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Information Networks

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SPECIAL ISSUE—INFORMATION NETWORKS

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FOREWORD by Mike Armitage

It is a very great pleasure for me to write the foreword to the *Journal*, and to commend this issue's set of articles on the theme of Information Networks.

The articles deal with the particulars of a set of very complex technologies, but the simple message is that changes of great significance are taking place throughout the world and in its markets. Information, and therefore information technology, is the heart of BT's—our—business and our future.

The contributors are several of BT's best and I know you will find reading this issue stimulating, enjoyable and of value.

M. ARMITAGE
Assistant Managing Director,
British Telecom UK

The Board of Editors would like to thank John Spackman, Director Computing and Information Services, BTUK, for his work as Guest Editor of this special issue of the *Journal*.

British Telecom in the Developing Global Information Network Industry

B. R. BOND†, and W. G. T. JONES*

In financial terms, British Telecom ranks with the largest companies in the world, though to date its main role has been as the major telecommunications provider in the UK. Globally, as well as in the UK, the situation in telecommunications and allied fields is evolving with changing customer requirements, regulatory environments and the positions being taken by companies. BT is therefore developing the strategy by which it will maintain its strength and achieve its vision, in terms of the markets it will address and how it will meet the needs of customers in those markets.

INTRODUCTION

By any standards, British Telecom is a large and successful organisation. In terms of publicly quoted companies, BT is in the world's top 30 for market capitalisation (number of shares multiplied by share price) and in the top ten for profit. In a sense, this is hardly surprising since only a few years ago, before BT was privatised and telecommunications was liberalised in the UK, BT was the monopoly PTT in a country with one of the world's largest networks. Its revenue, therefore, came almost entirely from the provision of telecommunications services within the UK and from carrying telecommunications traffic between the UK and other countries. Situations like that do not change overnight, so although BT has taken a number of strategic actions in the last few years, its sources of revenue and profit remain largely the same.

Such a position makes BT highly dependent on two important factors: the UK economic situation and the UK regulatory environment. In telecommunications and the information industry generally however, the world is changing rapidly with significant developments taking place in most of the advanced countries. The UK is no exception; indeed, in some ways it leads the pack.

One facet of these changes is in the nature of the business itself. Telecommunications has always been about carrying information, but increasingly there is convergence between areas which used to be treated separately: telecommunications as the information transporter, the information which is carried, information technology, and entertainment.

Given this complex and evolving situation, BT clearly needs to review its strategy and decide the vision it wishes to achieve in the future. Starting from its strengths in UK telecommunications, what role does BT want to play in the developing global information networks industry?

† Director Corporate Strategy, British Telecom
* Corporate Strategy Department, British Telecom

MISSION AND VISION

BT has determined its Mission, its central purpose, which defines the broad area of business in which it operates, and this has been stated publicly so that shareholders can see the nature of the business in which they are investing. BT's Mission, as printed annually in the Report and Accounts, is as follows:

- to provide world class telecommunications and information products and services, and
- to develop and exploit our networks at home and overseas,

so that we can:

- meet the requirements of our customers,
- sustain growth in the earnings of the group on behalf of our shareholders, and
- make a fitting contribution to the community in which we conduct our business.

While it is obviously important for the company to have such basic objectives, the Mission is not intended to provide planning guidance to the business units. To achieve that, there must be a vision of where the company wants to be at some future time, from which successive levels of more specific and quantified goals can be determined.

BT has a vision which is simply stated: to become the most successful world-wide telecommunications group. As with any company, success will come only by meeting the needs of customers in the chosen area of business, so the first requirement is a strategic market framework. Such a framework examines the relevant markets world-wide, their relative attractiveness and BT's ability to address them.

THE WORLD SCENE

The world's population is about five billion, the total gross domestic product (GDP) some 19 trillion dollars, and the world telecommunications market, broadly defined, is around $500 billion. Not surprisingly, the geographic distribution of these three factors is very uneven. The areas often known as the *triad*—North America, Western Europe and Japan—take a disproportionate share in relation to their population, as shown by the approximate figures in Table 1.

TABLE 1
The Triad as a Proportion of the World
(approximate figures)

	Population %	GDP %	Telecommunications Revenue %
N. America	5	26	50
W. Europe	7	26	30
Japan	2	13	15
Total	14	65	95

TABLE 2
Major IT and Telecommunications Companies

Company	Approximate Turnover $ billion	Location of Parent
IBM	58	N. America
NTT	42	Japan
AT&T	38	N. America
Deutsche Telekom	31	W. Europe
BT	19	W. Europe
NEC	17	Japan
France Telecom	15	W. Europe
GTE	14	N. America
Bell South	14	N. America
Fujitsu	14	Japan
CGE	13	W. Europe
Digital	12	N. America
Siemens	12	W. Europe
BCE (Canada)	12	N. America
Bell Atlantic	11	N. America
STET	11	W. Europe
NYNEX	11	N. America
Hitachi	10	Japan
Pacific Telesis	10	N. America
Unisys	9	N. America

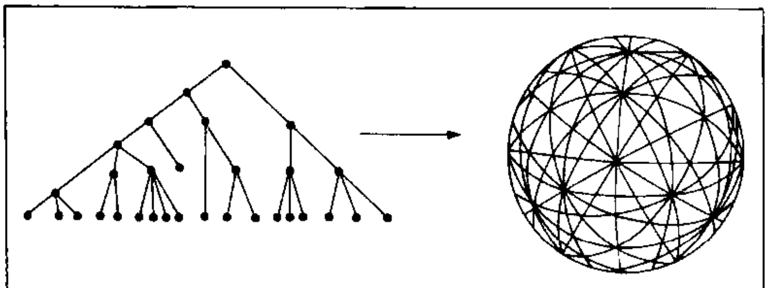


Figure 1—From pyramid to geodesic network

It is obvious that, in order to be a major world player in telecommunications, the triad markets are far the most important. But where does Western Europe stand? It has half of the triad population but only 40% of the GDP. Its expenditure on information technology is only 30% of the triad total and it produces only 40% of its own information technology (IT) equipment. Most significant of all, it has only 7% of the world's IT production. In this area of information, then, Europe has relatively low consumption and is weak in competition with the rest of the triad.

The point is emphasised by looking at the companies involved. Table 2 lists some of the world's leading companies in IT and telecommunications, showing that only six of these are based in Europe and only one in the UK: BT.

THE UK PICTURE

BT certainly still has a major position in UK telecommunications, but liberalisation of the market and the government's determination to introduce competition has brought many new entrants, and a changing structure to the industry. There is plenty of evidence that the concept of a geodesic network is happening in the UK just as in the USA. This concept, derived by Huber† in 1987, arises because customers want the benefits of information, through telecommunications and IT, with the flexibility of multiple options and mediums. They also need to be able to control and simplify the complexity that can result.

The traditional view of the network as a pyramid of switching nodes connected by transmission links is thus becoming obsolete, being replaced by a geodesic structure as illustrated in Figure 1. In the last five years, the number of PBXs and private circuits has grown significantly faster than PSTN calls and business lines. New operators in fixed and mobile networks have appeared, some extending their business geographically into the UK and others coming from a manufacturing background. The enthusiasm over licence applications for Telepoint and personal communication networks, and the type of companies involved, makes an interesting study.

Similarly in cable TV, after a period of relative stagnation, many franchises are being awarded with active participation by foreign telecommunications operators such as the US regional Bell operating companies (RBOCs). In the data area, too, there is rapid growth in managed data network services (MDNS) and applications such as electronic data interchange (EDI), with familiar names from the IT and telecommunications industry playing prominent parts.

† HUBER, P. W. The Geodesic Network. 1987 Report on Competition in the Telephone Industry. Washington DC (Jan 1987).

Companies are finding new ways to gain competitive advantage with telecommunications, such as using 0800 and 0345 services and paying for all or part of the call from a prospective customer. Others are gaining new revenue from providing information over 0898 lines. Customers, both at work and as consumers, have quickly adapted to these new opportunities, just as they have in areas where the use of telecommunications is almost invisible, as with cash dispensers.

So it is clear that the UK market is attractive to both customers and operators. The growth rate of telecommunications is higher than in many countries; for example, the number of exchange lines for businesses is growing at about 11% per annum. Britain is a major economic centre, strong in financial services, as discussed later, which encourages companies in this and other fields to come to the UK.

Coupled with this, companies from the US often regard the UK as the gateway to Europe. The UK market is more open than most, in many fields including telecommunications, while the American language and culture are closer to those of the UK than to continental European countries. British Telecom has played a part in this growth; for example, by providing international dialling at an early date and making direct dialled access available to almost all countries in the world.

With telecommunications becoming more complex and the number of operators increasing, organisational customers are facing a growing problem. How do they benefit from telecommunications, take advantage of all the options available, control them so that they serve their needs in the most effective way, and not spend too much time and money in managing their telecommunications facilities? To examine this and the role for BT, we need to look more closely at the requirements of customers.

MEETING CUSTOMER NEEDS

So what is a market? It is the coming together of customers, who have needs, with products or services which satisfy those needs. Well then, who are the customers? For a start, they are not all the same. As with many types of business, BT's revenues are distributed very unevenly among its customers, with a large proportion of the revenue coming from only a small percentage of the customers. This applies both to the totality of revenue and to individual services. It reaches an extreme, perhaps, in the few residential lines which generate most of the international calls from households, though even for local calls the distribution is far from uniform.

Some customers are thus more information intensive than others, and it is vital that they form part of BT's customer base or the company will not obtain a sufficient proportion of the available revenue.

TABLE 3
Customer Needs

Organisations	Consumers
Increase revenues	Physiological
Reducc expenses	Security
Efficient use of capital	Affiliation
	Esteem
	Knowledge and understanding
	Aesthetics
	Control of personal environment

But what are their needs which have to be satisfied? To examine that, let us start without reference to telecommunications. Table 3 gives some of the separate base level needs for organisations and consumers.

Information can be used increasingly in the business environment, as shown by the growing proportion of workers who are 'knowledge based' in Figure 2, compared to those involved in manufacturing.

To compound the situation, the market arenas are changing too. In the past, most workers led two lives, one at work and the other as a domestic consumer. And in the working environment, there was clear separation between the functional areas: manufacture, design, procurement, distribution, marketing and sales, and so on. There were probably knowledge workers within each area, but they had little ability to intercommunicate effectively.

Increasingly, there is a growing ability to handle large quantities of data and turn it into useful information, thereby integrating the total functions of an organisation to much greater effect. In addition, the knowledge worker is sometimes out of the office and wants to have the same capabilities of communicating and

Figure 2
UK labour force

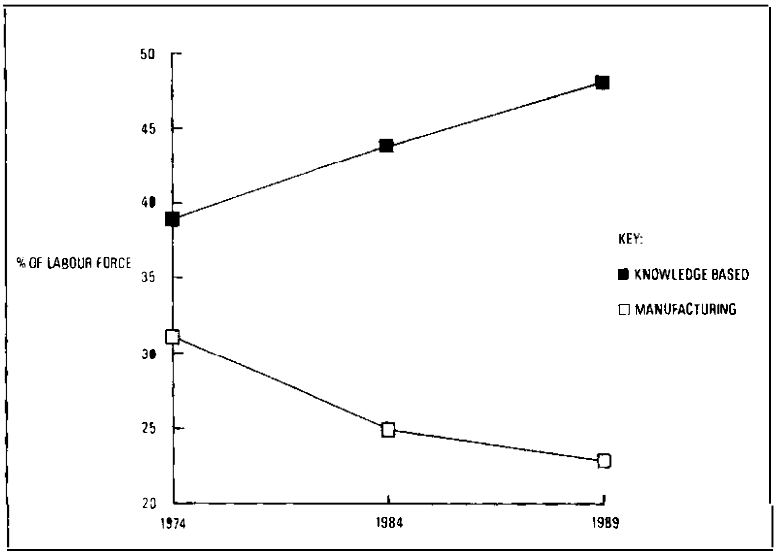
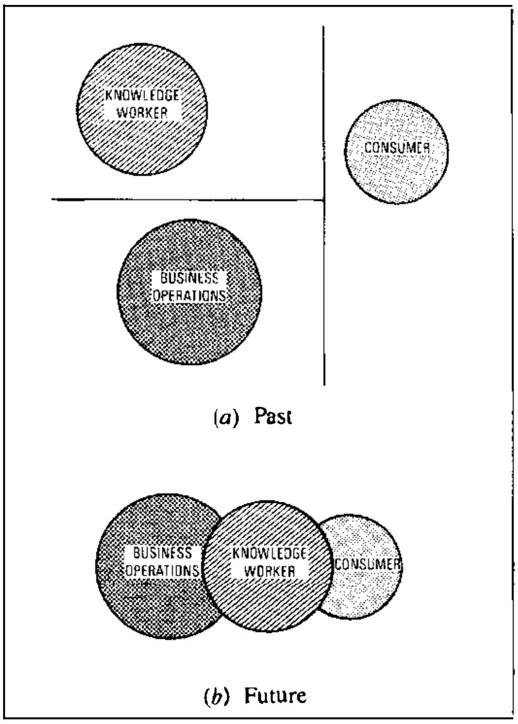


Figure 3
Market arenas



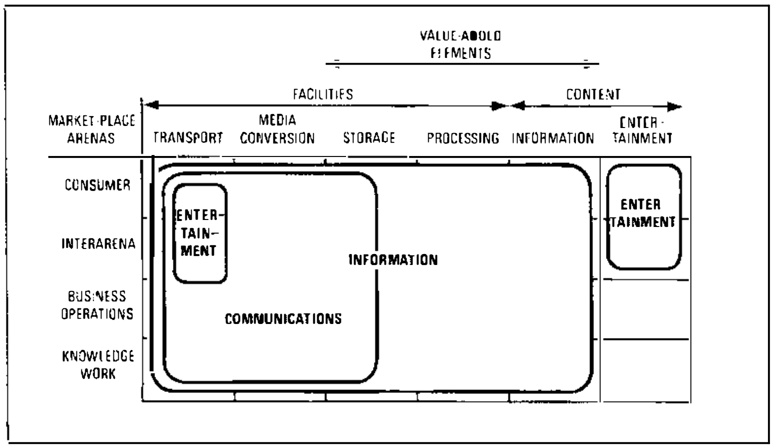
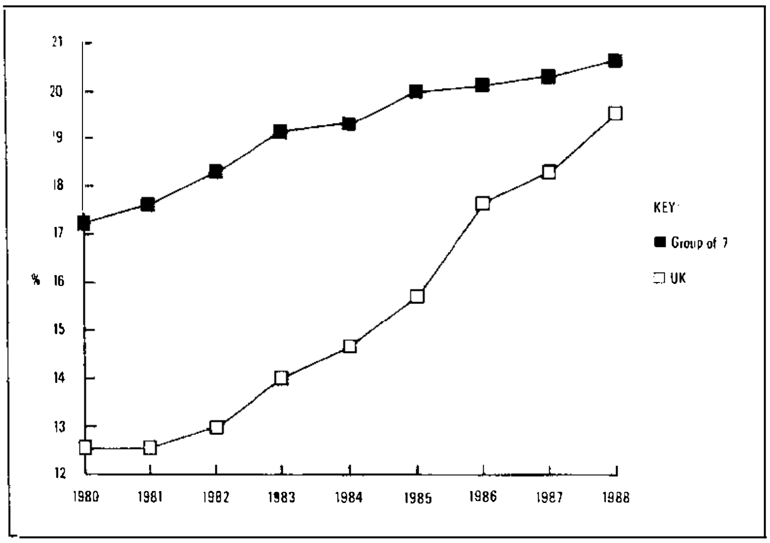


Figure 4—Information industry map



Sources: OECD National Accounts, Bank of Canada Review, IFS (IMS)
Figure 5—Financial services as share of GDP

dealing with information, whether on the move or at home. Indeed, there is the possibility of doing much of the work from home and spending less time travelling to and from the office. And if the worker has sophisticated information equipment in the office, and at home for work purposes, then it will be used increasingly for things other than work. The functions and needs of the worker and consumer begin to merge, indeed the whole scene starts to converge as illustrated by the two parts of Figure 3. Going back to Table 3, it can be seen that information and communications are necessary to satisfy several of the base needs of individuals as consumers as well as those when the individual forms part of an organisation.

Because of this convergence, in determining company strategy it is useful to break down the facilities involved in handling information and the type of information being handled. The elements can then be matched against the market-place arenas. A simple first approach to this is shown in Figure 4, using a map developed by management consultants Booz Allen and Hamilton. The diagram shows the clear overlap between what were previously treated as separate areas. Of particular importance to a company such as BT is the interarena market-place, operating between the groups of customers. By definition, this is a major function of public telecommunications.

To illustrate the expansion of information intensive businesses, look at financial services and how the companies involved have grown in the UK. Figure 5 compares the position with the top seven OECD (Organisation for Economic Co-operation and Development) countries, showing that although the UK started behind, it has grown much faster. This is partly due to foreign financial companies entering the UK, encouraged by the open telecommunications environment, and combines with the need of successful companies to follow their customers. They are global customers who need to move information around the world in sophisticated ways and at high speed. These companies are not only information intensive, hungry for advanced facilities, they are also strong international communicators and prime exponents of the need for a geodesic network. They have an increasing range of options as to how they do it, and BT has a responsibility to help them satisfy their needs.

TECHNOLOGY AS THE ENABLER

This article will not dwell on technology since that is the purpose of the other articles in this issue. However, in the turbulent information industry, it is technology which provides the enabling function to satisfy the driving force of customer needs. Fortunately, technology is serving us well. The last few decades have seen a technological explosion affecting telecommunications, IT, and every aspect of the information business. One can take almost any area, such as processors, memory devices, telephone exchanges or transmission links, and put figures on the axes of graphs as in Figure 6.

Just as important, given the earlier comments on the influence of the regulator, is the essential truth of a saying which has developed: what customers require and technology can provide, the regulator will eventually permit.

The question for BT is: **when** will the regulator permit?

BT AS A GLOBAL PLAYER

The attraction of the UK for organisations in all areas of business has been described, and BT has worked to meet their needs to date by improving the trunk network with extensive use of optical fibre, bringing in digital switching at the rate of two exchanges a day, interconnecting these exchanges with probably the world's largest network of common-channel signalling, and controlling the network with comprehensive network management centres. But that is not enough. As customer needs evolve and companies become global in their outlook, so must BT.

Global companies operate throughout the triad regions with links into other parts of the world. The triad moves towards being almost a single region for business purposes and companies look for transparency of communications across it. BT must therefore work with its customers and build on the richness of its relationships with others in the information business.

BT has many strengths which can be extended to benefit customers. It is strong in technology in two of the most important areas: broadband services and mobile communications. It is pioneering in the work of developing fibre systems to reach the home, and highly active in cellular radio and Telepoint techniques, leading towards the concept of personal communications. BT has many correspondent relationships with operators overseas and works with them actively in the standards arena.

It is inevitable, therefore, that BT plays an essential role in Europe and throughout the triad region. It will focus on customers and their needs, forming alliances of various types with other operators, and it will be a leader where appropriate.

CONCLUSION

British Telecom is probably the only UK company likely to be able to achieve a vision of becoming the most successful world-wide telecommunications group. Even in Europe, Deutsche Telekom and France Telecom, which are the closest contenders, have yet to experience the full rigours of a competitive environment, and so far have had little chance to develop overseas activity.

As customer needs evolve and their telecommunications options increase, BT must help them manage and control their information flows to their greatest advantage. As their outlook becomes global, so must BT's, providing services and applications not only in the UK but by appropriate methods in all geographic regions, particularly the most developed countries. A start has been made in the mobile market of North America, through a stake in the US cellular operator McCaw. Similarly, acquiring Tymnet will allow BT to serve needs for data applications on a broader geographic basis. The customer also needs to be able to contact BT easily, so a series of offices is being set up in countries around the world. Technology is being developed, not to be technology led but to take best advantage of technical capability in matching customer requirements.

The future is always uncertain, but BT has adopted a strategy which will position it well in the developing global information network industry. There is no surer way of achieving the vision of becoming the most successful world-wide telecommunications group.

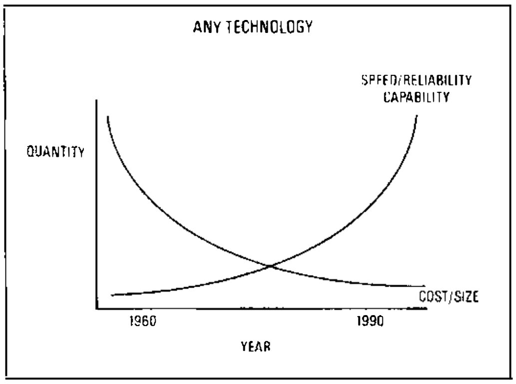


Figure 6
Explosion in technology for information

Biographies

Bruce Bond is Director of Corporate Strategy for BT and joined in the summer of 1989 from US West, one of the Bell operating companies. There he had been Corporate Vice President, Strategic Planning, for two years after a period in a similar position with Mountain Bell. Prior to that, he held a variety of posts in planning and marketing with AT&T and Bell operating companies. He obtained his first degree, in Psychology, from Colorado State University in 1967, has a Sloan Management Degree from MIT, and an MBA from the University of Dayton.

Bill Jones joined BT in 1960 and obtained a B.Sc. in Electrical Engineering from Portsmouth Polytechnic in 1965. Most of his career has been on the research and development (R&D) side, with periods at British Telecom Research Laboratories, Martlesham Heath, on digital switching and transmission followed by five years on System X. He then became Director of one of the two R&D Departments which existed in 1983, leading to Chief Executive Technology responsible for all BT's central R&D activity. During 1987, he was an Executive-in-Residence at the International Management Institute based in Geneva, returning to BT in 1988 as Director of Technology Studies in the Corporate Strategy Department. He is a Fellow of the Institution of Electrical Engineers and an Honorary Fellow of Portsmouth Polytechnic.

The Networked Organisation

J. W. C. SPACKMAN†

In a changing world and, hence, in a changing market-place, the way in which companies manage the information resource will be a key factor in their economic survival. Information technology, while not a panacea, can, if properly managed, so facilitate the effective use of information as to lead to considerable competitive advantage. The problem remains of how to store and distribute useful information effectively through the organisation. A managed integrated information network is the only option for large organisations. This article examines the need for 'information resource management' and describes how networks can be developed which support this concept—'integrated corporate information networks'.

> 'Many, perhaps a majority of companies today, are in serious trouble without realising it. Their predicament is a direct consequence of their failure to appreciate how drastically information technology (IT) is changing the structure of their industries, altering the balance of competition within it and favouring those companies which exploit IT to best advantage.'
>
> Alan Kane, Financial Times,
> Success depends on IT,
> EDIP publications, 1988

A CHANGING WORLD

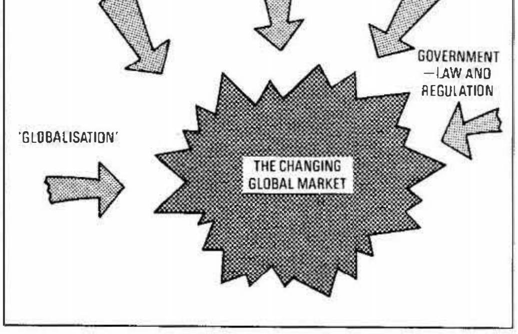
Businesses today operate in a dynamic ever-changing market where technological, social, economic, demographic and political changes occur at such speed that businesses, however large, need to be light-footed to survive (Figure 1).

The potential customer population is expanding as a result of 'globalisation' of the world's markets and through the moves towards European unity. Demographic shifts are altering the structure of these markets. At the same time, the customer's perception of needs is constantly changing, leading to a demand for new products and better service. The demands from home and business increasingly reflect a communications-based life-style. As the market changes, so does the technology which enables companies to meet this market demand. These market changes represent both opportunity, through market expansion; and threat, through competition and Government regulation (Figure 2).

Under these conditions, the whole business must be capable of reacting rapidly to change, with all functional and operational organisations pulling together to respond fast to the opportunities of a changing market-place, and to ward off the threats.

† Director Computing and Information Services, British Telecom UK

Figure 1
The forces of change



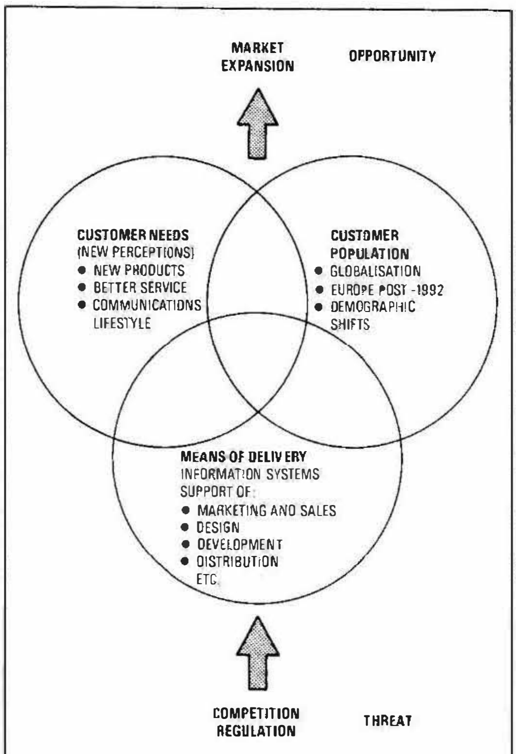


Figure 2—The changing market

Under stable conditions, rigid hierarchical organisations can function effectively, but under rapidly changing conditions, they are too inflexible to survive and ways have to be found to break down inter-functional barriers. These hierarchies are sometimes referred to as *pyramid* organisations. The term is apt for, as Robb Wilmot (Chairman, OASiS and former Chief Executive ICL) points out, 'pyramids are where the innovators get buried!' In the responsive organisations (Figure 3), front-line managers can call on the core capabilities (like Networks), and on the resource and support managers to form flexible groupings to respond to specific customer needs.

Ensuring that the right information is delivered to the right manager at the right time and in the right form is a key enabler in the responsive organisation. It means providing information to assess moves in the market, to predict customer demand, to plan product development, to monitor the efficiency of business performance, to control costs and to monitor progress; and delivering it much faster and with much greater accuracy and consistency than in the past.

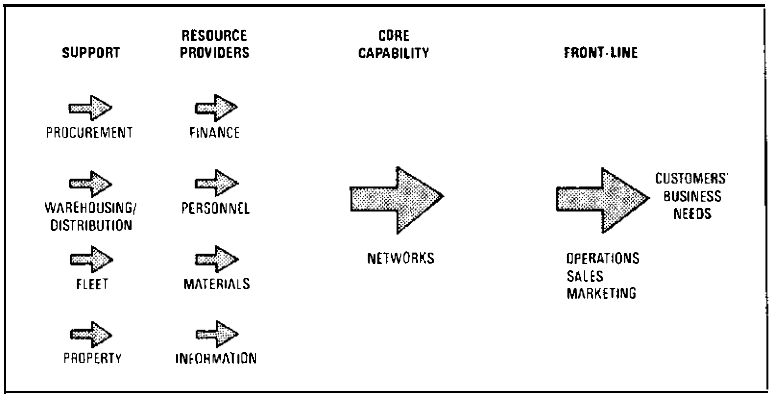


Figure 3
The responsive organisation

IT'S NOT JUST ABOUT COMPUTING

'Computing' is the subject of some powerfully embedded preconceptions, which reflect a more general and peculiarly British tendency to think about people, organisations and issues in rigid narrowly-defined separate compartments. Other cultures have organisational hierarchies, but nowhere are the barriers more inflexibly imposed than in Britain. Computer people, in particular, tend to view the world from the technology outwards, while most general managers view all technology as separate and secondary to their business functions.

Compartmental barriers exist even within the technology between telecommunications engineers and the data-processing community. This pigeon-hole approach to business organisations leads to poor communication between management functions and a lack of understanding of the value of other people's contributions to the essential team work of management. General managers do not understand computing; computer managers do not understand the business. Yet, in this dynamic environment, it is essential that the technology of modern business operations is not artificially separated from the general conduct of business. Modern managers should understand how to use the new tools at their disposal, and, in particular, the tools for handling information—the most fundamental of all business resources. Thus, the issues are much more complex than simple considerations of cost reduction through automation. It is not simply about replacing human effort by machines, nor about handling very high volume complex transactions, nor about storing large volumes of data, although all these functions will take place within an information network. It is not about automating business processes, but it is about **communicating**; that is, transferring information between people and between business processes, ensuring that consistent and correct information gets to customers or to managers, in the way they want it, when they want it.

The real concern is with the management of business information through the effective use of the electronic technology which is now put at our disposal. Information management, using information technology as the tool, is all about the efficient running of the business. Today, this means that all forms of electronic, optical or opto-electronic storage, retrieval, processing transmission and presentation of information should be used in a cost-effective way to support business needs. The technology of the information tools has already converged; the business use of the tools will converge as voice telephony, data processing, data transmission, facsimile, electronic mail, video conferencing are used, where and when appropriate, to provide the integrated services which supply the information needed to run a responsive integrated business.

ALL ORGANISATIONS ARE 'INFORMATION SYSTEMS'

Information is the primary resource available to man. It is that resource from which, ultimately, all others flow. Even the supply of food, man's most important physical resource, has, from the time of the nomadic hunter to the time of the genetic scientist, depended on the accumulation of data: where to find food, what makes it grow, what hereditary factors influence growth, and so on. These data are then ordered into patterns of linked and correlated facts that are termed *information* (Figure 4). This is then used by the human mind to create *knowledge* which brings the ability to predict, plan and execute change; in the instance quoted, to increase the supply of food. Adequate supplies of any physical resource, be it food, or warmth, or shelter or money, will always depend on the intangible resource of **information**.

Both data and information can be stored on 'machine' systems; for example, a tallyman's beads, a clay tablet, the written word, the

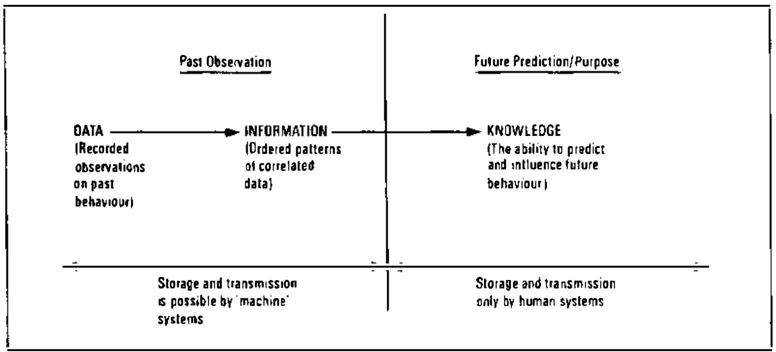


Figure 4
The information chain

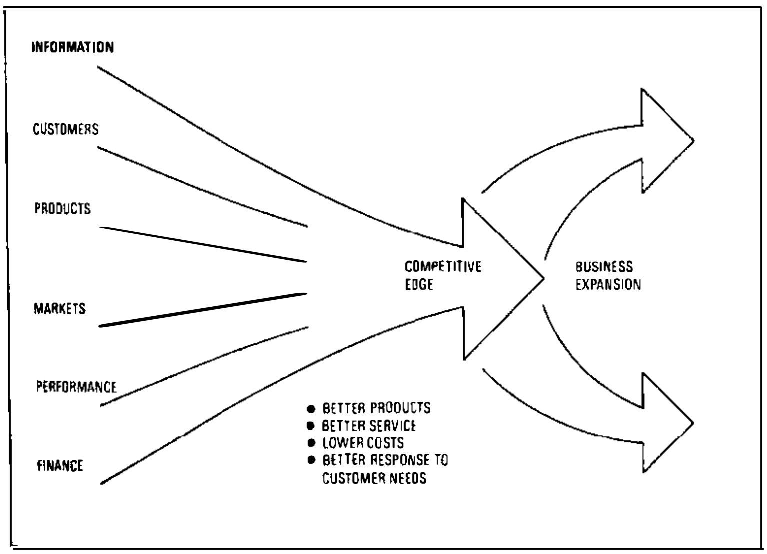
printed word, or a computer file. These are all mechanical technological means of storing data or information. Both data and information relate to observation on **past** behaviour. A process that, until very recently, has been exclusively a human attribute is to take that information, and from it predict future behaviour. This is at the root of what we describe as 'knowledge'. (Artificial intelligence has recently and uncomfortably blurred the precision of that distinction, but to such a limited extent that we may still, for all practical purposes and, for a while at least, regard knowledge as a wholly human attribute.)

All human organisations, beyond the family unit, exist primarily because their members agree a common purpose and share the information that allows them to accumulate physical resources, whether this is by husbandry, by hunting, or by competition or conflict with other organisations; and whether we are concerned with the acquisition of food, warmth, shelter, material possessions, or, indeed, corporate profit. All organisations are therefore characterised by the way in which they share information for the accumulation of physical resources. All organisations are *information systems*.

INFORMATION—THE KEY TO COMPETITIVE SURVIVAL

While organisations commonly manage the physical resources of manpower, materials, property and money as a shared uniformly-managed corporate resource, they rarely manage in any systematic way the primary resource—information. *Information resource management* is about managing the corporate information and the information network that provides it in a similar systematic way to the management of the physical resources of the company, and for similar reasons. Information resource management does not usurp the authority of individual business units, but provides them with expert support and allows the resources to be shared to meet business priorities.

Figure 5
The information edge



To quote Robert Holland: 'Organisations must come to terms with the fact that data is a resource, as indispensable to success as raw material, facilities, cash reserves or employees. Information resource management (IRM) is:

The management philosophy
The analytical methods
The implementation guidelines

which enable an organisation to integrate and share its information resource'.

Already, then, it can be seen that the corporate information model extends well beyond the automation of business processes and into the ability not only to run processes effectively, but to provide information about customers and their needs and expectations; about competitors and their strategies and performance; about the external environment, demographic, social, political, regulatory, or economic influences that shape the market and about the internal performance of the firm as a whole, and all its component parts—costs, budgetary performance, sales performance, service performance—indeed, all relevant key performance indicators. This information leads to better products, better service and better performance, at lower cost. (Figure 5.)

Not only that, but the systematic evaluation of this information provides some even more important components of long-term success. As mentioned earlier, we live in a world of dramatic technological, social and economic change. In such a world, companies can never rely on good short-term performance to carry them safely into the future; both IBM's and Digital's current corporate performance give a clear indication of how difficult a market this is even for players of such excellence.

Competitive survival depends on far more than good short-term financial performance: it needs a great clarity of long-term strategic purpose and it needs controls to steer the organisation towards that purpose. Finally, since plans and tactics directed at the achievement of the long-term goals will change in response to competitive moves, to technology and to market changes, it is essential to be flexible and capable of adaptation to gain from new opportunities and to ward off new threats. Long-term competitive survival therefore depends on the way firms use information to ensure good performance from today's operations; to set strategic direction for future operations; to control progress towards the future, and to adapt to unpredicted change.

There is, of course, no single intelligence called 'the company'. British Telecom, for example, is a complex network of interrelated Divisions, functions and operations. In this network, there is no such thing as a 'stand-alone' process, for all processes draw information from and/or send information to other processes. Because fallible human and paper-based systems are used to transfer most of this information, even the most basic records, for example, pair allocation in the local loop, or even as simple an issue as customer addresses, are modified by different transactions in different parts of the organisation without any mechanism for correlation. Therefore, this information, even when transferred to machine-based computer systems, is replicated inaccurately with no easy basis for establishing which, if any, is the correct information on which to base action. Even the names and codes of certain items differ in different systems and different parts of the organisation.

The question for the future is: Can this situation be improved by a systematic structured approach to the corporate information network using the power of information technology to give confidence in the consistency, integrity, security and availability of business information?

STRUCTURED INFORMATION NETWORKS ARE DERIVED FROM STRUCTURED BUSINESS MODELS

It is possible to develop, in a formal way, a 'top-down' description of the business processes of an organisation. It is further possible to describe the organisation as it is now, and the organisation as it is intended it shall be, and to chart the major process steps in making the transition. This work has been completed, for example, in BTUK by Dr. Chris Brown, who has developed the Strategic Systems Plan for BTUK, based on a broadly similar approach to that used by James Martin in his *Information Engineering*. It is not a fixed and rigid model, but one that can change in the light of organisational or external change. This form of model is the starting point for a logically structured corporate information network, for it identifies what information is used by what business processes, and shows how information flows through the organisation. But who is responsible for the specification of these business processes and their information needs?

INFORMATION IS A SHARED CORPORATE RESOURCE

The word 'ownership' is frequently used in both total quality management (TQM) and project management literature in the sense of the nominated 'owner' taking responsibility for a project, or a process and for the related information. The intention is to convey the sense of a single point of responsibility which is inclusive of the total quality needs of the organisation, but it is all too often converted to a sense of **proprietary** and **exclusive** ownership: 'This is **my** project serving **my** function and this is **my** information'. Perhaps 'custodian' would have been a better word to have chosen, for no business process serves its nominated 'owner' exclusively and no information is confined to one function or one process. Information must be regarded essentially as a shared resource. Call statistics, for example, are of value to Finance as a primary aspect of revenue flow; to Networks for network planning and allocation; to Marketing and Sales as an indicator of customer demand; and to Field Operations as a basic feature of operational planning. Financial performance information cannot be logically separated from other performance indicators which all have financial consequences. It is all 'management information'.

Tom Peters (*Thriving on Chaos*) states: 'Information hoarding .... has been commonplace throughout American industry, service and manufacturing alike. It will be an impossible millstone around the neck of tomorrow's organisation. Sharing is a must. Sharing means .... the availability of all data to facility managers. Equally important, it means the availability of virtually all data to everyone, all the time'.

He goes on to list a number of advantages stemming from the free availability of information:

'● Information provides critical confirmation that the firm sees the worker as a partner and a problem solver.
● The widespread availability of information is the only basis for effective day-to-day problem solving which abets continuous improvement programmes.
● Sharing information on the front line inhibits the upper-level power game that is the prime energy of flexibility and moving fast.
● Visible posting of information radically speeds problem solving and action taking.
● Information sharing stirs the competitive juices.
● (Useful) information begets more (useful) information.
● Information abets flattening the organisation pyramid.'

There are then no simple billing or payroll or any other stand-alone systems which belong exclusively to functional managers—they should only be repositories of information on a corporate information network where information is shared by business processes and by business managers. For the future, **the network is the system**; not, however, the data transmission network, but the complete information network that connects managers throughout the organisation to the information they need to run the business and which extends from the mainframe computers and their databases to the user terminals themselves.

