VOLUME 12 PART 4 JANUARY 1994

BRITISH TELECOMMUNICATIONS ENGINEERING

Included in this Issue

Multimedia Communications

Broadband

PC-Based Visual Communications

Benchmarking

New Feature—Field Focus

The Journal of The Institution of British Telecommunications Engineers

BRITISH
TELECOMMUNICATIONS
ENGINEERING

Contents

VOL 12 ■ PART 4 ■ JANUARY 1994

John Prior

Broadening the Issues

In recent years, the Institution of British Telecommunications Engineers (IBTE) has been giving considerable effort to developing its publications to ensure that they continue to provide an essential service to readers. *British Telecommunications Engineering* itself has been restyled and its content broadened; the *Structured Information Programme*, introduced in July 1991, is now well established and is receiving much favourable comment from readers; and, recently, IBTE's new membership magazine *Newsview* was introduced to provide all IBTE Members with news from both the Senior and Associate Sections.

Recently, the Board of Editors of the *Journal* has been focusing attention on managing the *Journal*'s forward editorial plan along the lines of 'themes'. The idea is that a topical theme is identified by the Board, and a series of articles based on the theme commissioned and published over several issues. A theme editor is invited to oversee each series and assist the Board in identifying appropriate articles.

In future issues of the *Journal*, readers can look forward to several important and interesting theme series including Telecommunications in the 21st Century, Network Architecture, Wireless Access, Usability by Design, Operational Achievements, International Developments and so on. Ultimately, we anticipate that each edition of the *Journal* will include articles from several of these themes.

This approach will not only help to ensure that the *Journal* continues to provide invaluable information on a wide range of telecommunications developments, but will assist with the development of the *Journal*'s aim of reaching a wider audience and providing a broader view of the telecommunications industry.

Readers will be interested to note that a new feature, called *Field Focus*, begins in this issue of the *Journal* (see p. 316). This series of short articles instigated by IBTE Local Centres will provide a much needed 'local' flavour to the *Journal*.

IBTE is committed to continuous improvement and, over the coming months, will be considering further major developments to its publications. Ultimately, of course, it is you, the reader, we serve, and your views and suggestions would be very welcome. Please write to The Managing Editor, Paul Nichols, Post Point G012, 2–12 Gresham Street, London EC2V 7AG.

John Prior

Chairman
Board of Editors

Alan W. Rudge, O.B.E., F.R.S., F.ENG.

I'll Be Seeing You: Multimedia Communications in the 21st Century

This article outlines some of the key technologies which have underpinned the development of the world's telecommunications network and argues that rapid technological advance, coupled with a convergence of technologies and markets in the IT sector, will create a highly competitive multimedia environment characterised by revolutionary, rather than evolutionary change. Full multimedia capabilitity, with integrated voice, text and fixed and moving images, will create major market opportunities and have a pervasive impact on all aspects of commerce and social life.

Introduction

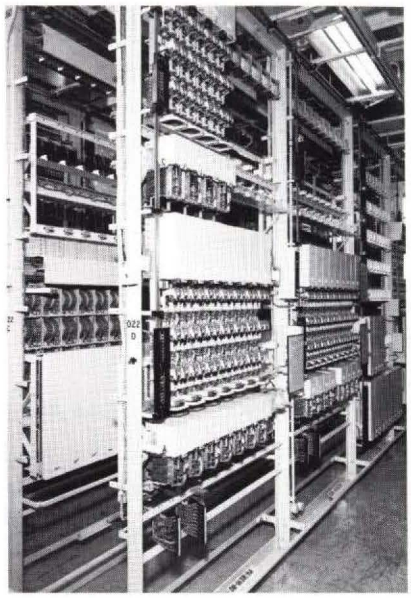
The world's telecommunications network is the largest man-made machine of all time. It is also the most complex. In the 1990s, it has handled in excess of 1000 billion calls every year, as well as an immense amount of data. It provides the means for basic voice and data communications to be sent and received almost anywhere in the world, virtually without censorship or control. Its very existence is an important element of our personal freedom.

It is interesting to reflect that, although the concept of telephonic communications existed at least 300 years ago, the practical realisation is not yet 120 years old. It was not until 1876, when Alexander Graham Bell invented and patented his electric speaking telephone, that the modern age of telephony can be said to have commenced. Even then it was not born to a rapturous reception. In the winter of 1876, Bell's financial backer offered the full rights of the invention to the Western Union Telegraph Company for the then considerable, but not unrealistic, sum of $100 000. The negative response—'What use could this company make of an electrical toy?'—must rate among the world's all-time best examples of missed opportunity.

This article is based on the address given by Dr. Alan Rudge in October 1993 at his inauguration as the new President of the Institution of Electrical Engineers (IEE). Dr Rudge is also President of the Institution of British Telecommunications Engineers. The article is reprinted with permission of the IEE

Nevertheless, the Bell Telephone Company was formed in 1877 and, after a rather slow and stuttering start, the progressive penetration of telephony into everyday life began and has continued steadily ever since. In 1889, a significant milestone was reached when a Kansas City undertaker, Almon B. Strowger, patented the first automatic exchange. Strowger was driven by simple commercial motives: he was concerned that switchboard operators might be directing the enquiries of distraught customers to his rivals. Remarkably, his concept of the rotary automatic switch has stood the test of time, and electromechanical exchanges based upon this principle are still in use around the world, although they are now being progressively replaced by electronic and digital-electronic equipment (Figure 1).

Figure 1—A Strowger-type electromechanical switch



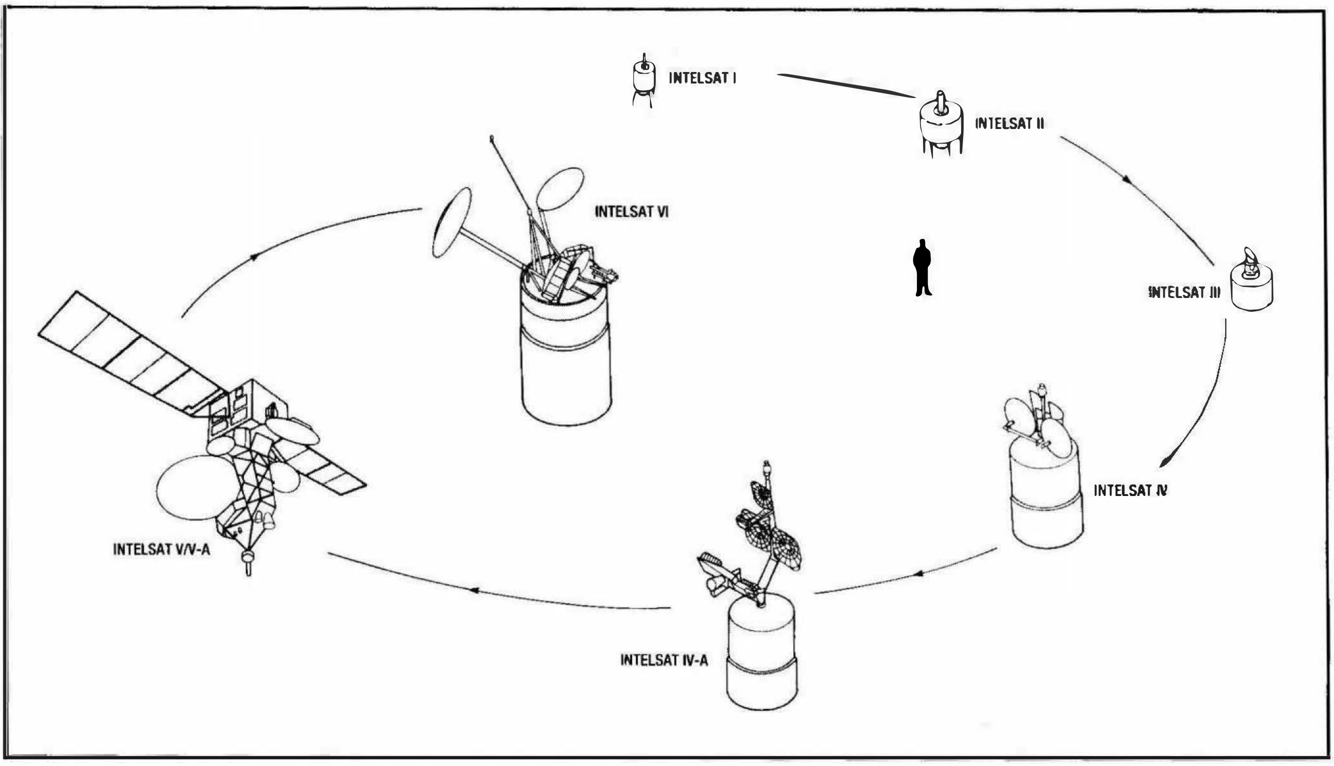


Figure 2—Evolution of INTELSAT satellites

Table 1 Evolution of INTELSAT Satellites

	Year of Launch	Bandwidth (MHz)	Circuit Capacity
INTELSAT I	1965	50	240 or 1 TV
INTELSAT II	1967	130	240 or 1 TV
INTELSAT III	1968	300	1500 and 4 TV
INTELSAT IV	1971	500	4000 and 2 TV
INTELSAT IV-A	1975	800	6000 and 2 TV
INTELSAT V	1980	2144	12000 and 2 TV
INTELSAT V-A	1985	2250	15000 and 2 TV
INTELSAT VI	1989	3300	24000 and 3 TV

While telephony began to flourish in the USA, its development was a much slower process in the UK and Europe, where telecommunications were provided by Government Post and Telegraph Departments who were, in general, slow to appreciate the potential of new technology and restrictive in its application. In 1922, the year of Bell's death, one of my presidential predecessors, Frank Gill, asked two questions in his inaugural address: 'Has telephony, during the 46 years it has been available, been as much use to Europe as it might have been? Have the organisations, Government and otherwise, been permitted to do what they wished to do?' Gill quite rightly believed the answer to both questions was 'Most decidedly, *no*!'

At that time, despite Britain's interest in world trade, there were only 23 telephone circuits available between the UK and Europe, many of them of doubtful quality. It was not until 1927 that the first commercial transatlantic telephone service commenced, and this was based upon a single high-frequency radio telephony channel! A 3 minute USA–UK call cost £15—a substantial sum at the time, equivalent to more than £400 in today's currency.

Although transatlantic telegraph cables had been in use since the 1860s, it was not until 1956 that the first transatlantic telephone cable came into service. This cable had been designed to offer just 36 telephone channels and, on the basis that this would be ample, the radio circuits were closed down.

There was a distinct lack of vision apparent in the early European approach to telephony and a failure to appreciate the scale of the opportunity and the impact it could have on commerce and social life. As a Government Department, the General Post Office (GPO) was often faced with financial contraints which had no bearing upon the needs of its subscribers or the business opportunities they represented. With inadequate investment, increasing demand became an embarrassment and led to waiting lists and deteriorating service.

The GPO and many of its European counterparts, although often not lacking in technical ability, were disinclined to market the telephone service too vigorously. This lack of commercial drive contributed towards a major development gap between the USA and the rest of the world. By 1937, half of the world's 38 million telephones were in the USA, and New York City had more telephones than all of France. This early lead established by the USA was critical, and in terms of the range of services offered and the usage of the telephone, but not always in the technology or network quality, the USA still retains an edge.

Transmission Technology Accelerates the Pace

In the 1960s, led by the USA, the international telecommunications community took another major step forward with the onset of geosynchronous satellite communications. The INTELSAT programme commenced in 1965 with the launch of the first non-experimental communications satellite, *Early Bird*, or INTELSAT I, which provided a continuous line-of-sight radio link for 240 telephone circuits, or one TV channel, between North America and Europe. This was followed by a series of geostationary satellites which, with each generation,

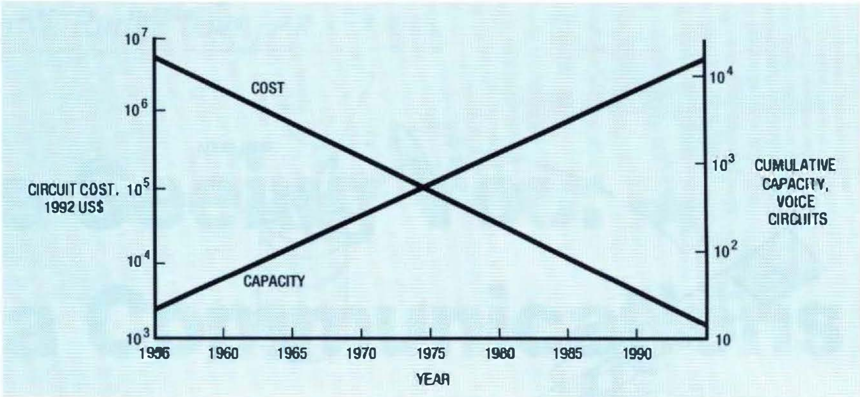


Figure 4—Transatlantic cable systems

have grown in size, complexity and capability (see Figure 2 and Table 1). INTELSAT VI, which was launched in 1989, offers simultaneously 24 000 telephone circuits and three TV channels across the Atlantic.

Cable technology, however, was far from dormant. In 1965, Kao and Hockam at STC Laboratories in the UK published their work on optical fibre which laid the theoretical basis for a revolution in cable technology and opened the prospect of telecommunications using photons of light as the transmission medium rather than electrons. The GPO was among the first to see the potential of the new medium and especially that of single-mode fibre (Figure 3).

If the many technological challenges could be overcome, including the development of optical transmitters and receivers, each hair-like strand of fibre would be capable of conveying hundreds, if not thousands, of gigabits of information per second—virtually limitless bandwidths, certainly capable of the simultaneous transmission of tens of thousands of telephone channels on a single laser beam. (To put this into perspective, at a transmission rate of 2·4 Gbit/s, which is well inside today's capabilities, the entire contents of the *Encyclopaedia Britannica* could be transmitted over a single-mode fibre in less than half a second.)

The GPO and later BT, through the work in its laboratories at Dollis Hill and later Martlesham Heath, its sponsorship of UK universities and industry and early deployment of fibre in the network, played a major role in establishing the UK as one of the world leaders in this new technology. The BT network in the UK now contains more than two million kilometres of optical fibre. BT played a major role in the development and introduction of the first optical-fibre cable linking the UK to Europe in 1985 and the first transatlantic optical-fibre cable between the UK and the USA in 1988.

With each optical fibre providing tens of thousands of telephone circuits, or their equivalent, with significantly higher quality than can be achieved by geosynchronous satellites, optical technology is progressively replacing satellite communications for telephony on all high-capacity international routes. Optical-fibre cables now span the globe and are being deployed on high-traffic routes by every major network operator, providing a continuation of the logarithmic improvement in capacity and costs which commenced with the first transatlantic cable in 1956 (Figure 4).

The combined effect of these technological advances on global transmission capacity has been dramatic and is likely to continue in the foreseeable future (Figure 5). The growth in transatlantic telephone traffic over the years (Figure 6) and the reduction in call charges (Figure 7) provides an excellent illustration of the impact.

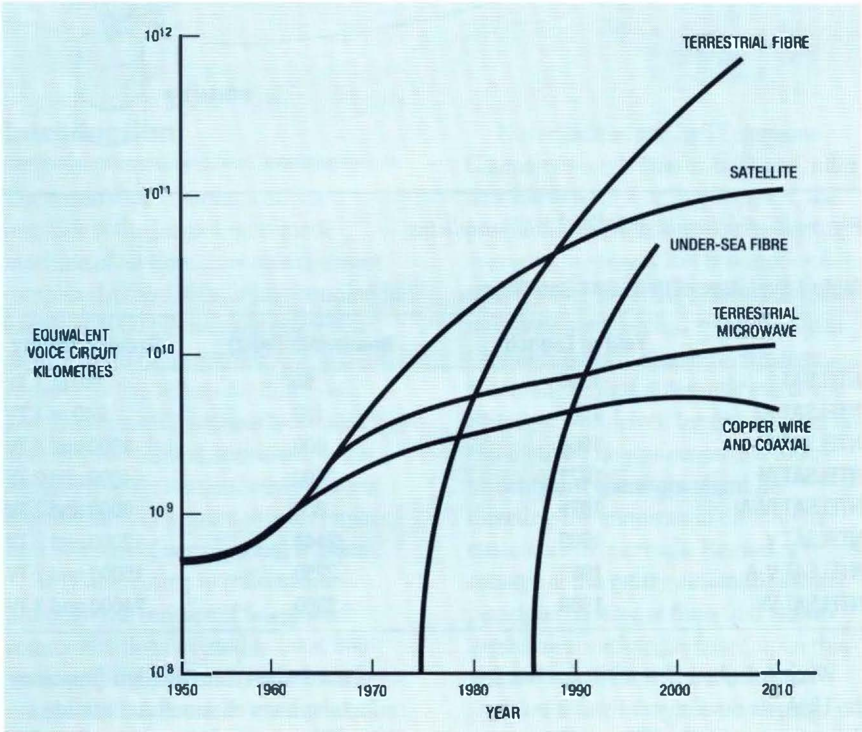
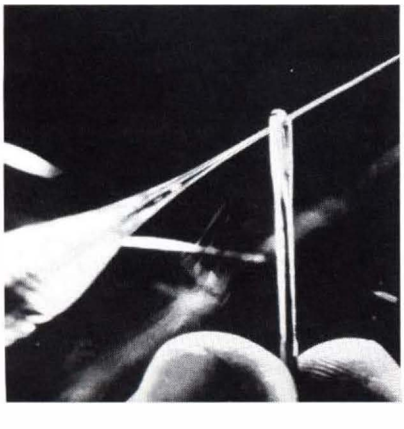


Figure 5—Global transmission capacity

Figure 3—A hair-like strand of glass fibre drawn from a rod of pure glass



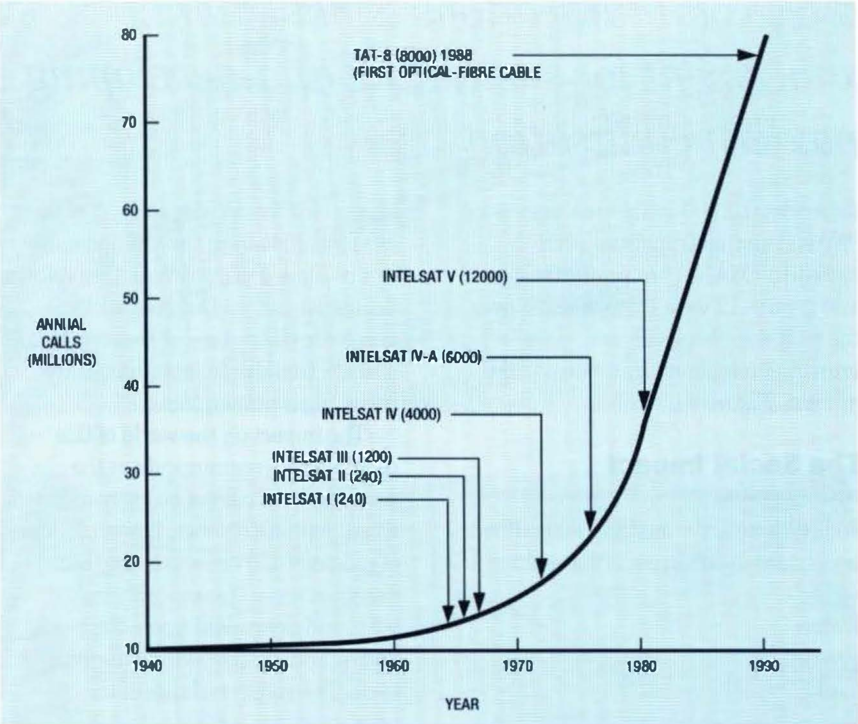


Figure 6—Telephone calls between the UK and North America

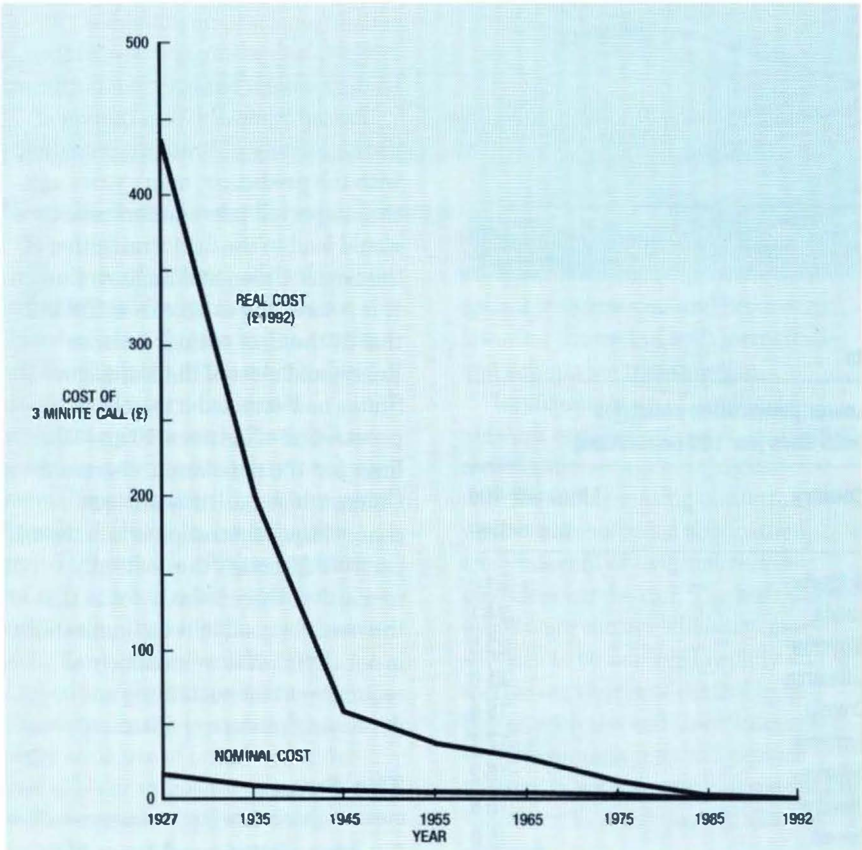


Figure 7—Cost of a transatlantic call

either via an operator or direct dialling.

In parallel with these advances in transmission technology, however, equally momentous changes were occurring with advances in electronics, computing and radio technology. The advent of integrated-circuit electronics, software engineering and new digital technologies has resulted in dramatic advances in computing, switching, electronic signal processing, and radio-frequency engineering, which have combined with optical technology to initiate a transformation of telecommunication services.

Integrated Circuits, Software and Digital Technology

Although the progress in transmission technologies led to an impressive increase in the reach of telephony and data services and to significant reductions in cost and improvements in quality, it did relatively little to change the fundamentals of the public service as experienced by the user. From the user's point of view, the public telephone networks have always provided narrowband speech connectivity between two points

Technology and the Networks

Since privatisation in 1985, BT has invested more than £19 billion in modernising its networks with digital electronic switching, computerised network management, new billing and customer-service systems, and optical-fibre transmission. In the UK during this period a new competitive regime has been established: Mercury Communications Limited (MCL) has built a second national long-distance network, two major cellular radio telephony networks (Cellnet and Vodafone) have become established, serving more than a million mobile users, and a number of additional network operators have been licensed.

Since 1985, the first 'intelligent' public network services have appeared; these make use of the software-controlled potential of exchange switches and network-based computers to do more than merely connect two points. Examples which are now in common use include the 0800 and 0345 services, card services, voice-bank and voice-messaging, and Star Services, which offer features such as call forwarding, call waiting and 3-party calling. These are but a few examples of the plethora of new services which the networks can, and will, offer over the next few years. The software-controlled intelligent-network technology will make this diversity possible and will allow a much greater *the need for good telecommunications is not trivial: it is a fundamental requirement for sustaining and developing modern civilisation*

degree of 'tailoring' of services to suit individual needs, despite the large numbers of customers involved.

It is not only in telephony that these technological advances have been felt. The rapid growth of computing has led to a growing need for data transmission to allow computing machines to interchange data and to enable users to access and share data remotely. Driven by the exponential growth of computing, local area networks (LANs), wide area networks (WANs) and metropolitan area networks (MANs) are proliferating and growth in data transmission over the past decade has exceeded the growth of telephony by a substantial margin (Figure 8).

The Social Impact

Today, there are more than 800 million telephones in use in some 230 countries around the world. Virtually all of them are accessible from the UK and most can be dialled directly for either voice or fax transmission. Data networks permeate the globe and electronic mail and electronic data interchange are becoming commonplace.

The impact on the world of this capability to communicate at the personal level cannot be overestimated. Every nation's defence, trade, efficiency of industry and commerce and social practices are all inextricably linked with, and dependent upon, the reach and quality of their telecommunications. The recent collapse of the nondemocratic states in the USSR and Eastern Europe cannot be attributed to a single cause, but the growing ability of their peoples to communicate directly, both within and beyond their borders, cannot be neglected as a factor.

Indeed Professor Tom Stonier of the University of Bradford is credited with the prediction, many years ago, that improved telecommunications would lead to the democratisation of the Soviet Union and Eastern Europe. It is interesting to note from Table 2 that at the time of their collapse Russia and most of the European States had attained a telephone penetration of between 10 and 20 lines per 100 population whereas for China, which has resisted such change, the penetration is less than 1 per 100. Although this is hardly conclusive, there is little doubt that the need for good telecommunications is not trivial: it is a fundamental requirement for sustaining and developing modern civilisation.

Figure 8—Growth of voice and data communication

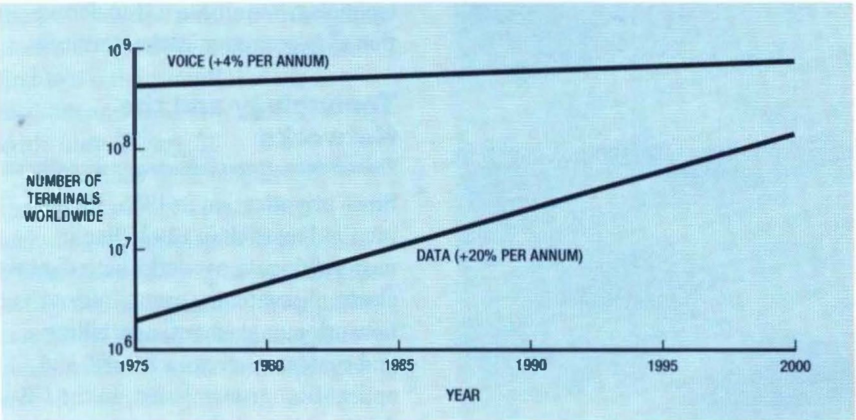


Table 2 Telephony Penetration in World Markets

Higher penetration countries (>25 lines per 100 population)		**Lower penetration countries (<25 lines per 100 population)**	
Country	**Lines per 100 population**	**Country**	**Lines per 100 population**
Sweden	68·8	Bulgaria	24·6
Canada	58·6	Latvia	24·1
Denmark	57·7	Slovenia	23·5
Luxembourg	51·8	Lithuania	21·8
United States	51·6	Croatia	18·6
France	51·0	Armenia	17·7
Netherlands	47·6	Belarus	16·2
Australia	46·4	Ukraine	15·6
Hong Kong	45·2	Russia	15·0
Japan	45·1	Turkey	12·2
United Kingdom	*44·6*	Rumania	10·5
New Zealand	44·2	Georgia	10·3
Greece	41·6	South Africa	9·5
Belgium	41·6	Mexico	6·7
Italy	40·4	China	0·7
Germany	40·4	Indonesia	0·7
Korea	34·3	Kenya	0·7
Spain	34·0	India	0·6
Ireland	29·3		

The Future

But what of the future? It would be easy to dismiss the progress of telecommunications as merely following the natural course of evolution. However, there are good reasons why such a conclusion would constitute a lack of vision of even greater scale than that which held back many of the European nations in the early days of telephony. Let us consider some of the salient points.

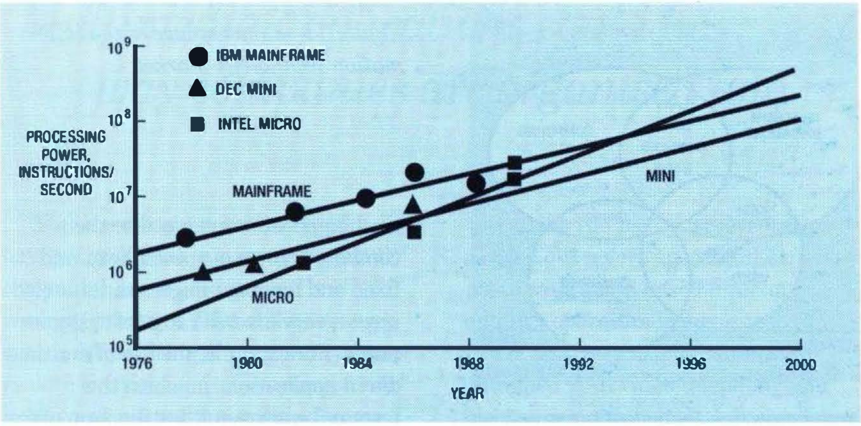


Figure 9—Computer processing power by year

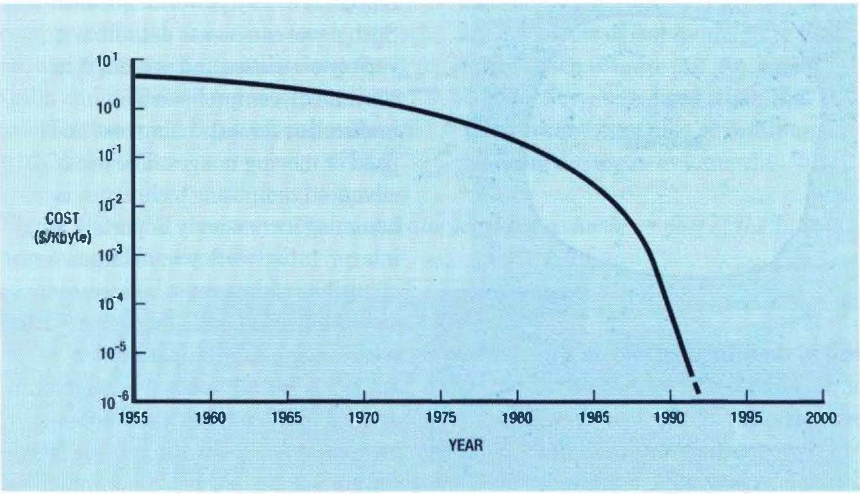


Figure 10—Cost of computer memory storage

The rate of progress of the key technologies is accelerating rather than declining. Driven by the continued development of the silicon chip, computer memory and signal-processing power for a given volume is doubling approximately every two years (Figure 9). For the same power, costs are halving in the same time period (Figure 10). Supercomputers of the 1980s are available today on a single chip. Digital signal-processing techniques, and especially those applied to video compression, are transforming the prospects for a wider scale use of image and video over cable or radio systems.

Transmission and switching capabilities are being transformed with optical networks offering the potential for gigabit switched bandwidths. New digital transmission techniques such as SDH (synchronous digital hierarchy) and ATM (asynchronous transfer mode) will offer higher transmission rates, lower unit costs and much improved network quality. Optical amplifiers, which are now becoming available, will provide another enormous step forward in optical transmission and processing, lowering the cost of both terrestrial and submarine transmission.

Implementation of intelligent-network architectures will, in essence, convert the networks into giant distributed computing platforms, upon which software applications from internal or external service providers can be run. The high degree of software control will allow new services to be deployed rapidly and an increasing degree of control to be placed with the end-user. Integrated service management will provide customers with simple and convenient interfaces to order, modify and pay for services.

The growth of telecommunications usage is limited as much by the cost of terminal equipment as by the network. However, driven by the highly competitive consumer electronics market, peripheral technologies such as displays, batteries and miniaturised electromechanical components are also advancing rapidly as are all aspects of the optoelectronic, photonic and radio technologies required for customer premises equipment. Dramatically lower costs for complex equipment are already becoming apparent, with the prices of fax machines, mobile telephones and personal computers providing examples of a trend which will certainly continue under the twin pressures of technological progress and competition.

Systems and software engineering are emerging as critical skills in managing complex equipments and networks and in implementing the services of the future. Despite enormous progress over the past decade, software engineering still suffers from being too much of an art and not enough of a science and much remains to be done to establish it on a firmer scientific basis. However, the key issues are receiving enormous attention worldwide and, despite the difficulties, it is unlikely that software engineering will become the log-jam of technological progress.

In summary, as far as technology is concerned, the rate of progress is such that the issue is not 'can it be done', but rather 'what needs to be done'. It is noteworthy, however, that these key technologies underpin not only the telecommunications industry but also computing, broadcasting, consumer electronics and a diverse range of business activities which can be very broadly defined as the 'information technology' sector.

In addressing the needs of their customers, major companies which previously operated in relatively independent sectors of the information technology market, for example telecommunications, broadcasting and computing, now find themselves progressively drawing upon a converging range of digital information technologies to provide integrated solutions. In doing so they increasingly find themselves engaged in competition with organisations from adjacent sectors that are armed with the same skills and technologies and seeking to meet the same needs. The net effect of this dual convergence of

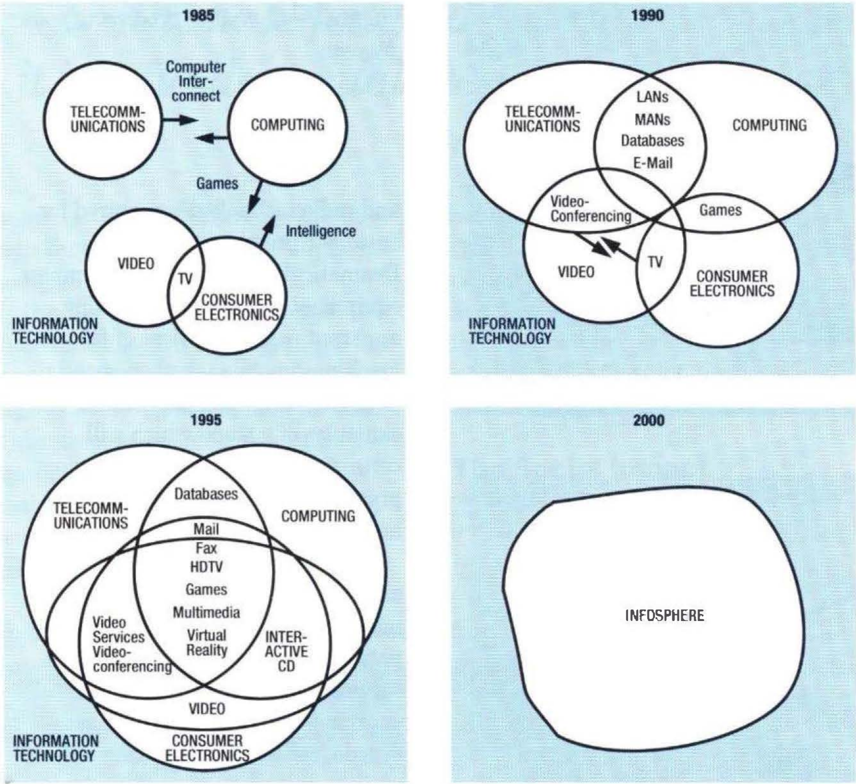


Figure 11—Convergence of the information technology market

technology on the one hand and markets on the other (Figure 11) will be a dramatic increase in competition, on a global scale, and a further acceleration of a rate of change which some would already describe as frenetic.

A Multimedia Era

In the past, the separate identity and licensing of telephony and data and broadcast services was emphasised by technology differences and the transmission of these services over networks was treated accordingly. More recent services, such as video-conferencing and video telephony, are still in their infancy and, in the case of the former, still largely conveyed over private circuits. However, the rapid progression toward digital technology is making a nonsense of artificial boundaries between the processing and conveyance of any of these services since, once digitised, the information is transformed into a series of pulses and, in network or processing terms, the distinctions become arbitrary.

More importantly, advances in digital technology provide very clear indications of the enormous potential of integrating and processing the constituent information flows to provide a very broad range of multimedia applications. Such applications can utilise the combined power of speech, text, and fixed and moving images, and thereby meet a very diverse range of customer needs. For example, the use of multimedia in applications in which the terminal equipment has the form of a personal computer or workstation can represent a very powerful business tool. Such a tool can access data from a variety of sources and present it in convenient, comprehensible, multicolour formats using text and fixed or moving images. The use of advanced computing techniques is becoming increasingly important for interpretative work where large quantities of data must be accessed, displayed, visualised and compared, to resolve complex multiparameter problems. With combined telecommunications and computing capabilities such an application could also provide for the simultaneous sharing of information and working documents with other users perhaps hundreds or thousands of miles away, and provide integrated voice and video communications and electronic mail facilities one-to-one or one-to-many within the working session.

Figure 12—Video wall in the office of the future

Such applications can be networked over private digital circuits, but products are now emerging which will operate on the public integrated services digital network (ISDN) using the existing switched copper network. The ISDN can, with the use of digital compression techniques, support multimedia applications employing fixed or moving images, including video telephony and small-screen videoconferencing.

The current capabilities of these applications are limited primarily by the bandwidth constraints imposed by the network. However, in the future, with the advent of switched broadband networks, the quantities of data transmitted and displayed and the quality and scale of the video component will be dramatically increased. A broadband network for example, would facilitate high-resolution video 'walls' rather than small-screen video pictures (Figure 12).

Multimedia applications could have a significant impact on the way companies are organised and on working practices.

Multimedia applications could have a significant impact on the way companies are organised and on working practices. The ability to work with a full multimedia capability from remote locations, or teleworking for at least some part of the working week, offers obvious business advantages. The thinking and reaction time of companies could be greatly accelerated, and their ability to utilise scarce skills and to access and interpret information could be much enhanced with these tools.

During the past year, BT has carried out a very successful experiment with home-based directory enquiry operators in Inverness. The use of an operator's workstation equipped with video telephony and electronic noticeboards, which allowed communication both with supervisors and colleagues, successfully overcame the problems of isolation and remote supervision (Figure 13). An unexpected benefit was realised when the teleworkers were able to continue working during heavy snowfall which prevented their office-based colleagues reaching their workplace.

For organisations utilising these multimedia tools, reductions in accommodation requirements and travel time and costs could also be anticipated. The relief in travel congestion which could arise from wide-scale adoption of these practices would offer major national benefit. Although the saving in energy costs is not the prime benefit, the comparison shown in Table 3 is thought-provoking.

Figure 13—A BT directory enquiry operator working at home as part of the Inverness teleworking experiment

Table 3 Energy Equivalence of Transport and Telecommunications

Type of Call	Mode of Transport	Distance (km)	Length of Time on Telephone to Use Equivalent Amount of Energy
Local	Car	10	21 hours
Trunk	Rail	320	33 hours
Trunk	Car	320	7 days
International	Air	5000	5 weeks

Multimedia Applications

There are many examples of potential multimedia applications, some of which are shown in Figure 14, which illustrates the exponential growth in telecommunication services. A few specific examples are given below:

- home-shopping and home-banking—to improve convenience and substitute for today's catalogue shopping and, in the case of the latter, to improve security with video recognition;
- estate agents—video clips for house-hunting to give dramatic savings in time and transport costs;
- travel agents—selection of holidays and hotels;
- market research—video demonstrations and polling;
- education and training—including interactive teaching and the ability to mix entertainment with education;
- healthcare—consultation with, and between, doctors and specialists;
- security—checking on home, children, elderly relatives; and
- consultancy—access to specialist skills and experience.

On the entertainment front the potential is equally interesting. Many of these applications require large computing resources, which could be

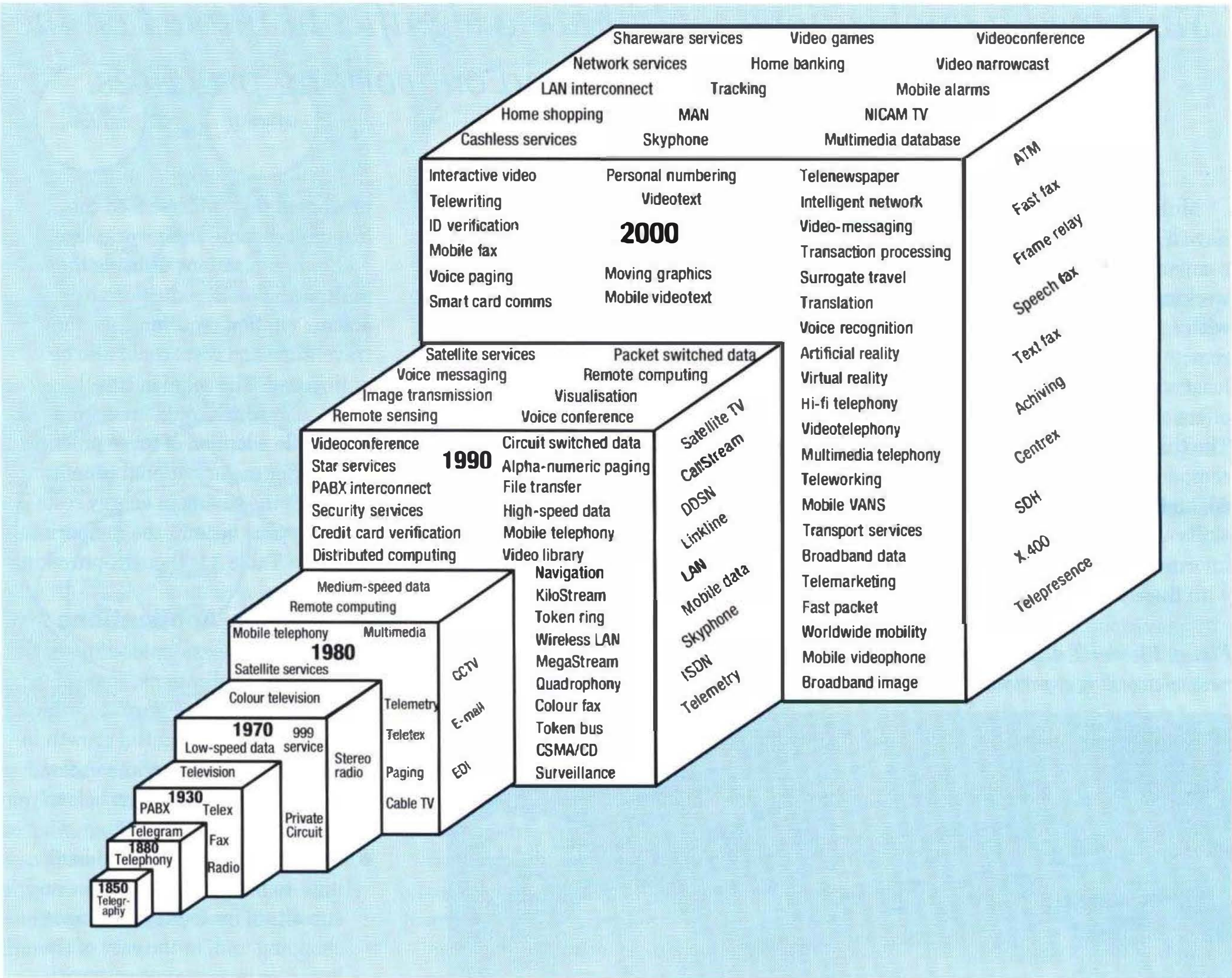


Figure 14—The growth of telecommunication services

located with the service provider and connected via a broadband network. Examples are:

- interactive games, including the enormous potential offered by virtual reality;
- video-on-demand, including, in the future, high-definition video;
- telepresence—be a spectator 'inside' a game, concert or theatre;
- video books and library facilities;
- video meetings—parties and coffee mornings or special interest groups; and
- holography—three-dimensional viewing for business or entertainment.

