of all the components, as well as the final testing and assessment of applications before they were released to customers.

Conclusion

When it was completed at the beginning of 1996, the BT interactive TV service was the largest such service in the world. The intention was to assess the response of customers to a wide range of multimedia services delivered to the home, including entertainment, shopping, banking, education and information services. All the major technical elements of the trial have proved not only to meet the functional requirements, but also to be resilient enough to deliver a meaningful service. BT interactive TV will be seen as a major step along the way to mass deployment of multimedia services to the residential marketplace.

Biography

Alec Livingstone
BT Networks and Systems

Alec Livingstone has been with BT since 1972. After a number of years in the research laboratories, followed by a brief secondment to NTT in Tokyo, he moved into group headquarters in 1984. Since that time, he has had several jobs relating to the strategic use of technology, principally in architecture and portfolio planning. He is currently responsible for building the innovative products and services being delivered by BT Laboratories to the company's product managers. In particular, he was responsible for the video-on-demand technology trial launched in March 1994, and the interactive TV service launched in October 1995.

Isabel Tibbitts

Multimedia Market Forecast and Evolution

This article covers two main themes: cost—as a driver and a barrier, and evolution before revolution. Service provision costs are a catalyst to disintermediation (removal of intermediary functions) initially with interim technologies and then via true multimedia. The article looks at how established infrastructures will influence this. Mass markets do not readily recognise the benefits of multimedia. Thus barriers of technical change can only be overcome through gradual, social familiarisation.

Introduction

This article discusses the path of multimedia development and the influence of cost. It covers:

- cost as a driver and as a barrier; and
- evolutionary before revolutionary change.

In discussing multimedia it is difficult to strike the right balance between blue-sky and short-term thinking. It is foreseeable that the huge benefits and advances expected from multimedia will take many years to arrive for the population at large. Further, that point will finally be reached only after going through many stages, most of which will build on existing market systems and structures, products and services.

There will be failures and successes at every stage with two of the prime factors being financial viability and social 'familiarity'. Recognising financial viability is straightforward, but the concept of 'familiarity' needs explanation. Successful development in a market is often a combination of concept development and evolution. Consumers more easily understand what they know. More important, familiarity builds the confidence to overcome the risk of change.

For example, the design of early motor cars replicated horse-drawn vehicles, without the horse! Similarly, early driving habits called for directional 'arm' indicators positioned in the middle of the car body as an imitation of earlier hand signals. All are now replaced by front and tail lights.

> *'You can make money on the Internet by selling stuff or by saving money....that's serious, hard, bottom line....'*
>
> *'The Internet is a very effective way of reducing the cost, creating a far-reaching, ubiquitous service—just like the telephone.'*
>
> *'Main use of Internet technology will be by businesses for the foreseeable future.'*
>
> Jim Barksdale,
> President and Chief Executive of
> Netscape Communications

The revolutionary concept of multimedia is attractive because of the size of its perceived potential, but it is unlikely to be achieved in the short term on a wide scale. The single step is just too great. Familiarity with multimedia services will evolve gradually and the speed of that social acceptance will determine the pace and structure of development.

The purpose of this article is to consider the how, not the what, of the multimedia future and to emphasise the importance of cost and evolutionary factors.

Cost as a Driver and as a Barrier

Firstly, the highest importance can be ascribed to finance and consumer cost in multimedia. Principally:

This article is based on a paper presented by the author at the 35th European Telecommunications (FITCE) Congress, 27 August–1 September 1996, Vienna.

If consumers are to buy the services on offer, they need cheap, easy and global connectivity for greater access; connectivity leading to choices.....there must be niche markets on a mass scale.

- investment in infrastructure,
- costs of access and services for consumers, and
- costs for suppliers of services.

Cost and the infrastructure providers

The infrastructure necessary for delivery of fully interactive multimedia services to every home does not yet exist. It is expected it will be provided by major players in telephony, computing or possibly in entertainment. The cost of this investment to these major players (recently estimated at between \$5000–\$10 000 per household) influences their view of the market opportunity. As they consider entry in the market, their objective is to justify that investment on the returns expected.

Hence the search for the 'killer application', which could bring the maximum number of users for major services. This means concentration on entertainment, games, home shopping, banking, education, etc. Each of these is a huge market in itself and there is an assumption of an immediate consumer switch away from the existing to the new technology once it is available. What information there is from trials does not support this view.

Furthermore, the commercial framework for exploiting the potential of these vast but diverse services is proving difficult. New alliances need to be struck and existing commercial structures (many producing good revenues) disrupted. So the supporting evidence for investment in major single infrastructure projects is limited. Without the investment from major players, single technology infrastructures cannot easily be established.

For example, consider the cost/revenue barriers facing a public telecommunications operator (PTO):

- commoditisation of network capacity;
- network control migrating away from PTOs;
- existing pricing based on time and speed of delivery;
- existing networks unsuitable, expensive to run or needing costly upgrades;
- price levels may be set by service provider or content owner;
- price levels set by existing market perception; for example, videos, newspapers; and
- margins squeezed by sharing of revenues with service providers.

Aware of these issues and without confidence in major returns, PTOs are reluctant to commit fully to major investment.

So the enormous investment in infrastructure is proving a barrier. Another approach to understanding the 'how' in the process of developing the multimedia market is needed. A closer view of the consumer, the ultimate buyer of multimedia services, must come first.

Costs and the consumer

Try to give a single definition of the potential consumers of multimedia services. There is no standard definition. There cannot be one. The reason lies in the technology itself and core benefits offered by multimedia. There is the expansion of choices and links. Choices must be expanded across many services, with access to global information and to new and existing combinations of media such as music and vision. If consumers are to buy the services on offer, they need cheap, easy and global connectivity for greater access; connectivity leading to choices. In other words, there must be niche markets on a mass scale.

But it is now difficult to show evidence of consumer desire to switch wholesale to new media. Service possibilities have not yet developed to tempt significant revenues from consumers. Benefits over existing services are unclear and for the consumer there is no clear cost advantage in moving to a multimedia service. If anything there are cost barriers, such as:

- requirement to pay for new equipment,
- duplication of existing services (shopping trips still also required), and
- initial single provider solutions resulting in limited price options.

Part of the consumer conundrum lies in whether the PC or the TV will be the chosen route into the home. There is good evidence of rapid growth in particular products to particular groups of consumers such as PCs or software over the Internet. The rapid growth of the games market is another example. But there seems no wholesale desire from consumers to invest in technologies to switch to home shopping say.

We are still in the early stages of development. There is not yet a clearly recognisable benefit over the competitive services (for example, print). Indeed, under competitive pressure, CD-ROM content prices have been dropping (for example, Oxford dictionary). There have been reviews of multimedia investments, such as Sony and Matsushita in Hollywood and Microsoft in Dorling Kindersley. This is not surprising as multimedia has not so far expanded the market overall. So there is unlikely to be a major increase in the overall household spend on entertainment or services, merely a shift from one supplier to another.

Costs for businesses providing services

Leaving aside, for the purposes of this article, the question of inter- and intra-business operations and extended electronic data interchange (EDI) applications, all of which will also have a bearing on the acceptance of high bandwidth and multimedia applications, the main cost/revenue questions for businesses serving consumers are:

- cost saving by removing intermediate operations;
- cost saving in entry to new markets and customer groups;
- cost saving in customer management;
- cost increase in reducing exploitation of existing infrastructure;
- cost increase in protecting customer base; and
- lower margins as competition grows with increasing access to consumers; for example, from primary manufacturers.

Implications

Cost is a barrier to establishing a single infrastructure. The level of investment required encourages a particular view of the market and the search for killer applications. The market indicates the infrastructure needed should provide global access to niche applications. So in considering investment cost, two questions need to be answered by the builders of the infrastructure:

- Will the infrastructure cater for the mass niche consumer?
- Can the infrastructure address the parallel paths likely to be used by the diverse mass niche customer?

As far as the other two key players are concerned (service providers and the consumer), to recap:

- for consumers, the cost of multimedia is a barrier to entry to the new services which do not have proven benefit; and
- for service providers, the cost of multimedia can be translated into savings.

Service providers can lead on influencing the pace and direction of multimedia growth. They already have existing services and a customer base. Service providers can switch savings made by the use of new technologies to their customers and so encourage change and grow the market.

In fact, for both businesses (the service providers) and the consumer, cost issues converge. These businesses will increasingly install multimedia and communication systems to save operational costs, especially in access routes to the market. These cost savings will be passed on to the consumer in order to maximise the use of the cost saving technologies. Once costs become a benefit not a barrier, they will have a strong influence on the pace and degree of acceptance of multimedia services.

Service providers can lead on influencing the pace and direction of multimedia growth.

Evolution before Revolution

At the beginning of this article, the concept of social familiarity and the influence this has on new developments were explained. This is now explored further and it is shown that social familiarity also has a bearing on the way investment and costs are viewed.

The discussion concentrates on the following questions:

- Does the information superhighway (national information infrastructure (NII) or global information infrastructure (GII)) need to be in place before multimedia services can develop?
- What factors are important for consumer acceptance of multimedia services?
- Is the barrier of cost linked to social familiarity?

Does the information superhighway (NII or GII) need to be in place before multimedia services can develop?

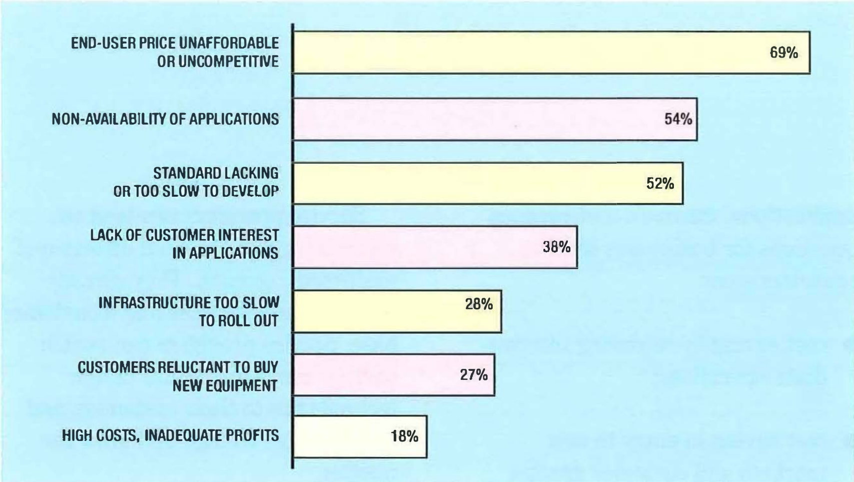
If your definition of a multimedia service is a strictly technical one, the answer to this question must be yes. By definition, multimedia is the combination of many 'media' and this defines the vision of the multimedia superhighway. But from an evolutionary standpoint it can be argued that there are already many services which do not exploit multimedia technologies but which contain the basic elements needed for long-term development into multimedia services.

Take for example First Direct, the pioneer home banking service in the UK. This service uses the POTS (plain old telephony service) network and human operators. It has gained over half a million customers since launch five years ago. It receives 26 000 calls per day (average 3 minutes) and adds 10 000 new customers every month.

First Direct does not use multimedia facilities—yet. It doesn't need to. Its customers are happy with using familiar technology without needing to invest in new equipment and with operational savings passed on. But First Direct banking has the characteristics of a multimedia service in the making. It has disintermediated (removed the intermediary) the high street bank. At some point it will be very easy to switch First Direct customers over to access through a PC or the TV.

CD-ROMs are similarly developing consumers' familiarity with the types of services which on-line

Barriers to multimedia growth (Touche Ross / Financial Times Survey)



multimedia can offer later. A recent example of this is shown in the UK government's driving standards agency proposals for virtual reality hazard perception testing. It is said the full version will take years to develop but the British School of Motoring's interactive compact disc similarly designed to test driver alertness is available today.

CD-ROMs act as an intermediate stage between print and full on-line multimedia. They have the physical presence of books but add the excitement of TV and access to, and interaction with, greater stored information.

What factors are important for consumer acceptance of multimedia?

It is likely that consumers are confused. While they remain confused they will not buy. Is it surprising the consumer is confused? Consider the range of choice under the general banner 'multimedia' and the influence of competing interests such as:

- computer and TV (entertainment versus home office),
- fixed and mobile, and
- local services versus national (NII) versus international (GII).

And consider the negative publicity building up around the Internet such as national concerns about:

- the power of global companies to undermine national legislation (Murdoch's Star in China or the US control of encryption systems),
- security of information (government or individual),
- global entertainment and news media and the risks to locally produced programming, and
- protection of young people from undesirable services.

So consumers are hesitant and the stimulus for change to multimedia solutions is weak.

In any new venture, risk of the unknown has to be weighed against the opportunity offered by the new. In multimedia, this risk can be translated into price (of the service and of new equipment). The risk can be minimised through familiarity with the service offering (even if through a different medium) and clear benefits of change.

An evolutionary process is more likely to deliver these requirements than a revolutionary one. (That is of course unless another player—for example, government—takes the risk on behalf of the consumer, as for example with France's Minitel.) This is borne out by the experience of selling over the Internet where computers and software have sold well to a group familiar with the products on offer. Sales of other products have been disappointing.

Familiarity will build gradually. It will translate from one market to the next. For example, familiarity with equipment, services, etc. in the office will increase confidence in using such services domestically. Choice will be made through choices already made for the office in the home.