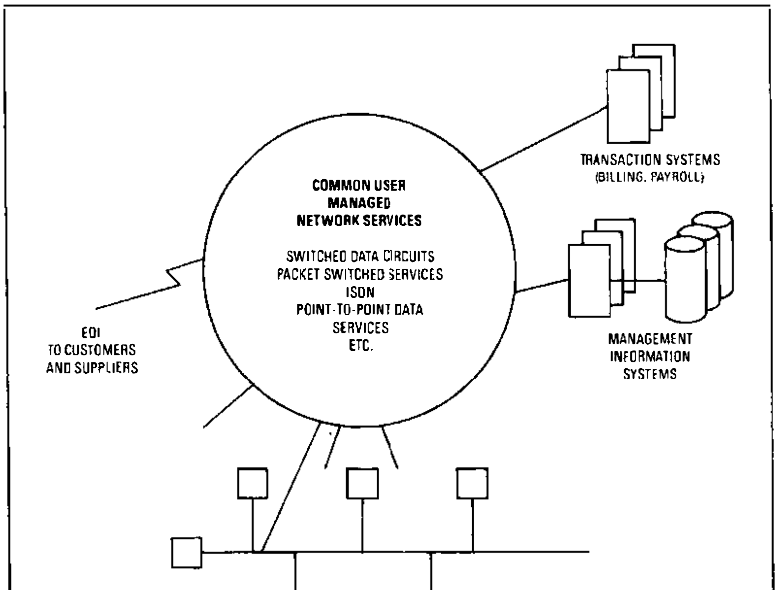
There are then two important concepts emerging strongly in leading-edge US industry, and following somewhat tentatively behind in European industry:

- *Information Resource Management*—the idea that information must be managed as a shared corporate resource.
- *The Integrated Corporate Information Network*—the concept that information should be delivered over an integrated corporate network which ensures the consistency and timely availability of information. This means in future few, if any, stand-alone personal computers, and no independent application developments. Everything must fit as part of the network if the true potential of the technology as an information provider is to be realised.

THE INTEGRATED CORPORATE INFORMATION NETWORK

Although it may depend on a physical infrastructure of computers and communications for its efficient and effective implementation, the information network is not principally a technological issue. Nor is it a means of **centralising** information. Robb Wilmot stated at the IT Perspectives conference in 1988: 'Instead of viewing an organisation having information sluggishly flowing in to the centre, you have to think of it having information flowing out from the central resources. You've got to think of networking as both a technology and a key organisational and interpersonal process. Power bases aren't allowed to be built on the privilege of knowledge which is the key characteristic of hierarchical organisations. In the new style of organisation, networks are used to mobilise the entire resource and knowhow of the enterprise around innovation occurring at the customer interface.'

Figure 6
The integrated corporate network



Nevertheless, in a publication such as this, it is permissible to talk a little about the physical infrastructure necessary for operating such a network. Figure 6 shows a conceptual arrangement for an integrated corporate network.

The core is a set of managed communication services established not on a project-by-project basis, but as an infrastructure available to all corporate users. In BT, this is provided by the Internal Communications Provisioning Authority through the set of managed network services that has been termed *INTERNET*. This network offers a variety of services: switched MegaStream circuits, packet switched services where appropriate, and point-to-point communications where necessary. It will in the future offer ISDN services. This network provides the highways for electronic mail and video conferencing as well as all forms of data transmission for the various transaction and management information systems.

It is perfectly possible to use common carrier data services and provide the actual network protocols on a proprietary basis. The market leaders would certainly be IBM with SNA and Digital with DECnet. These have the advantages of mature network management capabilities, but have the overriding disadvantage of locking users into a single supplier and, more importantly, locking them out of some of the leading-edge cost competitive advances from the IT industry—specialist database 'engines' like TERADATA, powerful and very low-cost UNIX servers and workstations such as PYRAMID, SUN, SEQUENT and so on. The dominant form of the integrated corporate network is nevertheless still based on proprietary networks, mainly DECnet or SNA. There are some hybrid networks with gateways between DECnet and SNA but, as yet, few 'Open Systems' networks. However, for many reasons, it is expected that the industry will now migrate fairly rapidly to universal Open Systems networking standards and many major players are firmly committed, including US Department of Defense, Department of Treasury and other US Government agencies, the UK Government and the European Commission. British Telecom is in the forefront of pressing for Open Systems standards and has adopted these for its internal networks, although currently the network is actually a hybrid of several proprietary networking architectures and Open Systems Interconnection (OSI).

The network allows user terminals to access mainframe computer systems which need not, indeed should not, be collocated with the terminal users. Provided the controls are in place to ensure a responsive reliable service, then the user should neither know nor care where the mainframe is located, any more than a telephone user needs to know or care where the exchanges are. This has many advantages:

- shared accommodation costs;
- shared plant, power, heating, air-conditioning etc;
- shared operating and technical support skills; and
- simplified networking by concentrating on fewer, larger centres.

It also allows work to be shared between processors, easier management of stand-by arrangements, greater flexibility and generally better use of mainframe resources. It is for these reasons that BT will progressively consolidate its mainframe computing resources into fewer larger centres. This pattern is also common among large industrial concerns, with IBM, AT&T and EDS in the forefront of this practice.

Although concerns are often expressed about the responsiveness and quality of service from centralised mainframe support, the modern mainframe environment is moving increasingly to unattended operation. Since neither development nor support need be collocated with computers, the quality of service to business users has little or nothing to do with the location of their mainframes.

For various technical reasons, it is anticipated that transaction systems in future will not have embedded management information capabilities, but rather that management information will be extracted and 'stock-piled' on large relational databases—*information warehouses* as they have been termed—which will run on separate mainframes.

At the local end, where there is a significant concentration of terminals, they will share the communications capabilities of local area networks. It is anticipated that users will not in future expect to find more than one terminal on their desks, but will use a single 'window' into any application they need; the technology of 'dumb' asynchronous terminals and intelligent workstations will converge and, increasingly, the industry will move to intelligent workstations; stand-alone personal computers will gradually be replaced by intelligent terminals on the network with sufficient local intelligence to provide the best of both worlds with regard to the characteristics of the personal computer and the mini- or mainframe-based systems. Portable terminals will be capable of temporary detachment from the network to work in the same way as a portable personal computer.

Application, print, file and network servers will sit on the LAN. Once again, because the LAN is interconnected with the common user wide area network (WAN), it is possible to get away from the debate of centralised versus distributed computing, and get the best of both worlds, centralising those applications which should be centralised and distributing those better handled locally.

Increasingly, the industry is moving to high-efficiency UNIX servers. A universal UNIX standard, giving complete interoperability and application portability, is very near to emerging and the present split in the industry looks like being soon healed. Effective mainframe implementations of UNIX are expected to follow which will have the capability of handling all but the very largest databases or transaction loads.

By concentrating on OSI and UNIX standards, British Telecom will provide a durable, flexible and economic networking architecture, firmly based on accepted industry standards, which allows forward organic development without large hardware communications and software systems having to be replaced every time there is an application or a technology change. Furthermore, by sharing communications and allowing one terminal to access many systems, the costs of communications for business applications will be progressively reduced. This general form for the integrated corporate network is increasingly the standard for large organisations. The most barren and fruitless argument of the industry has been the centralised versus distributed debate and the idea that either mainframes, or minis (or 'departmental' computers), or personal computers, provided the universal answer. Each architecture has its role and all need to intercommunicate, using a common communications network.

There will be several important additional trends over the next few years: videoconferencing and ISDN-based combined terminals, and telephone conferencing will grow in popularity. Electronic mail will increasingly take over (although probably never completely) from paper- based mail, but more importantly, the same 'mail' terminal, which will be provided in BT by COAST, will give access to corporate databases: standing instructions, performance statistics, customer information, product information and so on. Flexible 'executive information system' types of tools will be used so that users can easily extract information in the form they want—bar chart, graph, pie chart or table. There will be an increasing demand for image transmission, not just facsimile, but image incorporated into information systems so that, as well as text, one can transfer drawings or product images or sales campaign material and the like.

All this is traffic on the network and very good news for the Telcos.

Finally, there is a further important trend. Neither electronic transmission of information nor indeed the business information itself, is confined within the company. Information needs to be exchanged with suppliers and business customers. The integrated corporate network therefore becomes part of a wider mesh of inter-corporate networks that are increasingly crossing national boundaries to form a global membrane of business communications.

THE EXTENDED ORGANISATION

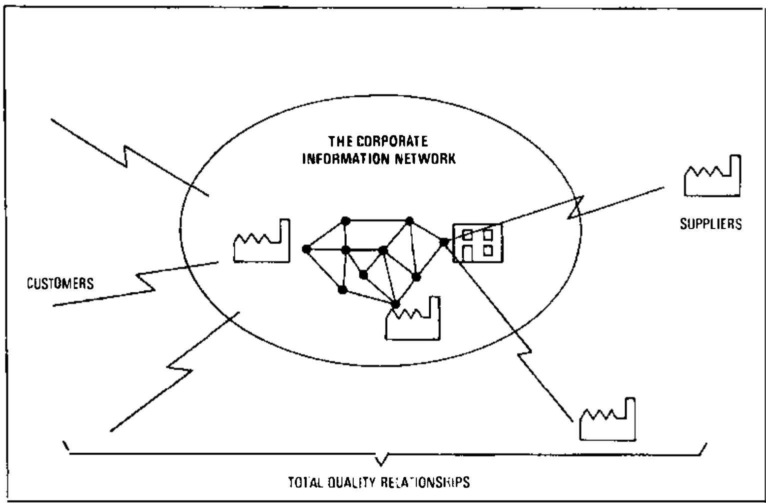
The business need to exchange information with customers and with suppliers is self-evident. What is less evident is the profound effect that electronic exchange of data and networking has on organisational relationships and on costs. In manufacturing, for example, electronic data interchange (EDI) offers a characteristic 'win-win' strategy where both sides of the game end up winning: customers, by reducing their inventory overheads through following 'just in time' inventory policies; manufacturers, in getting much smoother, more predictable demand and, hence, better production control. Long-term, stable, but not binding, total quality relationships can be more easily struck between customers and suppliers, and 'middle-men' become unnecessary. In BT's case, the possibility undoubtedly exists of getting customers' bills delivered in the form they want them at their customer premises; of customers configuring their own network through intelligent network services or of BT being able to detect faults or potential faults in customers' networks before they are detected by the customers themselves. All these capabilities are not simply technologically possible—they are, to a limited extent, actually being delivered today.

Electronic fund transfer at point of sale (EFTPOS) is another example of electronic information transfer.

Note that, in this extended model of an organisation, customers have many suppliers, suppliers many customers, so there are potentially a very large number of intersecting networks.

Most current EDI networks are private network services, set up among communities with common trading interests. Pressure is growing for international standardisation, and a United Nations body—EDIFACT—is attempting to obtain agreement to international standards. The European Telcos are working, through a British Telecom initiated co-operative body called *ETIS '92* (European Telecommunications Information Systems for 1992), towards standards for electronic data interchange on issues like international settlement or international installation and repair. *EDITEL* has been suggested as the name for such a standard.

Figure 7
The extended organisation



> 'IT is increasingly becoming central to the ability of companies to manage the entire value system, inside and outside the firm. Direct IT links between companies will be one of the major growth activities of the 1990s.'
>
> Michael Porter,
> Business Success and Information Technology,
> Amdahl Executive Institute Conference, 1988.

This form of direct IT link between businesses is predicted to be a very important market trend. (Figure 7.)

It should be noted that this form of exchange of information goes well beyond mere electronic mail or facsimile transmission, for the intention is that the information will be capable of being transferred between machine processes; a customer demand, for example, generating directly a goods order and, hence, picking and mailing instructions, with the related invoice being automatically returned over the EDI link.

Once again, the general trend is all good news for the Telcos, except, of course, that, in general, the higher up the value chain the service, the greater the profitability. The greatest competitive threat is therefore that private proprietary networks, operating over leased lines, will take most of the profit, leaving Telcos with line rental income only. This is the current dominant trend in the EDI market-place.

GLOBALISATION

Another major trend that affects the corporate network is the fact that, increasingly, business boundaries extend beyond national boundaries, and both the internal organisation of major corporations and their markets are global. This global market is currently dominated by three main market areas—North America, Europe, and Japan and the Pacific basin, the so-called *Triad*, but other international market areas are opening. Organisationally and technically, this poses a new problem for the information systems manager, for establishing an information network using the resources of many different national Telcos as data carriers or as value-added network providers is considerably more complex than providing the same services within the home country. Complex though it may be, if the customer base is international and the organisa-

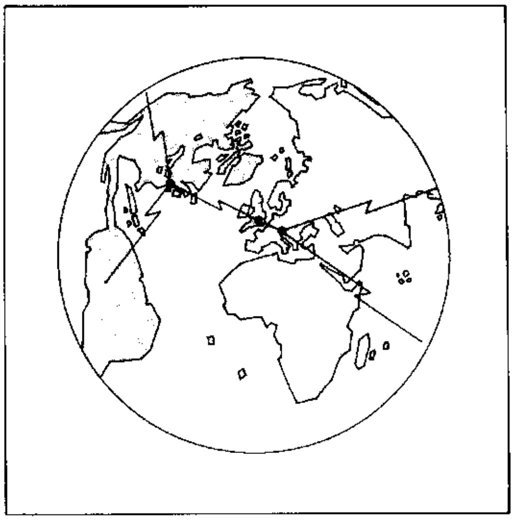


Figure 8—Global networking

tion is international, the information network must itself become international. (Figure 8.)

GETTING 'IT' RIGHT

The corporate information network needs to interconnect all business functions and departments; it must provide universal voice, messaging, and remote conferencing services; and it must allow information to pass when needed between all applications and databases. It must do this not only within the corporate organisation, but it needs to extend to both customers and suppliers, and, in a large international organisation, like BT, it must provide these services wherever the company operates. At first sight, this seems a task of such complexity as to be quite ridiculous to even contemplate and, of course, if such a network was ever tackled as a single endeavour, it would indeed be quite impossible. However, large networks are not built as a single endeavour. Our road and rail networks and the international telephone network have grown organically, but systematically, over many, many years. The integrated corporate network is just such an enterprise and, in one sense, it already exists, while in another, it will never be complete. The issue therefore is not how to **build** such a network, but rather how it is allowed to **grow**.

One thing is certain: every network, by its very nature, requires central control of its standards and of its conventions for use. Without the authority of the CCITT and the other standardisation bodies and without, for example, international agreement on the conventions for charging for transnational traffic, the global telephone network could not have been built. Control over what can be connected to a network is needed, together with the protocols for its use.

Beyond even that, there are a number of basic issues that need to be addressed in order to get the technology to support an information network right—'to get IT right'.

To discuss this even superficially would require another article; to discuss it fully, another book. However, some of the major requirements which are needed to enable the integrated corporate information network to grow are as follows:

- A management philosophy for information resource management.
- A shared infrastructure of communications and data processing.
- A 'top-down' strategic model of corporate information flow.
- Information needs identified directly from the business strategy.
- Strict architectural rules which define how elements of the network may be constructed.
- Strict protocols for communication, desirably non-proprietary open standards.
- Control over data standards.
- Control over the security of the network.
- High standards of formal systems engineering, particularly quality control and configuration management.
- Strict financial control and control over the delivery of benefits. Growth can then be controlled at the pace the business can afford and in accordance with business priorities.

Business disciplines are as important as technical disciplines, and there must be mechanisms to ensure the delivery of benefits that substantially exceed the cost of building and operating the network. However, as was indicated at the beginning of this article, the issue is much more subtle than merely reducing cost by reducing staff numbers through automation. Information services support the concepts and the effective implementation of TQM and the value derived mainly relates to the quality of business operations.

Figure 9 indicates the main processes that are information dependent.

While automation may reduce costs through simple cost displacement—'machines for people'—the real pay-back is in the financial value of controlling business operations that are just too complex to be undertaken without computer and telecommunications assistance. Running a Telco is probably the most complex business operation of the modern world. It is not possible to operate without machine assistance and certainly it is not possible to expand far beyond current boundaries and to hold off the

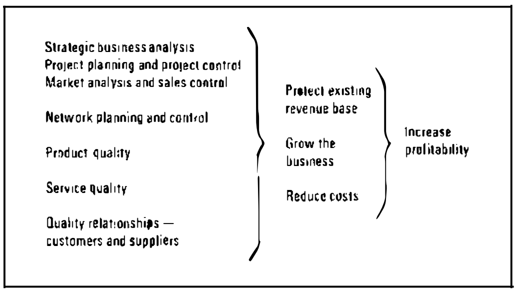


Figure 9 'Quality processes stem from quality information'

competition without continued information systems investment.

Thus, a Telco with a soundly managed integrated information network is doubly advantaged. Through the effective use of information, it gains a trading advantage over its competitors; through the sale of managed information network services, for customers too need these capabilities, it increases its share of an expanding market.

Moreover, the provision of the physical networking infrastructure with which to run integrated information services is an extremely complex task for any organisation, however large. There are clear signs of a tendency towards 'outsourcing' or using external computer and network providers to handle internal data in order to reduce cost and reduce the demand for very scarce technical skills. Managed network services for the future are very likely to include the management of both data centres and local area networks. A challenge for the Telcos of the future may be to convince their external customers that they have no more need to own their computers than they need to own transmission lines and exchanges.

CONCLUSION

Information resource management is believed by many to be the key to competitive edge and this article has suggested that the need can only be satisfied in large organisations by global information networks that extend into supplier and customer organisations. With their increasingly global networking infrastructure and with their knowledge of the integration and operation of very large information networks, the privatised Telcos and British Telecom, in particular, are extremely well positioned to take advantage of a rapid growth market, both by the effective internal use of integrated corporate information networks, and by selling all or part of these services to customers. However, the internal integrated information network is still a long way short of realisation. It is a priority task for British Telecom.

Biography

Dr. John Spackman is the Director responsible for the internal computing and information services of the major division of British Telecom—BTUK. He has held this post for the past 3 years. Prior to that, between 1984 and 1987, he was the Director of the Operational Strategy at the DHSS—an Under-Secretary in charge of the development and operation of all Social Security and National Insurance computing systems as well as the National Unemployment Benefit system. He took that position on premature retirement from the Army, where he retired as the Director of Supply Computer Services, having served in the RAOC, and in various PE and regimental appointments, as well as in SHAPE, as Branch Chief in Information Systems Division. He has a Ph.D. in Physics and an M.Sc. in Management Science. He is a Fellow of the British Computer Society and a Member of the Institute of Directors.

Strategic Planning of Business Operations and Information Systems

D. W. BROWN, R. C. BELL, and J. A. MOUNTFORD†

There is increasing use, in business generally and within BT, of the methodology known as Information Engineering (IE). *Using this approach, the analysis and realisation of information system requirements is driven by business objectives and carried out as an integral part of business operations. The end product is a set of integrated computer systems serving the whole business. This article outlines the IE approach, with particular emphasis on its use at the strategic planning level, and describes how it has been used in the production of the BTUK Strategic Systems Plan (SSP).*

INTRODUCTION

This article gives a brief overview of the methodology known as *Information Engineering* (IE), and an outline of its use in strategic modelling of British Telecom UK operations to provide a framework for process improvement and identification of information system requirements.

INFORMATION ENGINEERING—AN OVERVIEW

Aspects of IE Methodology

Information Engineering (IE) is a methodology which has several variants, in both the proprietary versions available from consultants and the adaptations developed by user organisations. The best known version of the methodology was pioneered by James Martin, who is a leading British authority on the use of business information and the application of information technology. IE typically has the following characteristics:

- Top-down analysis of the business to identify requirements for information and information systems support.
- An integrated process right through from strategic planning to systems implementation.
- Rigorous analysis methods which are consistent between development stages.
- All modelled objects properly defined.
- Confirmation of each successive level of analysis by comparison of each item with the items into which it is 'decomposed'.
- Joint analysis by the user community and specialist analysts.
- Creation of a structured business model.
- Use of a computer-aided software engineering (CASE) tool to support modelling activities. Whilst not absolutely essential, this can:

(*a*) speed the execution of repetitive tasks;
(*b*) greatly support good modelling practice; and
(*c*) ensure a quality, well-documented business model which can be used directly for information systems development.

Stages of Information Engineering

There are traditionally four main stages of IE: strategic planning, business area analysis, system design and system construction. The relationships between them are shown at Figure 1. Each of the stages is briefly described below.

It should be understood that it is a management decision how fully to pursue the IE life cycle. There are proclaimed benefits to be obtained from its complete adoption, but there is nothing to prevent breaking out at some point down the IE cycle and using other techniques for the remaining levels of development. However, it must be recognised that a hybrid approach will only work if the interface between the IE end products and the other methodology used can be satisfied effectively and efficiently.

Strategic Planning

This stage starts with the confirmation of the business direction in terms of objectives, goals, critical success factors, problems and external constraints. These are established by conducting interviews with senior management.

A top-level model is then constructed, which depicts how the business will need to operate in order to realise this direction. This model represents the main functions carried out, the information (entities) required by these functions, and a matrix showing the relationships between functions and entities. This matrix is analysed in order to determine optimum divisions of the high-level model into groups of closely related functions and entities. These groups, termed *business areas*, define the scope for the detailed analysis projects in the next stage.

† Strategic Systems Plan, British Telecom UK

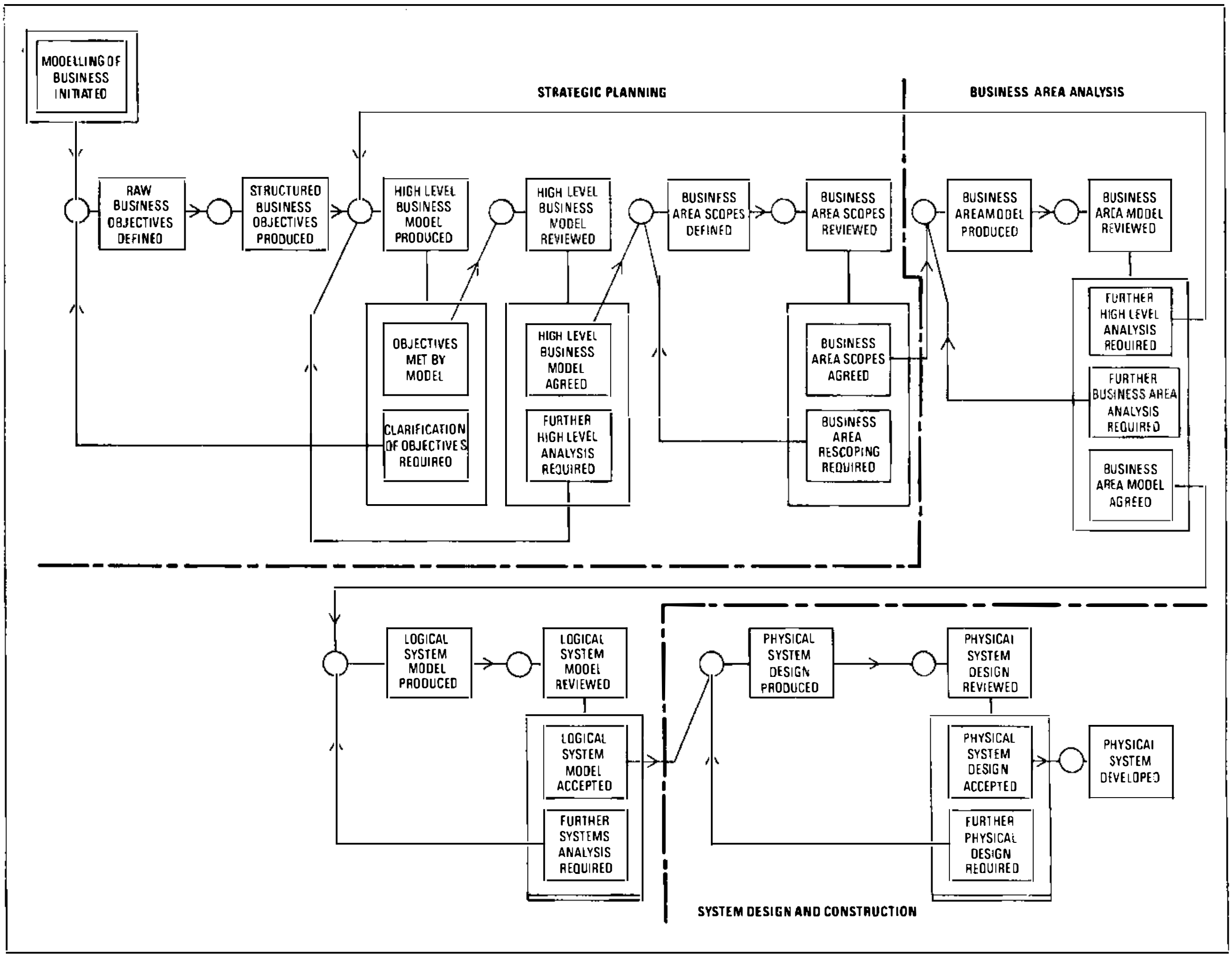


Figure 1
Stages of Information Engineering

Business Area Analysis

In this stage, the functions and entities within each business area are broken down into progressively greater detail until executable processes and elementary items of information (attributes of entities) are identified. This activity includes producing a matrix of the relationships between processes and entities. This matrix is analysed to determine optimum business ('logical') systems to be provided. This list of business systems is then compared to the (physical) systems already in existence to determine which, if any, can be retained (perhaps with enhancements), which should be discarded and what new systems are required.

System Design and Construction

The last two phases are, in principle, controlled along conventional systems project lines. The main features are the use of prototyping to speed development, the formal validation of designs against earlier analysis, and the facility (with some CASE tools) to generate much of the basic program code automatically.

USE OF IE IN BTUK STRATEGIC PLANNING

BTUK embarked on the formal development of a Strategic Systems Plan (SSP) in early-1988. The study covered the following major steps.

Business Direction

IE-based analysis requires a model which comprises:

● *Mission* The definition of the role of the business.
● *Objectives/Goals* The results (in order of priority) that the business will need to achieve within a specified number of years in order to satisfy the mission, and the milestones towards achievement of these results.
● *Critical Success Factors (CSFs)/Inhibitors* The factors which, though not objectives themselves, must go right if the objectives are to be achieved, and factors which could obstruct achievement of objectives.

Each CSF and each inhibitor can be related to one or more objective(s). The appropriate cross-references should be confirmed and recorded. The value added by the IE approach is that these high-level elements form the top level of an integrated model of the business, such that any lower-level elements can be referenced back to them.

The mission and business strategy in BTUK was well established. However, it was necessary to elicit, structure and confirm the long-term business direction in a way that could be related to business operations. The extraction of the necessary input was facilitated by holding senior management workshops representing all BTUK HQ functional directorates and field operating units. The results of this analysis provided a vision of BTUK in terms of how it would look to customers, shareholders, staff and suppliers in 1995/2000. It was endorsed by the Managing Director and the Board, demonstrating adherence to the principle that commitment to the deliverables of analysis must be obtained at each stage by the appropriate level of management. Many businesses have realised, when carrying out this stage of IE, that it has added significant depth to business strategy and direction.

This vision is now reflected in the top level guidance driving the quality plan and budget procedures.

Critical success factors were considered only after completion of the BTUK model in order to prioritise further study. Again, the approach was to involve senior management, in this instance the BTUK Management Board in a workshop setting.

Establishment of a Logical Business Model for Future Operations

The top-level objectives within the company vision are analysed to determine what major functions the business should carry out. These functions are defined in terms of what is to be done, not who should carry them out or how they will be physically implemented.

These functions are then progressively broken down to the level where processes—activities with a definable start and end point—begin to emerge. This is a reasonable indication that it is appropriate to cease the high-level analysis and scope the business areas (see the next section). Alternatively, there is opportunity for a business decision that the exercise should cease at a certain level. In the case of SSP, it was decided that the functions/processes four levels down from the top provided sufficient detail to manage ongoing work within definable areas.

The interfaces between different functions/processes at the same level of decomposition are documented in the form of dataflow diagrams.

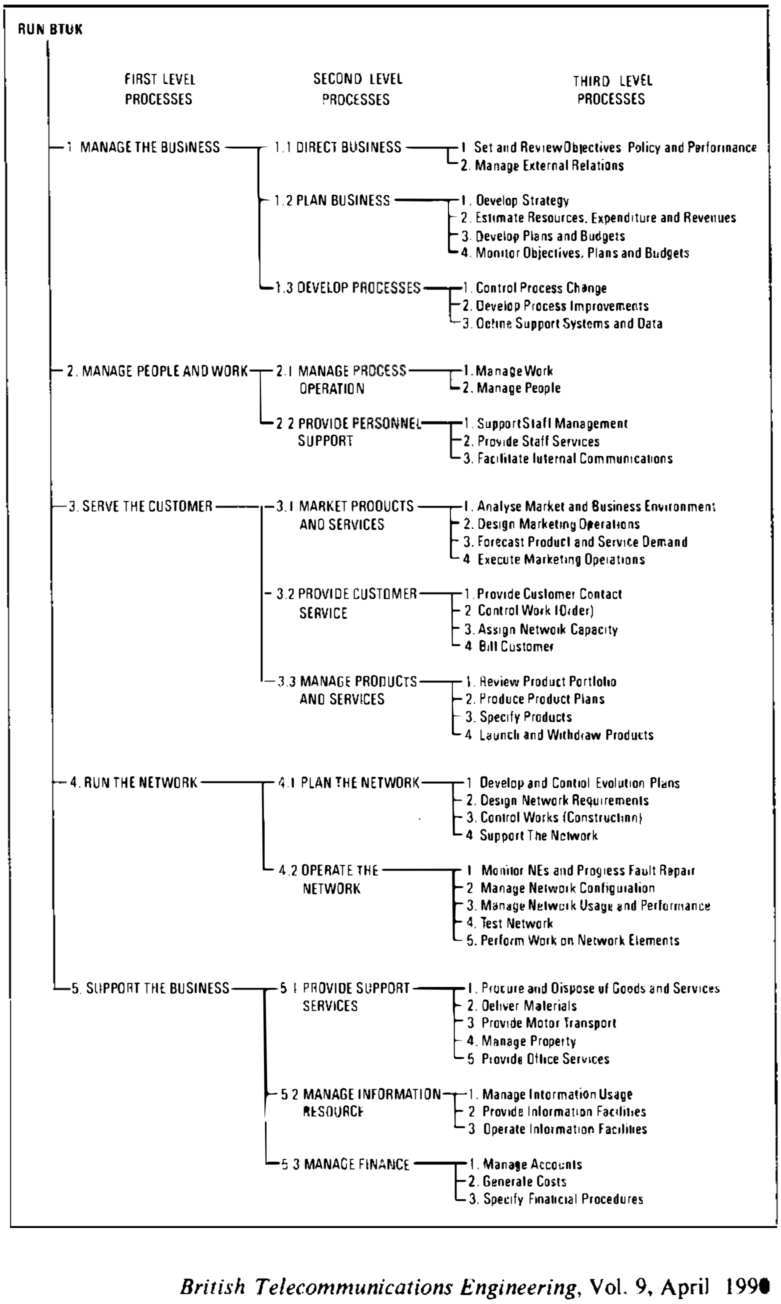
Concurrently with the modelling of functions, the business information is modelled. The starting point is the identification of the major *subject areas* of information used by the business, of which there are typically 15 to 20. These are then decomposed into *entities*. Each entity represents the identification and definition of a fundamental thing of relevance to the business; for example, customer, product, employee. As entities are identified, the relationships between them are confirmed and the entities are cross-referenced to the processes which need them.

This is a recursive process which was carried out by a group of managers representing all business functions. An important prior step was the creation of a sufficient knowledge base by the documentation of the present operations. This provided a reference base about today's operations whose functionality would need to be knowingly supported in the process model or not be required.

After several iterations to ensure robustness, the future operations model was made available to HQ units to allow pursuit of ongoing analysis of process improvement.

The process decomposition for BTUK down to the third level is shown in Figure 2.

Figure 2
BTUK process model



Scoping of the Logical Process Model into Business Areas

This activity breaks down the high-level model into areas which can then be individually analysed in detail in the next stage of IE.

The usage of entities by functions and processes is formed into a matrix showing each of these associations and the type of usage which has been identified: create, read, update or delete. Cluster analysis is then performed on this matrix to divide the functions and processes into groups on the basis of commonality of their usage of entities.

Each entity is then assigned a primary association with the most appropriate functional grouping. There are various selection criteria for this, but the one used for the BTUK model was to make the primary association with the group containing the process which creates the entity. In order to maintain links between different groups, each entity is also given a secondary association with each of the other groups which uses it. The business areas have now been formed and are ready for detailed analysis.

The results of the cluster analysis must be subject to a certain degree of business judgment. It is unlikely that any algorithm used to form the business area groupings will produce a complete set of hard and fast answers, and marginal cases will move from one group to another in response to changes in the clustering parameters used. This caveat applies whether the clustering is done by a software procedure (as provided in some CASE tools) or carried out manually.

The initial Strategic Systems Plan study, for various reasons, did not scope the model into business areas. Instead, the model was divided into blocks of closely related functions and processes, termed *strategic system areas*, each of which contained proposals for realisation of the physical systems to support process objectives. An initial systems migration strategy has been produced based on these strategic system areas.

Meanwhile, the SSP team has carried out an exercise to scope business areas according to the formal IE approach. To provide continuity, the description of each business area is referenced back to the functionality supported and the implementation proposals documented in the corresponding strategic system area(s). These business areas will be used as the framework for more detailed analysis of information system requirements.

Application of the BTUK Model

The original objectives of developing the model were to:

(*a*) specify the component elements of BTUK's target business operations to be prioritised and reflected in a migration plan, and

(*b*) provide the starting point for determining long-term information systems architecture.

The objectives have since been expanded to include:

(*c*) understanding the component business processes and their interlinking to support delivery of products and services, and

(*d*) using the model of the component business operations for planning and managing change.

CONCLUSION

The production of a BTUK model itself has been a major step forward on the path towards having a top-down structured approach towards the specification of business processes and their requirements for information systems support. A further and perhaps more important step forward will be the active exploitation of this framework to manage the business and, through business area analysis, to form the basis for future information systems development.

Biographies

David Brown is the manager in BTUK's Strategic Systems Plan (SSP) unit responsible for the process management programme. He gained a B.Sc. degree in 1966, and spent five years in GEC and Texas Instruments (TI) on semiconductor production, before joining the British Post Office (BPO). He worked for eight years in the Research Laboratories on semiconductor manufacture and quality assessment of semiconductor manufacture for submarine system amplifiers. From 1979 to 1983, he was responsible for economic analysis of modernisation options for the inland network. In 1983, he became head of Inland Communications Network Planning Division. He is a member of the IEE and holds the Diploma in Management Studies (DMS).

Bob Bell works in the SSP unit as part of the team responsible for model administration and methodology aspects. He joined the BPO in 1972 with a B.A. degree. He worked for 12 years in the Data Processing Executive (DPE) on support of computer systems for lines forecasting, planning and utilisation. After this he spent three years in the Internal Audit Division, working on the audit of computer systems (principally CSS) and computer installations.

John Mountford works in the SSP unit as part of the team responsible for model administration and methodology aspects. He joined the BPO in 1972 with a B.Sc. degree. He worked for nine years in the international side of the business, including work on staffing, service, and industrial relations. From 1981 to 1986, he worked within the London director area, dealing with trunk exchange equipment review, forecasting and switching planning for the outer London Districts. From 1986, he worked in the BTUK computing division in the areas of quality assurance, business analysis and business modelling.

INTERNET—An Integrated Data Network for British Telecom

A. J. TOMPKINS†

This article discusses the benefits of building a single data network (called INTERNET*) for the whole of British Telecom. INTERNET is currently being installed throughout BTUK Districts and will provide a data communications infrastructure to support all BT's strategic information systems. Initially, a flexible terminal strategy, the INTERNET infrastructure, will be progressively enhanced to full ONA functionality to provide an open systems showcase for BT system-integration skills.*

INTRODUCTION

Historically, BT has a large number of information systems which run on a variety of mainframe computers of differing manufacture. As many of these systems were developed as 'stand-alone' processes, the incompatible network architectures employed by the mainframe suppliers was not seen as a problem that needed to be resolved. The data networks to support these systems were similarly 'stand-alone' or 'discrete'; that is, a terminal accessing a system running on an IBM machine could not access an ICL-based information system.

The move towards *front office* and other initiatives to co-ordinate BT's customer-facing activities highlighted the need for access to information held on a variety of systems. Studies undertaken during the initial roll-out of Customer Service Systems (CSS) showed that some users would need access to more than five systems with the potential of five different screens on one desk to achieve the desired result.

This situation was clearly impractical and it was obvious that an entirely new approach to data communications was required. The solution would need the following characteristics:

(*a*) to have the ability to access systems, from a single terminal, running on machines of incompatible architecture;

(*b*) to make maximum use of BT products and services;

(*c*) to be cost-effective;

(*d*) to provide a platform for BT's Open Network Architecture (ONA);

(*e*) to make effective use of existing investment in data networking techniques; and

(*f*) to provide an adequate level of security and resilience.

In early-1986, a study team, drawn from many parts of BT, was set up in Mid-Yorkshire District with the task of developing a network solution to address the above requirements.

The team considered a number of alternatives before recommending the INTERNET solution, which has since been adopted as the strategic solution for data networking within BT.

The Internal Communications Provisioning Authority (ICPA) within BTUK's Computing and Information Services has full responsibility for the future development and implementation of INTERNET.

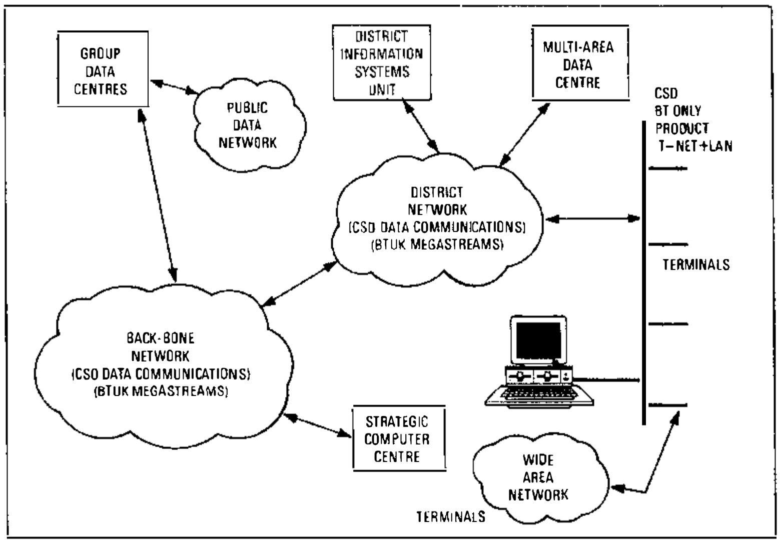
INTERNET COMPONENTS

INTERNET (see Figure 1) has a number of key components to service both national and local requirements:

INTERNET Backbone Transmission Network (IBTN) The IBTN forms the long-haul national 'backbone' of INTERNET. Based upon the original CSS fallback network, IBTN is a flexible high-capacity network built using BT Datelmux 7500 multiplexors connected together by MegaStream circuits. The IBTN is installed in all BT Districts and provides capacity for systems that need national coverage. Currently, the IBTN consists of more than 80 nodes which are managed from the ICPA network management centre in Pontefract.