In all of these applications, the use of multimedia provides a much enhanced interface between the user and the information. By use of fixed or moving images, combined with text and voice, information can be provided in forms which are more easily interpretable by the recipient. The potential for applications of wide-bandwidth multimedia technology is almost unbounded and is constrained only by the limits of imagination. Some of the applications listed above may appear frivolous but the impact on many aspects of business and social life will be significant. For example, on the education and training front, where the UK suffers badly from limited skilled resources, a fresh approach to the problem incorporating the widescale use of multimedia applications could offer major benefits.

The Intelligent Broadband Network

With the use of digital compression techniques, the current capabilities of the UK's narrowband networks can support the early stages of the multimedia era. However, bandwidth limitations cannot be ignored, particularly with regard to their constraining effects on video quality and the rapid transmission of large quantities of data.

An essential requirement for any nation with ambitions to establish a strong position in the 'Information Age' will be a ubiquitous intelligent, switched, broadband network over which new services can be delivered to end-customers in a responsive, efficient and cost-effective manner. In economic terms this will be the 21st century equivalent of today's motorways and their access roads.

The services provided over this broadband network will not be constrained to those offered by the network operators. Indeed, the economics of such a network demand a range of services which, both in concept and development, would be well beyond the capabilities of even a very large operator. The intelligent broadband network will provide interfaces for new service providers to enable them to offer new information

The market opportunities arising from the combination of multimedia applications and broadband intelligent networks will be huge, and the impact pervasive.

services and applications to business and personal customers alike. In doing so it will not only stimulate the telecommunications industry but also encourage the growth of a new sector of the IT industry, engaged in both the development and provision of such services.

In essence, the intelligent broadband network itself can be considered as a very large computer. Like any computer it can only be a commercial success if there are a multiplicity of application programs which its customers can acquire from either the computer manufacturer or, more commonly, from other suppliers.

The early implementation of a national broadband network will provide a significant strategic advantage for many sectors of industry but current government regulatory constraints on the major network operators in the UK, which prevent them from conveying entertainment services over their networks, is discouraging such a development. This is an area which warrants an urgent review by the Department of Trade and Industry.

In Conclusion

Although the development of telecommunications since the invention of the telephone has not been slow, the rapid advance of key technologies and the increasing competition worldwide in the converging IT markets will produce conditions closer to revolution than evolution over the next few decades. The market opportunities arising from the combination of multimedia applications and broadband intelligent networks will be huge, and the impact pervasive.

In the UK, early deployment of a ubiquitous broadband network would have obvious benefits for the UK-based telecommunications and computing industries in helping to establish them as global suppliers for systems and equipment. But no less important is the fact that the availability of such a network could bring major benefits to all aspects of the UK economy, including the stimulation of a completely new sector of the IT industry engaged in the development and provision of new services.

The multimedia examples given above constitute only a small set of the possibilities which innovative entrepreneurs could, and will, conceive. The benefits, not only in the direct stimulation of the economy and new forms of entertainment but also in improvements in business efficiency and effectiveness and in improved education and training, could be enormous, particularly for the UK.

There is no shortage of critics of multimedia who argue that there is little market demand and no commercial justification for these services. Of course, nothing is certain, but history is littered with the opinions of experts who underestimated either the latent demand for information in all its guises or the ability of technology to deliver it at an economic price.

As yet it cannot be stated with certainty exactly when the UK will have its intelligent broadband network, or how many of the new services touched upon above will be provided within this century. However, I can predict that many of the video and multimedia services which are in their infancy today, including applications based upon virtual reality, will be the norm within the next decade, with many other applications not mentioned and probably not yet conceived. Providing only that my health holds out, I feel sure that 'I'll be seeing you' courtesy of multimedia technology and the UK's broadband network.

Biography

Dr Alan Rudge
Managing Director
BT Development and Procurement, and Member of BT Main Board

Dr. Alan Rudge, was appointed Managing Director, BT Development and Procurement in April 1991, He was previously BT's Group Technology and Development Director, a position he had held since April 1989. Dr Rudge's line management responsibilities include the Group's research, development, information technology, computing and procurement and logistics activities.

He received his formal engineering training at the London Polytechnic and the University of Birmingham, where, in 1968, he received his Ph.D. in Electrical Engineering. After spending several years at IIT Research Institute in the USA, in 1971 he returned to the UK to join the staff of the University of Birmingham.

In 1974, he launched a joint US/UK venture in radio technology between IIT and ERA Technology Ltd at Leatherhead, Surrey. In 1979, the 'Radio Frequency Technology Centre' was aquired by ERA and Dr Rudge joined their Board. He was appointed Managing Director of ERA later the same year.

Dr. Rudge joined BT in January 1987 as Director, Research and Technology. He was appointed to the BT Management Board in April 1988 and the Main Board in April 1989.

He has served on several research advisory bodies in the UK, and is currently a member of the MoD Defence Research Agency Council and the Council of the Office of Science and Technology, which advises Government of issues pertaining to engineering, science and technology. Dr. Rudge is a visiting Professor and external examiner at London University. He is currently serving as President of the Institution of Electrical Engineers and was the Institution's 1991 Faraday Medallist. He has been awarded honorary degrees of Doctor of Engineering (Birmingham) and Doctor of Science (Strathclyde).

Dr. Rudge was elected to the Royal Academy of Engineering in 1984 and is a past Member of their Council. He was awarded the O.B.E. in 1987 and was elected to Fellowship of the Royal Society in 1992.

David Greenop, Ian Pearson and Trevor Johnson

Broadband—Liberating the Customer

In the future, the customer will capture, view, process, manipulate, and transfer information easily. The applications and communications will be transparent, and part of everyday activities. Today's narrowband communication infrastructure is a constraint for businesses and residential customers. Although broadband networks will start to address this problem, they are only one part of the picture. The most significant developments will be in new software applications. A new information environment will emerge, the infosphere. It will integrate a wide range of applications with broadband connectivity, to the business and mass market, at an acceptable cost.

Introduction

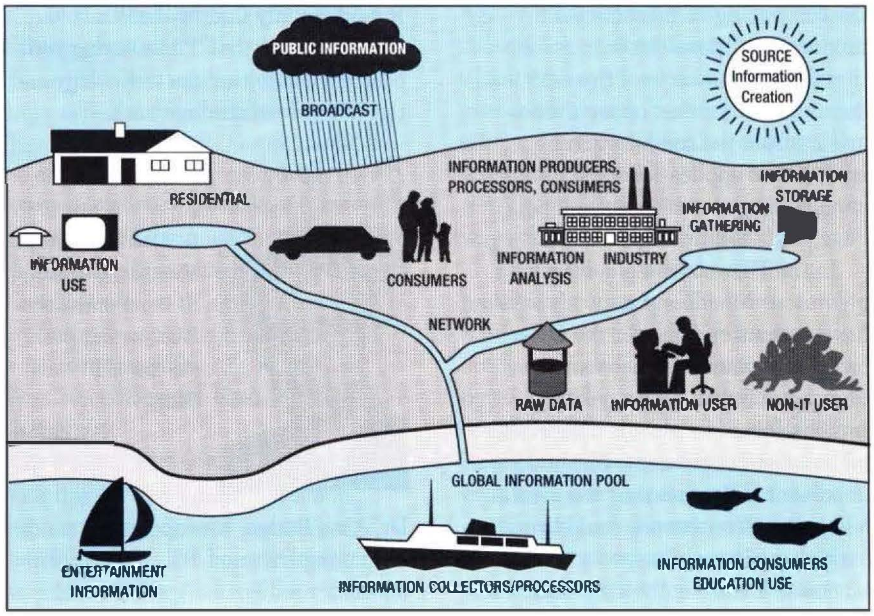
Imagine what it would be like if electricity was provided in the same way as telecommunications? Having just brought home a microwave oven, you now have to ring up the electricity board and ask for a connection. You are told it requires 8 A at 240 V and 50 Hz AC in 2 second bursts every 10 seconds. The electricity company say they can deliver in a few days. Imagine you have to do this for every electrical appliance you buy. It would be a nightmare!

Telecommunications must become as easy to access, easy to use and as much a part of the background as electricity. The *infosphere* is all about creating this transparency, removing the barriers to information flow, and liberating the customer. Figure 1 shows how information fits into every area of life, showing similarities between the information cycle and the water cycle. People use information at work and at play, both as a tool and as an end in itself. We can even build businesses just to gather, process and sell information as we do with water. As the figure also shows, those people who don't make use of IT in some way are rapidly becoming extinct. There will be no Jurassic Park for them either.

This article puts a long-term perspective on the development of broadband networks. The broadband market is growing, as the use of information technology (IT) increases. The use of IT will increase in three ways: firstly, a wider range of business activities will benefit from using IT; secondly, business activities that already benefit from IT developments will increase their use of IT; thirdly, with the growth in home computing,

This article is a revised version of a paper presented at the 32nd European Telecommunications Congress, held in Antwerp, Belgium, 29 August–4 September 1993. The authors received the award for Best Paper.

Figure 1—The information cycle



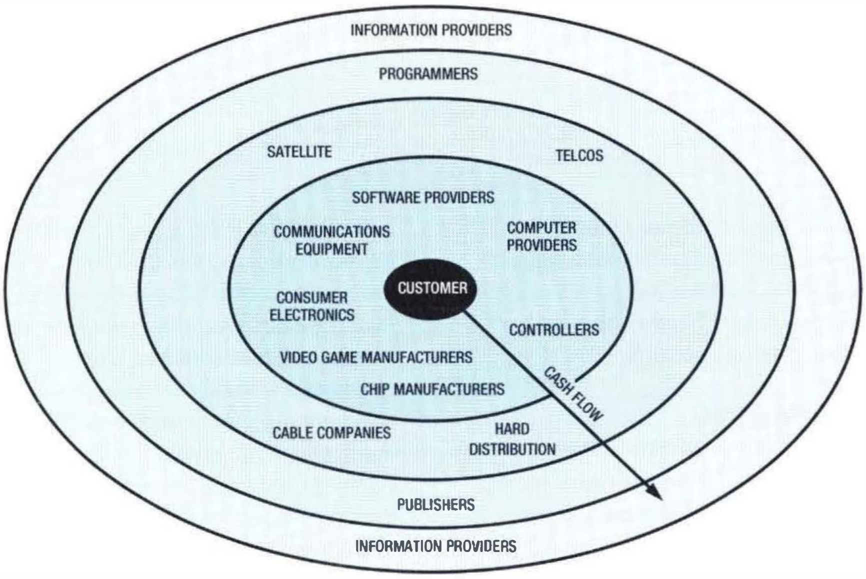


Figure 2—Information revenue chain

IT has started to penetrate the mass personal market in a significant way.

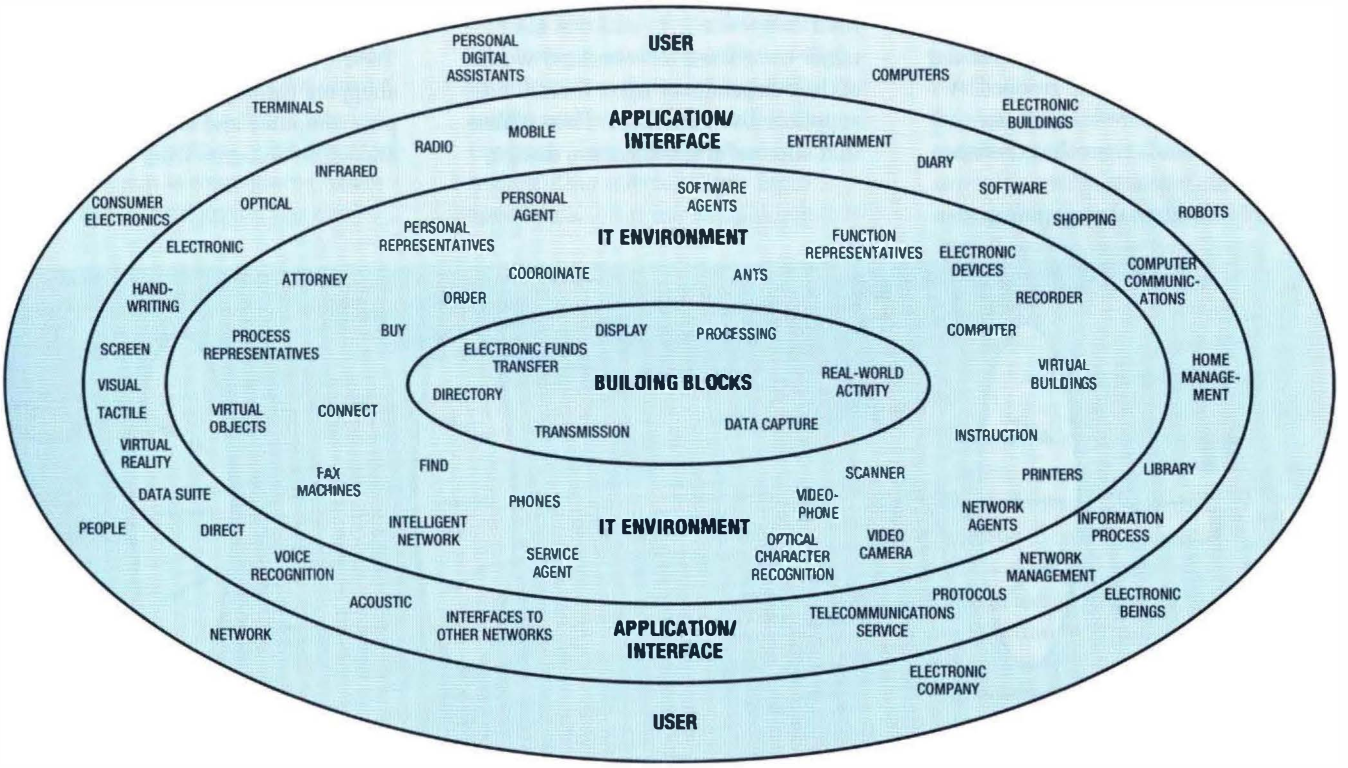
As we have seen with narrowband ISDN, it is not sufficient for public network operators (PNOs) to provide just a network. They have to demonstrate real benefits to the customers. From the customer's viewpoint, these benefits are most likely to arise through the wide availability of suitable end-user applications. PNOs are unlikely to be in a position to provide all of these applications. There will be the need for far greater collaboration between PNOs and others parts of the IT industry. This will result in a clear information chain, as shown in Figure 2, with the customer at the centre. As information flows in towards the customer, so revenue flows back to the information provider, with a slice being taken at each layer in between.

A broadband infrastructure is seen as a prerequisite for the eventual delivery of advanced multimedia information applications to the home as well as business. In several countries, cable operators are already providing a widespread distributive broadband infrastructure to deliver entertainment services. Eventually, this infrastructure will be upgraded for both-way broadband communications to support a wide range of information applications. This will be driven by the convergence of information, entertainment and communications industries. This is no longer a theory, it is now happening, as illustrated by recent developments in the USA involving the integration between telecommunication operators, cable operators and entertainment programme producers. By the year 2000, it will be impossible to see any clear boundaries between different parts of the IT industry. As we look into the next century all of us will be making abundant use of processing and communications in all aspects of our lives and we will come to appreciate the added value it brings to the world around us.

The Infosphere

The term *infosphere* is used to describe this future all-embracing information environment that we shall be living in. The infosphere, Figure 3, is an advanced distributed

Figure 3—Structure of the infosphere



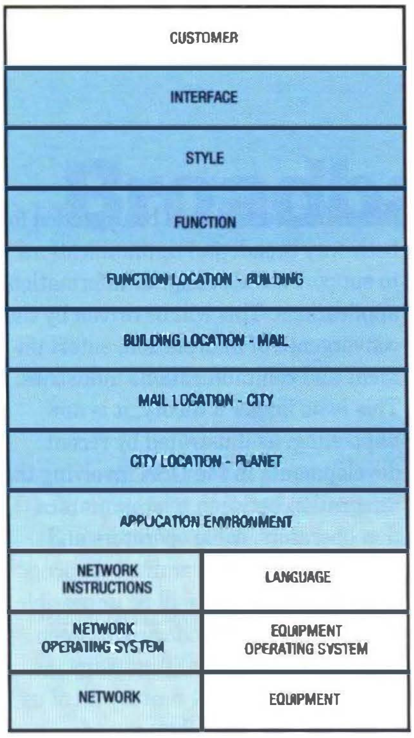


Figure 4—Possible applications architecture

information processing and communication environment whose reach extends from the devices people use to databases and computers situated anywhere on the globe, or beyond. Within the infosphere, the customer can capture, view, process, manipulate and transfer information. Access will be through multimedia interfaces and devices like the new generation of mobile personal computer communicators (PCCs). Intuitive interfaces to sophisticated applications will enable anyone to do anything, anywhere, at any time. These interfaces will follow a layered architecture to allow similar functionality levels to be grouped. A possible architecture is shown in Figure 4, and it is clear that there are market opportunities at each layer. The network infrastructure supporting the infosphere will have to supply unconstrained bandwidth whether over fixed links or radio.

The Market

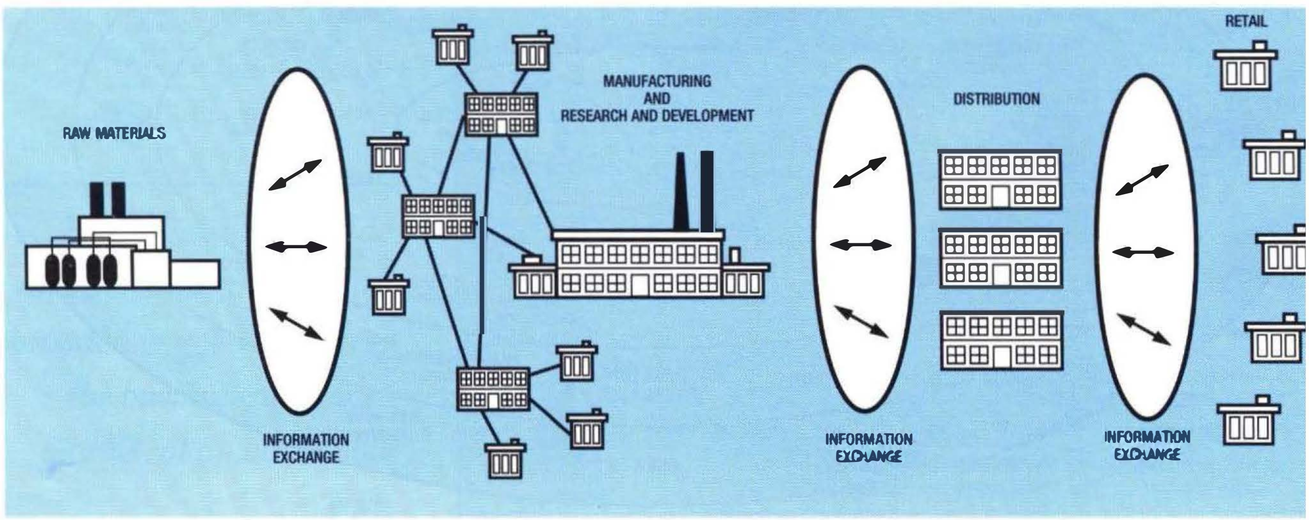
The demand for broadband is increasing for both the business and residential markets. Residential customers have access to broadband cable television networks, which are now starting to offer telephony. Businesses want higher-speed data services to transfer information between sites. Major businesses can no longer be content with their home markets. They must think globally and become multinational. Consequently, communications are essential to these companies.

Many industries have widely distributed operations that rely on telecommunications. Consider, for example, a major pharmaceutical company with research departments around the world, Figure 5. If their information can be shared, their resources pooled and the information down-loaded for production, their product will be on the market before their competitors. In addition many major companies have become aware of their dependency upon their suppliers and customers. They realise that successful specification, design, and manufacture of a product relies on cooperation between all the parties. As a result they are developing strategic links with customers and suppliers. These new business practices are highly reliant upon telecommunications and broadband applications, which are illustrated in Figure 6. For example, video-conferencing is becoming popular as a substitute for business travel.

Many UK service industries are becoming reliant on telecommunications to provide services, such as home banking, directly to their customers. Most of today's tele-services, however, are based on telephony. The banks and other industries, such as the mail order industry, want to link electronically with their customers. This is a significant trend considering the developments in personal computing.

People will want the same facilities at home as they have at work. For example, they will need to have access to the same computer programmes and databases, and want to discuss their work with their colleagues 'face to face' over a video link. For those with increasing leisure time, new entertainment and educational opportunities will become available. Today, people watch videos; use shopping catalogues to order goods; play computer and electronic games; and settle accounts from their home;

Figure 5—Industrial communications



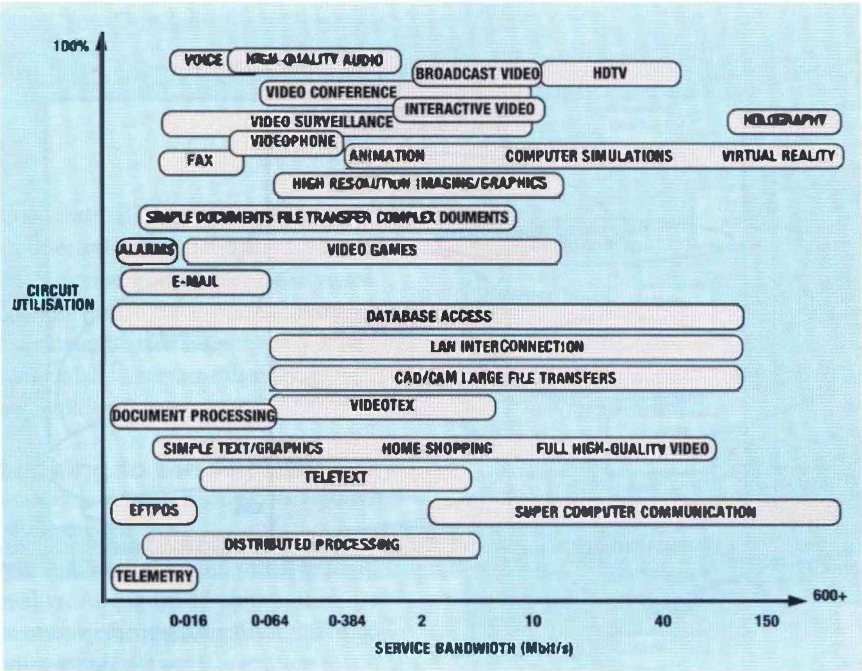


Figure 6—Service requirements

undertake leisure education or learn new skills. In the future, all of this will be accessed electronically in real-time, without the need to pre-book, providing choice and flexibility. The number and range of services and applications will continue to grow as users become familiar with the new opportunities provided and begin to develop and make available over the network their own applications.

As people move away from their families and friends, they will keep in contact using videoconferencing, play games together, or order birthday presents from their relative's local shop. Mass market electronic mail and fax will displace conventional mail and paper administration. Multimedia databases will revolutionise libraries, which may in the short term become places where people can go and access the new information applications. We can expect to see virtual shopping centres which will give customers a greater choice and convenience. Importantly from the ecological view, we will see an accelerating displacement of travel by high-quality video communications.

Implications

IT progress has strong implications for the network. Figure 7 shows how both processing speeds and memory chip capacities are increasing logarithmically, with no sign of slowing down in the foreseeable future. This will have an enormous effect on the intelligence and storage capability in future equipment, in the office and the home. Increased processing among other effects, allows high-speed data compression, making multimedia applications possible over narrowband networks. This will both stimulate calls on current networks, and reduce the amount of traffic per call. In the longer term, owing to the vast range of potential future services, the current argument over the need for increased bandwidth will almost certainly be won in favour of the broadband network. Many of these new services and applications will have very different network performance requirements from those currently provided, and the new broadband network must be designed in such a way as to offer a rapid and flexible response to new services and applications.

Multi-service networks, which can handle both high- and low-speed applications, are needed to meet all the customers' requirements. They will handle everything from constant bit rate services like voice and video, to bursty variable bit rate services, such as LAN interconnect. Although compression techniques will reduce bandwidth requirements, gigabyte backbone networks are still needed. The system will be user friendly, with good directory systems, and open interface standards to allow inter-working and compatibility between products. Access to the infosphere will be via either fixed links or a short free-space link. We can expect megabit-per-second free-space links to support portable multimedia terminals, giving users mobility and flexibility. The majority of users will continue to use the fixed network, provided higher bandwidths are made available. Both office and home will have a fixed optical connection to allow higher bandwidth delivery of multimedia applications, including video on demand and high-definition TV. Multi-megabit capability will be required for pseudo-independent access of several home appliances. The customer will expect suitable performance criteria, such as low delays for applications such as video games and video shopping. Eventually, telecommunications will be treated like any other utility.

Figure 7—Core technology trends

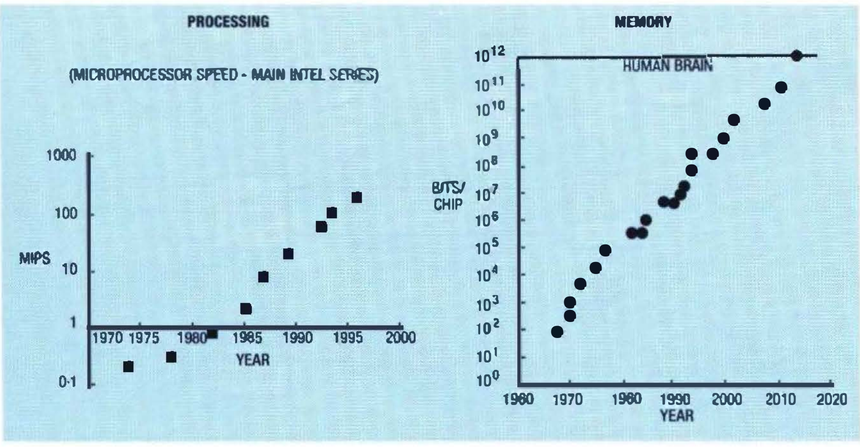
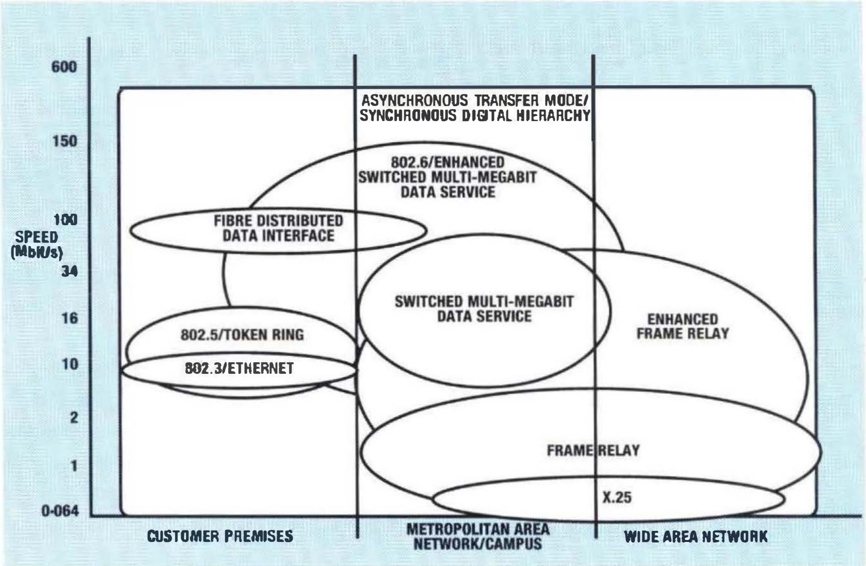


Figure 8—Technologies and speeds



Moving Forward

New techniques like synchronous digital hierarchy (SDH) and asynchronous transfer mode (ATM) allow voice, data and video traffic to be transported easily over the same network at a variety of speeds. These and other network options are illustrated in Figure 8. Technologies such as passive optical networks, see Figure 9, are maturing rapidly to enable both-way broadband delivery capabilities down to the customer. These will be a good platform on which to offer the future services and will work well with the infosphere. Advances in computer programming, such as client/server architecture, encourage distributed computing, while de facto industry standards allow data to be transferred between applications. Without these, users would remain constrained despite having a broadband infrastructure.

Many broadband switching trials are taking place or being planned around the world. Most trials are concentrating on cell-based switching technologies such as ATM. Partners in Europe's RACE (Research and Development in Advanced Communications in Europe) programme are developing the technology, user awareness and applications for broadband communications. The partners and users are exploring the development of implementation strategies for integrated broadband communications (IBC) systems, services and applications using advanced communication technologies. Importantly they are establishing common functional specifications and validation of standards.

A European inter-country ATM pilot is currently being planned for mid-1994. The object of this trial is to prove that the various ATM standards are implementable and that different implementations can inter-work. At present, 12 public network operators have agreed to participate in the trial.

In the UK, BT is following a similar approach to North America by providing both frame relay and switched multi-megabit data service (SMDS) to customers, Figure 10. The frame relay service provides access speeds of up to 2 Mbit/s as part of BT's Global Network Services (GNS). BT has been trialling SMDS equipment with the University of London since June 1992 and has a pilot service as part of the SuperJANET contract to provide universities and other research establishments with switched high-

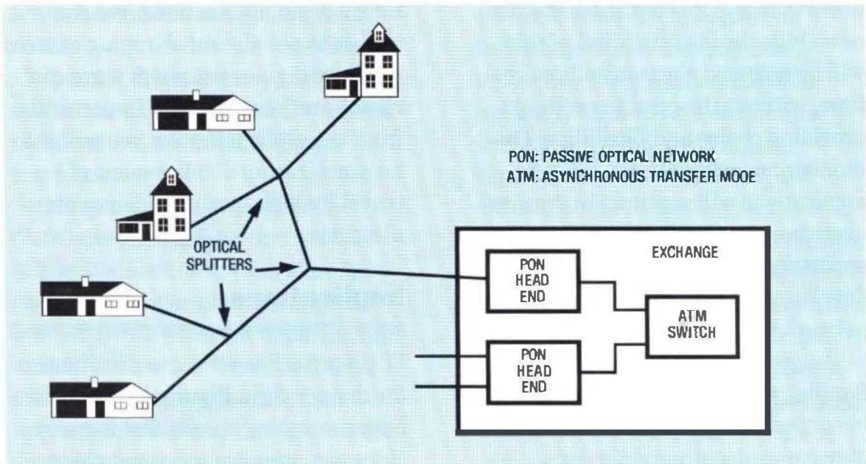


Figure 9—Passive optical networks

Figure 10—UK ATM trial

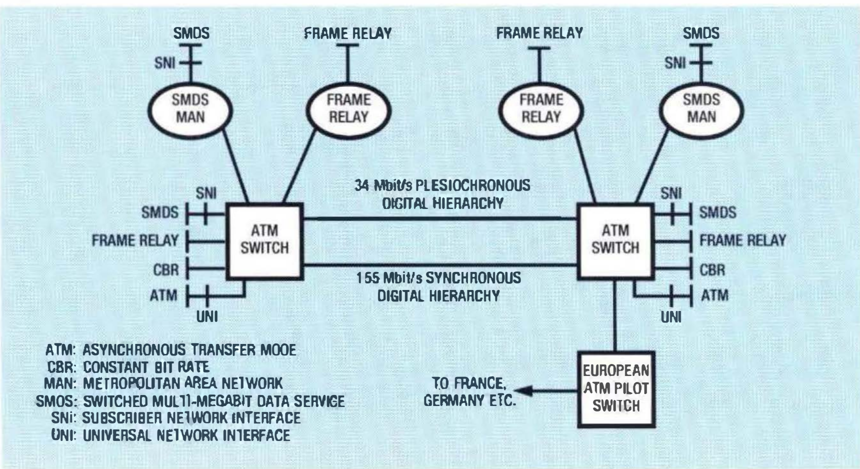
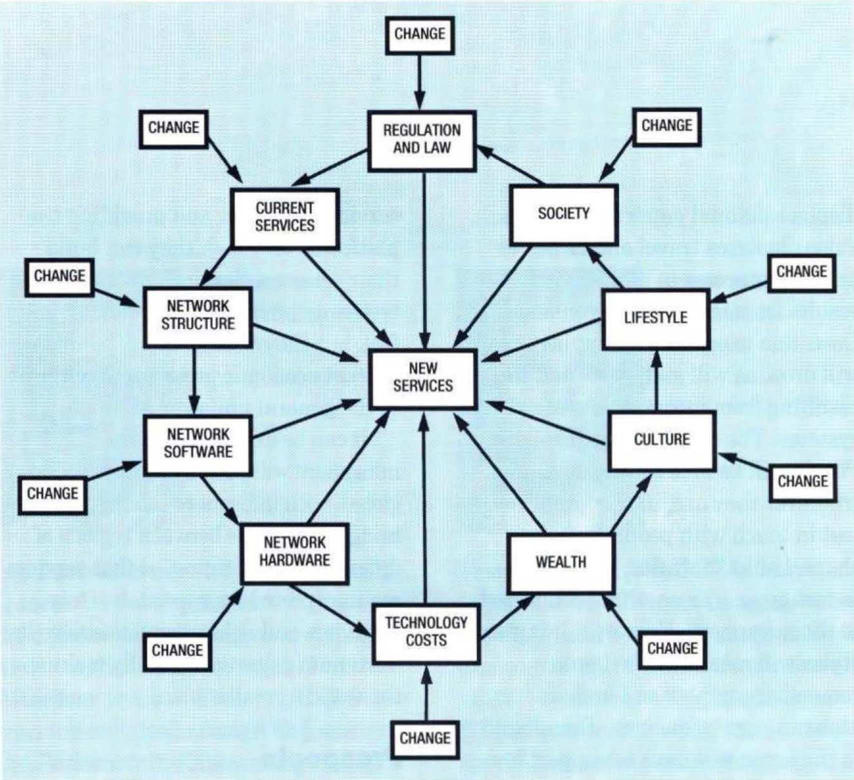


Figure 11—IT industry change cycle



speed data. BT is currently planning an internal ATM trial using commercially available equipment and views ATM as providing a common network infrastructure for supporting a wide range of data services flexibly at economic cost.

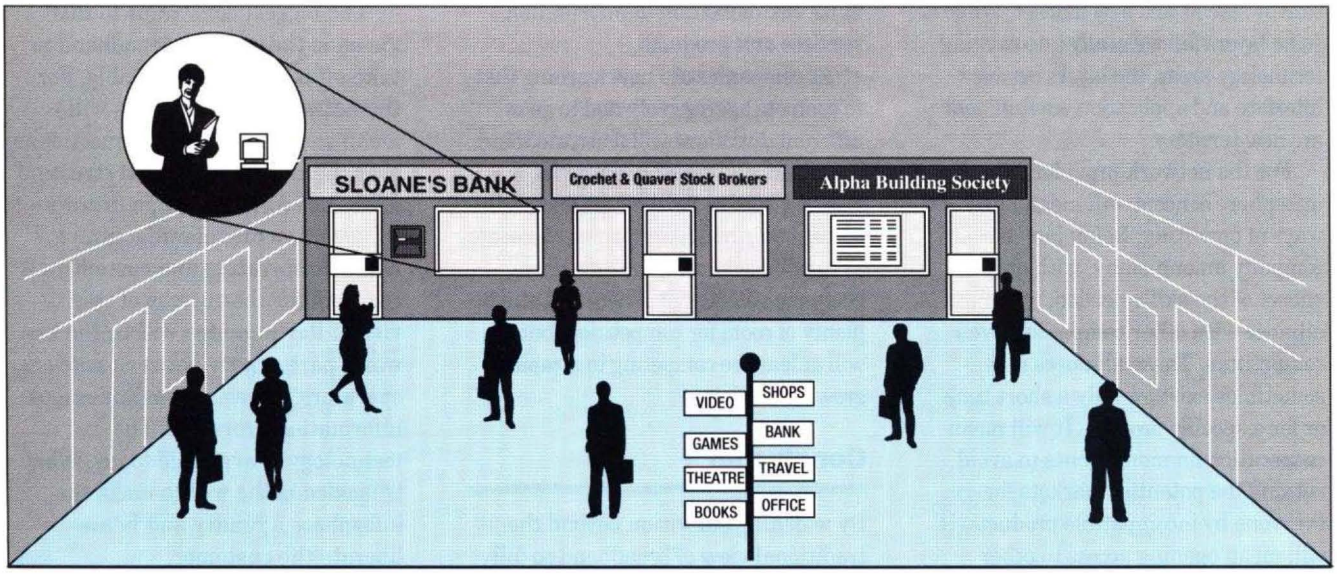
Looking to the Future

Technology is only a component part necessary to make the infosphere a reality. As Figure 11 shows, it is necessary for manufacturers to make equipment, network operators to implement it, service providers to provide applications and users to use it. Importantly, there needs to be a philosophy to make it happen. Governments and regulatory bodies are probably the only people who can provide the environment to make the information revolution happen. Without this realisation, broadband is only likely to find a niche market and its inter-operation, and integration into a universal environment, the infosphere, will not be achieved. The benefit of the infosphere is that it removes the boundaries between computing and telecommunications, allowing users to think about the task rather than its implementation. As a result, the network and all its services will be closer to the user.

The infosphere will gradually grow in sophistication, eventually supporting a wide range of interfaces from simple telephones to virtual reality and beyond, with the network making up for any lack of terminal intelligence to allow the user the fullest possible access. Service providers such as banks and publishers will build 'virtual buildings' in the environment which the user can then enter at will, Figure 12. People and 'things' may be represented by icons; directories and gateways as doors; products which people buy appear as virtual representations of the real thing. Transactions in this environment could be electronic analogies of the real world. Sending a fax may be as simple as picking up the virtual document and handing it to the virtual person. Although the look and feel of the infosphere may depend strongly on the interface available, the capability will be as full as possible wherever possible.

Its impact will influence every aspect of our life. Business will benefit as operating costs will fall. Automatic integrated electronic systems will

Figure 12—Infosphere interface



displace manual paper systems, as video displaces travel and as better and easier access to information results from the new environment. Costs due to errors and lost invoices will drop, as will staff costs and those resulting from incompatible computer systems. The individual will benefit. People will be able to remain in touch wherever they are, if they want; not just in touch with people, but with shops, banks, libraries, work, home, in fact anyone or anything connected to the infosphere. Universal interface styles will mean not having to remember complex and archaic alphanumeric sequences. Broadband to the home will have to support low delays for information retrieval, use of different services in every room, with instant access to any of a multitude of services, regardless of bandwidth requirements.

the infosphere provides the all-embracing framework within which the new market-place will develop

It is clear that the shopping mall type interface fits well with the layered architecture, (which is only one possible approach). There will undoubtedly be competition to provide each of the layers, with software and hardware providers from computing, telecommunications, and consumer electronics all side by side in this new market. While some layers fall naturally into existing technology areas, the layers between interface and application environment are new territory.

For the network providers, the infosphere concept will mean new ways of operating. Being just one company among many, with only a subset of the skills needed, will mean alliance with other companies, even competitors. These alliances may sometimes exist for only a short time or for a specific product. It will mean cooperation on many fronts to avoid ruining the potential markets for everyone by incompatible products. It will mean opening access to other service providers, and providing the platforms on which they can build their services. Service providers must be free to provide their own look and feel, but they will certainly be under market economic pressure to conform to the general philosophy.

It can be expected that the infosphere will become universal and global, with infosphere intelligence bridging the gaps between regions of differing sophistication, so that services are interpreted appropriately. Only when it is truly global will it achieve its maximum potential by really making the world a smaller place.

Prospects

The information technology areas of telecommunications, computing and consumer electronics have been suffering from difficult market conditions for some time. Revenues and profits are showing signs of levelling and even falling in some areas. New markets are desperately needed. We believe that the concept of the infosphere provides the all-embracing framework within which a new market-place will develop for the mass customisation of information services and products.

IT companies are now learning that to compete aggressively and to go in different directions will frustrate their customers and result in a slowly growing market for their products. If, on the other hand, companies cooperate at least on achieving the infosphere, everyone will benefit. There will still be plenty of room for competition, but we will at least be competing in a rapidly growing market.

Conclusion

By widening our vision beyond the traditional view of broadband to fully encompass the trends occurring in the computer and entertainment industries, we see an exciting future for telecommunication companies and their customers. There will be market pressure for broadband ubiquity from companies wishing to sell directly to their customers. Network customers will gain by greater flexibility and efficiency in carrying out their business, while supporting them in their leisure activities. As new applications develop, particularly in the leisure industry, multimedia and broadband networks will gain social acceptance and become an indispensable part of our way of life.

The information revolution promised by the infosphere also has a 'darkside'. It may become open to abuse, with the threat of 'big brother' and an invasion of personal privacy. There is likely to be a growth in socially undesirable services and the resulting difficulty of policing these types of information movements. There are also social implications: already sources of information are being protected and access restricted to those who can afford to pay. Without a clear understanding of the implications of these developments, society in the future will consist of the information rich and poor. As with so much of human technological achievement, it is not the technology itself that is bad, rather the use that we put it to.

The biggest constraint to this vision is the cost; for broadband to take-off it must be affordable. For the network operators this will mean some fundamental questioning over the role, purpose and structure of the network. A change in culture by governments, manufacturers, network operators and customers is required for the success of this vision. Partnerships will be the key word, particularly between network operators, software companies and information providers. The technology is available today. What is needed is the will to make the infosphere a reality and hence liberate the customer.

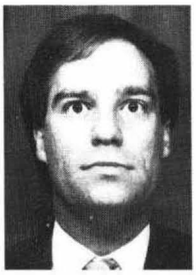
Biographies

David Greenop
BT Worldwide
Networks

David Greenop works in the Future Directions Unit, Network Strategy, BT Worldwide Networks. He has a B.Sc. joint honours degree in Physics and Logic, and a Masters degree in Telecommunications Systems. He joined BT in 1975 and spent a number of years on operational planning before moving to BT headquarters to work on the development of computer modelling tools for network planning. He has been involved in studies looking at various aspects of telecommunication networks. In recent years he has concentrated on the longer term developments in telecommunications and their impact upon the future network.

Ian Pearson
BT Development and
Procurement

Ian Pearson graduated in 1981 from Queens University, Belfast with a B.Sc. Joint honours degree in Applied Mathematics and Theoretical Physics. After four years at Shorts in Belfast working on missile design he joined the Performance Engineering Division at BT Laboratories studying data networks and protocols. He has since worked in several divisions, advising on the communication impact of technology developments, especially in computing and information technology. Inventions along the way include a free-format ATM derivative, various novel computer interfaces such as the active contact lens, and many other service and technology concepts. Since 1991 he has worked in the Systems Research Division investigating various aspects of future networks, whilst keeping a view of developments within IT.



Trevor Johnson
BT Worldwide
Networks

Trevor Johnson joined BT in May 1982 after installing and commissioning TXE2 and System X telephone exchanges with GEC for nearly three years. He has had a varied career in BT working on the testing and specification of digital exchanges, particularly in the area of signalling and call control, contributing to and attending CCITT, ETSI and T1S1 meetings. He joined BT's Network Strategy department in February 1991, with the specific responsibility for defining the strategy for broadband networks.