This is a two-way process. Services established through the mass medium of TV may affect the operation of service businesses because TV can provide the access to consumers. These service providers will then align their businesses more exactly to the market which in turn will further influence consumers.

Is the barrier of cost always linked to social familiarity?

For consumers, the answer is yes, but in the case of the infrastructure providers, probably not directly. As already discussed, they are seeking killer applications to justify investment. In the absence of these, as interim often proprietary services grow, infrastructure providers will cater for them using the existing technologies familiar to them.

So what is the benefit of a GII or even a NII to them? Fibre infrastructures have been considered but the short-term returns on fibre to every home are questionable. As commercial services have still not developed, fibre to the home may even provide an excess of capacity before it is needed.

Short-term alternatives already exist. Fibre to the locality is likely to be a viable interim solution, although the final services available to the home may be limited in some applications and inflexible in the return path. Coaxial cable and the twisted pair used for telephone services can provide many of the features of interactive services, especially when boosted through compression. Alternatives for access to the home such as wireless and satellite are also optional solutions.

Development will be determined by what is easiest, and it is easier to minimise costs by exploiting what already exists and extending incrementally. So, indirectly, infrastructure providers will make decisions based on known and familiar technologies.

The Internet is a good example of the process. It has built up through existing networks and systems as required. It is the closest we have got so far to a GII. But its growth is extending beyond its capacity, with consequent delays in accessing information and services. In an attempt to gain the benefits but avoid the congestion, larger organisations are establishing their own systems, intranets.

But as the Internet has reached near breaking point, investment has been there to answer the requirement (hence the recent agreement between MCI and BT to build global Internet capacity); in other words, investment in answer to proven demand.

Conclusion

We are now a few years on from the statement made by Al Gore of his vision of the 'Information Superhighway'. In its breadth, the concept was easy to understand and accept. That vision still drives views of multimedia potential, particularly within governments. But governments have so far been reluctant to provide the necessary finance. In the commercial arena, there has been reassessment of the practical requirements of bringing the vision to reality.

For commercial investors, the benefits to be gained from the enormous investment in a truly open and virtually free 'Information Superhighway' are questionable. For them, investment must be linked clearly to return. Smaller, more controlled initiatives show such benefits more readily.

However, this could damage the establishment of the single superhighway. For example, more commercial, less open systems like these detract from the free environment of the Internet, the very freedom which has encouraged its explosive growth. In the same way, as commercial transactions on the Internet grow, so do the commercial risks in the copyright, revenue and financial systems which service them. Protections through exclusive customer supplier deals again undermine the original Internet 'freedom'.

What are the chances of achieving the superhighway vision of unlimited bandwidth to every home with global interconnectivity? The example of the Internet supports the view that we are unlikely to see the full capabilities of multimedia technology available as a single entity for many years. Simply, one-step total revolution is impractical. The number of competing and conflicting views involved is too great.

Look rather at the moves already being made in content ownership, digital and satellite TV, fat client thin server (and vice versa) development in PCs. Consider the ownership of protocol gateways, the growth of particular intelligent agent technologies, and, finally, retailing and distribution. How are major retailing groups expanding into areas which will position them to service the mass niche customer?

Watching, joining or competing with these players will be the map for riding on the superhighway.

Biography

Isabel Tibbitts
Arthur D. Little
Limited

Isabel Tibbitts is in a unique position to analyse the development of new services in a multimedia environment. Now an affiliate with the international consultancy Arthur D. Little, she was until recently a strategy manager with BT and was a founder member of BT's former ICE programme (Information, Communications and Entertainment) and undertook an internal audit for BT of its own 'information content' resources. She has worked in many areas of telecommunications which are now influential in multimedia, such as videoconferencing, mobile satellite and smart and charge cards. Prior to joining BT, Isabel was in the retail and distribution industries including Procter and Gamble and United Breweries. With two young children, she is committed to developing greater awareness of computing and information technologies in schools and was involved in BT's schools support programme giving careers advice. She has also specialised in key areas of the multimedia scene where local government and private enterprise are liaising to develop multimedia, such as in healthcare (Reuters) and intelligent transport systems, the so called *journey market*.

Bob Semaine

The BT Global Challenge

Sponsoring the BT Global Challenge, widely regarded as 'the world's toughest yacht race', brings significant business benefits to BT. A key element of the project's success is the communications infrastructure developed by BT.

Introduction

The BT Global Challenge is the first major international event that BT has sponsored. The event has developed into the biggest marketing relationship programme the company has ever undertaken and it is timed to help drive home awareness of BT's global presence at a time when the company is seeking to build a family of alliances that is vital for the company's future success.

Although driven by Global Communications Marketing, many BT divisions have made major contributions to the event, particularly BT Laboratories at Martlesham Heath, which has developed the communications technology. At the centre of the event is a very special yacht race crewed by volunteers from all walks of life, of all age groups, who have made many personal sacrifices to take part in the trip. This mixture of human endeavour and business-to-business opportunity provides BT with an ideal platform to promote itself simultaneously across many different fronts.

The Race and its Founder

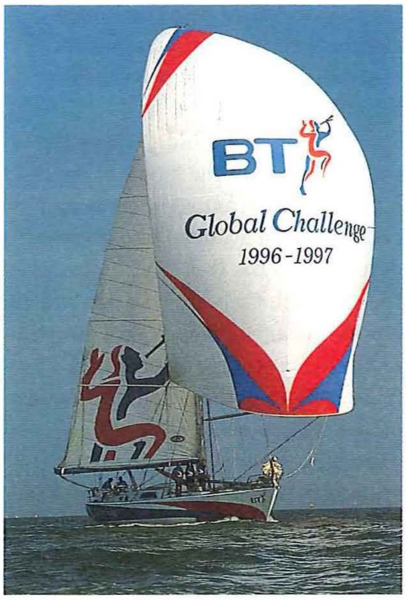
On Sunday 29 September 1996, Her Royal Highness The Princess Royal fired the gun that sent 14, one design, 67 ft steel cutter-rigged sloops off on a 30 000 mile voyage around the world. These 40 ton monsters are each crewed by 14 people, a professional skipper and 13 volunteers, who have specially trained over the past three years to achieve their challenge of a lifetime.

Ahead of them lie the many dangers of the world's oceans, the doldrums, Cape Horn and The Cape of Good Hope and the awesome might of the Southern Seas. For the majority of us who prefer their feet to remain on terra firma, this is an alarming prospect, and even more alarming when you consider that each of the volunteers has paid up to £18 750 to make the trip, making many sacrifices along the way to raise the funds to compete. Up to 70% of these crew volunteers had never sailed before signing up.

The race retraces the route that Chay Blyth, the founder of The Challenge Business, followed for his nonstop circumnavigation against the prevailing winds and currents in 1971, returning home to a tumultuous welcome in Southampton. He went on to achieve almost everything that there was to achieve in the world of transoceanic racing, and now he makes it possible for anyone with the enthusiasm for the dream to apply, train and take part.

Chay formed The Challenge Business in 1988 to deliver his personal vision of a round-the-world yacht race aimed at opening up this demanding sport to a much wider audience. He developed a turnkey package to crew and sponsors alike, eliminating expensive surprises and keeping expenditure down to prudent levels.

Figure 1—The BT Global Challenge training yacht



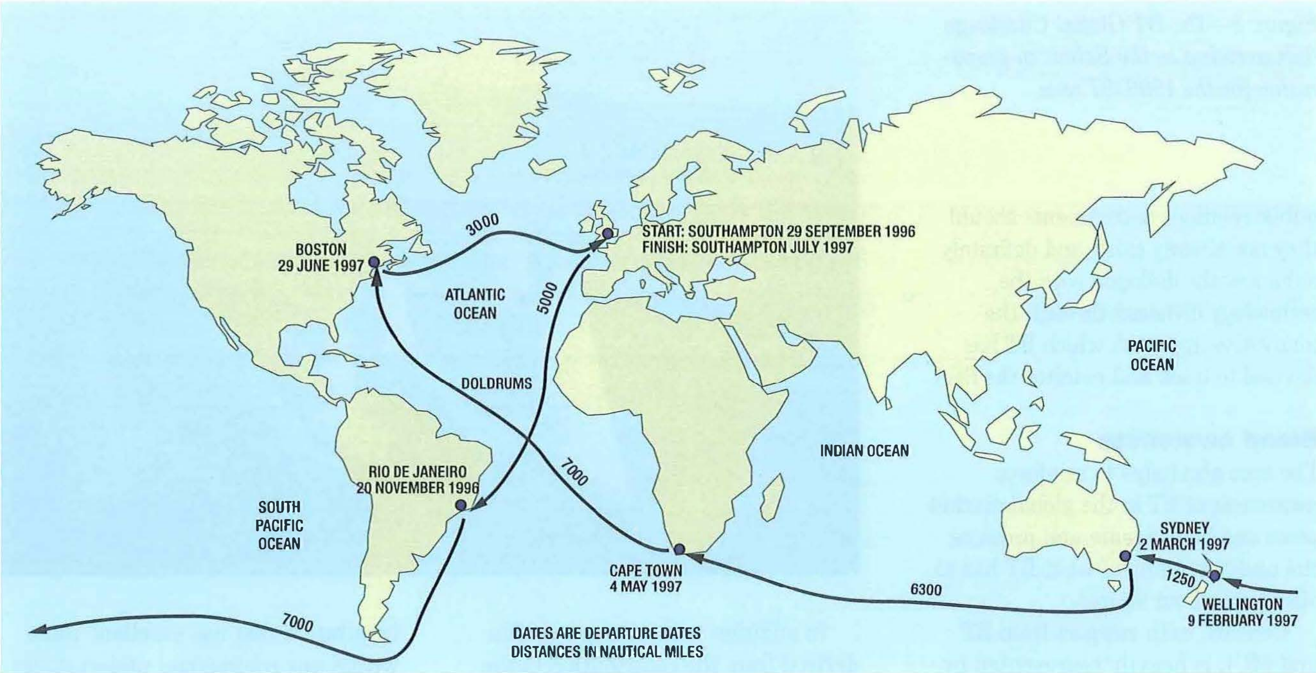


Figure 2—The BT Global Challenge, 1996–1997, 30 000 nautical miles

This formula of sponsorship proved highly successful in the first race (The British Steel Challenge) such that many sponsors returned for a second time to take part in this race. No less than five yacht sponsors returned to make the trip again, and two—Group Four and C E Heath—have recently sent their yachts on solo record-breaking attempts.

The race is divided into six legs (see Figure 2), with six ports of call, taking 10 months to complete.

Sponsorship Structure

The sponsorship structure provides a very robust business-to-business ethos with an intriguing mix of individual human stories. It is essentially a four-tiered arrangement with BT at the top as titleholder, supported by 14 companies or consortia sponsoring the individual yachts. Further sponsorship support is provided by up to 196 Business Club Members (subsponsors) many of whom are multinational companies in their own right. These layers are supported by the crew volunteers each of whom pays the fare of up to £18 750 per head to make the trip and from whom most of the human interest stories are derived.

The Marketing Opportunity

BT's investment in Global Challenge presents our company with a unique opportunity to promote, not only our Global Strategy, but also to provide a companywide focus which allows a contribution to objective achievement for many of our colleague divisions taking part.

An ideal cameo supporting BT's commitment to the community is readily recognised. The recent launch of the BT Global Challenge Education Pack, the many fund-raising activities being undertaken in support of The Save the Children Fund and the BT Community Programme's direct contribution to a charity supporting the sporting achievements of the disabled, the Time & Tide Trust, demonstrate how the project can simultaneously address and promote three of the key community programme activities.

Employee communications are also enhanced by the selection of 30 BT people, representing virtually every division in the company who will each sail on a leg of the race. This will encourage further interest from their many supporters who will now follow the progress of the fleet. To date, the BT leggers have raised approximately £150 000 for Save The Children. Incidentally both BT and The Challenge Business are corporate members of The Save the Children Fund.

But most importantly, Global Challenge provides BT with the opportunity to demonstrate actively the depth and breadth of its capability both at home and overseas, and addresses the following business objectives.

Business Objectives

Sponsorship of the race provides BT with business benefits in the following key areas:

Sales generation

With BT's markets under ever-increasing competitive pressures, the project helps to attract new business and establish new collaborations such that new sales opportunities can be derived.

The corporate benefits accruing from the titleholder's contract play a key role in this area by enabling BT's various sales forces to focus their customers' attention on BT and the race. The two objectives of increasing business level and customer understanding are at the forefront of every account manager's sales plan.

This sponsorship offers the company's sales force the opportunity to help with the achievement of these annual objectives, in particular for account managers whose accounts are directly involved in the sponsorship. The involvement of companies in The BT Global Challenge is, in almost every case, a main board decision. This provides the opportunity for account managers to use the event as common ground in any senior level discussion. It certainly helps to expand contact with marketing and

Figure 3—The BT Global Challenge fleet arriving in the Solent in preparation for the 1996–97 race

public relations departments should they not already exist, and definitely enhances the dialogue with the technology divisions through the innovative approach which BT has devised to track and monitor the fleet.

Brand awareness

The race also helps to reinforce awareness of BT in the global market place and helps create and promote the understanding of what BT has to offer beyond our shores.

Concert, with support from BT and MCI, is heavily represented by sponsoring a yacht in the race and wherever possible by using the Concert platforms to underpin the planned 'Technology Showcases' in the main corporate stopovers of Sydney and Boston. Concert involvement not only provides a focus on BT's acknowledged portfolio strengths but also helps to weld the BT family of alliances and partnerships together, demonstrating the company's customer-service infrastructure and allowing the company's people worldwide to become involved.