District Transmission Network (DTN) Each District has been equipped with a DTN, which was provided as part of the CSS project. A DTN is, in fact, a 'mini-IBTN' using the same multiplexor and MegaStream network techniques. The DTN is used to connect major buildings within a District to both the District computer centre and the IBTN.

Figure 1
INTERNET technical summary



† Internal Communications Provisioning Authority, Computing and Information Services, British Telecom UK

Local Area Network (LAN) Major sites within a District (usually where there are more than 10 terminals), are equipped with a standard LAN system (T-NET PLUS). It is the LAN, which has been extensively developed by BT Communications Systems Division (CSD) under the direction of the ICPA, which provides the protocol conversion and switching necessary to allow users to access systems running on computers of differing manufacture.

District Wide Area Network (WAN) The WAN is used to connect the large number of small sites (usually less than 10 terminals) within a District to the nearest LAN site. The WAN is an X.25 network.

Terminals The standard terminal for the INTERNET programme is the BT M1779. The M1779 is capable of emulating a variety of proprietary screens; for example, IBM 3179, DEC VT220 etc.

The infrastructure installed by INTERNET provides a platform for progressive migration to ONA.

IMPLEMENTATION

Most BT Districts are not 'green-field' sites for data communications. There is, in many cases, significant investment in proprietary data networking and this has been a major factor in defining an implementation timetable. Where strategically and financially viable, existing networks will, as in the case of the CSS IBTN and DTNs, be employed as part of the INTERNET programme. If an existing network cannot be effectively re-used, migration to INTERNET will be geared to investment life of the network so as to minimise the costs of early write-off.

These considerations mean that INTERNET is in varying stages of implementation throughout BTUK, but every District has at least DTN and IBTN access, with 13 Districts using the full INTERNET system for their data networking requirements.

BENEFITS

There are many benefits that accrue from the implementation of INTERNET:

(*a*) INTERNET provides a data communications infrastructure that can be shared between information systems. This results in reduced incremental networking costs for future information systems. The more systems implemented on INTERNET, the lower the incremental cost.

(*b*) As this shared infrastructure grows and reaches more users, the timescales and implementation costs of supporting new projects on the network will be reduced significantly. This will ensure that the operational benefits of the new system are available to BT at the earliest opportunity.

(*c*) The financial monitoring procedures, devised jointly by BTUK Finance and ICPA, will ensure, for the first time, that expenditure on BT's internal networks is both visible and tightly controlled.

(*d*) The high-degree of resilience built into INTERNET ensures that major operational information systems are not compromised by network failures.

(*e*) Depending on the number of new information systems deployed, the use of INTERNET rather than proprietary networks is estimated to produce savings of more than £300M.

(*f*) INTERNET, like the PSTN, is designed on a traffic rather than connection basis, resulting in significant bandwidth savings.

(*g*) BT system integration and support skills are clearly focussed on a limited set of communications products, resulting in higher individual skill levels and an overall reduction in the numbers of staff needed to support the network.

(*h*) The ICPA, as the owner of INTERNET, is able to develop co-ordinated equipment forecasts for all BT's internal networking. This facilitates a strong price negotiation position and is resulting in major price reductions from suppliers.

(*i*) The network can be planned and managed in a unified manner.

(*j*) It provides a showcase for BT networking expertise.

(*k*) It provides a platform for progressive migration to true open systems working.

THE FUTURE

INTERNET will continue to evolve towards true open systems architecture. The age of the intelligent network is upon us and is recognised by many large corporations as a key enabler for their future business activities.

The traditional view of information systems developers that the primary resource is the mainframe is on the decline. With the ever-increasing range of facilities offered by an intelligent network, the focus is changing. The ultimate conclusion is that *the network is the system* on which the mainframe is but one (albeit a powerful one) of the facilities available to a network user.

With large customers viewing the network as a major corporate resource, there is significant business potential for BT in this area. The implementation of INTERNET provides BT with the opportunity to develop and demonstrate the skills and techniques necessary to exploit this important market area.

Biography

Andy Tompkins joined the then British Post Office in 1977 after studying electronic engineering at Hull University and five years as a professional musician. His early career was spent with the National Data Processing Service, responsible for the analysis, design, programming and implementation of various commercial data processing systems. He has since been responsible for the specification and implementation of the data networks for CSS and, more recently, INTERNET. He is now in charge of Internal Network Strategy and Portfolio within the ICPA.

Information Resource Management

H. J. YATES†

Elsewhere in this issue of the Journal, *John Spackman has written about the integrated corporate information network. He refers extensively to information resource management (IRM) as the key to BT's future competitive advantage. This article takes the concept of IRM and analyses it in further detail. The following areas are explored: information characteristics, user needs, problems and opportunities, means of provision, financial justification and technical and organisational prerequisites.*

INTRODUCTION

Managing the information resource has been identified by the Strategic Systems Plan (SSP) project as the overall business process currently fulfilled in BTUK by the Computing and Information Systems (CIS) Directorate. Information resource management (IRM) switches the emphasis away from computing (hardware) and systems (hardware and software) towards **information** (the end-product which customers need). It also recognises information as a resource. Indeed, ultimately, information is the only resource managers have at their disposal, in the sense that they do not 'own' or 'control' people, money, buildings or equipment, but only information about those resources. Information is a 'super-resource' which subsumes all the others. Put another way, it is of no consequence that managers have hundreds or thousands of staff 'under' them if they have only poor information about those staff—about their capabilities, their performance and their aspirations. Without effective management of the substantial and growing information resource, decision-making will be impaired and failure costs will not be reduced.

INFORMATION CHARACTERISTICS

Many writers (for example, Toffler[1]) have referred to the *Information Age.* They identify three major stages in the post-industrial period: the Industrial Revolution, the Electronic Revolution and, now, the Information Age.

The Industrial Revolution was driven by increasing economies of scale in secondary industry, leading to new mass production and manufacturing techniques. This created opportunities for new sales, marketing, distribution, accounting and management control techniques. The large manufacturing organisations that grew up during this period demanded large support operations to provide this increased level of administration.

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The Electronic Revolution enabled this demand to be met. The developments of the valve, transistor and microchip have successively provided organisations with faster, more reliable processing power and data storage capability. With this new resource, organisations in the post-war era have been able to design and build systems to radically improve the performance of their administration.

The Information Age recognises that organisations now have another powerful new resource—information—which can be managed profitably just as the earlier stages created new resources and opportunities for economic growth.

Before considering the needs of the information user in this new age, it is appropriate to review some of the fundamental characteristics of information. Four such characteristics are described here. For each, a brief definition is given with an example based on stock market information, and a comment is made on how technology impacts on each characteristic. Information engineers must measure and comprehend these characteristics before they can successfully supply their customer's information needs.

Volatility

This relates to how quickly information changes; for example, stock market prices can vary by the second, and brokers need to track changes closely. The ability to handle rapidly changing data has been greatly facilitated by information technology (IT) tools, evidenced by the disappearance of Stock Exchange floor-traders and the emergence of high-technology dealing rooms at distributed locations across the City. Moreover, IT has provided the ability to restructure and redefine information at high speed, enabling technologically-advanced organisations to derive greater value from their information. Volatility can be measured in terms of *frequency of potential significant change.* This definition, in turn, demands a definition of *significant,* but this will vary by user and by data type. Information engineers must work with their customers to agree on what is significant.

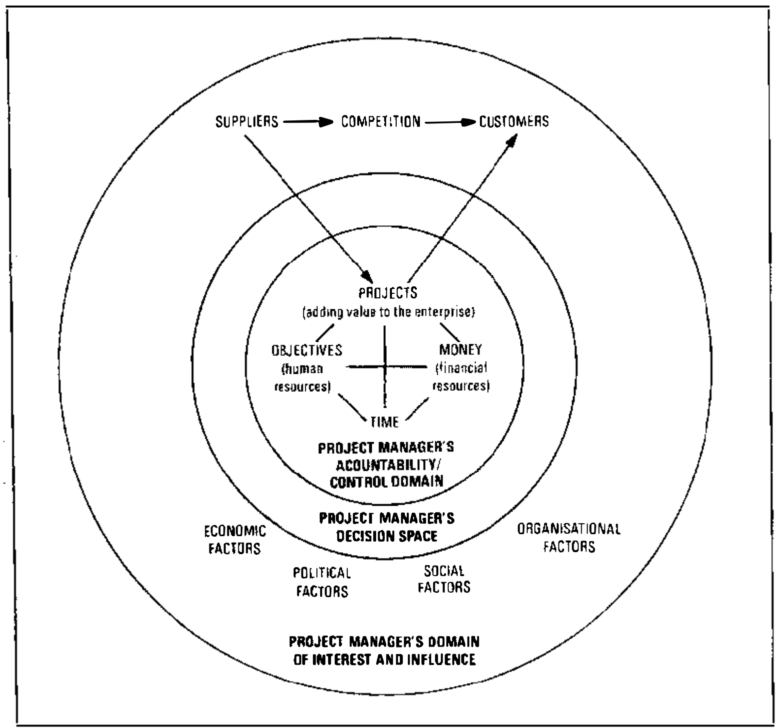
Volume

This relates simply to the *total amount of data of interest to a particular user.* In comparison with our grandfathers, for whom a handful of books usually provided a lifetime's supply of recorded information, we now have the ability to amass, check, store, process, collate and output vast quantities of information about ourselves and our environment. Stockbrokers through their terminals can access almost instantaneously not only up-to-date prices on their portfolio of interest, but also a wide range of political and economic information to factor into their commercial dealings. Their descendants will, no doubt, look back and consider them comparatively starved of information. BT's computers under the control of BTUK/CIS contain about 6 Tbyte (1 Tbyte = 10^{12} characters) of data created by several hundred application systems. Paradoxically, although we have this enormous data resource, very little is used to deliver information or knowledge directly to top management. One of the goals of IRM is to ensure that the corporate stock of data is used to provide the basis for effective decision support to managers throughout the business.

Currency

This characteristic relates to the accuracy of a particular item of information. This is not quite so clear cut as it may at first seem. As John Spackman says in his article[2], data relates to past events, and it is self-evident that past events can be interpreted in different ways depending upon the viewpoint of the observer. Information technology, and networking in particular, provide us with the ability to share a particular version of events with a wider audience. Prior to Big Bang†, a particular share at any instant in time would have had as many prices as there were markets. One effect of this was reduced shareholder confidence in the accuracy of price information supplied by their broker. Post-Big Bang, the Stock Exchange computer provides all dealers simultaneously with the most competitive price. Effectively, several separate markets have been electronically standardised and consolidated. As stock markets globalise, it will be possible to pay the same price for a share wherever in the world it is traded. In this way, information technology helps to create near-perfect markets and shareholders' confidence is increased. Currency (up-to-dateness, accuracy) can be measured, then, in terms of *the proportion of the community of interest who are prepared to accept this particular 'version of events' as helpful to their needs at a particular point in time.*

Figure 1
Manager's domains



Relevance

This characteristic is concerned with *whether or not a particular item of information is likely to have any significant impact on its user.* For example, shareholders are clearly interested in the current prices of shares in their portfolio; they are probably interested in a variety of economic statistics such as trade figures, interest rates and so on; but they might worry about a host of other parameters without knowing whether or how to factor these into their decisions. IT enables complex models to be created which are capable of manipulating an increasing variety of variables. Interestingly, many people believe that it was models of this type (for example, triggering share sales on the advice of computer programs) which precipitated the 1987 stock market crash. Given the subsequent recovery in the market, one might ask whether the crash was caused by brokers' expectations of information engineering running ahead of their ability to specify their highly complex and often intuitive behaviour. Despite the astonishing advances in IT, software intelligence continues to be limited (thank goodness) by human intellectual capabilities. Ada Lovelace's idea of a century and a half ago still holds. Programmed machines are capable of performing only those tasks we can describe to them.

These then are four important characteristics of information and the ways in which IT impacts on them. The next section deals with the needs of managers and information workers. Consideration of the four characteristics will be useful in this analysis.

USER NEEDS

Figure 1 is a representation of the various domains in which a typical manager can operate.

† 'Big Bang' is the popular name given to the opening of computerised trading on the London Stock Exchange

There are three principal domains:

- accountability and control,
- decision, and
- interest and influence.

At the broadest level, managers are able to exert influence in a wide variety of spheres, certainly within their own organisations, but also with their customers, suppliers, and perhaps even with their competitors. They are, of course, fully responsible for taking decisions which directly impact on the command and control of their own operation, but they are also able to take decisions which influence the world outside their personal sphere of responsibility. Ultimately, all managers in any organisation must, in some sense, add value to that organisation.

The diagram shows value added to the organisation through the completion of projects. Managers may not always be responsible for projects in the formal sense, but almost all managers carry out customer-facing activity even if their customers are members of the same organisation. In order to execute such activity, managers have resources in terms of people, money and, of course, personal time. In this sense, they are all, to some extent, project managers. They need to agree objectives with their staff, they need to control budgets, and to manage their personal time. In all these areas of activity, they need good quality, timely, up-to-date and relevant information. They also need information about the world outside their immediate control domain; information about the behaviour and performance of the rest of the organisation, and information about economic, political and social factors which may have some bearing on the control domain for which their organisation holds them accountable.

Figure 2 represents the idea that the set of data relevant to a particular project manager is only part of a much greater organisational dataset. Furthermore, project managers need to view their 'relevance set' in many different ways ($V_1 \ldots V_4$). They will not make good quality decisions if information is presented to them in rigid formats which are not sensitive to subtle but important changes in the underlying data. For full flexibility, they need to be able to switch between views at the press of a button. This is an issue about the friendliness of the human–computer interface to which we shall return later.

Table 1 lists some of the major data groupings and their sub-groupings which are of interest to managers. It is impossible to show on two-dimensional paper that these groupings interrelate in a multi-dimensional way. For example, project managers are interested in their team's financial performance from a number of different viewpoints. From a customer viewpoint, they need to know how project costs compare with revenue. From a personnel viewpoint, they need to appraise their budget managers on financial performance. From a personal viewpoint, they need to know whether they are achieving their own objectives for financial performance. The same basic data provides all the information used in these different views of managers' control domains.

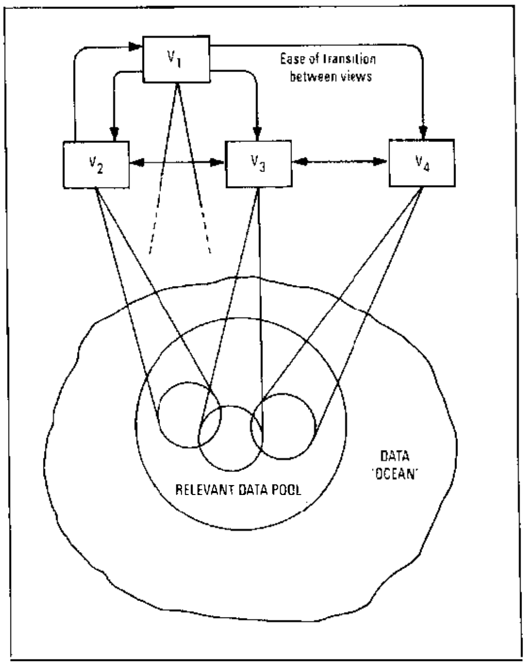


Figure 2
Manager's view of relevant information

TABLE 1
Major Data Groupings

Projects	**Organisations**
—Financial —Human —Functional specification —Timescales —Performance	—Procedures/policy/standing instructions —Resources/internal supplies (of people, facilities, information)
Money	**Customers**
—People (pay) —Non-pay —Capital —Transferred charges	—Needs —Budgets —Suppliers
Objectives	**Supplier**
—Personal —Direct reports —Customer facing —Resources management	—Products —Costs/prices/availability
Time	**Other Factors**
—Planning/decision making/monitoring —Project meetings —Objective reviews/appraisal meetings —Budget review meetings —Training —Customer meetings	—Economic —Previous experience/historical data

Just as IT enables an organisation to move towards a geodesic structure[3], and people in the organisation can begin to network in a flexible and dynamic way, so technology provides us with the means to create geodesic data structures, free from the constraints imposed by older hierarchical database management systems. Any item of data can be related to any other (or many other) items without loss of control.

Up to now, we have considered the logical information needs of the user. There are also a range of physical needs which can now be met by IT. Because of the instantaneous and ubiquitous nature of electronic information, it is possible for information workers to do their jobs anywhere and at any time. The growth of electronic networks and the increasing trend towards miniaturisation have helped create mobile managers who not only have a conventional office but also work from home, from cars, from customer premises and other offices, almost anywhere in the world and at any time of day or night. This electronic extension of ourselves (to use Marshall McLuhan's idea[4]) gives networked managers enormous leverage and value-adding capability compared with their non-networked counterparts. The organisational effects of these physical changes are profound. For example, it means that organisations can relocate to low-cost accommodation, depending more on electronically assisted networking and less on physical proximity. A major social effect is the trend towards teleworking and all that means for rush-hours, rigid contracts of employment and fractured family life.

Although IT can meet these users' needs, in practice few managers have taken up these new weapons with which to fight their competition, because of scepticism, lack of familiarity or lack of time to devote to training. But the technology itself is not yet a panacea, and there are a number of real problems to be overcome before IRM can deliver its full promise. The next section discusses some of these.

PROBLEMS/OPPORTUNITIES

Data Administration

The most difficult problem is undoubtedly how to migrate our current pools of system-specific data towards the cross-related, non-hierarchical 'ocean of data' described in the previous section. Up to now, the development of information systems has focussed on the automation of business processes. This will continue well into the foreseeable future, but increasingly it will become the management of our ever-growing data oceans which becomes the major challenge for IT workers. At present, the industry is concentrating on improving the tools it uses to specify, construct, test, implement and maintain high-quality information systems. There is comparatively little work being done on tools to ensure the quality of our information resource. Organisations which invest in this area over the next few years will be able to steal a significant lead over their competition.

The tools which will be required include the following:

Data Dictionaries These will hold definitions of data in terms of its structure, relationships, grammar and meaning of its content. They will also provide an index with which to access information efficiently.

Another type of dictionary is the data thesaurus providing details of data synonyms, data antonyms and other data relationships, again to improve the speed and accuracy with which required information can be accessed.

Data Quality Tools These will assist data analysts in measuring the costs of information failure. These costs can be quantified in terms of value subtracted from the business due to low accuracy information plus the opportunity cost of information vacuums; that is, non-existence of required information. Information engineers will also require automated assistance in the measurement of data accuracy. Having established measures, they will then require tools to help improve data accuracy and reduce information failure costs. These will include ownership inventories to record the details of data parents; that is, those responsible for data definitions and data content quality. In the longer term, facilities will be developed to recognise new patterns of data in terms of both structure and content. Beyond that, it is possible to envisage databases which dynamically restructure and reorganise themselves in order to provide their users with more helpful interpretations of their contents. At this point, it will no longer be necessary to identify owners for each data entity. Information resource management will be fully software controlled.

Data Warehousing

With the growth of management information systems, executive information systems, purpose-built database engines and other advanced database management systems, we have seen the emergence of the *data warehouse*. Essentially, this is a store of data items gathered from many sources and used to support a particular set of information requirements. In this way, systems designers are able to make use of the most appropriate technology at each stage in the information cycle. For example, they will design a batch processing data collector to gather bulk data, a transaction processor to perform on-line file updating and a data warehouse to provide management information. Each system uses different technology to optimise performance and efficiency. However, there can be problems with this approach, not least of which is the fact that data items become proliferated across several different warehouses. It then becomes difficult to maintain control between the original source of data and its various clones. Once the tools for automated structure control are available, this will be less of a problem, but, in the meantime, manual control systems must be used to keep information ambiguity and uncertainty (failure costs) to a minimum.

MEANS OF PROVISION

Reference has already been made to executive information systems, but the last few years have seen a host of new software tools to enable information users to get faster access to, and better presentation of, their information. We are now seeing the emergence of object-oriented systems which enable users to create their own personal views of their information environment as often as they need. Artificial intelligence encompasses knowledge engineering and expert systems, both of which have progressed over the last decade. However, they have yet to reach their full potential and it is likely that we shall see many exciting developments in this area during the next decade. *Groupware* is a term which has been coined to describe software tools which support groups of information workers, not necessarily located in the same physical workplace. Computer conferencing and decision conferencing fall into this category.

Applications using ISDN will make a major impact on the ability to communicate remotely with fellow information workers. Speech recognition and synthesis technologies will supply many useful products over the next 5 years. These will play a key role in improving human–computer interfaces.

FINANCIAL JUSTIFICATION

The justification for a major programme to implement information resource management can be based on the premise that information failure costs are unacceptably high and that, as a consequence, management value added is too low. Figure 3 shows a pyramid to represent a hierarchical organisational structure. It indicates how the pyramid is used, firstly, to transmit decisions down through the hierarchy, and, secondly, to transmit operational data up the management chain. This transmission process should add value to data, converting it into information with which managers can make better decisions. However, because of the depth of the pyramid, there are necessarily many interfaces. At each interface, noise is introduced into the system. Decisions, on their way down, and information, on its way up, become adapted and distorted through error, omission, misunderstanding and protectionist behaviour. This results in managers having low confidence in the information they receive, and operational staff may question the value of some management decisions. The way to break this vicious circle is to flatten the pyramid and to facilitate networked communications directly between members of the organisation who need to co-operate in the execution of the specific task.

Another feature of the non-networked organisation is the inordinately high proportion of time which managers need to spend in human communications. This is manifest in the number of meetings which they attend and the amount of correspondence with which they need to deal. A recent survey of the way in which directors allocate their time revealed an astonishing 62% spent in meetings and a further 19% spent in dealing with correspondence. Figure 4 shows the complete breakdown revealed by the survey. This shows that only 6% of directors' time (training and desk time) is spent on activities not directly connected with communications activity. We also know that the only electronic technology used by most directors to support their communications activity is the telephone. It is reasonable to suppose that wider adoption of technological aids by the management community could release more time for managers to devote to value-adding activity.

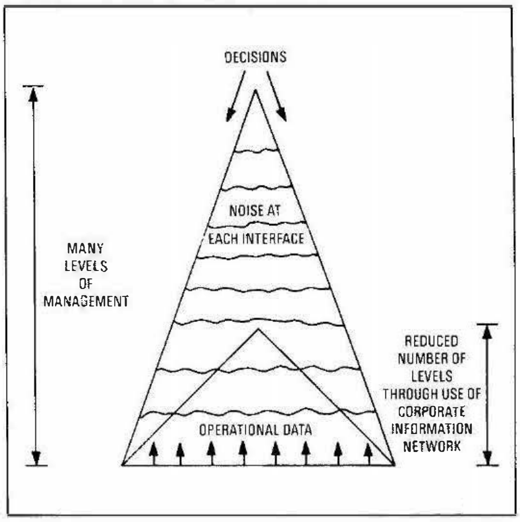


Figure 3
The organisational pyramid

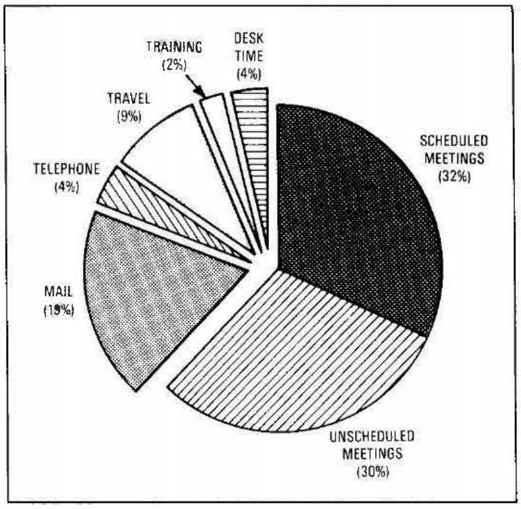


Figure 4
Director's week—percentage of time

TECHNOLOGICAL AND ORGANISATIONAL PREREQUISITES

Before this new information environment can be put into place, there are a number of enabling factors which need to be established.

Perhaps the most important of these is the new organisational culture to which reference has been made in this article and others in this issue of the *Journal*. This culture espouses:

- excellence in quality of service,
- constant attention to customers' requirements,
- recognition of information failure costs and desire to reduce them, and
- willingness to break the old hierarchical model and to network freely and co-operatively both inside and outside the organisation.

Within BT, the total quality management (TQM) programme has helped with focusing on customers' needs, and TQM principles can be used to identify and eliminate the costs of information failure. The COAST office automation programme will enable staff to record and transmit messages and files instantaneously throughout the organisation. INTERNET will provide the communications infrastructure by which the information resource will be delivered.

The Strategic Systems Plan project has established a clear analysis of business processes and provides a common language with which these processes and their supporting systems can be described. This type of analysis now needs to be carried further to encompass not only the systems, but also the information they provide, so that information workers throughout BT can use a common language to describe data structures, owners, content as well as report formats and other aspects of the human–computer interface. It would not be satisfactory if users had to remember different dialogue sequences or were presented with different menu structures when they used different systems. Similarly, consistency, or at least planned and progressive change, over time is also important. Sudden discontinuities in the supply of information are not conducive to user acceptance and understanding. In other words, we need a standard human–computer interface, so that whatever information is presented to any member of the organisation, it can be assimilated and understood rapidly and accurately.

SUMMARY

British Telecom, like many other technologically advanced organisations, now relies heavily on its information resource. It would be impossible to plan, design or manage the network without accurate computer records. Customer billing depends entirely on CSS (Customer Service System) information. The company's total information resource is colossal, amounting to the equivalent of 500 million A4 pages.

Effective management and use of this resource will enable BT to:

- flatten the organisation pyramid,
- introduce new methods of group working,
- improve decision-making quality, and
- make more effective use of management time.

Finally, enhanced information for control, planning and market analysis will provide BT with real advantage in an increasingly competitive market environment.

References

1 TOFFLER, A. The Third Wave.
2 SPACKMAN, J. W. C. The Networked Organisation. *Br. Telecommun. Eng.*, **9**, Apr. 1990 (this issue).
3 BOND, B. R., and JONES, W. G. T. British Telecom in the Developing Global Information Network Industry. *Br. Telecommun. Eng.*, **9**, Apr. 1990 (this issue).
4 MCLUHAN, M. Understanding Media.

Biography

Howard Yates joined BT in 1989, following a period with H. J. Heinz and 12 years with the Cable and Wireless Group (C&W). He took a B.Sc. in Economics at the LSE and, more recently, completed an MBA programme at the London Business School. He is a Member of the British Computer Society. Most of his career to date has been in information systems, although he has also been responsible for new business development in Mercury Communications and for managing C&W's bid for the Government Data Network. As General Manager, Systems Division, in C&W, he was responsible for the devolution of IS capability to overseas business units, including the provision of itemised billing and customer service systems. His responsibilities in CIS include planning the BTUK computing programme, customer relations and the development of an information resource management strategy.

Network Support Systems Architecture and the Control of Systems Evolution

M. J. SPOONER, J. R. ASH, and N. J. FURLEY†

The planning, operation and management of a complex modern telecommunications network requires a significant number of different computer support systems. In order to ensure that all the systems will work together and meet the needs of the business, an architecture is required against which all systems development can be planned. This article provides an overview of the architecture, and describes how it is being used in the Network Administration Implementation Programme (NAIP) to guide the evolution of the network support systems, under the direction of the Network Control Architecture Board (NCAB).

OBJECTIVES OF A NETWORK SUPPORT SYSTEMS ARCHITECTURE

British Telecom uses computer support systems to manage the increasingly complex equipment, procedures and people needed to run the network.

Network support systems have developed out of the convergence of conventional data processing and telecommunications. On the one hand, the data processing techniques that were applied to the order handling, forecasting, planning and billing parts of the business have been very similar to the approach that might have been applied to any other large business, and, like them, have been influenced by the advance in networking. On the other hand, the technology of the network itself has moved considerably towards computing, with developments such as the digitalisation of both transmission and switching.

Within BT, different groups of support systems were project-managed and developed by separate parts of the business, and took different approaches to solving their problems. This has resulted in there being no overall architecture or framework within which the systems have been developed. In fact, most developments have generally been stand-alone solutions to particular problems.

In addition, the major computer manufacturers have had very good marketing reasons for making it as difficult as possible to interwork their products, and 'locking in' their existing users to a development agenda which is under the manufacturers' control. It is becoming increasingly important for BT not to be locked into a single supplier as it strives to improve its services, and particularly to provide complex services and manage them as a single entity. In order to achieve this, therefore, it is fundamental for the business to have a basic architectural framework, within which each system development can be fitted and systems can migrate to achieve an overall integrated solution.

The specific objectives of the network support systems architecture are:

- *The reduction in systems duplication.* The Network Administration Task Force (NATF) study showed that there were at least 150 different network support systems. Many of these provided the same function for different elements of the network, but some covered the same elements in different parts of the company or of the country. By using the support systems architecture, the aim is to move towards providing the same functionality on a reduced number of systems, aiming for about 20 systems in the long term.
- *The deployment of systems capable of supporting increasingly complex services.* Developments in technology and services available in other countries have led to customer demand and competitive pressure for new services. The support systems provide an environment in which those complex services can be provided quickly and maintained to provide consistent high quality.
- *The creation of a hands-off network.* The trend in competing Telcos is in the direction of reducing costs. The newest network equipment not only needs much less maintenance attention, it actually functions better without human intervention. However, this is only possible where the functionality and data can be accessed remotely via clearly defined interfaces.
- *The faster delivery of systems.* Competitive pressures will continue to demand new services faster, and even in a totally structured architecture, there will be a pressing need for new systems and new facilities on existing systems. There is a set of common functions which forms a significant part of each system; re-using a common core of software will allow faster and

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cheaper development. New techniques such as the use of computer-aided software engineering (CASE) tools and expert systems will also speed up systems delivery.

- *The containment of cost.* Given that software maintenance is always the most expensive part of any computing project, a significant reduction in the number of systems is likely to contain costs. Techniques such as modularisation of software and CASE will allow enhancements to be made with the minimum of integration testing, which is currently a significant cost.
- *The efficient management of the network investment.* The network represents an enormous asset to BT. The network is the core of BT's business, and the source of most of the company's revenue. Optimising the management of the network is therefore of the highest priority.

CONTEXT—THE PRINCIPAL STRATEGIC INITIATIVES

Over the last few years there have been several strategic initiatives to pull together computing support within BT; some, for example, the Strategic Systems Plan (SSP), took a very wide view of the business as a whole; others focussed on network management, which is still a very large subject.

Open Network Architecture (ONA) is BT's corporate architecture for open systems; it allows BT to develop information systems and technology products and services that can:

- work together,
- conform to internationally agreed standards,
- present a consistent style to the user, and
- achieve savings through the re-use of hardware and software modules.

The use of international standards, particularly those associated with Open Systems Interconnection (OSI), forms a major part of ONA.

The Network Administration Task Force (NATF) reported in April 1987, and made wide-ranging recommendations on the re-structuring of the field staff and their support systems. Some of the recommendations were implemented immediately; others are now being addressed through the Network Administration Implementation Programme (NAIP).

The Network Strategy Unit developed a hierarchy of functionality in network management, known as the *network management architecture* (NMA). This was refined and generalised to apply to all BT operations, and aligned with BT's ONA initiative to become part of ONA-M.

The SSP examined the processes which constitute the operation of BT. It proposed a migration path from present operations to future operations by the end of the 1990s. The hierarchical breakdown into *levels* of process was very similar to that of ONA-M, and they are now being brought into full alignment.

FRAMEWORK—NMA AND ONA-M

Two major initiatives over the last two years have provided a framework for strategic work on support systems focussed on network management in the broadest sense.

Network Management Architecture (NMA)

The NMA provides a 'vertical' analysis of the network and its management systems. At the lowest level are the exchange switches and transmission equipment (network elements), and at the highest level reside the systems which support the interface to customers and other functions outside the management of the network. Since the NMA has been developed after most of the existing systems, they do not always map cleanly onto the levels of the hierarchy. Nor is there any immutable law which says that they must. The NMA is merely a tool for understanding how the functions, and the systems which provide them, should work together.

The levels of the NMA (Figure 1) are as follows:

External Interface Level (EIL) This includes the functions which provide order-taking, customer fault reporting, billing enquiries, etc.

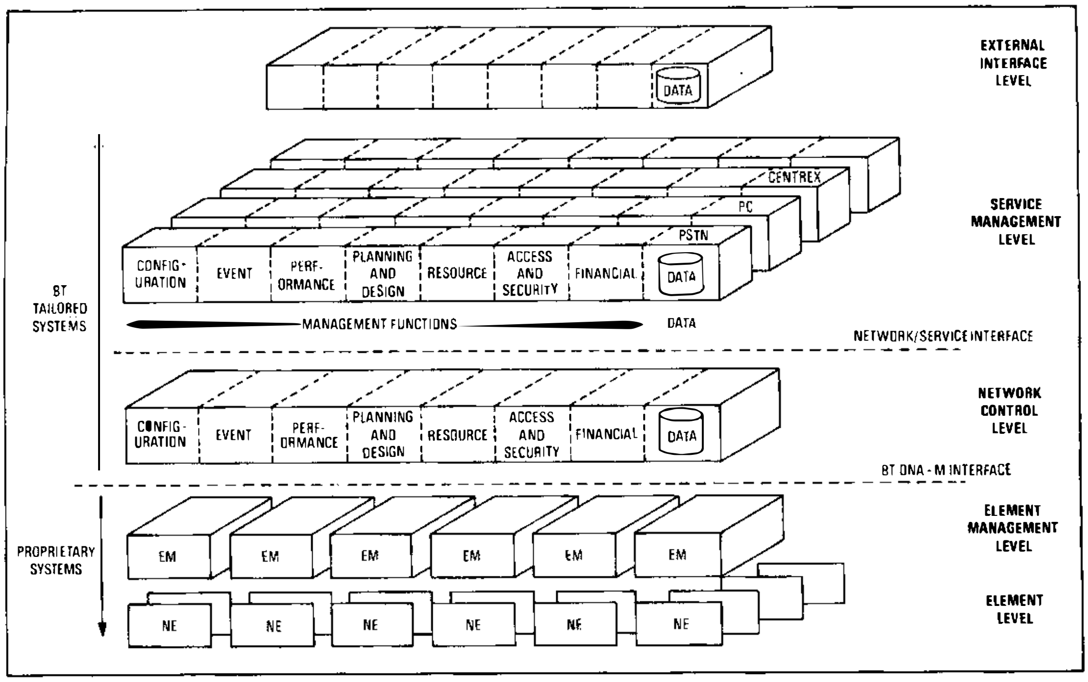
Service Management Level (SML) The SML provides for the management of BT's services across different types of equipment, to manage a service as a whole. Customer Service System (CSS) includes this function for the PSTN, although it also encompasses some network control level (NCL) functionality.

Network Control Level (NCL) This level is the one which binds together the management of equipment of different types and origin, and allows BT to administer the network. These systems are developed either by BT or to BT-specific requirements, and contain intellectual property which gives BT competitive advantage over other purchasers of exchanges and transmission equipment.

Element Management Level (EML) Most of the building blocks from which the network is composed have some management functionality, either built in (as in a System X exchange), or collocated (some forms of transmission equipment). This is the EML. The difference from the NCL is that EML is predominantly supplied by the proprietary manufacturer of the network element.

Network Element Level (NEL) This is the fundamental equipment which makes up the network itself: the exchange switches, the line systems, the multiplexers, and intelligent network databases.

The NMA recognised the crucial importance of data, and postulated that ideally each item of data would be held only once at the lowest possible level of the hierarchy, and accessed when required by the systems higher up. This



NE: Network elements   EM: Element managers

Figure 1 Network management architecture (a component of ONA-M)

is a fundamental change and will be difficult to implement, but gives a goal to strive towards.

ONA Management (ONA-M)

ONA-M brings together a number of initiatives within the company, including ONA, NMA and NATF, to give a common approach to management, not simply for BT's network services, but also for communication products that it sells. This is also co-ordinated, where appropriate, with other large computing and communications undertakings world-wide through the Network Management Forum, of which BT is a founder member. ONA-M has three major components:

- The *structural architecture* describes how the various layers and components of an overall management system fit together, how data is stored and how the information flows around; it is closely based on the NMA.
- The *functional architecture* (Figure 2) defines the functions that make up a management system, where they are performed and how they interact. It separates out the 'horizontal' functions within the layers into seven aspects of management; these are:

  configuration management,
  event management,
  performance management,
  planning and design management,
  resource management,
  access and security management, and
  financial management.

As in NMA, ONA-M recognises the fundamental importance of data, and this is represented as a central core around which the functions appear as segments.

These functions have a very clear relationship with the relevant processes of SSP (Figure 3).

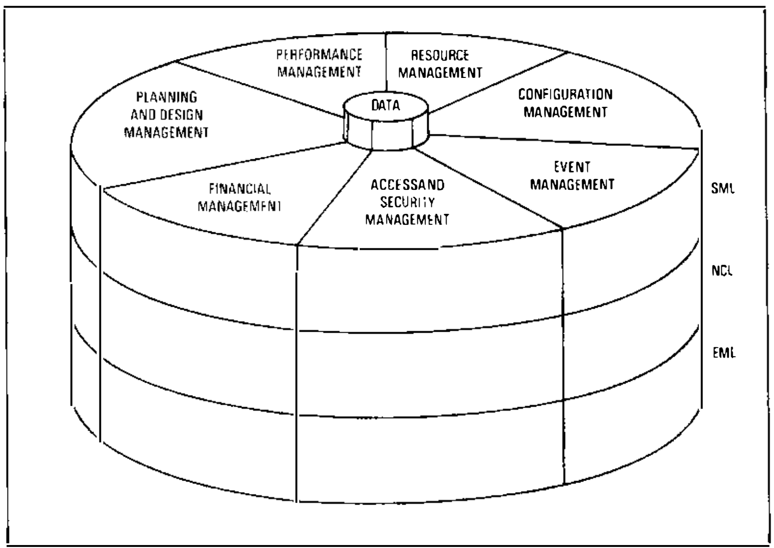
- The *interface architecture* describes how information is actually formatted and interchanged. It builds on the OSI-based work on ONA†, and comprises two main parts:

(*a*) *System Management Protocols* These are the seven layers of OSI, with ONA selecting a coherent sub-set of options at each layer from the plethora in the international standards. They provide the mechanism to transfer information, analogous to the tracks in a railway network.