Adam Scott

Apparatus—Gateway to the Network

This article uses a gateway as an analogy. Apparatus can be seen as the customer's gateway to network services and as the network's gateway to the customer. Believing that customers value BT's supply of world-class apparatus alongside its provision of network services, BT has stayed in the business. The article also gives an overview of how BT's Apparatus Supply Business is organised and of its programme, project and product management.

The Gateway Concept

Ancient city gateways usually proved too narrow for later traffic so most of them have long since been demolished. Yet the concept of a gateway lives on as in the idea of gateway airports, hubs where travellers on long-distance flights can change or switch to or from feeder flights.

We have retained the concept for international exchanges, gateways between the national network and the global network, places where we can cope with the differences between national signalling and global signalling.

Access

Ancient gateways were a way into civilisation for barbarians, whether they came to enjoy its benefits or to destroy it. When Hadrian built his wall across England, it was not that he wanted to stop trade or communications so much as to maintain control and to mark the boundary of civilised standards.

Security and tolls

Gateways provided a measure of security, an opportunity to control access and exits, to know who had come in and who had gone out, sometimes preventing access or exits, often levying tolls and offering free access to privileged citizens.

Meeting places

Gateways were significant for traders, for officials and simply as places for being sociable.

Usefulness and image

They were useful and sometimes designed to impress those who passed through them. Their names survived as in London's Newgate Street where the BT Centre now stands. Gateways emblazoned with heraldic symbols served to create or to reinforce images just as the large BT logo has on the front of the BT Centre.

The Network's Gateway to the Customer

When we think of apparatus as a gateway, our attitude will depend on which viewpoint we adopt.

We can think from the network's point of view:

Apparatus is the gateway which stands between the customer and ourselves. Without some form of apparatus, it is difficult to gain access to the customer's hearing, seeing or sense of touch. And without access to those three senses we are unlikely to get through to their hearts and minds.

The first form of access is simply to gain the customer's attention through a bell powered over a line using sound or through a flashing light using sight; alternatively, we may gain

BT Response 200 (including answering machine)

Cellular handset

Relate 2000 videophone

access over wireless through a vibrating pager using touch.

Access becomes more sophisticated if the customer has a private switch or local area network; we may need to gain access through an initial gateway into the customer's own system and then on through another gateway out of that system and to a person beyond it.

For this we may need to send an address, a means of identifying the addressee, as with direct dialling inbound (DDI) through a PABX or calls to a cellular handset. The next development is sending and displaying an identification of the caller, initially just the number of the calling line—calling line identification (CLI)—but, in future, the name of the caller so that the receiving customer may decide whether to accept the call and, if so, how to handle it.

Without an appropriate gateway to the customer, our enhanced network will be of little practical use.

The Customer's Gateway to the Network

Of course, the reverse is also true when we look at apparatus from a customer's point of view. The customer needs apparatus as a gateway into the network and through the network to people or to services beyond distant gateways.

Customers rely on apparatus to translate their desires into action over the network: obtaining the links required for a single call or for a longer time, faithfully reproducing messages and, sometimes as with a payphone, accurately charging their credit or debit card.

Customers generally look for apparatus that is both attractive and straightforward to install and to use so these criteria are critical not just in design but in preparing instructions. Most of us have experience of that very useful gadget that turns out to be a terrible bore to use.

Network operators have one set of requirements, customers another; BT's task in an Apparatus Supply Business is to meet both sets of requirements. Our task is to do so in ways that bring straightforward access to useful services and quality and value for money to the customers.

In succeeding we should bring increased usage and revenue to the network.

Customers generally look for apparatus that is both attractive and straightforward to install and to use

Change

Customers' requirements are changing, the technology is changing, the market is changing, liberalisation is already with us in the United Kingdom and we are looking at new relationships with suppliers and with our retail channels. Like everyone else we live in a changing world.

Customers and technical change

Just as there are changes in the network so there are changes in apparatus:

We have got used to multi-frequency (MF) keypads, which have speeded up dialling, yet many customers still send the network pulses from their unadjusted telephones.

We have memories which can help people to access their frequently called numbers yet many customers still have difficulty accessing our enhanced network services like call waiting.

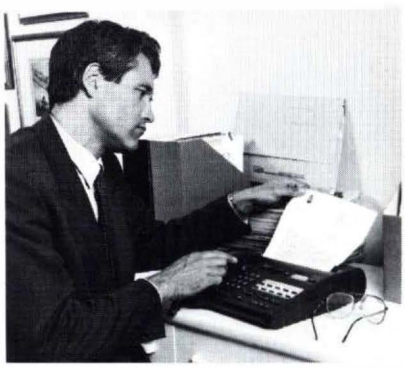
We are launching new telephones equipped to make access to these services more attractive.

Answering machines have moved on from using tapes for recording to using solid-state electronics.

Using ordinary analogue telephone lines, the current Relate 2000 videophones have moved video-telephony from being an expensive broadband dream to plug and play at hundreds of pounds rather than thousands of pounds. Meantime modern fax machines offer convenient text and image services on the desktop at home or in the office with a footprint little larger than A4.

Videophones are just one example of screen-based technology. At the more sophisticated end of today's apparatus portfolio come the screen-based systems for dealing rooms produced by BT's CBP subsidiary and, between the two, a range of apparatus

DF 200 incorporating telephone, answering machine and fax



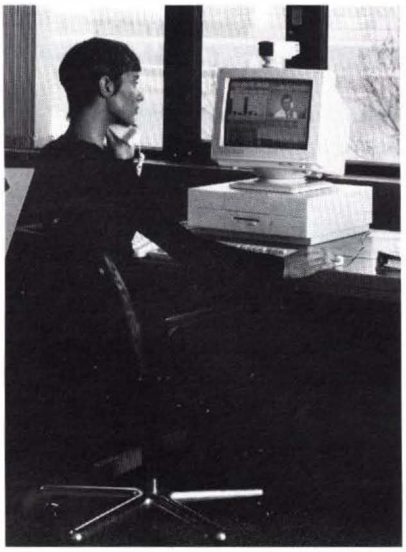
CBP dealing room at Moscow Norodny Bank, London

will grow up which will help customers to make better use of the network.

One example of this is the VC8000, which enables customers to convert their personal computers into multimedia terminals. Another is the work going on between Apple and Cellnet on putting communications facilities into palmtop personal digital assistants.

We are looking at opening up opportunities for fun as well as helping people to be more efficient or effective. Customers already use telecommunications intensively in trading but, as the capability of networks and apparatus expands and as costs fall, the potential of entertainment, education and interactive games will expand. BT made a start this year by launching a satellite television receiver ready for digital transmissions and trials of video-on-demand will soon follow.

VC8000 multimedia application



Apparatus will provide gateways into a network through which customers can access intelligent gateways into distant services.

Callcentres are an example of the intelligent gateway combining the potential of network, apparatus and computer to allow telephone-based businesses to become much more responsive.

Access through apparatus gateways will influence the ways in which many of our customers both live and work.

We have the opportunity to be imaginative in our use of the potential of new technologies.

Markets have changed rapidly but people are much the same

Customers face increasing choice in a market for apparatus thrown open by liberalisation. New technology, increases in network capability, more sophisticated apparatus and fresh applications crowd in upon us while personal ability to communicate and our personal data-processing capacity are probably not changing in the same dramatic way.

Today's more sophisticated apparatus can receive, process, code, store, and transmit digital data at a rate which could leave most people reeling. We should not be too depressed; slow we may be in communicating with each other or with machines, but our human minds remain superior at rapid image processing, at imagination and in associative memory, even if we are sometimes slightly unreliable[1].

Rather than being depressed, we should be realistic about the differences between interfaces within our networks and those between the networks and people. At that interface we must be prepared to wrestle with the capability and the limitations of our five senses. We have the opportunity to be imaginative in our use of the potential of new technologies.

As we look to the future, our apparatus should be designed to serve our customers rather than being designed round the convenience or constraints of our network engineering or the vagaries of our computer operating systems.

We can use the potential of new technology to design apparatus which enables customers to adapt their own personal gateway to the network to their own personal preferences. A simple example is providing programmable memories on telephones.

A good channel for suppliers

The liberalisation of telecommunications in the United Kingdom has meant not only that customers can choose from a wider range of suppliers but also that BT has been freed to look right round the world for the best suppliers.

In our search for quality, innovation and value for money we now look to suppliers on four continents.

Focusing on the individual customer's gateway we have a range of telephones, answering and fax machines designed specially for BT and sold under the BT brand.

For the business customer we have looked to suppliers with a global reputation for our new range of switches, local area network hubs, and

Putting the customers' viewpoint first caused BT's senior management to back the apparatus business rather than concentrating solely on the network.

the bridges and routers which link local area networks with the global network. This apparatus is usually sold under a supplier's own name.

When BT was still a monopoly, suppliers sought us out because we were generally their only route to the UK market. Today, there is a multitude of channels and many manufacturing groups sell direct to customers. So BT needs to be an attractive channel. World-class suppliers should have good reasons to believe that we offer them a good route to our customers.

In some cases, this is leading to much closer relationships, more like partnership, with the supplier's expertise in close support of the BT team.

Channels for BT

BT shops, our dedicated sales people, our engineers, those in Customer Service Centres, indeed any member of the BT team can play a part in promoting our apparatus to customers. But we back their efforts by working through good retail channels to customers.

Many of our telephones, fax and answering machines are sold through the thousands of non-BT retail outlets which have sprung up since liberalisation.

For the bigger customer, BT's project and service management capabilities come to the fore and we relish the opportunities to install strategically important infrastructure. BT may also become a sub-contractor in large jobs as well as offering its own system integration capability through Syntegra.

Regulatory change

Liberalisation has not freed BT's apparatus supply business from regulation. All suppliers have to meet certain standards before their apparatus is approved for connection to the network.

To encourage fair competition, BT has to abide by the relevant terms of its licence, by the specific terms of a direction made in 1991 by the then Director General of OFTEL, Sir Bryan Carsberg, and by those general laws about competition which apply within the United Kingdom or throughout the European Union.

People, Adaptability and Change

The threat of change turns some into innovators but others into conservatives—customers who may be reluctant to embrace new technology even though they know about competitive edges and cost effectiveness.

That inertia among many customers is matched by the very momentum of our network of which parts are modern and others old fashioned. The prospect of cabling offices with today's 100 Mbit/s capacity over unshielded copper pairs has to be seen against the 9·6 kbit/s capacity of a customer's existing analogue private circuits. For all the excitement of innovation and the technical potential for change, customers are understandably nervous about incompatibility and unreliability as they move ahead into the new information age.

Looked at from our customers' perspective, the information age may well look like a battle between approaching chaos and hopes for simplicity.

This challenges the apparatus business as well as the network business to deliver simplicity as well as quality, and simplicity as well as quality seen from the customers' viewpoint.

Why have an Apparatus Supply Business (ASB)?

Putting the customers' viewpoint first caused BT's senior management to back the apparatus business rather than concentrating solely on the network. As the gateway to our network and to its services, BT's apparatus should serve to reinforce BT's image of quality and value for money. We listen to customers and

BT shop

ASB Themes

- Reinforce the BT brand through quality and value for money.
- Encourage network use through attractive gateways
- Make a financial contribution to the BT group.

Most of these projects have a direct bearing on growing revenue, improving processes or reducing direct costs.

ASB Tools

- Programme management.
- Project management.
- Product team management.

keep a close watch on the results of independent tests, such as those in *Which?*, to check that we are meeting this requirement.

But the ASB must meet the requirements of BT's shareholders and regulators. BT's licence means that we have to provide OFTEL with separate accounts for the ASB and these have put the spotlight on the need to improve the financial contribution made by the ASB to the BT group.

ASB programme and projects

To ensure that we make these financial improvements while meeting customer requirements, BT has identified the ASB as one of its key cross-Divisional Programmes with a cross-Divisional Control Board and with the Group Managing Director as client for the programme.

Within the programme there are well over a hundred projects and feasibility studies registered with, and regularly monitored by, the Programme Office. Most of these projects have a direct bearing on growing revenue, improving processes or reducing direct costs.

There are two other important areas where projects are being pursued. The first area concerns information, because we believe that our management and customer service would be more effective if we had a better understanding of the business.

The second area focuses on functions like marketing, sales, planning, motor transport, procurement and logistics, computing, personnel and training and finance, whose tasks span several products and services and whose costs are allocated between different parts of the business.

These functions are often meeting demands placed on them by others who use the outputs. Projects may focus on efficient supply but they may also encourage managers to examine the underlying demands and to check whether effective use is being made of the results. For example, we may have ordered vehicles capable of carrying one tonne when a capacity of half a tonne would have sufficed or we may be hiring extra vehicles when suitable vehicles are lying idle in the yard. The programme encourages people to use project management disciplines in an imaginative way so that they become a welcome part of everyday life rather than a burdensome extra.

ASB products and teamwork

Within the ASB, a set of six cross-Divisional product teams are responsible for managing the development, launch, in-life management and withdrawal of the majority of BT's apparatus.

Product teams operate within the framework of the Product Team Handbook, itself part of BT's quality management system.

Their life would be simpler if the members alone were capable of completing the product task. In practice, each product task normally involves a great variety of people inside BT and beyond. Team members are expected to subscribe to team objectives knowing that they must take personal responsibility for negotiating the necessary support in their home Divisions.

This sort of working, cross-Divisional projects and product teams, is typical of the one-team approach essential to making effective use of BT's matrix organisation.

Amsterdam—A Seventeenth-Century Gateway

At Intelevent '93 in Amsterdam, Adam Scott used Amsterdam as a model for the future of apparatus:

In the seventeenth century, Amsterdam had become a gateway to Europe and a gateway to the world. It was a golden age whose roots included two marvellous sixteenth-century inventions: the Exchange originally founded in 1530 and the flyboat invented in 1570.

In 1608, a New Exchange opened as the place where merchants could meet and do their business. It provided any-to-any connectivity, conveniently, reliably and using the processing power of individuals. If we think of computers in our own time then we can see the Exchange as the Ethernet of its time. The Exchange provided all this without a need for Amsterdam's merchants to travel long distances.

Of course, trade demanded long-distance transport and the low-cost asynchronous transfer mode of its day was the flyboat.

These boats gave Dutch merchant seamen high capacity, low operating cost, transmission over the sea lanes that formed their global network[2]. Meantime the network of canals was a trading equivalent of the local area network.

These factors, combined with an open house for merchants, thinkers and artists, caused the French mathematician and philosopher René Descartes to write, in a letter dated 5 May 1631[3]:

'What place on earth could one choose where all the commodities and all the curiosities one could wish for were as easy to find as in this city ?'

In the future, a latter day Descartes might ask:

'What apparatus will one be able to choose for any place on earth through which all the services and all the curiosities one could wish for are easy to find?'

Today, team objectives and cross-Divisional working can seem like an uphill task and we need to apply each of BT's values and the best management disciplines to making team work effective.

The BT team

BT team members, wherever they are, can play a part in helping customers to find the apparatus which will become their gateway to the network.

Within the code of practice which exists to ensure that we do not misuse our network knowledge, engineers are becoming involved through Customer Focus, and Customer Service Centres have their own apparatus programme.

Today's apparatus portfolio is one each BT team member can be proud of; the task facing the product teams is to develop new products, the products which our customers will find easy to use as their gateways to tomorrow's network services.

Acknowledgements

I am happy to acknowledge insights gained from fellow members of the BT team particularly from customer equipment product management colleagues, from John F. Buckley, Bob Foster, Jeremy Newton and Paul Sharma and from Henry Boettinger.

References

1 GILDER, GEORGE. The death of telephony; 150 Economist years. *The Economist*, 11 September 1993.

2 GILDER, GEORGE. Telecosm. Technology Supplement to *Forbes ASAP*. 13 September 1993. pp. 158–166. (Recommended if the reader wants to think more about this analogy.)

3 DESCARTES, R. Oeuvres I. Correspondance 1969, p. 204, quoted in BRAUDEL *le Temps du Monde*, 1979.

Biography

Adam Scott
Director, Customer Equipment
BT Products and Services Management

Adam Scott is currently Director, Customer Equipment, Chairman of the ASB Control Board and a trustee of the BT Benevolent Fund. In 1977, he joined the Post Office from Standard Telephones and Cables as an intellectual-property lawyer who had been called to the Bar in 1972. He is a Chartered Electrical Engineer who participates in the Worldwide Networks mentoring scheme, and a business school graduate with a keen interest in BT's Telecommunications Masters Programme. He was ordained in 1975 and serves as Anglican Dean for Ministers in Secular Employment in South East London.

Graham Mills, and Dave Griffiths

PC-Based Visual Communications Services

The first of a new series of products based on BT visual technology is the VC8000, an adapter that will convert a desk-top personal computer into a multimedia communications terminal. This article provides a technical overview of this new product and describes its entry into the market-place. Future developments are also discussed.

Introduction

An earlier article[1] discussed the medium- to long-term implications of video telephony and multimedia applications for BT and the markets in which the company operates. It was concluded that by the year 2000 worldwide revenues totalling more than £19 billion a year would be earned from video telecommunications. Of that, by far the greater proportion, some £14 billion, would derive from incremental network revenues.

In order for BT to be in a position to earn an appropriate share of those revenues, the company has taken a number of innovative and entrepreneurial steps to 'kick start' the market to ensure that users eager to make use of the new technologies are able to do so. The network infrastructure is already mostly in place, both in the United Kingdom, and internationally. The next phase is to ensure that user terminal equipment is available that is affordable, efficient and meets international standards. BT is well advanced with its plans for the introduction of such equipment.

In spring 1994, the first of a series of new products will appear on the market based on BT visual technology. It will take the form of an adapter that will convert a desk-top personal computer into a multimedia communications terminal.

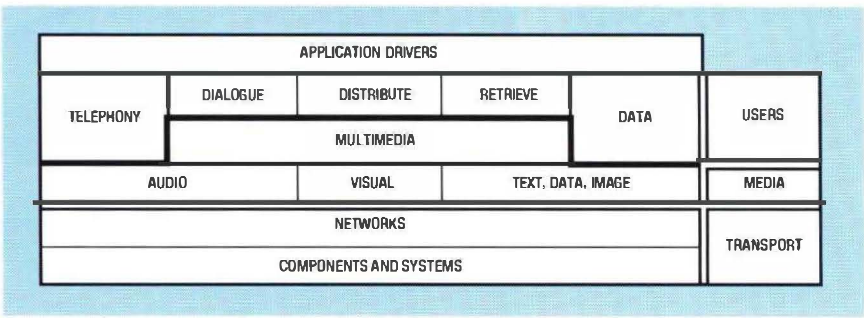
BT and Multimedia

Multimedia is a very misused word. For BT, however, it has a very specific meaning: the use of telecommunications networks to interchange a variety of different types of information including, audio, video, text, images and data. The structure of the market can be best seen as a series of layers as shown in Figure 1.

In the lowest layer lie the components and systems that make desktop multimedia communications possible. The physical terminal products are closely associated with the networks themselves. Above that, are the different media separating out as audio; visual; text, data and image. Image applications are included with text and data since they are not interactive, but more akin to the transfer of files.

Multimedia applications divide into three generic types of communication, each of which places its own demand on the network. First is dialogue—interactive communications between two people, or between numbers of

Figure 1—Structure of the multimedia market



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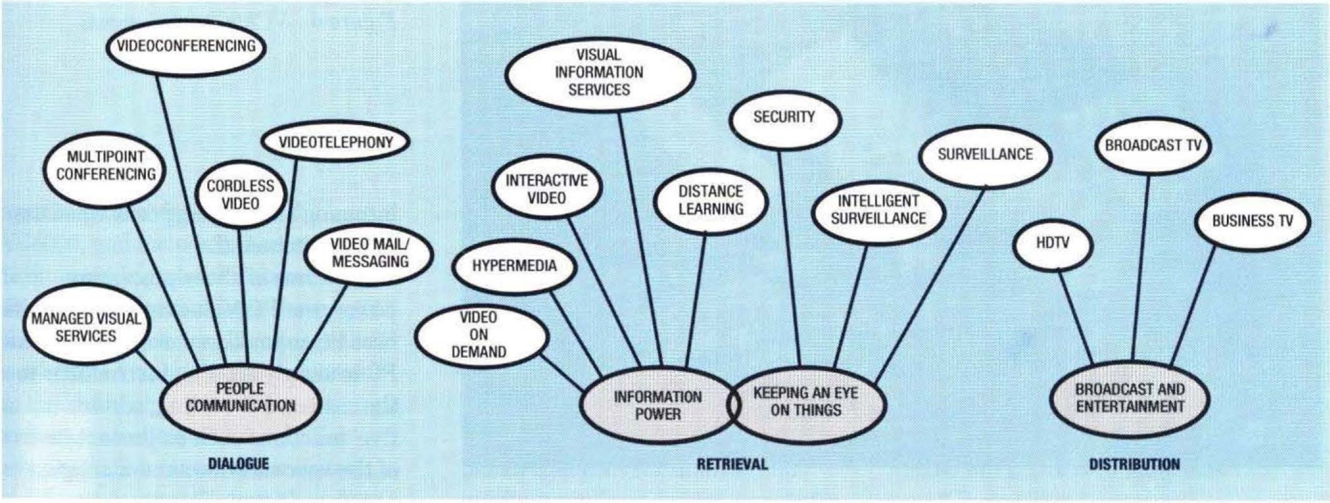


Figure 2—Visual applications and services

people simultaneously where the flow of information is bidirectional and balanced. Distribution of information is a broadcast concept where one source is communicating to many recipients, who may or may not respond. Finally there are retrieval applications. Simplified retrieval implies many remote terminal users connecting to a single point from which information is extracted or in which it is deposited. (See Figure 2.)

BT's primary role is to provide the infrastructure to support these applications: the network and service management required to offer, deliver, bill and support multimedia services, rather than the manufacture of equipment. In broad terms, a typical multimedia call will generate up to six times the revenue of an ordinary voice call. It will use two B-channels in a basic-rate integrated services digital network (ISDN) circuit. Also, experience during recent Europe-wide trials showed that the holding time for that type of call is typically three times longer than a standard audio-only call.

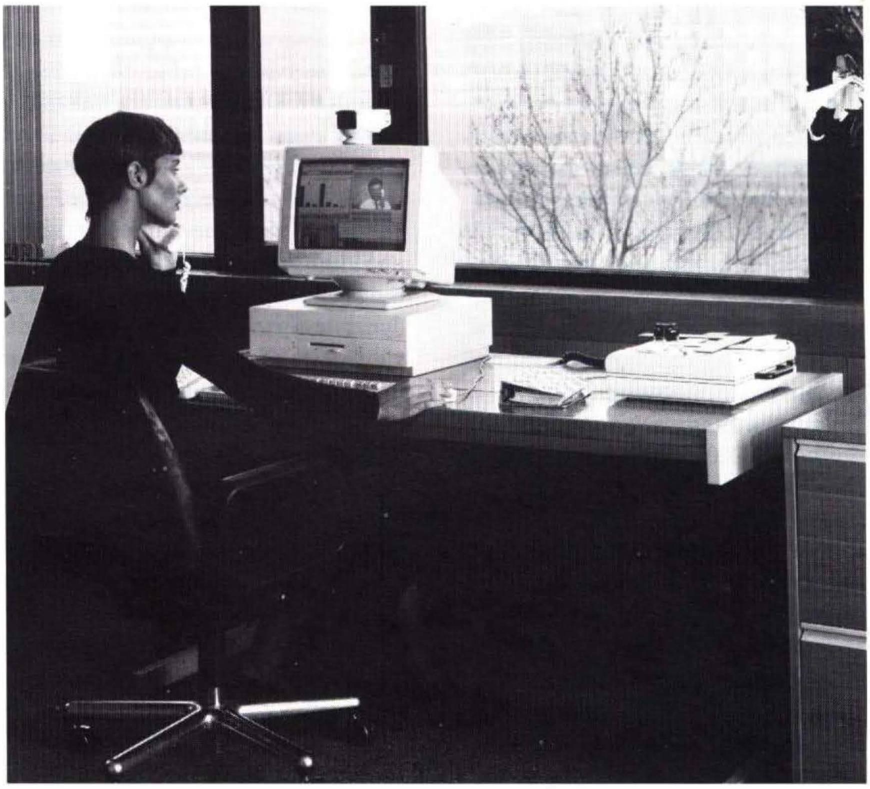
Although BT is not manufacturing terminal equipment, the company has played a major part in the definition of international audio/visual communications standards. These have been based on the results of extensive research and development into the enabling technologies. The culmination of this work is a series of designs which are being manufactured for BT and marketed by a number of partners from the computer and consumer electronics industry. The objective is to take advantage of volume production for mass markets so that costs may be kept as low as possible.

VC8000 Multimedia Terminal

Overview

The first commercially-available BT-designed product for desktop multimedia application is the VC8000. It provides the means of converting an ordinary personal computer into a complete multimedia communications station and ISDN terminal. A card simply plugs into the standard expansion bus of a personal computer, an installation operation that most competent users can carry out in just a few minutes. In addition to the card itself, users will be supplied with a telephone handset and dial pad, a miniature solid-state television camera and software. (See Figures 3 and 4.)

Figure 3—VC8000 application



Together, the card and its peripherals will provide an all-purpose interface between the personal-computer user and public and private ISDNs to provide on-demand dialled connection for interactive multimedia transactions. These transactions include:

- ordinary audio telephony;
- one-to-one video telephony;
- one-to-many videoconferencing;

Figure 4—VC8000 components

- 'chalk board' interaction, where parties to a multi-media conversation can be given access to each other's computer screens to display in real time the output from, and accept input to, locally running programs; and

- background high-speed transfer of data and high-resolution image files.

While the TV camera and audio handset will be the prime means of input for video and audio signals, there are many other possibilities. Provision of a standard BNC video connector allows input from any source that can provide a video signal in any of the standard television formats. Suitable sources include video-cassette players, satellite TV decoders or camcorders. Also, an audio socket will accept inputs from any line audio source. At the same time, the interface between the card and its host computer provides access to the PC's hard-disk and other local mass storage media such as CD-ROM or optical disk. This means that the VC8000 can be used to capture audio and video images for local storage and retrieval during ISDN transaction sessions or for maintaining personal multimedia archives.

The VC8000 comprises two printed circuit boards (PCBs) in a 'mezzanine' arrangement, where the PCBs are arranged parallel to each other. The larger of the two cards—the motherboard—provides the interface with the PC and carries ISDN 'S' bus interface components and circuits to handle analogue video and audio signals. It carries input and output connectors for video and audio, and for connecting with the PC's display monitor. System memory and PC bus interface controllers are also housed on this board.

A smaller 'daughter' board carries digital video and audio processing coder-decoder (codec) circuits. Audio compression conforms to CCITT Recommendations G.728, G.711 and G.722. Video compression complies with CCITT Recommendation H.261. A channel formatter carries out flexible multiplexing and the control of communications channels.

A prerequisite of the system is that it should be able to communicate with an ordinary voice telephone or a videotelephone, neither of which can handle file transfer, as well as to another terminal with similar capabilities. Therefore, it must be able to determine the abilities of a remote terminal.

As an ISDN adapter, the VC8000 can make use of both 64 kbit/s B-channels to provide a total bandwidth of 128 kbit/s. Initially, the entire bandwidth would be allocated to voice and video. During file transfer, part of the bandwidth can be reallocated dynamically to carry data. Audio and video ports allow preparation of image or audio messages off line for subsequent replay down line. Files can also be stored on the computer's hard disk.

In use, calls are set-up just as though the PC were an ordinary telephone. Once a connection has been established, its first task is to assess the capabilities of the remote terminal. If it finds a non-ISDN terminal then it will drop the line, but immediately reconnect using appropriate signalling protocols. It will continue to operate as an ordinary telephone for both incoming and outgoing calls when the PC is switched off.

In terms of sheer processing power, the PC-Video card outrates its host PC many times over. In fact, the PC is simply sending instructions to the card and providing 'administrative' functions such as presentation of the user interface and managing peripherals such as mass data storage. At the heart of the system, picture compression is handled by a pair of powerful digital signal processor (DSP) chips. Two more handle audio compression and decompression. Two more microprocessors are used to manage communications and to control the system as a whole. More specialised functions are handled by six custom-designed chips.

The VC8000 is almost totally self-contained, with its own massive memory for temporary storage of pictures, and its own clock generators. A significant design feature is the use of non-volatile 'flash' memory chips to contain low level 'firmware'. This means that the card can be up-dated if necessary should coding parameters or standards change and ensures that there is a high degree of 'futureproofing' built in to the card. New firmware could be installed by a user directly from a floppy disk.

Architecture

Four main functional blocks make up the complete VC8000 system. One provides and controls the interface between the host computer and the card; next are two signal processing blocks one for video, one for audio; and finally there is a group of circuits which together provide the communications interface for the card. This last section manages the allocation of the relative proportions of video, audio and data capacity that are passed through to the ISDN interface.

PC command interpreter and interface adapter

The PC command interpreter and interface adapter provide buffering and logic for interfacing the PC bus and the control functions of the VC8000, and include a microcontroller to interpret high-level instructions from the PC. It translates these into the low-level 'machine' language that can be acted on by the major element in the block, a purpose-designed system controller--effectively the administrative centre of the system.

The main controller manages the routing and high-level manipulation of digitised video signals. Its tasks include controlling the movement and scaling of digital video within the hardware of the card. It also manages the storage and retrieval of digital video information on the host computer's hard disk.

It is able to receive sampled RGB video either from external video inputs or from the H.261 video decoder, and to scale these signals horizontally before passing them for processing. On the display side, it takes care of the extraction of data from the output of the video decoder and its conversion into an analogue format. These signals are synchronised with the host computer's video before being sent on to a video switch which merges the full motion pictures with the computer's display.

As well as synchronisation with the computer display, the picture must respond to commands from the user who will want to adjust its size and position on the screen. Scaling and positioning are carried out in a memory array configured as a frame buffer, and addressable by both the main system controller and a digital-to-analogue converter. Movement is organised by a monitor video switch which takes charge of the output from the PC's graphics board, switching between this source and signals extracted from the frame buffer.

Other functions within the 'administration' block include a block of static memory, in a dual port configuration, that is shared between the ISDN interface and applications software running on the host computer. This provides the host PC with control of all call and channel management facilities on the card. Lastly, the block includes a facility for testing the integrity of the card on powering up, and for the initialisation of the system.

Video and audio processing

Most of the system's processing power is expended in the two core function blocks that convert, analyse and reformat audio and video signals for onward transmission either into or from the telecommunications network. Both functions must be carried out symmetrically and in real time.

The video-conversion part of the video-processing block outputs preconditioned video signals to the video codec, where they are analysed, compressed and coded ready for transmission. Its input is selected from either a miniature TV camera or from an auxiliary video input generally in a format similar to that used for broadcast television—PAL in Europe or NTSC in the USA and Japan. As a preliminary, these formats are digitised to comply with the international standard called *common intermediate format* (CIF). The VC8000 will work at quarter CIF (QCIF) resolution. QCIF encoded data is then passed to the video codec for compression.

At the same time, the video converter is able to send pure analogue red, green and blue (RGB) signals to the main controller. These may be derived either from a PAL or NTSC camera or auxiliary input device or from the output of the decoder itself. This allows the PC to display pictures which are generated locally or which are decoded from the telecommunications network.

The video codec itself provides digital video compression and decompression for a variable transmission rate up to 126·4 kbit/s in accordance with CCITT Recommendation H.261. This allows video information to be multiplexed and synchronised with digitised audio, using rules set out in CCITT Recommendation H.221, before being launched into the network.

The audio codec provides audio compression and decompression in accordance with two international standards: CCITT Recommendation G.728 for a transmission rate of 16 kbit/s and G.722 for a rate of 48 or 56 kbit/s. In addition, it can pass G.711 digital audio uncompressed at the full ISDN B-channel data rate of 56 or 64 kbit/s.

Channel control and ISDN interface

A major feature of the VC8000 is its ability to take flexible advantage of the full 128 kbit/s bandwidth available with a basic-rate ISDN line. Such a line is equivalent in capacity to two ordinary telephone lines, each with a digital data-rate capacity of 64 kbit/s. In basic-rate access configuration, these are defined as two independent channels designated *B-channels*. In addition, a third channel, the *D-channel*, which operates at 16 kbit/s, is used for signalling commands and administrative information to the network.

Since the two B-channels are independent, simultaneous connections may follow entirely different routes through the network, even though both calls have the same destination. As a result, there will be a difference in the time the two calls take to pass through the ISDN network. Although this time difference will be small in terms of human perception, at high data rates it will be significant. In order to be able to use both B-channels as though they were one, the two data streams must be carefully synchronised.

The parameters for achieving this channel aggregation are set out in CCITT Recommendation H.221, and in the VC8000 are handled by the channel formatter and controller block. At the same time, H.221 specifies the standards which must be met for proper synchronisation of audio and video signals, so that, for example, in a videophone call the movements of the participants lips match the sounds coming from them.

The channel formatter also performs the task of multiplexing background data transactions such as file transfers and interactive 'chalk board' sessions with the foreground live video and audio transmissions. It does this by dynamically allocating portions of the total bandwidth available to the various data streams, taking and/or adding them in increments of 8 kbit/s, as specified in CCITT Recommendation H.221.

While the VC8000 is compliant with these recommendations, it needs to be able to communicate with less sophisticated terminals. It therefore needs to be able to identify and adjust for any differences in their performance and abilities. This task is the responsibility of a channel controller which implements the protocols specified in CCITT Recommendation H.242.

Finally, the physical connection to the ISDN is controlled by an ISDN interface. Under control of the host computer, it communicates directly with the ISDN network to provide the basic telephony functions of call set up and answering, and the passing of data from the two B-channels to and from the channel formatter. In addition, since the VC8000 must be able to provide basic telephone services, even when its host is switched off, or its application program is not running, analogue audio interfaces are provided for direct connection of the audio handset and for ancillary equipment.

Data from either or both B-channels is passed to the PC through this block, allowing direct PC-to-PC communication or file transfers over the network. The ISDN interface also provides LAP-B and LAP-D data communications protocols.

Standards compliance

At every stage in the process of converting and combining video, audio and data into a format suitable for transmission over the public switched network and for subsequent processing by a standard personal computer, there has been strict adherence to published international standards and recommendations. Indeed, BT's VC8000 can possibly claim to incorporate more international standards per square centimetre of printed circuit board than any other communications terminal available.

Generally speaking, technical standards, especially telecommunications standards, set out mainly to define the bare minimum specifications required to ensure compatibility between terminals made by different manufacturers. The VC8000 has been engineered to exceed in all respects the basic requirements of the many standards to which it conforms. Nevertheless, it can be manufactured in volume for a price that will make it available to mass markets.

The VC8000 has been engineered to exceed in all respects the basic requirements of the many standards to which it conforms.

Bringing VC8000 to the Marketplace

The VC8000 will be manufactured for BT in the UK by Motorola on a purpose-designed production line at the Stotfold, Hertfordshire, factory belonging to its Automotive and Industrial Electronics Group. Volume production is scheduled to commence during the second quarter of 1994.

Initially, marketing and distribution will be carried out by two major computer companies, IBM and Olivetti, using their extensive dealer channels. In the longer term, it is expected that other companies will form similar partnership arrangements. Within 12 months from the launch, VC8000 will be on sale in a score of countries around the world. First targets are the UK, Western Europe and North America.

In the meantime, a batch of 250 VC8000 cards will be distributed to trial users from January 1994. Some 40 firms have been selected to take part in the trials. These are all major national or multinational organisations.

The VC8000 electronics will also be used to produce a dedicated desk-top ISDN videophone. This is scheduled to be launched soon after the PC card. Design and engineering of the videophone has been carried out in partnership with the Japanese consumer-electronics giant, Matsushita, known in the UK for its Panasonic brand. There will be two versions of the videophone, one designed to integrate with BT's range of telephones, and to carry the BT brand. The second will be marketed worldwide by Matsushita under the Panasonic brand.

Future Developments

'Chalk board' interaction

While a great deal of attention has been paid to technical standards for the hardware to ensure that the VC8000 is truly compatible and able to interwork with all other terminals that comply with the CCITT standards, there is one remaining uncertainty. As yet there are no ratified international standards governing applications software for 'chalk board' interaction, where parties to a multimedia conversation can be given access to each other's computer screens to display in real time the output from, and accept input to, locally running programs.

To resolve this omission, a BT initiative has led to the formation of the Multimedia Communications—Community of Interest, or MC-COI. It was formed in June 1993 by BT, IBM, Intel, Teltsra, France Telecom, Deutsche Bundespost Telekom and *it is envisaged that the chip-set will become a standard feature rather than an option in the next generation of personal computers, built into their main motherboard*

Northern Telecom. The group now has 26 members representing a cross-section of computer manufacturers, telecommunications companies and software vendors. A further 11 companies have signalled their intention to join the group.

The objective of MC-COI is not to act as a standards-setting body, but as a practical proving ground for manufacturers and network operators to interchange experience to ensure that the sound technical ideas embodied in existing standards are well implemented so users of different suppliers products can interwork. As part of that work, MC-COI intends to adopt a common applications programming interface (API) for chalk board and desktop multimedia conference applications. The plan is to have a specifications stage through 1994 and into 1995 to define the function set and the API, to carry out laboratory and practical testing in various countries and then to establish customer trials. The project is seen as a very practical way of proving the standards and enabling worldwide acceptance.

Advanced chip-sets

Again, BT's prime objective is the promotion of communications-intensive applications rather than to develop its own marketing force for the terminal hardware. From the projection of the relative values of the market for hardware and the potential for network revenues by the end of this decade, it can be seen that the latter must eventually grow at a faster rate than the former. Initially, however, it is to be expected that terminal equipment sales will generate more income than network usage. The crucial point for BT and other network operators is when the network revenues become substantial. For them it is imperative to bring that point as close as possible to the present.

The launch of the VC8000 and the ISDN videophone in mid-1994 is intended to accelerate that process.

Ultimately however, if videophones are to become the standard purchase for residential and business users, more engineering development work will be needed to reduce the cost of user equipment, improve still further the video quality and add new features.

The first of these aims will be achieved in 1995 with the completion of the development of a set of semiconductor chips named *Chimera*. These are being developed jointly by BT and Motorola, and effectively distil the technology of the VC8000 from a 12-inch-long printed circuit card onto four chips. It is projected that these will immediately reduce, by a factor of ten, the cost of the equivalent functionality of the VC8000. At the same time, the Chimera chip-set promises improved picture resolution, the incorporation of the M-PEG standard and other performance enhancements, for both adapted personal computers and standalone videophones. Indeed, it is envisaged that the chipset will become a standard feature rather than an option in the next generation of personal computers, built into their main motherboards.

Local area networks

Plans for the future also take account of how people may alter the way in which they use their personal computers. Currently, it is estimated by the major manufacturers that more than 30% of all desktop personal computers are connected to a local area network (LAN). However, convenient and reliable communications for terminals such as the VC8000 presently require a circuit switched network to the desk, either directly from the public network or through a digital PABX. But the capabilities of LANs are being enhanced and it can be foreseen that more and more companies will have access to a LAN that can carry integrated voice and video. For example, those based on high-speed Ethernet, the fibre distributed data interface (FDDI) standard and asynchronous transfer mode (ATM) technology.

This raises the question of which will be the preferred route for multimedia traffic to the desktop:

- direct from the switched public network,
- switched through a PABX,
- direct to the desk via a local area network interconnected with the switched public network, or
- from a connectionless or other type of broadband private or public wide area network.

The MC-COI group has already set out to address these problems and has identified the need for a LAN Sub Group to complement existing working groups on switched networks. One of its many aims is to define a practical method of ensuring there can be a seamless integration between LANs and the public network.

Mobile services

Even further into the future, although perhaps not so far as many might think, more and more people will want to use multimedia communications services while they are away from desks. Then there will be a requirement for a means of carrying multimedia services over a radio link or other cordless or wireless interface.

Several companies including BT, British Gas, Rank Xerox, the electricity companies and the AA have already defined their minimum requirements of a portable computer for field maintenance workers.

One can foresee a future requirement to offer multi-communications to people on the move, as well as to office staff with standard PCs.

References

1 Mills, Graham and Bayley, Ken. Corporate Visual Services—An Overview. *Br. Telecommun Eng.*, July 1993, **12**, p. 97.

Bill Richards and Dick Borwick

Submarine Cable Systems

Digital transmission over optical fibres has enabled submarine cable systems to provide a significant proportion of the primary platform for BT's global network, and has enabled considerable transmission capacity to be available competitively worldwide. The ready availability of capacity, together with significant advances in network design and cross-connect capability are enhancing the worldwide competitiveness of BT's services. In addition, there exists within the current submarine cable system technology potential developments that could further enhance the capacity, flexibility and dynamic management capabilities of the network.

Introduction

Submarine cable systems

In simple terms, a submarine cable system is not dissimilar to an inland optical-fibre cable system. Again in simple terms, it provides the same performance. Its differences lie in the inaccessible environment into which the system has to be installed, its specialised reliability and repair requirements, and in the multinational efforts taken to ensure competitive provision together with low whole-life costs. (See Figure 1.)

The costs of a system can be apportioned to the following:

- the cost of the 'dry bit',
- the cost of the 'wet bit', and
- the cost of the 'marine installation'.

For short- and medium-length systems, the major cost of each system is the marine installation (typically 50%, followed by the cost of the submersible plant at about 30%) and for long-length systems the major cost of each system is the submersible plant (typically 50%, followed by the cost of the marine installation at about 30%). Much effort, therefore, has been, and still is being, invested in reducing the cost of the marine installations, increasing the available capacity from each single fibre-pair installed, and reducing the cost of the submersible plant. This is generally achieved by increasing the span before which repeaters are required and increasing the separation between repeaters.

Every effort is made to avoid having to undertake a marine repair while the system is in service because of the difficulty and time needed to effect that repair. (Consider locating a cable fault 1500 km out to sea and locating and recovering a 3 cm diameter cable that is up to 8000 m under water!) It is significant to note that all the effort to avoid having to undertake a marine repair is carried out up to the time the submersible plant is installed, as planned maintenance on the submersible plant once installed is expensive.

Background and scope of this article

This article is the third in a series of articles on the global network[1,2]. It first seeks to show how evolution in the performance, capacity and financial competitiveness of submarine cable systems has enabled those systems to provide (together with satellites, as covered in the fourth article[3] in the series) the primary transmission platform for BT's global network.

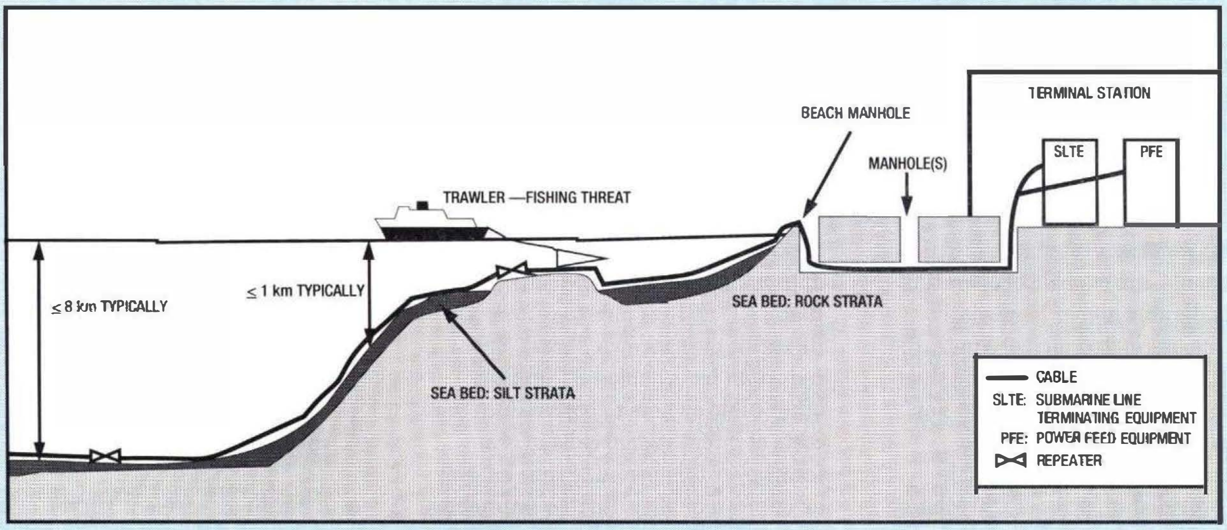
The article notes that, through the close co-ordination of network and submarine cable system design, a basic structure has been created to support the flexible network of the future.