BT's technological innovation is also demonstrated by the delivery of the BT race information system which has been installed in the Southampton race headquarters to track the fleet across the oceans. With this ability to communicate with a yacht in the Southern Ocean, the most hostile of environments, then BT can communicate with anyone, anywhere.

Brand loyalty

The project presents BT as a global business service provider and the BT family as the preferred supplier of choice.

Corporate citizenship

Just as within the UK, it is important for BT to be recognised overseas as a responsible company which contributes to the community in which it operates. The community programme work described within the UK is naturally repeated in the ports of call.

In addition to obtaining benefits derived from the contribution to the community programme, BT is keen to encourage companywide participation by BT people. The company's 30 leggers are key participants. The crew are ordinary people doing an extraordinary thing and they offer an inspiration that has excellent value within any commercial undertaking; qualities of leadership, genuine teamwork, professionalism, expertise and training are required to win the race and can be equated with the qualities that are required to succeed in business today.

Yacht sponsors

The list below identifies individual companies or consortia of companies sponsoring a yacht. It provides an interesting mix of companies all keen to win.

Company/Consortium		*Yacht*
C E Heath		*Heath Insured 2*
Commercial Union		*Commercial Union Assurance*
Courtaulds Coatings		*Courtaulds International*
Concert		*Concert*
MCI		
BT		
Group 4 Securitas		*Group 4*
Motorola		*Motorola*
Nuclear Electric		*Nuclear Electric*
Rover Group		*Ocean Rover*
Royal British Legion		*Pause to Remember*
Serco		*Save The Children*
Teamwork Consortium		*Global Teamwork*
Amdahl UK	Nortel	
Ericsson	Oracle UK	
GPT	Sun Microsystems	
Hewlett Packard	Tandem Computers	
Time & Tide Trust		*Time & Tide*
Deutsche Morgan Grenfell		
BT Community Programme		
Symbol Technologies		
Zurich Insurance		
Church & Co		
Henry Lloyd		
IPC/iXmet		
Toshiba Information Systemsm		*Toshiba Wave Warrior*
3Com		*3Com*

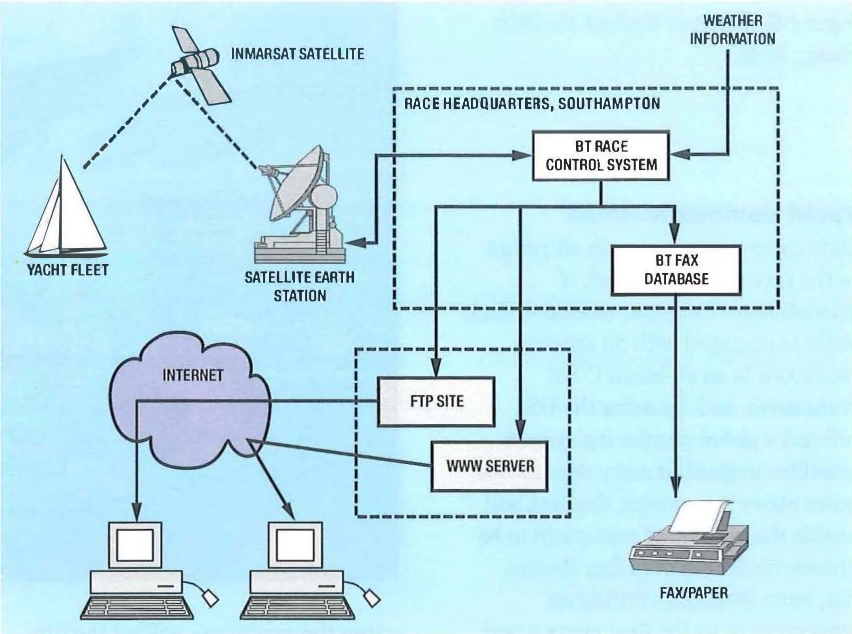


Figure 4—Overview of the BT race control and information system

IT and Communications Infrastructure

Over the past 10 years, BT's reputation for technological innovation has been enhanced by successive involvement in preceding global yacht races.

Through association with these events, the multimedia team based at BT Laboratories, Martlesham Heath, had, over the years, developed a race tracking and control system that was second to none. For the BT Global Challenge, another major step forward has been taken by converting the system to a Windows 95 application. This, and the additional development of a web site, now provides access of the event to a worldwide public audience with the opportunity to tune in daily to monitor the fleet's progress.

To support the race, a sophisticated computer and communications infrastructure has been developed by engineers at BT Laboratories (see Figures 4 and 5). By combining satellite technology with BT-developed software programming, the World Wide Web and a fax information retrieval system, latest race news and information is being made available to people around the globe.

Information from each yacht is fed, via satellite, to the race headquarters in Southampton, analysed, processed and then distributed to race watchers on a 24 hour/day basis.

The system comprises the key elements of yacht communications, the race control system and information access.

Voice communications are relayed over powerful high-frequency (HF) radio via BT Portishead to and from the yachts such that it is possible for anyone to call them up. HF radio will also be used to receive weather forecast information which will be displayed on the on-board laptop PCs.

HF and very-high-frequency (VHF) radio are used for communication yachts to communicate between one another.

Figure 5—Race control and information system in greater detail

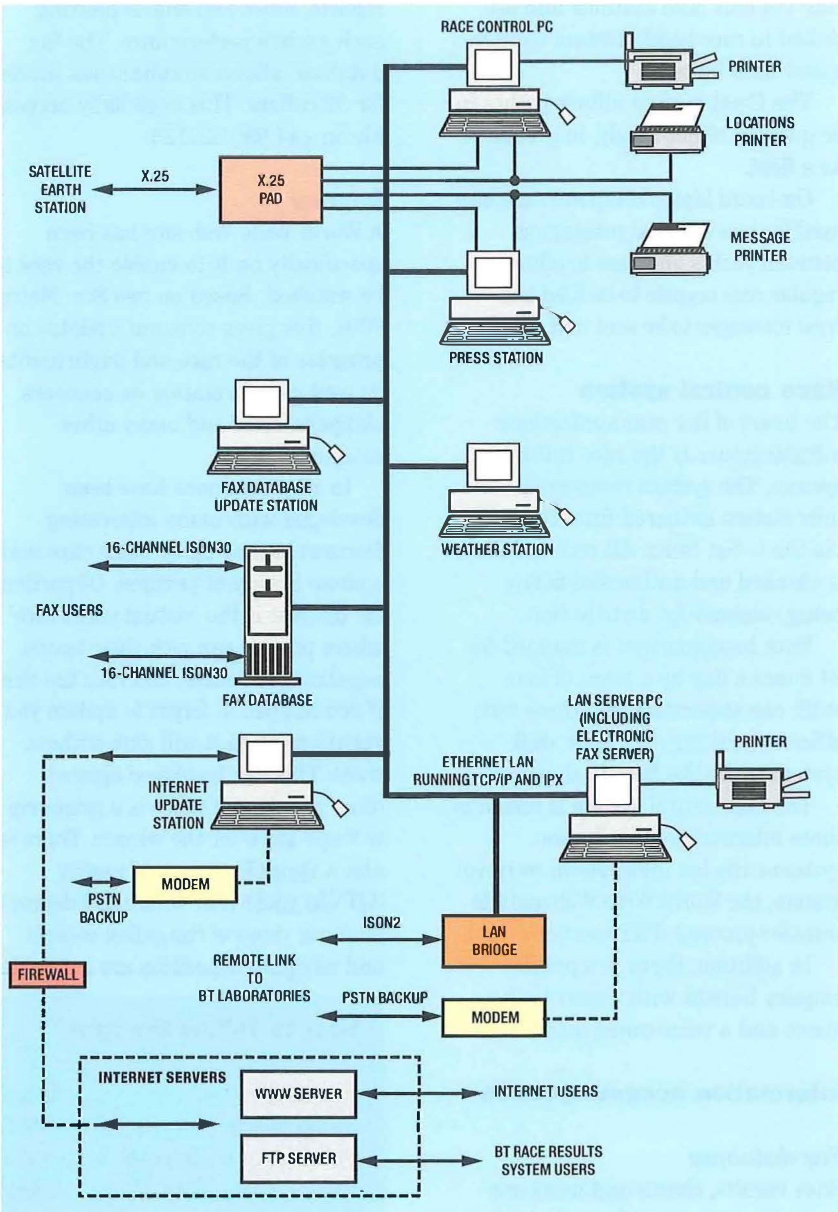


Figure 6—Internet deck at the Boat Show, 1996

Yacht communications

Data communications with all yachts in the race use the network of geostationary Inmarsat satellites. Each yacht is equipped with an antenna connected to an on-board C-Sat transceiver, and, by using the US military's global positioning system satellites in geostationary orbit 22 500 miles above the equator, this link will enable the position of each yacht to be automatically reported four times a day, more frequently during an emergency or as the fleet nears a port of call or other points of interest.

The Inmarsat satellites communicate via four land stations and are linked to race headquarters by high-speed X.25 links.

The C-sat system allows yachts to be quizzed either singly, in groups or as a fleet.

On-board laptop computers are also used for two-way text messaging between yachts and base to allow regular race reports to be filed and crew messages to be sent and received.

Race control system

The heart of the communications infrastructure is the race control system. The system receives all information gathered from the yachts via the C-Sat links. All received data is checked and authorised before being released for distribution.

Race headquarters is manned for 24 hours a day by a team of four staff, one supervisor and three race officers, working a 12 hour shift system while the fleet is at sea.

The race control system is linked to three information distribution systems: the fax information retrieval system, the World Wide Web and file transfer protocol (FTP) servers.

In addition, there is a public enquiry bureau with access to the above and a voice commentary line.

Information access systems

Fax database

Race results, charts and news are available to anyone throughout the race with access to a fax machine. By using the machine's polling facility, callers can select from a series of 10 options which include latest position reports, news and charts plotting each yacht's performance. The fax database allows simultaneous access for 32 callers. This is globally accessible on +44 990 321123.

Internet

A World Wide Web site has been specifically built to enable the race to be watched. Based on two Sun Netra 600s, this gives constant updates on progress of the race and participants as well as information on sponsors, skippers, crew and many other categories.

In all, 10 sections have been developed with many interesting features backed up by video clips and a photo library of pictures. Of particular interest is the 'virtual yacht race' where players can pick their teams, supplies and routes, and race the fleet. If you happen to forget to update your yacht's position it will sink without trace. This can be played against other people and there is a prize trip to Cape Town for the winner. There is also a QuickTime virtual reality (QTVR) yacht tour where 360 degree panning views of the galley, cockpit and navigator's position are available.

The web site is a significant advance over what was previously available to follow ocean racing. The site was trialled at the London Boat Show in January 1996 and in that two-week period over 10 000 people came to the BT Global Challenge stand to use a terminal (see Figure 6), and in the period 1 January–8 February 1996 an average of over 2000 hits per day was recorded. The test site was not publicised but clearly demonstrated the potential depth of interest.

The address is http://www.btchallenge.com

FTP servers

A limited number of race information system software packages have been produced for key users such as yacht sponsors to follow the race.

By using the BT-designed Windows 95-based software, users can download files from the official web site at race headquarters. Available files include detailed charts showing the progress of every yacht. Users can plot individual or groups of yachts, zoom in for further detail, and compare with previous charts. Detailed tables give precise locations, speed and distances covered together with historical information for the entire race.

How to follow the race

Internet	http://www.btchallenge.com
Fax polling	+44 990 321123
Public enquiry bureau	+44 1703 212124
Voice commentary line	0891 505550
Television	BBC2

This approach also requires an Internet connection to download the latest data before going off-line to use it.

Public enquiry bureau
This bureau has been established in Bristol using BT's Connections in Business service. Its prime function is to answer enquiry calls from the general public relating to the event and is staffed by up to 10 operatives, 7 days a week from 0800–1800 hours. Should the need arise this can be expanded to provide a full 24-hour multilingual service. The operatives have full access to the Internet web site and fax polling system, and can provide the caller with the latest racing positions. Brochures and other event-related leaflets are mailed via a fulfilment house if required. Any specific sponsor enquiries are referred via fax within the hour to a nominated representative.

The bureau can be contacted on +44 1703 212124.

Voice commentary line
A voice race line also provides an audio commentary line for the race. Based on an 0891 service, this is updated daily and all profits will be donated to the BT Global Challenge nominated charities.

Television
Finally a series of six documentaries are being made for screening the event on BBC2 during the race period.

The first programme was transmitted on start day showed the build-up to the event, the crews' selection and training, the yachts being prepared and the start in the Solent.

Measurement
Statistical data are produced to monitor the number of people accessing the web site, fax retrieval system, public enquiry bureau and 0891 service on a monthly basis. Together with press reports, surveys, television and radio appearances, BT will build a comprehensive view of the event's success.

Acknowledgement

The BT Global Challenge team at Martlesham led by Darryl Morgan of Multimedia Services.

Biography

Bob Semaine
BT Global Communications

Bob Semaine is in the Global Sales and Service division of BT Global Communications. He joined the company in 1965 as a Trainee Technician Apprentice. He served in various customer-facing roles in the City. At privatisation in 1984, he joined the initial sales force in the City Telephone Area supporting big switch and dealing system tendering. In 1986, he became an account manager looking after the Stock Exchange and Bank of England. In 1991, he became sales manager looking after a team of account managers and engineers selling into the central market of the City. In 1994, he started the BT Global Challenge project. Initially he was responsible for putting in place all the major building blocks for the event. Since January 1996, the responsibilities have been divided such that colleagues in Global Marketing have the role of event organisers and Bob handles the race technology. Working in close cooperation with his Global Marketing colleagues, he is responsible for delivering all the systems required to monitor, track and control the race and for facilitating public access to race information and race management.