(*b*) *Message Sets* These convey the management messages, analogous to people in the carriages in a railway.

† Open Network Architecture Release 1.0. (4 Vols.). The ONA Secretariat, BT plc, Technology Application Laboratory, St Vincent House, 1 Cutler Street, Ipswich IP1 1UX.

Figure 2 ONA-M functional architecture



SML: Service management level   NCL: Network control level
EML: Element management level

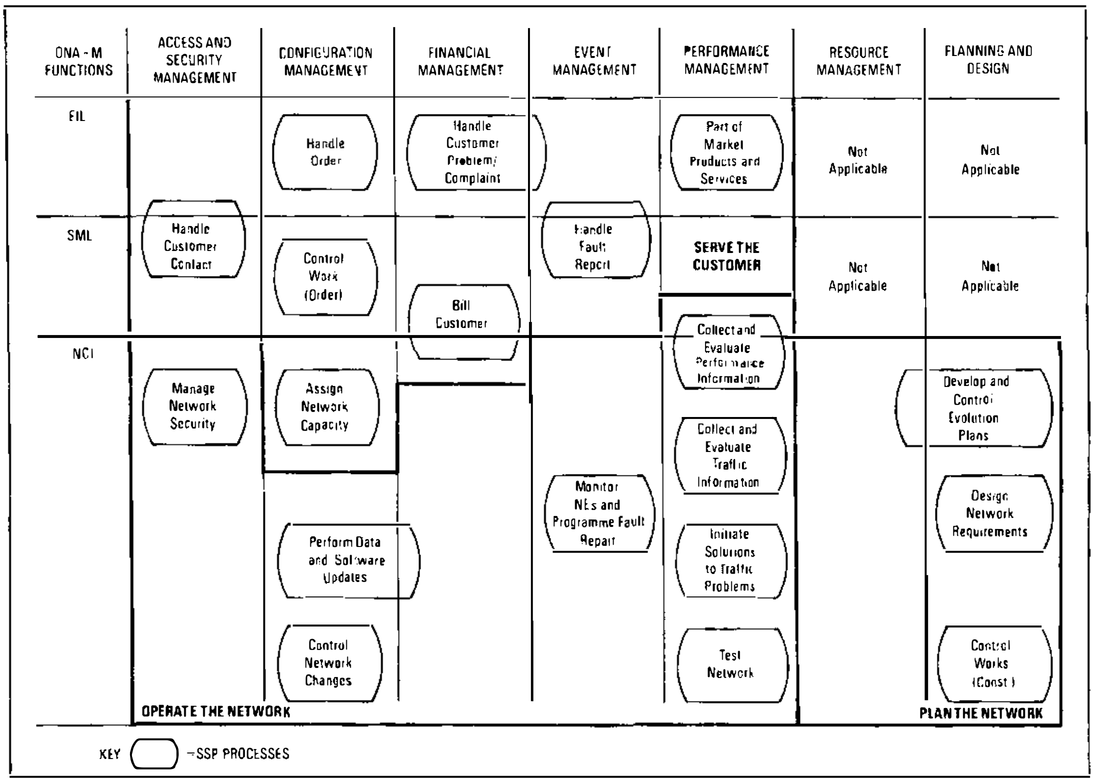


Figure 3
Mapping of SSP processes onto the ONA-M architecture

NETWORK SUPPORT SYSTEMS ARCHITECTURE

In the past, it might have been thought desirable to have a separate system serving each function (for example, configuration management) in each level of the architecture, for each management unit, but, in practice, some functions are needed on a local basis, some only on a national basis, and some co-ordinated between both. Equally, computer systems could span levels in the architecture, or perform a number of functional categories, or both. The water is further muddied by the many existing systems, each with its own development plans. The best evolution path, therefore, is a very complex matter, and hence it is important to have a long-term support systems framework which can be used to guide the migration path of systems towards the vision.

This framework, which focuses on the NCL, is called the *network support systems architecture* and is derived from the strategic systems proposals contained in the SSP report. At this level of definition, physical systems are not identified, only logical systems areas are shown, together with the relationship between them and to other system areas outside of the NCL. Where appropriate, each systems area can be mapped into one of the segments of the NCL ONA-M functional architecture.

It is important to note that the architecture applies to the administration of all network elements including the copper or fibre loop, switches, transmission and intelligent network databases. Whilst separate physical systems may be required to manage the different types of network technology, the relationships between the systems will still be defined by architecture.

Figure 4, which defines the architecture, shows a number of systems areas; the following is a brief description of the functions which are contained within each area.

Network Analysis and Planning Systems

This systems area is responsible for the aggregation of all network services forecasts, traffic levels and network utilisation information in order to identify and plan extra network capacity needed. It relies heavily on the network configuration model for decision making and interacts with the business planning and budgetting functions to receive authorisation for providing extra or replacement capacity.

Examples of current systems are EXPRES, NMP, JNS, TRANSPLAN, and SWITCHPLAN.

Network Element Design Systems

The principal role of this systems area is to automate the design of individual construction jobs for all line plant, switching and transmission equipment. It interacts with procurement to place contracts and with the stores management systems to identify where equipment needs to be ordered.

Examples of current systems are EXPRES, JNS, TRANSPLAN, SWITCHPLAN and EDM.

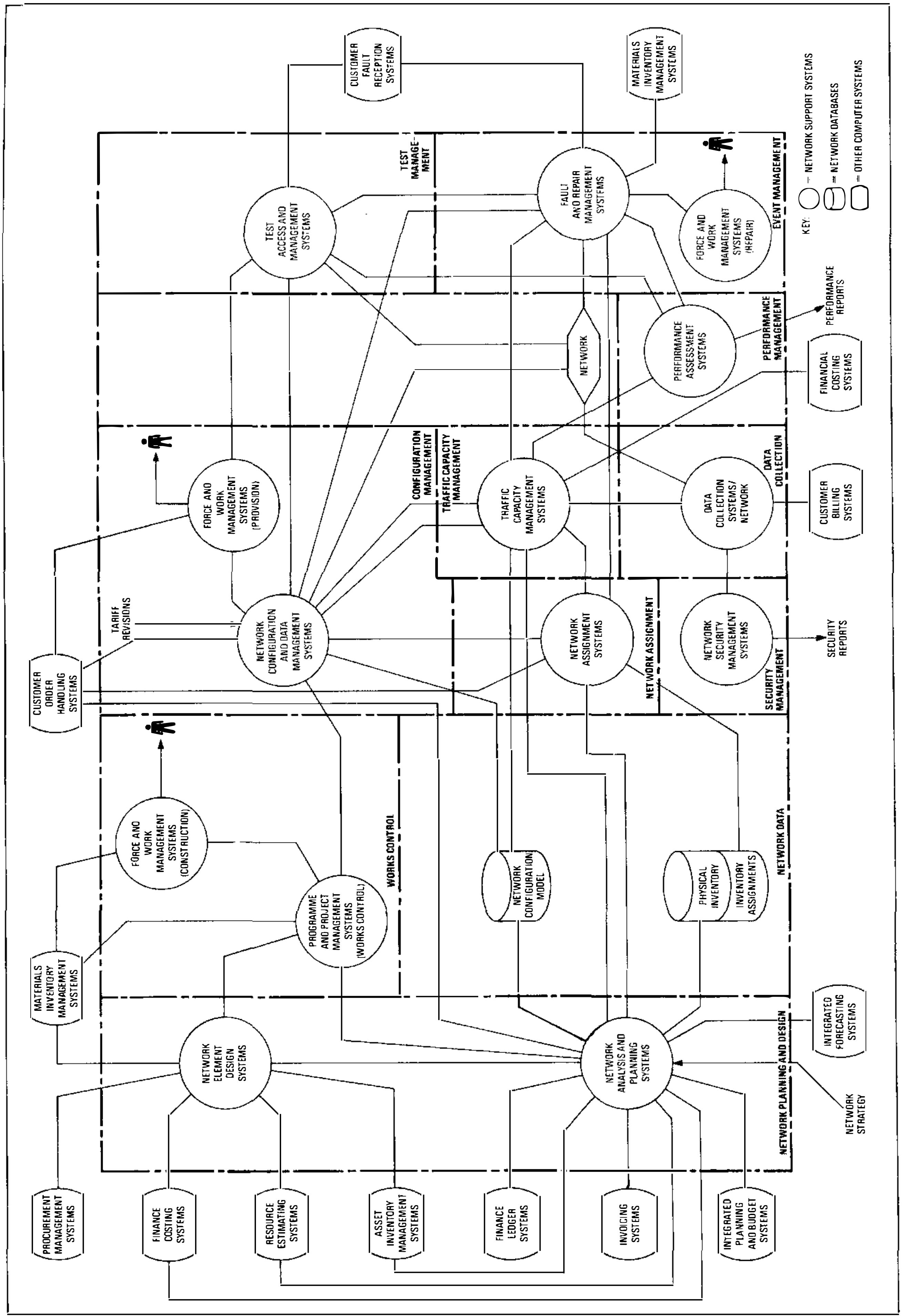


Figure 4—Network support systems architecture

Project and Programme Management Systems

This systems area contains those functions that today would support the external and internal works controls, in order to plan and manage the various construction activities. It is responsible for tracking progress and identifying resource shortfalls.

Examples of current systems are: IWIS, MACE, WASP.

Force and Work Management Systems

The role of this systems area is to assign tasks to the work-force in the most efficient manner taking account of priority, availability, skills and location of the staff. The three principal types of work are construction, provision and repair. While these three areas are shown separately in the architecture, to give greater clarity, they could in reality be realised by the same physical system.

Example of a current systems is NOMS2.

Network Configuration and Data Management Systems

The function of this systems area is to control all changes to the configuration of the network (hardware, software or data). It is responsible for reading and updating data in the network and performing all software and data archiving. Data changes which can arise from customer orders, construction activities, faults, traffic problems or tariff revisions, etc., are all verified and recorded before being loaded into the network. Total failure of a network element due to software or data corruption can be overcome by reloading a data archive, together with any recorded changes.

Examples of current systems are OMC, DCD, DESS, SDBCS, and MFOS.

Network Assignment Systems

This systems area provides the necessary functions to assign network capacity to meet customers' orders or internally generated orders for traffic circuits. It therefore has access to all information about the network inventory and contains the necessary algorithms for plant, equipment and directory number assignments. It also monitors the utilisation of all capacity against thresholds to identify capacity shortfalls in good time for the planning function to provide additional capacity.

Examples of current systems are LLIS, SRS, JNS, MANUS, and ANSWERS.

Network Security Management Systems

This systems area is responsible for maintaining the network access security data, which can identify an individual's access privileges to systems, buildings, or specific functions as required. It also analyses all transaction logs to verify that security levels have been maintained.

An example of a current system is LTLA.

Traffic Capacity Management Systems

This systems area has three distinct functions, firstly to collect and analyse traffic information (calls, circuit loadings, etc.) output from the network and to pass on only that data which is required by other systems and processes. The second is to identify, test through modelling and initiate solutions to real-time traffic problems. The third is to identify where additional traffic capacity is needed and to request plant to be assigned and the network to be configured to meet the demand.

Examples of current systems are NTMS, OTIS, SXTR, and AETR.

Performance Assessment Systems

The role of this systems area is to collect and evaluate all performance information about the network and the various network elements. This information will arise from a number of activities, namely routine testing, network monitoring, equipment repair and traffic monitoring. In general, performance information will be in one of three categories:

- network element performance,
- service performance (for example, percentage call failures), and
- operational performance (for example, time to repair).

Examples of current systems are MAC, PASTE, EIR, and SCOUR.

Fault and Repair Management Systems

The principal functions of this systems area are to monitor the alarm status of all network elements, to correlate and diagnose faults and to manage all repair activities. The fault information can arise from a number of sources, namely the network, routine testing, customers via the front office and performance analysis. In addition, this systems area is responsible for informing the front office of all customer-affecting network faults.

Examples of current systems are OMC, OMUSS, NOMS1, CAMSS, TMS, and MFOS.

Test Access and Management Systems

The overall functions of this systems area can be summarised as carrying out testing of the network to locate faults, or to identify degradation in performance. Tests can be instigated either from a network- or customer-reported fault or as part of a schedule of routine testing.

Examples of current systems are LTS, RATES, and MAC.

Data Collection Systems/Networks

This systems area is unique in as much that it can be realised either by a computer system or by a network solution. It is responsible for the collection of network administration information; that is, traffic data, billing data, performance statistics, and security logs. Some information may be collected via a store-and-forward system, whereas some may be collected directly over an administration data network.

Examples of current systems/networks are DDC, TNDC, and ADPN.

IMPLEMENTING THE ARCHITECTURE

This article has so far attempted to show that establishing a framework for managing the network is quite complex and difficult. However, it pales into insignificance in comparison with making it happen. BT is already in a period of major change, and the support systems have individual programmes for the provision of urgently needed customer facilities, as well as mapping new releases of network element equipment, and rolling out the modernised network across the customer base.

The Network Control Architecture Board (NCAB) was set up to own the network control level, and guide the evolution of the support systems towards an integrated NCL to align with NMA, ONA-M and SSP.

Unfortunately, given the nature of the business, it is not possible to throw away the existing network and move immediately to the 'brave new world' of architected systems. The NCAB approach has been:

(*a*) to work with programme teams to capture and analyse requirements;

(*b*) to generate a vision of the future from a forward look at the technological enablers;

(*c*) to select key systems with the best architectural fit, and migrate the functionality of the others onto them;

(*d*) to run feasibility studies addressing strategic aspects;

(*e*) to map out an evolution plan for the key systems towards the vision; and

(*f*) to monitor and support system developments to ensure that they migrate towards the architecture.

REQUIREMENTS CAPTURE

In the past, system developments often arose from a perceived need, and moved into a hardware and software design without full consideration of business benefits or related functions.

Support systems developments within BT will now be project managed in accordance with TELSTAR II procedures. The architectural aspects will be principally covered in the two early stages, the business survey and the feasibility study. The latter includes the preparation of a financial business case in which the benefits and costs can be assessed and the proposal prioritised.

NATF Recommendations

The NATF made a large number of high-level recommendations for ways of integrating and streamlining the administration of the network. Some have already been implemented; for example, the concentration of systems into 10 network administration computer centres (NACCs). Others, like the move towards a single logical database, will take many years. They all form a vital input to the NCAB support systems evolution plan.

NAIP Requirements

When the NAIP was set up to implement the NATF recommendations, it was realised that the commitment of field people was essential to its success. This was harnessed by instituting a number of functional working groups (FWGs), each led by a field manager. FWGs were each asked to generate a set of requirements in their area, and these were processed by an NCAB team to give order-of-magnitude costs in order to evaluate NAIP viability.

Network Programme Requirements

Most of the major programmes for enhancement to the network, for example, flexible access, advanced services, managed private circuits, involve computer support systems. The NCAB provides a representative on each feasibility study team with the dual role of feeding support system requirements for that programme back to the NCAB, and monitoring the architectural aspects of the programme. In this way, the required functionality can be co-ordinated with the similar needs of other systems and programmes.

NCL VISION

When establishing the direction the network control level should be taking, and trying to map out an evolution plan, it is essential to have a clear target. The NCAB chose the year 1995, and has mapped out a target implementation of computer systems for the NCL at that date. This is based on the outputs of business surveys for network programmes, plus the informed opinions of strategists, developers, systems specifiers and users, both inside and outside BT. This vision has also been aligned with the future operations model of SSP and the network evolution plans prepared by Network Strategy. The NCAB 'NCL Vision for 1995', is summarised below.

Computing Platform

The computing platform for the NCL, that is, the basic hardware and operating systems, will, by 1995, be obtained from a significantly reduced number of vendors, since this policy reduces the variety of development and maintenance skills required. On the other hand, the penetration of open systems concepts, particularly in communications and operating systems will allow some functions to be transported between computers. There will be a migration towards the UNIX open operating system, but this will be far from complete in the NCL by 1995.

In general, there will be a concentration of functions onto clusters of large processors on a small number of sites. These sites (NACCs) may be unstaffed (*lights out*) and run from a staffed site which provides fallback, archiving and other file-store management facilities. In addition, there will be further rationalisation of computer centres as the programme for establishing a number of strategic computer centres (SCCs) for BTUK is implemented.

User Access (Figure 5)

A key requirement from the field has been to allow users to access all the systems they need from a single terminal. This is being addressed for clusters of users by the INTERNET T-NET Plus LAN. By 1995, the LAN will probably be running at 100 Mbit/s or above. Local processing and high-speed communications will give sub-second response times. Where required, very-high-resolution screens on intelligent workstations will be provided. Both the workstations and ordinary terminals, and the LAN, will be ONA conformant. Mobile field staff will use hand-held terminals linked into the network operations unit (NOU) LANs.

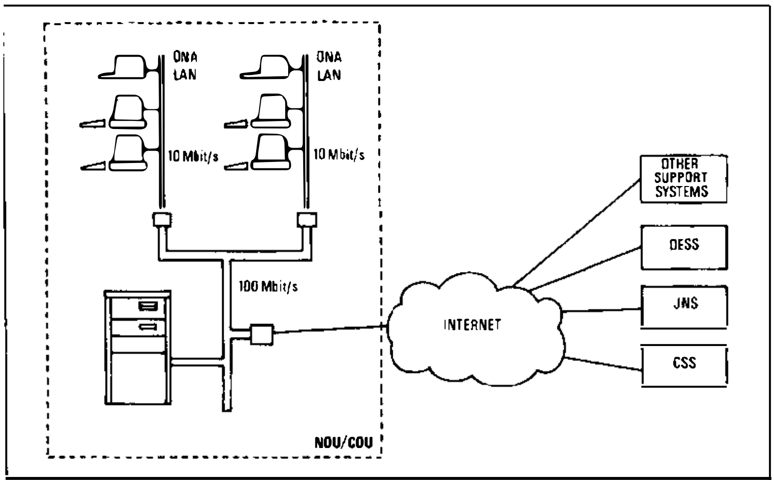


Figure 5—1995 NCL vision—user access

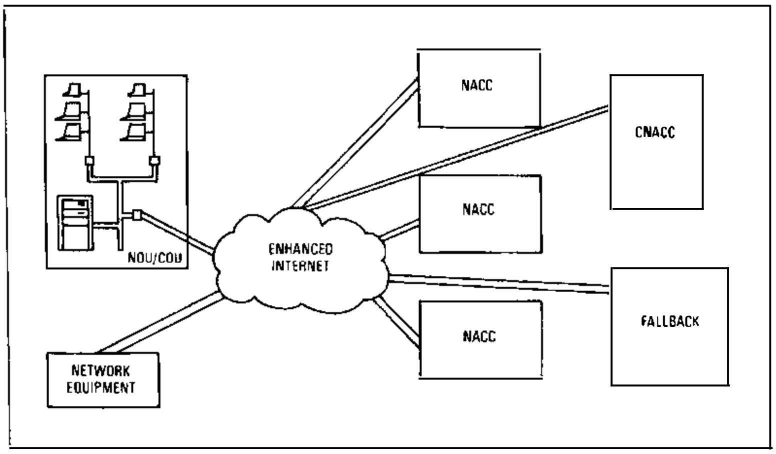


Figure 6—1995 NCL vision—networking

Networking (Figure 6)

Many of the NCL objectives are dependent on a fast secure network with high availability. These include:

(*a*) off-site archiving of data for NACCs,
(*b*) security back-up of data to the fallback site,
(*c*) short user response times,
(*d*) short database access times, and
(*e*) mobility.

This network will be provided by enhanced INTERNET (which will include both the administration data packet network (ADPN) and the INTERNET backbone transmission network (IBTN)) and will operate at 2 Mbit/s or higher speeds.

This increasing level of interaction between systems will require compatible interfaces, and this will be provided by ONA protocols and message sets.

Data

Data is simultaneously an area with tremendous potential for operational improvement, and an area where the cost justifications and priorities for change are most difficult to achieve. By 1995, there will have been significant progress towards:

(*a*) a single logical database,
(*b*) standardisation of data structures,
(*c*) sharing of the database both within the NCL and with other levels,
(*d*) custodianship of the data entities, and
(*e*) data consistency across systems.

Development Environment

New development techniques will have a substantial impact on both delivery times and quality of software; among these will be:

(*a*) integrated CASE tools, enforcing structured programming, and generating code automatically;
(*b*) development of *core* software;
(*c*) use of rule-based expert systems; and
(*d*) partitioning of large systems to remove dependency on major drops.

Security

The business' dependence on computer support systems will be safeguarded by a number of mechanisms:

(*a*) user identification and password,

(*b*) physical token (smart card) at terminals/workstations,

(*c*) encryption where required on communications access, and

(*d*) terminal identities registered with host computers.

KEY SYSTEMS SELECTION AND EVOLUTION

A vital aspect of the NCAB vision is the reduction of the total number of systems, and the co-ordination of the evolutionary systems to form a coherent means of running the network. The selection of the *key systems* was carried out in a rigorous way on the basis of a set of criteria agreed by the NCAB. The plan for non-key systems is that their functions will migrate over a sensible period into the key systems. The key systems provide a basis for making decisions on where to provide new functions, to avoid developing new systems.

Criteria

Existing systems were mapped onto the groupings defined by the network support systems architecture. Within each group, the systems were checked against a set of criteria, ranked in order of importance:

(*a*) endurance—currently successful and meeting a continuing need;

(*b*) architecturally conformant—functions aligned with the architecture, and software, data and interfaces at least potentially conforming to ONA;

(*c*) extendibility—capable of enhancement to functions;

(*d*) platform—computing platform has a long-term future in BT;

(*e*) most comprehensive in functionality;

(*f*) least disruptive to customer service when modified;

(*g*) most comprehensive in data; and

(*h*) greatest volume of data.

Selection

The actual selection, while using the above criteria, was carried out as a two-stage process with the experts in each functional area. The first stage was to select a preferred set of 50 systems from the 150 currently in use; the second was to reduce to a smaller number of key systems for future development. The results, including the reasons for non-selection, were documented and approved by the NCAB. This gave an initial set of key systems which is now the subject of ongoing further evaluation.

Feasibility Studies and Evolution Paths

Having mapped out a 1995 vision, evolution paths are needed from the support systems existing today to the vision, accepting that the vision itself will evolve as time passes. High-level plans have been prepared in a number of functional areas, and a series of feasibility studies is planned to give strategic direction to the support system developments. The feasibility studies will be carried out by experts from the programme teams and systems teams in Network Planning and Works (NPW), Network Systems Engineering and Technology (NSET) and Network Operations Support (NOS), development specialists from Computing and Information Services (CIS) and Research and Technology (R&T), the Network Strategy Unit and the NCAB Support Team. The results of these studies will be a set of systems evolution plans which include migration steps, projected development costs and savings arising from deployment.

Since the amount of development work on network support systems exceeds the resource that can be allocated to it, developments will have to be prioritised. The prioritisation criteria will need to take account of potential savings, business/regulatory imperatives and the need to make investments of a strategic nature to achieve the long-term vision of network administration.

MONITORING AND CONTROL

The NCAB, which has already been operating for some 12 months with permanent representatives from NOS, NPW, R&T, CIS/SD and ICPA Departments, is now recognised as the authoritative body for ensuring all developments fit within the network support systems architecture. It has four principal responsibilities:

(*a*) to ensure that functions are developed in the correct systems as defined by the architecture and that functional duplication is minimised;

(*b*) to ensure that data duplication is minimised across systems, data standards are adopted and databases are effectively managed;

(*c*) to control the realisation of system-to-system interfaces, and promote the use of OSI protocols; and

(*d*) to ensure that the computing hardware and operating systems, software and database systems, conform to the computing platform adopted by BTUK.

All network support systems development proposals now require an architectural sign-off from the NCAB before financial authorisation is granted.

FUTURE

With the establishment of the network support systems architecture and NCAB to control all future developments, the aim is that the planning, operation and management of BT's network will migrate towards being supported by a small set of computer systems, each of which:

(*a*) has a clearly defined set of functions, in the context of the SSP process 'Run the Network';

(*b*) has well-documented interfaces to the elements of the network, to other support systems, and to system users;

(*c*) runs on a computer platform which conforms to BT policy;

(*d*) accesses data defined by BT's data standards held on a single logical database;

(*e*) is developed and implemented on time, to budget, and at lowest cost, in accordance with an evolution plan meeting a quality set of business requirements; and

(*f*) will reduce costs and improve the quality of the processes by which BT runs the network.

Biographies

Mike Spooner, is the manager in BTUK Network Operations Support responsible for network configuration management and support systems development and architecture. He joined the then British Post Office (BPO) in 1971 having obtained B.Sc. and M.Sc. degrees in Mathematics and Physics. He initially worked on the development of the packet switching service. As a member of the Joint Systems Team, he worked on System X requirements and design. He then worked on the development of network administration support systems and became a member of the Network Administration Task Force (NATF). He has recently become a member of the Strategic Systems Planning Project.

Jonathan Ash heads the Network Administration Systems Evolution Section in BTUK Network Operations Support. He graduated in Electrical Engineering (with Electronics) from Imperial College, University of London, in 1971, and joined the BPO in the same year. His experience includes Strowger Telex planning, and the development of frequency-division multiplex and optical-fibre line systems. As a member of the System X development Joint System Team, he specified the early OSI interfaces between the digital exchanges and their support systems, and established the administration data packet network. His current responsibilities include steering network support systems developments towards a coherent integrated future. He is a Member of the Institution of Electrical Engineers.

Nick Furley is head of the group supporting the Network Control Architecture Board, providing strategic guidance and assistance to Support System Project managers and network programmes on the evolution of support systems. He joined the then BPO in 1969 as a Post Office Student, and obtained a B.Sc. in Electrical Engineering and Electronics. He worked initially on national and international register-translator development including the design of custom-designed integrated circuits for replacement of electromechanical functions. He has also worked on project management of the electronic meter replacement, call logging systems for analogue exchanges, district data collectors, and the digital exchange support system.

British Telecom's Group Architecture

In this issue of the *Journal*, the terms CNA and ONA are used in the context of British Telecom's architecture. Co-operative Networking Architecture (CNA) represents the next logical stage in the development of BT's architecture from the Open Network Architecture (ONA) in response to commercial requirements.

CNA is the technical framework within which all BT's products and services are developed. These products and services include those which the company sells as well as those it uses internally.

The adoption of the architecture is reflected in the creation of a coherent portfolio with consistency of style and operation.

The architecture is not static, but evolves with time to reflect changing business pressures and advancing technology.

The present position is the result of the evolutionary process which has broadened the scope of the architecture since it was first launched as Open Network Architecture (ONA) in 1986.

The emphasis of ONA is on the use of open systems, based on the work of international standards bodies and industry consortia, from the CCITT to the OSI/Network Management Forum.

The need for open systems, however, is not universal whereas the benefits of architecture can be demonstrated in all areas of operation. The use of standardised specifications and software building blocks under ONA has led to economies of scale, flexibility, and the development of transferable skills. These benefits can also be reaped through the use of a consistent technical architecture in areas where open systems are not appropriate for a variety of commercial and technical reasons.

BT's Product Style Initiative, for example, defines recommendations to ensure a consistent style is achieved across BT's range of hardware, from terminals to telephones. Such recommendations are not appropriate for international recommendations, but benefits accrue to BT from the development of a consistent high-quality brand image, and from the use of standardised specifications for BT's designers and suppliers.

This commercial reality is reflected in the maturing of BT's Group Architecture to encompass a variety of standards, whether open (as defined in ONA), *de facto* or proprietary. However, the policy will be to define open systems as the strategic direction. ONA is the subset of CNA that specifies how to use open systems standards.

This repositioning of the Group Architecture will also enable BT to capitalise on its investment in architecture in the US, where the term ONA is already widely used to describe the regulatory position for value-added telephony. This is particularly important to BT following the acquisition of Tymnet.

The infrastructure of documentation and procedures needed to point the way around the detailed standards is defined as the *Co-operative Networking Architecture*.

Customer Managed Communications—British Telecom's Approach to Open Integrated Network Management

N. MELLOR†

This article examines the market factors which are leading customers to demand open integrated solutions for managing their complex information systems, and outlines the response which the industry and specifically British Telecom is making to put the customer in control. British Telecom's major Customer Managed Communications and Concert™ initiative in integrated network management is explained in terms both of its positioning and functionality. This includes examination of BT's Co-operative Networking Architecture and the work of the Network Management Forum in defining and implementing common open specifications. In summary, the benefits both to the customer and to BT are described, and the future direction for network management and the ongoing development of Customer Managed Communications are outlined.

INTRODUCTION

British Telecom understands the customer's need to control and manage today's increasingly complex multi-vendor communications network in order to achieve business success and competitive edge. As a result, British Telecom has developed proven comprehensive integrated solutions based on its own experience as a major network operator.

MARKET BACKGROUND

Network management is becoming one of the most discussed subjects in the world of business communications and technology. Many businesses today are heavily dependant upon and realise the key strategic importance of their information networks. These networks have graduated from being support systems to the central 'oxygen links', vital to the success of the business.

Gradual liberalisation of telecommunications markets world-wide, rapidly advancing technology and the drive for increased business competitiveness have generated an explosive growth in data communications traffic. As markets have grown into globalised trading, so too corporate communications systems must meet the challenge of transcending geographic boundaries.

National boundaries are not the only obstacles to the network planner. A typical corporate network may comprise products and services from at least 20 different suppliers. This presents inevitable problems in integrating equipment to exchange information, and even greater problems in attempting to manage a large and complicated 'patchwork' from end to end.

Corporate information networks have become increasingly complex and strategically important, while simultaneously the demands made upon them have risen dramatically. The demand for effective end-to-end management of these systems has never been greater.

Network management is an overworked term which can be more simply defined as 'all the tasks which must be accomplished to enable the planning, building and operation of an information system which meets business and financial targets.' The financial implications of operating the network are frequently overlooked. Over a five year period, the costs of operating the network can be more than double the initial cost of building it.

Network management involves optimising the benefit of the network asset to the company by maximising its revenue earning or enhancing potential, while minimising its actual running costs. Under effective management, the costs of hardware, software and personnel can all be reduced, while response time and service quality can be increased and downtime minimised. The network is tuned to increase the flexibility, responsiveness and competitiveness of the organisation it serves.

The communications network lies at the heart of an information system. All parts of an organisation's management, in production, sales, accounts and so on, depend upon the timely receipt of information. Thus, not only does the network require to be managed optimally, but the integration of the communications network, computing and applications must be achieved.

The importance of the ability of communications to function across both geographic and

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technical vendor boundaries has already been mentioned. Equipment must not only 'talk' the same language, but must also be capable of being managed in a common way. This is not as simple as it may at first seem.

Imagine a conversation between a Greek philosopher in Athens and a schoolboy in London. Firstly, a compatible physical means of connecting the two must be provided; so a telephone line is installed. This does not solve the problem, however, as they are speaking different native languages; so they agree to converse in Esperanto, which both understand. Even now, there is no effective communication, as the philosopher's lofty ideas are unintelligible to the boy; so commonly understood messages need to be defined and exchanged. Only now is there a meaningful communications link!

These same principles apply to the integration of different supplier's communications and information systems; internationally agreed and adopted standards must be used for the interchange of management information on the network.

NETWORK MANAGEMENT FORUM

The Network Mangement Forum was formed in June 1988 by British Telecom, AT&T, Hewlett-Packard, Northern Telecom, Telecom Canada, STC and Unisys; the Forum now numbers 95 members in 13 countries world-wide, and incorporates all of the major computing and communications suppliers, including IBM and DEC. It is dedicated to defining specifications for the interworking of management information in real networks between vendors, and delivering to market interoperable products from member companies. The Forum comprises voting and associate members. Voting members commit skilled people and working capital and are instrumental in achieving the considerable technical goals set out. Associate members commit a lower investment, and share in the output of the Forum's work. Only by harnessing the international information industry, users, network equipment suppliers, computer companies and service providers can the goal of global multi-vendor network management become a reality. The Forum is making rapid progress in achieving this.

British Telecom has taken a pro-active lead in the Forum since its inception, with Keith Willetts, head of British Telecom's Customer Managed Communications project as the current President, having co-founded the organisation with John Miller of AT&T.

In common with British Telecom, many Forum members are now working to implement these agreed technical specifications into demonstrable products with open network management capability. Under the Forum framework, vendors will proceed to public demonstrations of such products and services during early-1991.

BRITISH TELECOM'S RESPONSE

It is in no customer's interests to be locked into one manufacturer's products and services where these cannot work with those of other suppliers. Today, the demand is for interoperable components with suppliers competing on quality and support, not proprietary architectures.

British Telecom has responded to this demand from customers (and its own network) with the development of a co-operative approach to architectural specifications for all aspects of communications systems. This new approach recognises the need for partnership, working alongside other vendors and customers to define truly interoperable systems that cope with today's multi-vendor, multi-location networking market-place. British Telecom's *Co-operative Networking Architecture* takes a step beyond open systems by putting in place the specifications and agreements to ensure that real products and services will be able to work together and conform to international standards.

The specifications of the Forum are the bedrock of British Telecom's own architecture for achieving open network management. These comprehensive 'rules' define in detail the functions, structures and interfaces that enable management systems to interact, giving an end-to-end view of the network. As one of the largest network operators in the world, British Telecom is investing heavily in systems built against Co-operative Networking Architecture for its own networks, and is now actively implementing these principles into its customer products and services. By harmonising the architecture and management capabilities of its products and services, British Telecom will offer to the customer a true end-to-end managed communications capability within its own portfolio, and within multi-vendor networks.

The architecture represents a significant achievement in analysing the various 'flavours' of Open Systems Interconnection (OSI) adopted by bodies in different countries, and defines a common 'thread' through OSI, which is truly open, internationally accepted and conformant with all national implementations. This reflects British Telecom's commitment, as a major force in the world-wide communications market-place, to offering a consistent portfolio of products which conform to a coherent set of international standards. This is the task for *Customer Managed Communications*.

CUSTOMER MANAGED COMMUNICATIONS

Customer Managed Communications is British Telecom's approach to open integrated management of communications systems for its customers world-wide. It offers customers the ability to manage their communications system from end to end through a coherent portfolio of products and services, capable of being managed in a uniform way.

The Customer Managed Communications portfolio will include many of British Telecom's products and services, harmonised in terms of architecture and management capabilities, providing a managed communications capability not only within the company, but also within multi-vendor networks, with other vendors complying with Forum specifications.

The capability which enables all of these products and services to be managed in a common way, the 'ingredient', is called *Concert™*. Concert™ can also facilitate the integrated management of computer systems, providing a true end-to-end management capability throughout the information system. Built on internationally agreed OSI network management specifications, Concert™ is effectively the ingredient which defines the management functions of network elements, and orchestrates them into a single tailor-made package—a communications system which is manageable and controllable from end to end. Its implementation in different products or *managed objects* may vary, but it enables each to communicate via open interfaces conforming to the specifications of the Network Management Forum, complying fully with BT's Co-operative Networking Architecture.

Figure 1 illustrates the positioning of Customer Managed Communications and Concert™ in the overall British Telecom portfolio. Customer Managed Communications is that subset of the total portfolio which is manageable; Concert™ is the 'horizontal ingredient' which renders that manageability possible.

So how, in practice, will this management capability be brought about in the customer's network?

Figure 2 shows a simple diagram of how an open integrated managed network would be structured in practice. Each product or service to be managed (modems, multiplexers, local area networks, X.25, KiloStream, etc.) or *network element* is directly managed by an *element manager*. For example, a rack of modems may be managed by a PC or workstation which receives a variety of information from each modem on its status, and is capable of monitoring, analysing, storing and displaying that information, and flagging up problems, etc. Information from all the element managers is then correlated by an integration system which gives an end-to-end view of the network, for the first time capable of integrating the management functions of all the elements into a single screen.

The system is therefore managed as a single entity, like any other corporate asset, with a hierarchy of management levels corresponding to those of the organisation itself. Not only are the individual elements which constitute the network managed, but the system is viewed as a whole, permitting improved service levels by reducing response times and providing faster problem solving.

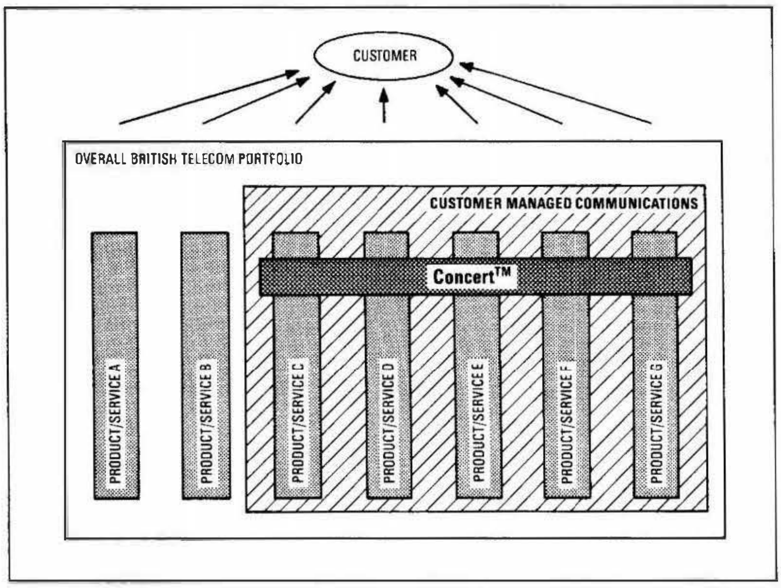


Figure 1
Positioning of Customer Managed Communications in the British Telecom product portfolio

This will not only be capable of pulling together the elements within British Telecom's portfolio, but also many products from other suppliers. It is this capability which permits, for example, management messages from a computer system to be combined with those from the communications network, providing a true system-wide view of operations. All interfaces and messages flowing through the system are to Forum specifications to ensure complete openness of the system.

DELIVERING THE BENEFITS

Customer Managed Communications is not an overnight remedy for the problems of managing a large heterogeneous network. The programme represents a long-term migration of British Telecom's products and services to meet the customer needs of the 1990s and beyond. Progressive releases of products incorporating the Concert™ capability will increase both the number and functionality of the range of manageable elements within British Telecom's overall portfolio. In practice, this roll-out will take the form of a series of announcements from late-1990, through to 1992.