Finally, the article indicates that offered within the current system technology there are potential developments which would further enhance network flexibility, and goes on to stress that continued coordination between network planning and cable system design is essential to make use of the existing and developing potential.

Technological Evolution

Coaxial/analogue systems

Until the early 1980s, all of BT's submarine cable systems utilised analogue technology via coaxial cable. Although this medium had proved reliable, it was ultimately unable to provide the high-capacity increases required by the rapidly expanding international cable network.



CABLE:	SEA CABLE: Fibre package similar to land cable, but ● power feed to repeaters requires power conductor capability of 10 kVA, ● strength to support the weight of the cable catenery down to 8 km depth when laying/recovering, and ● protection (armour) to minimise damage from fishing activity or motion when exposed on seabed.		LAND CABLE: Similar to inland cables but with power conductor for power feeding repeaters.
ENVIRON-MENTAL:	DEEP SEA: Generally benign, but significantly more difficult to recover submerged equipment (repeaters, branching units, etc.).	CONTINENTAL SHELF: Area of maximum threat to cable, thus the need to maximise cable protection by burial into seabed where possible. Threats are fishing activity (trawlers etc.) and movement by sea currents or storm activitiy. Reasonable to recover submerged equipment.	ASHORE: Benign—similar to conventional inland equipment except for the need to power feed the repeaters. (Equipment rated 10 kVA typically.) Cable is ducted to beach manhole, where joint between land cable and sea cable is made.

Figure 1—Essential elements of a submarine cable system

These systems used a single copper/aluminium cable employing bi-directional transmission, the separation between transmit and receive paths being achieved by using different frequency bands. The relatively high attenuation of the coaxial cable necessitated frequent amplification of the signal, the need for which increased with system capacity. The highest-capacity coaxial system provided approximately 4000 circuits and utilised a total frequency band of 45 MHz. At these frequencies, amplification was necessary at 5 km span intervals.

To facilitate higher system capacities, a combination of physically larger cable and decreased amplifier (repeater) spans would have been necessary at proportionally increased cost. With the larger number of repeaters, system reliability would also have been worse.

Operational flexibility was low. All system configurations were of simple point-to-point nature because the large physical size of the coaxial signal path together with the high pressures on the ocean floor permitted only one transmission medium to be employed in each cable, hence underwater branching units were impractical.

By 1980, the development of analogue/coaxial cable technology had been taken as far as was practical and it was replaced by optical-fibre/digital technology systems. The last BT coaxial submarine cable was installed between England and Holland in 1983.

Optical-fibre/digital systems

By the early 1980s, major manufacturers were developing optical-fibre cable systems with the advantages of cost and facilities that this medium offered. BT was instrumental in the provision of the world's first international optical-fibre cable, UK–Belgium No. 5 in 1986[4].

The change from analogue to digital transmission led to several revolutionary improvements in cost and operational facilities.

System capacity was dramatically increased by the almost unlimited bandwidth capability of optical fibre; for example, the first-generation optical systems (for example, UK–Belgium No. 5) offered 11 500 64 kbit/s circuits compared with the latest-generation analogue equivalent of 4000 audio circuits.

The lower attenuation of optical fibre meant fewer submerged repeaters. While the attenuation of coaxial cable was 7 dB/km, the figure for the first-generation optical cable was approximately 0·5 dB/km, resulting in an improvement factor of ten in the distance between repeaters.

The second generation of optical systems further increased the distance between repeaters by using a laser wavelength of 1·5 microns, which gave an almost 100% improvement over the attenuation of the earlier 1·3 micron systems. This in turn introduced the possibility of much longer unrepeatered systems with the consequent saving in cost and reliability improvements.

As an indication of the rapid progress in this technology, the first-generation unrepeatered systems installed in the late-1980s had a maximum range of about 140 km, each fibre being operated at 140 Mbit/s. Some systems being installed in 1994, such as the UK–Channel Islands No. 8 and the CELTIC (UK–Ireland No. 3) systems, will have a range of in excess of 250 km and will operate at 2·5 Gbit/s, representing a sixteenfold increase in system capacity.

The next generation of long-range systems will optically amplify rather

Service can be maintained with minimal interruption—critically important in the drive to provide the highest level of service to customers.

than electronically regenerate the signal. Optical amplifiers, due to their relatively simple design, use fewer components, are capable of operating at considerably higher bandwidths (with the associated increase in traffic capacity), are more reliable, and thus offer the chance to reduce costs. For example, the first transatlantic optical system, TAT-8 installed in 1988, provided capacity of 280 Mbit/s on each fibre, whereas TAT 12/13 to be installed in 1995, will have a capacity of 4·8 Gbit/s per fibre, a 16 times increase within 7 years.

Optical systems also offer a higher operating flexibility than coaxial analogue systems. Owing to the small physical dimensions of the fibres, current cables contain fibre packages facilitating multiple transmission paths rather than the single path available with coaxial designs. Thus traffic-carrying capacity is further improved and the cable is able to support complex networks with multiple landing points, individual fibre pairs being switchable within submerged branching units or within repeaters. In the event of a fault occurring on one fibre pair, service could be restored by switching to an alternative traffic path. Systems currently being planned according to the CCITT recommendations on synchronous digital hierarchy (SDH), with its increased facilities of system management, allow networks of cables to be interconnected so that transmission can be automatically and easily switched to a different cable in the event of a fault, or traffic streams managed on a time or load basis. Service can be maintained with minimal interruption—critically important in the drive to provide the highest level of service to customers.

The foregoing improvements in system capabilities have had an equally dramatic affect upon the cost of individual circuits, mainly owing to the increases in traffic-carrying capacity of each cable. Comparing the last transatlantic analogue cable, TAT-7 installed in 1983, with TAT-12/13 due in 1995, the costs of an individual 64 kbit/s circuit (compared with a 4 kHz audio circuit) have fallen by a factor of approximately five (or approximately ten, if one considers that TAT-12/13 is able to restore all its traffic over its own fibres). This reduction has enabled BT and the other cable owners to both reduce the costs of international calls in real terms over this period of time as well as improve quality, further improving the service to customers.

Marine installation and maintenance

Marine installation and maintenance have also changed. During the 'copper-years', the submarine cable was placed on the seabed and generally relied on the armouring of the cable to be the principle protection method against damage. With each cable having a relatively low circuit capacity, telecommunication traffic relied on numerous cables between any two countries. If any one cable was damaged, principally by the beams or otter boards of trawlers, there was enough diversity to re-route its traffic via the other cables, thus ensuring a low proportion of traffic failing and a high probability of complete restoration. Cable repair would then be carried out.

With the advent of optical-fibre technology, each cable can carry a much higher traffic capacity, which in turn has resulted in the requirement for fewer cables. However, if one of these cables is damaged, it represents a much greater proportion of the total traffic and this results in the requirements for both greater protection of the cable against damage and the development of self-healing network configurations (the latter will be discussed later).

Over the past seven years the installation and maintenance of submarine cables has fundamentally changed with much more effort being concentrated on the choice of route and cable protection with techniques including burial using a plough towed behind the laying ship. The techniques for selecting the best cable routes include:

- comprehensive 'desk studies' to find a suitable route for the cable;
- an electronic survey which charts out a kilometre wide corridor for the cable using echo sounder, sub-bottom profiler, side-scan sonar, magnetometer, tide gauges and core sampling; and
- a burial assessment survey using a dummy cable plough to assess the ability to bury the cable to a required depth below the seabed.

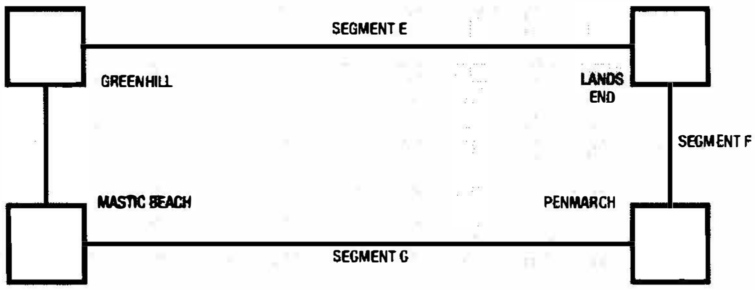
Should the initial burial not be totally successful, then a post-lay burial operation is undertaken for any areas of cable left exposed on the seabed after the main installation; such operations use remotely operated vehicles (ROVs) which have water-jetting tools and/or mechanical cutters.

Many network operators have set up their own subsidiary operations to ensure control of the quality of these critical tasks. BT (Marine), BT's wholly owned subsidiary that undertakes these tasks both for BT and for others, has the latest equipment that includes:

- the cableship *CS Sovereign* which has dynamic positioning allowing it to maintain its position automatically with an accuracy of better than ±10 m in severe weather conditions,
- deep sea ploughs capable of burying cables down to 0·75 m below the seabed in water depths of 1000 m, and
- ROVs with an ability to work using burial tools to 1000 m and to inspect down to 2000 m water depth. These ROVs can bury cable to 2 m into the seabed using mechanical cutters or to 1 m using water jetting tools.

Even with these extra precautions, the maintenance of submarine cables has benefited from technological

Figure 2—TAT-12/13



improvements. One of the most significant is the development led by BT(M) (in conjunction with AT&T, KDD, ALCATEL) of the universal joint. This allows different manufacturers' cables to be joined together thereby releasing the cable owner from total reliance on the original cable manufacturer to supply spare cable. It also allows the system maintenance authority to pool resources among a number of systems. This technology is being used increasingly around the world by both maintenance authorities and system suppliers.

Current Systems

Design of optical-fibre submarine cable systems has evolved from the first digital point-to-point systems (UK–Belgium No. 5) and passively branched systems (TAT-8), through the use of active underwater multiplexing (TAT-9), to complex undersea systems and self-healing SDH rings of which TAT-12/13, among a number of systems currently being procured, is a prime example (see Figure 2).

TAT-12/13 will provide a repeatered self-healing SDH ring connecting USA, UK and France. Traffic over the submarine links will emerge at a 2·4 Gbit/s interface formatted as an STM-16 frame made up of byte-interleaved STM-1 modules.

The planned (TAT-12/13) system-protection equipment provides the self-healing capability, and ensures that after a failure of one of the STM-16 paths, traffic is re-routed via the remaining links without even dropping a call. In practical terms, one of the two fibre pairs in each cable is for traffic and the other is for protection. In the event of a failure in any of the system's STM-16 paths, the two add/drop multiplexer nodes directly affected will control the switching of all nodes, via SDH overhead bytes within the STM-16 frame, and re-route traffic over the unaffected protection fibres in less than 500 ms.

The demand for greater capacity at ever-decreasing unit costs has been satisfied, in the past, by the continuing increase in line rate of traditional regenerated systems to 2·4 Gbit/s per fibre pair. However, the technology to implement conventional regenerative systems is becoming increasingly difficult and expensive. Optical amplifiers, based on erbium-doped fibre, have changed the transmission technology for the next generation of systems. TAT-12/13 will use optical amplifiers spaced at intervals along the line, which do not need to convert the signal from an optical into an electrical signal. Although the new technology will require a larger number of repeaters, as their spacing will be reduced from 100 km to 65–70 km (for medium-length systems) or to 45–50 km (for long-length systems), the erbium-doped fibre amplifiers cost less, are more reliable and have potential to utilise non-linear optical regimes which might further increase the total transmission distances and capabilities.

As part of the primary platform for BT's global network, subsea cable systems will also need to integrate with the CCITT recommendations for a Telecommunications Management Network (TMN). The provision of integrated system management, enabling management down to path level, is becoming a reality with SDH-based systems owing to the built-in management signalling overhead at the various path levels. The element manager, as the lowest level of TMN management, will be responsible for the transparent management of the submarine cable system's elements and is to be realised, at this early stage of definition, through the use of suppliers' proprietary supervisory systems, which allow monitoring and control of the submarine system power and transmission features.

The terminal stations, which tend to be in different countries and thus managed by separate organisations, will each have separate element managers for the subsea cable, multiplex equipment and digital cross-connects. Each of these element managers can then be extended to remote locations, if required, to make central control of one or more submersible systems possible. This move to unmanned, remotely-operated systems further improves the cost-effectiveness of the subsea cable system and contributes to the flexibility for management of the global network, with prioritisation and re-routing of traffic.

As the technology of submarine cable systems develops, so to does BT management of system procurement. TAT-12/13 will integrate a number of major sub-systems from different suppliers, and this is consistent with the Submarine Cables Systems Unit's continued drive to improve the cost-effectiveness of procuring systems through competitive turnkey procurement with project management focused at the key performance cost and delivery aspects. The introduction of ISO 9000 and key processes is ensuring the continued delivery of high-quality, high-specification, systems at lowest cost from multiple suppliers.

The technology and sub-system configurations recently tendered, for a variety of applications, have offered performance in excess of internal requirements and, sometimes, the potential to improve the system performance at a later date. For example, the CELTIC submarine cable system could have been implemented with a 15 year design life with 622 Mbit/s technology; however, the tender offered to implement 2·5 Gbit/s technology with minimal increase in price and minimal complexity in whole-life implications. Through cooperation between network planning and cable system procurement, this system is being implemented in such a way to ensure that the poten-

The potential exists to use unrepeatered submarine cable systems to form part of the national network

tial is available to the network. As the technology continues to develop, this cooperation between planning and procurement will become more important to ensure that systems are implemented with the maximum 'future-proofing' and optimum flexibility for networking purposes.

Potential

With unrepeatered systems, the composition of the fibre itself is the only limiting factor controlling the increases in capacity that can be achieved by simply replacing the terminal equipment but, with repeatered systems, the limiting factor tends to be the capacity of the electronic equipment underwater.

The potential to expand the capability of submarine cable systems exists in three basic forms:

- within some existing installations;
- within the technology, both to address new applications and to extend existing applications; and
- system element design—specifically the configuration of the transmission paths between the landing sites.

In the longer term, new transmission technologies, such as soliton technology, exploiting fibre non-linearity, may be implemented.

Within existing installations

It has long been recognised that the cost of including extra spare fibres is insignificant compared to the cost of the marine installation. Therefore, all new BT unrepeatered systems will be installed with additional spare fibres to allow for possible up-grading, by adding extra terminal equipment, later (see Figure 3). This would be uneconomic for repeatered systems because of the cost of the repeaters.

Alternatively, on existing unrepeatered systems which have not been provided with spare fibres, the same increase in capacity may be achieved by replacing the existing terminal equipment with newer designs working at higher bit rates. For repeatered systems, this is uneconomic because of the cost of the replacement repeaters (able to operate at the higher transmission rates) and their marine installation.

Within the technology

To address new applications

The potential exists to use unrepeatered submarine cable systems to form part of the national network, providing shorter (for example, across bays), more simple and diverse implementations economically (see Figure 4). Many network operators, including BT, are already employing one or more of these techniques over short lengths.

To extend existing applications

This basic area contains a wealth of development that should come on to the market within the not-too-distant future; examples of emerging developments are given below.

- *Optical amplification* Optical amplifier technology provides the potential to increase the transmission rate beyond the current

Figure 3—Potential within existing installations

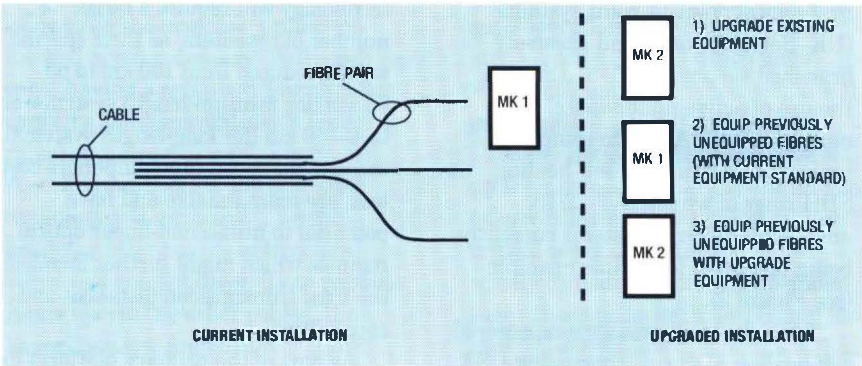
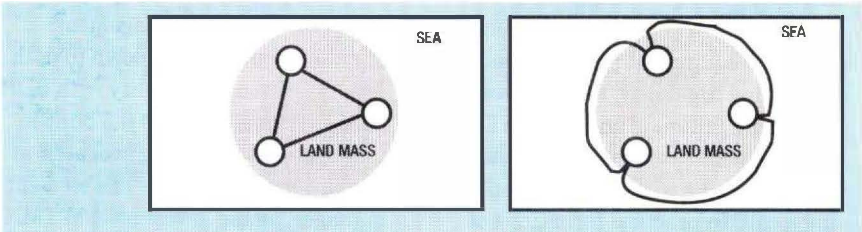
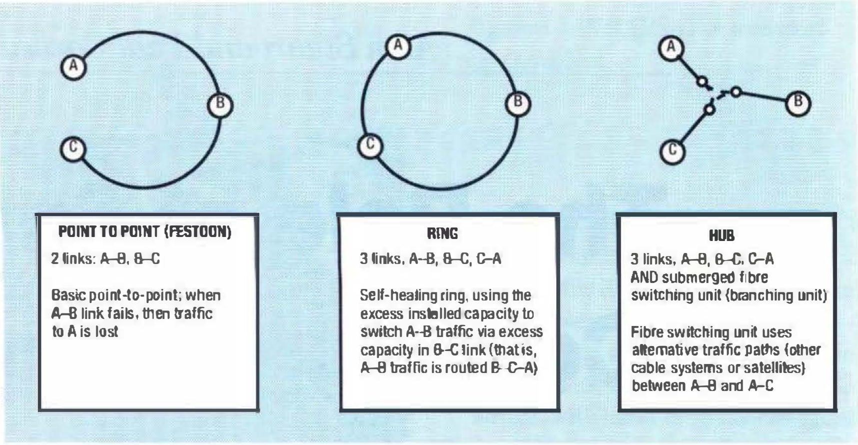


Figure 4—Potential within the technology



	INLAND RING	OFF-SHORE RING FESTOON
TIMESCALE (contract to in-service):	A function of the time to get wayleaves and the separation of the exchanges	A function of the separation of the terminal stations but typically within 18 months
DIVERSITY:	Significant diversity possible	Significant diversity possible
COST:	Significantly dependent upon the degree of urbanisation through which the ducts must go and the cost of repeaters, if any	£15k–£45k per kilometre but many variables affect price, and can be unrepeatered for up to 300 km
WAYLEAVES:	Significant number required for well-separated exchanges	Few required to get off-shore
INSTALLATION:	This can be difficult if the route is through urban or mountainous areas	Relatively uncomplicated
OTHERS:		Consider the combination of inland prime routes with off-shore diversity

gure 5—Cable system design



5 Gbit/s range. By comparison, it has become significantly more difficult to increase the transmission rate of silicon-based regenerators, while retaining sufficient reliability for underwater use. Consequently, optical amplifiers provide the access to increased traffic capacity while regenerators do not.

Error correction It is likely that error correction will be applied to systems over the next 5 years both to extend the range of unrepeatered systems and possibly to improve the error performance of both unrepeatered and repeatered systems while adding little overhead to the transmission rate.

WDM A longer-term technological improvement is the potential of the wavelength-division multiplexer (WDM) to transmit two (or more) separate channels simultaneously along the same fibre path, either unidirectionally or bi-directionally. WDM offers an even more significant potential, as the passive equivalent of an electronic multiplexer, with the consequential improvement in availability and reduction in complexity (and possibly cost). A network operator could select which destination to connect to by selecting the transmission wavelength which would be 'switched' through an underwater WDM.

:able system design

'oint-to-point systems, by their very ature, provide little scope for omplex configurations; however, ıulti-landing point systems can be onfigured in many ways; for examle, festoon, ring, or hub (see Figure ı). The selection of the configuration equires careful consideration as it ignificantly impacts cable system lesign requirements. As an example, onsider what would happen to a ystem's ability to receive the status f all terminals, via the management overhead bytes, when one terminal is switched out of the network. Again, this emphasises the need for close cooperation between the planning and procurement activities.

Summary

Submarine cable system technology has undergone a fundamental change over the past decade, from analogue copper-based to digital fibre-based systems, introducing significant performance and cost advantages, together with the necessity to review their installation and associated project management. The rapid expansion of the submarine cable system, to gain the technological advantage, combined with massive increases in capacity, has enabled submarine cable systems to support the development of the primary platform for BT's global network.

The continued evolution of the technology towards managed systems, both within the cable system (that is, self-healing ring configurations) and as part of BT's networking continues unabated. It is the continued close coordination in planning the global network and in implementing the submarine cable system designs that allow the additional potential inherent in the systems to be unlocked and for BT to gain the competitive edge.

References

1 READ, MIKE. The BT Global Network. *Br. Telecommun. Eng.*, Oct. 1993, **12**, p. 162.

2 D'SA, DINO and LOWE, ALAN. Planning the International Network. *ibid.*, Oct. 93, **12**, p. 165.

3 STUART, ALAN and COXHEAD, PAUL. The Role of Satellite Communications in BT's Global Networks. *ibid.*, Jan. 1994, **12**, (this issue).

4 Special edition on Optical-Fibre Submarine Cable Systems. *Br. Telecommun. Eng.*, July 1986, **5**.

Biographies

Bill Richards
BT Worldwide Networks

Bill Richards is a project manager within the Submarine Cable Systems group of BT Worldwide Networks. He is responsible for the project management of the activities from invitation to tender through procurement and installation to acceptance of assigned submarine cable systems.

Dick Borwick
BT (Marine) Limited

Dick Borwick is Construction Manager for BT (Marine) Ltd's Telecom Division. He is responsible for the project management of all the telecommunication and power cable installation projects. He has worked with BT Marine since 1981 as Cable Officer on the cableships, Cable Consultant on cable route surveys, Offshore Superintendent and as a project manager prior to taking on his current duties.

Alan Stuart and Paul Coxhead

The Role of Satellite Communications in BT's Global Networks

Satellite communications form an integral part of the BT global network providing not only high-capacity point-to-point links but increasingly other services such as mobile and private links. As such, satellite communications play an important role in support of both the 'correspondent' and 'non-correspondent' towers of the twin peaks model described in a previous article[1].

Introduction

Commercial communications via geostationary satellites have developed rapidly since the first trials over 30 years ago from BT's satellite earth station at Goonhilly Downs in Cornwall. Much has been written about the technicalities of satellite communications (satcoms) and their use for mainstream point-to-point communications from Goonhilly, from Madley in Hereford and from the London Teleport. However, increasingly this use of satcoms is being overtaken by the use of low-cost and high-capacity modern optical cable systems. This article therefore looks at the strengths of satcoms and describes where it has an important role to play in supporting and providing BT's global services now and in the near future.

While satcoms suffer the disadvantages of transmission delay and lower capacity over modern cable transmission, the advantages are many. Apart from unique applications for broadcast and mobile services, satcoms also have the advantage of being quick and easy to install, especially for thin routes in locations where the infrastructure is poor. Satellite links additionally give operators flexibility to reconfigure and resize relatively easily.

Satellites continue to grow in capacity and flexibility. With large numbers of earth stations it has become more economic to put investment in the space segment rather than on the ground. The increased transmitted power of these modern satellites coupled with technological advances in transmission techniques results in smaller antennas being required for the earth station. The lower cost and portability of some of the smaller units now brings satcoms into the hands of everyday users. From the early days of very heavy investments in large antenna structures (typically 30 m diameter) used for point-to-point services by PTTs, satcoms are now possible from small units no bigger than a briefcase and from mobile units on land, sea and in the air.

The advantages of satcoms can now be more fully realised and many applications are now evolving. Television viewers are becoming accustomed to live on-the-spot news reports, mobile customers have high-quality telephone links, and communications are being supplied to areas of great need.

The use of satcoms in the mobile, and then the fixed environments, is now described in greater depth.

Satellite Communications for Mobile Customers

INMARSAT (International Maritime Satellite Organisation) provides satellites and defines associated parameters for maritime, land mobile and aeronautical communications. It has divided the earth's surface into four areas, called *ocean regions*, each served by a satellite located in the geostationary orbit, giving near-global coverage. Five major satcoms systems now serve mobile customers; these are designated the *INMARSAT-A*, *B*, *C*,

Figure 1—INMARSAT-A transportable terminal

M and *Aeronautical*, see Table 1. BT has been at the forefront of the development of these systems and currently operates them from the Goonhilly earth station.

INMARSAT-A system

The INMARSAT-A system[2,3] was the first major mobile system to be implemented worldwide. It was designed for use by ships and has now been in operation for over 10 years. It provides for telephony, fax, data and telex communication. The system is now heavily used by the world's shipping and land terminals with over 21 000 customers.

The mobile terminal equipment on ship comprises a gyro-stabilised 08 m antenna coupled to below-decks equipment and is capable of a transmit power of 36 dBW effective isotropic radiated power (EIRP). The characteristic white radome over the antenna can be seen on many large ships nowadays. There is also a land mobile version which can be packed away into a suitcase, and such terminals have played a vital part in providing good communications for emergencies and for audio news gathering, (see Figure 1).

The architecture of the system uses random access request channel and demand-assigned telephony channels, with a controlling broadcast time-division multiplex (TDM) channel. Telex traffic is sent from shore to ship as multiplexed data on the TDM channel, and from the ship to shore in time-division multiple access (TDMA) format, with burst time-slots assigned from the fixed coast earth station. The telephony channels utilise frequency modulation (FM) with a channel spacing of 50 kHz. Although the system is now mature and is being replaced by the INMARSAT-B system, new service functionality is still being added to the system. One new service recently provided by BT is the provision of 64 kbit/s channels for use either as high-quality sound circuits, or for data transmission.

The advent of digital modulation, voice coding techniques, and digital signalling processing technology, coupled with advances in antenna design, has brought a new generation of mobile satcoms systems into reality and promises exciting opportunities for the future.

Table 1 INMARSAT Satcoms Mobile Systems

System	Application	Services	Mobile Size (m)
A	Original system for maritime Large vessels and land customers	Voice Fax High-speed data Telex	0·8
B	New system for maritime Large vessels and land customers	Voice Fax High-speed data Telex	0·8
C	Maritime/land/air Small unit	Telex Data Fax Store and forward	0·15
M	Maritime/land Small unit	Voice Fax Data	0·5 and smaller
Aero	Airborne	Voice Fax Data	Various

INMARSAT-B system

INMARSAT-B has been developed as the successor to the A system to deliver the full range of facilities to the professional customer. Designed to take advantage of these advances in technology, the B system features digital telephony channels, using sophisticated error correction and voice coding techniques similar in principle to the Aeronautical system described later, but with a channel rate of 24 kbit/s and a voice coding rate of 16 kbit/s. Although the mobile antenna size is similar to that of INMARSAT-A, the transmit power required is half that of the A system at 33 dBW EIRP. The lower power requirement, coupled with the smaller bandwidth resulting from the digital modulation, results in a significant increase in total system capacity and lower space segment costs for customers over the A system.

INMARSAT-M system

INMARSAT-M, derived from the B system, has been developed for

The era of briefcase satellite telephony is here now, and instant telephony communications from most parts of the globe are now available to the travelling customer.

smaller vessels and can also be used effectively on land. This new service will open up new markets based on lower cost and terminal size. Despite the use of a voice coding rate of only 6·4 kbit/s, intelligibility and voice recognition are very good. The mobile has an antenna size significantly smaller than the B system, at around 50 cm, and the transmit power required is only 24 dBW. Complete terminals are now coming onto the market that are contained within a briefcase (see Figure 2). The era of briefcase satellite telephony is here now, and instant telephony communications from most parts of the globe are now available to the travelling customer. An even smaller version is expected to be available in a few years time when a new generation of INMARSAT spacecraft is launched providing the capability of spot-beam operation. This is a feature of the satellite where power is focused onto several specific high traffic areas, or spots, of the globe's surface, as well as a general illumination. The increased satellite signal received in these spots allows for the use of smaller mobile unit antennas.

Aeronautical satellite communications

In 1990, the BT satellite earth station at Goonhilly scored another first by being the first station in the world to start operating the new INMARSAT Aeronautical service[4]. To provide a satellite-based communications system for aircraft was a difficult technical challenge.

The practical problems of aeronautical satellite communications stem from mobile terminal weight and power limitations, antenna size and wind resistance, aircraft attitude excursions and an overriding concern for safety. These constraints on the avionics result in the installation providing only a relatively small signal towards the satellite 36 000 km away. Typically, the aircraft will radiate an EIRP of 26 dBW at best, and with an isotropic path loss to the satellite of around 189 dB, the signal received at the satellite is at a low level of −163 dBW (0·05 femtowatt). For such a small signal to convey voice information using existing satellites and ground stations, the use of modern coding and modulation techniques became essential. This aeronautical system is described here more fully to indicate the type of transmission used by many of the new generation of mobile satcoms systems.

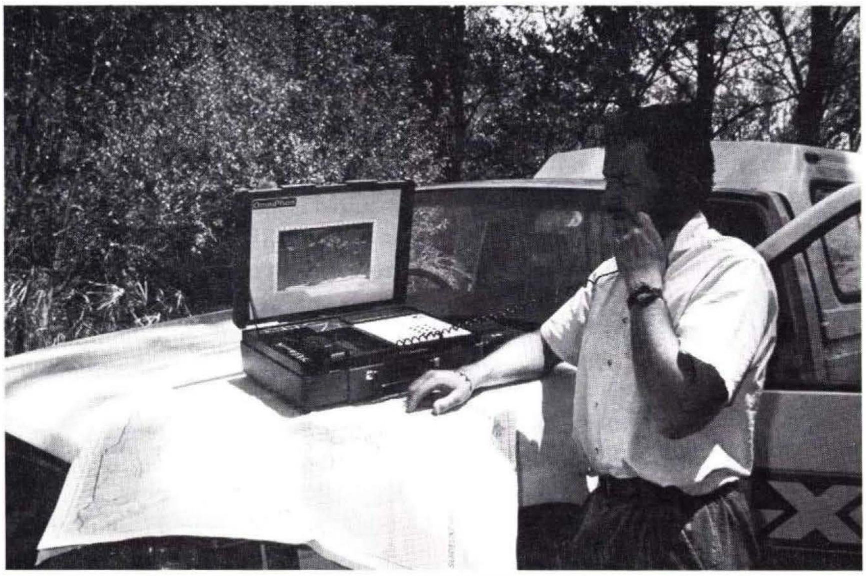
The first element of this is voice coding. Normal public switched telephone network (PSTN) speech entering the system at 64 kbit/s is passed to a special voice encoder developed by BT Research Laboratories and now established as the worldwide standard for aeronautical use. This voice encoder[5] codes the speech into a 9·6 kbit/s output thereby providing valuable information rate reduction. The second element is the process of additional coding and modulation. The 9·6 kbit/s speech is multiplexed with a signalling channel stream, and then the combined digital signal is scrambled with a pseudo noise scrambler[6] to smooth out the spectrum. The output from the scrambler is passed to a forward error correction (FEC) coder which, although doubling the effective data rate, provides for greater data recovery at the distant end. The output from the FEC is split into blocks which are interleaved to spread the information in the time domain. This is done to prevent sharp fades caused by multi-path reception resulting from reflections of the incoming satellite signal from the earth and aircraft body, which causes a total loss of information. Finally, the bit stream is framed and sent to a radio-frequency (RF) modulator with an effective channel rate of 21 kbit/s and producing offset quaternary phased shift keying (QPSK). The distant end terminal performs all of these sequences in reverse to recover the 64 kbit/s speech.

Customers of aeronautical satellite communications are in three main groups: public, private and air traffic control.

While people have grown to expect a telephone to be available whether on land or sea, the air has until recently been a communications 'black hole' for passengers on long distance flights. Satellite communications opens the way for passengers to have direct dial access to any part of the world from the aircraft. Passengers will benefit by the forward booking of cars and hotels and by keeping friends updated on estimated arrival times and unexpected diversions.

For the business traveller, staying in touch is often of great commercial importance. Customers with private

Figure 2—INMARSAT-M briefcase terminal



While it is unlikely that satcoms would ever be any cheaper than terrestrial-based systems, it is conceivable that the two could be merged into a unified seamless global mobile communications system.

jets benefit not only from continuously available ground-to-air and air-to-ground direct dialling communication, but also from an added element of privacy when compared with high-frequency (HF) communication.

In addition to public demand, the aviation community has looked for a long time to satellite communications as a way of improving efficiency and safety. Airline operators benefit by having continuously-available good-quality communication links with their aircraft. The benefits include better fleet management; faster turn rounds by the anticipation of stores, fuel and technical requirements; and economies by closer control over routings and technical performance.

For air traffic control (ATC), the primary advantage of aeronautical satellite communications is the ability to provide good communication links over large sea and land masses, otherwise without reliable communications, and thus the means for greater safety and flow efficiency. In addition, satellite communications provide the means for automatic dependent surveillance, where each aircraft can automatically report its position derived from navigational systems by data link to the ATC centre, thus providing the controllers with a pseudo radar plot of the aircraft positions. In addition to the inertial navigation systems now fitted to most aircraft, other navigational systems on board can include not only traditional systems such as LORAN and OMEGA, but also the satellite-based global positioning system. With increased confidence in the location of flights, the spacings can be reduced and flow of traffic increased.

Figure 3—IMARSAT-C terminal

INMARSAT-C system

INMARSAT-C[7] differs from the other systems described because the communication is store-and-forward data. The customer transmits the information to the BT station at Goonhilly, which stores the complete message and then re-transmits it to its destination.

The system has been designed to make the mobile terminal as portable and as low cost as possible and it is easily small enough to fit into a car or truck, (see Figure 3). To meet this objective, omnidirectional antennas are used to avoid the need to track the location of the satellite; typical implementations are helical antennas about 280 mm high enclosed in conical radomes. In its smallest implementation, the whole mobile satcoms unit is contained in a briefcase. The transmit power requirements are the lowest of the mobile systems at 12 dBW EIRP. The system is quick and easy to operate and opens up two-way messaging from almost any part of the world from a briefcase.

The C system has extensive use for maritime customers, from yachts to large vessels, and, as the mobile terminal is smaller and simpler, offers mobile communications to a much larger range of customers at sea and on land. Being a reliable messaging system, it is used for the dissemination of safety and meteorological information, as well as a two-way communication medium. Another application is for remote data collection; meteorological or similar data collected by remote unattended equipment is relayed by satellite to a central point. New applications are rapidly appearing; for example, with the mobile unit linked to a position-determination system. In this configuration, the mobile can either automatically, or on demand, relay its position via the C satellite communication system, to a central point. This provides for a very powerful application where a central fleet control point can not only monitor the movements of its vehicles, vessels, or aircraft, but also send and receive messages.

Global paging

A low-cost direct pager service is proposed using the INMARSAT global satellite network. It offers an attractive means of achieving wide area coverage by direct satellite-to-user communication and can cover areas impossible or uneconomic to serve by terrestrial means. The pager is expected to be about the size of a 'walkman'. The intended customers are likely to be international business travellers and long-distance hauliers. Trials are currently underway to ascertain coverage and signal penetration into buildings.

Future mobile systems

Developments are now underway for even smaller mobile satellite terminals. With increased satellite power, low earth orbits, even more advanced voice and transmission coding techniques and a smaller size of receiver circuitry, several organisations are now planning systems that would provide for truly personal global satellite communications from a unit comparable in size to the modern cellphone. Such developments hold not only technical challenges but also challenges for international agreements. While it is unlikely that satcoms would ever be any cheaper than terrestrial-based systems, it is conceivable that the two could be merged into a unified seamless global mobile communications system. In such a system, satellites would provide coverage where terrestrial-based systems were either not possible or economic.

Fixed Services

Point-to-point data services

Satstream

The Satstream service started life in the 1980s when BT pioneered the use of satellite terminals at customer premises to provide point-to-point data services. Since that time, with advances in technology and the advent of new higher-power satellites, the terminals have reduced in cost by a factor of 10, with antenna sizes reducing from 5·5 m to 2·4 m. This new technology was provided by BT to the UN forces in Bosnia to establish a 768 kbit/s link to the UK enabling the troops to call home to their families over the Christmas period in 1992 (see Figure 4).

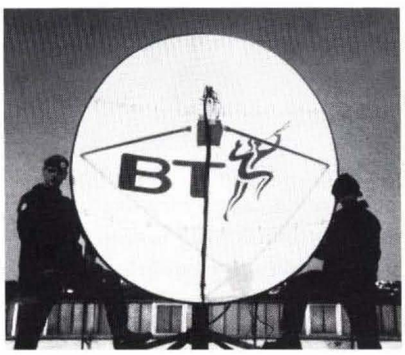
Where digital circuits are not available by terrestrial means in Europe, this approach enables BT to offer its customers an end-to-end digital circuit up to 2 Mbit/s on a one-stop shop basis. BT then makes appropriate arrangements with the correspondent administration.

Satstream Offshore

Initially, troposcatter was the preferred transmission technique for providing reliable analogue communication to oil rigs many hundred kilometres offshore. However, by the early 1980s, satellite communications were proving to be a cost-effective and reliable means of telecommunications.

In 1985, BT launched its Satstream Offshore service, which provided custom-designed analogue and digital telecommunications from a dedicated 8 m earth station in Aberdeen. This earth station operated via the EUTELSAT SMS payload on 7E and provided private circuits at rates of $n \times 64$ kbit/s. Growth in customer demand and the requirement for earth station diversity resulted in BT commissioning a second teleport at Mormond Hill in January 1992, operating via the EUTELSAT SMS payload at 10E. In 1992, BT Offshore Services also introduced its 'short term' offering, which enabled oil companies to have service for periods of as little as 3 months, with very short notice provision. This type of service was provided to aid offshore activities including 'hook up' of new platforms and drilling/exploration rigs, and has facilitated the rapid growth of transportable stabilised earth stations used offshore.

Figure 4—Cpl Dave Newbitt and Lance-Cpl Jason Stewart of 30 Signals Regiment with BT terminal in Vitez, Bosnia



Broadcast TV

Satellite communications and BT's global network are playing an increasingly important role in the field of broadcast television. The number and diversity of TV channels are increasing dramatically, and this increase in demand is being met through satellite distribution.

BT is in the forefront of direct broadcast by satellite and, as well as providing uplinks to distribution satellites, also provides point-to-point video links that are then retransmitted via other distribution satellites or cable operators. Over 40 channels pass through the London Teleport.

The statistics of the numbers of viewers are staggering. Audiences of 25 million are quoted for the Astra satellites, and Asiasat is broadcast in an area embracing some 30% of the world's population.

The introduction of digital TV compression will see a massive increase in the number of channels that can be carried in the same bandwidth. Initially, fairly high bit rates (typically 34 Mbit/s) will be utilised, but it is forecast that bit rates in the range 2–8 Mbit/s will soon be possible.

VSAT networks

Very small aperture terminal (VSAT) networks are a fast emerging phenomenon which utilise the major benefits of satellite: broadcast, cost independent of distance, rapid implementation at the point of service (even in remote regions) and customer configuration control.

As ubiquitous telecommunications service becomes the norm in western Europe and North America, multinational companies investing in regions such as eastern Europe, Africa and Latin America expect equal facilities and quality of service in these emerging nations. Satellite communications can meet this need through cost-effective deployment of terminals at the customer premises until such time as the local infrastructure is modernised.

A range of new and innovative products are available to BT's customers as follows:

Business television

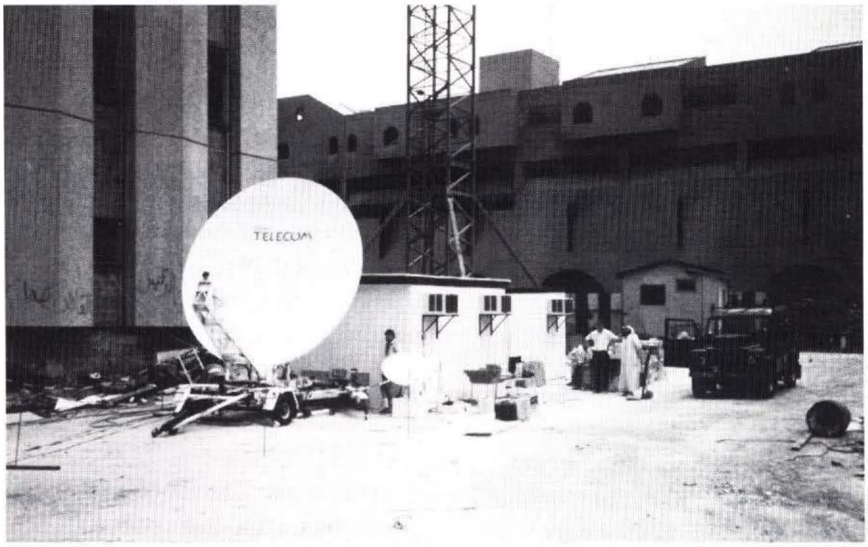
Business television is a one-way point-to-multipoint video and audio service for closed user groups allowing a company to communicate simultaneously with any number of sites virtually throughout the world.

The customer is able to choose from a wide range of service features including encryption of transmissions for security, up to six audio channels for multilingual transmissions and a low-rate audio return link via the PSTN to allow audiences in remote sites to communicate back to programme presenters[8].

Satellite Data Services

Satellite Data Services is a point-to-multipoint, one-way, data broadcast or distribution service which provides customers with secure dedicated and flexible telecommunication network

Figure 5—Johnwroe, Kuwait



operating at speeds from 1·2 kbit/s to 2 Mbit/s. Examples of this type of service include remote printing at multiple locations, relay of time-sensitive financial price information to regional offices and pager system call distribution[8].

SATSTAR

SATSTAR is a point-to-multipoint, two-way data network for customers requiring interactive data to a large number of remote sites. This is a packet-switched network with the associated benefits of bandwidth management and high-quality transmission. In addition, the same equipment can be used (if required) for business television and broadcast of audio signals.

The SATSTAR central hub is linked to the customer's main computer. This hub consists of control and operational equipment for the network and the earth station from which signals are transmitted to the satellite for reception by relatively small (0·9–1·8 m) terminals located directly at the customer's premises. From this small terminal the customer can send data at up to 64 kbit/s back to the hub system and the host computer.

On the outbound route, the capacity is shared by using statistical TDM techniques which enable the satellite capacity to be dynamically and efficiently shared between all sites on the network.