Bob Martin-Royle

Year of Engineering Success

*1997 is to be **The Year of Engineering Success**— 12 months in which the role of the engineer and the importance of engineering will be highlighted in villages, towns and cities across the country. As a build up to the 1997 campaign the final quarter of 1996 has a number of events aimed at alerting the public and media to YES. What is YES and how did it come about?*

Background

The Government recognised in its 1993 White Paper 'Realising Our Potential' that steps were urgently needed to restore confidence in the UK engineering industry and return it to the position of international pre-eminence, a position which it had earned and enjoyed through much of the 20th century.

In October 1994, at the invitation of the Rt. Hon. Michael Heseltine, then President of the Board of Trade, a programme entitled 'Action for Engineering' was launched. Its mission statement was expressed as follows:

'Action for Engineering aims through coordinated action to increase substantially the influence, involvement and achievements of professional engineers and technicians for the benefit of British industry'.

During 1995 and early-1996, Action for Engineering had a season of engineering-based television programmes and published brochures outlining the role of engineering in today's society. These were supported by lectures and poster campaigns.

Another key feature of 1994 and 1995 was the work to establish a new structure for the Engineering Profession in the UK. This work, led by Dr Alan Rudge in his capacity as President of the IEE followed on from the initiative by Sir John Fairclough. A new Engineering Council for the engineering profession in the UK came into being at the start of 1996. The new structure allows for the continuing independence of the individual institutions but means that the engineering profession in the UK through the new Engineering Council speaks with one authoritative voice, a feature again very much welcomed by Michael Hesseltine.

Clearly there is recognition at senior Government level that engineers and engineering are key to the future prosperity of the UK and this message must be put across to opinion formers, the public and most importantly young people.

Year of Engineering Success

Following on from the Department of Trade and Industry's 'Action for Engineering' umbrella, **The Year of Engineering Success (YES)**, will target public awareness by recognising achievement but, above all, by stressing the enormous contribution of engineering to Britain's future prosperity.

Engineering's most ambitious public-participation ever, YES will take in all levels from directors to the youngest primary school students. It will extend from September 1996 through 1997 dovetailing into the Millennium activities, to which engineering will be a significant contributor.

The Year of Engineering Success will be regionally based on themes designed to demystify engineering for the general public and relate the engineering profession and achievements to everyday life. The efforts will be supplemented to create a national impact.

The Year of Engineering Success

The Director General of YES is Dr Mary Harris formerly Head of Technology Strategy at British Gas. Mary Harris has welcomed the widespread support already pledged for the campaign.

'We need to create the same awareness throughout society as a whole so that talented people are attracted to engineering. We want to leave in place a series of follow-on activities to ensure that neither momentum nor talent is lost for the future good of this country'.

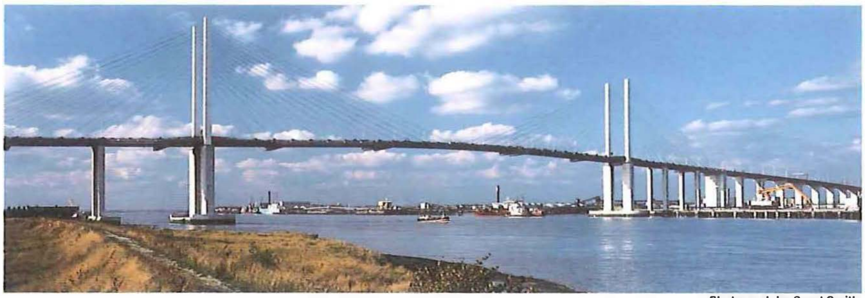
The YES themes include:

- engineering in the home and leisure;
- engineering in transport;
- engineering in communications;
- engineering in healthcare and consumers in the community;
- engineering in the environment;
- engineering in safety;
- engineering in energy;
- engineering in agriculture;
- engineering in defence.

So what are the aims of YES and how will it be managed and financed?

Principal Aim of YES

The principal aim of the promotion is to bring about a better understanding of the importance of engineering for the future prosperity of the United Kingdom. The principal audience is the general public. The engineer as an individual must emerge from the promotion as a figure that the general public values, understands and appreciates.



Photograph by Grant Smith

Subsidiary Aims and Target Audiences

Within the principal aim of the promotion there are the following subsidiary aims and associated target audiences:

- *Aim*: Achieve a significant change in public awareness of the central importance of engineering to their quality of life.
  Target Audience: General public and opinion formers.

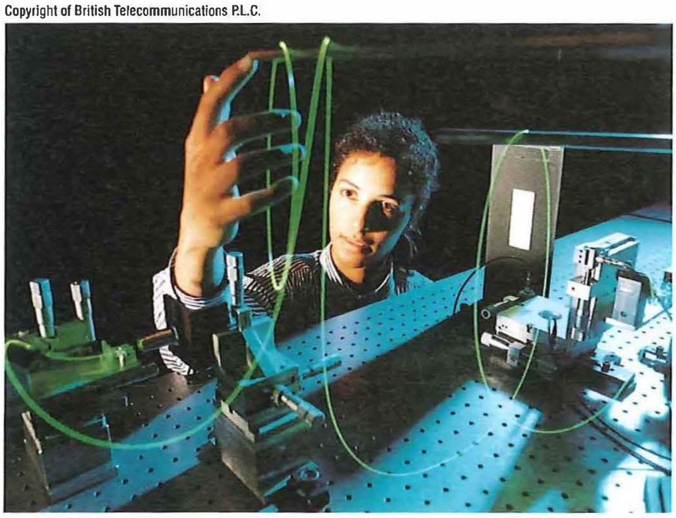
- *Aim*: Highlight the contribution which engineering makes to the competitiveness and profitability of British industry; and to the need for continuing access to world-class engineering skills to maintain competitiveness in the future.
  Target Audience: Engineering-based business, the general public and opinion formers.

- *Aim*: Ensure that the importance of engineering to the British economy as recognised in the Science and Technology White Paper is properly reflected in Government policies.
  Target Audience: Ministers, senior civil servants and opinion formers.

- *Aim*: to encourage more of the abler children to take engineering/technology courses.
  Target Audience: Parents of young families, primary school children; teachers and teachers in training.

- *Aim*: Encourage the media to project a more positive image of engineering as an exciting and challenging career open to both men and women, to project a more positive image of the UK as a leading engineering country, and to increase the coverage given to engineering.
  Target Audience: Opinion formers, editors, journalists, etc.

- *Aim*: to highlight the contribution which engineering makes to the environment, both through new developments and in cleaning up past dereliction.
  Target Audience: General public, particularly young people, and opinion formers.



- *Aim*: To encourage members of the engineering profession to be more active in promoting engineering.
  Target Audience: Younger members of the profession in particular.

- *Aim*: To support activities already being undertaken by the Institutions and others in education.
  Target Audience: Young people; all schools and teachers.

Organisation

At national level, the Year of Engineering Success is being coordinated by a secretariat operating through a Companies Act Company limited by Guarantee (YearCo Ltd.), which has been granted charitable status. YearCo will organise a concentrated media compaign in the run up to and during YES, starting with a presentation and press conference for key national and regional media targets and a series of informative news releases. YearCo will commission publicity material in support of specific activities including a series of Engineering Success books.

YES will be regionally based with the emphasis on regional initiatives, supplemented by activities organised at national level. Regional Working Groups drawn from the members and staff of the supporting organisations, local firms and Government departments will co-ordinate the regional programmes. Follow-on activities will be undertaken after the end of YES to ensure that momentum is not lost.

YearCo is being financed by its patrons and associates. A substantial grant has been made by the Departments of Trade and Industry, Employment, Environment and the Office of Science and Technology.

The list of those pledging their support to YES is shown in the panel.

YES patrons, associates and supporters

Patrons
BT Networks and Systems
British Gas plc
British Petroleum
Engineering Employers Federation
Engineering Training Authority
GEC plc
Institution of Civil Engineers
Institution of Electrical Engineers
Institution of Mechanical Engineers
National Grid plc
National Power plc
Nuclear Electric plc
Royal Academy of Engineering
The Engineering Council
Vickers plc

Associates
BICC plc
Department of Education and Employment
Department of Trade and Industry
Department of the Environment
HSBC Holdings plc
ICL
IBM UK Ltd.
Institution of Electronics and Electrical Incorporated Engineers
Unilever plc

Supporters (Engineering and Scientific Institutions)
British Association for the Advancement of Science
British Computer Society
Chartered Institution of Building Services Engineers
Chartered Institution of Water and Environmental Management
Institute of Acoustics
Institute of Energy
Institute of Engineers and Technicians
Institute of Hospital Engineering
Institute of Marine Engineers
Institute of Materials
Institute of Measurement and Control
Institute of Physics
Institute of Plumbing
Institute of Quality Assurance
Institute of Road Transport Engineers
Institution of Agricultural Engineers
Institution of Chemical Engineers
Institution of Engineers and Shipbuilders in Scotland
Institution of Gas Engineers
Institution of Incorporated Executive Engineers
Institution of Lighting Engineers
Institution of Mechanical Incorporated Engineers
Institution of Mining Engineers
Institution of Mining and Metallurgy
Institution of Nuclear Engineers
Institution of Physics and Engineering in Medicine and Biology
Institution of Plant Engineers
Institution of Structural Engineers
Royal Aeronautical Society
Royal Institution of Naval Architects
Royal Society
Royal Society of Arts
SCSST
Women's Engineering Society

Supporters
Parliamentary Group for Engineering Development

Supporters (General)
Amalgamated Engineering and Electrical Union
Association of University Teachers
BEAMA
British Nuclear Industries Forum
Chemical Industries Association
Confederation of British Industry
Design Council
Domestic Appliance Service Association
Engineering Centre for Wales
Engineering Education Scheme
Engineers and Managers Association
EnTra
Federation of the Electronics Industry
Gwent Training & Enterprise Council
Heating and Ventilating Contractors Association
Institute of Directors
Institute of Professionals, Managers and Specialists
Manufacturing Science Finance Union
Northern Engineering Centre
Science Museum
The Welding Institute
Trade Union Congress
Transport and General Workers' Union
Water Services Association
Year in Industry

Supporters (Firms)
ALHCO
Babtic Group
Boots Contract Manufacturing
British Aerospace plc
British Waterways
Eastern Electricity
Imperial Chemical Industries plc
Ingersoll Engineers Ltd.
KPMG
Lucas Industries plc
MANWEB plc
Nissan Motor Manufacturing (UK) Ltd.
Northern Electric plc
Northumbrian Water Ltd.
NORWEB plc
P.E International plc
Rust Consulting Ltd.
Rust Kennedy and Donkin Ltd.
SWEB plc
SEEBOARD plc
Sir Alexander Gibb & Partners Ltd.
WS Atkins Ltd.
Wessex Water plc

BT Networks and Systems (and before that Worldwide Networks) has been involved from the very start.

Lead in Events

The final quarter of 1996 is essentially about promoting the YES image in readiness for the national launch in January 1997.

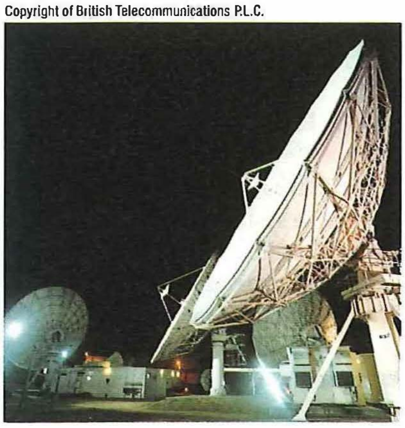
The YES autumn timetable began early in September with a major presentation at the Engineering Council's first annual conference in London. Hard on its heels followed the British Association for the Advancement od Science's Annual Festival in Birmingham where YES and its patrons were major exhibitors.

The first national event badged in support of YES was when the Engineering Employers' Federation took 640 young people to France on a very special 'away-day' by Eurostar.

The schedule up to the new year will be punctuated with YES events and activities designed to bring the campaign to the attention of the widest possible audience. The IEE is joined by BT, ICL and IBM in setting up a Cybercafe in Savoy Place aimed at a wide spectrum from MPs to schoolchildren.

An advertising campaign has started on the London Underground and a similar campaign will be launched in various parts of the country. The IEE has taken a leading role in launching this initiative. The advertisements are badged for YES.

Space was taken in the Lord Mayor's Show in London in November. An attention-grabbing entry related engineering achievement very closely to life around the City. Younger members from at least two of the engineering institutions undertook the project.



BT Activities

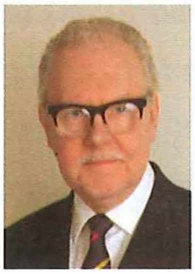
BT has been involved with YES since its concept and has given major support to YearCo. A small steering group under the chairmanship of Chris Wheddon, Director Systems Engineering, Networks and Systems, manages the BT involvement. A national support programme is envisaged for the regional activities where the Network and Systems Zones will play a key role.