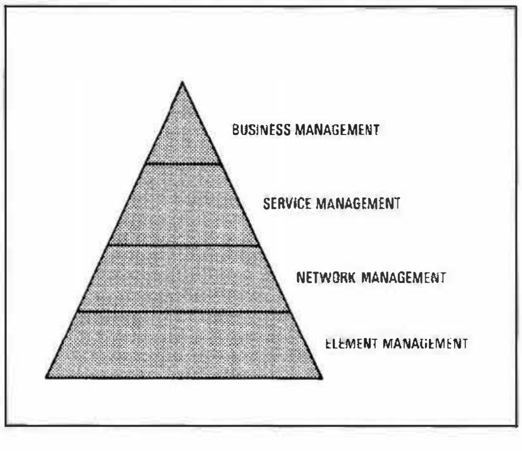


Figure 2
Open integrated managed network

The Customer Managed Communications initiative will be of real benefit to the business community world-wide. Organisations will improve radically their ability to manage in an integrated and open way the networks which transport the information so vital to their success. By making the network management task both simpler and more efficient, customers will be able to devote more of their time and resource to the core business activity: generating revenue and profit.

The benefits to British Telecom are also significant. Quite apart from the considerable benefits to the management of its own network, by presenting to customers a coherent and manageable portfolio, meeting their needs for future communications systems, Customer Managed Communications provides a major tool with which to achieve BT's goal of becoming the leader in the global communications marketplace.

Biography

Neil Mellor is currently Market Communications Manager within the Managed Communications business unit in Customer Systems, BT Communications Systems Division, having joined BT in July 1989. His specific responsibilities cover all aspects of market communications relating to Concert™ and Customer Managed Communications world-wide. Prior to this, he was Marketing Manager of a major UK-based modem and network developer, with technical and commercial responsibilities. Previously, his career included industrial and consumer marketing roles within BP, Procter and Gamble and Hydro Group, having graduated from Loughborough University in 1981 with a B.Sc. Honours degree in Banking and Finance, under industrial scholarship from Midland Bank Group.

Office Automation—A Fundamental Tool for Strategic Advantage in the 1990s

T. F. SMITH†

Office automation (OA) is making an increasing impact in business generally, and in British Telecom in particular. As well as aiding routine office tasks, it will improve the basis for decision making at all levels of management. This article gives an overview of two OA systems: WEB and COAST. WEB is already widely used in British Telecom Research Laboratories as an office system, for project control and information services, while COAST is being developed as a large company-wide fully-supported OA system with a wide range of facilities and based on open technology, with the object of enhancing company efficiency.

INTRODUCTION

The image of office automation (OA) has changed significantly over the past decade. At the beginning of this period, the media carried many stories heralding the arrival of the *electronic office* or the *paperless office*. On the one hand, it was generally recognised that the necessary systems were not available, but at the same time there was a tide of optimism that suggested that the required products were just around the corner. Even the Government was prepared to fund the revolution, and in 1983/4 about 20 office automation pilot projects were funded by the Department of Trade and Industry (DTI). BT took part in this initiative with a DEC All-in-One system installed at the then Long Range Studies Unit at Cambridge.

The DTI initiative encompassed a range of users (from BBC Breakfast TV to Brighton Health Authority) and an equally wide range of technology. The resulting studies and reports that flowed from these schemes tended to be somewhat inconclusive and in some cases were even rather negative, although there were exceptions.

The overall message that began to form was that a rather bland approach, which merely provided electronic mail and a few peripheral facilities; while it could be called OA, it did not excite many organisations. Neither did it easily meet cost justification criteria: OA had to offer more and deliver more.

Later in the 1980s, the thrust therefore changed in three particular ways:

- Office automation gradually became equated to the broader *information technology* (IT). Although rarely defined accurately, old-style OA usually conjured up visions of electronic mail and little else. IT on the other hand was always considered as being a broad brush application of all that computing, telecommunications, and other (electronic) technology could offer to solve a business problem.
- The pyramidal description of a business became the basis of thinking (Figure 1). This shows that the bulk of the typical business workforce is at the base of the pyramid performing relatively well-structured tasks. A smaller number, in middle management, are less structured in their work (now called *knowledge workers*) and the remaining top people have a very unstructured work profile. The message was that traditional data-processing (DP) systems had tackled the base of the pyramid and that IT (or OA) needed to focus on the upper two layers. More recently, an inverted pyramid has been described, overlayed on the structure, which represents the impact that OA/IT can still have on organisations. The inverted pyramid shows that computer support has already significantly impacted on the well-structured tasks. At the other extreme, top management is pro-

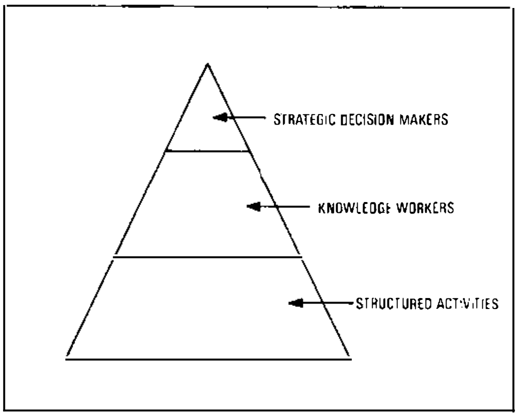


Figure 1—A typical organisation

† IT Systems Division, British Telecom Research and Technology

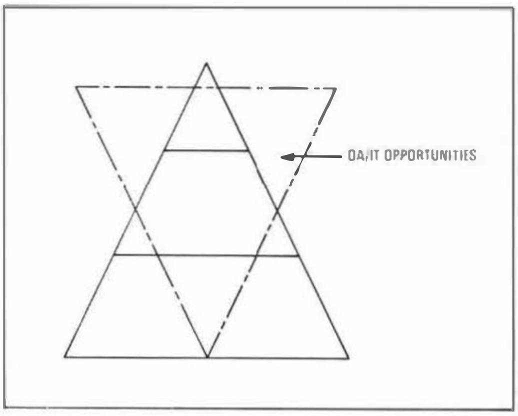


Figure 2—Potential impact of IT

portionately less computer supported in its task of strategic decision making. (Figure 2.)

- In the early-1980s, OA was targeted to improve the efficiency of the organisation and thus reduce running costs. While this is still an objective of current OA projects, much attention is now centred on using OA or IT for strategic advantage. Advantage can be gained over a competitor in a number of ways using IT. Within the organisation, decisions can be made on better, more accurate and timely information. External to the organisation, IT can be used to generate better interfaces to customers and suppliers. BT is becoming increasingly involved in a competitive market-place, so there are clear messages for the company here.

This article gives an overview of OA activities in BT by focusing on two projects:

(*a*) the system known as the *WEB* installed and developed over the last 5 years at the British Telecom Research Laboratories (BTRL), and

(*b*) the new company-wide OA initiative COAST (Common OA System for Telecommunications) which will have a major impact on BT Districts over the next few years.

WEB

The decision to install an OA system at BTRL was taken in 1984. BTRL is a campus-style location with currently more than 50 buildings spread over a 100 acre site (Figure 3). As might be expected, the use of computers is extensive in a research and development environment, and the installed computer base was a factor that had to be taken into account in planning the system.

The WEB will be described in terms of:

(*a*) the *facilities* offered to users, and

(*b*) the *platform* upon which these facilities are built.

Figure 3
British Telecom Research Laboratories

Facilities

In keeping with the philosophy described above, initially the facilities provided were traditional electronic mail/messaging, but these were then followed by other services; in particular what are known in WEB parlance as *procedures*. Procedures are the automation of semi-structured tasks which often represent activities in the middle sector of the pyramid (Figure 1). A structured task covers the simple act of logging on to a computer; for example, to debit an account. This is often called *transaction processing*. WEB procedures take this further to allow the WEB messaging network to act as a sophisticated front-end to simple transaction processing. A key factor in this process is the *Directory of Users* which holds not only a list of names but also their structure or hierarchy-forming organisation. The two major procedure packages in use at BTRL are *Purchase Order* (PO) and *Group Manpower Returns* (GMR), and the concept is best explained by examining these. Both these packages were developed at BTRL.

Purchase Order

Each year, about 40 000 purchase orders are made by staff at BTRL. The value of each order ranges from a few pounds to several million pounds. The tight financial procedures in BT Research and Technology (R&T) require each order to be set against a valid project. Further, controls are necessary to ensure that individuals do not purchase on projects for which they have no authority. Normal hierarchical financial authorisation limits also apply. Order originators wish to know the status of their order; has it been authorised, has it been placed, delivered etc? Finally, the stores and financial duties have to be able to identify owners of equipment delivered and pay valid invoices. In all, this is a typical stores ordering problem and one that is very difficult to handle in a quality fashion by paper means.

Two files of structured data are particularly key in the application:

(*a*) *R&T hierarchical structure* This directory currently contains approaching 5000 entries for all R&T staff and organisational groups; that is, duty codes. The database, which includes telephone numbers, is updated daily and is taken as the definitive organisational information in R&T. From it is printed a paper telephone directory although, as will be seen below, the need for a paper telephone directory in R&T is virtually eliminated. Site telephone operators use the electronic file in dealing with calls.

The user is able to select an entry either by name or duty code. The phonetic spelling capability even gives a good chance of success if the name is spelt wrongly. If a duty code is selected, all the members of that duty are listed in alphabetical order. Once an individual has been chosen, a further choice is available in that building location, or his or her position in the organisation can be indicated including the title/function of the group where the person works.

(*b*) *The project database* R&T's financial reports are based upon projects (of which there are in excess of 400) and Divisional accounts. The project information file is managed by R&T's Business Operations Division to represent the current work profile on R&T. In particular, it indicates which Divisions are working on each particular project and hence which R&T staff are eligible to book expenditure to each project.

To return to the PO system itself, it can now be seen that the hierarchical and project title files provide the basis of the control that is required. In addition, normal BT financial procedures will require authorisation at certain levels depending upon the value of the order. The resulting flow chart for placing an order is shown in Figure 4.

In reality, the system provides a number of screens for Order Originator, Project Manager etc. Messages are passed around the system seeking appropriate authorisation. At any point a *justification* can be requested which causes an appropriate message to be sent to the originator. Further complexity arises because any authoriser may wish to delegate his/her responsibility to someone else (and the system checks if this is valid within the financial rules); and a project manager may wish to set a threshold below which he/she does not wish to see orders.

Figure 4 shows a flow of messages which is functionally *structured* but in other respects *unstructured*. The WEB is effectively a front-end to the more traditional transaction processing accounting system. The output from Figure 4 is a set of transactions, fully authorised, which is then fed into the R&T financial system. This is based on Millenium Software running on IBM machines. Feedback is also obtained from the financial system to WEB users to enable them to check on the progress of orders.

The value to R&T of such a system is tighter financial control and more accurate accounting. Rekeying of data is eliminated. The users also find added value in that it is now possible for them to monitor the progress of an order more effectively.

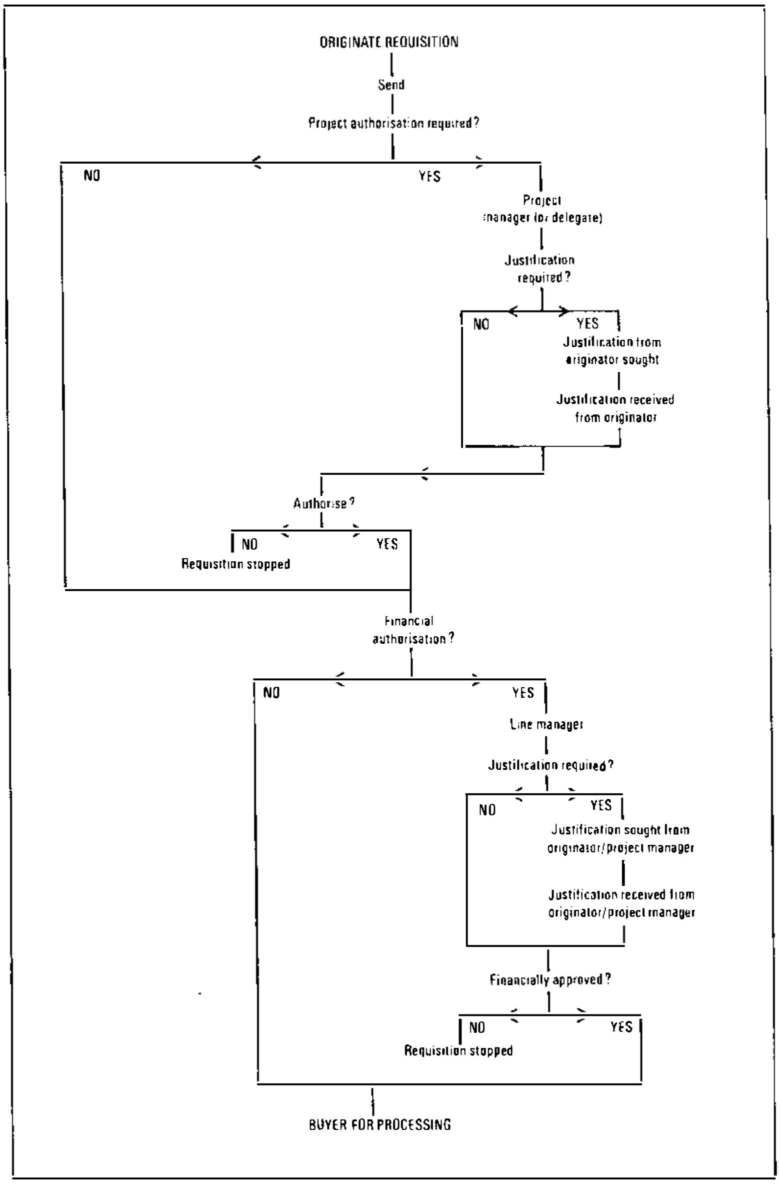


Figure 4
Purchase order system

Group Manpower Records (GMRs)

In common with most units in BT, it is necessary to account for the way in which staff time is spent. The R&T *timesheet* is in the form of a monthly report completed by Heads of Group and above. Time may be charged to one of the 400 projects or to various jobs on an overheads budget called *Division*. Labour charges are the largest element in most projects so it is crucial that the bookings are accurate.

Before WEB was introduced, the returns were collected on paper and the system suffered from many problems:

(*a*) A large percentage (up to 40%) were obviously incorrect (for example, concerning the number of staff in the unit or days in the month!), and a further percentage were probably incorrect (for example, in terms of project number).

(*b*) Many forms were received late thus making the monthly data collection inaccurate.

(*c*) All data had to be rekeyed with the possibility of further errors.

The earlier description of PO has already indicated how the WEB and the two key data files make an effective GMR system possible.

The system has now been in use for two years and has enabled extremely accurate data to be collected, consolidated and presented to senior managers immediately on line. The features of the system include:

- message reminders to all managers of the need to input a GMR;
- automatic escalation of the reminder if the return is not made;
- accurate indication of the staff in the unit and hence the total number of days to be booked;
- control of project numbers that can be used; each project is only open to certain staff; and
- summary listings of project and overhead time to all managers.

Figure 5 shows a typical GMR screen that would be used by a Head of Group, and Figure 6 an actual form.

The system has been found to be extremely successful both in cost reduction (eliminating the effort for rekeying and virtually all of the manual checking) and, possibly more importantly, in giving much more timely and accurate financial information to managers.

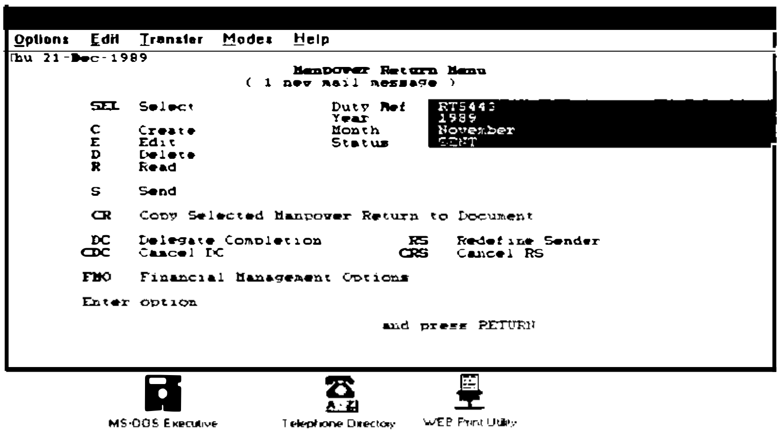


Figure 5—GMR screen

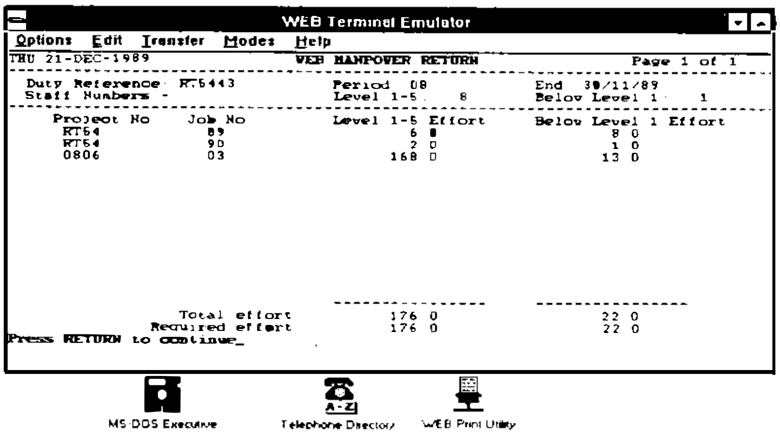


Figure 6—GMR return

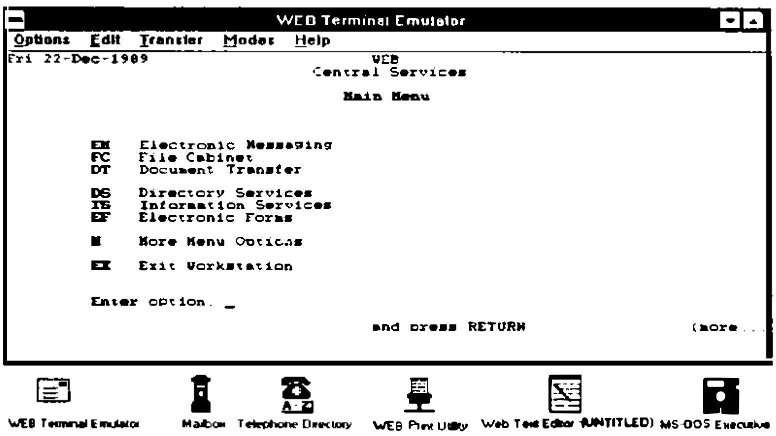


Figure 7—WEB screen

OA Tools

The more general OA tools provided on WEB may be classified as those primarily resident in the terminal environment and those making use of *Central Services* (CS).

(*a*) *Terminal Environment* The preferred user interface to all the WEB facilities is through an M5000 series personal computer (PC) running Microsoft Windows software. A typical user screen is shown in Figure 7. The operations are largely mouse driven and various icons can be seen. Space prohibits a description of all the OA tools that are available but some of the more important include:

A mail notify symbol. When mail is awaiting a user's attention this icon flashes.

PC Mail. This is a new facility currently undergoing beta test which allows mail to be sent and collected without the user personally having to log on to the central system. Operationally this opens up a new range of exciting possibilities.

The PC telephone directory. Comments about the value of an up-to-date telephone directory have been made above. One operational problem with a directory residing on a central service is the delay in the logging on process, security being a factor which contributes to this delay. The PC telephone directory provides virtually all of the Central Service features but, being held locally, is available in a fraction of a second. It is mouse driven and downloaded from Central Services periodically.

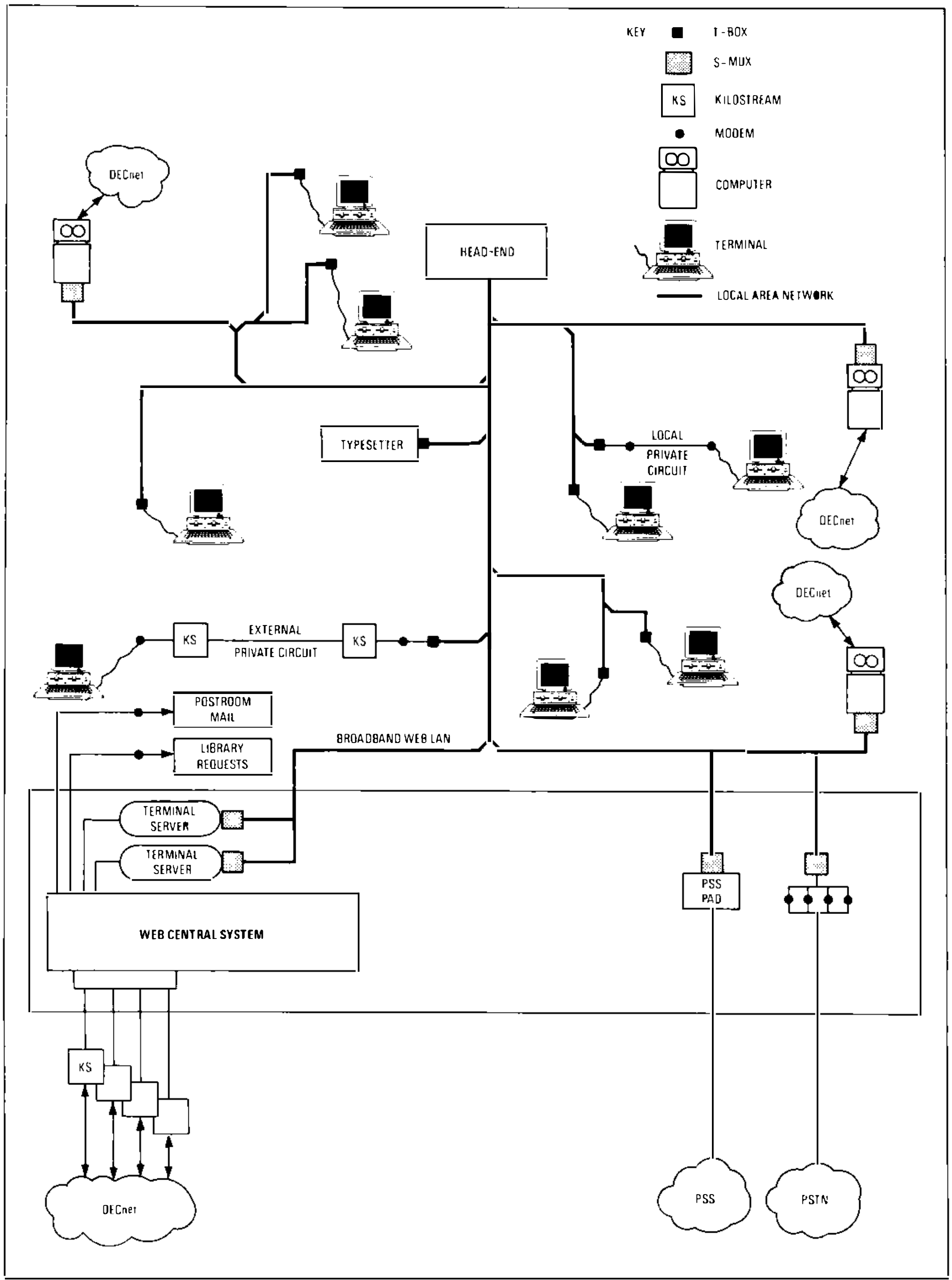


Figure 8
WEB networks

(*b*) *Central Services (CS)* CS provides a full set of OA messaging tools for the generation of messages, copying, filing, forwarding etc., which is the bedrock of any OA service. However, beyond communications and procedures, OA can provide access to *information* and this is the other main contribution that WEB makes to R&T effectiveness.

The operation of R&T requires the generation of instructions and notices to cover the day-to-day working of the Department. While paper copies of the documents are still available, all issues are now held electronically on WEB CS. Further, each file is processed so that it can be searched at very high speed. In this way, users can see, on their screens, documents containing any specific word. The search can be based on a logical combination of words; for example,

Costs + *Training* + (NOT *Apprentices*).

This is a very powerful tool and is significantly reducing the amount of (often out of date) paper that can clutter up an organisation.

Even some of the more routine forms used in day-to-day business are now available on WEB. Some forms are 'simple' in that the user is just presented with a form layout on screen with blank fields. Other forms are more 'intelligent' in that certain fields are filled in or controlled depending upon the circumstance.

The Platform

R&T has a large installed base of DEC VAX machines so it is not surprising that the initial WEB studies recommended the use of DEC All-in-One as the basic messaging package, although the previous paragraphs should have indicated that WEB is now much wider than All-in-One. The messaging service is installed in a cluster of DEC machines (2 × 8530, 1 × 11/785, 1 × 6310).

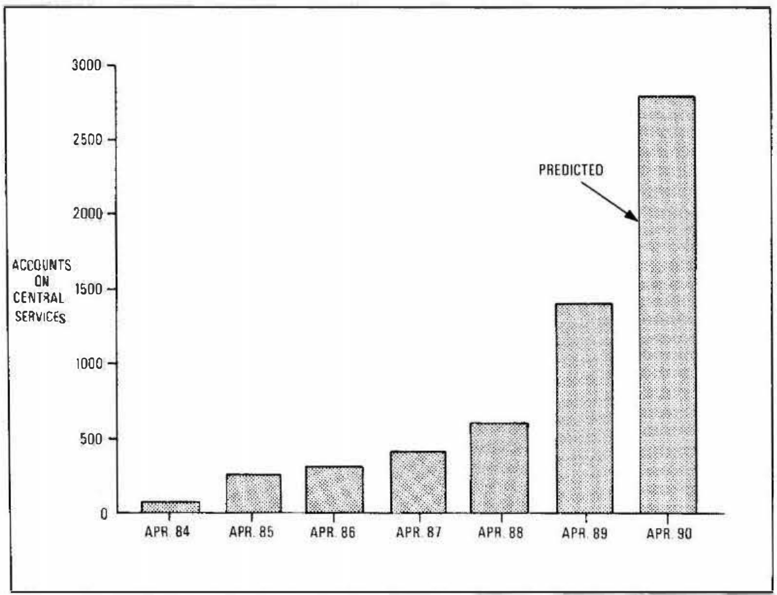
Two communications networks are provided as shown in Figure 8. A new local area network (LAN) was provided for WEB linking every building on site. This is a broadband LAN which can carry additional (non-WEB) services. WEB use is in an asynchronous mode at a VT220 emulation level at present.

There are currently about 3000 terminals on the LAN which also provides access to external services over PSS or PSTN. A management system operates and provides security features.

The second network is an extensive DECnet which connects most of the VAXs in R&T both on site and at remote locations. Currently, there are more than 300 nodes on the DECnet, one of the largest in Europe.

The terminal environment has been indicated in the previous section. A decision to standardise on IBM compatibles was taken even before the M5000 series was part of the BT portfolio. A new user is able to procure a package of necessary hardware and software from the R&T stores, and full training courses and support services are available. The terminal software environment is Microsoft Windows and all new WEB facilities run under Windows usually with icon/mouse control.

Figure 9
WEB—accounts on Central Services



Summary

WEB has been operational for about 5 years. The initial growth was slow because of the facilities provided and because of a cautious reaction from prospective users. (Figure 9.) As confidence has been gained and procedures such as GMR and PO added together with Information Services it is now becoming a part of R&T culture to use WEB to operate more effectively. The rapid growth in accounts is predicted to continue into 1990.

COAST

COAST is an exciting programme that should have a major impact on the method of office working throughout BT. COAST is primarily focussed at the middle layer of semi-structured tasks (Figure 1), but will also link in to the transaction process (largely the domain of Customer Service Systems (CSS)), and the yet to be developed Information Services and support for senior managers. It is planned that COAST will provide the window through which much of BT's business computing will take place.

What is COAST?

COAST is a programme to provide a uniform cost-effective set of office automation facilities for users throughout BT, and is designed so that migration and conformity to BT's Open Network Architecture (ONA) and Open Systems Interconnection (OSI) commitments can be facilitated. When completely implemented, COAST is expected to serve up to 60 000 users worldwide. It will also provide rapid intercommunication between senior managers and this will incorporate enhanced security for storage and transmission.

The variety of *ad hoc* OA initiatives in the company, while bringing benefit at local level, generally do not intercommunicate to any significant extent nor do they necessarily use products that form part of BT's portfolio. COAST therefore has three main objectives:

- to bring an effective OA facility to all units with a high level of functionality;
- to be based on an open technology platform; and
- to make fullest possible use of BT portfolio products.

Commitment to this strategic initiative by local management will give them the opportunity to contribute to the building of an infrastructure capable of meeting the competitive challenge of the 1990s which is vital for the commercial success of BT.

COAST Facilities and Software

The decision to establish a national OA system based around the UNIX operating system confirms BT's commitment to open systems. UNIX has emerged as the major non-proprietary operating system in this area and COAST will standardise on this 'open' operating system.

The core office automation software to be used on COAST is Uniplex II Plus. Uniplex is a world leader in integrated office automation packages for UNIX machines providing a rich basic OA environment. The facilities include:

Word Processing This may be achieved either using the Uniplex PC or certain packages that run on PCs. In due course most transfer of documents will use the Open System standard Open Document Architecture (ODA).

Electronic Mail This will extend company-wide with the addition of a sophisticated directory system (Inter-View) and the use of the Open X.400 standard.

Time Manager/Diary Much time will be saved in the scheduling of meetings when searches of diaries can be made.

Spreadsheet The easy-to-use spreadsheet accepts Lotus-like commands and can be imported and exported to other industry-standard products

Database This is a relational database which includes a user-friendly report writer.

Office Tools Other office tools such as a personal organiser (data file), presentation graphics and simple form making are available.

The system has a consistent user interface allowing the user to move information freely between the applications. The Internal Communications Provisioning Authority of BTUK Computer and Information Systems (CIS/ICPA) has extended the Uniplex software to include an external communications facility, MS-DOS-to-Uniplex file transfer, standard file structure, COAST node list and the ability to access other applications or systems. PC users can continue to use their existing PC applications software, passing documents or files between them and Uniplex as necessary. As indicated, plans are in hand for Uniplex to support BT's Office Document Architecture (ODA).

The UNIX operating system is not regarded, generally, as a user-friendly operating system, and steps have been taken to prevent COAST users from gaining direct access to UNIX. Users will therefore find that knowledge of, and entry into, the operating system are not required. The work of making COAST more secure is a continuing process and changes are being made through improvements in the product set.

COAST also provides a simplified system administrator's front end (SAFE) package, allowing system administration routines to be conducted more efficiently and without recourse to knowledge of the underlying operating system.

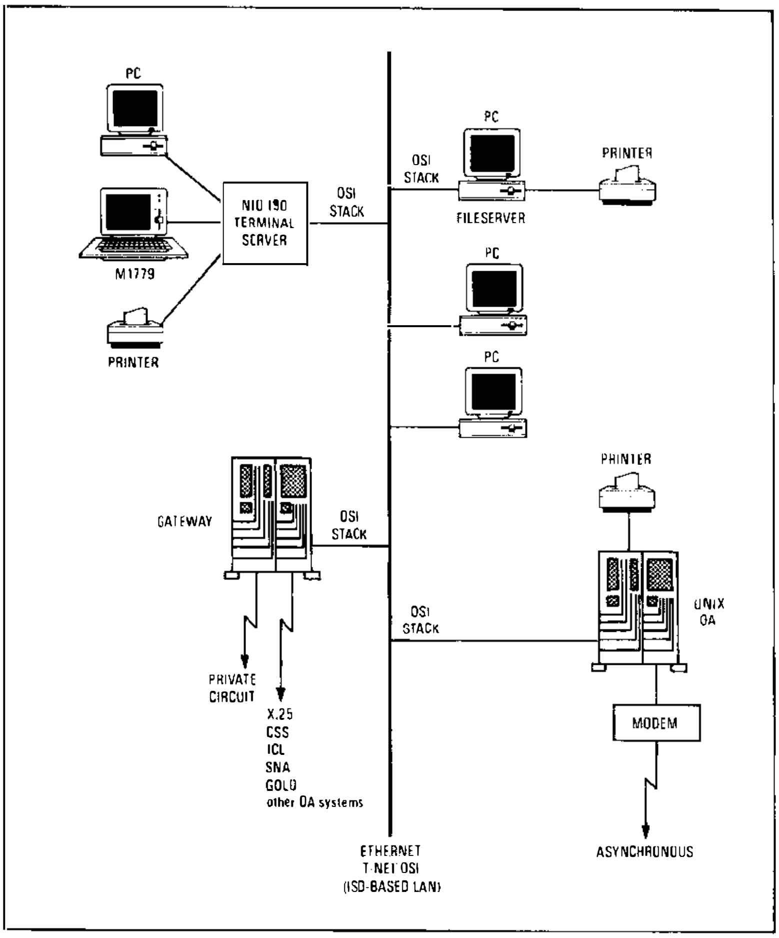
However, these useful but fundamental OA facilities should be viewed as simply the base upon which higher levels of functionality will be built. An important aspect of the COAST programme is to identify and develop procedures and other services that customers require, just as was done for WEB.

The Hardware Platform

The target hardware configurations will be based on an OSI local area network (T-NET OSI) with a number of OA processors currently running UNIX. The processors will support the OA tasks and provide the connection to external systems and services. User terminals may be either dumb (via a terminal server) or PCs. The general move towards intelligent (PC) terminals will be encouraged, although the PC is, in due course, likely to be disc-less picking up its disc capacity from a server on the LAN. A general system configuration is shown in Figure 10.

The evolving BT range of local area networks will be used in the implementation of COAST and due note will have to be taken of BT's existing investment. Connections between buildings will use the X.25 facilities provided on BT's INTERNET wide area network. INTERNET[1], in providing a single integrated and managed network, will rationalise all BT data communications requirements enabling users to connect to a variety of different computer systems. Again, wherever possible, INTERNET, like COAST, will use BT portfolio products and will migrate to ONA as soon as practicable.

Figure 10 COAST configuration



COAST Deployment

BTUK/CIS/ICPA will be responsible for the future development and direction of the COAST platform and, in conjunction with Strategy and Planning Department (CIS/SP), R&T and other suppliers, will facilitate the integration of new services and facilities into COAST.

COAST will employ BT developed products wherever it can be shown that such products can enhance performance, improve user acceptability or contribute to the successful utilisation of international standards. For example, the ICPA corporate directory system Inter-View, currently in the first phase of implementation, will assist COAST users to identify and contact staff throughout Headquarters and, later, Districts. An X.400 system will be integrated when it becomes available. The use of X.400 messaging is an essential element in the way forward for COAST in that all future non-proprietary systems will be based on these standards.

COAST implementations will be project managed by ICPA utilising structured project management techniques based on PROMPT and PERT. A programme planning office has been established which will co-ordinate all implementation activities associated with the successful introduction of COAST. Individual project plans are already being drawn up for those units which are about to take COAST.

CIS is fully committed to the support of COAST and will maintain a fully staffed help desk to provide second-line support to system administrators. It will be a function of the central support unit to manage and co-ordinate all the change control procedures essential for the maintenance of such a large distributed OA system. Training needs will be met, either by direct training of users, or by cascade training of trainers, depending upon local requirements and resources.

THE FUTURE

The two systems described in this paper are important steps in BT's move to making full use of OA on a company-wide basis. Experience gained on WEB will enable BT to define, develop and provide the tools that its staff will need in the 1990s. COAST is strategically important to BT in that, as the competitive pressures on the company increase, it is vital that it operates in an efficient manner to gain the maximum strategic advantage from OA. COAST is that way forward.

Reference

1 TOMKINS, A. INTERNET—An Integrated Data Network for British Telecom. *Br. Telecommun. Eng.*, Apr. 1990 (this issue).

Biography

Terry Smith joined the British Post Office in 1960 as a Student Apprentice. Most of his career has been spent in research and development, although he has also had a tour of duty with the Post Office Appointments Centre working on graduate engineering recruitment. After his Ph.D. studies at Essex University, on stored-program control switching systems, he has been responsible for various computer-based projects including switching and computer-aided design. He now heads the Information Technology Systems Division at British Telecom Research Laboratories with responsibilities that include OA development for R&T and the programme management of COAST.

The Practical Issues of Managing Large Complex Networked Applications

K. J. HARE†

This article considers some of the technical and managerial issues which are arising as computing moves from a set of discrete applications towards an integrated complex of networked applications serving the entire needs of a business enterprise. Practical issues are highlighted and operational solutions are outlined. Account is also taken of the fact that this evolutionary process is occurring during a period of rapid technological, regulatory and organisational change.

INTRODUCTION

We are all used to picking up a telephone and being able automatically to contact people, both in the UK and abroad. Within the computing fraternity there is a similar need for a single terminal to access a multiplicity of systems, and global access is already a requirement for many multinational companies.

Historically, we have designed and run discrete computerised systems, and data has been transferred between systems externally by physical tape (media) moves or, more recently, by electronic-file transfer. However, the advent of high-speed reliable data communications has enabled us to design systems which can be considered as an integrated large complex of networked applications. Indeed, this reflects more accurately a model of the business itself.

Unfortunately, this sounds more straightforward than it is and this article attempts to highlight the major practical issues of managing such a large network of application systems.

BTUK COMPUTING

There is a danger in system design in concentrating on producing systems which reflect the current organisation. What was intended as an enabler of change then becomes an inhibitor as the organisation evolves and changes, as undoubtedly BT will do and needs to do. The challenge therefore is to produce flexible systems which allow organisational or functional change. Just as systems design needs to be flexible, so does the operational unit which runs the systems.

In BT, the Customer Service System (CSS) has been a huge success. However, the seamless design features now under development, designed to overcome the inherent geographical limitations of the system, and the consolidation of systems in London to run in London information service units (LISUs), together with current plans for further computer-centre consolidation, exemplify the type of flexibility required. Consequently, the appreciation of the fact that requirements are not static must continue to be fostered along with an awareness that the primary business need is for a locally-based, highly-responsive service to support the interface to the external customer.

This latter point is equally true where there are corporate systems which need an overall view of the company or which aim to gain economies of scale, such as finance and payroll systems. The advent of improved data communications in such cases allows the provision of responsive, and apparently local, systems without the computer system having to be physically near to the terminal. The aim, therefore, must be to provide efficient access to all systems from any terminal. In effect, the computing entities must appear to the user as a single networked application.

THE ISSUES

The adoption of this approach raises a number of practical issues which must be addressed if the networked application service is to be a viable solution. The obvious ones which spring to mind are standards, security, fallback and resilience. However, service management now becomes the key area where tight control and improvement is needed and at this stage more tools are needed to assist with the management of the required service.

Standards

Proprietary operating systems such as MVS, VME and VMS from suppliers are expected to be perpetuated for some considerable time. Ultimately, there is hope that evolving open standards such as UNIX and SQL will loosen the straight-jacket but, in the meantime, we need to cope with what we have. BTUK can claim considerable success in achieving standardisation of the versions and modifications of suppliers' operating systems and this work will

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continue. Work can therefore concentrate on defining standards which interface to those proprietary systems and these are the main aims of open systems.