On the inbound direction (from the remote site to the hub) the satellite capacity is again shared by using techniques (for example, slotted Aloha) to maximise traffic throughput.

SATSTAR is applicable as a cost-effective solution for a wide range of applications including business electronic mail, local area network (LAN) interconnect, EPOS/EFTPOS, electronic stock control and shelf tagging where there is a relatively large number of remote sites.

MESHSAT

Over the past couple of years, major oil companies in particular have begun to demand a variety of communications to exploration and production sites in other remote parts of the world. To meet this demand, BT Offshore Services has recently introduced its MESHSAT service, based on VSAT technology.

MESHSAT is a custom-designed service, which provides a managed voice and data communications network, and utilises international satellites to provide virtually global coverage of Africa, eastern Europe and the CIS. It is designed to permit any terminal to communicate with any other terminal in the customer's network, recognising the customer's need to have a flexible extension to their existing corporate private network. Low-rate voice coding schemes are employed to maximise the efficient use of the space segment (typically 16 kbit/s and below). Synchronous data rates are provided from 9·6 kbit/s to 64 kbit/s as standard, and data rates of up to 2 Mbit/s are possible. Perhaps the most significant feature of the MESHSAT service is BT's ability to provide a complete turnkey managed service, including provision, network and performance monitoring, service reconfigurations, and fault management and control.

Satellites continue to play a major role in BT's global network supporting the core IDD product

International direct dialling

Satellites continue to play a major role in BT's global network supporting the core international direct dialling (IDD) product to well over 100 correspondent countries without subsea fibre links.

Additionally, BT is increasingly involved in a wide range of projects involving satellite communications overseas working closely with its correspondents and customers. Recent examples of these projects illustrate the strength, flexibility and merit of satellite communications.

The first example was at the end of the Gulf War. Within weeks of the end of the conflict, BT deployed a mobile satellite terminal to restore international communications. The mobile terminal was installed next to the damaged international exchange and direct connection made to the telephone switch (see Figure 5). Within 72 hours of the BT team arriving, IDD communications were restored. This simple facility saw rapid expansion and within weeks was being used to support 240 telephone circuits plus a number of private leased services. Service was established through BT's global network to over 100 countries.

BT and its customers were to see additional benefits from this initiative with provision through the mobile terminal of the first digital private circuits within Kuwait City.

The second example is of an assistance project BT has undertaken with its correspondent in Sri Lanka. This project involved the provision and installation of an 11 m terminal next to the Sri Lankan Telecom international switching centre in Colombo City. This facility, provided within a period of 5 months, enabled growth of traffic and provided a diverse route from the existing Sri Lankan facilities at Paduka some 40 km from Colombo. Quality of service to BT customers was improved and costs were significantly reduced.

Conclusion

Satellite communication offers a wide range of benefits to enable BT to extend its global reach, providing customers with a total solution.

The main benefits of flexibility, accessibility, speed of provision, independence from national infrastructure and direct customer access mean that satellite communications have an important role to play in extending BT's global platform.

In particular with the advent of advanced core services such as the Global Flexible Bandwidth Service, Syncordia Managed Services and ISDN, satcoms will enable BT to provide these services to all regions of the globe. For mobile users, the concept of true global telecommunications, whether on land, sea or in the air, is already a reality.

Acknowledgements

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References

1 READ, MIKE. The BT Global Network. *Br. Telecommun. Eng.*, Oct. 1993, **12**, p. 242.

2 FLACK, M., and NEILL, E. J. A New Earth Station at Goonhilly Downs for a Satellite Service to Ships. Part 1—The Design of the Antenna and Radio Equipment. *ibid.* July 1982, **1**, p. 85.

3 FLACK, M., and KENT, T. J. A New Earth Station at Goonhilly Downs for a Satellite Service to Ships. Part 2—The Access Control and Signalling Equipment. *ibid.*, Apr. 1983, **2**, p. 17.

4 STUART, A. Skyphone. *ibid.*, Jan. 1992, **10**, p. 285.

5 BOYD, I., SOUTHCOTT, C. B., CROWE, D. P., and BOLINGBROKE, P. J. Speech Codec for the Skyphone Aeronautical Telephone Service. *ibid.*, July 1989, **8**, p. 83.

6 CCIR Report 384-3 Annex III Section 3 Method 1.

7 WARRY, TREVOR, and HAWKES, JOHN. INMARSAT-C Satellite Data Communications for Land and Maritime Mobiles. *Br. Telecommun. Eng.*, Oct. 1992, **11**, p. 188.

8 RYBACKI, TONY and WARREN, GRAHAM. BT Broadcast and Satellite Services. *Br. Telecommun. Eng.*, Oct. 1994, **12**, p. 200.

Biographies

Alan Stuart
BT Worldwide Networks

Alan Stuart joined BT in 1971 as a sponsored student and after graduating in Physics at Surrey University became responsible for the procurement of general-purpose test equipment throughout the business. In 1982, he transferred to satellite communications work and was involved with the provision of the first two 11/14 Ghz terminals installed at Madley Earth Station. Since 1985, he has been involved with satellite mobile communications with particular emphasis on the definition and procurement of ground control equipment.

Paul Coxhead
BT Worldwide Networks

Paul Coxhead, a Chartered Engineer, is a Manager for Overseas and Customer Satcoms Projects, he joined BT in 1983 and has worked on a wide range of satellite projects. These have included a range of terminals at customer premises for Satstream, transportable terminals in the UK and overseas, and overseas projects to support the BT global network. He is currently involved in definition and development of new systems to meet customer satcom requirements overseas.

Brian Wright

Trying to Keep the Customer Satisfied

To succeed in today's market-place, companies must pay particular attention to quality. An effective and durable quality system is therefore essential. Quality standards such as the ISO 9000 series, and models like the European Quality Model, help in demonstrating the ability to attain world-class quality in a company's products and services.

Introduction

Competition is regarded by the competitive as a chance to excel. Others freeze in its shadow expecting merciless price wars and overnight bankruptcy. One thing is certain: BT is facing competition as never before. Competitors exist for all BT products and services and are present in many different guises. There are faster, cheaper, quicker and more flexible providers fighting ever smarter in a finite market. To thrive, or even survive, in the current market-place will depend on attention to quality. Attention to the quality of processes used to achieve the deliverables is as important as the absolute quality of the finished product.

Many organisations have proved that quality programmes, which examine and improve prevalent management practices or systems, are necessary for future company survival. Quality programmes can be applied to implement quality management systems across an organisation.

A quality management system can be described in a very simplistic way as 'the way we do business around here'. In essence, it is the culmination of all tasks performed to achieve the end result, whether that be the provision of a service or delivery of a product.

Defining and implementing a quality system are daunting tasks for any organisation large or small. Anyone undertaking the implementation of such a system across an organisation will face physical, geographical and cultural barriers and deciding where to begin is often so difficult that many quality programmes never leave the starting block. This condition is quite common and is termed 'total quality paralysis'.

Practical programmes to implement quality management systems generally evolve through the following four phases :

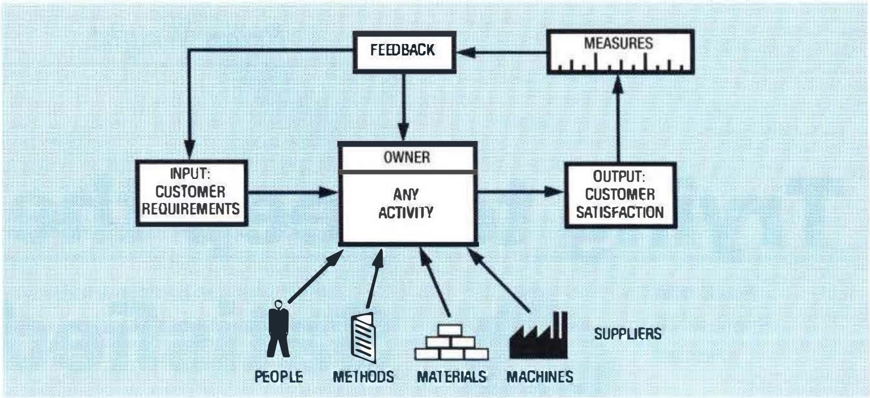
- diagnosis and preparation;
- management commitment and management focus;
- planned implementation and employee involvement; and
- review and restart.

Diagnosis and Preparation

This is when you must answer the question 'what are we supplying for our customers and how well do we think we are doing it ?' Current activities are investigated to highlight any existing processes and best practice where similar tasks are repeated across the organisation. Questioning the status quo can avail surprising results as complex situations are placed under the microscope. Responses are forced for a plethora of assumptions and misconceptions. Most advances in human history have taken place because someone questioned an assumption: the world is flat, we will never fly to the moon, the competitor will never gain enough market share to be a threat to us.

It is important to obtain constant feedback for the system output for diagnosis. Any divergence of opinion between yourself and the customers will give an indication of the scale of change required. A supplier must work toward satisfying the needs of the customer but one can only understand customers if one

Figure 1—Activity model



remembers that they are people, like ourselves, with many and varying needs.

Ideally, a supplier should be asking the following questions of the customer:

- *Who are our customers and what are their requirements?*
  A little fundamental but this can be difficult to identify, and what seems to be an obvious question can be the subject of much debate.

- *Why does the customer use our product/service?*
  For a customer to want something, there must be a need or problem to which you ultimately, in the eyes of the customer, provide a solution. Talking to the customer about his or her problems may identify previously unrealised opportunity.

- *Why does the customer choose us to provide it?*
  Competition implies a difference, a unique selling point, a 'something special'. It is to do what others don't or can't. Low prices are frequently over-estimated as an enabler for a sale, but can be regarded as short-term advantage if the acceptable quality is not achieved or sustained. Understanding what you do better than others is an important step in the learning process.

- *What does the customer think of our product/service?*
  A customer who buys a product or pays for a service is also paying for a piece of the supplier, a piece of the personality, or image. Everything the customer knows, feels or believes about the company is etched on the company image in their minds. When customers have to choose in a competitive situation, the customers' 'feelings' will decide and possibly override the paper arguments. For any organisation, customer perception is reality.

Management Commitment

A quality programme without senior management commitment is like a bicycle without a saddle: very painful to perform well and destined to crash, sooner or later. Senior management must be totally committed to quality and continually seen to be so. If a senior manager is secretly not committed, or only half committed, it cannot be disguised from the organisation whatever the public announcements. Lack of commitment is transmitted via grapevine mechanisms from private comments or from the priorities revealed in decision making and deployment of resource. In his report of the IBM EXCEL quality programme[1], P. K. Doran stated that the time and nervous energy investment in getting a unified senior-management approach was justified by its success. He also observed the opposing effects of those work areas with less than the required commitment level.

A tremendously important step for Doran and his team was the onset of a visible public display of targets and performance. They supported an environment where people at all levels set challenging targets with the risk that they may not be met. This fragile state could have dissolved overnight had they not taken steps to avoid penalising the risk takers.

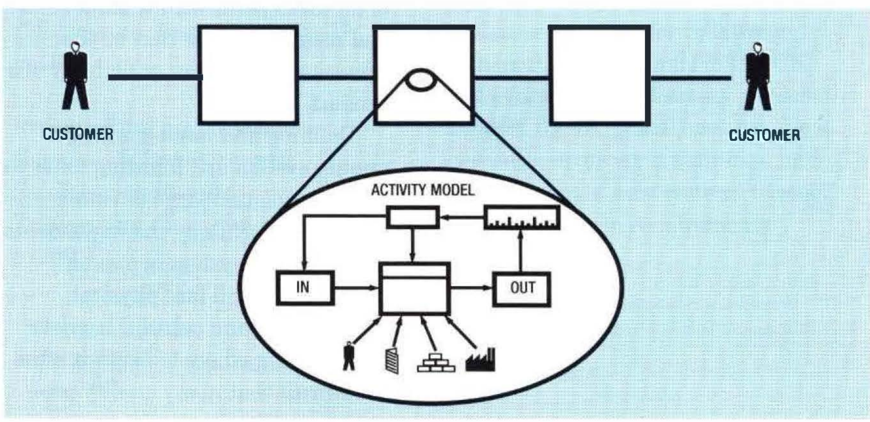
Management Focus

Quality management systems enable people to take control of their processes and activities. The committed managers will need to begin to bring their key activities under managerial control, if they have not done so already. An activity model (Figure 1) is a useful tool for gaining control over activities. The data collected in diagnostics will enable completion of the model.

Any activity within a work area, from ordering stationery to managing a large company, can be expressed simply in this form. The model is implicitly iterative and facilitates awareness of gaps in the system. If the measured output is not the required output, feedback must occur to change the activity.

Activities can also be linked together to form serial and parallel chains, output(s) to input(s). Furthermore, a 'process' is described as a set of linked activities (Figure 2). This is

Figure 2—A process: a set of linked activities



an important point as it highlights a connection between quality management and process management. These methodologies are often regarded as separate even though both relate to managing and controlling activities.

Process management occurs within a quality management system and may be defined as a systematic approach which brings processes under control and improves them.

Planned Implementation

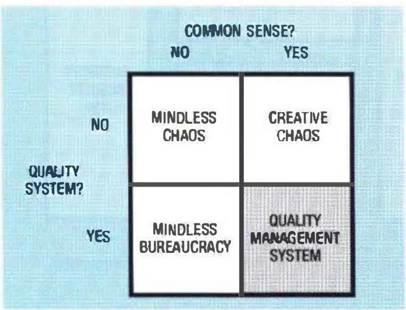
If an organisation has successfully mastered diagnosis, gained commitment and become suitably focussed, the next phase is implementation.

It is important not to destroy all the useful preparation work and existing quality management by rushing headlong into implementation. Don't panic. Implementation requires a consistent and sensitive approach; it is unlikely that the quality programme is operating in a vacuum. The objective of implementation is to achieve a common framework which enables people to take control and improve their activities.

Quality standards, discussed later, provide requirements which can be used as an aid for implementation. They can be used as a reference point, specifying the key requirements upon which to focus the common framework.

Figure 3 shows how common sense plays a part in implementation of quality systems. The more flexible the approach, the more flexible the system. Life is a compromise and no single system can easily sustain performing in any one extreme owing

Figure 3



to the ever-present opposing forces. It is a management task to strive for order in a chaotic environment, but, in opposition to this, a phenomena called *process-entropy* will cause processes to be constantly drawn toward disorder, eventually diluting unsustained efforts.

It is achieving a balance that ensures the durability of a system. If too much effort is spent on the system, the product or service will never be delivered. Too little time and there is less chance that the customer will be satisfied, or even consulted. A major criticism of BT's previous attempts at quality systems was that the systems were vastly over-documented and advanced the onset of bureaucratic values.

It is worth noting that although Figure 3 is simplistic, it serves to remind us of the boundary conditions. Those familiar with Karnaugh maps may suggest that the quality zone would be correctly termed 'creative bureaucracy', which is not too far from reality.

Employee Involvement

Employee communications is fundamental in involving people at all stages of the quality programme. The objective of any communication is to manage the commitment of those parties involved, affected, or even those interested in the decision-making process. Planned communications are too often omitted from the implementation of projects. Quality programmes can affect large numbers of employees, many anxiously poring over whatever information can be obtained. Quality affects all employees, and communications must be targeted carefully. Audiences can be unforgiving; what is taken as a clear explanation by one person, may be a patronising statement to another.

Review and Restart

Implementing a quality system is not enough to sustain the ability to be competitive. Process entropy, mentioned earlier, will cause systems to decay with time. In simple terms, everything put together will eventually fall apart. Therefore, to perpetuate the quality momentum gathered in implementation, one must continually review and restart the quality programme.

Audit

Internal audit is a mechanism for providing management confidence that quality exists and persists. It serves, when used in a supportive manner, as a discipline to keep quality awareness at a high level. An ongoing programme of audits ensures that the system is regularly checked for conformance to the documented system. Analysis of the information derived from the audit programme may also provide opportunity for further improvement.

Benchmarking

What can you do when you think you have a perfect activity? Easy. Improve it. Once you have a system in place, it is possible to compare your activity with others, especially external organisations. The practice of external comparison is known as *benchmarking*. Benchmarking can be defined as the continuous process of measuring a company's products against the toughest competitors or those companies renowned as the leaders. The objective is superiority in all areas: quality, reliability and cost.

Process re-engineering

Process re-engineering is a longer-term improvement activity, often using benchmarking data. Process re-engineering is a 'zero-based' approach to process design. In other words, the new process is designed from scratch to replace existing processes. Re-engineering should occur when there is a significant gap between the current process performance and the process vision, and a step change in performance is required to meet business objectives.

Customers expect to see minimum standards from companies claiming to exude quality.

Quality Standards

The present market and customer expectation of 'quality' companies has never been so high. Customers expect to see minimum standards from companies claiming to exude quality. The ISO 9000 series (identical to the BS 5750 and EN 29000 series) is a set of quality standards; that is, they specify the minimum requirements to which a customer/supplier relationship should adhere.

Cynics are quick to point out that the standards do not guarantee a decent product but in doing so highlight a valid point. Specifically, ISO 9001[2] requires suppliers to control their activities and demonstrate this internally and externally.

Suppliers wanting to meet the requirements of the standard undergo a process of registration. Registration is an independent assessment of the company's quality system against the requirements of the standard. Successful suppliers become registered suppliers and this means business advantage. Customers accept the opinion of an independent body like the British Standards Institution (BSI).

European Quality Award

The European Foundation for Quality Management (EFQM) was formed in 1989 by 14 leading western-European businesses of which BT was the sole UK representative.

Two key roles of the EFQM are:

- accelerating the acceptance of quality as a strategy for global competitive advantage; and
- stimulating and assisting the deployment of quality improvement initiatives to achieve business excellence.

In 1992, the EFQM devised the European Quality Award (EQA). This award is presented annually to the (one) applicant company which is deemed to be the most successful exponent of quality management in western Europe. Companies apply for the award by submitting a self appraisal report based upon the European Quality Model[3] (Figure 4).

There are several differences between the European Quality Model and the ISO 9000 series of standards.

The model:

- is not a standard;
- is scored equally between enablers and results;
- can be used for all organisations;
- is not biased toward manufacturing functions;
- uses benchmarking to compare with world-best performance; and
- is concerned with results.

The EFQM has taken the lead in supporting quality and has developed the model so that businesses can perform the self-appraisal of their quality operations.

The numbers shown on the model are the maximum scores for each of the criteria and the maximum total score is 1000. Companies are expected to report against each of the nine criteria assessing how well the organisation is doing against a scale where 0% relates to anecdotal evidence—that is, none—through to 100% where the current activity performs so well that it should be used as a role model for other organisations. After figures are weighted accordingly, the organisation will have achieved a total score which can be charted against other companies' performance.

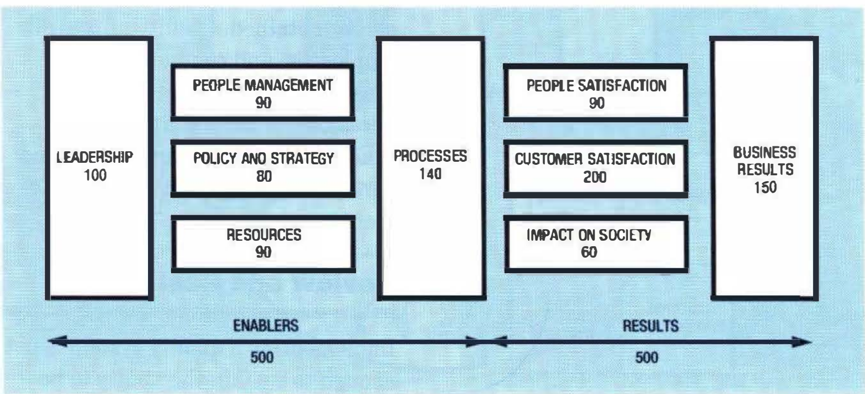
To win this prestigious and limited award will have far reaching marketing advantages for any organisation. It is the business equivalent of winning the European Cup with all the associated glory. Similarly, the EQA model does not differentiate by size or status. Small companies of less than 300–500 employees may score as well as large multinationals.

In summary, quality systems are concerned with people doing things right to survive. The European Quality Model is subtly different and used wisely will help organisations in doing the right things to win.

Conclusion

Many companies, including BT, have expressed their commitment to quality. For BT to sustain competitive advantage and to further enhance customer perception, it is imperative that BT succeed in achieving registration to ISO 9001. Customer expectations are increasing and just 'trying to keep the customer satisfied' is not sufficient for sustained survival. Considered application of practical quality programmes will be necessary for further continuous improvement.

Figure 4—European Quality Model



References

1 DORAN, P. K. A Total Quality Improvement Programme. *International Journal of Quality and Reliability Management*, 2(3).

2 ISO 9001. Model for quality assurance in design/development, production, installation and servicing. 1987.

3 The European Model for Self Appraisal 1993, Guidelines for identifying and addressing Total Quality Issues. European Foundation for Quality Management, 1992.

Bibliography

RIGBY, P. J., STODDART, A. G., and NORRIS, M. T. Assuring Quality in Software—Practical Experiences in Attaining ISO 9001. *Br. Telecommun. Eng.*, Jan. 1990, 8, p. 244.

CBI. Working for Customers.

PA Consultancy Group. How to Take Part in the Quality Revolution: A Management Guide.

Biography

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Brian Wright graduated from Aston University with a degree in Electrical and Electronic Engineering. He began his career in the System X Product Support Group. He now works for Operational Policy and Systems (OPS), providing quality-systems support. He is also responsible for managing the primary employee communications for the department. He is a member of the Board of Editors of *British Telecommunications Engineering Journal*.

Paul Cherrett

Practical Benchmarking

Today's competitive operating environment demands ever-increasing levels of cost reduction and performance enhancement in order to grow or even maintain market share. Traditional year-on-year incremental improvements are unlikely to deliver against accelerating customer expectation. In the drive for 'best practice', benchmarking can be a formidable tool. This article endeavours to provide the reader with some guidance on practical essential elements necessary for a successful benchmarking programme.

Introduction

A *benchmark* is generally seen as a high-performance measure of 'what' result is being achieved by someone somewhere, whereas *benchmarking* determines 'how' this result might be achieved or surpassed.

Benchmarking is about improvement through change. The acid test is 'if you don't bring about improvement, you're not benchmarking'.

Benchmarking is here to stay. Benchmarking activity impacts on more than 40% of European Quality Award (EQA) markings. Some 20 books currently extol its virtues. Recent research by Coopers & Lybrand indicates that 67% of the 1000 top companies listed in *The Times* claim to be actively involved in some form of benchmarking. The study further suggests that, from the companies surveyed, 82% of benchmarking projects undertaken were successful.

Roots

Although of Japanese origin, it was the Xerox Corporation which pioneered the current legally respectable Western form of benchmarking during the 1970s and 1980s. Faced with a reduction in market share from 80% down to around 30%, and with Canon copiers being retailed at less than Xerox manufacturing cost, Xerox, in this competitive 'brink of the abyss' position, was forced to take radical action to survive. Xerox's initial benchmarking exercises with companies in Japan concentrated on the manufacturing area, but this was then extended to include many other processes and activities.

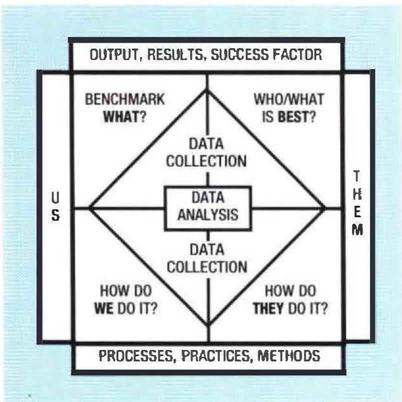
Considered to be more of an art than a science, Xerox defines benchmarking as 'the continuous process of measuring our products, services and business practices against the toughest competitors and those companies recognised as industry leaders.'

Notably, Xerox is as strong on its commitment to benchmarking today as it was in 1979. A strengthening of its market-share position and attainment of both the prestigious Malcolm Baldridge Award and the European Quality Award reflect the benefit of a successful benchmarking strategy. Figure 1 shows Xerox's benchmarking model.

Whether based on fear of competition or just plain old curiosity, the natural practice of 'peering over the wall' at what others are doing has always existed but, here in the UK, it is only during the last five years or so that formal benchmarking has begun to make a mark.

In the early stages of a company's attention to the art of benchmarking, there is a tendency to look for single-measure comparisons; that is, the benchmarks. Who achieves best customer satisfaction? Who is the fastest at provision or repair of service? Who has lowest cost? etc.

Figure 1—Rank Xerox benchmarking model (template)



BT has become increasingly active in the search for benchmarks, building on traditional competitor analysis of markets, products and services.

This popular 'league table' study stage can often result in nothing more than varying degrees of interesting 'apples and oranges' comparisons particularly when cost parameters are viewed in isolation. However, as a management first step it does have a positive value in that it gives rise to debate within the company. The perceived performance gaps are examined, and the validity of targets questioned. Bridging the gaps identified—through committed benchmarking activity—is the greatest challenge.

BT's Experience to Date

BT has become increasingly active in the search for benchmarks, building on traditional competitor analysis of markets, products and services. Through the analysis of publicly available data, BT has been able to compare competitive costs such as telephony unit costs, return on capital and overall manpower efficiency against major telecommunications players such as the Regional Bell Operating Companies of North America. Additionally, a growing number of information exchange opportunities has permitted the comparison of both operational quality-of-service parameters against other telecommunications operators and non-competitor parameters with those of other businesses. Where appropriate and relevant, the focus on the resultant performance gaps identified provides a useful input for strategic planning purposes.

Experience in the art of benchmarking within BT continues to grow; however, there is still much to learn. One particular lesson already learnt is that of customer focus. In undertaking any study, there is a need to link those elements of 'customer experience' which are most likely to be affected and to ensure that the relevant customer measures are included in the output matrix.

To aid the coordination of benchmarking activity across the business, and to provide guidance, a BT Benchmark Forum has been introduced.

BT benchmarking initiatives include formal structured benchmarking activities often with the support of a third party. However, it is also valid to take a more informal approach by using a simple bilateral exchange of ideas with a targeted partner.

A practical example of this informal approach is as follows. Desk-based research was carried out to produce a short list of potential leaders with respect to targeted aspects of network performance. Investigation by a senior management focus group further narrowed potential partners and paved the way for follow-up benchmarking activity involving the relevant 'on-the-floor' specialists. Benefits for BT included considerable input to the customer access network and billing improvement programmes.

Practical Benchmarking

Success through benchmarking should incorporate the following principles:

- ensure management commitment exists—there must be a willingness to implement improvement through benchmarking;
- benchmark for the right reason—a desire to learn and improve;
- benchmark the right activities—impact should be on the specific business imperatives of customer satisfaction/expectation, employee satisfaction, market share and/or return on assets;
- have an in-depth understanding of own process, activity or practice which is to be benchmarked;
- seek to understand, emulate and improve on the performance of recognised leaders;
- establish an environment where targets are related to 'best-in-class'—not last year's results; and
- be ethical—preparedness for honest, open exchange of information with benchmarking partners.

Basic Types of Benchmarking

Four basic types of benchmarking are used: internal, competitive, functional and generic.

Internal

Within a company, comparisons of best practice can be made between operating units, departments and sister companies. Although the focus is internal, with less barriers to cooperation, this method is the easiest form of benchmarking, but probably is the least stretching in improvement terms. It can also be considered as a very useful extension of total quality management (TQM).

Competitive

Competitor companies can be studied. These will often require third-party involvement in order to sanitise competitive information and thereby provide anonymity for partner companies. Focus on non-competitive topics is possibly more appropriate; for example, safety, training. However, even among direct competitors, the cooperative nature of benchmarking should be viewed as a healthy exercise. By reducing communication barriers, increasing mutual understanding and by sharing the common desire to bring about improvement, the opportunity is enabled for all customers to benefit.

Functional

Processes and practices can be compared with the 'best in the industry'. Although the use of a third party is still useful, the issue here is less contentious because companies are not directly competing. It follows that this type of benchmarking offers good breakthrough opportunities as the level of detailed investigation can be that much deeper.

Generic
Through the broader opportunity of comparing with companies outside a company's own industry area, real 'best in class' benchmarks can be established. Maximum interchange of ideas is likely and higher gains made possible.

Ethics of Benchmarking

The key here is to ask only for that information you are willing to share yourself.

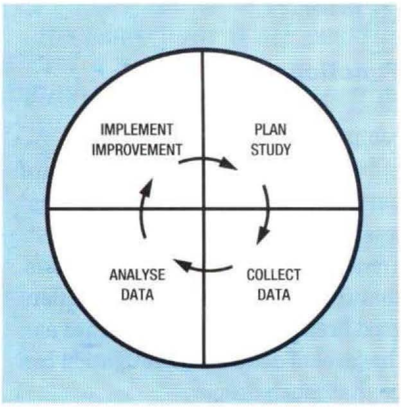
Anti-competitive behaviour involving collusion on fixing prices or confidential customer information, together with company misrepresentation or the use of disparaging remarks concerning a competitor's business, has no place in benchmarking. Such actions, viewed by European Community officials as anti-competitive, can lead to punitive fines for those companies convicted.

A useful reference on benchmarking ethics is 'The Benchmarking Code of Conduct' developed jointly by the American Productivity & Quality Center's Clearinghouse (APQC IBC) and the Strategic Planning Institute (SPI) Council on Benchmarking.

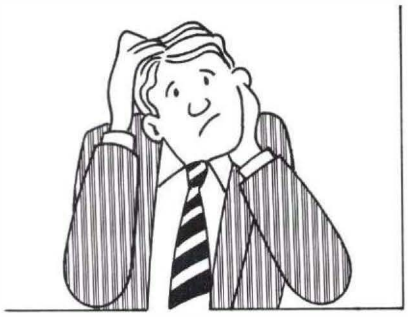
Practical Steps Model for a Benchmarking Exercise

The key features of the revolving benchmarking process remain the same in all valid benchmarking models, and these are shown in Figure 2 The essential activities in this process are now discussed.

Figure 2—The benchmarking 'plan, do, check, act' model



(1) What to benchmark—selection



- Prioritise and consider benchmarking a select few 'critical' processes (estimate 6–9 months per project). For the chosen project, confirm the associated business critical success imperatives—why we really have to do this. Target the specific process or process activity area for benchmarking.

- Establish a small coordinating benchmarking team involving both the process owner (top-down commitment) and delivery experts (people on the ground). Also evaluate benefits of including external third-party support to facilitate and, where necessary, help to gather sensitive data.

- Break down the top-level measures into component operating input and output parameters to enable the whole or section of the process to be evaluated. The introduction of new more-appropriate process measures may be necessary.

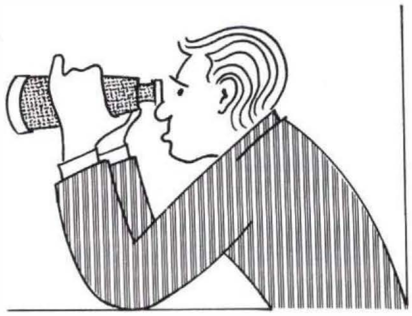
- Internally benchmark—evaluate own best practices used in the process. Ensure that, before approaching potential best-in-class companies, the team

— is fully conversant with its own process and best practice;

— is aware of the level of value-add and non-value-add activities incorporated in its own best practice; and

— is able to produce a concise questionnaire or activity check list which reflects an appreciation of the essential elements.

(2) Who to benchmark against—identifying suitable partners



- Identify the best-in-class. Seek out information making maximum use of public-domain material. Talk to own employees, suppliers, customers and benchmarking consortia to supplement library search. Where appropriate, look outside own industry as non-competitor companies are likely to be more willing to share information and therefore easier to benchmark against. It isn't always possible or necessarily practical to benchmark against the best player. The reasons could be:

— cannot identify them;

— sensitivity of data;

— inappropriate business imperatives; and

— unwillingness to cooperate.

Evaluate information to indicate a short list of suitable candidates.

- Place courtesy telephone calls to the likely benchmark companies as a warm up and to establish an initial sounding of the enthusiasm of that company to take part in the benchmark exercise. If required, meet and establish trust to secure a good working relationship.

(3) Data collection and analysis

- Follow-up with questionnaire or activity check list, together with a covering letter, explaining detail and committing to share results as previously discussed.
- Analyse returned questionnaires and select the most appropriate companies as benchmarking partners (say three companies).
- Telephone individual company(ies) selected to agree a face-to-face opportunity. Explain that you would like to discuss say 10 specific items and offer them the opportunity to include 10 of their own choice for discussion. Arrange two ½-day face-to-face meetings.
- Meeting—Day 1. The first meeting starts with a meet-and-greet lunch followed by interviews and specifically targeted observations (avoid the customary plant tour). Avoid invitations to dinner if possible. The team then returns to base or hotel to enable all essential points to be captured and to consider whether to ask for any realignment of the next day's visit.
- Meeting—Day 2. Hold a breakfast meeting, finish interviews and observations, complete by lunch time. After lunch, return to base where team immediately finalises output and all data material is collected.
- Finally, analyse the data. Identify improvementopportunities, develop recommendations to include adaptation and modifications to process required, and equate impact of changes on original specified business imperatives.

(4) Communicating results and implementing change

- Share results and thank benchmarking partners as agreed.
- Present findings to decision makers. Ensure 'weighted' results reflect an informed view of the differences in operating performance which are due to environmental impacting factors existing on comparison companies. (*Note*: There is a need to balance strategic drivers when analysing results from a benchmarking investigation of another company. Factors influencing the needs or ability of one company to excel at a particular process may not justify emulation; that is, it does not necessarily follow to be the best at everything.)
- Make decision to allow step-change. Implement, monitor results, and recalibrate benchmark.

Conclusion

With the competitive thrust for quality improvement, the use of benchmarking, within BT, continues to gather pace particularly in support of improvement projects such as re-engineering. However, further cultural change is still required before the company reaches 'benchmark' status. The culture has to be one where the individual's enthusiasm to examine world's best practice takes precedence over the deceptive practice of cosy reflection of internal performance results.

Acknowledgements

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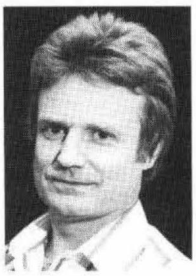
Bibliography

CAMP, ROBERT. Benchmarking—The search for industry best practices that lead to superior performance. Quality Resources.

ZAIRI, M. Competitive Benchmarking. Technical Communications Publishing Ltd.

WATSON, GREGORY H. Strategic Benchmarking. Wiley.

Biography



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Kevin D. Fogarty, and Kurt Katzeff

EURESCOM—A New Opportunity for Collaborative R&D in European Telecommunications

A new collaborative research and development institute has been established in Europe, EURESCOM—the European Institute for Research and Strategic Studies in Telecommunications. This article gives an overview of the history, organisation and achievements to date of this institute, which is jointly owned by 26 European public network operators. It explains how, via the EURESCOM instrument, developments in European telecommunications can be accelerated and achieved more efficiently.

Background to the Establishment of EURESCOM

History

The intention to found EURESCOM (the European Institute for Research and Strategic Studies in Telecommunications) was based on a decision taken by CEPT (European Conference of Postal and Telecommunications Administrations) and a meeting of the Ministers of Posts and Telecommunications of the EC in September 1989. At the beginning of 1990, a Memorandum of Understanding was signed by 23 public network operators (PNOs) from 18 European countries, all of which had to be members of CEPT.

As a consequence, a Preparatory Committee was set up, which held its first meeting in Munich on 16 March 1990, and whose working groups drew up the basic agreements necessary for the foundation and the work of EURESCOM:

- the legal and financial structure,
- agreement concerning the transfer of intellectual property rights,
- a work programme for short-term and long-term projects, and
- the programme and project management.

A proposal to locate EURESCOM in Heidelberg was agreed in May 1990. After this decision, Deutsche Bundespost Telekom purchased a property (the Villa Rainer) on the edge of the town, near the famous Heidelberg Castle, and provided the necessary installation and refurbishment.

After the foundation of EURESCOM on 14 March 1991, the official inauguration event at the Villa was celebrated on 25 June 1991. The permanent staff, which consisted at that time of three people, supported by two from Deutsche Telekom, has now grown to 20. Also the membership of EURESCOM has now grown to 26 PNOs from 22 countries.

Objectives of EURESCOM

The rationale behind the initiative to form EURESCOM was:

- the need to ensure the interoperability of national services and to promote the development of pan-European services;
- the need to make the most efficient use of the limited resources, taking into account the new role of the European PNOs and their common identity;
- the wish to stay competitive and take responsibility for the economic success of their investments;

- the wish to make maximum profit of the results of the European research and development (R&D) programmes; and

- the EC Council Declaration of 7 December 1989 on new forms of cooperation in the field of R&D for integrated broadband communication.

The overall objectives of EURESCOM are to support the development and provision of harmonised pan-European public fixed telecommunications networks and services by the furthering of science and research in the field of telecommunications and the assessment of its importance and usefulness in the process of European integration. This means in particular to:

- enable the development of harmonised strategies for the planning and the provision of future European public networks and services;

- stimulate and carry out pre-competitive and pre-normative research projects;

- stimulate and coordinate field trials; and

- contribute to European and worldwide standardisation.

The objectives of EURESCOM are carried out in accordance with the following principles:

- The activities of the Institute will not hinder or restrict in any way competition among its members.

- The Institute will not speak on behalf of its members, unless asked to do so.

- The members are not bound by the recommendations of the Institute.

These general principles are set out in the Articles of Association (AoA).

In addition to the Articles of Association, all members have signed an Intellectual Property Rights (IPR) Agreement to govern the treatment of any IPR in relation to EURESCOM projects.

The prospect of increasing and further competition between the PNOs in Europe is a fact of life within which the cooperative structure of EURESCOM has to coexist. The liberalisation of the telecommunication market in Europe is also a way of stimulating the wide use of telecommunication services. However, liberalisation has also meant competition between different operators and this has sometimes led to the opinion that cooperation is not allowed or should not be encouraged. As the objectives are to improve the European infrastructure by establishing a highly-available reliable and secure pan-European network for a wide range of pan-European services, there is clearly a requirement that the operators work together to establish the building blocks, the interfaces, and the procedures and protocols for this network and its services. This is the role of EURESCOM.

EURESCOM Structure, Membership and Way of Working

Structure of EURESCOM

As a consequence of the decision to locate EURESCOM in Germany, and to operate this collaborative R&D activity as a professionally-managed and soundly-based activity from a financial point of view, it was decided to establish EURESCOM as an Institute having the legal status of a German GmbH (limited liability company) with its permanent seat in Heidelberg.

Based on the general structure of German companies, EURESCOM has the following bodies:

- A General Assembly (GA), in which all members of the GmbH are represented and exercise their voting rights in accordance with the established rules.

- A Board of Governors (BoG) as a permanent management and supervisory body. The Board of Governors of EURESCOM has nine members, elected by the General Assembly. The current board is chaired by Mr. F. Thabard of France Telecom. The other eight members come from Deutsche Telekom, BT, STET, Telefonica, PTT NL, Telecom Finland, Telecom Portugal, and TeleDanmark.

- The GmbH staff, which comprises 20 members, is headed by a Director (Mr Kurt Katzeff) and is located at the EURESCOM Headquarters in Heidelberg. The Director is supported by four functional heads:

— the Administrative Director in charge of administrative, financial and personnel questions;

— the Senior Manager for Strategic Studies in charge of the definition of the work programme;

— the Senior Programme Manager in charge of the execution of the work programme; and

— the Senior Quality Manager in charge of quality aspects and the transfer of results.

This structure of EURESCOM is illustrated in Figure 1.

The name EURESCOM means two things, namely the registered GmbH owned by the shareholders and the organisation for cooperation in R&D among the shareholders. In this organisation, the shareholders play different roles as initiators of different R&D projects, as performers of these projects, and as receivers of the results from the projects. This kind of cooperation has been considered necessary to establish pan-European telecommunication services in addition to the

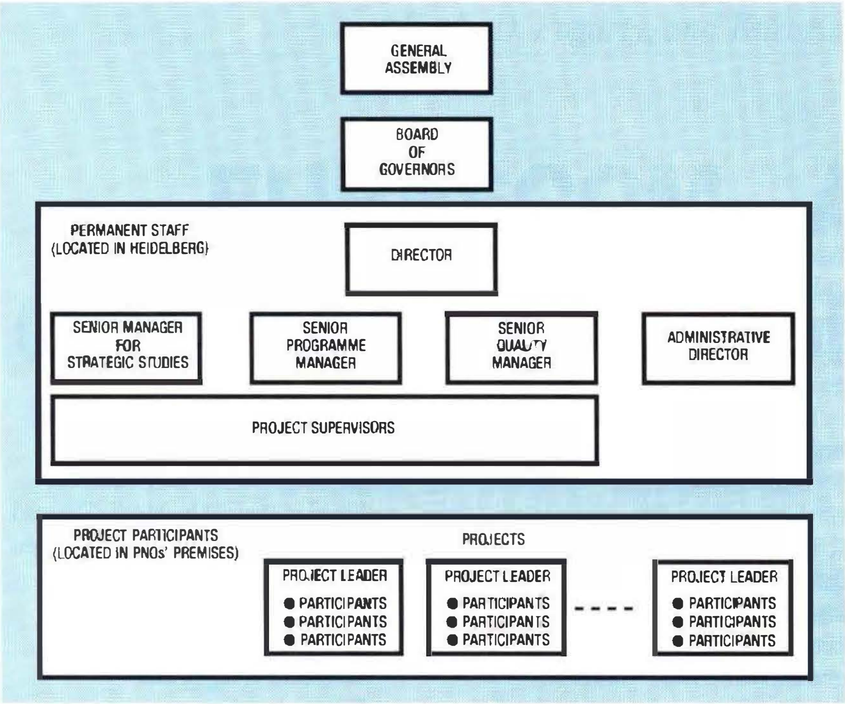


Figure 1—Overall structure of EURESCOM

already existing telephone service. The intention is that the customers will have the same services available all over Europe and that these services will, as the customers see them, function in the same way everywhere independent of which network operator provides them.

Members, shareholders of EURESCOM

All European PNOs providing national and/or international public fixed telecommunications networks that have been granted special or exclusive rights or obligations for the provisioning of network infrastructures or basic services, or holding companies of such PNOs or associations representing one or more of such PNOs may become members of EURESCOM.

All members must belong to countries falling within the geographical area of CEPT. They must have a strong interest in ensuring the convergence and integrity of the European network infrastructure, and the interoperability of services across Europe, and commit themselves to support advanced collaborative R&D activities. European PNOs that are currently members of EURESCOM are listed in Table 1.

Each member holds a share in EURESCOM GmbH according to its turnover from public fixed networks in 1992 which is grouped into nine classes. The smallest members hold a share of DEM 500 each; the largest members hold a share of DEM 32 000 each. Consequently the members of EURESCOM are known as its *shareholders*.

How EURESCOM projects are proposed, established and managed

Overview of the EURESCOM process

EURESCOM is an Institute for the members and run by the members. This is also reflected in the way projects are defined (see Figure 2). All new project proposals, with a few exceptions, are put forward by the members. Project proposals are given a first assessment by the EURESCOM permanent staff (EPS). For a more thorough examination, the permanent staff is supported by groups of experts from members going through the proposals work area by work area.