One initiative from BT is the creation of MuseNet—a link up of some 12 museums around the country using ISDN6 with Internet service provision included. This technology would allow museums to conceive inter-site events which could be to the general public using large screen displays. The concept is still under active discussion with the lead museums concerned; that is, Science Museum, Kensington; the Bradford Museums of Film Photography and the National Museum of Liverpool; and will develop to suit the needs of each individual museum. The concept has great potential to show the public in general and young people in particular the successes of telecommunications in transcending geographic boundaries.

British Telecommunications Engineering journal plans to publish a series of articles throughout 1997 looking at engineering successes in the telecommunications field in line with the YES aims and objectives.

As we approach the new millenium, the vital role of engineers and engineering to the future prosperity of the country will become a continuing theme of which YES should be seen as a start and not an end in itself.

Biography



Bob Martin-Royle

Bob Martin-Royle recently retired from BT as Head of Interconnect and Emergency Planning. In a career spanning nearly 44 years, Bob worked on microwave radio relay, optical fibre and transmission systems. He was a founder member of National Networks (NN) in the early 1980s with the challenge of rapid modernisation of the trunk network in the face of the newly created competitive environment. Bob eventually became Deputy Chief Engineer for NN, responsible for all transmission and switching works. An active member of the IEE, which is a major force behind the YES campaign. Bob served on the IEE Council from 1993–96, is currently a member of the Centres Board, a Past Chairman of IEE Kent Centre and is currently Chairman of Kent Centre Electronics Section. Because of his IEE background, the Managing Director of Worldwide Networks asked Bob to coordinate the early stages of BT involvement in the Year of Engineering Success. He will act as Guest Editor for a series of articles in this *Journal* in support of YES.

Colin Hord

On-Line Meteorological Information From MIST

The telecommunications industry, like many others, can be seriously affected by severe weather conditions. Advance warning of such weather can allow preparations to be made to limit the impact on service. Meteorological information provides warnings, but such information needs to be available in plenty of time, and in detail, to allow action to be taken. Companies can now access detailed weather information, both the current situation and forecasts, through their personal computers using the Meteorological Office's MIST system.

Introduction

The weather has always had a major impact on the running of the telecommunications industry. Strong winds, heatwaves, ice, lightning—and a host of other factors—impact on everything from equipment and cables through workload to safety.

There is an array of well-established services available for industry in general: for helping anticipate regional problems,tackling site-specific tasks, and providing warnings of severe weather.

Most services are based on advice from forecasters at The Meteorological Office (The Met. Office), with information conveyed mainly by telephone or facsimile. For instance, energy companies forecast demand, farmers decide when to spray crops, pilots when to fly, and highway engineers when to grit roads.

The Met. Office now supplements this advice by placing weather information, in a directly useable form, in the hands of the user for the first time. It uses a PC-based weather-information system known as *MIST*, developed for The Met. Office, which allows unlimited access to a range of UK, European and even global graphical weather information and forecasts.

MIST is the acronym for meteorological information self-briefing terminal and was originally developed for the Royal Air Force as a tool for pilot self-briefing, since knowledge of the weather conditions is extremely important when flying. Although the package was designed specifically for air crews, the huge commercial potential of the system was soon recognised and it is now widely available to anyone needing detailed and up-to-date weather information.

A collaboration between Matra Marconi Space (MMS) and The Met. Office has made this potential a reality. MMS has responsibility for system design, software development and installations, while The Met. Office provides the meteorological data.

Meteorological Information

Information on MIST comes from a wide variety of sources, including radar network, weather centres, reporting stations and direct from numerical weather-prediction models, providing hundreds of images, some updated every five minutes.

MIST images are downloaded, as required, direct from one of the world's largest supercomputing complexes at The Met. Office in Bracknell, Berkshire.

MIST is already used in parts of the telecommunications industry, where high winds, lightning, heavy rain and snow can contribute to increased fault volumes. MIST helps managers prepare additional resource in advance of changes in the weather, to be able to take direct action at the most appropriate time.

MIST Network

The MIST host at Bracknell is the hub of the system. It is a network of personal computers that collects, stores and distributes data to users. These computers include:

- a communications processor, which continuously receives meteorological data from The Met. Office's central computing and telecommunications system, processing the data for storing in the MIST database;

- a file server, where the MIST data files physically reside;
- a communications server which handles all communications with MIST users; and
- a work station which allows The Met. Office helpdesk to supervise the MIST host and carry out a range of system management functions.

The MIST host is directly connected to a modem bank which is connected to The Met. Office PABX.

Since the host is permanently on-line, processing and saving data, the weather information available to users is always the latest at the time of access.

Accessing the MIST host

The communications package used with the MIST software is Xcellenet Remoteware. This is a sophisticated package with a number of specialised features:

- complex password protection system ensuring only registered users have access to the data;
- fault detection and diagnosis facilities on the workstation;
- customer billing and connection details; and
- single transmission of information to ensure users do not get the same information more than once, thereby keeping costs to a minimum. When information is requested, the host checks if the same data has been downloaded by the same user before.

Users can access MIST in two ways:

Dial-in

Most users only need weather information occasionally on a dial-up basis, so they only get—and pay for—the specific data they need.

Users choose the information required on the product-select menu. This could be a wind-forecast graphic, a surface-pressure chart, the latest weather reports, or any combination of these. Selection is made off-line which enables the connection costs to be kept to a minimum.

Users instruct their PC to dial the host, direct in Bracknell, connecting to a modem bank in The Met. Office telecommunications centre. The host sends back the requested data to the user's hard drive and automatically disconnects. Since the data files are kept on hard disk, information can be viewed any time.

Screen shots can also be saved as graphical bitmap files and stored for use in reports or archives.

Dial-out

Daily users can have all the relevant weather data and graphics they need delivered to their PC or network at agreed times. Customers can dial-in to access more information if needed, like an update on current conditions, or additional charts not routinely delivered.

Typical users of the daily dial-out delivery are energy companies, requiring temperature forecasts and water companies wanting rainfall radar images.

This delivery method also supplies data to the public display MIST terminals provided at the Houses of Parliament and Ministry of Defence HQ.

An integrated services digital network (ISDN) connection is possible to MIST. This is ideal for servicing users who require large volumes of data, like The Met. Office's forecast office in Singapore.

Using a scheduler on the MIST system is a hands-free option, allowing users to dial-up automatically at specified periods and print the information they need.

During a large thunderstorm, for instance, when staff are at their busiest, the scheduler can be set to download more frequently. Ensuring all data on-screen is up to date, so business decisions affected by the weather can be made with confidence.

Applications

The MIST system complements existing forecast services, but allows conditions to be tracked more precisely, enabling actual weather to be monitored almost minute-by-minute.

MIST is designed to provide businesses with the ability to monitor the current weather situation, in detail, across many regions.

Tracking severe weather

By keeping up to date with a severe weather event as it moves from region to region, managers can anticipate how their resources should be allocated.

For example, ensuring maintenance engineers are in place for storm damage, help desks are sufficiently manned, or contingency plans are ready to be started.

Information on MIST is presented in simple-to-understand colour graphics, designed specifically for non-meteorological users. Users can zoom in to their area of interest as small as 50 km × 50 km, allowing considerable detail to be seen, so showers and individual thunderstorms can be easily tracked.

A wide range of geographical features can be displayed on the maps, including towns, roads, rivers and railways. Customer-specific information can also be made available; for example, the Environment Agency is able to display its regional boundaries on their dedicated MIST system.

Rainfall

With MIST, the telecommunications industry can anticipate heavy

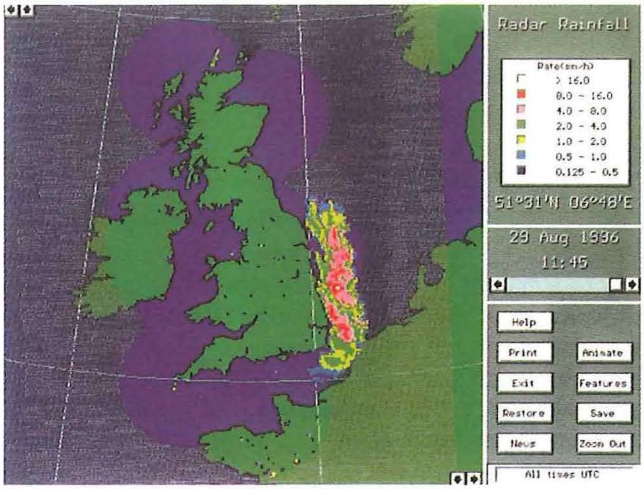


Figure 1 – Rainfall radar image

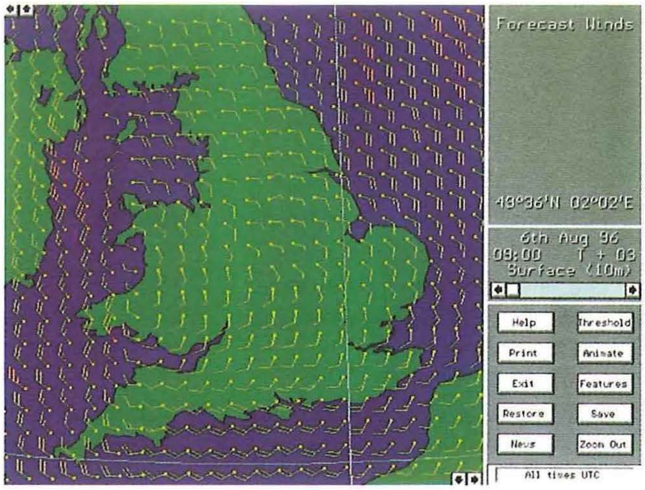


Figure 2 – Wind forecast

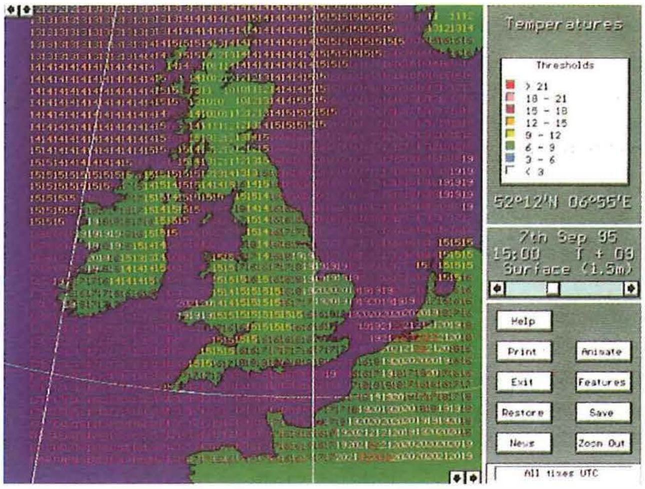


Figure 3 – Temperature display

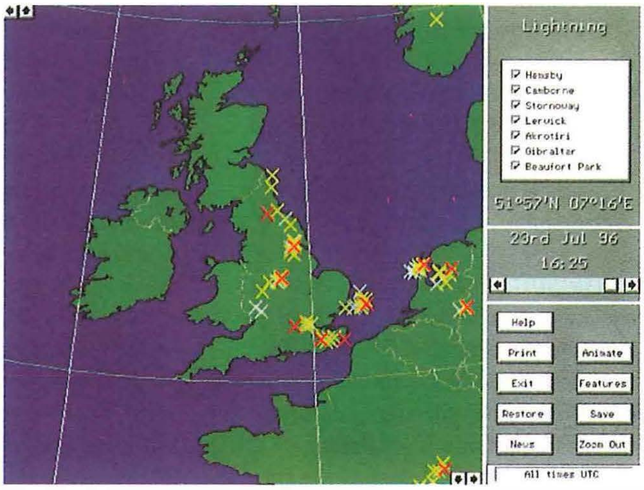


Figure 4 – Lightning strikes

rainfall and flooding, enabling systems to be geared up, or shut down, to avoid damage. Rainfall radar images – similar to those seen nightly on TV screens – can be updated every 15 minutes.

These show not only the location but also the intensity of the rain (Figure 1), each colour showing a different rate of rainfall. The data can also be animated for visualising the movement of the rain bands, so users can see if showers and rain are becoming more or less intense.

Using actual information, along with the computer-generated predictions of rainfall six hours in advance, users can see when best to carry out maintenance, or when to call back crews if the weather worsens.

Severe wind

Severe winds, threatening structures and communications lines, can be anticipated and monitored through spot readings, often delivered hourly, from over 100 observation points throughout the UK. European readings are also available.

These observations include considerable detail on the state of the atmosphere, including pressure, wind speed and direction, visibility, temperature, humidity, cloud information as well as the current weather conditions, like rain, snow, hail or fog.

When strong winds blow, gust values are shown. As these cause problems to communication lines, seeing where line damage could occur is very useful to control-room personnel.

All this information is displayed graphically on the map. Users only need to select the elements they wish to view.

Forecasts of wind speed and direction can also be viewed. Spot readings can be given every 30 km and animated over the 18 or 36 hour forecast period (Figure 2).

The threshold feature is very popular with MIST users. A specific wind speed can be entered, so all wind arrows over this level are indicated in red, alerting control rooms at a glance to impending strong winds over the UK, the North Sea and Europe.

Temperature

Freezing conditions are a major concern to telecommunication-line maintenance engineers, as ice-build can lead to lines snapping under the extra weight.

MIST can anticipate and monitor freezing and other cold weather conditions, using spot-readings, forecasts and graphical temperature images to help tackle potential disruption to systems, access to sites and factories etc (Figure 3).