The decision to proceed with a common BT network has provided the crucial platform for achieving a truly open network. Already users can access different systems from the same terminal and as INTERNET is rolled out this will be available to all. The interface between suppliers' architecture and INTERNET, although common, is one where we can speculate on developments. For example, in the IBM system at the moment, network changes need to be fed into the front-end processors (FEPs) and this is not dynamic; except for minor changes, it requires a reload of new software. The usefulness of the FEP must now be questionable. It was designed at the time when the aim was to reduce the load from an expensive central processor; but as technology has changed, the advantage is no longer needed. If the FEP is redundant, then entry to mainframe computers will require a true open definition and could provide telephone companies with a much more direct method of managing computer networks. These are unresolved issues, and in the next decade it will be interesting to see how much progress is made.

Security

Physical and logical security of systems and data are now major issues. There is not only a commercial requirement to protect an extremely valuable business resource but there are an increasing number of regulatory requirements imposed by, for example, the Telecommunications Act, OFTEL, Stock Exchange Listings Agreement, and the Data Protection Act. This imposes the need to restrict and control access and the use of information within the company on a need-to-know basis, whereas it would be easier, and probably more efficient, to allow the widest usage.

With every terminal potentially connectable to every subsystem, together with a need to make systems simple and easy to use, management of **effective** security is a major challenge which must be met. At lower levels in the organisation, it is usually less of a problem as individual access can be limited by function. At higher levels though, where wide subsystem access is required in the future, schemes will be necessary to avoid multiple-user identities and passwords which minimise management costs and maximise user acceptability without compromising or generating a false sense of security. Logically this could be done by recording a user's access rights and checking identities at the local gateway to the network. This is, however, dangerous, as a breach of network security or one password could provide access to large areas of the networked application. The ultimate solution will almost certainly depend on 'smart cards', signature devices etc., but in the interim, workable solutions to the problem will depend on management processes and security checking software at computer centres, local District offices and within the sponsoring organisational units for specific subsystems. In effect, a combination of local, central global and hierarchical systems designed to meet specific security needs is necessary.

Fallback/Resilience

Part of any service agreement with the user obviously has to be what happens if disaster strikes. To some extent this is dictated by the business case for the availability of a subsystem and the risk assessment of likely failure. But, in the final analysis, as the business becomes more and more reliant on a large networked application, such considerations lead to the issue of the provision of resilience and fallback for computer centres. This must be approached, as already stated, by the use of standards and appropriate network provision. But it also requires the planned provision of spare, or reassignable, capacity as well as secure, accessible back-up copies of programs and data together with proven procedures to mount systems on alternative hardware.

One of the major problems in this area is keeping such plans up to date. At each site, hardware configuration and technological changes are an ongoing process which must be reflected in disaster plans if they are to be effective. In BT, currently this requires continuing management action to keep the reassignable fallback system in step with developments elsewhere. In future it is likely to be more difficult if fallback capacity is distributed around the network and it will generate a requirement for an overall model of the network and its performance. In particular, this will be necessary as the current practice of fallback rehearsal is unlikely to be feasible due to the complexity involved.

Service Management

The integration of applications, networking and access provides the opportunity for BT's customers to receive an integrated service. At the moment this service is provided piecemeal and problem resolution is not as well defined a process as necessary. A task force is currently tackling these issues, but it is worthwhile identifying some of the areas which need to be addressed. If BT is to provide a networked service as outlined, then to ensure transparency of the infrastructure to the customer an 'end-to-end service' will need to be provided. The customer end is clearly defined in that it has to be the terminal or access point, but the path is then variable and the application end can be in various places. For example, to access a mainframe application such as CSS the route could be as shown in Figure 1.

Consequently, if end-to-end service management is needed, the end point could be considered to lie at the FEP or somewhere in the mainframe computer. This integrated service-management approach will need a set of tools to be effective and BT's Servicentre product is being used by BT's Internal Communications Provisioning Authority (ICPA) team in addition to the IBM INFOMAN problem and change management product which is used in computer centres.

The BT VME Service Centre within Computer Operations and Technical Services (COTS) provides a central support function for all of BT's ICL VME systems. It uses Open Systems Interconnection (OSI) networking to assist the management of the VME common system uniformly across all sites. Problems and trends encountered in the field, coupled with new requirements, are fed into incremental releases which are automatically distributed via file transfer to operational sites. In collaboration with ICL, products such as Open System Control Centre (OSCC) will further automate the management of distributed operational systems. On-site support and maintenance of BT's VME systems is already efficient compared with other mainframe architectures, as a result of the common system software and effective centralised support.

There is considerable scope for further development in this area, particularly as we move to an open architecture. The traditional network boundary will change to reflect the customer need for an integrated service, and BT needs to gain experience of its internal needs, which are more likely to be at the leading edge of what its external customers need tomorrow.

Currently, the concepts of service management are being tackled by the introduction of help desks, service-level agreements and customer-support representatives. This will undoubtedly help to set targets and measurements of quality and performance, but considerable inroads still need to be made.

OPERATIONAL SOLUTIONS

Despite problems within the operational environment, there have been significant achievements in some of the important areas where practical solutions have had to be evolved. In particular, these are problem management, configuration management, software-version control, and managed file transfer. Some examples of what has been achieved are discussed below. Figure 2 illustrates how the main management issues fit into an overall system management model.

Problem Management

While emphasising that the best form of problem management is prevention, it must be recognised that problems will occur. Products like ICL SERVMAN and IBM's NETVIEW are used to correct problem situations, sometimes in real-time, but a problem recording and tracking system is essential also, particularly for those problems requiring more extensive human involvement.

IBM's INFOMAN is mainly used for this purpose within BTUK. New releases to be delivered to data centres in 1990 establish excellent connectivity between INFOMAN and NETVIEW. These will further automate and standardise the recognition of problems and the provision of more comprehensive diagnostic information—critical to speedy resolution.

Currently, District INFOMAN databases can pass problem information to Computing and Information Services (CIS) databases to ensure registration of known problems and improve the quality of subsequent releases of application systems.

Problem management is being standardised across all of BT's ICL series 39 VME systems by using a central problem management service called *ICL SERVMAN* (Figure 3). This allows problem reports to be passed automatically to the BT VME service centre via an X.25 link. These problems are then forwarded automatically to an ICL world-wide knowledge database where a search for a resolution to the problem occurs. If a resolution is found then this is

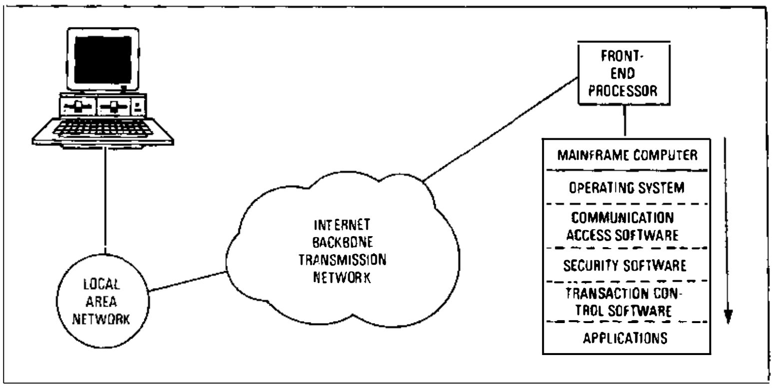

Figure 1
Service management service chain

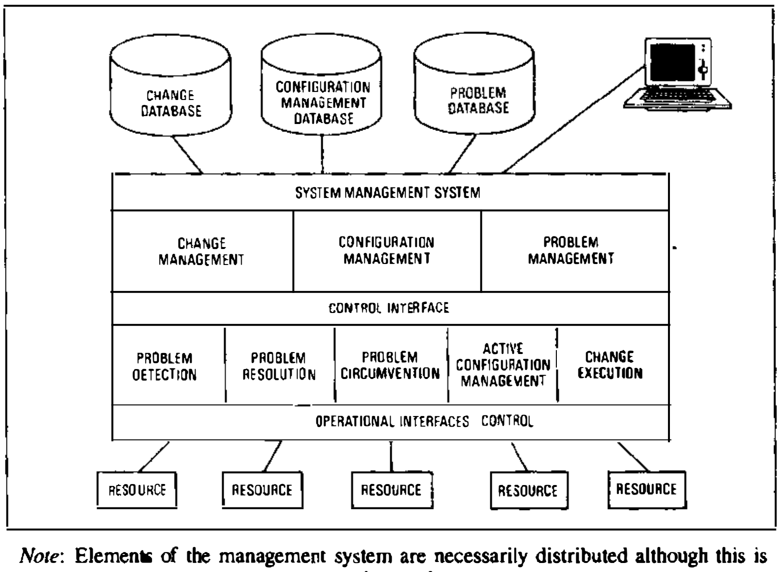

Figure 2
Simplified view of system management structure

Note: Elements of the management system are necessarily distributed although this is not shown above

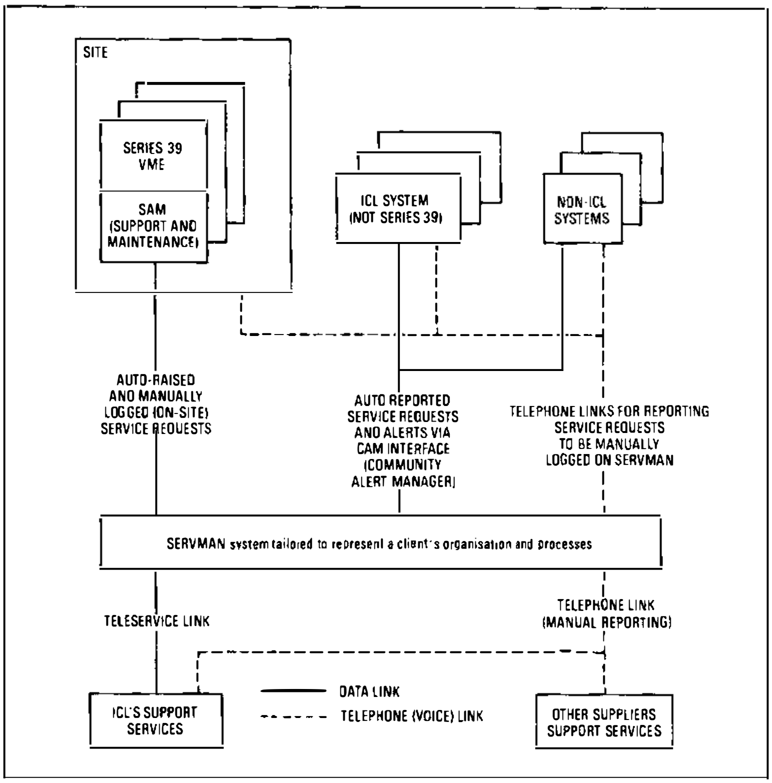

Figure 3
Overview of SERVMAN support network

immediately passed back to the originating site via ICL SERVMAN. ICL SERVMAN is also used to progress unresolved problems with reports passing electronically between ICL support, the BT VME Service Centre, and the VME sites. Combined with sensible human oversight and control by COTS, this greatly speeds up the problem detection and resolution process.

It is expected that problem resolution offers fertile ground for future exploitation of knowledge-based systems.

Configuration Management

A key element in the control of complex networked systems is the ability to manage effectively all of the elements which make up the total enterprise-wide system. The greater the degree of linkage between these elements, and the greater their number, the more pressing and difficult this challenge becomes. Present-day tools and mechanisms for achieving this control are not up to the task and significant progress is needed to enable future challenges to be met.

Configuration management needs to be viewed from two aspects. The first, and relatively easier task, is management of static elements and could be considered a variant of inventory management. The more difficult job of managing the connectivity of the elements is critical to the delivery of reliable networked systems to the business. Much of this connectivity is expressed in almost abstract relationships between elements of hardware, software and links between them involving rules, conventions and processes for establishment and termination of such relationships. The management of such intangibles, where the relationship between two or more elements is an element itself, is rather poorly addressed by currently available architectures and the commercial products which implement them. Indeed, static configuration management is also not well addressed as evidenced by the existence in BTUK of a variety of home-grown partial solutions to the problem.

Among the mechanisms currently in use, probably the most widespread is IBM's INFOMAN product which is used for configuration management of both hardware and software elements.

If static configuration management, in the sense of the establishment and maintenance of the configuration, may be considered a 'back-office' system, then active configuration management is very much the 'front-office' implementation of the overall task. For a number of reasons, including performance, this control must be executed in a real-time environment as it acts directly on the various elements of the system in order to effect planned changes or to respond to changing operational circumstances. Much of this activity is currently oriented towards human involvement and is insufficiently responsive to operational system requirements.

Tools are needed to automate this control; naturally they require considerable integration with configuration management and can be considered the executive arm of system management. Considerable progress has been made over the last few years in addressing this issue and is well demonstrated by such initiatives as ONA-M and products from major vendors such as IBM's NETVIEW. NETVIEW is widely used within BTUK and is viewed by IBM as its key offering for both system and network management.

Some uses to which BTUK puts NETVIEW include improved system interfaces for help-desk staff, developed in a co-operative effort between COTS and South Downs District Information Systems Unit (DISU), along with system 'health' indicators in which NETVIEW is used to monitor the state of key system tasks and components and alert people in the event of trouble, also developed by the same team. Other benefits include rationalising operator consoles, resulting in fewer screens needing to be watched combined with message traffic reduction, leading to less clutter on those screens.

In the ICL VME environment, the Open Systems Control Centre (OSCC) addresses the same issues. This family of products is represented in BT by the use of ICL SERVMAN, Community Alert Manager and Community File Transfer.

Much more remains to be done, and it is confidently expected that considerable strides will be made over the next few years with the aid of increased attention to this area of system management by the major vendors.

As systems become even larger and more complex, so the task of control over the code becomes more challenging. A system such as

CSS incorporates millions of lines of BT code which in turn depends on an operating system infrastructure which itself comprises many millions of lines of code. None of this code is static, all of it being potentially subject to change. In such complex systems, a relatively minor modification, in size terms, may have considerable impact on other dependent or interconnected elements.

Again quoting CSS as an example, the fact that this system is duplicated in a number of interconnected centres across the country makes the management of the integrity of the code all the more challenging and imperative. Although the process commences with initial scoping and design of a system, the system life-cycle phase which is more critical is during development, because this is when the code has greatest volatility. It is important both for the quality of the end-product and for the effectiveness and productivity of the developer that the correct version of software is being worked on at any particular time.

Given that major systems are generally implemented on a release basis, it is necessary to manage the existence of several valid versions of any particular programme at any one time, each in a different phase of its life cycle.

This aspect of configuration management presents its own unique challenges. A physical entity such as a mainframe computer has only one valid instance of itself at any point in time—a characteristic not shared by a program. Effective use of computer-aided software engineering (CASE) environments demands the existence of reliable software version-control mechanisms. The most prominent such systems in CIS currently rely on a combination of BT-developed systems and IBM's INFOMAN product. Considerable advances are needed on these mechanisms to equip us for the future.

Complementary to version control is the technique of ensuring co-ordination of versions in use by electronic distribution of software along with automatic uploading, or bringing into productive service. Within CIS, much of our ICL software control is managed in this fashion and we may expect to see much more of this both in the ICL environment and in the IBM and Digital mainframe environments. Equally, considerable gains can be made by electronic distribution of PC software as more and more of these machines are networked.

Managed File Transfer

As mentioned already, much data transfer between systems is by means of tape transfer, although increasing emphasis is placed on electronic means. Future systems will make extensive use of data transmission protocols other than file transfer, but it will still have a significant role both for new applications and as a relatively inexpensive way to improve the functionality and cost-effectiveness of existing systems.

The likelihood of substantial volumes of such transfer activities highlights another aspect of system management; that is, the need to control and manage this file transfer activity and to integrate this capability into operational systems in as transparent a way as possible.

Currently, a variety of mechanisms is in use including IBM's File Transfer Programme, Blue Book FTF, Network Data Mover, Netex, and Digital's Data Transfer Facility. Development work is underway on the introduction of OSI file transfer and access management (FTAM) which is now being implemented by the major vendors in the form of product offerings. Irrespective of the product or protocols used, it is essential that the facility incorporates the capability of being automated and integrated into operational systems. Existing mechanisms are insufficiently sophisticated in practice, and usually require too much human involvement in terms of transfer scheduling, error recovery and confirmation. This lack of sufficiently developed, protocol independent, managed capability is a significant barrier to full exploitation of electronic file transfer and must be resolved.

Considerable progress has been made in CIS on this issue by improving the usability of IBM's FTP and Blue Book FTF but much remains to be done. A COTS-produced managed 'standardised' file transfer service is already in use across BT, interworking ICL VME and IBM MVS services. It has already improved operational efficiency of data exchange between sites aiding consolidation of workloads while meeting day-to-day operational deadlines.

No opportunity is lost to pressure major vendors to address this issue in tandem with progress towards full FTAM compliance.

CONCLUSIONS

Technology and organisation will continue to change. The emphasis of the computing operational arm will be more and more towards providing service to customers and managing this service. This service management is needed now and will gradually expand as we understand it better. The opportunities will grow for telcos and computer suppliers, and boundaries of responsibility will change. However, BT has all the signs of recognising the opportunity and we can all ensure that this opportunity is turned into success. It is a fascinating future for us all.

Biography

Kevin Hare graduated from Southampton University with a B.Sc. degree in Chemistry in 1969 and an M.Sc. in Numerical Science in 1970. His Master's degree was involved with the use of computer-controlled NMR machines to record the changes in liquid crystals with temperature. After this early introduction to computers, he joined the Post Office in 1970 where he focused on computers for scientific and engineering applications. His whole career has been with the Post Office and British Telecom and he has covered all specialisms within the computing operations and technical services areas in this time.

Introducing Engineering Disciplines to Software Development and Operation

K. A. FAWTHROP†

This article describes the initiatives under way in Computing and Information Services, British Telecom UK to adopt an engineering-like approach to the planning, construction, operation and maintenance of commercial data processing software. It describes the methods, automation and support layers of the programme and discusses some of the future directions for the strategy.

INTRODUCTION

Information technology (IT) now plays an increasingly large role in the operations and the future business strategy of most large corporations. Whereas a certain level of support for financial and administrative functions has been commonplace for some time, there are many progressive companies who depend upon computerised functions for survival in their day-to-day business, and several who have begun to use IT as a pro-active, competitive weapon. British Telecom, recently privatised and de-monopolised, has been obliged to undergo a learning process faster than most in order to grow through these increasing levels of IT maturity. The company is a prime example of the need for computerised information systems to provide support for key business objectives, in BT's case the provision of quality communications services and products to its customers.

The environment of increasing competition and de-regulation within which BT operates, coupled with falling revenues derivable from basic network services, and the emergence of the commodity market in products and services, emphasises the importance of the company's business strategy.

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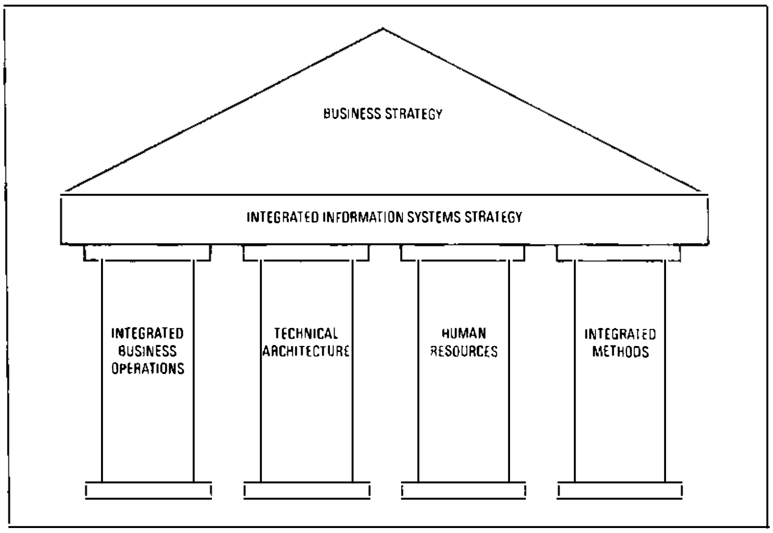

Figure 1
Information systems strategy

The business strategy in turn depends upon a dynamic and responsive information systems strategy, a fact recognised by BTUK's fifth strategic objective which is 'to establish cost competitive integrated computer systems and related managed procedures to support better operational management'. The requirements for integration and support of the business are reflected strongly in the mission statements of both BTUK Computing and Information Services (CIS) and the Systems Development function within it.

The information systems strategy is supported in turn by appropriate business operations, the technical architecture (the hardware and software), human resources (the technical skills) and by integrated methods. (See Figure 1.) The development of these methods, their automation and their implementation and support forms the core of the *systems engineering* programme.

PROBLEMS IN SOFTWARE DEVELOPMENT

The systems engineering programme is aimed at solving the following problems arising from the increasing maturity of the industry:

Complexity Many applications within the organisation have passed through the relatively straightforward stage of implementing base functions. Batch systems have gone on-line, central systems are becoming distributed, the end-user expects greater functionality and responsiveness, networks have increased in speed and size and so on. The need now is to build much larger, more-complex systems which involve very large numbers of software components and large teams of software builders. The versions, configurations and interrelations of these components are becoming too complex for manual techniques to cope with.

Criticality Software systems are being built upon which BT depends for its operation and profitability. Security, quality and legal/regulatory requirements mean that software must not only be seen to be accurate, but failures in stores handling, works management and fault-handling systems upon which BT's engineers depend means financial penalties in customer and supplier relationships. It is necessary to build reliable, available, checkable and accurate software to a tighter specification than ever before.

Cost and Timescale Despite over 30 years experience, it is still difficult to deliver accurate software systems which meet business needs and expectations reliably to cost and timescale. Project managers need better support for the planning, estimating, organising and control of software projects.

Maintenance Maintaining the vast array of systems and interfaces which already exist is a major drain on resources. In general, maintenance contributes over two-thirds of the lifespan costs of software. While this appears to limit the resource available for new developments, existing systems often contain data and functionality needed to meet requirements. However, the documentation, tools and techniques which enable this enormous asset to be utilised through adaptive maintenance and re-engineering approaches are rarely available. As a consequence, new systems are developed and the backlogs increase.

IT Skills Shortage The skills shortage in critical areas has been with us for some time and there is evidence that demand for these skills will continue to outstrip supply. The real solution is to make better use of the resources currently available. Software tools are needed which will allow:

(*a*) quality software to be created quickly and simply;

(*b*) the value in existing software to be exploited by being able to reuse it;

(*c*) all laborious, slow, error prone tasks in the software process to be automated; and

(*d*) technical staff to be used more flexibly.

Further, a good technical environment is likely to be a key factor in the future for attracting and retaining the most highly-skilled staff.

Meeting Requirements Systems must be built which exactly meet the needs of the business. Systems which do not deliver the function required are a drain on resources by causing rework, are inefficient and miss opportunities. Systems which cannot work together through poor interfaces, function gaps, function overlaps, data overlaps and inconsistencies mean that the business is not being adequately supported by the information system infrastructure. The business costs of these failures are not acceptable in today's quality environment.

Control An organisation which wants to gain control of its software development and quality costs needs to have an agreed set of methods and tools. In this way, it can minimise staff (re-)training costs, implement a coherent set of measures of the process and audit compliance to the process.

THE SYSTEMS ENGINEERING STRATEGY

Systems engineering is an approach which is being increasingly adopted by large corporations throughout the world, and by major players in the IT industry. It describes an engineering-oriented approach concerned with a systematic attack on the problems of software quality, software productivity and the re-use of existing software components.

British Telecom has chosen to tackle these types of problems by focussing on system quality. The following key contributing components have been identified:

organisation;
management;
business culture;
training;
standards;
methods and procedures; and
tools and techniques.

Projects and initiatives are in place to pursue each of these components. The last three are addressed by the *systems engineering* programme.

Systems engineering is a top-down approach to the management of the entire software process covering:

(*a*) organisation and automation of the entire software development life cycle from the capture of new requirements through to the eventual retirement of software;

(*b*) definition and analysis of information related to strategic business plans;

(*c*) modelling business data and processes for the entire organisation;

(*d*) analysis, design, construction, testing, validation and documentation for new systems;

(*e*) maintenance and evolution of existing systems; and

(*f*) key activities concerned with the management of the process and the deliverables within that process.

The approach is significantly different from the varied and traditional approaches of the past. Systems engineering is a structured, defined approach which is as much about organisational and management change as it is about technical change. It involves a fundamental recasting of the view that software development is a slow, manual, expensive and undisciplined craft, to the expectation that it is a rapid, automated, predictable, controlled, and quality-assured engineering discipline. The analogy with engineering provides defined components which progress through a factory and are built by the use of tools. The components progress according to a pre-defined process. They are modules within a larger configuration which are brought together when the final assembly is built. The pieces fit together because their interfaces were planned and designed in advance. The components can often be used in other assemblies because they

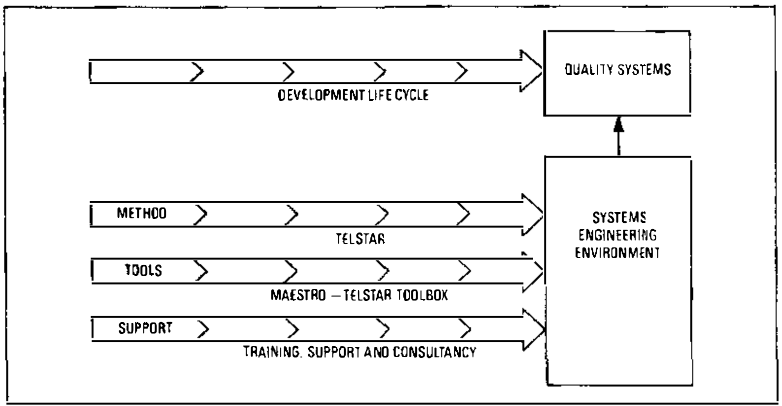

Figure 2
BTUK systems engineering

provide common functions. The aim of systems engineering is to follow a similar disciplined process in the construction of software assemblies. Software tools are used to build applications in the software factory.

The structure of the programme described in Figure 2 consists of a three-layer architecture: methods, automation and support and education. These are:

TELSTAR The software methodology, is the vehicle by which the procedures for how the running of the business will be defined. It provides a complete and coherent framework for all activities, defining a common direction for all computing staff. Continuously reviewed and enhanced, it is able to support a systems engineering approach. It provides the baseline system against which the implementation of business policies for quality can be judged.

MAESTRO The software platform chosen to automate, implement and enforce the TELSTAR software methodology. It offers a dedicated hardware and software environment for the development process, allowing the integration of control and management facilities.

Education and Support The introduction of new methods and tools requires a thorough, integrated training programme to be developed. If all staff are to be able to carry out the roles and technical activities ascribed to them within a systems engineering environment, then they must be given the appropriate courses and workshops at the right time and supported in their use.

INTEGRATED METHODS—TELSTAR

The purpose of TELSTAR is to provide an agreed documented reference-point for how business-led information systems are planned, developed, operated and maintained. The keynote of TELSTAR is **integration**, integration of method and technique into a work structure that supports the integration of IT products and services into the business. TELSTAR has been refined into a framework into which the best of current proven working method has been integrated. The top-end logical model covers twelve modules:

Strategic Planning describes the process of defining the information systems and technical architecture which will support long-term business objectives. It includes high-level data- and process-modelling techniques which produce a pure future view of the information system strategy. It considers a timescale of up to five years and beyond.

Planning and Resource Management describes the production of shorter-term development plans over the 12–18 month horizon. Its inputs are the strategic plans produced above, together with a realistic view of current systems, architectures, priorities and resources.

Architecture Management describes the processes needed to maintain accurate descriptions of current and proposed applications and data architectures. It assists the planning and development activities to support business objectives, and is the technical focus for systems integration. It is particularly useful in helping to define the ownership of cross-functional systems, and in resolving a wide range of duplication and interface problems.

Requirements Management describes the organisational processes of eliciting, assessing, prioritising, authorising and progressing a wide range of requirements inputs. It oversees the execution of authorised activity in pursuit of the business's strategic needs, and ensures the correct development of the large integrated environment required in BT.

Systems Development describes the system development life cycle from strategic requirements through analysis, design and construction to the implementation and maintenance of the software. It covers the technical processes required to create system deliverables (code, JCL, documentation).

Testing covers those activities concerned with the rigorous planning, execution and measurement of the software testing process.

Computer Installation Management describes the full range of operations and technical services activities required to support a large complex set of applications systems across multiple networked mainframes.

Data Management describes how data is managed across the business in accordance with the corporate data policy. It includes both data (dictionary) administration and database administration processes. It ensures the compatibility of strategic, development and operational data models by the provision of a three-level dictionary architecture, surmounted by the corporate data dictionary.

Project Management describes the activities necessary to ensure that all technical processes within TELSTAR are effectively managed to timescale and cost targets.

Quality Management provides a focal point for the mechanisms needed to manage quality in all other modules. Each of the other modules contains in-line activities for defect prevention, quality appraisals and controls and defect correction. The module states the policy and principles from which these mechanisms were determined. It identifies the quality roles and support functions which are needed to manage quality within a business unit, and sets out a system which can be used to obtain registration under appropriate international standards (currently ISO 9000).

Office Management describes the evaluation, installation, testing and development processes associated with the provision of office automation facilities and local computing.

Security provides a central point of reference for all modules to ensure that security requirements are observed in the design and operation of software.

THE NEED FOR AUTOMATION

The above description of TELSTAR conveys something of its scale and scope. The comprehensive and integrated nature of the product is intentional but requires extensive automation if it is not to collapse under a weight of paper. The system has been designed with automation in mind from the outset.

In approaching automation, a software product was required which would enable the automation, implementation and enforcement of the TELSTAR specification. None of the computer-aided software engineering (CASE) products on the market offered this capability and, accordingly, a different type of product was chosen. Softlab's MAESTRO integrated project support environment (IPSE) technology is being used as the basis of a customised product, known as the *TELSTAR TOOLBOX*, which provides all the technical and management control facilities which are required for building software. It is being developed to provide an environment which is:

(*a*) team-based and therefore multi-user;

(*b*) comprehensive in providing all types of tools needed in the software process;

(*c*) integrated via the use of a common user interface and a single object-managed repository;

(*d*) portable between hardware environments via the use of UNIX;

(*e*) open by connecting to a range of hardware and software regimes in the execution environment (as guided by portfolio and policy decisions);

(*f*) adaptable, flexible and improvable by the adoption of international standards thus allowing a mix-and-match approach to the provision of software tools;

(*g*) independent of proprietary mainframe hardware and software regimes;

(*h*) compatible with all management, development and operational aspects of BT's IT environment; and

(*i*) extensible by the addition of further network-based distributed services and terminals.

MAESTRO provides the base facilities, programming interface and object-managed repository which are needed to meet the automated requirement (see Figure 3). BT is customising the product to build on the basic IPSE in order:

(*a*) to tailor the product to meet specific needs; that is, to meet the TELSTAR specification;

(*b*) to support the most appropriate tools, whether bought-in or developed in-house;

(*c*) to remain in control of direction and facilities of the environment;

(*d*) to ensure that the appropriate linkages are developed and supported; and

(*e*) to ensure compliance with BT's Open Network Architecture.

By using this software, a pilot IPSE was built during the early part of 1989. The components of the software were used to build a composite task structure (CTS) which enabled:

(*a*) tasks from different TELSTAR modules to be associated into a procedural stream;

(*b*) task breakdowns and compositions to be held within the structure;

(*c*) documents to be related to tasks;

(*d*) roles/responsibilities to be related to tasks;

(*e*) certain outputs to be generated automatically; and

(*f*) external inputs to be accepted.

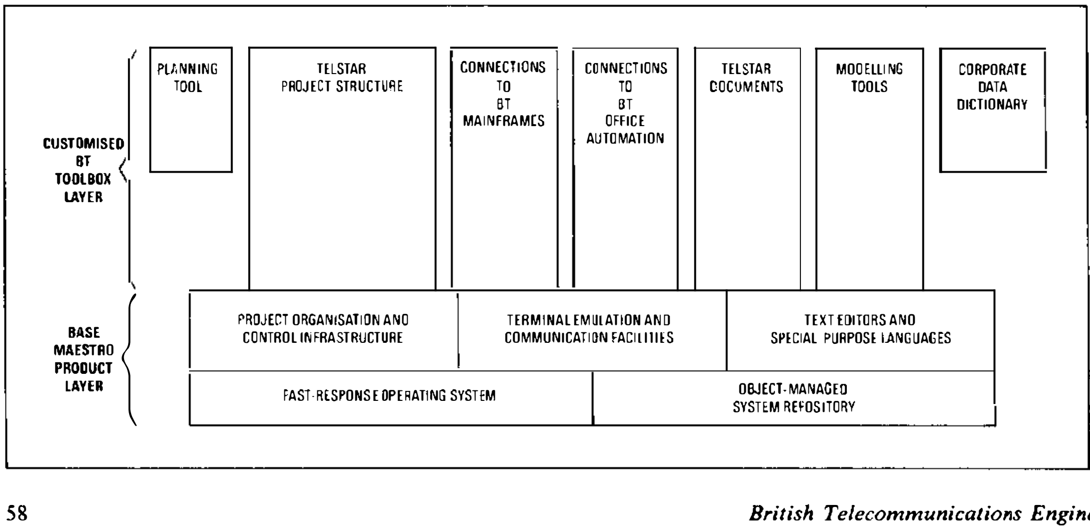

Figure 3 Creating the TELSTAR TOOLBOX

The main successes of the experiment were:

(*a*) a coherent structure of processes was presented to the user;
(*b*) techniques, notations and controls were enforceable (when required); and
(*c*) technical and management disciplines were integrated.

The main problems were:

(*a*) the sheer size and complexity of the task structure which needed to be built to automate TELSTAR;
(*b*) maintenance of that structure;
(*c*) the need for flexibility to suit differing project sizes;
(*d*) some shortcomings in the capabilities of the base software (it is not yet fully object-oriented); and
(*e*) the depth and scarcity of skills required to carry out IPSE programming.

Sufficient encouragement and insight were obtained from this experiment to endorse the strategy for future developments.

IMPLEMENTATION, SUPPORT AND CONSULTANCY

The programme of methods and tools is now being rolled out within BTUK/CIS. All staff within the systems engineering environment are to be fully trained and supported, in order that roles are clearly understood and that procedures can be effectively carried out. Training courses, workshops and on-the-job consultancy have been developed and several centrally-supported projects are now under way. A full problem management and change control system is in operation and a helpdesk service has been launched. Overview seminars, presentations to senior management and the appointments of local implementation managers have already taken place.

To date, most of the feedback which has been received has been very positive as managers begin to realise the value of clearly-defined integrated processes.

FUTURE

The programme's objectives from the outset have included a commitment to continuous improvement. To that end, TELSTAR will be increased in scope in order to cater for:

financial management,
vendor management,
development of real-time systems,
development of secure systems,
design of distributed systems, and
requirements beyond CIS and BTUK.

In parallel, the TELSTAR TOOLBOX will be improved by the application of:

expert systems,
artificial intelligence,
human factors expertise, and
extended configuration management.

TELSTAR will provide a focus for the embodiment of software and systems engineering capabilities acrross the BT group, and its TOOLBOX will be developed in parallel in order to provide comprehensive automated support. The vision is to provide BT with one of the most advanced open systems engineering environments in the industry.

CONCLUSION

A long-term view of the problems facing BT today has been adopted and from the belief that a systems engineering approach towards driving up quality and productivity and driving down costs is the correct one. The top-down approach, covering every technical and managerial aspect, has led to strong investment in the three-layer architecture of methods, automation and support. The methods are integrated, the automation is provided directly in support of those methods and the support programme is vital to ensure the successful adoption of both methods and automation.

The programme has come a long way over the past two years, but there is very much further to go in order to achieve the long-term objectives. Extensive resources have already been invested; these things do not happen overnight and it requires time to effect a major cultural change of this type.

The programme would not have got this far without strong and continuous senior management commitment. This exists because there are clear business goals and a visible long-term strategy, and it can be seen that systems engineering contributes directly to both. Systems engineering is a key initiative in BT's commitment to the use of IT as a competitive weapon.

BT's investment in systems engineering will contribute directly to key business objectives—the provision of quality communications products and services to its customers.

ACKNOWLEDGEMENTS

The author would like to thank the members of the CIS Systems Engineering sections who have contributed to the developments described, and particularly Sue Valiant and Chris Bradley; Systems Engineering Programme Managers, who have assisted in the preparation of this article.

Biography

Andy Fawthrop is the Systems Engineering Development Manager in BTUK/CIS. He joined BT in 1977 as a computer programmer. He has worked on a wide range of commercial systems development projects for Network and for Marketing, and has been involved in many disciplines of computer software: systems analysis, project management, communications programming and systems programming. He is currently Head of Section responsible for the development of integrated methods and automated support.

Consolidating Towards Modern Computing Operations

R. JOHNS†

Business needs are driving companies towards increasingly complex computing solutions. Many large organisations are consolidating their computing onto fewer sites in order to improve their control. This article describes the benefits that companies have derived from these moves, the future opportunities for these large sites, and British Telecom's intentions.

INTRODUCTION

It is well recognised that good information is a vital resource for any organisation. The information must be up to date, accurate and relevant. It must reflect the real world as it is, and it must be presented in such a way as to generate or allow management action in response to it. Large organisations in particular, handling vast amounts of data on a daily basis, require that this data is converted and compressed into usable information. It is the role of the computing arm of the organisation to receive and manage this data and to organise its conversion into information on which managers can act.

Information is not only a resource, it is also a source of potential risk. Some of this information must be shared and made available to all who have a legitimate interest in it; some of it is confidential, and access to it must be tightly controlled. It is the responsibility of the computing function to manage and control the dissemination of this information, in accordance with the rules prescribed by the organisation it serves.

INCREASED COMPLEXITY OF BUSINESS NEEDS

Most large companies now have their basic business processes handled to some extent by computer systems. Many of the systems in use today were designed in the past in response to problems experienced in single parts of the company. The main drive behind most systems was the need to reduce the company's cost base. Systems were frequently designed in isolation from each other.

Companies now expect computing to be more than a cost cutting tool. They require computer systems which can give them a competitive edge. They require information quickly so that they can take the lead over the competition, or at least respond quickly to competitive pressure.

The systems which were designed merely to address individual business problems are now seen as inhibitors on the progress of the company. The isolation of these individual systems delays or at worst prevents the process of combining raw data from individual systems into consolidated information on which management can act. Hence the need, now widely recognised, for systems integration. Fully integrated systems are seldom achieved, and probably not achieved, by large complex organisations whose computing demands far exceed the capacity of even the most advanced processors available today. The systems development units of such businesses are today creating integrating systems, with interfaces to each other built in. At worst, they are building increasingly complex interfaces between old systems whose initial design often ignored such needs.