The basis for the work programme will, in the future, be an outlook or

Figure 2—The circular role of members in carrying out the work of EURESCOM

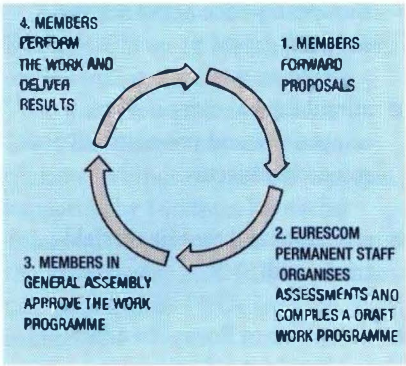


Table 1 Members of EURESCOM

Association of Telephone Companies in Finland, Finland	Koninklijke PTT Nederland N.V., The Netherlands
Enterprise des Postes et Télécommunications, Luxembourg	Norwegian Telecom, Norway
Österreichische Post und Telegraphenverwaltung, Austria	Hellenic Telecommunications Organisation S.A., Greece
British Telecommunications plc, United Kingdom	BELGACOM, Belgium
Swiss Telecom PTT, Switzerland	Telia AB, Sweden
TeleDanmark A/S, Denmark	SPT TELECOM, s.p., Czech Republic
Deutsche Bundespost Telekom, Germany	Slovak Telecommunications, State Enterprise, Slovak Republic
France Telecom, France	Telecom Eireann, Ireland
Hungarian Telecommunications Company Ltd., Hungary	Telefonica de España S.A., Spain
General Directorate of Posts and Telecommunications, Iceland	Posts and Telecommunications of Finland, Finland
STET Societá Finanziaria Telefonica p.a., Italy	Telecom Portugal S.A., Portugal
Telefones de Lisboa e Porto (TLP), S.A., Portugal	[Community of Yugoslav Posts, Telegraphs and Telephones, Yugoslavia, excluded]
Mercury Communications Ltd., United Kingdom	
Companhia Portuguesa Radio Marconi S.A., Portugal	

strategic prediction from the ongoing strategic studies, fact-finding studies and pre-studies. The strategic studies project performed within EURESCOM during 1992 has influenced the work programmes for 1992 and 1993 as well as the general framework which has formed the basis for the work programme 1994.

It is the task of the permanent staff to define a draft of the EURESCOM work programme. This draft is discussed by the Board of Governors, which forwards a proposal to the General Assembly. The General Assembly, being the highest body of EURESCOM, then decides upon which project proposals to support and fund. After the work programme has been approved by the General Assembly, the permanent staff ask the shareholders if, and to what extent, they are willing to participate in the projects. The permanent staff invite the participants to 'set up meetings' for the different projects at which the different tasks within a project are discussed, agreed and distributed among the participants. During the life of the projects, seminars and reviews are organised by the permanent staff who also check the quality and organisation of the deliverables.

The whole process of establishing the work programme lasts roughly one year. The calendar for this process is generally as shown in Table 2.

Table 2 Calendar for Establishing the EURESCOM Work Programme

Period	Activity
January–February	Preparation by the Board of Governors and the permanent staff of a general framework for the work programme
March–April	Call for project proposals for the work programme
May	Assessment of proposals by the permanent staff supported by task forces
June	Compilation of draft EURESCOM work programme
July–August	Review of draft work programme by Board of Governors
September	Recommendation of the work programme by Board of Governors
October	Approval by General Assembly
December–January	Projects set up

Results of EURESCOM projects related to time

According to the likely implementation or exploitation of their results, EURESCOM projects may fall into one of the following categories:

- short-term projects where the results are likely to be implemented in less than 3 years time;
- medium-term projects where the results are likely to be implemented in 3–5 years time; and
- long-term projects where the results are likely to be implemented in more than 5 years time.

The duration of project work is independent of these categories. Independent of the duration, however, the intention is that the first results of a project should preferably be available to the members within one year after the start of the project and absolutely within two years.

This categorisation should be considered as a general guideline. Most EURESCOM projects belong to the medium-term category.

Work item types and their exploitation

All work items of the EURESCOM work programme are *Projects (Pnxx)*, where '*n*' refers to the year the project starts in; for example, the projects P3xx started in 1993. According to the support the corresponding project proposal attracts at the GA, projects are assigned to one of the two following categories:

- *General-interest (GI) projects* where a clear majority (> 75% of the weighted votes) of the members consider that they should be part of the GI programme. General-interest projects are 100% funded by all EURESCOM members.
- *Special-interest (SI) projects* where members consider that a project is useful to a group of members but not justifiable as jointly funded. Special-interest projects are funded only by the participants themselves.

The members who work in the GI projects are paid for this work according to a fixed manpower rate. All results obtained in a general-interest project are the property of the members who performed the work but according to the IPR Agreement they can be used by any member in its role as an operator.

A Cost Sharing Agreement sets out the rules for financing the Institute. All members contribute to the general operational budget and to the costs of the general-interest projects of the EURESCOM work programme in relation to the different class of shares.

For a better preparation of the work programme and the planning of the work in the projects, fact-finding studies and pre-studies are used. Fact-finding studies are of an explorative nature addressing new technologies and/or areas of assumed *new disciplines of software engineering, protocol specification, network architecture, network / service management are now dominating R&D activities in telecommunications*

mutual interest to most PNOs, aiming at:

- recommendations on further actions to be taken by EURESCOM permanent staff or members, and
- the definition of project proposals.

All current fact-finding studies belong to the general-interest category.

Pre-studies are of a preparatory nature aiming at getting a better foundation for planning future activities in areas of recognised mutual interest to most PNOs.

During 1991 and 1992, EURESCOM has only had general-interest projects. During 1992, proposals for some special-interest projects were prepared. The size of the annual EURESCOM work programme budget has grown as shown in Table 3.

In 1994 the total budget for EURESCOM, including project and operational costs, will be 36 MECU.

Current Activities in EURESCOM

As always in the complicated subject of telecommunications it is difficult to partition work in an orthogonal manner, avoiding overlaps, but at the same time taking account of the various disciplines that have arisen in telecommunications. It is clear, however, that the 'old' disciplines of 'switching', 'signalling', 'transmission', etc. are merging and new disciplines of software engineering, protocol specification, network architecture, network/service management, etc. are now dominating R&D activities in telecommunications. EURESCOM has adopted these new disciplines and must be able to adapt its work areas in future as new technologies and techniques emerge.

Based on the general framework, six work areas are defined in the current EURESCOM work programme:

- strategic studies,
- infrastructure and switched networks (I&SNs),
- intelligent networks (INs),
- telecommunications management network (TMN),
- telecommunication services, and
- software requirements and practices.

The following is a brief summary of the intent and the work to be carried out in EURESCOM projects in each of these work areas.

Table 3 Growth in EURESCOM General-Interest Programme

Year	Size of GI programme in man-months
1991	191
1992	1328
1993	1764
1994	2351

Strategic studies

One of the main objectives of EURESCOM is the development of harmonised strategies by its members for the planning and provision of future European public networks and services. The activities in this work area concentrate on the development and maintenance of future-oriented framework visions integrating assessments of market trends, business sector trends, technological and institutional/regulatory trends. Based on agreed framework visions and evolution scenarios, guidance to ongoing projects and new proposals for projects can be derived in order to prepare consistent and updated EURESCOM work programmes.

Although the scope of the strategic studies work area is quite broad, a concentration on the following focal points is aimed for:

- evolution of technology, networks and services;
- models for system integration;
- impact of telecommunications on the way of organising work; and
- techno-economic modelling and assessments.

The first EURESCOM project on strategic studies produced a vision and scenarios for European telecommunications. This result formed a key element in determining the EURESCOM general framework document. It is also of interest to many other organisations in the European telecommunications scene.

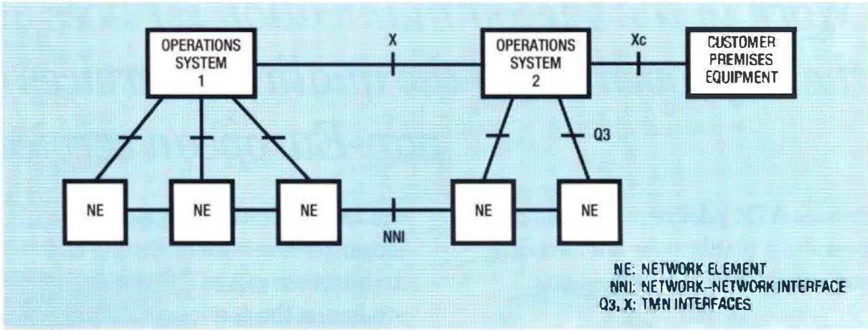
Infrastructure and switched networks (I&SNs)

This work area encompasses the transport and access networks as well as some work on network performance. The transport network will remain a very large part of PNOs' costs for services provision. One of the means that could lead to a reduction in these costs is the worldwide standardisation of the synchronous digital hierarchy (SDH) and its gradual introduction that will allow for a flexible and cost-effective control of the transmission network. By combining this technology with switching nodes based on asynchronous transfer mode (ATM) technology, the PNOs will have at their disposal core networks capable of transporting all kind of information, including broadband services, on a medium-to-long-term perspective. Also, for the most costly network part, the local access network, developments of all-optical solutions seem very promising. Several projects in this area address these issues.

Intelligent networks (INs)

The intelligent network is an architectural concept that allows new and innovative services to be introduced into the public telecommunications network in a rapid and cost-effective

Figure 3—Overview of the ATM VP handling architecture



way. The IN architecture allows a clean separation between service control and transport control, opening up the market both for more competitive supply of equipment and for liberalisation in service provision. The EURESCOM work follows on from, and in its longer-term work contributes to, the international standardisation work going on in this field. The EURESCOM intention is to produce specifications that will allow INs to be interconnected in Europe.

Telecommunications management network (TMN)

TMN offers one of the best possibilities for reducing the costs for the PNOs. TMN will not only allow for a better exploitation of already deployed equipment, but will also result in a harmonised and automated interworking between service providers and transport network providers.

The EURESCOM work on TMN focuses on:

- specifying management services,
- providing guidelines for implementation of pan-European solutions, and
- specifying TMN applications.

The latter point is the real goal of EURESCOM TMN work; that is, to specify TMN systems to manage, for example, pan-European transmission networks.

Telecommunication services

Telecommunication services *per se* are the *raison d'être* for the PNOs. In virtually all ongoing EURESCOM projects and new project proposals reference is made to the development and specification of pan-European services. Consequently, it is obvious that work is needed to define and specify these services before or in association with the specifications of the related platforms. In some cases, the technical specification of the service has already been adequately arrived at by ETSI or CCITT. In other cases, PNOs may collectively decide on a new service for pan-European implementation which has not been defined (or adequately defined) by ETSI and so EURESCOM efforts will be devoted to it.

Software requirements and practices

Modern telecommunication systems can be seen as a synergy between several technologies (for example, electronics, optronics, etc.). Software has a special role in this synergy: it is the glue that ties things together into a system fit for its purpose. From the advent of the first stored-program control (SPC) switching systems in the late 1960s, software has evolved to be one of the major technologies for PNOs, both from an application and cost point of view. The integration of components into maintainable and profitable telecommunication systems serving customers' needs are today done by software. Within EURESCOM, several projects in the area of software requirements and practices address:

- harmonisation of software practices,
- software quality assurance, and
- common platforms.

Achievements To Date

EURESCOM projects produce results that are delivered for exploitation to its members, the PNOs. Many deliverables have now been generated by projects, approved by the Board of Governors and delivered to all members. The PNOs use such results according to their needs, sometimes internally, sometimes in cooperation with other PNOs. A few examples of results obtained so far by EURESCOM's activities are:

Project P104 (ISDN End-to-End Testing)

This project, which is now complete, has produced abstract test suites (ATSs) for testing ISDN–ISDN international connections, as well as testing guidelines, and guidelines for the procurement of test tools. The ISDN MoU Implementation Management Group (IMIMG) has recognised the importance of the EURESCOM results and recommends its PNOs to make use of these results. In addition, several organisations outside EURESCOM have requested access to these results. A licensing scheme is currently being finalised to allow a fair and equitable means for the owners of these results to benefit from their worldwide dissemination and exploitation. Several PNOs currently are undertaking procurement of abstract test tools which also includes the development of executable test suites (ETSs) to run the tests automatically.

Project P105 (European ATM Network Studies)

This project, which has just recently completed its work, has developed the specification of a pan-European virtual path (VP) ATM network. These specifications have been used by the European ATM Pilot Group, and a lot of press publicity was made of this fact. In addition, the project in its recent end-phase has produced the specification of the VP handling system (that is, the management of a pan-European VP network). This specification is also required for use by the ATM Pilot Group for a later phase of their implementation. The project's final deliverable specifies the functions and necessary information flows over interfaces between network operations systems and between network operations systems and customer premises installations (see Figure 3). With that focus, it ad-

Work in the telecommunication services area is concentrating on the improvement of the quality of services and the development of pan-European services.

dresses ATM pilot requirements and provides a platform for later service support by the pilot participants.

Project P107 (EURESCOM METRAN Studies)
Various technical studies have been carried out in EURESCOM on behalf of the METRAN (Managed European Transmission Network) organisation. These include the technical specifications of SDH path layer and their management.

Directory projects
Several related EURESCOM projects have studied pan-European directory services, and this has triggered the preparation for the launch of a European pilot of OSI directory services based on CCITT X.500 Recommendations.

Furthermore, many contributions to CCITT and ETSI have been prepared by several PNOs on the basis of results achieved in the EURESCOM projects; for example, on international virtual private networks, on ATM, on security requirements, on TMN, and on the service life cycle model.

Future Work Plans

The EURESCOM work programme 1994–1998 is building on the achievements of earlier work programmes. So far, about 20 EURESCOM projects have been successfully completed. With 18 existing projects which will continue after 1993, five proposed add-ons to existing projects and 12 new project proposals, there is an increasing need for coordination of projects not only within the different work areas, but in particular between work areas.

Work in the telecommunication services area is concentrating on the improvement of the quality of services and the development of pan-European services.

Work in the intelligent network area will concentrate on the harmonisation of IN architectures in Europe and on testing and dimensioning of the IN. In addition, the work on longer-term service modelling and architecture will be enhanced with studies on the service-creation environment.

In the TMN area, international standards are now emerging and the necessary preparations for implementation of TMNs will be carried out within EURESCOM. There is now a large interest for a continuation of TMN specifications for implementation of applications in the real world; that is, preparation for pan-European field trials for early introduction of TMN.

In the infrastructures and switched networks area, the emphasis in 1994 will be put on the preparation of the implementation of ATM technologies and networks and enhanced access networks (using either fibre in the loop (FITL), enhanced twisted pairs, coaxial or radio in the loop (RITL)). Also, subjects like dimensioning rules, and practical implementation issues such as powering, housing, operations and maintenance work, which need to be resolved in a short-term perspective, will be addressed.

In addition, EURESCOM has been following developments in the worldwide Telecommunications Information Networking Architecture (TINA) Consortium, which will issue its first results at the end of 1993. These results will be assessed from a European perspective and actions may be necessary to match the work done by TINA-C by a European (auxiliary) project(s).

EURESCOM has had a close working relationship with the MoU METRAN (Managed European Transmission Network), and its signatories are asking EURESCOM to continue some technical support work on more implementation-related items for the take-off of METRAN operations.

Conclusions

The most pressing demand of today for the PNOs is to improve their efficiency or productivity. There are in principle two ways to do this, namely:

- cost savings, which often means by staff reductions; and
- increased revenue without any staff increases.

Cost savings will also be achieved by implementation of results from a number of EURESCOM projects particularly in the TMN area. Unfortunately, this may mean additional investments which should be less costly because of the common use by the EURESCOM members. Staff reductions may, however, also be costly. It is therefore also an essential objective to combine cost savings with increased traffic and increased revenue. Increased traffic will be generated by:

- new services,
- increased availability, and
- increased reliability.

The EURESCOM projects and activities are supporting all these three items. If new services are developed and implemented jointly for pan-European applications, the development and implementation will be cheaper than if these tasks are performed individually. In addition, if the focus is on pan-European applications there is a higher probability of success. The additional hardware and software will also be considerably cheaper both in the network and in the terminals if the implementation is on a pan-European level.

The European research programmes of today are perhaps too much driven by the researchers and the research organisations and too little by the expected users and their required results. EURESCOM has a unique opportunity to rectify this situation and that should be a major task for the years to come. This means that the operational and commercial sides of the EURESCOM shareholders should pay increased attention to the EURESCOM projects.

The true exploitation of EURESCOM results could involve a greater role in future for the Institute; for example, maintaining and updating project results and supporting implementations. While there is currently no plan for a significant increase in the size of the EURESCOM headquarters, the Villa, which seemed to be very large in the early days, is now often very crowded, not only by the permanent staff, but by the number of project participants who need to come to Heidelberg for project meetings and seminars. At present, on the initiative of Deutsche Bundespost Telekom, construction work on an extension building and for some additional interim office space is under way.

Bibliography

General Framework for the EURESCOM Work Programmes. EURESCOM GmbH, Heidelberg, April 1993.

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Biographies

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Kevin Fogarty received a Bachelor of Engineering degree with honours in Electrical Engineering from the National University of Ireland in 1971. He then joined BT Research Laboratories in Ipswich to work on digital radio relay systems. After obtaining an M.Sc. in Telecommunication Systems from the University of Essex in 1976 he moved to the Systems Strategy department of BT. He has been involved in international standards work for data communications and ISDN since 1977. Between 1988 and 1991 he was the BT member of the Consensus Management team of RACE located in Brussels. Since the beginning of 1992 he has been employed, on secondment from BT, as the Senior Programme Manager of EURESCOM in Heidelberg, Germany, with overall responsibility for the technical work of EURESCOM.

Kurt Katzeff
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Kurt Katzeff was born in Stockholm, Sweden. He obtained a Master's Degree in Electrical Engineering at the Royal University of Technology, Stockholm, in 1950, after which he joined Ericsson. By 1972, he had risen to Chief Engineer and Director of the Technical Department of the Telephone Exchange Division. From 1972 until 1980 he worked in Brussels with ITT Europe and was Technical Director of Switching, and later, of Telecommunications. Kurt joined Swedish Telecom in 1980 and, three years later, was promoted to Chief Scientist and Head of the Technology Department where he remained until his appointment in 1991 as Director of EURESCOM GmbH, in Heidelberg.

Keith Williams and Bryan Law

ISDN Access Signalling

This article, another in a series in the Journal on international standards for ISDN, provides an overview of the signalling used by terminals in accessing the ISDN network. The article considers the operation of the ISDN access signalling system to control basic circuit switched calls as well as supplementary services and reviews the emerging conformance and testing standards for the signalling system. Looking beyond narrowband ISDN, the article concludes with a review of the access signalling standards for broadband ISDN which are currently under development.

Technical Overview of ISDN Access Signalling

The network capabilities of the integrated service digital network (ISDN) can be divided into static and dynamic functions. The information flows associated with the user–network signalling represent one aspect of the dynamic interactions of the ISDN, and are modelled in accordance with the ISDN Protocol Reference Model. The model is based along the general principles of Open Systems Interconnection (OSI), but brings out clearly the dual perspectives of user and control information flows. Figure 1 shows the Protocol Reference Model within the context of the user–network interface. Highlighted in the figure are the areas associated with the standardisation of the user–network signalling system.

Layer 3 of the signalling system is detailed in CCITT Recommendations I.450 and I.451 (also called Q.930 and Q.931), which describe the message and procedures associated with call control of circuit switched connections, the provision of user-to-user information transfer and the handling of packet communication. In this review of the signalling system, the principle elements involved in call establishment, call clearing and user-to-user information transfer are briefly considered.

Recommendations I.440 and I.441 (also called Q.920 and Q.921) describe layer 2 of the signalling system, which is known as *LAP D* (link access protocol on the D-channel). LAP D provides for the reliable delivery of the layer 3 signalling messages, and is built up from elements of procedure associated with high-level data link control (HDLC). The resulting procedures are very close to those used in X.25 packet networks using LAP B (link access protocol—balanced) but they provide both unacknowledged and acknowledged data transfer services. In addition, LAP D enables multiplexed data link connections for signalling and other purposes (for example, packet switched data) to be simultaneously established over both point-to-point and point-to-multipoint configurations.

Only layers 2 and 3 are common to all types of ISDN access as the layer 1 aspects of the signalling system describe the procedural, mechanical and electrical characteristics of the interface. Recommendation I.430 describes the layer 1 characteristices of the basic-rate access, and I.431 the primary-rate access. The interface standard for the latter is based on the existing primary-rate pulse-code modulation (PCM) structure used in the public switched telephone network. Recommendation I.430, on the other hand, is a new standard based around the concept of a 'passive bus'.

Further information is given in the following sub-sections.

Layer 1 for basic access (I.430)

The passive bus enables a group of terminals to be easily and effectively connected to an ISDN. The bus allows up to eight terminals to share the two 64 kbit/s B-channels of the basic-rate access, by negotiation for their use during call establishment. The D-channel, though, is always shared and its possible simultaneous use by two or more terminals is catered for through the use of a D-echo channel in order to detect collisions (see Figure 2). Each terminal accessing the D-channel must monitor the D-channel and 'back off' if the echoed signal deviates from its own previous transmission. Terminals which have lost the contention for the D-channel must wait for a period of inactivity before re-attempting to use the channel.

The line coding employs alternate mark (pulse) inversion (AMI), with

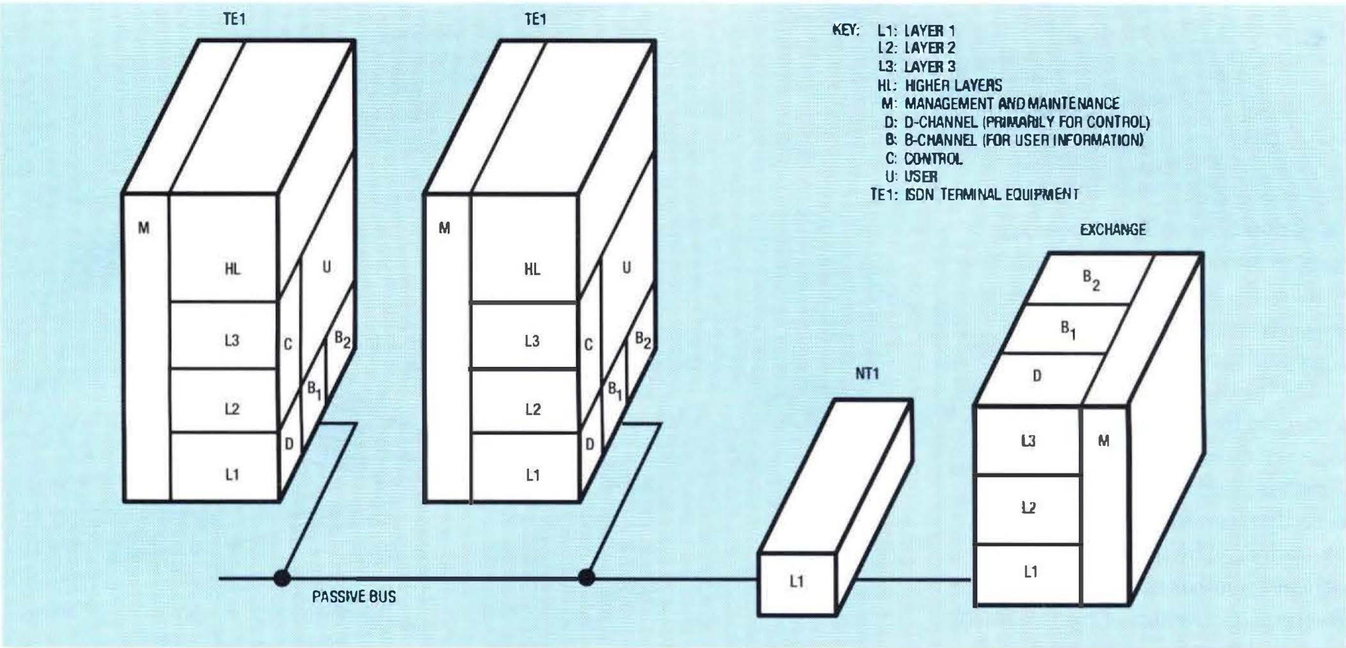


Figure 1—Protocol Reference Model

the binary ones encoded as high impedances and the binary zeros as alternating full-width pulses. Violations of the coding mark the beginning and end of the layer 1 frames which are used to carry the B- and D-channel data across the user–network interface. The physical connection across the interface consists of eight wires, two balanced pairs being used for transmission of the layer 1 signals to and from the network and the remaining two pairs for optional power feeding. Power feeding over the transmit and receive pairs (that is, phantom powering) is also possible.

Figure 2—D-echo channel collision detection

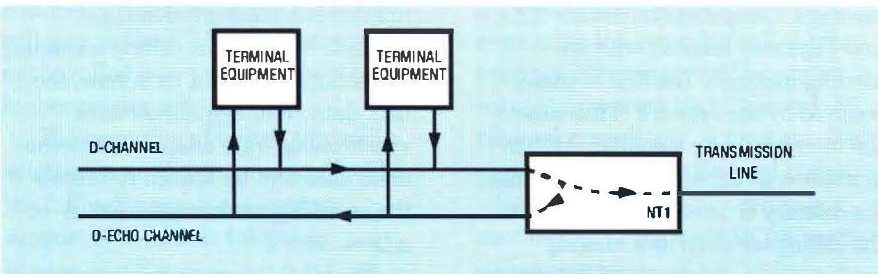
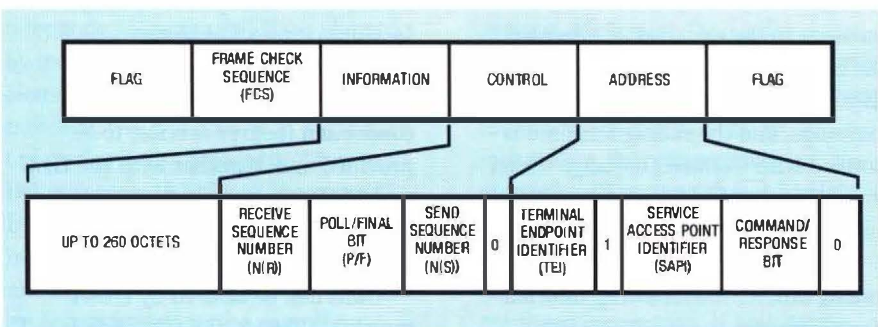


Figure 3—Layer 2 information frames



An activation/deactivation mechanism is also specified so that when there is no traffic on the ISDN access, the exchange may power down the basic access into a monitoring mode and save exchange power.

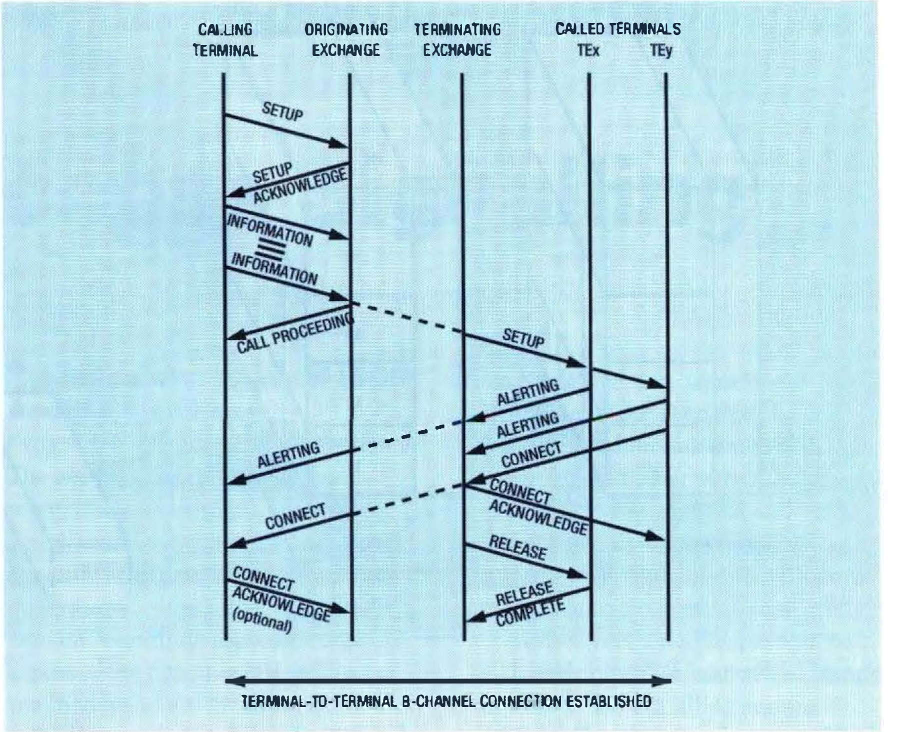
Layer 1 primary-rate access (I.431)

The primary-rate ISDN access is based on existing primary-rate PCM multiplex structures, and therefore reflects the two alternative international standards for this structure, 2·048 and 1·544 Mbit/s. In Europe, the 2·048 Mbit/s is used to provide 30 B-channels (time-slots 1–15 and 17–31) and one D-channel (time-slot 16) all operating at 64 kbit/s, while in North America the 1·544 Mbit/s system is used to give either 23 B-channels and one D-channel, or 24 channels. In the case of the latter, the signalling information is transported on the D-channel of a parallel access. The primary-rate access is permanently activated and operates in a point-to-point manner, and therefore has no requirement for activiation/deactivation procedures or D-channel contention resolution.

Layer 2 (I.440/1; also called Q.920/1)

Layer 3 messages are transferred between the user and network signalling entities in layer 2 information frames (see Figure 3) within the D-channel. Each frame is bounded by flags and contains an address field, control field, information field and frame check sequence (FCS). To meet the requirements of the point-to-multipoint configuration of the passive bus, it is necessary to multiplex over the D-channel unique data link connections between the network and each of the terminals. This is achieved by using a different terminal endpoint identifier (TEI) value within the layer 2 frame address field. In addition, each received frame is further routed within each terminal by the service access point identifier (SAPI), which selects one out of a possible range of layer 3 destinations;

Figure 4—Overlap sending



for example, signalling or management. A single TEI value, recognised by all of the terminals connected to the passive bus, is reserved for broadcast communications.

The in-sequence delivery of frames is ensured by the use of the N(S) sequence number in the control field of each information frame. Each correctly-received frame is then acknowledged by the use of the N(R) sequence number carried by frames in the opposite direction of transmission. Corrupted frames are detected by the FCS and are discarded. If no acknowledgement is received for a frame, error recovery procedures are invoked which make use of the P/F bit to determine whether it was the information frame or its acknowledgement that had been lost. If it was the information frame, it is retransmitted. LAP D also provides an unacknowledged data transfer service for use on the broadcast data link connection, which does not provide any form of error recovery mechanism.

Layer 3 (I.450/1; also called Q.930/1)

The first step in setting up a call across the ISDN is the transmission to the originating exchange of a *setup* message, which contains information in the following four broad categories: address, basic service requirements, supplementary service requirements, and access channel selection. The address information may be carried *en bloc* within the *setup* message, or delivered progressively 'overlap' in subsequent *information* messages.

Overlap sending is initiated by the originating exchange, through the transmission of a *setup acknowledge* message, when insufficient information is received in the *setup* message to allow call delivery. This is portrayed in Figure 4. The *setup acknowledge* message will also complete the local access channel selection to allow the provision of dial tone when appropriate. When the local exchange has received sufficient information to route the call, it returns a *call proceeding* message. The initial *setup* message contains the basic service requirements of the call, this being one aspect in the definition of a telecommunications service. The other aspect, the supplementary service requirements, can be included within both call control messages and specialised facility messages.

In the case of call delivery to a basic access, the exchange will broadcast a *setup* message to all of the connected terminals using the broadcast data link connection at layer 2. Terminal compatibility is established from the basic service requirement information provided within the incoming *setup* message. Compatible terminals (TEx and TEy) may respond with an *alerting* message. The first of these received by the network (TEx) causes the inter-exchange signalling system to initiate, at the originating exchange, the delivery of an *alerting* message to the calling terminal as a 'ringing' indication. To answer the call, terminals transmit a *connect* message to the terminating exchange. The first terminal (TEy) to send a connect message to the exchange is allocated the call. The successful call 'pick up' is then relayed back to the originating exchange, and the calling terminal is notified with a *connect* message which it may respond to with a *connect acknowledge*.

The *setup* message includes, among others, the following information elements:

- bearer capability (BC),
- low-layer compatibility (LLC),
- high-layer compatibility (HLC).

The BC identifies the bearer service requested to be provided by the network; for example, speech, 3·1 kHz audio, 64 kbit/s unrestricted data.

The LLC is used to provide a means of compatibility checking for an addressed entity (for example, a remote user, an interworking unit or a high-layer function network node addressed by a calling user). The LLC information element identifies characteristics of the calling terminal; for example, for data terminals, the user data rate, asynchronous or synchronous, rate adaptation mechanism used and for speech terminals the encoding mechanism used (A- or μ-law).

The HLC information element is also used to carry out compatibility checking and identifies the service to be used; for example, telephony, facsimile group 4 or telex.

Hence, the BC is used by the network to determine the type of connection (bearer service) to be provided and, together with the HLC and LLC information elements, is used by the called terminal for terminal compatibility checking.

Calls can be cleared by either terminal through the transmission of

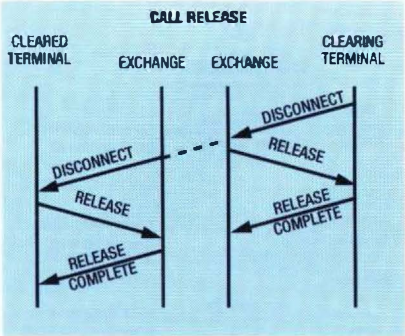


Figure 5—Transmission of a discon-nect *message*

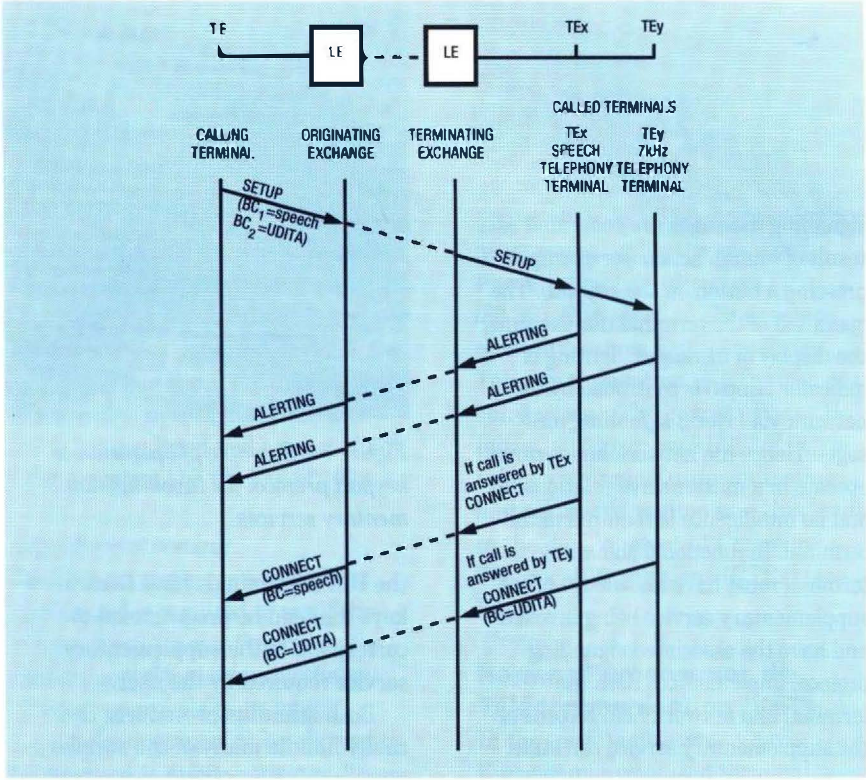


Figure 6—Call offering in the case of 7 kHz telephony with 'fallback' allowed

a *disconnect* message (see Figure 5). The receipt of the *disconnect* message initiates the clearance of the transmission path across the network. Clearance of the transmission path causes the distant exchange and terminal to also enter into a *disconnect*, *release* sequence. In both cases, the *release complete* message is used to confirm the release and complete the message exchange.

Enhancements to call establishment procedures

Enhancements to the basic call establishment procedures, as exemplified in Figure 4, have been specified to allow negotiation of bearer capability and high layer compatibility. These additional features are used to support services such as 7 kHz telephony and videotelephony. For these services, the originating user may indicate the desired service (for example, 7 kHz telephony or videotelephony) and an alternative (normal 3·1 kHz bandwidth telephony) service to which the call may 'fall back' if either the network or the called user cannot support the higher-prority service.

The operation of bearer capability selection procedures is exemplified by the fallback procedures used in support of the 7 kHz telephony service. See Figure 6.

The calling 7 kHz telephony terminal indicates that fallback and interworking with the public switched telephone network (PSTN) is allowed by including 2 BC information elements in the outgoing *setup* message; the BCs will be in ascending order of priority. Hence the first BC_1 = speech, G.711 and the second BC_2 = 64 kbit/s unrestricted digital information with tones/announcements (UDITA), G.722/G.725. This is an enhancement to the signalling procedures since previously only one BC was allowed in the *setup* message.

The procedure at the called side is illustrated in Figure 6. At the called side, the *setup* message containing the two BCs is broadcast to all terminals on the passive bus. Existing speech (3·1 kHz) terminals, which only expect to receive a single BC in the incoming *setup* message, will ignore the second BC and process only the first BC. Hence, provided the remaining contents of the *setup* message is compatible with the terminal, the 3·1 kHz telephony terminal will respond to the incoming call. 7 kHz telephony terminals will be implemented to process both BCs and respond accordingly. A further enhancement to the protocol is that when an incoming *setup* message contains more than one BC, a terminal answering a call will include in the *connect* message the BC accepted by the terminal unless it is a terminal with an earlier version of the layer 3 protocol. Hence for the 7 kHz telephony terminal, the terminal will include BC = UDITA, G.722/G.725 in the *connect* message. If no BC is included in the *connect* message, the network will assume that 3·1 kHz telephony is required. In either case, the *connect* message to the calling terminal will contain the BC of the resultant connection. If both terminals are answered simultaneously, the network will allocate the call to the terminal from which the *connect* message is received first.

Supplementary Services

Development of access protocols for supplementary services

It was considered that in order to make ISDN an attractive service offering to users, it must support many supplementary services, particularly those that are typically available on PABXs and private networks today. Hence many man-years of effort have been expended in the last four years in the international standards fora to specify all the standards that are necessary to implement ISDN supplementary services on an international basis.

For the user–network interface, two types of generic layer 3 signalling protocols have been specified for the control of supplementary services, namely *functional* and *stimulus signalling* procedures.

In stimulus signalling procedures, the terminal is not required to have any knowledge of the supplementary service being invoked. No records of the supplementary service call state are held by the terminal and layer 3 signalling messages are generated as a result of human action (for example, pressing a button on the keypad). The operation of the terminal (for example, the display of messages, lighting of indicator lamps) is controlled by the network via layer 3 signalling messages. Hence the network and terminal operate in a master/slave relationship and no intelligence is required in the terminal. In functional signalling, the terminal must have knowledge of the supplementary service being invoked and have the associated signalling protocol implemented. Both the terminal and network hold records of the supplementary service call state.

Stimulus signalling for supplementary services

Two types of stimulus procedures are defined: the keypad protocol and the feature key management. Both stimulus procedures use the basic call control layer 3 messages, particularly the *information* message, as the transport mechanism for conveying the stimulus information between the terminal and the network. In the keypad protocol, the user invokes a supplementary service by keying in the appropriate sequence of digits delimited by '*' and '#' in the same manner as current BT Star Services (see Figure 7). Only the generic procedure has been specified and the sequence of '*', '#' and digits for any given supplementary service is network dependent.

The feature key management protocol requires the network to hold a terminal or service profile for a given terminal. A given supplementary service is allocated a feature number and is invoked by the terminal signalling that feature number to the network; for example, a pre-programmed key on the terminal marked CALL TRANSFER will generate an information message containing Feature Activation No. 3, which corresponds to the call transfer supplementary service in the service profile held for that terminal in the local exchange (see Figure 8). This mechanism is very similar to that currently offered on PABXs, where the PABX terminals have feature keys that can be programmed to correspond to the supplementary service required by the user.

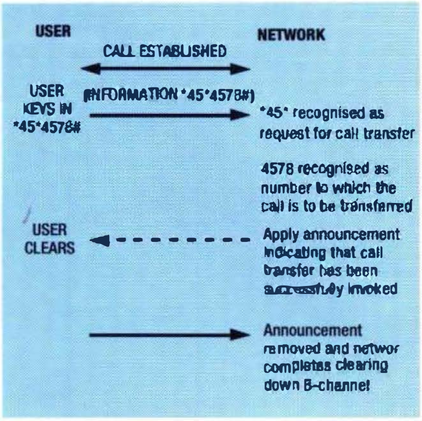


Figure 7—Example of operation of keypad protocol for invoking supplementary services

Both stimulus procedures can easily handle many of the supplementary services involving only a single call, but are unsuitable for those supplementary services involving more than one call; for example, conference calls. In addition, it was considered desirable that for integrated services PBXs (ISPBXs), the same generic protocol could be used whether the ISPBX was operating to a public network or direct to another ISPBX in a private network configuration. In order to meet these requirements, it was necessary to define a functional protocol, and it is the functional protocol which has been specified not only as a generic protocol but also for each ISDN supplementary service defined by the CCITT. Hence it is intended that the functional protocol is specified in detail for all CCITT/ETSI defined ISDN supplementary services and the stimulus protocol will be used either for an early introduction of these supplementary services or for the control of network or manufacturer specified supplementary services (that is, non-CCITT/ETSI defined services).

Functional signalling for supplementary services

The functional protocol is based on using the facility information element, which is conveyed in the basic call control messages if the supplementary service is invoked during either call establishment or call clearing and in the *facility* message otherwise. For the control of supplementary services which are independent of an active call, the *register* message is used to convey the facility information element. In addition, specific layer 3 messages have been defined for the function of holding and retrieving a call.

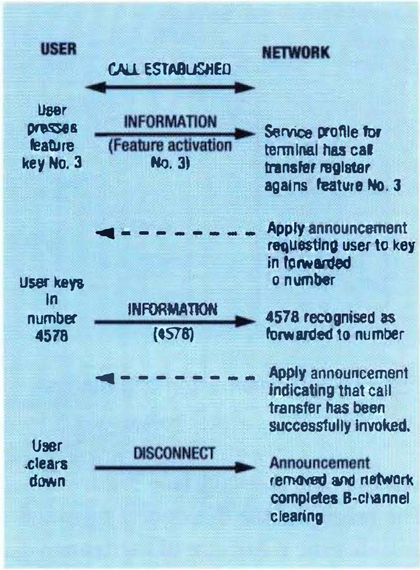


Figure 8—Example of operation of feature key management protocol for invoking supplementary services

The protocol applicable to the supplementary service information contained in the facility information element is based on the ROSE (remote operations service element) protocol. The ROSE protocol is used to support applications where interactive control of objects is required in an open systems environment. The full specification of the range of services provided by the ROSE protocol is defined in CCITT Recommendation X.219, and the ROSE protocol is defined in CCITT Recommendation X.229.