Heatwaves and unseasonably-high temperatures cause problems too, putting extra loading and stress on equipment and personnel. Using MIST, work can be easily scheduled for cooler periods, as temperature forecasts can be colour coded. If, for instance, a company can not service generators when it is hotter than

25°C, the software can be set to clearly indicate when or if the threshold is likely to be reached.

Lightning

Lightning is not only dangerous for telecommunications engineers, but also can cause line malfunctions. Knowledge of approaching storms allows precautions to be taken (Figure 4).

Lightning information is displayed in two ways on MIST:

- A colour-coded map of the UK shows the risk of lightning with a rating from none to high. The information is updated every six hours and is available 24 hours a day.
- Actual lightning strikes can be viewed on-screen. The images, updated every five minutes, are generated by The Met. Office lightning detection system. This pinpoints strikes to an accuracy of 5 km in central England. As with the rainfall-radar display, images can be built up into an animated sequence. The strikes and storm can be easily tracked, using colour graphics.

Power generation is another major consideration for many industries, who need to anticipate when supplies are at risk, so precautions can be taken, like using standby generators.

Large companies, with sophisticated computer networks, are also exposed to risk of power loss and require to forecast when backup is needed.

Severe weather draws bigger responses from the public across a range of businesses, so customer help desks can be staffed up or down according to the weather forecast.

Snow

During winter, a wide range of customers need to know when snow is due. To help this, The Met. Office can now forecast the type of precipitation.

On MIST each map of the UK is overlaid with colours denoting the kind of precipitation: rain, drizzle, sleet, snow or freezing rain. As with other displays, a six-hour forecast can be animated to show the movement of precipitation, zooming in for specific area information if needed (Figure 5).

All weather services are constantly under development, and MIST has its own full-time system programmers. Next year The Met. Office expect to offer a Windows version, so multiple graphics can be on-screen simultaneously.

In severe weather situations, businesses can be put under considerable pressure to satisfy customer needs. Being able to keep up-to-date with the latest weather information is an essential tool for faster and more informed decision-making.

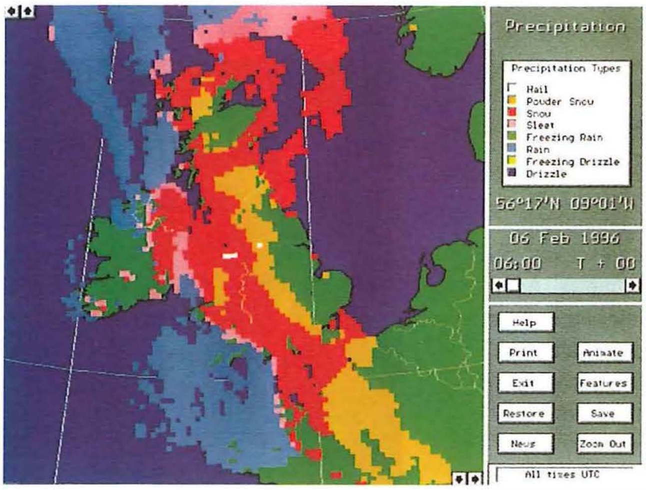
For more information contact:
Colin Hord
The Meteorological Office
(01344) 856284

Biography

Colin Hord
The Meteorological Office

Colin joined The Met. Office in 1984 where his initial posting was to the atmospheric chemistry group with responsibility for developing a specialised system for analysing air samples. In 1990, he moved to the Meteorological Research Flight (MRF), based in Farnborough. There he spent much of his time flying in the MRF Hercules collecting air samples, including one trip to Bahrain measuring smoke pollution after the Gulf War. In 1994, Colin took on the project management for the MIST system where he is helping businesses make better use of weather information.

Figure 5 – Types of precipitation



Journal Awards for 1995/96

Journal Best Article award winners with IBTE President Chris Earnshaw. Left to right: Ian Pearson, David Wheatley, Chris Earnshaw and Peter Cochrane

Introduction

The *British Telecommunications Engineering* journal is an important record by which the membership of the Institution of British Telecommunications Engineers (IBTE) and others can keep abreast of various items of interest in telecommunications.

To encourage readers in furthering the role of the *Journal*, and to give authors due recognition for outstanding contributions, the Board of Editors operates an annual award scheme. Prizes are awarded to the authors of articles which, in the opinion of the Board, demonstrate excellence in content and presentation and which enhance the quality and range of contributions published.

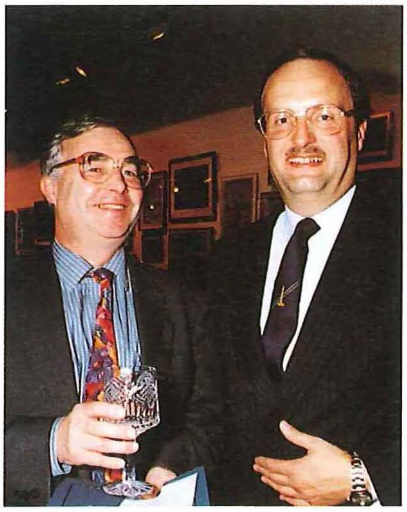
The Mall Galleries in London was the colourful setting for a special awards dinner on 4 October 1996 at which IBTE President Chris Earnshaw, Managing Director of BT Networks and Systems, presented the prizes for 1995/96.

Top Award for 'Who Cares?'

The prize for the best article from Volume 14 of the *Journal* went to Peter Cochrane, Ian Pearson and David Heatley for their article 'Who Cares? Future of Telemedical Technology', published in the October 1995 edition. They received crystal bowls inscribed with the IBTE's insignia, certificates and a cash prize.

This article is part of an extensive series on the theme 'Telecommunications in the 21st Century' which Peter Cochrane has been leading. The article shows how the worlds of the communication industry and the medical profession will move forward into the future, and what an article! From a gentle beginning discussing the trends of carers per head of the population, it goes on to take us into the world of automated surgical operations. It takes us into the realms of automated outpatient visits, operations performed by a surgeon hundreds of miles away, and doctors becoming 'cybernauts'. All this is supported by detailed, colourful surgical photographs of knee operations and endoscopic images—not for the squeamish! The medical profession and telecommunications industries are closely linked now, but will become ever more so in years to come. The question 'Who Cares?' becomes more difficult to answer. Perhaps the answer is in the final paragraph of the article: 'Probably the greatest challenge will be the design and engineering of interfaces that can be successfully mastered by an old, infirm and sometimes confused population. The emphasis has to be a human one as increasingly it will be the machines that care!'

Bill Whyte receiving his Journal runner-up award



Andy Reid receiving his Journal runner-up award (Bonnie Ralph, his co-author, was not able to attend)

Russell Silk—winner of the award for Best Unit from the Structured Information Programme

Runners-up for the Structured Information Programme—from the right, Mick Sharpe, Ray Guyon and Peter Lisle

Journal Runners-Up

The Board of Editors awarded two runner-up prizes for the *Journal*. The authors received crystal goblets, cash prizes and certificates.

The World at Work and Play

The first runner-up prize went to Bill Whyte for his article 'The World at Work and Play' published in the October 1995 edition as part of the 'Telecommunications in the 21st Century' series.

Bill's article examines radical changes to the way we work and play that will be made possible by evolving technologies that realise massive computing power, very wideband transmission, humanised interfaces, multimedia and artificial intelligence. He offers us a stimulating view of the world of tomorrow in a very readable piece touched with an element of humour.

Convergence—Synthesising a New Industry

Volume 14 introduced a theme on the 'Information Industry and its Key Technologies'. Some 17 articles were published including electronic commerce and security, community networks and the future shape of the information society. Bonnie Ralph was the driving force behind making this theme such a great success. One of the articles from that series 'Convergence—Synthesising a New Industry', from the January 1996 edition, by Bonnie Ralph and Andy Reid, was the second runner-up article. They present an authoritative overview of the new information industry that is arising from the convergence of content creation, computing and telecommunications. They managed to guide the reader through the many complexities of this subject area in a style which is both educational and stimulating.

Winning 'Satellite Communications' Unit

The prize for the best unit from the units published in issues 16–19 of the *Structured Information Programme* (SIP) went to Russell Silk for his unit 'Introduction to Satellite Communications', Chapter 8, Unit 2. He received a crystal bowl inscribed with the IBTE's insignia, a cheque and a certificate.

Russell begins his excellent unit by reliving the exciting days of the early 1960s, when communication by satellite was still magical and not the commonplace occurrence of today. He guides us through the development of satellite systems from the early small-capacity satellites to today's services such as direct-to-home satellite-television broadcasting and mobile satellite telephony using the very high-capacity systems now available. The unit explains some of the technical aspects of satellite communications. In addition to the telecommunications aspects, Russell tells us about the physical design of satellites themselves, the rockets used to launch them, and the means of placing them in the correct geostationary orbit, 36 000 km high! This is a very delicate operation, particularly when one remembers that it is carried out by firing rocket motors attached to a satellite costing many millions of pounds.

SIP Runner-Up

The runner-up prize for the *Structured Information Programme* went to Mick Sharpe, Ray Guyon and Peter Lisle for their unit 'The Evolving Structure of the Access Network', Chapter 10, Unit 1. They received crystal goblets, certificates and a cash prize.

As network planners within BT and other licensed operators consider the evolution of their access networks or the creation of new access networks, they need to consider the likely opportunities as well as the possible pitfalls that each of the many technology options open to them brings. The authors' very readable and structured unit examines the capabilities and applications of current technology options as well as some that promise to emerge over the next few years. It concludes that to achieve optimum network structure and to minimise operating costs it is vital in the longer term to rationalise the many technical options. This hitch-hiker's guide to the access network is a very worthy runner-up.

Peter Cochrane, Head of Advanced Applications and Technologies, at BT Laboratories, Martlesham Heath, continues his regular column in the* Journal *by looking at fundamental new roles for banks as the information age gathers pace.

Banking on IT

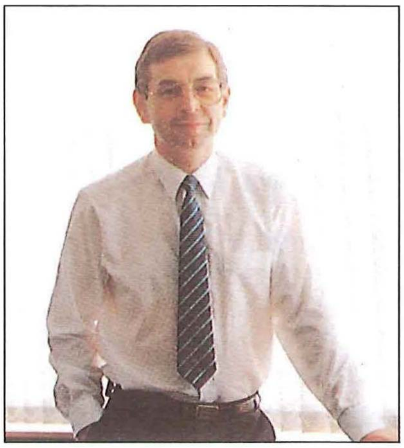
Until recently banking has been a clearly defined and somewhat exclusive sector. Today it is becoming destabilised by a diverse range of organisations including building societies, insurance companies, car manufacturers, telecommunication operating companies and other institutions offering a myriad of new banking and financial services. The attraction of linking banking with large-scale investment and product purchases to incentive schemes giving customers a package deal has created a market for new forms of banking. This process is being driven by fundamental changes in technology and industry as well as the wider restructuring of society that will continue well into the 21st century.

Not so long ago, customers would sign up with a bank and stay a loyal customer for life. Perhaps the difficulty in moving an established account engendered this life-long relationship, or just a lack of choice. No matter, today information technology (IT) makes that transition far easier, and indeed, we are already seeing an emerging world of virtual organisations that include banks. The advantage is simple—open 24 hours a day—always available for business with or without human intervention. For many people, the notion of travelling into town to visit a physical branch to conclude business is already an anathema. For the most part, it can all be done by telephone, and on-line from a PC.

So what are the fundamental drivers invoking all this change? For aeons mankind has taken raw materials and shaped them into artefacts we could barter. Expensive physical articles have been dominant in the market place with money an absolute necessity to oil the wheels of commerce. Putting aside the occasional economic crash or misdemeanour, banks have been an essential cornerstone of the economic system and necessary to support global commerce. Lately, a more ethereal market has arisen within a newer world of bits—not raw material. The information world and market is concerned with the construction and production of a new kind. Manufacturing bits can be very expensive, but their replication, storage and transportation is not. Using computers, networks and terminals instead of warehouses, trains, planes, trucks, wholesalers and shops, means we can distribute faster and sell far more. Hence, we are witnessing the start of something new.

Macroeconomies based on microprices is a trend that is already visible as software and services are sold on-line, on demand, any place, any time. Libraries of classic books, reference works, interactive multimedia entertainment, health and education packages are now available on-line. This future of micro-money will see the birth of new macroeconomies, and companies that go on-line will see some remarkable new phenomenon. People will buy and discard products faster, markets will become more fickle, companies will be created, come to dominate, and then die faster, as the economic cycle speeds up through enhanced productivity and communication.

At this point, traditional banks are really no more than databases with no need of direct human contact required for most transactions. They must be electronic as it is uneconomic to process cheques or coinage in such small amounts. Unfortunately, it is also clear that anyone with a PC and a modest software programming capability can open their own bank. It is not entirely by accident or inspiration that car manufacturers and telephone operating companies have now moved into banking. Perhaps large software suppliers will soon do the same as they can make enormous savings by integrating their operations. One company that recently put



its sales and marketing catalogue on-line now deals with 1·7 million enquiries a week and has seen a trade increase of over 50%. This is fundamentally impossible for humans as the interface of a conventional retail outlet chain.

As we move into the 21st century, the information age will gradually migrate toward experience with virtual worlds in education, training, transport, work, entertainment medicine and care—plus many others! These new industries will require a new commerce—a new way to charge and pay. This will be a far faster world of much more for much less. People working from anywhere for anyone with no jobs for life—a more chaotic and opportunistic world far removed from that of today!