The requirement to achieve the integration or interface of systems is driving companies to more complex computing solutions to their problems. Very large companies are forced to adopt networked solutions to their problems. The strain which these developments impose on the network environment is addressed elsewhere in this *Journal*.

The computing environment also will become more technical and more demanding in response to these pressures. The task of managing the synchronisation of data between different systems will become significant and will demand great expertise. The task of managing and controlling access to these integrating systems, particularly in an open network environment, will also pose a greater technical and management challenge.

THE NEED FOR CONSOLIDATION

These trends—the closer relationships between separate systems, the need to manage these relationships in order to convert data into information more quickly, the consequently greater technical and management demands—have persuaded many large companies that they must concentrate their computing power. They have been driven to the conclusion that the increased volume and importance of inter-system data transfers can be managed only by reducing the number of computer nodes on the network. They

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have similarly concluded that the greater technical challenge must be met by concentrating their technical resources into fewer more highly-skilled sites.

These companies have also decided they must bring these computer centres under a single line control. They insist that all centres must operate to common standards in the face of the increased demands imposed on them, and that only a single management authority can impose the degree of uniformity required.

POTENTIAL BARRIERS TO CONSOLIDATION

In the past, there have been a number of real or imaginary reasons why companies were unwilling to concentrate their computing onto very large sites. The first of these was the belief that the systems development activity and the computing hardware needed to be co-located. Many companies, including British Telecom have demonstrated the fallacy of this argument. Within many organisations, a gradual polarisation of development effort has occurred. There is a central development team creating the major cross-functional systems on the one hand, and on the other, the local development team, or information centre, creating small-scale departmental systems in response to local need. Neither of these development environments need dictate the location of the mainframe computer on which the development activity is supported. Similarly, the site of the processors delivering the developed operational service is independent of the siting of the developers.

Another reason for not concentrating hardware in the past has been the load imposed on computer centre management by the failure of hardware and software components, and the amount of management attention required to resolve problems. BT has found, like other large computer users, that hardware reliability has improved greatly over the years. Standards of operating systems reliability have also improved. The adoption of standard operating environments, and tight control over changes to them, have also reduced the load on management. The effect of these trends has been to relieve management of many of the old event-driven headaches to which they were subjected, and to enable them to concentrate on planning and control of their environment. Management of hardware environments is becoming easier. In the context of this trend, the adoption of large computer centres no longer holds the fears it once did.

A third reason is the risk a company faces from a major failure at one of its computer centres. This risk increases as computer power is concentrated. In large companies, it is this risk which determines the extent to which they are willing to concentrate their computing activities. The risk can be minimised by the careful design of a centre into modular building blocks, but in the final analysis most large companies are unwilling to commit themselves to a single centre. If fallback procedures are carefully planned in the light of changing business priorities, and if they are regularly tested, then the risk can be managed. This risk is not a reason for avoiding consolidation of computer centres; it is a reason for defining the limits of consolidation.

A fourth potential barrier to consolidation is the fear of an increased exposure to service failure arising through the extension of the network linking the user to the mainframe. This fear is groundless. Provided that the network has resilience and self-healing properties built in, there is no increase in risk. Users are irrationally afraid of slower responses as distance increases. Those who have such fears should see the response, for example, that Texas Instruments employees in the UK enjoy from their computer centre in Texas. Networks are so reliable today that users have no reason to fear the distance of their computer centre. Indeed, average users have no reason to know the location of the computer serving them. IBM in the UK has demonstrated this frequently. The company moves workloads from site to site around the UK, does not warn users of the move since the move should be invisible, and the users are not aware that the move has occurred. The length of wire serving the user is totally unimportant.

The final reason for resistance to the move of a computing facility to a large remote site is users' fear of loss of control. This control they believe they have is illusory. The only users who have real control over their computers are the single PC users. As soon as users share access with others, they lose control. The belief by users that they have control is a tribute to the success of the service organisation responsible for satisfying their computing requirements.

SERVICE ORGANISATION

A good effective communicative service organisation is essential to the operation of any computer service. The service organisation is itself a shared resource, but its success is measured by the degree to which it appears uniquely dedicated to the service of each user community. The key to its success is its prime interface to the user, the service desk or help desk. If the service desk is well managed and easy to contact in the event of user problems, then the siting of the service desk and the siting of the computing service it fronts are immaterial. The user needs only to know how to contact the service desk, and the method of contact, the telephone number used, should remain fixed. Further, provided that the procedures followed by the service desk and the rest of the service organisation are well designed and properly managed, the siting of the service desk and the rest of the service organisation can be independent of the siting of the computers which deliver the service.

OTHER REASONS FOR CONSOLIDATION

Many companies, driven by the business needs listed earlier, have consolidated their computer operations. The reasons are many, and many of the benefits are common:

shared technical resources,
improved physical security,
shared mainframe capacity yielding higher processor utilisation,
increased flexibility provides faster fallback capability in response to processor failure,
improved professionalism of staff,
better service,
tighter control of data security,
the ability to concentrate systems onto a small number of sites and thus avoid spreading skills too thinly,
the faster rollout of application software, and
more easily achieved common operating environment.

Then there are many areas in which costs are reduced:

hardware maintenance costs,
software licence fees (arising from the use of fewer larger processors),
heating and lighting,
floorspace,
staff costs, and
management overheads.

The overall impact of achieving savings in each of these areas is a very large reduction in a company's cost base. The potential for these reductions is so great that no business can afford to ignore it.

FURTHER OPPORTUNITIES IN LARGE-SCALE COMPUTING

Beyond the immediate benefits from consolidating computer operations, there will be other opportunities for businesses and their computing staff:

(*a*) New purpose-built centres will be designed from the outset with a view to segregating the hardware which requires operator intervention from that which does not. Lights-out computing is already practised in many organisations. New sites can take full advantage of the opportunity.

Figure 1 shows a new computer hall being built by BT at Bletchley. When complete, this will be entirely unmanned. All systems will be run from an operations bridge in another hall on the same site.

(*b*) Remote operation of the hardware can be performed. In some cases, organisations will be able to consolidate their key staff and skills, but leave the hardware running unmanned in its original location until an opportunity to relocate the hardware arises.

(*c*) Remote print/dispatch can be considered, increasing the segregation between the skilled staff at the computer centre and the less skilled staff in the dispatch area. If print/dispatch operations were sited alongside mail-sorting offices, postal delays to customers would be minimised, with obvious potential cash flow benefits.

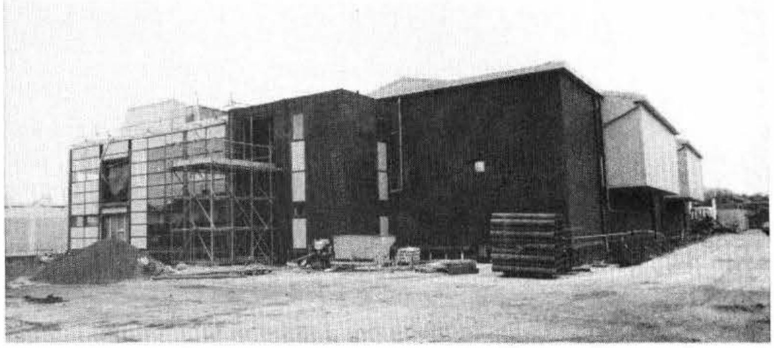


Figure 1
A new computer building module, to be operated lights-out

(*d*) A number of new software products are appearing, designed to increase the degree of automation in computer operations. Among these are the console handling products, which eliminate unwanted messages and allow pre-definition of operator responses. Most of these products will yield greatest benefits to an organisation which has concentrated its computer operations into a smaller number of sites.

(*e*) The above products eliminate many of the unskilled tasks in computer operations. The emphasis in large centres will fall increasingly on the skilled operators with the knowledge and authority to take decisions rather than merely push buttons. The concentration of these skills can be seen in Figure 2. The operations bridge illustrated controls many systems which run on both IBM and ICL architectures.

(*f*) Fully-automatic cartridge libraries are becoming available. These are capital intensive, and hence are more easily justified at larger data centres. Figure 3 illustrates a library system currently on trial within BT. There will undoubtedly be other developments in the future which will be of interest to large sites only.

Figure 2
The operations control bridge at BT's Bletchley computer centre

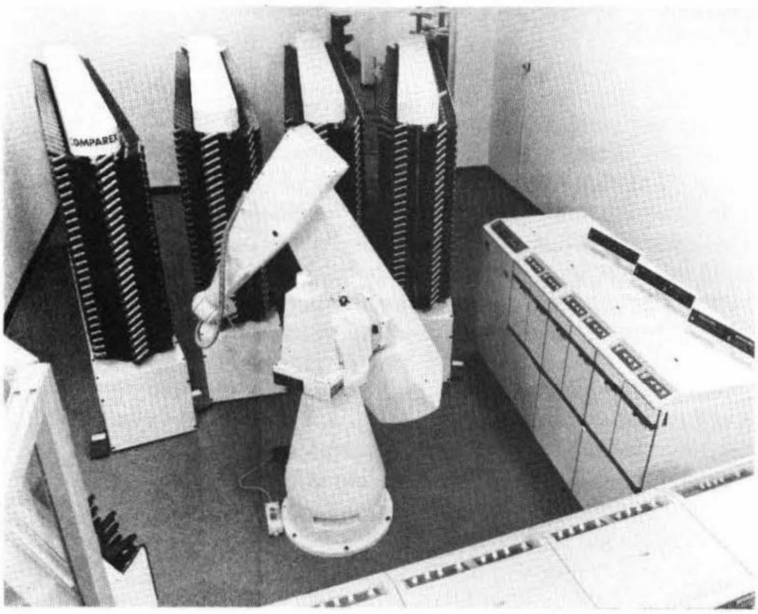


Figure 3 Cartridge library robot under trial within BT

PRACTICAL EXPERIENCES OF CONSOLIDATION

IBM, New York

Between 1985 and 1989, IBM in New York consolidated from 17 computer centres to 2. It had concluded that it would be unable to handle its expected terminal growth rate of 35% per annum unless it concentrated its computing resources and management control.

As part of its consolidation programme, it achieved the following:

- standard hardware configurations,
- standard storage-management techniques,
- standard operating-system implementations,
- the abandonment of local working practices,
- flexibility of workload moves,
- optimised use of scarce skills,
- significant staff savings, and
- improved fallback provision.

Rolls-Royce

In the UK, Rolls-Royce, faced with a very different mix of technical and commercial applications, has embarked on its own consolidation programme. Its objectives are as follows:

- the harmonisation of operating software,
- a single technical-support organisation,
- improved cost effectiveness,
- to give the company a competitive edge,
- to help the organisation achieve certain integration goals, and
- to ensure that geographic location and distance cease to be important.

Inland Revenue

The above examples of consolidation have both involved heavy concentration of hardware. However, consolidation of computer operations can take different forms.

The Inland Revenue in the UK adopted a very different approach when setting up its new computer centres. The organisation started with an almost clean sheet, since it was designing computer operations to handle a new tax administration system to replace a paper system. There was therefore no need to close any computer centres. The system required 30 000 terminals, supported by ICL processors. It was decided to house these processors at 12 computer centres.

The decision taken at the outset was that there would be strong central control of all computer operations. Thus, today only the low-level mechanical activities, print, dispatch and media handling are staffed at the 12 sites. These sites are effectively slaves to the command centre at Telford. The control imposed from there has the following characteristics:

- all work is scheduled, and all decisions made, at the command centre;
- a single central problem-management system is imposed across the organisation;
- technical services, storage management, performance monitoring and capacity planning are performed centrally;
- all operating-system and application-system changes are exhaustively tested at an integrity centre before issue;
- once tested, all changes are delivered electronically, and applied simultaneously at all sites overnight; and
- all suppliers have had to adopt a corresponding strong central control over their contacts with Inland Revenue.

British Telecom

BT has itself performed a number of consolidation exercises. The most successful recent example involved its computer centre at Bletchley. In a period of 13 months, four data centres were closed and their work was transferred to Bletchley, at a time of rapid growth of many of these workloads. The moves involved consolidation of both IBM and ICL workloads. Some of the achievements were:

- the number of system images was reduced from 18 to 14,
- the number of software licences was reduced from 10 to 5,
- storage requirements were reduced,
- staff numbers were halved,
- expensive accommodation was abandoned, and
- the revenue cost per annum was reduced from £12·8M to £7·0M, on a rising workload.

BRITISH TELECOM TODAY

BTUK, the UK operating division of BT, runs many computer systems on many types of hardware. Some systems are national in scope and run at a single centre. An example of these are the trunk-network systems. Some systems are national in scope, and need to be run on a single processor configuration, but because their processing requirements exceed the maximum capacity of available processors, they are run on several machines. These include the systems which support the provision of private circuits.

Many systems are designed to handle single-District workloads and are based on District processors. The principal such system is the Customer Service System (CSS). However, even this system cannot easily deal with the customer who calls from his workplace with a query about his domestic telephone bill—and has crossed a District boundary to get to work. To cope with this and other problems in a system which originally seemed to need no on-line inter-District communication, the business is developing a 'seamless' version of the system, which will make District boundaries invisible to customers. This is a good example of the increased demand for interfaces between systems in the face of heightened customer expectation.

A number of influences have helped create the situation in which BTUK finds its computing today:

(*a*) In the past, the business, when designing a new system, too readily chose new hardware and too readily built a new computer centre to house the hardware. There was a proliferation of centres.

(*b*) The business made a conscious decision when designing CSS that each District would be responsible for its own computer centre. Only London was excluded from this decision. This was consistent with the business intention, following privatisation of the company, to make each operating District a self-supporting unit. The decision was influenced also by the wish to improve computer literacy in Districts.

(*c*) In the meantime, many national systems, run at group data centres, were being consolidated down to a smaller number of larger centres. Bletchley, referred to earlier, is the largest of these.

BTUK is the largest computer user in the UK today. The scale of its computer operations is shown by some sample figures in Table 1. The expected growth in terminal population, as demonstrated in Figure 4, implies a significant uplift in all areas of computer capacity during the next 5 years.

TABLE 1
BTUK Computing, 1989

User Community	
Users	60 000
Terminals	40 000
Mainframe Supply	
Computer centres	32
Floorspace (m^2)	25 000
Processors	97
Relative processor power	3000
Storage (Gbyte)	9500

How are computer operations organised within BTUK?

Physically, computing operations are performed at a large number of computer centres. The map at Figure 5 illustrates this. Ten of the centres are network administration computer centres (NACCs), themselves the result of a major consolidation programme. They contain no mainframes. Mainframe computing is performed at 32 centres. On the one hand, there are group data centres running national systems; on the other hand, there are District information systems units, or consolidated London centres, running District systems. Some applications are run at 22 or more computer centres.

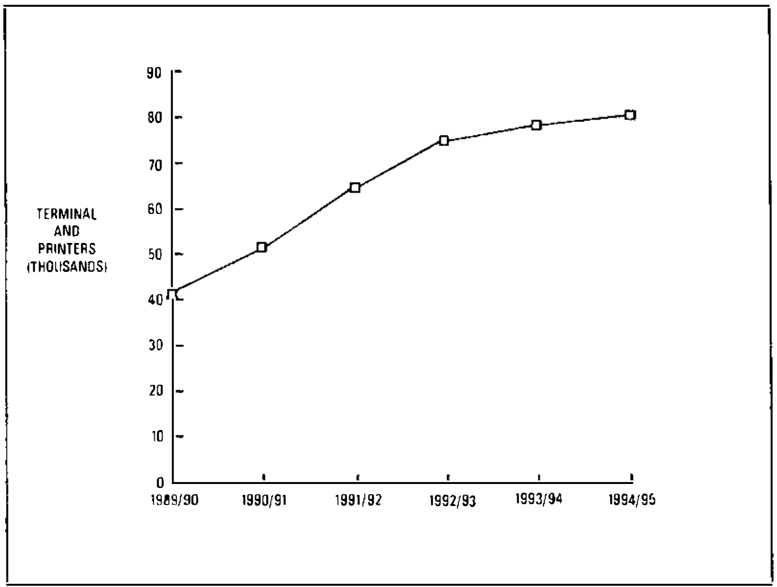
Organisationally, control of these centres is not unified. Group data centres are controlled by the computing arm; all others are managed by the operational units they serve.

In spite of potential difficulties caused by the absence of a single line control, a number of initiatives have been taken across all centres in the last two years. Costs have been reduced, and will be further reduced. A significant measure of standardisation of operating systems has been achieved. Work has been initiated to introduce standard working practices into all sites.

The business has now decided that the present diffuse geography of its computing operations is inappropriate to meet its future requirements of computing. It has given approval to a strategy which envisages consolidation to a smaller number of very large computer centres. The advantages it expects to gain from this exercise include:

improved control over computer operations,
totally standard operating environments and working practices,
better security of data,
improved opportunities for running integrating systems more effectively,
improved fallback capability in response to processor failure,
more flexible management of workloads,
higher hardware utilisation,

Figure 4
Growth in BT terminal population



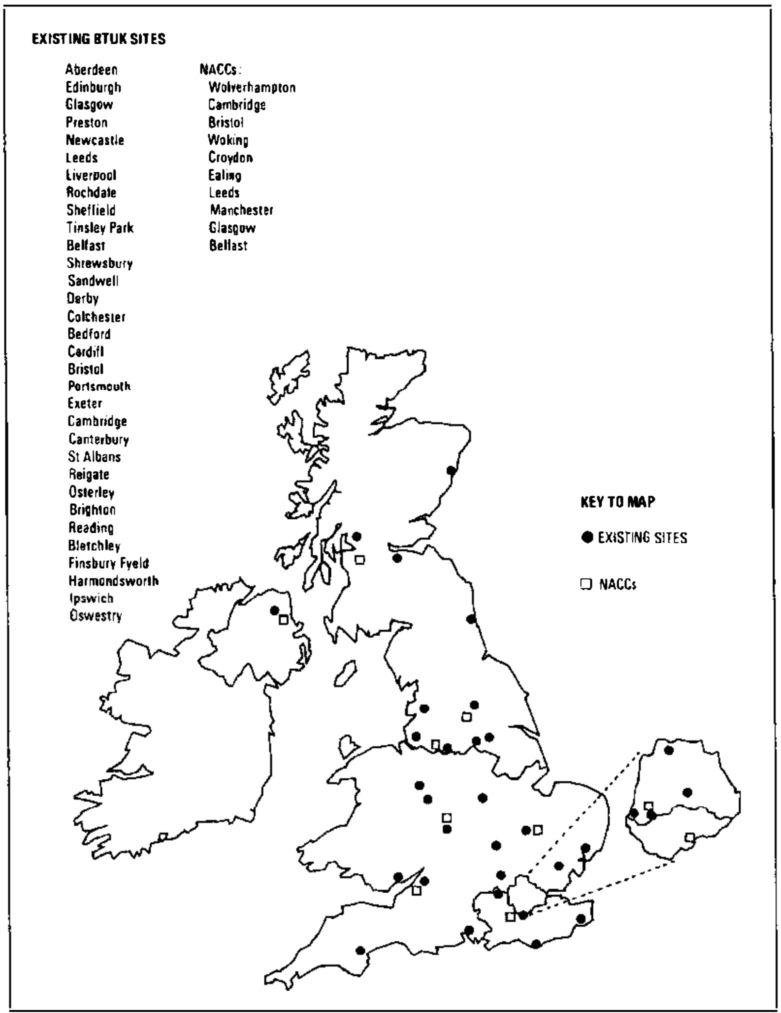


Figure 5—BTUK computing sites

- faster rollout of application releases,
- greater technical expertise at each site,
- the opportunity to achieve greater specialisation of operations in the future, and
- a reduced cost base.

For all these reasons, the business is now fully committed to consolidating its computer operations. The first site to receive an entire District workload from another centre will probably be Derby, during 1990. Further consolidations will follow.

THE CHALLENGE

The challenge facing BTUK computing, as it begins its programme of consolidating District computer centres, is to deliver the improvements in efficiency while preserving the effectiveness of the service which the existing sites are perceived to deliver to their internal customers. The importance of successful service management was stressed earlier. The quality of the operational service levels required can be enshrined into service level agreements, and can then be monitored through regular reports. There is no reason to doubt that good levels of service availability can be achieved.

A more difficult task is to achieve, through service management, the ability to respond quickly to changes in customer priorities. District managers, currently in control of their own computer centres, have enjoyed a high level of contact with their computing service providers. The quality of contact must be preserved when the computer centre moves away. This requires more than a competent service desk. Good strong account management procedures must be put in place with each customer group. The account managers must spend time with customer groups if they are to understand and respond to the pressures being imposed on their customers. They must ensure that all computer centre staff are sensitive to these customer needs. With these relationships and procedures securely in place, perception of service will thrive. Perception of service is as important to the customer as are good results in the more easily measured elements of a service level agreement.

CONCLUSION

BTUK has been driven to the decision to consolidate its computer operations by the same business arguments that have motivated the other organisations mentioned above. The need to improve control of computer operations, and the wish to make service levels more secure, are major considerations. Even more important, the opportunities for improvement in the operations and communications areas will allow substantial reductions in the cost of computing. These cost savings are on such large scales that the company will pursue them with the utmost vigour.

Biography

Roger Johns joined BT in November 1985 as Deputy Director National Networks (Management Information Systems), and, in January 1988, became General Manager of Computer Operations and Technical Services (COTS). He began his computing career as a systems analyst in 1955, and studied at McGill and Toronto Universities, and later at Harvard. He has held many key posts in industry, and has gained a great deal of international experience, working in France, Germany, Holland, Canada, the USA and South America.

Artificial Intelligence and Corporate Knowledge

D. L. HASKINS†

This article presents a basic technical background in artificial intelligence (AI), exploring the current maturity of techniques and products, illustrated with examples and experience in British Telecom. The article introduces emerging ideas on how this technology is best managed, and used to advantage, concluding with thoughts on how BT might move ahead to capitalise on its sound skill-base and global reputation as an AI practitioner developed in the last decade.

INTRODUCTION

British Telecom's success and experience with strands of information systems design subsumed under the popular banner of *artificial intelligence* (AI) are worth re-evaluating at the start of a decade, as BT's activity, results, and issues:

- mirror global patterns in many sectors;
- are illustrative of both technical and organisational problems to be addressed in profitably and appropriately applying novel techniques; and
- help understanding of the evolution of 'computing' into 'information management'.

As enterprises such as BT become aware that information and knowledge comprise an asset of equal potential to raw materials, capital, and labour, the recent global experience in capturing and applying knowledge and expertise through AI is critical reference material.

WHAT AND WHERE IS ARTIFICIAL INTELLIGENCE?

The description 'artificial intelligence' is used to cover a range of computing techniques which were developed for academic research into human intellectual processes as the disciplines of psychology and engineering came together in a new direction of enquiry. The idea was that if machines could be programmed to behave in ways which seemed intelligent, then these programs might throw light on the nature of intelligence itself.

The possibility of machine intelligence was among the first realisations to emerge in the 1940s when the first general-purpose computers were being built, and Alan Turing suggested a test based upon the apparent external behaviour of a machine to determine if a degree of plausible intelligence had been instantiated. Fierce academic debate has always accompanied this work, with the idea of ascribing human attributes to artefacts seeming repellent to many. While argument raged on however, increasingly sophisticated computing tools and techniques were discovered and began to emerge from laboratories into the world of information systems design, as a kind of by-product.

So what are these AI techniques and how do they differ from more conventional information technology (IT) methods? Intelligence might be characterised as including criteria such as the ability to make abstractions and generalisations, to draw analogies between different situations and adapt to new ones, to detect and correct mistakes, to cope with missing or incomplete data, and to learn from examples. AI has been described as extending computing beyond explicit manipulation of rigid methods and data assisted by a machine's speed at calculation of known algorithms, to a state where human-like reasoning techniques, like those listed, can be brought to bear in handling large volumes of data. General situations might be described, and logical tools allowed to sift, organise, and solve problems in ways not explicitly laid out in set orders in a program. The intelligence is implied in the program's ability to 'work things out for itself' from sets of possibilities or potential strategies.

If the practical use of AI went under a less contentious name, it is probable that progress might have been smoother, that it might have attracted a little less media attention, and that it might have more easily and neatly slipped into the repertoire of tools for IT designers. The short history of commercial use of AI techniques in the 1980s is one of initial excitement at the horizons, media inflation of promise, a difficulty in quantifying benefit, hard work in integrating the techniques with IT bedrock, and, at last, real results coming on-stream. BT has been right through all of these phases.

A fundamental element of the subject area is *symbolic computing*, made possible by specialist languages such as Lisp and Prolog designed to manipulate strings of symbols with logical rather than numeric operators. These highly flexible languages provide a structure for incorporation of knowledge about a particular domain, permit-

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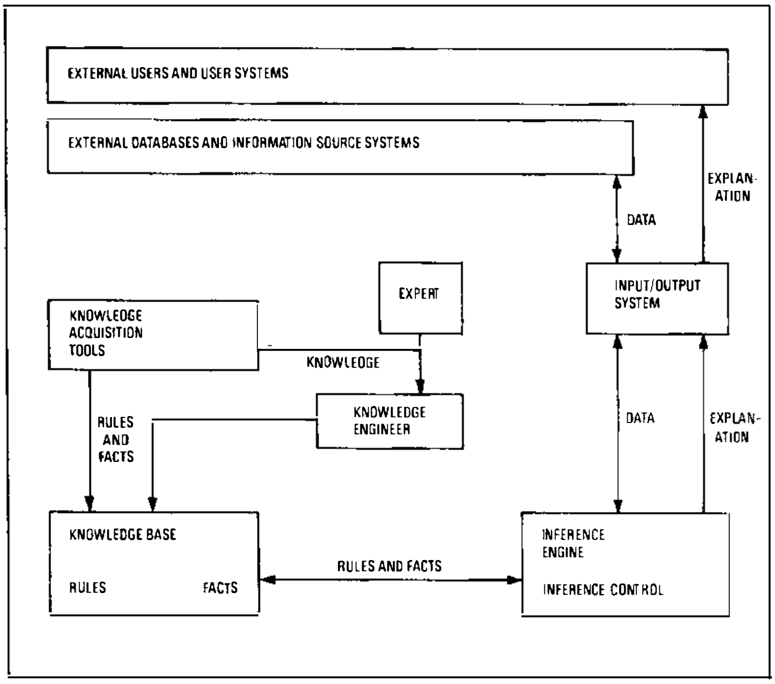
ting complex situational descriptions to be constructed as a basis for machine reasoning. Strategies for structuring descriptions are covered by techniques for *knowledge representation* including:

- *Heuristics or Rules*—used when most of the knowledge about a domain may be expressed as rules of thumb relating conditions to conclusions or actions, with 'if...then..' statements.
- *Frames*—used for complex structural descriptions requiring specific objects or concepts to be associated with each other perhaps in a hierarchical or classed way, or to have appropriate pieces of knowledge, activity, reasoning, derivation or method associated with them.
- *Logic Statements*—expressing constraints which a solution must satisfy, including techniques for dynamically constraining the problem space to reduce the effect of combinatorial explosion where exponentially large numbers of alternative solutions can be generated as possibilities to be evaluated and tracked.
- *Model-Based Reasoning*—employing a complete operational description of the structure and behaviour of a process from first principles in detail, often using object-oriented techniques. Also known as *deep reasoning*.

The most common commercial application of AI is to *knowledge-based* or *expert* systems (KBSs) which attempt to acquire, represent, and organise domain-expert knowledge to incorporate in problem-solving systems, initially stand-alone, but more recently as integrated modules within larger conventional IT systems. Other approaches such as the application of AI to the understanding of natural language, and to the building of neural networks, or connectionist models of the brain are of less immediate business relevance, though attracting a high degree of research focus. (Figure 1.)

Figure 1
Integrated KBS architecture



The practical success of KBS makes practitioners aware of the value of the knowledge which can be represented and used, and of the value of those humans who possess it, exercise it, in critical business or technical roles. It raises ethical and legal problems about the status of 'intelligent agents' realised in systems which offer advice, or actually interact to control or manipulate real states of affairs. It also raises questions about keeping knowledge timely, accurate, and consistent across system boundaries; in fact, knowledge-management for the corporation is indistinguishable from careful attendance to material, human, and material assets.

IS AI USEFUL NOW?

The best answer to this question is to illustrate what is being achieved and used at the moment, and to understand the strategic or business drive behind some these initiatives. Rather than being systems that perform something faster than a previous automation attempt, they are largely applications which could not have been automated without AI techniques.

Military applications in logistics, electronic warfare and simulation, and battle management are typically huge systems, and the US DARPA programme has an annual AI budget of more than \$100M, providing considerable impetus to industry effort to produce development and delivery hardware and software. The military AI programme acts as a driver for a whole industry, in much the same fashion as did the Apollo programme in the 1960s and 70s.

The financial sector has deployed KBS widely and successfully in loan and credit authorisation, financial planning, trading and portfolio management, and insurance underwriting, claims assessment, and auditing. These systems enable speed of response to market changes, and maximum spread of standardised expertise across operations, giving an edge in a very competitive market. New information-based products can be designed, produced and delivered with a flexibility allowing tightly controlled differentiation.

In manufacturing, the motor industry is engaged in extensive KBS development for process planning, computer-aided design, and computer integrated manufacturing, making possible global application of standard process instructions over variant languages and cultures where assembly is effected. In computer manufacture, KBSs have been used for configuration and to control the entire production and delivery cycle. AI techniques will allow 'what-if' production models to integrate with computer-aided design (CAD), robotics, factory networking protocols, and electronic data interchange (EDI) to realise a concept of 'desk-top manufacture'.

In the transportation sector, scheduling and loading have been successfully automated in complex container management systems, rail network systems, and airport gate assignment.

These are typical operational research modelling problems suitable for AI solutions.

In energy, systems are in place for interpretation of seismic data, well-logging, petrochemical process control, production scheduling, plant design, fire and accident prevention, and the monitoring and control of electricity supply including nuclear installations.

The potential of KBSs in delivering and regulating procedure, effecting standard policy and expertise, and providing training, support and explanation is enabling wider shallower management structures; this has had an impact in the retail sector.

Within the area of commercial data processing, the most active aspects seen now are in the close-coupling of KBSs with databases, networks, transaction processing systems, hypertext, and multi-media, adding a flexible, non-algorithmic layer between users and systems which can function as a kind of 'glue' to maximise connectivity between disparate architectures.

The last decade has seen the technology emerge from academic laboratories, and taken up by corporations as an experimental idea for prototyping. There has been a slide in the fortunes of vendors of specialist AI hardware while increasing functionality became available on PCs, and increasingly in mainframe tools as major vendors began to realise the practicality and power of the approach. A boom decade is being forecast widely by industry watchers, after a two-year 'KBS winter' in which initial media enthusiasm was dampened while corporate systems people took time to get to grips with the deep problems entailed in integrating the technology with traditional approaches. (Figure 2.)

HOW BT HAS APPLIED AI

The telecommunications sector offers many opportunities for the introduction of intelligent systems in key bottlenecks, and the many prototype and pilot KBSs used in BT are in the forefront of world experience and in typical application areas. BT has been engaged for much of the 1980s in three broad strands of AI work, covering network applications, commercial and administrative systems, and connectionist and natural language research.

The application of KBSs to network management, operations and design has focused on systems facilitating an intelligent network in which dynamic customer-tailored product configuration and management across geography and technology will be made possible. Systems in place in BT cover areas including network and component configuration, exchange maintenance, fault diagnosis, workforce management, network monitoring, routing and network modelling.

KBS techniques applied to commercial business operations and supporting information systems have covered a wide range of functions due to an early strategy of providing a standard in-house basic expert systems shell to any interested parties. This product, *Tracker*, permitted a sharing of knowledge bases around the company, and a low-level end-user interest to flourish. The many stand-alone PC-based applications developed included a multiple-module help-desk facility for District computing, personnel systems for compulsory transfer and employee expenses administration, general administrative support services, training advice, monitoring and control, directory compilation, and report writing. Mainframe developments have included systems for project prioritisation, and on-line text database access, as shells for larger platforms have become available.

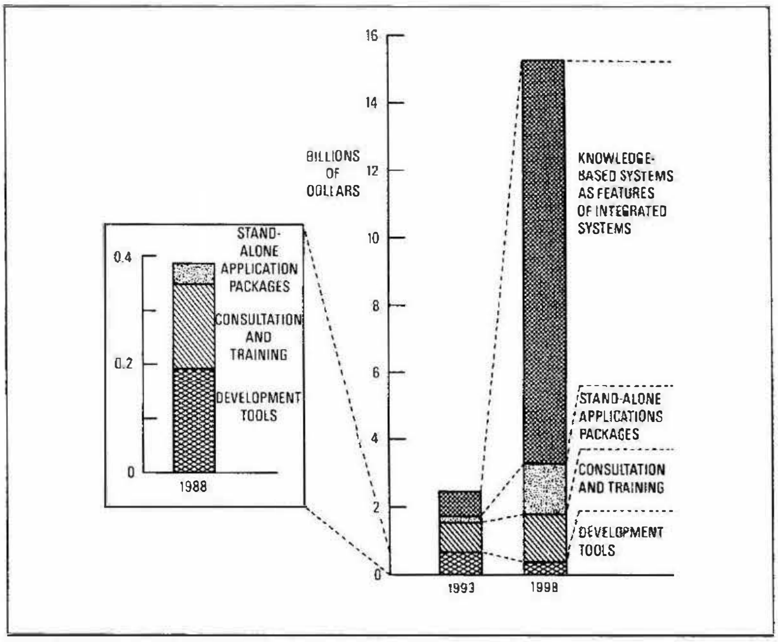
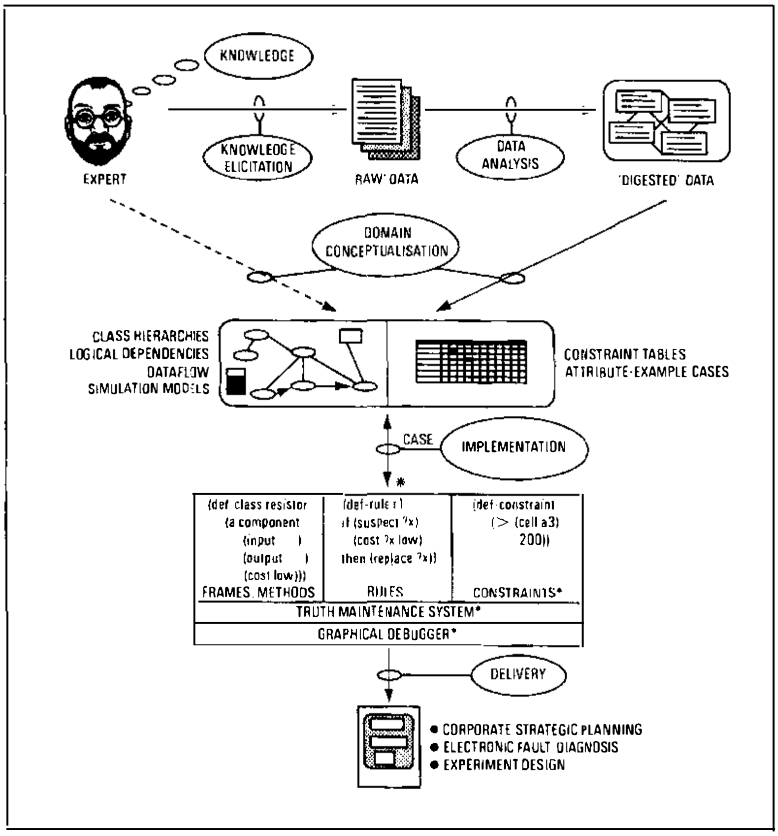


Figure 2
KBS forecast growth in 1990s
(Source: SRI International, 1989)

A sophisticated toolkit, a computer-aided software engineering (CASE) tool for knowledge engineering, *KEATS*, is being developed in conjunction with the Open University, in readiness for the more complex development and maintenance issues which need addressing as mainframe tools emerge for large integrated KBSs for company-wide delivery. The first direct use of this has been in a prototype marketing strategy model. (Figure 3.)

An example of the potential of large KBSs integrated with existing mainframe systems and networks, now becoming technically feasible, is the expert system for customer facing environments (ESCFE), which is in an early design stage (Figure 4). This system will start from the premise that any customer contact is a potential marketing channel, and steering and support for queries, complaints, and dialogue by intelligent embedded help and prompting modules will assist staff in direct contact to be up to date, technically and commercially briefed, and following current marketing concepts and directives. It also acts as an intelligent buffering layer in the network to permit flexible access across



* Unique to KEATS

Figure 3—The KEATS toolkit

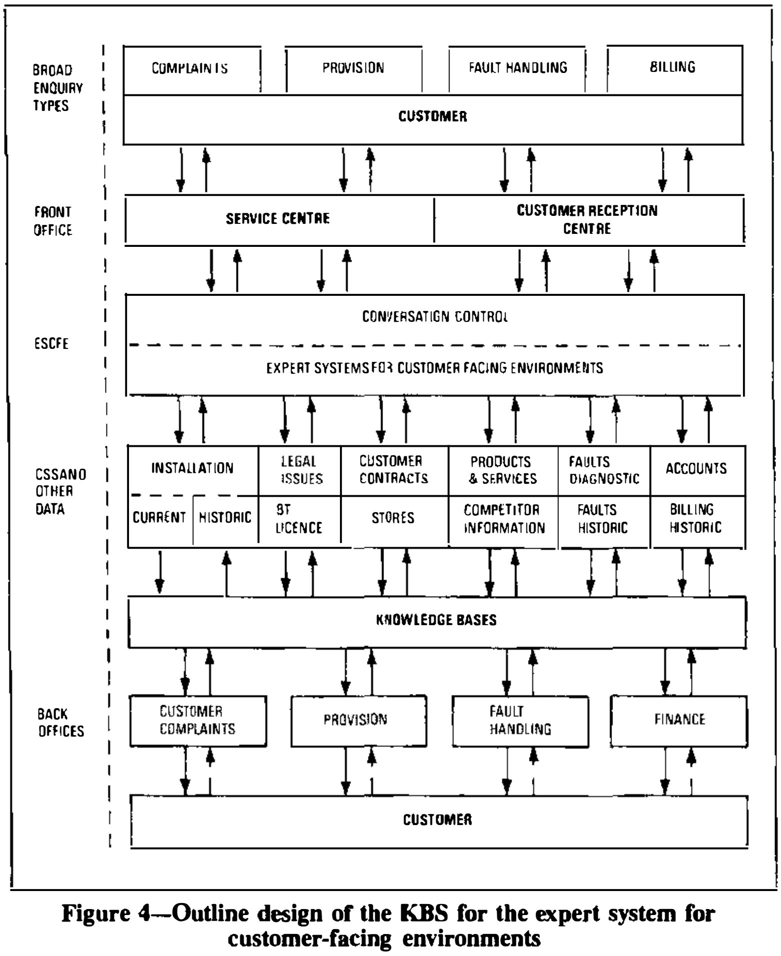


Figure 4—Outline design of the KBS for the expert system for customer-facing environments

vertically arranged functional information systems. This kind of system will assist service centres and customer reception centres to function, by providing deeper pertinent knowledge across a range of disciplines to non-specialists who can then concentrate on effective communication. Without KBS techniques, this type of systems design would not be feasible.