The ROSE protocol is used in the context of the ISDN functional supplementary services to control functional entities (application processes) within networks (either local or remote to the user). The ROSE protocol was seen as appropriate for use in the context of the supplementary services since the following operations are required in the control of supplementary services and these are provided by the ROSE protocol:

- initiation of the service process;
- confirmation response (either positive or negative); and
- further control after initiation.

The ROSE procedures specified in CCITT Recommendation X.229 is self-contained in that it contains two methods for transportation of the ROSE application protocol data units (APDUs). However, for the purpose of supplementary service control over the user–network interface, the ROSE APDUs are transported within the facility information element within one of the layer 3 signalling messages as described above. Hence some simplification of the full ROSE protocol has been possible.

Table 1 lists the ISDN supplementary services specified using the functional protocol.

Terminals

Terminal equipment testing

Two types of testing are associated with terminal equipment, namely

- conformance testing, and
- attachment testing.

Conformance testing

Conformance testing is testing the terminal implementation against the standards to which is was designed to see if the implementation conforms to those standards. Conformance testing is testing the quality of the implementation and should test the terminal against every aspect of the standard(s) to which it is designed. International standards for conformance testing of the D-channel signalling protocol in terminal equipment are being produced and are expected to be completed by the end of 1993.

Table 1 ISDN Supplementary Services

Advice of charge
Call deflection
Call forwarding busy
Call forwarding no reply
Call forwarding unconditional
Calling line identification presentation
Calling line identification restriction
Completion of calls to busy subscribers
Conference call, add-on
Connected line identification presentation
Connected line identification restriction
Closed users group
Call waiting
Direct dialling in
Freephone
Malicious call identification
Meet-me conference
Multiple subscriber number
Sub-addressing
Terminal portability
Three-party service
User-to-user signalling

Attachment testing

Attachment testing is a regulatory matter and is required to see if the terminal implementation meets the requirements, laid down by the relevant approvals body, which terminals must meet to be allowed to be attached to public networks. These attachment tests in general form a subset of the conformance tests.

The requirements for attachment testing vary for country to country. For example:

- In the USA, attachment testing only requires that the terminal is electrically safe; that is, it does not generate any potentially harmful voltages or currents on to the network, and there are no requirements for the terminal to actually work. Third-party testing is not required and a system of self-certification operates.
- In Europe, prior to the European Community's initiatives in this area, each country had its own test requirements and testing houses and, in general, in addition to electrical safety, some degree of testing to ensure that the terminal could make and receive calls was carried out.

The Commission of the European Community's (CEC's) initiative on free trade and telecommunications harmonisation in Europe firstly aimed to harmonise the test requirements and have recognition of the test results by the approvals body in each European country (that is, the terminal equipment would be tested only once and the test results would be accepted by each national approvals body). This harmonisation programme under the so-called Phase I directive (directive /86/361/EEC) lead to the development of Normes Européenes de Télécommunication (NETs) (see next sub-section). The current Phase II initiative (directive 91/263/EEC) is to have a single European testing and approvals regime and this leads to the development of Common Technical Regulations (CTRs) (see later).

Normes Européennes de Télécommunication (NET)

In the initial initiative to have European harmonised terminal attachment requirements, European countries agreed to harmonise their terminal equipment attachment approval requirements and tests. These harmonised requirements and tests are specified in European standards (Normes Européennes de Télécommunication (NETs)). There are two types of NET: *access* NET and *terminal* NET. An access NET is intended to cover the requirements for attachment of any type of terminal to a given network and the requirements are aimed to ensure that the terminal does not harm the network and that it can interwork with the network for establishing, controlling and clearing a basic call. A terminal NET is intended to be applied to regulated services (for example, telephony) to ensure end-to-end compatibility. A terminal NET specifies requirements which are in addition to the appropriate access NET.

Tables 1 and 2 identify the NETS required for the ISDN.

Common Technical Regulations (CTRs)

CTRs will replace NETs in the telecommunications terminal equipment arena. They are established under EC Directive 91/263/EEC (Phase II directive) and provide one-stop approvals for Europe (NETs only covered test results, and approvals were the prerogative of each national administration). The purpose of the directive is to harmonise conditions for placing telecommunication equipment on the market. This will establish a single European market for equipment approved to a CTR, as well as giving legal simplification and technical opportunity. Approval to CTRs by any national authority will apply across Europe. EFTA countries via the *Statement of Intent on CTRs* will also apply (and therefore accept apparatus so approved).

The Phase II directive called for CTRs to replace NETs by 6 November 1992. The study to convert approved and draft NETs into CTRs failed to be completed by 6 November 1992 and hence it has been agreed that approved NETs will remain in force until the equivalent CTR has been approved. For ISDN, the CTRs will be available this year.

Table 2 Access NETs

	Title	Status	Application/ End of Transition Period Dates of NET	CTR Replacement
NET 3	Attachment approval requirements for connection of terminal equipment to ISDN basic access (Part 1 for layers1 and 2, and Part 2 for layer 3 requirements)	Approved (Part 1, revised version, Oct. 92; Part 2, July 91)	App. date: 16 Oct. 92 tran. per. ends: 31 Dec. 93*	CTR 3
NET 5	Attachment approval requirements for connection of terminal equipment to ISDN primary-rate access	Approved: Oct. 92	App. date: 16 Oct. 92 tran. per. ends: 31 Dec. 93*	CTR 4
NET 7	X.20 *bis*, X.21 and X.21 *bis* ISDN terminal adaptor attachment requirements	Standard finalised but not approved. Standard will not be adpoted as NET	---	---

* Recognising that there are early implementations of non-standard ISDNs existing, national standards for terminal attachment to these ISDNs may exist up to the end of 1995

Table 3 Terminal NETs

	Title	Status	Application/ End of Transition Period Dates of NET	CTR Replacement
NET 33	Attachment requirements for ISDN telephony	Approved Dec. 90	App. date: 1 Apr. 92 tran. per. ends: 31 Mar. 93	CTR 8

Future Development of Access Signalling Standards for Broadband ISDN

What is Broadband ISDN (B-ISDN)?

While the narrowband ISDN (N-ISDN) provides the user with the capability of using a multiplicity of services on a single network access, there are finite limits to the scope of these services. Although studies have enabled $n \times 64$ kbit/s to be offered, and further work is set to produce a more flexible application of $n \times 64$ kbit/s during a call, the service that can be offered will be limited by a maximum bandwidth of 2 Mbit/s. To provide a greater bandwidth and achieve the required synchronisation, a move away from a 64 bit/s switched plesiochronous network is required.

To achieve this, the asynchronous transfer mode (ATM) is used. With this technique, circuits are virtual circuits comprising ATM cells rather than time-slots. Each cell has a header which identifies the virtual circuit to which it belongs plus a payload carrying the information to be conveyed. Hence at the switching nodes the cells are switched in accordance with information in the header rather than on the basis of the time-slot concerned. This technique not only allows bandwidths in excess of 2 Mbit/s to be switched but also allows a more flexible allocation of resources, other than in modules of 64 kbit/s, to be provided. A network of this nature will allow services such as wideband area network interconnect, high-bandwidth data, high-definition video services (distribution as well point-to-point and conference), transmission of high-definition medical reprographics (X-ray transfer) and computer-aided design information to be freely and flexibly transfered across a switched public network. In addition, services such as those already carried in the N-ISDN will be supported giving the user the opportunity of accessing a wide range of services on one network.

Although the ATM technique is used at the switching level, the actual cells can be carried in the frame of a synchronised digital hierarchy (SDH) transmission system as well as on an ATM system. It is almost certain that any initial service will use the SDH transmission capability and bandwidth offered at the access will be 155 Mbit/s. A move to increase this to 600 Mbit/s will probably depend on optical-fibre access being available.

Therefore, the ATM switched network and access provides the B-ISDN as currently being studied by the international standards bodies.

Why N-ISDN signalling cannot be used

The N-ISDN standards have been studied for a considerable number of years and are now reaching a degree of stability and maturity. Therefore, it would seem that they would provide a perfect platform for developing signalling standards for the B-ISDN and initial studies did investigate taking this path. However, the access signalling system, Digital Subscriber Signalling System No. 1 (DSS 1) and its network counterpart Signalling System No. 7 ISDN user part (SS No. 7 ISDN-UP) are based on the need to control services using a 64 kbit/s network and a basic access of 144 kbit/s or primary-rate access of 2 Mbit/s. Because of this, the changes required would be considerable. In addition, both these existing mechanisms were also being enhanced to support fully the N-ISDN services about to be offered by BT and other worldwide operators on their networks and the incorporation of the B-ISDN requirements would have delayed and confused this process. For these reasons it was decided that new standards should be produced for the support of B-ISDN. For B-ISDN access signalling, this is now known as *Digital Subscriber Signalling System No. 2* (DSS 2).

The situation was further complicated, however, by a number of participants in the international standards bodies, identifying an early requirement for the support of the initial set of B-ISDN services, known as the *Release 1* services. Since these services were providing a bearer established and released simultaneously with the call, the short time-scale available could be met only by basing the new standard for the support of Release 1 services on the existing N-ISDN standards (Q.931 and ISDN-UP Q.76x recommendations). Hence for the access, the draft standard Q.2931 (formerly Q.93B) (for Release 1) can be clearly identified as a derivative of Q.931.

Metasignalling

To maintain the flexibility of resource utilisation on the B-ISDN user network interface, unlike the N-ISDN there is no permanent signalling channel. Instead a simple protocol using a low-bandwidth channel controls the allocation of signalling virtual channels to the terminating equipment when demanded by the end user. This protocol specified in Recommendation Q.2120 is *metasignalling*. Metasignalling is considered to be located in the ATM layer management (see Figure 10, later).

Signalling AAL

Because of the cellular nature of the ATM transport mechanism, there is a requirement for a mechanism to match the characteristics of the service being supported by the ATM network to this structure. This is achieved by means of the ATM adaptation layer (AAL). This applies not only to the user plane but also to the control plane where the signalling AAL (SAAL) not only carries out this function but also incorporates the normal layer 2 functions of the access and internodal control mechanisms.

The SAAL comprises:

- *Common part*—providing basic AAL functions, using a standard AAL type. The common part for the SAAL is provided by the AAL type 5 (specified in I.363 by SG 13), which while providing the segmentation and reassembly (SAR) functions, common part convergeance sublayer (CPCS) providing transparent signalling data unit transport between layers and a powerful 32 bit CRC, adds no further overhead.

- *Service specific connection oriented protocol* (SSCOP)—providing the generic layer 2 functions. SSCOP is a new protocol which gives assured data transfer.

- *Signalling specific coordination function* (SSCF)—providing the special requirements at layer 2 for matching to user–network interface (UNI) or network node interface (NNI) layer 3 as appropriate. The SSCF for the access provides a mapping function between the SSCOP and a specific layer 3 to ensure that the service provided by the SAAL affords similar functions to those provided by Q.921 for N-ISDN layer 2. (For the NNI, the matching enables a similar service to SS No. 7 message transfer part level 2.

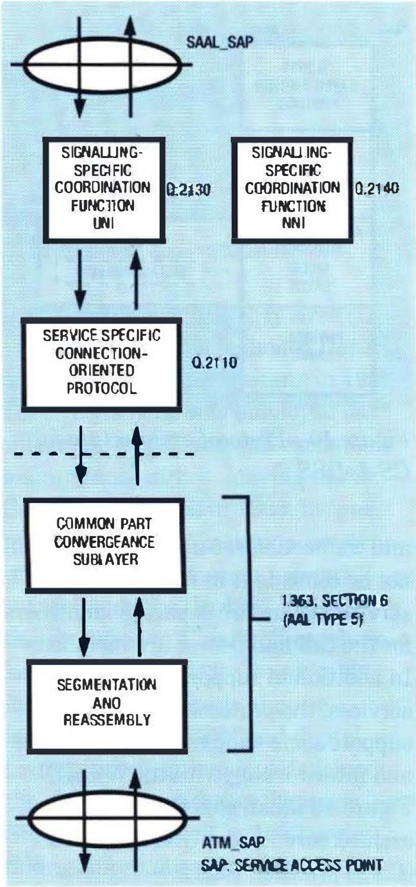


Figure 9—Architecture of signalling AAL

The structure of the AAL for signalling applications is given in Figure 9.

B-ISDN layer 3 signalling

As stated earlier, to meet the short time-scale for supporting Release 1 services in certain networks, the initial signalling mechanisms are based very closely on their N-ISDN counterparts. For this reason, Q.2931, the layer 3 access protocol, is based very closely on the Q.931 (1992 version), but is not an identical protocol and has a different protocol discriminator. The special requirements of supporting bearer connections in an ATM environment of virtual channels and virtual paths is met by the inclusion of ATM traffic descriptors dealing with such attributes as ATM user cell rate and AAL parameters etc. In addition, a degree of forward proofing is contained by using compatibility mechanisms based on instruction indicators. Note is also taken of the fact that call

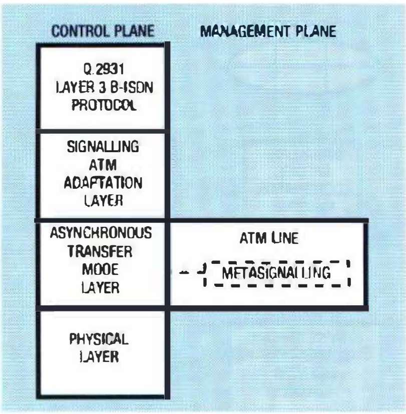


Figure 10—Protocol architecture for CS-1, DSS 2

and connection set-up and release will not be coincident in future advanced services, therefore separate identifiers for the call and bearer are included. In addition to supporting B-ISDN services, the protocol also has to support some supplementary services and interworking with the N-ISDN. Figure 10 illustrates the protocol architecture for the UNI Release 1 (CS-1) protocol, DSS 2.

While work on the Release 1 or Capability Set 1 (CS-1) protocol is nearly complete, studies are about to start on the CS-2 protocol. This again, on the access, will take Q.2931 as the core for simultaneous call/bearer control. However, for sequential call/bearer control when parties/connections may be added or released during the duration of a call, the possibility of using ROSE-based mechanisms as adjuncts to the basic core, is being studied. A series of concepts based on the OSI application layer service has been investigated in both CCITT and ETSI resulting in the documentation of the ISCP (integrated services control part) and BAP (broadband application part). Both have provided useful architecture studies for the NNI and UNI B-ISDN protocols. Further studies for the CS-2 and beyond protocols will take account of these architecture studies and should lead to a flexible mechanism with high evolutionary potential. Furthermore the architecture used to specify the intelligent network application part (INAP) is also based on OSI application layer principles. BT is seeking as close an alignment as possible of future studies of the IN and B-ISDN protocols. Not only will this prevent a proliferation of protocols in the network but will be necessary if the advanced services identified as potential users of the B-ISDN are to be realised.

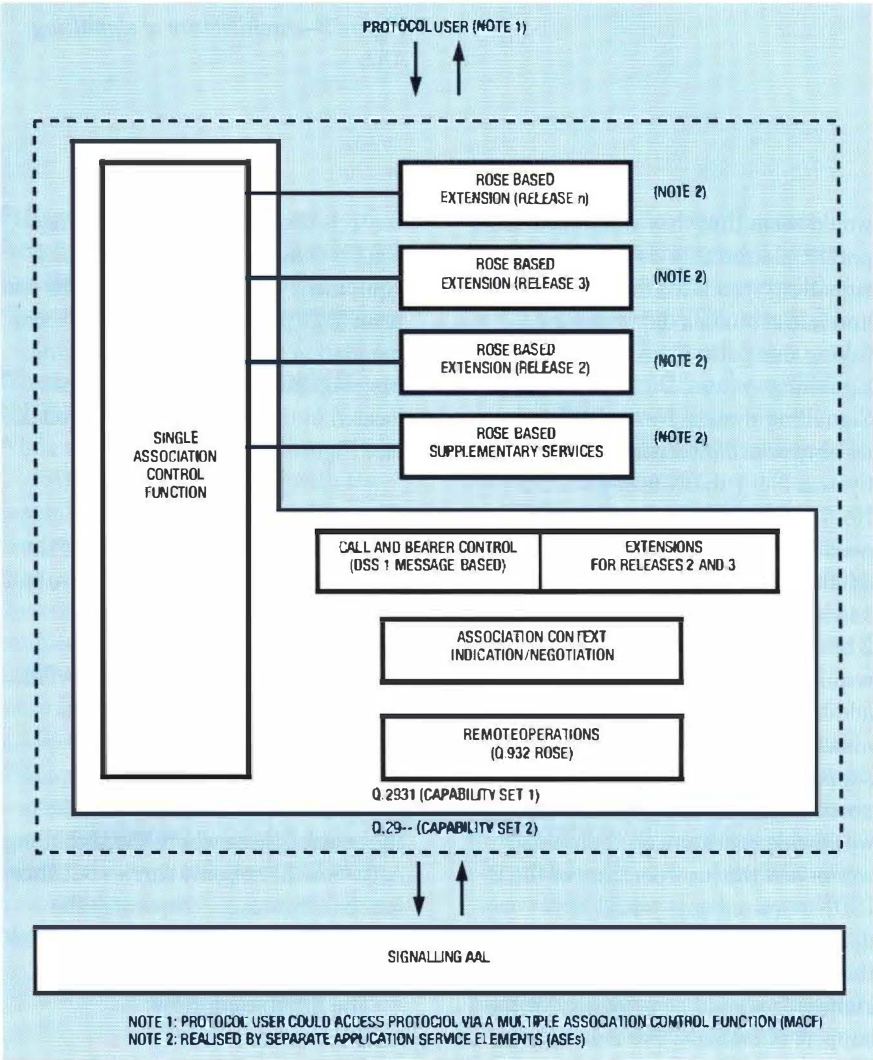


Figure 11—Possible protocol architecture for B-ISDN CS-2 signalling

A possible architecture for the CS-2 access protocol based on the principles described above is given in Figure 11.

Timetable for production of standards

Due to the pace of technological change, specification of broadband services and the necessary network requirements to support them have been released in phases. These releases, referred to earlier, have been studied and delivered by the standards body responsible, CCITT SG XVIII (now ITU-TS SG 13). At present Releases 1 and 2 have been passed to SG 11 (the standards body responsible) for commencement of the stage 2 and 3 studies. The stage 2 work involves the identification of signalling requirements, production of the functional model and information flows to support these requirements. The stage 3 work builds on the stage 2 studies and involves the specification of the detailed signalling protocol to realise the signalling requirements.

Release 1 mainly provides for point-to-point simple bearer services. The supporting recommendations for the access are:

- Layer 2—Q.2100, 2110 and 2130, completed December 1993 for acceptance by ITU-TS SG 11, 1994. This recommendation is expected to support all future releases of B-ISDN layer 3 signalling.

- Layer 3—Q.2931, completed December 1993 for acceptance by ITU-TS SG 11, 1994.

- Metasignalling—Q.2120 due for completion and acceptance by ITU-TS SG 11, 1994.

Release 2 provides for point-to-multipoint and multipoint-to-point services and multiple bearer services in addition to Release 1 services. Support of virtual path switching at ATM cross-connects and the interface with the IN is also included in Release 2. The supporting recommendations for Release 2 on the access are being introduced in a stepwise approach of capability sets. CS-2 work has been considered and the content now finalised to cover point-to-multipoint, multiconnection (point-to-point) services and negotiation/renegotiation of traffic characteristics. Current completion for the enhanced layer protocol, as discussed earlier, is scheduled for post 1994. The metasignalling and SAAL protocols produced for Release 1 will be used to support CS-2 layer 3 and future protocols.

Release 3 is being finalised in SG 13 and will introduce multiparty multimedia calls in addition to the existing Release 1 and 2 requirements. The expected date for delivery to SG 11 is early 1994; therefore protocol studies will probably not be finalised until 1995/6. Later releases will probably cover interactive and distributive services based on the network capabilities required for Releases 1–3. Hence the need for a flexible signalling mechanism capable of evolution on the access.

Standardisation work in ETSI is mapping the broadband activity in ITU-TS SG 11. Although ETSI has more frequent meetings and the Release 1 standards may be ready for approval slightly in advance of SG 1, it has been agreed that the B-ISDN ETSs will only be submitted for approval when SG 11 has agreed the equivalent draft Q. series recommendations.

References

1 CLARKE, PETER G. ISDN Standards: An Overview. *Br. Telecommun. Eng.*, Apr. 1993, **12**, p. 47.

2 BIMPSON, ALAN. Standardisation of Services for the ISDN. *ibid.*, Apr. 1993, **12**, p. 56.

3 KENT, TREVOR. Standards for ISDN Architecture. *ibid.*, July 1993, **12**, p. 114.

Biographies

Keith Williams
BT Development and Procurement

Keith Williams joined the British Post Office London North Area as an apprentice in 1963 and following on from this specialised in Strowger exchange maintenance. In 1973, he transferred to Post Office Telecommunications Headquarters and became involved with the evaluation of attachments to telecommunication services. Initially, this work involved attachments to PABXs but later also included attachments to private circuits and the public switched telephone network. Following on from this he developed a specialism in the safety aspects of attachments and for several years headed a team assessing equipment for safety approval purposes. During the period when the British Standards for attachments were evolving he acted as a safety consultant to suppliers of attachments. In 1992 he transferred to work on the negotiation of ISDN signalling standards and currently works in the Core Technology and Standards department of BT Development and Procurement.

Bryan Law
BT Development and Procurement

Bryan Law joined the City Area (LTR) of the Post Office Telephones Department as a Youth-in-Training in 1958. For five years he was employed on subscriber apparatus and exchange maintenance duties. Moving to the Centre Area (LTR) in 1963, he was involved in repeater station construction work and television network switching duties. In 1967 he joined the Engineer-in-Chief's office where he was responsible for trunk cable installation standards and the commisioning of FDM and digital transmission equipment. He joined the Telecommunication Strategic Studies department in 1980 undertaking information flow studies for System X and then the specification of CCITT SS No. 7 for the BT network. During this period, he represented BT at the international standards meetings responsible for the study of CCITT SS No. 7. He joined his present group in 1989 to work on the RACE project studying access signalling for the support of B-ISDN. He currently represents BT in ETSI and ITU-TS studies of B-ISDN signalling and N-ISDN access signalling and is responsible for coordinating BT activity in the area of B-ISDN signalling standards.

Mike Parry

32nd European Telecommunications Congress

This article reports on the 32nd European Telecommunications Congress, held in Antwerp, Belgium, from 30 August to 4 September 1993, organised by the Federation of Telecommunications Engineers of the European Community (FITCE).

Introduction

The 1993 annual congress of the Federation of Telecommunications Engineers of the European Community (FITCE) was hosted by the Belgacom Association of Engineers BITT/UPITT under the chairmanship of Ir. A Hendrickx, Director General, Switching Department, Belgacom.

Antwerp, the Cultural Capital of Europe, 1993, was the host city to the fourth Congress to be held in Belgium since the first Congress in 1962—1967 and 1973 in Brussels and 1980 in Liege. At the administrative heart of Europe, Antwerp was an ideal location being a gateway and distribution centre for northern Europe linked to a history spanning six centuries of communication through its impressive harbour complex.

The theme of the Congress—'Broadband Networks and Services in the Europe of Tomorrow and the Impact on Residential and Business Users'—attracted over 600 attendees. An impressive number of papers were submitted to the Papers Selection Committee under the chairmanship of Andy Valdar, BT, and 30 were selected for presentation. It was particularly encouraging to welcome an enthusiastic delegation from the Czech Republic and a well-informed delegate from Israel.

Opening Ceremony

The Congress opened at the Zoo's Congress Centre on 30 August and was honoured by the attendance of a number of prominent visitors and speakers. The Honorary Committee included BT's Chairman Iain Vallance and President of IBTE Dr. Alan Rudge.

Ir. Alfons Hendrickx, Chairman of the Organising Committee, opened by welcoming all and noting the high numbers of people and countries represented.

Mr. Andreas Kingsbergen, Governor of the Province of Antwerp, reflected on the growth of new technologies and demonstrated his real understanding of the challenges and opportunities through initiatives with businesses and universities.

Mr Bessel Kok, Chief Executive Officer, Belgacom, noted the significant year for Belgium telecommunications and looked forward to a variety of different emphases on regulation, competition and customers.

Professor Dimitri Kouremenos, President of FITCE, remarked on the beautiful City of Antwerp and the fact that, driven by the evolution of technology, the telecommunications landscape of Europe will be forced to be adaptive to new situations and the FITCE Congress can be one of the fora for discussion and contribution to ways for improvements.

Technical Papers

The theme of 'Broadband Networks and Services in the Europe of Tomorrow and the Impact on Residential and Business Users' stimulated an excellent range of papers covering a wide spectrum. Four papers originated from the UK, three of which came from BT authors.

The technical sessions began under the chairmanship of R. David (Belgium) with Barry Reynolds (Telecom Eireann) questioning 'The Broadband Market—Does it Exist and How Good is the Product'. The paper was a stimulating and thought-provoking opening producing active questioning.

Under the chairmanship of H. Gabler (Germany), the second day's proceedings continued the theme. Ian Pearson's (BT Development and Procurement) and Trevor Johnson's (BT Worldwide Networks) presentation of a paper co-authored with David Greenop (BT Worldwide Networks) introduced the innovative and exciting concept of the Infosphere as an all-embracing advanced distribution processing environment. At the end of the presentation, the audience were left in no doubt that the convergence between information, entertainment and communication is no longer a theory but that it is beginning to happen. (A revised version of their paper is included in this issue of the *Journal*[1].) This session also included the youngest presenter of the Congress, BT's Phillip Packman, who outlined the philosophy of optical fibre in the local loop and discussed the tenuous link between customer, supplier, industry and the regulator.

P. Fenichel (France) chaired the third day's proceedings, which included R. Slabon's (Germany) 'ATM Global European Project'.

A theme increasingly developing with each Congress is the growing importance of the customer. In the next session, under the chairmanship of R. Casale (SIP, Italy), Stan Bihun of Northern Telecom in the UK used his marketing expertise to graphically challenge any idea of barriers: success demands the integration of marketing and engineering into a cohesive product and service, and determining who should lead—the engineer or the marketeer—is a time-wasting luxury that cannot be afforded. Also in this session, Hans-Erhard Reiter's (Austria) paper reminded delegates of the vast investment that exists in copper cables and the need for cost awareness in broadband services with particular emphasis on the customer. He stimulated the audience by questioning the term *broadband* and introduced the term *voice-band equivalent* (VBE), whereby more than one VBE would be broadband and a video-recorder-quality equivalent (VRE) would be *wideband*.

To complement the pure theory of some papers, John Welsh of BT Laboratories, in a session chaired by W. Wapenaar (Netherlands), dramatically illustrated the positive developments being made in the UK through the active involvement of customer, technicians, industry and research engineers in the Bishops Stortford trial and in the expansion of the trial based on the background information gained.

In the final technical session, chaired by A. Valdar (BT), G. Georgiadis (Greece) provided an insight into the implementation of broadband services in rural points of Greece.

Congress Awards

As an outward recognition of the time and effort put into the preparation of papers, awards were presented as follows:

The Best Technical Paper award went to Ian Pearson and Trevor Johnson for their paper co-authored with David Greenop 'Broadband—Liberating the Customer' which had introduced the thought-provoking concept of the infosphere.

The award for Best Presentation Material went to Willem Verbiest (Belgium) for the paper 'Video on Demand' which illustrated the scope for development if we widen our horizons.

For his paper 'The Third Revolution in Publishing', W. M. Remners (Netherlands) received the Most Promising Young Engineer award. The paper provided an interesting insight into a developing field from the eyes of a non-purist engineer.

Study Commission Reports

Two study commissions presented their final reports to the Congress in a dedicated session—a reinforcement of the emphasis FITCE places on the interchange of development and stimulating new perspectives though shared experience and study. The outcomes provide a major tangible benefit of FITCE.

The Local Loop Commission, with BT's Mike Parry as Vice-Chairman and Peter Smith as Assistant Secretary, demonstrated that the development of techniques for utilising the extensive infrastructure of copper conductors in the underground network plays a critical role in comparison of costs against optical-fibre cable. The differences across Europe in the economic, regulatory and topographic states of individual countries need to be taken into account when deciding when and how to enhance the modernisation of the local access.

The Network Performance Commission, under the Chairmanship of Tony Mullee, BT, with Antony Oodan as Secretary, outlined a generic framework for capturing customers' quality of service for telecommunication services through a two-dimensional matrix which comprised service-quality criteria on one axis and service functions on the other axis.

Closing Session

A round table review, led by R. David (Belgium) plus the Session Chairmen and R. Hüber (Commission of the European Communities, DGXIII) considered the salient aspects of broadband provision—the resulting questioning over a wide range of technical and economic issues provided a lively and interactive close to the technical session. The discussion emphasised the variety of approaches to the topics raised from pure technical details to the more subjective customer overview. It was particularly interesting to note R. Hüber's views which provided an interesting and often marked contrast with some national PTT/telco views.

Technical Visits

The Organising Committee through some of their sponsors was able to provide a wide selection of visits: Alcatel Bell, Atea-Siemens, AT&T, Belgacom and a Belgian Cable Manufacture.

Each provided an informative insight into their specific specialism and gave the opportunity to continue discussion away from the Technical Sessions.

Raychem complemented the technical visits through their technical demonstration during a lunch period.

Social and Cultural Events

To complement the technical sessions, delegates were able to maximise the opportunities afforded by Antwerp's status of Cultural Capital of Europe and Belgium's compact geographical boundaries.

The opening evening reception was hosted at 't Elzenveld, a former hospital whose impressive interior and grounds formed an ideal setting to greet new colleagues and strengthen previous meetings.

Opportunity was afforded to combine a technical visit to the earth station at Lessive with a visit to the impressive caves of Han-sur-Lesse and a journey along the River Meuse.

The combination and juxtaposition of technical, social and cultural events afforded the opportunities to understand what other countries were involved with and to enhance the personal relationships developed during this and previous Congresses.

FITCE General Assembly

The proceedings in Antwerp were completed with the General Assembly of the Federation under the chairmanship of Professor Dimitrios Kouremenos (President of FITCE).

The President bestowed honorary membership on three distinguished Comité de Direction members who were retiring after many years of enthusiastic and supportive work: Charles Dondelinger of Luxembourg, Werner Hufnagal of Germany, and Gerry Condon of Ireland.

1994 Congress Venue and Theme

The 33rd FITCE Congress will be hosted by Deutsche Bundespost Telekom, the German Telecommunication Industry and the VHP Association and will take place in Dresden from 29 August–3 September 1994. The theme of the congress will be 'The European Challenge to Telecommunications in East and West'.

Conclusion

The 32nd FITCE Congress provided a stimulating and thought-provoking venue for focusing attention on broadband services and applications.

The rapid changes in technology and customer requirements are influencing the structure of the telecommunications society and the cooperation between national telecos through a greater understanding between each other was fully facilitated by the Congress.

The Study Commissions reiterated the enhanced understanding of members' technical and social cultures in maintaining their attention to high-quality work.

Appreciation is extended to the Organising Committee, honoured guests and the sponsors for the warm, generous and professional hospitality extended to all delegates. Particular appreciation is extended to the FITCE UK President Chris Earnshaw and Chairman Chris Seymour for their support and encouragement to the delegation coupled with the support of respective Managing Directors and line management.

References

1 Greenop, David; Pearson, Ian and Johnson, Trevor. Broadband—Liberating the Customer. *Br. Telecommun. Eng.*, Jan. 1994, **12** (this issue).

Biography

Mike Parry
BT Worldwide Networks

Mike Parry is currently Network Contracts Manager for South Wales. Mike joined the then British Post Office in the Wales and the Marches District and has been responsible for managing local access maintenance and construction in addition to customer product maintenance and installation plus network planning and drawing offices. Mike is an Incorporated Engineer, with a B.A. degree in Telecommunications Systems, a member of the Institution of Electronics and Electrical Incorporated Engineers and a member of the Institute of Management.

Journal Awards for Volume 11

The *British Telecommunications Engineering* Award Scheme encourages readers in furthering the role of the *Journal*, and gives authors due recognition for outstanding contributions. Each year, the Board of Editors awards prizes 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.

At its fourth annual congress and dinner held in October 1993, the Institution of British Telecommunications Engineers (IBTE) again honoured authors from the *Journal*. Robert Brace, BT Group Finance Director, presented awards to authors of outstanding articles from Volume 11 (April 1992–January 1993).

Top Award for Payphones Article

The prize for the best article went to John Empringham for his article 'Developments in Payphones', which appeared in the July 1992 issue. He received a crystal bowl inscribed with the IBTE's insignia, and a cash prize.

The article covers the recent history of the payphone with the introduction of the first self-contained payphone, the Blue Payphone, in 1980, and further developments which were only possible with the advancing technology of microprocessors, enabling increased facilities, flexibility for changes in currency and a three-fold improvement in reliability. The article clearly describes the new range of payphones, explaining the features which will give BT a competitive edge in the market, with dual credit card and coin payment on the same call, and product orientation to align with a range of customers' requirements.

John Empringham (right), winner of the Best Article Prize, pictured with Robert Brace

The author structured the article with a wide readership in mind; it is easy to understand and gives an insight into how the product has developed from both a user's and service provider's perspective.

Runners-Up

The Board of Editors also awarded a number of runners-up prizes for Volume 11. Each article received a cash prize, and each author a crystal paperweight.

The first runner-up prize was awarded to Geoff Payne for 'The One Bill Development', which was published in the January 1993 issue.

BT's business customers require a consolidated bill covering charges for all services provided by BT. The ONEBILL replacement system was designed to overcome constraints imposed by BT's current billing systems. This interesting and very-readable article describes the system and how its implementation was achieved in comparatively short timescales by using a combination of team working and alternative systems development techniques.

The second runner-up prize was awarded to Andy Valdar, David Newman, Roger Wood and David Greenop for their article 'A Vision of the Future Network'. The authors present some of the important elements of a future vision of BT's worldwide network, identifying the range of challenges facing telephone companies, and particularly the important role that network management has in ensuring business success and customer satisfaction in a complex regulatory and competitive environment.

The article is highly readable and provides a tantilising glimpse of the emerging network technologies and architectures which will be needed to provide future customers with an ever-increasing range of services.

The third runner-up prize went to Dick Landau for his article 'Exchange Transfer: Challenge and Innovation', which appeared in the October 1992 issue.

His article deals with the challenge of exchange transfers associated with modernising analogue local exchanges. The article describes how various initiatives centred on the main distribution frame, such as new PC software and the use of cable cutters, have led to reduced fault rates, lower costs and improved customer satisfaction. Dick Landau emphasises how the problems encountered were enthusiastically investigated and innovatively solved by BT people.

Finally, John Shepherd and Kevin Bosher were awarded a runner-up prize for 'Managed Recorded Information Services–An Overview', which appeared in the April 1992 edition.

Recorded information services have moved on dramatically from the days of the first speaking clock in 1936 and now encompass a large range of applications, ranging from generating and distributing network announcements to providing call management and answering services for Callstream and Linkline customers.

John Shepherd's and Kevin Bosher's article provides an excellent overview of the network architecture and equipment involved and takes the reader smoothly from past history through to future trends. It makes effective use of comprehensive diagrams to support the text and therefore addresses the needs of laymen and experts alike.

Harlow TPON Pilot Project

In 1992, BT Zones were invited to propose potential sites for BT's national pilot of TPON (telecommunications over passive optical networks) to test the technology and support systems. The criteria for selected sites were that they should contain both business and residential customers; that the business area should have customers of various sizes and communication requirements, and using the full range of BT services from PSTN to X-Stream; and that the residential area should be a greenfield development with known potential growth rather than an existing developed area.

Northern Home Counties proposed Harlow as a site that met these requirements. TPON also overcame the problems of serving a new housing development at the extremity of the exchange area. Harlow was ultimately chosen as one of the first two pilot areas alongside Bristol.

Harlow is a medium-size town situated just north of the M25. It was developed as part of the London overspill project to provide residential housing with adjacent industry. It consists of fairly well-defined areas of residential and business customers. An industrial area known as Temple Fields met the criteria for the business portion of the pilot. Temple Fields will be used to pilot BTPON (business TPON), which involves the provision of optical fibre from the exchange into the customers' premises. For the pilot only, selected customers having five or more working circuits will be connected. The new development at Church Langley will be the area for piloting the residential TPON. Residential and small businesses (less than five lines) will pilot STPON (street TPON), which involves taking fibre to a terminating point located in the street with a copper feed to the customers' premises. An important aspect of the pilot will be to ensure that all the support processes for future provision and maintenance of all services are in place and working.

The pilot at Harlow will consist of providing a 96-fibre cable in a ring architecture to form the primary infrastructure. The secondary network to the customers will be provided from the primary by using blown-fibre technology. The primary ring will have a number of fibre nodes where connection to the secondary networks will be made (see Figure 1). The capacity of the primary infrastructure has been designed to cater for not only the pilot requirements but also the future forecast demand for all fibre services in the node catchment areas. The nodes have been positioned to take account of their geographical locations and existing ductwork for the secondary networks. From the node, fibre will be taken to the primary splitter position for the secondary network. (The primary splitter may be housed within the primary node joint.) Fibres will be provided from the primary to secondary splitters, which are located as near as possible to the customers they will serve. From the secondary splitters, blown fibre will be provided into either the customer's premises or a street unit (Figure 2).

Figure 1—Harlow 96-fibre primary infrastructure

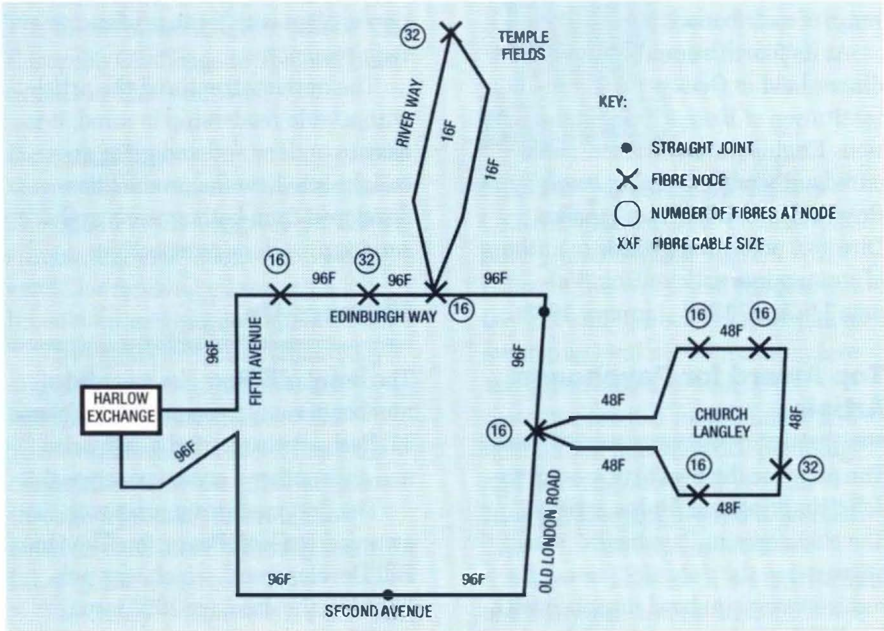
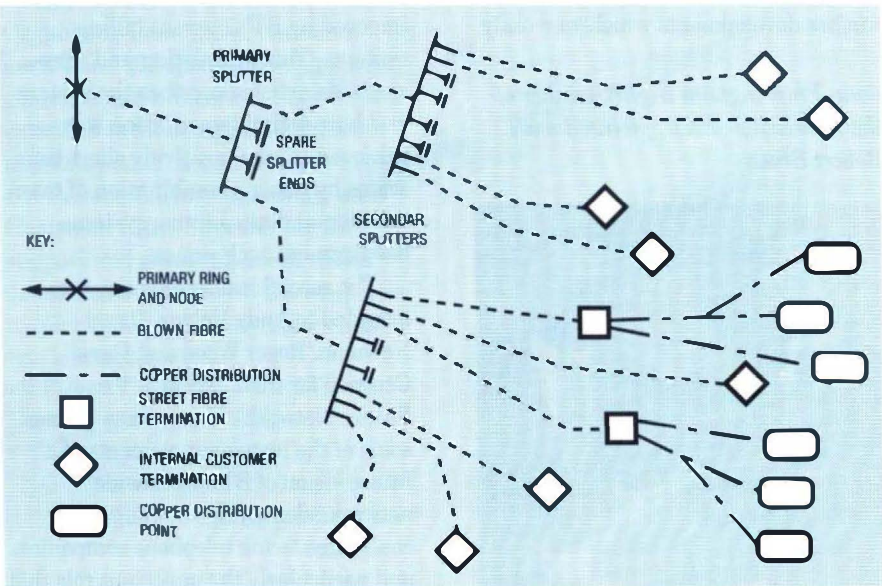


Figure 2—Typical secondary network layout



The use of a ring architecture for the primary infrastructure has the major advantage that from the nodes the two pairs of fibres (main and stand-by) from the primary splitter can be routed diversely around the ring. In locations where, because of physical constraints or the existing duct layout, cables forming part of a ring follow the same duct route, resilience is provided by housing the two cables in separate duct bores.

In both the primary and secondary networks, OTIAN™ (Optical Telecommunications Infrastructure for the Access Network) plant will be used. OTIAN™ is a new range of equipment developed for use at the exchange, fibre nodes and termination points in the customers' premises. It allows work to be performed on an individual fibre circuit, at any of these points, without affecting any other fibres. The trial of this plant is another major part of the TPON pilot scheme.

Derek Rodgers, for IBTE East Anglia Centre

Moorgate Frame Cleanse

BT's commitment to put the customer first has been more than demonstrated in the modernisation programmes and its continued expenditure on improvement projects. One of the key areas focused upon is *frame uplift*.

Although the frame is an elementary piece of apparatus, its importance should not be underestimated. Its design, working procedures and upkeep are crucial to the improvements in the speed of provision and quality of service offered to customers.

The main distribution frame (MDF) is the interconnection point between the customers' line plant and the exchange equipment which provides the telecommunications service required. It is therefore the key flexibility point and a suitable access point for testing both plant and equipment and localising faults.

In inner-city exchanges, the situation can become a little more complicated as it is not an unfamiliar sight to see multiple frames. This is due to the volume of exchange lines provided which can be equalled, and in some cases surpassed, by the number of private circuits.

After deregulation of the City in the 1980s (Big Bang), companies expanded or reorganised which led to rapid growth in demand for telecommunications services. This unprecedented level of activity on the frame meant that normal control processes were subordinated to exceptionally high volumes of provision and churn which led to the deterioration of some frames.

One particular exchange affected to a far greater extent than most was Moorgate. Moorgate has two very large double-height frames dominated by private circuits serving part of the City of London. The level of activity during Big Bang, coupled with the deployment of RATES (remote access and test equipment system), threatened to make the frame inoperable.

Several short-term solutions were introduced to keep the frame operational while a long-term solution was investigated. These measures consisted of providing plastic straps to keep overflowing jumpers attached to the correct level and an expressway (an alternative routing for jumper wire) was constructed for jumpers running from one end of the frame to the other.

The solution to the problem had to meet the following criteria:

- it would not be allowed to cause any further deterioration in the quality of service provided to customers, and
- it would have to provide service improvements and benefits as quickly as possible.

Two options were investigated. The first was a capital-funded project to replace one of the existing three MDFs with a modular frame; the second was to carry out a frame cleanse to remove all the spare jumpers from two frames and the interconnecting overhead bridges.