All of this will further erode the traditional banking sector and be compounded by a disappearing commodity—coinage. It seems remarkable that metallic and paper tokens (money) are still used in a world of information technology and electronics. Credit cards, electronic cash cards, the electronic purse (MONDEX) and other on-line variants are in everyday use and there are further developments on the horizon. In this information world, no money is exchanged—databases are merely updated. There is no gold, or any need for it—it is a moribund concept! In a sense, geography is also dead and for the customer the choice will increasingly become stark. You can still travel into town, with all the inconvenience and time wasting it entails, and pay the additional overhead of a shop, wholesaler and distribution chain. Alternatively, you can go direct to manufacturer in the USA, make a purchase and have your software delivered on-line at a fraction of the price, by-passing the VAT man in two countries. At the same time the databases of only two banks, customer and producer, change negligibly!

We can now see banking for what it really is—not money, just information! Interestingly, this information market spurns a new concept—information about information. The first evidence of this comes from the United States where publishing details of television programmes and information databases makes more money than those producing the raw information—programmes. Here is a new opportunity—banks hold a vast amount of information about companies and individuals; they have the databases and the infrastructure to supply new services.

So what should conventional banks do? Firstly they have to recognise that they are increasingly in the 'information about information' business. For many organisations, billing for services and goods supplied is becoming a very large operating overhead and a process they do not want to be in. Banks do this extremely well and we might see a future where they become an ethereal point of sale, providing a range of financial, physical and information goods supply services. Why do we have gas, electricity, water, television, entertainment, hotel and insurance bills as separate entities? These are very often paid by direct debit and could easily be integrated into one electronic statement. In the information future, we may therefore see banks becoming the universal billing system for all human activity. This would then allow some novel service groupings able to provide new opportunities for purchase incentives, discount and loyalty bonuses, price and cost reductions. Clearly, as the bureaucracy involved in collecting and moving money around the planet is reduced to its bare essentials, data, the nature of banking will migrate into new information-based activities.

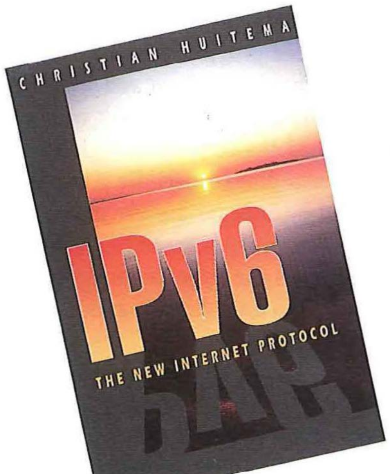
Banks as the ultimate billing machine could also focus on charging for the important, negotiating the tractable and providing instant access on the screen. This could be the primary point of contact, but it is interesting to contemplate the future of high-street banks as they may remain a required point of human interaction for things information technology cannot do. For some time yet detailed negotiation may require human contact.

In 20 years, we are likely to look back with wry humour at the arguments of long-gone politicians and a large proportion of the population with their insistence for regional currencies bearing the profile of the head of state. Such concepts are likely to have been assigned to museums as the obvious alternative, bits in databases, take over. By 2015, our world and economy will have been transformed by IT and machines with intelligence approaching our own. They may well be smart enough to question and bypass the old human ideas that necessitated banks, and if not in 20 years, then in 30. In 2015, some coinage and paper money might remain, and perhaps even a few cheques, but I wouldn't bank on it.

book reviews

IPv6—The New Internet Protocol

Christian Huitema



This 188 pages describes the next generation Internet protocol (IP), the scheme used to convey most data on the Internet.

The popularity of the Internet, as measured by numbers of hosts and users, has ballooned over the last few years and this growth looks set to continue for the foreseeable future. This growth has stretched some of the design assumptions behind the Internet's addressing scheme and protocols to breaking point and the redesign of IP was in response to fears that the stock of addresses would run out (compare this with the telephone situation requiring the recent phONEday and the proposed phTWOday). Added to the increase in usage is an increase in uses for the Internet as new types of application (for example, electronic commerce) and data flow (like multi-media or bulk data transfer) are deployed.

This is a specialist text intended for readers who are familiar with the current generation of Internet protocols and is intended to describe the new version of IP with reference to the present version where there are significant design differences. New features are explained together with a rationale for design choices where this is appropriate. Each chapter includes suggestions for further reading.

An especially useful feature is the inclusion of a 'points of controversy' section in each chapter which describes design features that are still being hotly debated. Although intended for a specialist audience, many readers could gain an insight into many actual or potential shortcomings of the Internet by reading about ongoing controversies. There is also a glossary.

Topics covered include the design of IPv6, routeing and addressing, autoconfiguration features, security, real time and flows. The book ends with a discussion of Internet transition issues.

People with a need to know, such as those concerned with low-level Internet support or involved in applications with critical quality-of-service requirements will find this a useful overview of the future of the Internet. Others will benefit from judicious skimming.

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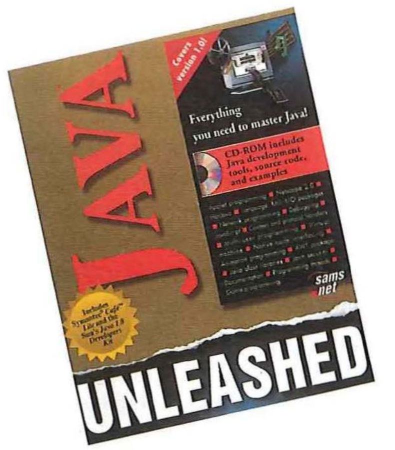
Reviewed by Ed Oskiewicz

Java Unleashed
Editor: Cindy Morrow



Even though it is just over a year old (officially launched at SunWorld '95), many see Java as the next big development on the Internet after the arrival of the World Wide Web. Specifically Java is a distributed, object-oriented machine-independent programming language. It is a set of software tools for developing applets and applications in the Java language. This book sets out to cover a lot of ground in and around Java for a wide audience in its 44 chapters, six appendices, and glossary. There is something in this book for most people, although for those interested in only part of the picture a smaller, more focused, book might prove more appropriate. However, I liked the breadth of coverage.

Part 1 introduces the origins, capabilities, and potential of Java together with a technical overview. The high-level examples of, and on-line sources for applets make this section suitable for all readers and illustrate well some of Java's features. At a similar level of detail, the next section gives an overview of the Netscape and HotJava browsers, reviews each component of the Java developer's kit (JDK) and describes available development environments and programming libraries. At this point a good account of the jargon has been delivered and will give novices an appreciation of the issues surrounding Java.

The following five sections are for programmers. The detailed (but readable) section on the JAVA language introduces classes, interfaces and packages (groupings of related classes and interfaces), and gives a concise, but good, primer on object-oriented programming. A helpful chapter on threads and multitasking illuminates an area that will be new to many. The reader is then well prepared to move on to more detail in the sections that follow, the first of which provides insight into the language, utilities and input/output packages.

The section on applet programming discusses applets and their limitations, class hierarchy, life cycle, and associated hypertext markup language (HTML). Event handling and the various graphical user interface components are covered well and an example user interface is developed. Useful guidelines on producing real world applets and animation techniques are complemented by practical development of two complete applications.

Two sections on network programming and Java's use in the games, multimedia and virtual reality modelling language (VRML) arenas are followed by one on advanced Java. This gives helpful insights into multi-user programming, compiling for and using the Java debugger, using the javadoc generator to produce application programming interface documentation directly from the source code, and the pros and cons of native methods. Coverage of the fundamental parts of the Java virtual machine is followed by a discussion of Java's security model, suitable for all readers, which gives a set of realistic issues which need to be considered in choosing whether or not to use Java.

The final section introduces JavaScript: what it is and where it came from, its relationship to Java, and the language itself. The coverage is reinforced by a number of example programs which develop the reader's understanding of the topics discussed.

The book concludes with a set of appendices, a short glossary and a thorough index. It also comes with a CD-ROM containing JDK 1.01, Symantec Cafe Lite (an integrated Java development environment), third-party tools and utilities and, thankfully for typographically-challenged typists, such as myself, examples from the text. There is a tendency to repeat information at differing levels of detail, in different chapters—pedagogically not necessarily a bad thing. I would have preferred to see specific details of the book's intended audience and expected level of knowledge in the introduction.

For those creating web pages using applets rather than developing them using Java, this book may be overkill, although it contains much useful information. They will probably find the Java language details heavy going, however these can be safely skipped without penalty if Java development is not of interest. It's well worth reading for experienced programmers seeking an introduction to Java and wishing to develop applets. The book will provide such an audience with a good grounding, especially if supplemented by appropriate use of the on-line resources presented throughout. It combines the hype and nitty-gritty of Java into an interesting and worthwhile read.

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Reviewed by Mike Ceolho

BT Announces New Venture in France

BT has announced that it has signed an agreement with Compagnie Generale des Eaux to take a 25 per cent stake in CEGETEL, the new French telecommunications group. The consideration is Ffr 8·85 billion (£1·1 billion) in cash plus the share capital of BT France, and final agreements will be concluded by the end of 1996.

The new group is well positioned to be the main competitor to France Telecom. It will provide the full range of telecommunications services in France, with mobile through SFR, as well as fixed services and paging. CEGETEL will be applying for a fixed licence to operate a full range of telephony services from 1 January 1998.

SFR is already the number two mobile operator in France with over 700 000 customers in a market less developed than in the UK.

BT Chairman, Sir Iain Vallance, said: 'This agreement positions BT as the only telecommunications company capable of a pan-European assault on the market and I'm delighted that it has been reached after such a short and intense period of negotiation.'

Sir Peter Bonfield, BT's chief executive, added: 'Although BT has been operating successfully in France for several years it has been no secret that we have been looking for a joint venture with a substantial French partner.

'SFR is now taking more than 40 per cent of new mobile customers every month and is expected to be profitable by 1998. It is already a major competitor to France Telecom and its growth prospects are exciting.'

CEGETEL's fixed operation will provide a wide range of data and voice services—initially mainly to the business community but will also include some residential customers.

Concert services will be an integral part of the new company's portfolio and will give CEGETEL a significant advantage over all other competitors.

BT will be CGE's main strategic partner in CEGETEL. Other partners will include SBC, formerly South Western Bell, and Mannesmann, the major German group. Vodafone has a stake in SFR.

M. Jean-Marie Messier, President Directeur General of CGE, said: 'I am particularly happy to welcome BT as the main strategic partner of Generale des Eaux in CEGETEL.

'This international partnership will enable CEGETEL to become the only effective alternative telecom operator on the French market.

'The success of BT and the quality of the links already established between our operational teams bode well for the success of our partnership.'

BT Joint Venture In The Netherlands

BT and Nederlands Spoorwegen (NS) have formally celebrated the creation of their joint venture company in the Netherlands. The new company, called *Telfort*, has been launched to address the Dutch business community.

Pat Gallagher, Director BT Europe, said: 'We are delighted to have reached this stage in the development of our plans for the Dutch market. In NS we have found a partner who shares our vision for extending telecommunications choice in the Netherlands.'

Leendert Schouten, Board Member of NS, said: 'Today's celebration places the BT/NS joint venture firmly on the Dutch telecommunications map, and we are marking a significant milestone in the history of Dutch communications.'

Headquartered in Amsterdam, Telfort will offer initially data, corporate voice and virtual private networks, as well as international voice and data services from Concert. The company will also offer management and outsourcing services. A full national portfolio of products and services will be available once a licence has been awarded.

Koos van der Meulen, the new Managing Director of Telfort, said: 'Today marks a new beginning for both BT and NS in the Netherlands. Telfort represents the strengths of both parent companies. Through BT, the Dutch business community will continue to have access to the world's leading global telecommunications supplier, and through NS, Telfort's national network will reach every major town and city in the Netherlands. We look forward to extending our products and services to meet the demands of the domestic Dutch market.'

Plans for Telfort to address the Dutch residential and mobile markets are also being developed, with the firm intention of positioning the joint venture as the alternative telecommunications company in the Netherlands.

BT and News International to Launch Major Consumer On-line Service

BT and News International have announced plans to launch *Springboard*—an Internet service designed for the UK mass consumer market. The service, planned to be launched in January 1997, will provide fast and easy access to content drawn from major News International and News Corporation brands, such as *The Times*, *The Sunday Times*, *The Sun and the News of the World*.

Springboard, a new joint venture company to be owned by BT and News International, will create and deliver—via the Internet—entertainment, information and education to UK homes.

Springboard will use the latest technologies and quality content to give potential customers a real reason to go on-line. The Springboard environment will be highly personalised, multimedia-rich, easy to use and above all secure. For the first time, families looking to explore the Internet and benefit from a wide variety of on-line and interactive services will be offered a total solution.

Rupert Gavin, BT's Director of Multimedia Services, said: 'Unlike current services, which appeal only to limited sectors of the community, Springboard will have the depth of material and ease of use to appeal to a wide range of households.

'We will be able to offer teenagers help with their homework as well as news on their favourite football team, while providing parents with the latest in holidays, banking or local events.'

Springboard will work with third-party partners to provide a broad spectrum of useful services including up-to-the-minute local and national news, weather, sport, events, listings and ticketing, as well as games, retailing and a definitive reference library.

In addition, Springboard subscribers will benefit from BT's world class communications infrastructure to gain fast and reliable local access to the Internet. This will be backed up by BT's customer support teams, and the new company will strive to transform the enthusiasts' Internet-access market into a universal and popular medium.