The first option was rejected on the grounds that the improvements would not be realised for five years. The second option was chosen on the basis that improvements would be obtained on a linear basis throughout the life of the project as each level was cleansed.

After careful research, a strategy for recovering jumper wire without increasing fault levels was devised. A team who carried out a successful frame cleanse at Mondial House was brought in to carry out a feasibility trial on the Moorgate frame. This lasted for three months and, after careful analysis of the results, an adjudication team deemed it a success. A project management team was appointed to formulate a plan and financial case for the implementation of a full frame cleanse.

Detailed measurements of the cross-sectional area of the jumper wire for each level were recorded. By using this information and the total weight of jumper wire recovered from the trial bed, estimates of the amount of unrecovered jumper wire were calculated. Work packages were then created with the assistance of the frame manager who carried out the trial. With this information, the time and cost of the project were forecast.

Control mechanisms were established on the project with the assistance of the Business Communications Division, which provided reports on frame fault levels for both exchange lines and private circuits. This information enabled any adverse effects that the project might have on customer serrvice to be detected at an early stage so that preventative action could be taken.

The project began in the spring of 1992 and, by the time of writing (December 1993), nine of the existing levels had been cleansed. A total weight of 24 tonnes of jumper wire—greater than the weight ot two London Transport double-decker buses—had been removed from the frame.

The projected benefits in relation to circuit provision and fault rates have already been achieved and, on completion of the project, will be well within the national performance standard despite the size and complexity of the installation.

Worldwide Networks London is ensuring that the important frames–

network interface is professionally managed, people are trained to possess not only the relevant skills but also the work ethics to provide the quality of service and provision that BT's customers require to manage their businesses successfully.

Jim Collins, IBTE London Centre

Screen-Based Planning

Picture, if you will, a planner who never leaves the office, has all the necessary information available from a single computer terminal and knows that any information database interrogated is 100% correct or is the latest version of a document. This is the concept of *screen-based planning*.

Within Southern Home Counties, several initiatives are in the embryo stage and will ultimately come together as a single planning tool. The early initiatives include scanning and storing digital (System X) exchange name documentation (ENDs), and compiling a database of miscellaneous equipment racks that can be produced as a screen image or a paper copy showing the rack itself both from a front and side view. This will ensure that new equipment can be allocated only to spare shelf spaces and that, for example, equipment with extra depth is identified so that the rack safety bar can be modified if necessary.

These initiatives are linked via formal project management to the Southern Home Counties Planning Unit computing strategy, which delivers common information to all planners via local area and metropolitan area networks (LANs and MANs).

Software, called *Page Keeper*, is being evaluated. This could provide the means of setting up a library of all locally produced documents in such a way that identification of the correct document by either title, number, subject or analysis of content is possible.

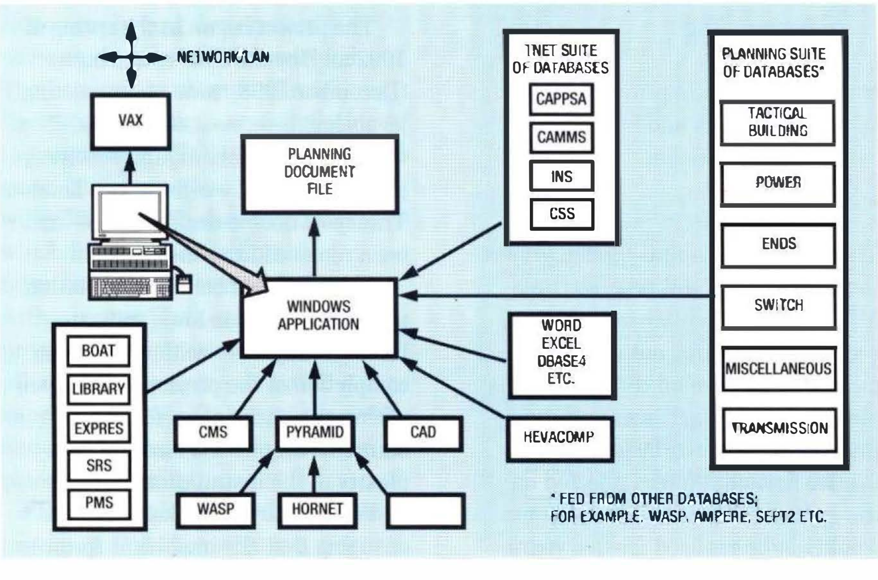
A drawings database, initially for electrical distribution records, is being created. Processes are in hand to transfer all paper records to the database, which could be interrogated by any planner or draughtsperson throughout Southern Home Counties.

By linking all the elements together, it will be possible not only for planners to work from their desks, but any changes they make to be indicated on other databases. For example, the planned provision of a new piece of equipment will require a specified floor area or rack space. Interrogation of the database will immediately indicate in which exchanges the equipment can be installed at minimum cost and which will require additional racks, power supplies, ventilation or even a building extension.

Figure 3 indicates the concept.

Nick Smith, IBTE North Downs Centre

Figure 3—Screen-based planning for the Southern Home Counties Engineering Planning Unit—the concept



Payphone Activities and Developments in North Downs

Early last year, BT Payphones completed a national reorganisation that reduced the number of Payphone Zones from four to three. As part of this reorganisation, Home Counties and London were amalgamated and are now known as the *South East Zone*. The North Downs area was merged with Southern London District and now makes up a new District known as *South East Thames*.

Public payphone performance in the North Downs area has continued at a very high standard. For the third year running, North Downs received the award for 'The Best Overall Payphone Quality'. This award takes into account the serviceability result (the number of payphones found in service by an external surveyor), and includes aspects related to the cleanliness, lighting and overall condition of the kiosks. This success is unprecedented for the North Downs payphone team.

Complementing this success has been the performance in a number of projects, Eurotunnel being a major one. BT Payphones will be providing 80 of the next-generation payphones, the P2000, which has recently undergone successful trials around the country. These payphones allow customers to choose from the full range of payment options and a variety of languages. The new payphone has been developed for BT by Landis and Gyr. An interesting concept being introduced is the installation of 18 external French housings on the British side of the tunnel. Called *Cabines*, they are being modified to accept the new-design British payphone. A reciprocal arrangement is planned for BT external housings on the French side of the tunnel. Installation began in January 1993 in preparation for the opening of the tunnel later this year. The new-generation payphone will also be installed at the newly-redesigned Dover Docks complex. The installation of around 120 payphones begins in early 1994.

Another successful project was the installation of 37 payphones at the newly-opened M25 Clackett Lane

Figure 4—Rare K1 payphone, Tunbridge Wells

Service Station. They were installed in KX Housings with modifications to allow wheelchair access.

Product development has not only been confined to the public payphone field. BT Payphones has developed new product ranges for the private payphone market. These began in 1992 with the launch of the Payphone 190, a replacement for the older 'moneybox' type products. The new mid-range products—Payphones 290, 390, 490—have been introduced throughout the year, along with the budget range, Payphone 90. A new desk-top credit-card payphone, the C10, has also been launched. This product is intended for use at airports and larger motorway services lodges where business clients are in the majority.

On the more unusual side, the discovery of a K1 kiosk, dating back to around 1921, proved to be an interesting refurbishment project for the Tunbridge Wells payphone team. This historic kiosk (the K1 was the first standardised kiosk brought out by the GPO) was discovered at the Neville Cricket Ground, Tunbridge Wells, and was being used as a tool shed! It has now been restored to its original cream colour and to full working order (see Figure 4). It is now an officially listed building and is one of only two working K1 kiosks in existence in the UK.

Malcolm Couldrey, IBTE North Downs Centre

BT and Scientific Atlanta Join Forces for Pan-European VSAT Services

BT and Scientific Atlanta have formed a strategic relationship to set up and service pan-European very-small-aperture terminal (VSAT) satellite networks.

Scientific Atlanta will become a principal supplier to BT's Visual and Broadcast Services of satellite hub stations and remote VSAT equipment for interactive data communications. BT will become the principal distributor of Scientific Atlanta VSAT equipment in Europe.

Ian McKenzie, BT's business and marketing manager, Broadcast and Satellite Services, said: 'Scientific Atlanta has been selected as principal supplier of VSAT equipment because of its ability to supply quality equipment globally. The relationship will enhance BT's offering to customers across Europe and improve service provision to the VSAT market'.

Thom Degnan, Director of Scientific Atlanta's European VSAT business said: 'BT was selected as principal distributor because of its ability to provide integrated telecommunications solutions, which include installation, maintenance, programme management and 24-hour operation of pan-European VSAT networks.'

Construction of BT's new satellite hub in London has begun and will be completed early this year. The hub will provide complete interactive VSAT services to ensure virtually continuous communications, between customers' head offices and remote locations. BT will also have a hub based in Paris, fully licensed and operational, and a pan-European service will be offered from both facilities.

Steve Maine, Director, BT Visual and Broadcast Services, said: 'Industry experts estimate that the VSAT services market in Europe will be worth approximately £200M by 1995, with satellite services accounting for a substantial share of telecommunications traffic by the end of the decade. It is expected that demand for VSAT technology in Europe will grow steadily over the next ten years as companies recognise VSAT's ability to provide a single communications platform with cross-border capabilities for data, audio and video. Scientific Atlanta is a leading supplier of VSAT technology worldwide and a strategic alliance will benefit our customers on a pan-European basis.'

Sam Stavro, President of Scientific Atlanta's VSAT business said: 'We are looking forward to working with BT and view the selection of S-A as their principal supplier a testimony to our technology. The combination of BT's expertise as a global network provider and S-A's VSAT technology will provide the marketplace with a comprehensive solution for pan-European networking'.

Are you aware of a local BT project that would make the subject of an interesting 'Field Focus' article? Please contact your IBTE Local-Centre Secretary (see p. 328) or the Managing Editor (071-356 8022).

BT Streamlines International Telephone Charges via EDI

BT has developed a new solution to the problem of settling for international calls, based on electronic document interchange (EDI). This will help BT and other international telecommunications carriers to cope with the increasingly complex task of reimbursing each other for the growing volume of international traffic.

Current practice is that the charge for any international call, as it is routed from one country to another, is shared out by the operators through whose territory it passes. To settle up at the end of each quarter, BT and its overseas counterparts then negotiate the costs.

The data produced by ISAAC, the international settlement and accounting system, at the end of each month, showing what funds need to be transferred between BT and the other carriers, is at present passed around manually by post or by fax.

A team from BT's Development and Procurement division, working with BT's network finance international, has come up with a better solution. This involves using existing processes on ISAAC which interface with EDI messaging services via PC-based 'bridging' software.

Monthly outgoing account data via EDI is extracted from the ISAAC database using the existing method, with an extra process for handling the EDI aspects. Accounts arriving via EDI are loaded on to the ISAAC database using a batch version of the existing incoming accounts process. The bridging software converts outgoing accounts data into the required format for transmission to foreign carriers and translates incoming data back into ISAAC format.

The team has achieved the powerful combination of a technical solution and a marketing tool which BT can take around the world to encourage the use of EDI as the data communications language of the future for international carriers.

BT is already using the system to encourage the use of EDI to several major telecommunications carriers, and the programme has attracted great interest from these carriers.

New KiloStream Services

BT has extended its KiloStream (N) range with the introduction of KiloStream (N) Voice service. This gives companies a cost-effective way of connecting digital private circuits to their main PBX to support voice facilities, without the need for additional expenditure in multiplexers. Companies were previously restricted to purchasing either analogue service or MegaStream for their remote sites.

The new service enables multi-site companies to plug the circuit into a G703/4 PBX port and provides advanced facilities such as ringback-when-free, call diversion and call pick-up, which were generally not available over analogue circuits to remote sites.

KiloStream N Voice gives companies the ability to purchase just the capacity needed to support various applications by selecting the number of 64 kbit/s channels they require from 2–16. KiloStream (N) Voice supports a mix of speech and data applications, such as videoconferencing, database access or file transfer.

KiloStream N was launched in March 1992 to fill the gap between BT's KiloStream and MegaStream services. It offers point-to-point transmission speeds of up to 1024 kbit/s, in increments of 64 kbit/s for customers who need greater capacity than KiloStream 64 kbit/s but less than the MegaStream 2 Mbit/s. The 'N' refers to multiples of 64 kbit/s; for example, if a customer wants 256 kbit/s, the value of 'N' would be 4; if they wanted 768 kbit/s, the value of 'N' would be 12 and so on. The maximum multiple of 'N' is 16 at 1024 kbit/s. The KiloStream N portfolio now comprises KiloStream N Data and KiloStream N Voice.

BT Implements Euro-Standard

Last October, BT announced that it had successfully implemented the compliant I.421 service. I.421 is the international interface for digital connection to ISDN primary-rate services and is based on a common standard agreed by the European Telecommunications Standards Institute (ETSI).

Since early 1993, when BT first announced its intention to make the service available within twelve months, over a dozen manufacturers of ISDN-compatible equipment have been using BT's testing facilities at Martlesham Heath to develop products in accordance with the European standard. I.421 will be available in a number of telephone exchanges where customer demand is the greatest. Equipment manufacturers will be able to access and replicate the testing and evaluation conditions required during product development, either on their own premises or their customers' sites. The I.421 service is expected to be available nationwide towards the end of 1994.

To date, ISDN primary-rate service has been used by large organisations for mostly voice communications. However, the availability of I.421 opens up opportunities for BT customers to use the service for new data applications. Customers, as a result, will have the advantage of increased flexibility and functionality that ISDN 30 can offer both in the UK and Europe.

BT is continuing to support the existing ISDN primary-rate standard, DASS 2, the existing prevalent signalling standard, and guarantee's compatibility between DASS 2 and I.421.

BT and Microsoft Joint Initiative to Provide Windows for Workgroups 3.11 Across ISDN

BT and Microsoft® have announced a joint initiative to enable users of Windows™ for Workgroups 3.11 to communicate with each other directly through the integrated services digital network (ISDN). This service will allow 'virtual' terms working between any number of remote sites to share files and documents easily and cost effectively, thereby broadening the reach of networking. BT and Microsoft are committed to converging on an international common standard for Windows to communicate across ISDN services.

ISDN is of particular value for Window applications which require the transmission of high data levels, such as videoconferencing and imaging, and for users needing to transmit high levels of data on a regular basis. All you need to participate is an ISDN card for your PC and the installation of a line.

By enabling Windows for Workgroups 3.11 to utilise ISDN, Microsoft is not only giving their customers access to these benefits, but actually replicating network conditions outside the office. Windows for Workgroups 3.11 users will be able to share information, peripherals and communicate via Mail and Schedule+ with remote users as they would with users in their own local area network (LAN).

BT is a leading member of the group within the European Telecommunications Standards Institute (ETSI) that specifies European standards for ISDN. The work with Microsoft is complementary to this activity and greatly advances the pursuit of ISDN applications standards.

Seeing is Believing

Sales representatives do not need to leave the office to make a sale. By using BT's Multimedia Call Centre, sales can be conducted by letting customers see products and purchase them over the telephone.

Multimedia is the medium of the future and the 'Multimedia Call Centre' means the telemarketeers can not only see the caller but actually show them products. This has many advantages for companies involved with sales, product maintenance or complaints and billing enquiries.

A Call Centre is that portion of a business where a large volume of calls enter or leaves. The purposes of the calls are largely predictable and designated agents, or a voice processing application, can complete them.

Andy Jervis, Marketing Specialist, BT's Voice Products, said, 'The phone is often the first and only point of contact with the customer or potential customer, and the efficiency of a company's call handling influences the caller's perception of that organisation. A Call Centre can improve customer service, increase revenue and reduce costs.'

BT has a number of Call Centre Solutions which can help any business improve its call management.

BT's *Agentless Call Centre* shows how a business can offer customer service day or night without staff manning the telephones. With the help of call routing, automated attendant, and voice messaging, companies can ensure simple customer service, reduce the costs of overheads and effectively manage large volumes of incoming calls.

The *Intelligent Call Centre* identifies the caller and simultaneously retrieves caller information from company-wide databases so telemarketers can use the information to create sales opportunities while on the telephone to the customer.

In today's highly competitive markets, conducting business by telephone can prove to be the most inexpensive and time-saving means of providing good customer service. Call Centres are the perfect mechanism for this and over the past few years they have become essential business tools.

BT's Call Centre Solutions have the potential to transform the way business is conducted in the UK by allowing companies to use the telephone to achieve outstanding results in sales, market growth and customer service.

BT Launches New Low-Cost Access to Telephone Number Information

BT has launched an on-line directory enquiry system for personal computer users. Called *TeleDirectory*, the system is aimed at customers who require five or more telephone numbers a day.

Updated daily with about 40 000 changes, the system allows customers to access more than 17 million UK businesses and residential numbers and addresses.

Independent tests carried out by Gallup showed that, with only 10 minutes' training, TeleDirectory users were able to obtain telephone numbers within seconds.

David Rosenbaum, Manager of TeleDirectory at BT MNS, explained: 'BT recognises that businesses need to make increasing use of telephone number information to maintain and extend their records and support regular contact with customers and prospects. The launch of TeleDirectory, thanks to a combination of innovative software and the power of today's PC, has allowed us to provide our customers with easy access to up-to-date telephone number information quickly and accurately. Even companies currently obtaining only five telephone numbers a day can find TeleDirectory cost-effective'.

TeleDirectory is the first Windows-based telephone number information service in the UK. It uses the latest technology to provide an easy-to-use and fast system, with responses taking around 15 seconds per enquiry. The software uses an intelligent searching process ('fuzzy logic') to find the best match to an enquiry, and parallel processing to allow the user to continue to enter enquiries while it processes those just entered.

An additional facility, called *File Transfer Mechanism*, is also available as part of TeleDirectory. This allows batches of up to 10 000 records to be taken directly from a customer database and processed in one go. TeleDirectory is available by using either a modem or a dedicated connection via BT's Global Network Services.

BT Global Network Services Launches GNS X.25 Dial Service

BT Global network Services has launched GNS X.25 Dial, a cost-effective and flexible dial-up data transmission service designed for low-volume and mobile users who require the functions and benefits of the X.25 standard normally associated with leased-line X.25 dedicated connections.

The service has a number of features: a choice of speeds ranging from 2400–9600 bit/s, with support for up to 16 simultaneous sessions; end-to-end error correction; network user identification during log-on; support for IBM 3270 equipment; and, to give users even greater control, the ability to create, change and delete passwords and usernames using TymValidate, the GNS network management system.

In practice, GNS X.25 Dial will allow businesses to interconnect geographically-dispersed computer systems and terminals via the GNS network to national and international hosts. This is ideal for single users needing short-term simultaneous access to more than one host computer in order to perform multiple transactions. The service can also be used where IBM functionality is required from remote sources to IBM hosts. Additionally, GNS X.25 Dial can prove very useful in situations (such as disaster recovery) where a new site has to be brought on-line very quickly for short periods.

Richard Fryer, UK Marketing Manager for BT GNS, commented: 'The launch of GNS X.25 Dial—in response to a growth in market demand for faster interactive response times and file transfers—takes us a step further towards BT's vision of truly global communications. In future our customers will be able to dial up the X.25 service and use a common log-on procedure that they are familiar with—regardless of where in the world they might be.'

Exchange Language Barrier Comes Down

BT Laboratories (BTL) claimed another technological first on 8 December 1993, with a demonstration of a new switch interface which will standardise the way in which exchanges from different manufactures can be configured to provide customer services.

Until now, exchanges from BT's three principle suppliers—GPT, Ericsson and Northern Telecom—have been configured using man–machine languages specific to each type of exchange. This has required the development of specific interfaces on BT's management systems, which has been the barrier to the introduction of new exchange types and switch services.

BTL's advanced configuration management group has solved the problem by introducing a common computer interface—based on the CMIS/CMIP protocol running over X.25—which makes all exchanges 'appear' to be the same. In collaboration with GPT Telecoms Management, at Poole, a prototype development of this interface has been completed.

The demonstration, which used a BT network management application, a GPT switch element manager, a System X exchange and a set of telephone lines, showed how easily customer services such as three-way calling and call diversion can be provided. This development creates an opportunity for switch suppliers to develop and supply switch element managers to BT.

Roger Parker, technical group leader at BTL, said: 'By introducing switch element managers, BT will be able to introduce new services more quickly, and with reduced development costs.

'The switch manager 2000 demonstration has proved the effectiveness of using an open interface to configure swich services via GPT switch element managers.'

NatWest Applauds Improved BT Billing Service

BT has won praise from The National Westminster Bank after delivering a substantially improved billing service for the bank. This follows the work undertaken during a six month project by a joint BT and NatWest quality of service task force coordinated by BT's Customer Quality Centre. The collaborative task force was established to address the special needs of the bank and to provide advanced levels of service.

Commercial Manager, IT Network Services, Peter Morrissey, commented: 'The introduction of a new billing procedure has reduced our workload, improved our confidence in its accuracy and speeded up our payment cycle.'

NatWest had originally been receiving up to 9000 BT bills per quarter which were complicated and took a great deal of time to process. This resulted in lengthy delays, frustration and expense for both BT and NatWest. The new billing system allows greater budget control and accountability, and a reduction in the time spent checking and processing bills.

Included in the new billing format is a summary of key NatWest sites with charges allocated to NatWest cost centres, the addition of purchase order references for payment authorisation and a single BT point of contact for any billing enquiries.

'Strong Case' for Number Portability

OFTEL has concluded that there is a very strong and robust case for introducing number portability following a six-month cost-benefit analysis.

Director General Don Cruickshank said that number portability would enable customers to keep their own numbers when they change from one operator to another.

'This will give them freedom of choice to select their suppliers on the basis of price and quality of service,' he said.

'Lack of portability acts as a disincentive to changing supplier. If this barrier is removed, I am convinced that suppliers will strive to improve their services to attract new customers and improve efficiency.'

Before portability can be made widely available, negotiations between operators on technical and practical aspects will have to take place. Although it is up to operators to take the lead, OFTEL has a role to play in providing a forum in which these negotiations will take place. OFTEL's Network Interfaces Committee is to coordinate technical work and draw up a timetable for discussions and the implementation of work. OFTEL will prepare directions requiring BT to introduce portability in respect of those PTOs who have already provided OFTEL with information on when and where they can make portability available.

The cost-benefit analysis examined six methods of providing number portability:

- a transitional option, using call-forwarding techniques;
- two medium-term options: call redirection with local exchange (DLE) interconnection, and call redirection with trunk exchange (DMSU) interconnection;
- three long-term options: call rerouting using switch-based data; call rerouting using intelligent network (IN)-based data; a total IN solution.

The analysis indicated a positive net benefit for all options except the total IN solution.

Mondex—The Key to Global Cash

National Westminster Bank has joined forces with BT and Midland Bank in a joint venture to introduce *Mondex*, a new electronic cash payment service.

Developed by NatWest, Mondex is an alternative to cash and is not intended to replace debit or credit cards. At the heart of the system is a plastic smart card which stores electronic cash values, and which will enable customers to use specially-adapted NatWest and Midland cash machines or a new generation of BT telephones to transfer cash between accounts and cards.

Once funds have been transferred onto the Mondex card, it can be used to make purchases up to the cash value on the card or to make payments by telephone. The banks have already begun discussions with major retailers as a first step towards implementing Mondex in the UK through a range of service providers.

A new range of BT payphones and home telephones will enable cardholders to check how much cash they have on their cards.

World Telecommunications Development Conference

The first World Telecommunications Development Conference is to be held in Buenos Aires from 21–29 March 1994. The aim of the conference is to develop a global strategy for balanced telecommunications development by the year 2000 and beyond, within which national policies can be developed. It is also to provide a comprehensive and result-oriented plan of action in all areas relating to telecommunications development.

In addition to ministers and high-level representatives of governments, multilateral and bilateral funding agencies, senior executives, managers and corporate planners of telecommunications companies, eminent personalities and key leaders have been invited to present their vision. They will share with participants their experiences and the strategies which, for some, have enabled their countries to experience spectacular progress or, for others, have guided their companies' success.

Europe Moves Closer to Full Liberalisation

The European Commission moved further towards liberalising Europe's telecommunications monopolies in November with the adoption of a Communication on the development of a universal service. The provision of a service for all users at an affordable price is the cornerstone of Community telecommunications policy which aims for liberalisation by 1 January 1998. However, estimates show that as much as 16 billion ECUs each year are transferred from profitable long-distance and international calls to cover losses made on local service obligations.

Digital Mobile—A Problem with Hearing Aids

A specialist panel has been set up by the British Standards Institution (BSI) to look into concerns that digital mobile telephones are causing interference to hearing aid users.

The problem is that digital mobile telephones use a form of radio transmission called *time-division multiple access* (TDMA), which relies on switching the radio-frequency carrier rapidly on and off. If a hearing aid user is close to a mobile telephone, this switching of the radio frequency may be picked up on the circuitry of the hearing aid. Where this occurs, it results in a buzzing noise which can vary from being faint to the maximum loudness of the aid.

The BSI panel, which consists of representatives of the digital mobile telephone operating companies, the Department of Trade and Industry, the Department of Health, manufacturers of hearing aids and hearing aid users, will establish standardised test methods to measure levels of interference, determine acceptable levels of hearing aid immunity and establish annoyance factors. After its investigations, the panel will make recommendations to the European and international standards bodies through the BSI as the national standards organisation.

New Code of Practice for Information Security

The British Standards Institution (BSI) has published a new code of practice for information security management. The new code provides practical advice for organisations in managing their information technology resources and was developed in response to a need for a common basis for effective security management practice. It acts as a common reference document for managers and information security staff helping firms conform to legislative and insurance requirements and serving to promote confidence in inter-company trading.

The code is the result of a joint venture between the Department of Trade and Industry (DTI), BSI and a group of leading UK and international companies—the BOC Group, BT, Marks and Spencers, Midland Bank, Nationwide Building Society, Shell International Petroleum, Shell UK and Unilever.

The code of practice contains a wide range of advice which is based on proven, practical measures designed by business experts who have developed and used them in their own companies. It gives concise descriptions of around 100 individual security controls under ten major headings. The code can be used to identify measures required for particular issues or specific areas of responsibility and highlights the ten key controls considered fundamental to information security. A management overview has also been published which provides an introduction to the code of practice and how to use it. It will provide a briefing for senior business managers explaining why information security is needed.

BT Joins Industry on Portable PC Proposals

A group of major UK companies has developed a document describing the main features of a portable PC specifically suited to field workers.

The discussion paper focuses on the need to give field staff access to very large amounts of technical data to improve service to customers. It is being supported by major companies, including BT, British Gas and Rank Xerox.

One of the authors of the document, BT's Colin Maunder, said: 'With the increasing complexity and diversity of remote equipment, it is essential that field staff have access to up-to-date technical support. The portable computer approach appears to be a great advance over paper and fiche-based systems.'

Everyone involved agrees that there is currently no commercially-available cost-effective and light-weight portable computer, with integral mass storage. It is hoped that the document will encourage manufacturers to consider the proposals.

Mercury Radio Option

Mercury Communications Ltd has announced that it plans to bypass BT and link directly to customers via a radio local loop. Mercury is looking at four technologies, all developed in the US, two of which are in use; it may end up using different technologies in different places. Mercury would then have to apply for a licence to use the frequencies.

Rabbit Closure

Hong Kong-based Hutchinson Whampoa Group closed its Rabbit UK CT2 telepoint service on 31 December. The company cites four reasons for the service's failure:

- mass-market demand for two-way telephony, partly fuelled by the arrival of low-cost cellular service options from Cellnet and Vodafone;
- patchy service coverage;
- 'lack of timely support' from electronic and telecommunications product manufacturers to offer consumers a 'wide range of affordable handsets and home base stations'; and
- an 'inability to properly educate the market on the cost-effective benefits' of telepoint.

Hutchinson has confirmed that the launch and roll-out of its digital personal communications network (PCN) is on target for April this year. The company says that it will reach 50% of the UK population 'on day one' and 70% by the end of 1994.

Mercury Targets BT ISDN Customers

Mercury Communications has announced a new basic-rate ISDN service. Called *ISDN 132*, it is being pitched at existing BT customers, since it allows them the option of routing calls through the Mercury system by dialling a three-figure prefix (the '132' of the service's name). Once the user is registered with Mercury, any calls prefixed with this number are automatically routed via Mercury. An interconnect arrangement between BT and Mercury has been finalised, enabling traffic to pass transparently between both carriers' ISDN networks.

New Global Service from INMARSAT

INMARSAT has announced the global availability of the INMARSAT-M service, which provides global digital telephony and 2·4 kbit/s facsimile data services.

It has also revealed that L. M. Ericcson AB is to be its new partner for its forthcoming Project 21 global mobile telephony service.

Coverage is provided through nine land earth stations, and to provide redundancy and give users the option of different service providers, each of the four coverage areas has at least two earth stations. BT and Comsat cover the Atlantic Ocean region east and west and Australia's Telestra and Japan's KDD plus Comsat cover the Indian Ocean and Pacific Ocean regions.

Outsourcing—Europe's Unexploited Market

Outsourcing of corporate telecommunications networks in Europe represents a potential market of $11 700M, of which only some $175M is likely to be tapped in 1993, says a study by London management consultancy Datamonitor Ltd. Of this, the banking industry makes up the largest share, accounting for 16% of the total.

The report, *Managed Network Services—Strategies for Europe*, finds that managed network services account for about 16% of the $8000M European value-added network services market. It further suggests that telecommunications managers of large firms must decide either to build and manage their own communications networks, or switch over to managed services, run by outside suppliers.

Managed network services are said to be lagging behind computer facilities management, but the past year has seen a dramatic rise in the number of companies offering such services, spurred by the continuing deregulation in Europe's telecommunications environment.

At the moment the largest managed network services market is for data services, which is forecast to generate $685M in Europe this year. By 1997, Datamonitor researchers expect this to rise to $2175M, an average annual increase of 34%.

Passive Optical Network Contract

BT has awarded a multi-million pound contract to Northern Telecom Europe to supply a system providing business telecommunications over passive optical networks. The national direct fibre-in-the-loop system will deliver a range of narrow- and broadband services to businesses, and will also be deployed as a fibre-to-the-kerb system for smaller businesses and residential customers. The initial contract is for 20 000 lines, subject to a satisfactory pilot.

OFTEL Puts Customers First

Real competition with telecommunications companies offering a choice of services the customers want was the message from Don Cruickshank, Director General of Telecommunications, at the Telecommunications Managers Association at their Annual Conference in Brighton in November.

He said: 'The 1984 Act says that I should promote the interests of consumers, purchasers and other users. Luckily, that is my natural inclination. I intend that servicing customers should be the resonant theme of my time as Director General.

He continued: 'OFTEL's overall goal is to obtain the best possible deal for the customer in terms of quality, choice and value for money. What does this mean? My criterion is simple. Are there three or more service providers knocking at the door, equipped to provide a full range of services at a tariff structure of their own choosing? I repeat three or more, not two. That is real choice.'

Mr. Cruickshank pointed out that only a few large companies, on concentrated sites like the City of London, now have such a choice. 'There is a long way to go and we must not be lulled into a false sense of security just because licences have been granted, competing infrastructures are being built, and promises are being made. The prospects for competition are good, but in reality we have taken but a tentative step.

'OFTEL's strategy will be able to secure start ups for new operators and ensure that they have the opportunity to build businesses which are sustainable in a competitive market, so providing choice at competitive prices. The focus will be competition in the local loop and here competing infrastructure will be crucial if the criterion is choice. It follows that there must be fair access to operators' networks—particularly BT's. This is about getting interconnection terms right; about a sensible waiver policy on ADCs (access deficit contributions); about accounting separation and about bringing down barriers to entry.'

Turning to OFTEL's role in ensuring licence compliance, he said that he intended that OFTEL would become much more proactive. 'If the present regime can only provide a real sanction after an order from the Director General, and the burden of proof is on the Director General, then the sooner investigations start the better.'

Looking to the future, Don Cruickshank remarked that, in mobile services, just one new entrant—One-2-One—has had a startling effect on the market-place and has prompted a lot of thinking about tariffs. He predicted that this would become the pattern of the future.

He concluded: 'My vision of the future of telecommunications is a consumer service delivered by marketing-oriented companies. In the future, we will see a cost structure in which infrastructure and access charges reduce; and in which costs will rise in three important areas—new service developments to exploit new technologies; software and system development to deliver these new services; and marketing and selling expertise.'

ATM—A Commercial Reality

Asynchronous transfer mode (ATM) is the technology that will deliver true multimedia to the desktop, putting power in the hands of users and the local area network (LAN) vendors, says Analysys in its first major published study of ATM products and deployment plans, published in October. The arrival of ATM as a commercial reality heralds the start of a new order in telecommunications and computing: the era of true multimedia communications. As a result, there will be a fundamental restructuring of the telecommunications and computing sectors, the main beneficiaries of which will be users and LAN vendors.

The report—*ATM: Vendor and Operator Strategies*—provides three kinds of evidence for its conclusions:

- analysis of the trends in the ATM market,
- modelling of the financial case for ATM in public networks, and
- product and strategy profiles of more than 50 of the industry's key players.

'ATM will shift the balance of power away from the telecommunications operators and their suppliers and towards end-users and the vendors of customer premises equipment,' commented David Cleevely, Managing Director of Analysys and one of the report's authors.

'Corporate users won't just sit back and wait for the operators. They are already installing ATM in LANs, and re-drawing the boundary between their own networks and the public network, capturing more and more of the functionality and added value on their side.'

The report argues that this shift in balance of power will be the result of the uneven way in which the costs and benefits of ATM are distributed between the players. Large corporate telecommunications users, in particular, are set to gain enormous benefits—universal interconnection for all services (voice, point-to-multipoint data, point-to-point data, video, and multimedia), and a way of sharing overall network capacity cost-effectively between different services. ATM also simplifies the management and configuration of networks by abolishing the distinction between local area and wide area networks.

'The player with most to lose from ATM is the telecommunications operator,' said Peter Aknai, another of the authors. 'ATM threatens to reduce the operator's dominant role in the telecommunications value chain to that of a commodity bit-carrier. But if the operators don't provide ATM, then large users and resellers will buy transmission capacity and exploit the benefits of ATM themselves.'

Nevertheless, the report shows that operators will benefit from ATM, enabling them to deliver new high-bandwidth services profitably, and support a wide variety of services on a common infrastructure, bringing economies of scope, scale and integration. The benefits, however, will come on the revenue side—from the provision of advanced services—not from cost savings.

The traditional telecommunications equipment manufacturers will face many of the same challenges as the operators. Their pricing structures and routes to market are being turned upside down by the arrival of a host of new entrants from the LAN, WAN and customer premises network (CPN) sectors. 'The traditional vendors are matched against a range of new competitors who share none of their preconceptions,' commented David Cleevely. 'Many of the new entrants come from the computer and networking sectors, whose life cycles are measured in months not decades. They also expect to establish standards quickly, through bodies such as the ATM Forum, bypassing traditional mechanisms like the ITU.'

David Cleevely concludes: 'This is not a market-place where established practice or past experience will guarantee success to any individual player. Rapid acquisition of understanding of the evolving market will be the key success factor.'

Vision of a Cordless Society

The benefits of the cordless society may be slow to emerge simply because the world is unclear what new technology has to offer, according to INMARSAT Director General Olof Lundberg.

'We may sometimes feel that the world is moving too fast for comprehension. But the fact is that the speed of advance is governed by our inability to wake up quickly to the full commercial and social implications of new technology. This will certainly be true of handheld mobile satcoms,' he told the INMARSAT International Conference on Mobile Satellite Communications in Paris.

Mr. Lundberg was looking ahead to the introduction of INMARSAT-P, the proposed global hand-held satphone service scheduled to be launched in the 1998–2000 timeframe. A combined cellular-satellite mobile telephone is expected to cost about $1500 in 1993 terms.

'In time we will all adjust our ways of thinking and working to accommodate the universal availability of portable, multipurpose communications. The need and desire can be expected to build slowly at first, but one day the universal communicator will be as commonplace as the camcorder and the present generation of portable telephones.

'It will be just one aspect of the cordless society. It is people that communicate, not places, and the time will surely come when no personal communications device, whether in the home, the office or out of doors, will have a cord attached.'

Assembly Moves to Speed Changes to INMARSAT

Actions taken by the INMARSAT Assembly will speed the process of changing the INMARSAT organisation. The changes will enable the organisation to meet the needs of a global mass market for personal satellite communications services.

'While no specific decisions were taken, the Assembly, which recently met in Paris, unanimously agreed that change was essential if INMARSAT was to fulfil its role of providing global mobile communications for the 21st century. Among the possible changes being considered are:

- the full range of options for the structure and status of the organisation,
- commercialising the investment structure of the organisation, and
- improving commercial and operational access to the INMARSAT system.

Other topics which will be discussed include changing the name of the organisation to the International Mobile Satellite Organisation to reflect the growing role of land mobile and aeronautical users in INMARSAT's business; ways of protecting the intellectual property rights of the organisation; and the privileges and immunities which INMARSAT has had as an international organisation from its inception.

A Handbook for Digital Signal Processing

by S. K. Mitra and J. F. Kaiser

Over the past 30 years, digital signal processing (DSP) has emerged as a key enabling technolgy, and has been successfully applied to fields as diverse as consumer electronics, entertainment, telecommunications, automotive systems, avionics, instrumentation, speech and image processing, seismology and medicine. This broad development has been spurred on by rapid advances in high-speed microelectronics and integrated circuit fabrication techniques. An ever-increasing assortment of integrated circuit parts, specifically tailored to perform common DSP functions, is available to the designer. More than 50 000 journal and conference papers and more than 100 textbooks have been published in the general areas of digital signal processing. It has become a virtually hopeless task to be familar with, or even to be aware of, the majority of the algorithms, implementation strategies and design techniques that comprise the subject.

One of the stated objectives of the *Handbook for Digital Signal Processing* is to distill the extensive literature of the central ideas and primary analysis methods for the design and implementation of DSP systems. The book achieves this very well, and points the reader to the primary reference sources that give more detail to the various methods described. The handbook also includes several computer programs, and links, wherever possible, the primary design methods to relevant published software.

The book comprises 16 chapters covering both fundamental and advanced topics. Much of this book is directed towards the theory and design of linear time-invariant discrete-time systems for the processing of discrete-time signals. Chapter 1 provides a useful introduction to the basic concepts of signal processing and includes several typical examples of applications. The mathematical foundations of signal processing are provided in Chapter 2. Chapter 3 describes several mathematical representations of digital filters.

Chapters 4, 5 and 13 outline various methods for the design of such filters. Chapter 6 is concerned with the issues that are common to most types of practical implementations of digital filters, such as limited- precision word-lengths. Chapter 7 reviews digital filter structures that minimise such detrimental effects. Chapter 8 delineates some commonly used algorithms for fast computations of the discrete Fourier transform, an important DSP tool for the analysis of signals. It also describes a number of algorithms for the implementation of fast convolution. Chapter 9 reviews the basic principles of residue number system arithmetic and describes some related DSP applications. The interface technology needed for the digital processing of continuous-time signals is treated in Chapter 10. Chapters 11 and 12 describe various techniques for the hardware and software implementation of DSP algorithms, and includes a comprehensive review of some popular commercial programmable microcomputers, specifically targetted at DSP applications. Chapter 14 is devoted to a review of important DSP techniques which allow operation at multiple sample rates. The subject of adaptive filter theory and design is considered in Chapter 15. Finally Chapter 16 reviews a number of algorithms and techniques for spectral analysis.

The editors and the contributing authors of this comprehensive handbook are all internationally recognised experts, and each provides a broad and rigorous treatment of their respective DSP technologies. Although a number of practical applications are described in the book, it is a little disappointing that more space could not be devoted to the major applications for DSP in the important sphere of telecommunications. For example, the well-established fields of speech coding and modem data transmission have been the main beneficiaries of DSP technologies in recent years and yet are barely mentioned. The increasingly important subject of adaptive filtering could also have justified more than a single chapter. Much of the detail relating to specific DSP devices described in Chapters 11 and 12 can be expected to date quickly, especially in the rapidly expanding spheres of parallel, floating point and mixed analogue/digital hardware technologies. Nevertheless, the information provided on the underlying architectural and programming considerations will be more lasting. It is surprising that, although numerous programming examples are given, very little is provided on commercial DSP support tools and development environments, which are an important aid to designers who need to ensure that the full benefits of these sophisticated devices are economically unleased.

These are minor points, however, as this comprehensive handbook provides a wealth of useful information on DSP systems and techniques. Practising DSP professionals, researchers and advanced students in telecommunications, computer science and electronics, will find this to be a most valuable reference for years to come.

Published by John Wiley & Sons, Inc. £80·00. xxxi + 1268 pp. ISBN 0-471-61995-7.

Reviewed by Fred Westall

Digital Transmission Systems, Second Edition

David R. Smith

This is an uncompromisingly American book, but readers should not allow themselves to be put off by the continual references to US practices and standards, rather than the more familiar European ones. Tolerance is particularly necessary when dealing with the practical examples cited throughout the text. These all relate to the author's US-based experience.

It is, however, worth the effort to convert the 1·544 Mbit/s view of the world into 2·048 Mbit/s, because overall this is an attractive book that manages to be both informative and relatively easy to read.

It is clearly pitched for breadth rather than depth and provides a good reference text for engineers and perhaps final-year students.

The book is rationally structured, moving along lines of historically based technology, starting with simple pulse-code modulation (PCM) and arriving around page 800 at the broadband integrated services digital network (ISDN).

Each chapter begins by setting out a few clearly stated objectives. These are remarkably useful in focusing the mind. The text is obviously produced with engineers in mind and is well illustrated with plenty of pictures and explanatory diagrams. The mathematics are well handled, and in general provide illumination, rather than becoming an end in themselves. Each chapter finishes with a summary and a series of problems to test understanding, though it is a pity that the author does not provide standard answers.

The coverage of the subject is reasonably good, with some excellent chapters on optical-fibre systems, though it is perhaps surprising that network management and signalling are almost totally omitted.

Published by Van Nostrand Reinhold. £66·00. xiv+818 pp. ISBN 0-442-00917-8.

Reviewd by Derek Nash

notes and comments

Contributions of articles to the *Journal* are always welcome. Anyone who feels that he or she could contribute a telecommunications-related article (either short or long), which may embrace technological, commercial and managerial issues, is invited to contact the Managing Editor, BTE Journal, Post Point G012, 2–12 Gresham Street, London EC2V 7AG (Tel: 071-356 8022; Fax: 071–356 7942). Guidance notes for authors are available and these will be sent on request.

Articles for 'Field Focus' are particularly welcome. For example, novel solutions to field problems could form the basis of very interesting articles. Potential authors are encouraged to contact the Managing Editor or IBTE Local-Centre Secretaries (see p. 328).

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33rd European Telecommunications Congress

CALL FOR PAPERS

The 33rd FITCE Congress, which will be held in Dresden, Germany, from 29 August–3 September 1994, will be based on the theme:

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Paul Nichols, FITCE UK Papers Coordinator, Post Point G012, 2–12 Gresham Street, London EC2V 7AG (Telephone: 071–356 8022; Facsimile: 071–356 7942).

Copies of the FITCE standard form are available from the above address, and will be sent on demand.

Authors will be advised of the papers that have been selected during early-April 1994, after the final programme has been determined.

The full text of a selected paper, which is required by 15 May 1994, should be about 2000 words to allow for a 25 minute presentation and 5 minutes for questions and debate.

FITCE

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Contents

The Journal of The Institution of British Telecommunications Engineers