Douglas Flynn, Managing Director, News International, said: 'Springboard will develop a true UK consumer mass market for on-line services. With News International's expertise in publishing, multimedia and news gathering, and BT's experience in multimedia and communications, the new venture will establish a very attractive service for the UK market.'

As well as enjoying unique high-quality content, customers will be able to use e-mail, chat online, participate in interactive debates and post their own Internet pages.

Mobiq Provides Global Communications

The world's smallest global communications system will soon be on the market following the completion of successful trials. A breakthrough in mobile communications, Mobiq is a joint initiative between BT and Norway's Telenor.

As small and light as a notebook PC (weighing about 2·3 kg), Mobiq is the world's most diminutive satellite telephone. Making calls possible from the most remote places in the world—such as the Gobi Desert or the Amazon rainforest—Mobiq also provides coverage of the areas where cellular phones do not currently reach. Now mobile calls will be possible from places such as Eastern Europe, South America, Asia, most of Africa and even the Scottish Highlands. Mobiq communicates via satellite and is capable of high-quality voice, fax and data communications, including e-mail, and comes as a complete package of telephone and airtime. For security and flexibility, it operates with a SIM card which is removable and allows users to share handsets.

Trials of Mobiq are currently under way at Eik satellite station in Norway. Knut Reed, Telenor's satellite services director said: 'We are very excited about Mobiq and, even at this early stage, the trials have been going extremely well. This product will mean that all travellers—from aid workers to businessmen—will be able to go literally anywhere in the world secure in the knowledge that they're contactable and can make contact.'

Inmarsat satellites positioned high over the equator will provide the links for Mobiq. This new generation of satellites have powerful spot-beams focused on the world's land masses. The high power of the satellites means less power is needed on the ground, paving the way for smaller terminals. Initially available in continental Europe, Asia, the Middle East, Western Australia and most of Africa, the service will be extended to encompass the rest of the world during 1997 when mobile users will be able to use their handset virtually anywhere.

A Mobiq satellite telephone

industry news

New National Numbering Scheme Proposals

Don Cruickshank, Director General of Telecommunications, has published a consultative document on the future of the national numbering scheme. The document sets out proposals for the final phase of the evolution of the scheme which began with PhONEday last year.

The Director General said: 'The UK is at the front of the information revolution because we have one of the world's most competitive and dynamic markets in telecommunications networks and services. If we are to maintain our leading position, and reap the rewards that flow from that, our numbering scheme must keep pace. PhONEday created 8 billion new numbers for us and now we have to take advantage of this opportunity and develop a coherent, flexible and robust scheme to secure the long term availability of numbers for both residential and business users.

'Last year I published a consultative document which outlined proposals for the future of geographic numbers. The least change options put forward then were rejected by the industry and consumer groups. Since then OFTEL has worked closely with the Numbering Advisory Group, which comprises representatives from consumer groups and the telecommunications industry, to evolve the numbering strategy outlined in the document. I hope that it will trigger off a lively and responsible debate because the results will have a significant impact on us all for the next 20 years.'

The proposals put forward in the document suggest:

- mechanisms for providing more numbers wherever and whenever they are needed;
- providing a new 'corporate numbering range' for large businesses to exploit new opportunities using the 05 prefix;

- measures which will allow customers to recognise types of services (and the likely cost) from the numbering prefix; and

- ways of extending number portability both to mobile services and to services such as Freephone and Premium rate calls.

OFTEL has undertaken research that shows that 25–30 areas will require more numbers in the next 15–20 years. Demand for numbers for other services such as mobile, freephone, and premium rate, and from independent service providers, is likely to rise substantially. The numbering scheme must be able to accommodate all these demands.

More urgently, there are five areas that need action within 5 years to ensure adequate supply of numbers:

London: The existing 0171/0181 codes will be unable to accommodate growth beyond the year 2001. Londoners are being offered a choice of numbering arrangements from the year 2000 onwards. Either all of London can be unified into a single code of 020, or the present split between inner and outer London can be maintained by the introduction of the codes 020 and 022. These short prefixes will be followed by 8 digit numbers. The unified option would create 64 million new numbers and the split option 144 million.

Cardiff: The new 0282 code could replace 01222 in the year 2000. Adjacent areas could be amalgamated into the new code so that up to 1 million customers in South East Wales would benefit from local dialling.

Belfast: The new code 0292 could replace the existing 01232 code in the year 2000. Surrounding areas could be incorporated into the new code to provide a larger local-call area. Given sufficient demand it would be possible to introduce a single code for all of Northern Ireland so that no one would have to dial an area code anywhere in the province. This would require a short code of 029 with 8 digit local numbering and could be fully in place by 2003.

Portsmouth and Southampton: New codes of 0233 for Southampton and 0235 for Portsmouth could be introduced in the year 2000. For both new codes, adjacent areas could be incorporated to provide local-call dialling over larger areas.

Currently mobile services are spread across a number of codes—beginning 03, 04, 05, 08 and 09. OFTEL's proposal is to rationalise this by moving all existing numbers to the 07 range—together with personal numbers and paging services—by 2001. Under the proposals, 07 will be established as a *find me anywhere* range where callers know that they have a good chance of getting a call through to the person being called. OFTEL is also proposing that portability is introduced for all 07 services.

For specially tariffed services, such as freephone, local- and national-rate services, OFTEL's primary aim is to establish portability at an early date. This will transfer power to customers, allowing them to decide which operator should provide them with service. OFTEL intends that all these specially tariffed services will be grouped together behind the 08 prefix.

For premium rate services, OFTEL has taken account of the results of market research published jointly by ICSTIS and OFTEL last week, which showed a strong consumer demand for such services to be moved away from freephone and other specially tariffed services on 08. OFTEL is therefore proposing that these services move to the new 09 range by 1999. A substructure is also being suggested which will give callers a clearer indication of the likely cost of the call.

The rest of the proposed scheme will be arranged as follows:

01	Fixed geographic lines.
02	Fixed geographic lines.
03	Reserved for future geographic use.
04	Reserved for future services.
05	Corporate numbering range.
06	Reserved for future services.
07	Find me anywhere—mobile, paging, personal numbers.
08	Specially-tariffed services: freephone, shared cost and shared revenue.
09	Premium rate services.

In future, the beginning of a number will give customers a clear indication of the type of service behind that prefix and therefore information about the likely cost of their calls.

France Introduces New Numbering Plan

From 18 October 1996, callers outside France have had to dial an extra digit when calling numbers in France, outside Paris. The new numbering plan was necessary because of the increasing demand for new numbers in France generated by growth in fax, mobile, Internet and other new services.

To call the Paris metropolitan region from outside France, numbers remain the same. Callers still dial 33, followed by 1 and the 8-digit number. For all other regions, callers should dial 33 and then add either 2, 3, 4 or 5 in front of the old 8-digit number:
'2' for northwest France;
'3' for the northeast France;
'4' for the southeast France; and
'5' for the southwest France.

To call a French number from inside France, 0 must be dialled before the 9-digit number, and to call abroad from France, the international access code is 00, instead of the current 19.

France requires over one million additional numbers each year. The new numbering plan will provide a pool of numbers for several decades to come. This marks a further step toward European and international harmonisation, in line with International Telecommunication Union (ITU) recommendations.

The French telecommunications regulatory authority, the DGPT, developed the new French numbering plan and, as the public operator, France Telecom is responsible for implementing the new plan.

Operational Aspects for International Freephone Approved

The International Telecommunication Union has approved a new revised standard which describes the service, the ordering processing and other operational aspects including access methods and implementation between carriers for the provision of the international freephone service (IFS). This new standard completes the conditions and principles which were recently approved.

A universal international freephone number (UIFN) enables an international freephone service customer to be allocated a unique freephone number or numbers that can be the same throughout the world.

The ITU Council endorsed the ITU's proposed role as registrar of these new numbers and set the cost of registration of each number.

Kitemark Scheme for Telephones

The British Standards Institution (BSI) is launching a new telecommunications Kitemark scheme. The scheme, which is the first of its kind, covers simple and hands free telephones and answering/recording machines. It is based on a product approval specification (PAS).

This new specification for the Kitemark scheme incorporates electrical and mechanical performance, electromagnetic compatibility and safety factors. It pioneers the introduction of hearing aid compatibility into the UK and also includes provisions for reducing common consumer annoyances such as twisted telephone cords, over sensitive hook switches, unreadable displays, colour fastness of mouldings, premature battery failure and breakable cord terminations. Industry-derived data and relevant European and international standards were used by BSI to develop the PAS.

This scheme is the first of a series BSI is planning for the telecommunications sector.

OFTEL Welcomes Free Conversion Offer

Anna Walker, Deputy Director General of Telecommunications, has welcomed the start of BT's offer to convert, free of charge, hardwired telephone connections to modern plugs and sockets.

Anna Walker said: 'A modern plug and socket system gives customers the freedom to choose whether to buy a telephone and who to buy it from. This wider choice is particularly important for vulnerable people who can benefit from equipment designed to cater for their additional communications needs. I hope that all customers who have found the cost of conversion off-putting will take up this offer and, if they wish, take advantage of the wide variety of telecommunications equipment available to buy in this very competitive part of the UK market. I see this as an important move towards improving customer choice and competition.'

Jean Gaffin, Chairman of OFTEL's Advisory Committee on Telecommunications for Disabled and Elderly People, added: 'This is great news for almost two million BT customers and it is something we have been pressing for years. It will benefit elderly people wanting connection to community alarm systems and more appropriate telephones, previously deterred by the cost of conversion.'

IBTE

It is with regret that we report the deaths of the following Members:

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notes and comments

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correspondence

Dear Sirs,

I would appreciate it if you would kindly forward the following comments to Mr. Paul Jenkins of Global Engineering, BT Networks and Systems, concerning his paper 'Internet' in the *British Telecommunications Engineering* journal, April 1996 issue:

I am somewhat confused by a contradiction which seems to exist between your statements in the first paragraph on p. 40 of the *Journal* concerning addresses and those of Professor J. Crowcroft in his article 'The Internet: A Tutorial' in the IEE *Electronics and Communications Engineering Journal*, June 1996. *Inter alia*, you say that addresses are allocated as a flat address space, a practice now causing difficulty with routeing systems. However, Professor Crowcroft seems to say that not only names but also addresses are hierarchical.

I would appreciate your clarification on this subject.....

Finally, I found the paper of considerable interest and it offered much enlightenment.

Yours faithfully,
W. H. Philpott

The author's reply is reproduced below.

Dear Mr. Philpott,

Thank you for your comments on my article in the *British Telecommunications Engineering* journal. It is always most satisfying to receive feedback having undertaken work like this.

With respect to your question, then in hindsight the text included may have oversimplified the issues. The addressing in IP networks is at one level hierarchical, but within the context of routeing within the global Internet the numbers are flat.

An IP address can be described as consisting of three fields:

- a variable number of bits indicating the type (called *class*) of address; followed by
- a variable number of bits called the *net-id*; followed by
- a variable number of octets called the *host-id*.

The class of the address determines the lengths of each of these fields as shown in Figure 1.

The net-id identifies a cabling infrastructure to which hosts (computers) are connected. A net-id is allocated by IANA (the Internet registration authority) to an administrator for the cabling system, who can then allocate host addresses to the computers attached. Thus each computer has an IP address starting with the same net-id. This cabling structure is then connected to the rest of the Internet by one or more routers. These routers will advertise (via routeing protocols) the location of systems on the cabling infrastructure by promulgating the net-id. This has several implications:

- IP addresses with the same net-id must identify hosts attached to the same cabling infrastructure;
- the Internet at large uses only the net-id part of the IP address to perform the routeing function; and
- even if two cabling structures have IP addresses from net-ids that are adjacent (that is, A and A+1) they cannot be aggregated and their locations are promulgated totally independently throughout the Internet†.

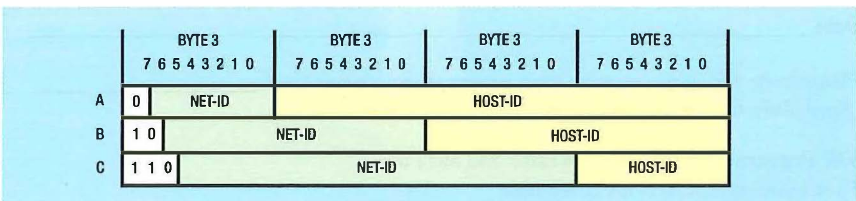
The net-ids are allocated as a flat number space so that net-id A could identify a network in London, A+1 could identify a network in Japan, and A+2 a network in Reading. This means that the Internet routers require knowledge of the location of **all** net-ids in the world in order to route.

In fact, most routers know only the location of a subset of these net-ids, and forward a packet to another more-knowledgable router if an unknown net-id is received. This reduces the burden so only a subset of routers needs to know the location of all the net-ids. However, due to the flat allocation of these ids, this can lead to some strange routeing decisions in order to reach a knowledgable router.

As can be seen from this explanation, the structure of IP addresses is hierarchical, strictly speaking. However, the way these addresses are allocated and used means that the Internet has to route on a flat address space. I hope that this helps to clear up any confusion between the two statements you referenced in your letter.

Yours sincerely,
Paul Jenkins

Figure 1



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Letters intended for publication should be sent to the Managing Editor,* British Telecommunications Engineering *journal, Post Point G012, 8–10 Gresham Street, London EC2V 7AG.

† This may be changing in that a proposal for classless inter-domain routeing (CIDR) would allow the aggregation of net-ids. However, these proposals are not being implemented as widely as it was thought they would be and the traditional routeing still holds sway.

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