Research and development initiatives in connectionist technology, and in natural language techniques are the most advanced strand, with commercial pay-off further downstream. These largely focus on the non-trivial problems of creating systems able to respond to user independent speech or free-form textual input, or perform visual pattern recognition. In speech, single-word speech recognition has advanced to world leadership; in vision, neural networks have been used for image compression techniques involved in tracking the movement of components in a visual field. Natural language techniques have also been applied to automatic abstraction of text and intelligent mail.

AI, INFORMATION AND CORPORATE KNOWLEDGE

A focus on information management includes initiatives in underlying hardware and software architectures, in data management, and in systems design methodologies. It is clear that tools and structures designed to support management and control of corporate information should account for the integration of KBSs. This implies possible concepts such as *knowledge topology*, or *critical expertise*, and of mappings between IT processes and underlying reasoning, explanation, and skills. It is immediately apparent that this kind of approach is not far from strategic planning and business modelling, and is closely akin to policy making and organisational design. Up till now, the KBSs developed have largely been attempted to prove the technology in a piecemeal fashion driven from a technical challenge to solve a problem. It will be important that the entirety of an organisation's knowledge and skill requirement is addressed in conjunction with initiatives addressing business processes and underlying information needs, that bottlenecks are identified, and that the first powerful integrated KBSs are built from business arguments now that the technical issues are largely solved. Scaling up now appears possible.

Practical difficulties exist in keeping KBS design methodologies in step, where appropriate, with software engineering practice, and in envisaging the kinds of automated tools which could support both traditional systems and KBSs. Tools exist which do parts of both jobs, but will have to evolve to cover the gaps which arise from variant approaches. KBSs are not formally specifiable, are often designed iteratively using prototyping cycles with close end-user and domain expert involvement in the design. Where KBSs link closely to operational data, mappings between database schema and knowledge representation will be required. There is also a rich potential in the area of applying KBSs to software engineering itself, by capturing expertise on whole system life cycle support and using this to encapsulate and organise CASE tools.

Advantages accruing to those successful in such integration will be the ability to create and recreate information systems rapidly for dynamic markets. Overcoming integration difficulties and deriving new systems for new needs may be advanced by applying knowledge expressed in KBS to existing system complexes, rather than rebuilding them from scratch according to fixed rigid designs, which are then unable to cope with rapid change.

CONCLUSIONS

The most appropriate next steps envisaged by the AI community are characterised by a concern to harness and share skills and resources, and to improve 'cross-disciplinary' links between network-focused and commercially-focused activity. This would include:

- delivering design tools for KBS work to an appropriate and available set of platforms, employing BT research carried out in the 1980s;
- working for the integration of the KBS approach into mainstream systems design, and assisting in the design of information and knowledge management tools which form part of the software engineering work-bench; and
- working with business analysts in both in-house and customer systems arenas at early stages in the design option process, utilising advanced technology to identify entirely new business opportunities.

A transfer of awareness of what this advanced information systems approach can offer to business analysis, systems design and systems development disciplines will enable BT to accrue advantage from a technical lead rooted in hard-won experience.

ACKNOWLEDGEMENTS

Groups involved in advanced systems design in BT R&T, CIS-SD, CIS-S&P, BTI and Districts are thanked for their sharing of experience and information.

Biography

David Haskins is a Head of Group in BTUK Computing and Information Services, Advanced Technology Unit, covering knowledge-based systems toolkit design, and expert systems integration with databases and on-line communications. After five years with Sperry Univac in hardware support, he took a degree in Philosophy before joining BT in 1981 to work in information systems strategy, evaluation, prototyping and technical support roles. He gained an M.Sc. in Information Systems Design in 1988, and is a member of the British Computer Society.

Object-Oriented Design

E. L. CUSACK†, C. CLOUGH†, and K. RICHARDS*

Object-oriented programming and design has been one of the liveliest computer science research issues of the 1980s. The last two years have been marked by a significant increase in the number of object-oriented languages and design tools on the market, and by the penetration of object-oriented ideas into a wider application base. This article attempts to give some insight into the features of the object-oriented approach which have contributed to its commercial success. Two examples are presented. The first illustrates the use of an object-oriented design methodology developed at British Telecom Research Laboratories. The second shows how object-oriented ideas are assisting in the specification of advanced network management systems. The article concludes with an assessment of the advantages and disadvantages of object-oriented design and gives some indication of current research directions.

INTRODUCTION

Object-oriented programming and design has been one of the liveliest computer science research issues of the 1980s. The last two years have been marked by a significant increase in the number of object-oriented languages and design tools on the market, and by the penetration of object-oriented ideas into a wider application base. Such foreshortening of the normal timescales for technology transfer is in part due to the fact that aspects of object-oriented design have recognisable roots in (variously) established technologies such as structured systems analysis and relational database, and programming languages such as ADA and C. In addition, object-oriented design depends on the intuitively appealing idea that the things we see about us in the world can be reliably and usefully classified. But the mere fact that the ideas seem natural would not alone have created such a stir. The key factor in the success of object-oriented design is that it permits the controlled reuse and flexible extension of chunks of specification or code. This makes the concept of libraries or catalogues of reusable software modules a reality.

Object-oriented design has its roots in programming language developments in the 1960s and 1970s and is often used to mean software construction in an object-oriented language such as Smalltalk-80 [1] or C^{++} [2]. In the 1980s, it became clear that object-oriented design can stand on its own as an implementation-independent specification approach. For example, British Telecom Research Laboratories (BTRL) develops major real-time communications software by implementing object-oriented designs in the (non-object-oriented) programming language C. There is also a natural affinity between object-oriented design and distributed systems definition. Current work in the international standards fora ISO and CCITT (in which BTRL is actively participating) suggests that, in the future, designers will use standard libraries of component specifications to assemble large-scale object-oriented designs of distributed systems. In short, object-oriented design is a major step towards making systems and software design an engineering discipline as opposed to a craft.

This article attempts to give some insight into the features of the object-oriented approach which have contributed to its commercial success. Two examples are presented. The first illustrates the use of an object-oriented software design methodology developed at BTRL. The second shows how object-oriented ideas are assisting in the specification of advanced network management systems. The article concludes with an assessment of the strengths and weaknesses of object-oriented design and gives some indication of current research directions. Some of the technical discussion has been simplified to keep the article to a manageable length. However, the reader interested in learning more about object-oriented design can take advantage of recently published textbooks such as Reference 3.

DEFINITIONS

Object-oriented design is an approach rather than a tightly defined methodology. This means that the fundamental definitions are generic. Their precise form will vary between particular object-oriented languages or specification techniques. For example, an object in Smalltalk-80 is a module of executable code whereas the

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managed objects discussed in the section on 'Object-Oriented System Specification' are described by nonexecutable specifications prepared in a common format.

Objects

An *object* is a self-contained entity. It is an abstraction of something in the real world which is deemed worthy of designation. The process of abstraction lets the designer concentrate on the important features of the real world item (say, data rate negotiation in the case of a modem) while suppressing things which are not relevant to the design process (such as the colour of the modem's case). The central idea is that the object must be (almost) completely understandable on its own. (The reason for the caveat will be explained in the section on 'Inheritance'.)

Objects are able to interact with each other according to some prescribed communication mechanism, but they must be *encapsulated*. This means that each object has a prescribed interface with the rest of its world; that is, with the other objects either actually or potentially in the system. Object-oriented design is the technique of assembling a system (that is, a composite specification or program) from interacting objects. Thus object-oriented design is a technique depending on the aggregation of identified objects in the problem space. (The examples given in later sections should help make this clear.) This means that object-oriented design can appear foreign to programmers and designers accustomed to top-down decomposition.

Classes

Systems often contain objects which are essentially replicates or clones of some prototype. Object-oriented design uses the concept of a *class* in order to exploit such similarities. Some object-oriented programming languages and methods define a class to be a 'template object' (rather like a cookie cutter) linked to an object-creation mechanism. Objects created accordingly are described as *instances of the class*. Instances usually possess some property (such as physical location) which allows them to be uniquely identified. (Think of the class 'telephone' .) A class interacts with other objects by responding to messages requesting that an instance be created.

Object-oriented specification methods which wish to be implementation-independent sometimes take a more general approach, motivated by the fact that object creation is intrinsically an implementation mechanism. The term *class* is used to mean the set of all objects sharing the features defined in a partial specification called a *template*. The template may itself be an object, but need not be. As an example, the V.32 modem standard can be considered as a family of templates defining classes of conforming modem specifications. This approach has been adopted by ISO and CCITT in their work on distributed systems specification, as it facilitates the introduction of a formal (that is, mathematically-based) framework for object-oriented design.

Objects in a design must be declared to be instances of some appropriate class. The key feature is that many objects derive their properties from one description.

Inheritance

A BT Facilityphone 200 is a particular sort of telephone. If we were to describe the BT Facilityphone 200 class to someone familiar with the plain old telephone class, we would concentrate on the additional features such as digital display and repertory dialling. We would not explain the basic call connection function of the telephone class.

This intuitive approach is captured by the object-oriented concept of *inheritance*. Inheritance depends on a designated collection of specialisation relationships between classes. A specialisation of a class is called a *subclass*. For example, the BT Facilityphone 200 class is a subclass of the telephone class. In this way, a hierarchy of classes can be constructed.

Inheritance can be summed up as the derivation of the properties of an object from the position of its class in the class hierarchy. In some programming languages, inheritance is implemented as a mechanism to share code—the subclass object actually accesses code contained in its parent class. Object-oriented specification, on the other hand, can use inheritance as a technique to catalogue and relate specification modules which are actually implemented quite separately. (The telephone example is a good illustration.) This is the approach being taken by the world-leading European Commission research project on distributed systems architecture—*Information Services Architecture*—in which BT is collaborating with major companies such as DEC and Hewlett Packard.

Object-oriented design gains its flexibility from inheritance. Classes can be identified and used in applications, but remain open for further specification if it is desired to introduce new subclasses.

APPLYING OBJECT-ORIENTED IDEAS IN BUSINESS

The earliest applications of object-oriented design were (quite naturally) in scientific simulation and later in exploratory programming (where a solution is iteratively developed from an initial idea). Neither of these is of immediate interest in the business and commercial world.

Traditionally, object-oriented design proceeds in an exploratory way—classes are identified, objects designated, a system design prototyped and explored, classes modified or new classes identified, and so on. This is clearly not satisfactory for business applications, so recently attention has been given to the methodology of requirements capture for object-oriented design. Books such as Reference 4 view object-oriented design as demanding a logical extension of structured systems analysis techniques and will help the process of technology transfer.

Software houses in the USA are beginning informally to publish statistics suggesting that object-oriented software with significant reuse of code is being produced considerably more cheaply than by traditional methods. A trend to more and larger companies devoted to object-oriented design and technology in the USA has been observed. There is also a significant market in object-oriented computer-aided software engineering (CASE) tools.

The object-oriented approach demands a rethink of the conventions of systems and software design. Object-oriented design supports an evolutionary style of systems development, where new classes are defined and tested before being introduced to the system. The traditional waterfall model of the software lifecycle is no longer appropriate. This has implications for project management which are not yet fully understood, but which will have to be addressed if the business world is to take advantage of object-oriented ideas.

The future use of object-oriented techniques in distributed systems design has already been indicated. This in turn relates to the question of object-oriented database technology (increasingly a subject in its own right—see, for example, Reference 5) and its application to management information systems.

OBJECT-ORIENTED SOFTWARE DESIGN

This section presents an illustrative example of an object-oriented design methodology developed at BTRL. The approach concentrates not on the overall functionality of the intended software system, but instead on the component entities—the objects which interact together to form the software system. The main consideration in the design is the identification and structuring of objects from the application domain. The behaviour of those objects is a secondary consideration. Designs are produced by a process of composition of objects, and are intended to be implemented in Smalltalk-80.

The basic stages of this methodology are as follows:

- clarify the problem space,
- identify the relevant objects within that space,
- identify the actions required of each object,
- structure the objects,
- implement the objects.

There is scope for some variation on this simple design process. In particular, the development process may be far more iterative than this suggests.

Boating Lake Example

Jackson introduces an example concerning the management of a boating lake in the first chapter of his book *System Development* [6]. He uses it to demonstrate the inadequacy of functional decomposition in the production of flexible systems. It is here used as a simple example of object-oriented design.

The Problem

A company offers boats for hire on a boating lake. Customers come to the boathouse and, if a boat is available, the attendant records its number and the start time of the session in a logbook. When the customer returns, the end time of the session is recorded, the session time calculated, and the customer charged accordingly.

The manager of the operation wants to see reports on each day's activity in the form:

Number of Sessions = nnn
Average Session Time = mmm

The proposed system will allow the entry of the start and end times of the sessions by the attendant, and will produce the management reports at the end of the day.

Identifying the Objects

Reading the above text immediately brings to light the following objects:

boat
lake
customer
boathouse
start/end time
attendant
logbook

Some thought suggests that the customer being charged implies a 'payment' object. Discussion with the manager, however, confirms that the system is not intended to be directly concerned with customers or their payments, so both these may be excluded.

What is perhaps less apparent is the abstract object 'session'. It is however important since the manager sees it as being central to the operation. It is the start times and end times of sessions which are recorded, and details of sessions which are required in the report. 'Session' is therefore a relevant object.

Identifying the Actions

These actions are those which are in some sense intrinsic to the objects concerned. The intention is to construct a framework which can be used for discussion with the manager as to exactly what the requirements of the system are. The additional actions to provide these requirements can then be added.

Boats have little intrinsic behaviour that is relevant to the proposed system. They each have a unique number which they must return when asked.

The lake is a collection of boats. It may have boats moved into it, or removed from it. It may be necessary to look at the lake to see if a particular boat is present.

The boathouse is where the boats are kept whenever they are not on the lake. It too is a collection of boats and will require similar actions to the lake.

The lake attendant receives requests from boating customers for sessions of boating, and returned boats once sessions are completed. The lake attendant is also responsible for producing the management report.

A session is a record of a particular use of a boat. Sessions have a start time, a stop time and are associated with a particular boat. Times should be able to perform simple arithmetic between themselves.

The logbook is a collection of sessions.

Structuring the Objects

Different objects are sometimes observed to be *like* one another in that they have similar behaviour. These relationships generally indicate the existence of some sort of inheritance link between object classes. In the example, the lake and the boathouse are clearly *like* one another in that they are both collections of boats with similar actions.

The other main type of relationship is the identification of those objects which need to interact with each other. Sessions will need to know about their start time, their end time and their associated boat. The lake attendant, when asked to start a new session, will have to move the relevant boat from the boathouse to the lake: these objects must therefore be visible to the lake attendant object. The lake attendant must also have visibility of the session log which they must maintain.

Implementation

The language used here for implementation is the influential object-oriented language/environment Smalltalk-80 mentioned in the introduction to this article. Classes in this language are 'template objects' which can create instances on request. An object invokes an action (or 'method') in another object by sending it a named message and awaiting a response. Objects can see only their own private instance variables and any objects passed to them as parameters of a message.

Boat is declared as a new class, with a single instance variable to reference the boat's number. A simple method is added to allow this number to be accessed by other objects.

Lake and **BoatHouse** were identified as being similar, which implies some sort of inheritance relationship. In this case, their desired behaviour is provided by the Smalltalk class **Set**, of which they are each declared to be subclasses.

Session is declared as a new class with the instance variables *startTime*, *endTime* and *boat*.

It is apparent that there is a distinction between sessions that are in progress and those that have been completed. When a boat customer returns a boat, the finishing time for the session is entered in the session logbook: that session is then no longer in progress, but is completed. Instance variables *currentSessions* and *completedSessions* are therefore added to the new class **SessionLog** to keep track of the two types of session. They are instances of the class **Set** which provides the necessary behaviour.

LakeAttendant is declared as a new class with instance variables *boatHouse*, *lake* and *sessionLog*.

That completes the framework of classes for this application. The following methods constitute the functionality required by the customer.

A new session is initiated by telling the **LakeAttendant** that a particular boat is being taken out. It responds by moving the appropriate boat from the boathouse to the lake, creating a new session referencing the boat and the time now, and adding this session to the set of current sessions.

When a boat is returned, the **LakeAttendant** is informed of the number. It moves the boat with that number from the lake to the boat house, finds the current session for that boat and fills in the stop time to be the time now, and moves that session to the set of completed sessions. When asked to produce a management report, the **LakeAttendant** must output the number of completed sessions (that is, the number of elements in **completedSessions**) as well as the average length of all the completed sessions. The first of these is trivial (instances of the Smalltalk class **Set** understand messages asking them their size) but the second needs the addition of a method to **SessionLog** to calculate the average. This method asks each session in **completedSessions** for its length (a method which we have yet to add to **Session**), sums the total, and divides by the number of sessions.

We must now add the method to **Session** which returns the length of an instance. This is simply achieved by returning the *endTime* minus the *startTime* (subtraction is included in the protocol of the Smalltalk class **Time**).

The *report* method can now be added to **LakeAttendant** to provide the desired management report when asked at the end of the day. It is unclear what should happen to the **completedSessions** after production of the report; perhaps they should be archived before being deleted ready for the next day's business. Such details should be decided with the customer.

Discussion

The software design we have just derived illustrates some of the features of the object-oriented approach. The code produced is flexible and reusable. If the boating operation expands, say by opening more boating lakes, the software can be appropriately extended by creating more instances of the classes **Lake**, **BoatHouse** and **LakeAttendant**. If separate management reports were required for each lake, then we could use inheritance to define new classes incorporating the necessary extensions to the classes **Session**, **SessionLog**, **LakeAttendant** and so on. The key point is that we do not have to throw away the work done already. The existing class library could be used to assemble software for boat rental operations of various sizes.

OBJECT-ORIENTED SYSTEM SPECIFICATION

BT's Open Network Architecture (ONA) Management is a major project which uses object-oriented design to specify interfaces between network management systems. The information which flows across these interfaces is defined using *managed objects*.

Modelling Management Information

A managed object provides a view of a particular aspect of a manageable resource in the real world. For example, a telephone exchange can be modelled in a way which represents the full functionality of an exchange, or it can be modelled simply as a means of interconnecting two telephones. The particular aspect represented by the managed object depends on the view the manager wishes to have, or on design choices made elsewhere. It is quite legitimate for a manager to use two, or more, managed object classes simultaneously to manage a single resource.

There is no single correct model (combination of managed object instances) for a particular network or resource. A model is produced to provide the information required by an individual manager. Thus, there may be many different models, giving varying levels of information about the same resources.

The Network Model

In order to maintain a consistent approach to modelling the different aspects of all these resources, a *network model* has been developed. This is a general-purpose view of any network, from which the view required for managing a network, or part of a network, may be derived.

When managing a real network, it is possible to take two fundamental views:

- what is being provided (the logical functions of the network), and
- the means of provision (the physical implementations in the network).

There is a third category of information which is to be modelled, namely extra data which is helpful when used in conjunction with either of the other views.

In this network model, these categorisations have given rise to three basic managed object classes at the top of the inheritance hierarchy:

- Function classes—managed object classes which represent the logical aspects of a resource. For example, modulation/demodulation is a function. The means of providing this function may vary enormously but this is often of little or no interest to a manager which requires a 'modem'.
- Implementation classes—managed object classes which represent physical resources which provide the functions. These represent the sort of information typically used for inventory control, such as manufacturer serial number.
- Information classes—managed object classes which represent information which is relevant to managing a function or implementation. Examples of information are 'location' and 'customer'.

The benefit of this approach is that similar characteristics can then be inherited when a class is refined. Thus, modulation/demodulation can be refined from function. Manufacturer-specific capabilities can then be added to consequent subclasses without impairing the ability of a manager which understands modulation/demodulation to manage the new class.

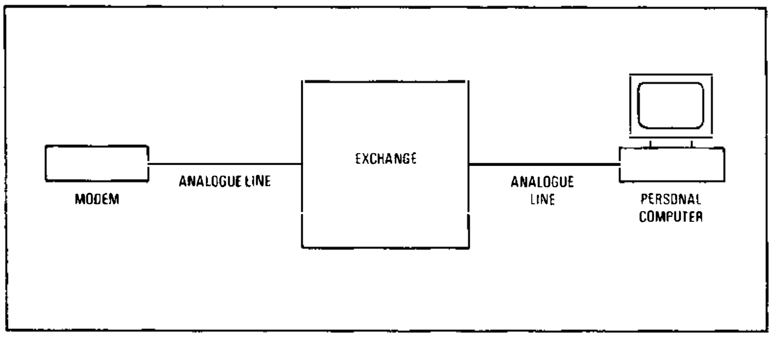
In the network model, instances of the *implementation* managed object class *provide* one or more instance(s) of the *function* managed object class. The same relationship holds true for any subclass of function or implementation.

Example

Figure 1 illustrates a simple dial-up modem link. A PC at one end has a modem card within it. It communicates with a dedicated modem via a switched analogue circuit; for example, the PSTN. What is beyond the dedicated modem is not of interest for the purposes of this example.

Figure 2 is intended to illustrate how the network model can be applied to model the scenario given in Figure 1. The various levels of view available within a single model, the use of the functional and implementation aspects of a resource to achieve technology independence, and the way in which different management

Figure 1 Actual network topology for a dial-up modem circuit



capabilities can be represented, will be illustrated.

The model given in Figure 2 allows a manager access to a high-level view of the functions involved in connecting two digital systems via a dial-up analogue link. A partial view of the implementations which provide this link is modelled, together with extra information on one particular resource. A large variety of models would have been equally valid to support managers with different requirements.

The notation used in the figure is that a managed instance is named in the range A–K, and is a member of the named managed object class. For example, instance A is a member of class **modulation/demodulation**.

The functions being modelled are instances A–E and represent resources which are logically interconnected. B and D are of class **circuit** which means they represent a logical connection between two other functions, in this case, A, C and E.

The implementations being modelled are instances F–I. This model shows a simple one-to-one use of the provides relationship; for example, F *provides* A. Multiple relationships are also legitimate. It is not necessary for a manager to obtain all the information about all the implementations through the single interface. The information may be stored internally or it may be obtained from a different manager.

The information being modelled is contained in instances J and K, which allow the manager to find out who the customer of A is, and where G is.

Both A and E model the same function, modulation/demodulation, and are identical from the perspective of the manager. However, they are provided by two entirely different implementations, a card in a personal computer and a modem. This demonstrates the technology independence offered by the approach, since the management capabilities provided by the two implementation classes are potentially very different. Future extensions of the manager's abilities might allow it to manage F with its manufacturer specific capabilities, without affecting I.

Instance G represents a physical connection between two implementations. In practice the resource which G is modelling could be an arbitarily complex physical network. For example, it could be the PSTN, with H representing a PBX. The PSTN could be modelled in more detail by using a series of facilities and exchanges. These can, in turn, be modelled in more detail. The possible recursions up and down are unlimited, and an appropriate level of detail must be chosen for a given manager.

CONCLUSIONS

This article has introduced the object-oriented design approach and given examples drawn from two British Telecom Research and Technology projects. The main strength of the approach is commonly recognised to be the flexible and reusable designs it produces. Some relative weaknesses are currently provoking considerable research. One problem yet to be solved is how to incorporate composition of objects into an object-oriented approach; that is, how to express one object as a combination of component objects, while preserving the principle of encapsulation. (At the moment, object-oriented designs tend to be 'flat'.) Another issue is the integration of global constraints on the behaviour of an object-oriented system into the design process.

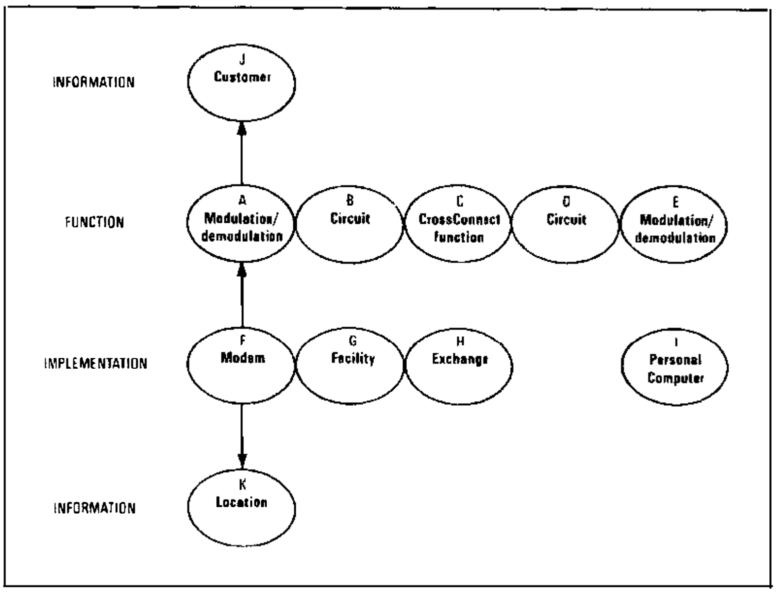


Figure 2
Managed objects to represent a dial-up modem link

Within British Telecom Research and Technology, there are already major projects using object-oriented design. Some interesting insights have been gained, such as the conceptual link identified in the ONA Management project between object-oriented ideas and the questions of *conformance* (say, of a protocol to its specification) and *refinement* (of a loosely-sketched specification into a more tightly defined design). Theoretical investigation of such relationships has led to an improved understanding of object-oriented design.

In addition, there are projects exploring the use of object-oriented design as an implementation-independent specification technique. One aspect of this work is the integration of object-oriented design with formal (that is mathematically defined) specification languages. Engineers in British Telecom Research and Technology have found that the strengths of some powerful formal specification languages complement those of object-oriented design, and can offer new ways to counter the disadvantages mentioned at the start of the section. This work is now attracting interest from outside British Telecom, especially for the formulation of international standards for open distributed processing systems.

Most major computer companies, including DEC, Apple and IBM, are now significantly interested in object-oriented design. This suggests that business applications of the techniques are not too far distant. Object-oriented design is not, however, a universal panacea. Undoubtedly, there may be business and commercial applications for which it is inappropriate. The challenge for business in the 1990s is to identify those areas where object-oriented design will offer rewards and to develop and implement appropriate changes to existing work practices and methods.

References

1 GOLDBERG, A., and ROBSON, D. Smalltalk-80: the language and its implementation. Addison-Wesley, 1983, reprinted 1985.
2 STROUSTRUP, B. The C^{++} programming language. Addison-Wesley, 1987.
3 MEYER, B. Object oriented software construction. Prentice-Hall International Series In Computer Science, 1988.
4 YOURDON, E., and DEMARCO, T. Object oriented structured analysis. Yourdon Press, 1990.
5 KIM, W., and LOCHOVSKY, F. (*eds*.) Object oriented concepts, databases and applications. ACM Press and Addison-Wesley, 1989.
6 JACKSON, M. System Development. Prentice-Hall International, 1983.

Biographies

Elspeth Cusack joined BT in 1979 on completing her Ph.D. in Mathematics at the University of East Anglia. She is currently a Head of Group in the BT Research and Technology's Information Services Standards Division, responsible for research and consultancy in the application of formal methods to distributed system design. She has published a number of research papers on the theory of object-oriented design, and represents the UK at ISO meetings on open distributed processing.

Chris Clough graduated from Nottingham University with a degree in Electronic Engineering. He joined BT in 1985, subsequently gaining an M.Sc. He supported various technical areas of ONA. In 1987, he moved into the field of network management standards and since then has been involved in various aspects of object modelling and definitions work.

Keith Richards joined British Telecom as a BT Student in 1981. After graduating from the University of East Anglia with a degree in Computer Science in 1985, he joined the Systems and Software Engineering Division of BTRL where his work was involved with the evaluation of various methods for requirements capture and software design. In 1987, he became interested in object-oriented programming and has since been working on how to apply object-oriented techniques to software development.

British Telecom Press Notice

British Telecom Announces Major Company Reshaping Putting Customers First

British Telecom has announced fundamental changes to shape the company for the markets of the 1990s. The changes will be introduced over the next 12 months.

Making the announcements, BT's Chairman, Iain Vallance, said: 'Our objective is to become a leaner and more subtle organisation, structured to meet the differing needs of all our customers. We are currently organised by product and geography. This might be convenient for us, but it does not suit our customers.

'Our new organisation will be focussed on specific market sectors, recognising the very different needs of, for example, the individual customer, the small businessman, or the multinational corporation.'

Under the new arrangements, there will be, by April 1991, two major new customer facing divisions—Personal Communications and Business Communications—focussing on the needs of individual and business customers respectively. They will be responsible for marketing, selling, delivering and supporting a range of products and services tailored to the needs of those customers world-wide.

The management of all customers premises' products and of network services will be brought into a single unit to provide, within a coherent architecture, a suitable range of world-class products and services for the new customer-facing Divisions.

BT's international and UK networks will be brought together into a new Worldwide Networks Division. Its task will be to provide the high-quality, cost-efficient network platform vital to the delivery of telecommuniations products and services to customers.

Finally, a number of business activities that are best managed independently will be placed in a separate Special Business Division.

'The key to these changes', said Iain Vallance 'is the need to understand our markets and customers in greater depth and to structure ourselves better to meet the specific requirements of those markets. By becoming a more market-driven organisation, by selling a quality range of products and services and by streamlining our organisation, we will give our customers better value for money'.

Although the new structure will not be fully in place until April 1991, one important immediate change for BT's customers is to bring together progressively the whole UK sales and marketing force—including District staff—under a unified management structure. The British Telecom International sales force will be integrated into this structure over the next few months.

'This is a clear indication of our customer orientation' said Iain Vallance. 'Together with our continuing emphasis on quality and on containing our costs, it underlines our aim of providing our customers with a service that is second to none.'

Storm Crisis

The devastating gale that struck Britain on Thursday 25 January 1990, and the subsequent storms and floods during January and February, brought havoc to many areas of the country and widespread disruption to telephone service.

Initial reports received by BT's Emergency Planning Unit on 25 January from the network management centre and the field indicated that the prevailing storm conditions were putting the network under strain and likely to create a large increase in faults, particularly in the overhead network. Therefore, the initial alerting procedure that was established after the storm in October 1987 was set into operation.

The BTUK Board, which was meeting at the time, was advised of the situation, and Mike Bett, Managing Director BTUK, appointed Brian Haigh, Director of Operations London and South East England, to co-ordinate BT's efforts in combating the effects of the storm. An emergency communications centre was set up and Districts were asked to send daily situation reports.

At the height of the crisis, some 100 000 faults were reported nationwide, with fault levels up to 800% above normal (Westward District). There was widespread loss of mains power especially in East Anglia and the West Country. In all about 850 exchanges needed to use stand-by power, of which 310 were in East Anglia and 350 in Westward District. There was widespread congestion all over Southern England during the afternoon and evening of 25 January, and it was necessary to introduce appropriate network management techniques. In addition, there was some congestion in the main network.

Worst hit were Westward, Wales and the Marches, Solent, Severnside, Thameswey, North Downs and the Weald, South Downs and Southern London Districts. The widespread nature of the damage severly restricted opportunities for redeploying staff between Districts, but arrangements were made for help to be given to the worst-hit Districts.

The damage to overhead plant brought large demands from Districts for pole erection units and elevating platforms. Motor Transport assisted in meeting most of the demand and loans between Districts assisted further. District materials managers kept in close contact with Materials Executive to ensure that stocks were adequate.

Repairing line damage caused by falling trees to restore telephone service to a remote farmhouse near Ruan Lanihorne in Cornwall

Brian Haigh (centre), Director of Operations London and South East England, at the Emergency Message Control Centre

Repair work was hampered by continuing bad weather, high winds and heavy rain, and flooding occurred in some areas. Staff worked hard and long often in atrocious weather conditions to reduce the backlog of faults. Provision of service had to be suspended or severely restricted in the worst-affected Districts so that resources could be concentrated on restoring service. By 23 February, the number of outstanding faults had been reduced to about 46% above normal. However, further severe storms on 25 and 26 February pushed the number of outstanding faults back to the level of 1 month previously.

The pattern in the numbers of outstanding faults that emerged from the daily reports up until the first week in March was one of stabilising the situation during Mondays–Fridays, and then using the weekends to make significant inroads into the backlog of faults. Over the weekend of 3/4 March, a reduction of 39 000 in the number of outstanding faults was achieved. By 12 March, the situation was nearly back to normal, and central control was finally lifted.

Westward was one of the worst effected Districts, where hurricane-force winds caused electricity supplies to be cut to large sections of the population and telephone service to be disrupted. Some 5500 staff from virtually every discipline coped with a huge extra workload. Engineers worked throughout weekends and cancelled leave to repair faults. This work was being done in atrocious weather conditions which continued for many days. The District received help from Lancs and Cumbria, West Midlands, City of London, Liverpool and Northern Ireland Districts, as well as from 40 Telecom Eireann staff. A number of special vehicles were lent to augment Westward's hard-pressed resources. At its peak, the January storm brought a tally of over 10 000 faults awaiting clearence. Some 2800 faults a day were being cleared despite atrocious weather conditions. More than 360 poles were brought down, either by the wind itself or as a result of trees falling on overhead cables.

Iain Vallance, Chairman of British Telecom, paid this tribute to staff: 'Once again British Telecom has been seen at its best—working hard to restore service to customers following a crisis or disaster.

'The recent storms caused damage over a much wider area than in the autumn of 1987 and I am proud of the way BT people have worked unsparingly to restore service to our customers.'

THE INSTITUTION OF BRITISH TELECOMMUNICATIONS ENGINEERS

(Founded as the Institution of Post Office Electrical Engineers in 1906)

General Secretary: Mr. J. H. Inchley, NPW9.3.1, 4A40, The Angel Centre, 403 St John Street, London EC1V 4PL; Telephone: 071–239 1912. Membership and other queries should be addressed to the appropriate Local-Centre Secretary as listed on p. 267 of the January 1990 issue of the *Journal*.

NEW YEAR HONOURS

The Institution congratulates its new Vice-President, Professor Eric Ash, who was made a Knight Batchelor in the New Year Honours list.

IBTE CONGRESS

It has been apparent for some time that the Institution has to re-evaluate its mission and purpose, and position itself to best serve its Members today and into the future. To do this, we have to understand the needs of our Members, identify our strategic objectives and the activities required to implement them.

Council recently dedicated a special meeting to consider these issues, and some tentative proposals are beginning to emerge. However, at that meeting, it was agreed that a Congress for IBTE office holders and activists was essential to give the grass roots Members an opportunity to influence the major decisions to be made.

The Congress will be held on 30 and 31 May 1990, in London, and will involve up to four representatives of each Local Centre, Council and the National Executive Committee of the Associate Section. The event will be chaired by our President, Clive Foxell. The Annual General Meeting of the Institution will take place at 17.30 hours on 30 May as part of the proceedings of the Congress.

RULE CHANGES

At its recent meeting in Newcastle, Council agreed to amend the Rules for the composition of Council. The Rules, which were intended to foster links between Centres and Council, have in fact created a number of difficulties, namely:

(*a*) The two year term is considered too short to be fully effective.

(*b*) With the changes in District organisations, some of the groupings originally formed have now been invalidated.

(*c*) Current Rules preclude Members being re-nominated by their Centre grouping for one year following their term of office.

To overcome these problems, Council has agreed to extend the term of office served by nominees to three years, and to reorganise the representation cycle to ensure that each 'constituency' comprises not more than two Centres. Detailed Rule changes will be published in the next issue of the *Journal*, but Council agreed to implement the changes with effect from the start of the 1990/91 session.

HONORARY MEMBERSHIP

Council has received three nominations for the award of Honorary Membership to outstanding servants of the Institution: Derek Norman, Ken Crooks and Chris Webb.

Derek Norman served for 17 years as Secretary of the Bletchley Centre, and had put a great deal of effort into building up and sustaining interest in the Institution. He will be greatly missed by his Centre and his Local Secretary colleagues.

Ken Crooks, as Vice President of the Associate Section, earned the respect and admiration of the Associate Section NEC, and unfailingly gave of his time and energy on their behalf. The growth and success of the Associate Section is in no small measure due to his efforts.

Chris Webb played a leading role in fostering and developing the current enthusiasm within the Associate Section, which he served via the NEC in a number of capacities, culminating in a term of office as Chairman. His drive and enthusiasm, lately transferred to his role as Secretary of London Centre after promotion, was exceptional, as was his commitment.

Council had great pleasure in voting for the award of Honorary Membership to these nominees.

The Secretary

IBTE/FITCE REGIONAL SEMINAR, GLASGOW: 'EUROPEAN TELECOMMUNICATIONS FACING UP TO 1992'

The fifth IBTE/FITCE Regional Seminar, the IBTE Scottish Centres' Seminar, was held in Mitchell Theatre, Glasgow, on 9 March 1990. Alastair Petrie, Chairman of West of Scotland Centre, welcomed the audience of IBTE members from all three Scottish Centres and then invited Colin Shurrock, Chairman of Council to address the meeting.

Colin pointed out that the IBTE had reached a new era and there was a need for changes. He referred to the formation of the President's Advisory Group, comprising senior BT engineers, and the existence of a partnership with BT. He informed the meeting that a challenge had been passed back to the IBTE to continue with its vital role in fostering engineering excellence among the membership. He also spoke about the development of a questionnaire to establish the needs of the membership.

Three distinguished speakers from the 28th FITCE Congress, in Lisbon, shared the platform for the technical part of the meeting with a respected BT engineer, Bill Medcraft, Chief Engineer, London and South East England Territory, BTUK. These three were Adrjanus Reppel of PTT Telecom, the Netherlands; Jose Herdade of Companhia Portuguesa Radio Marconi; and Graham Neilson of East of Scotland District, BTUK.

In his paper 'Doing Business with ISDN', Adrjanus Reppel said that in the quest for the right information in the right place at the right time, companies, either within themselves or with other companies, were transferring increasing volumes of information. The ISDN was a highly attractive bearer in such an environment, a bearer that can be used for a multitude of applications.

The next paper to be presented was Bill Medcraft's 'London Network Modernisation', which has been selected for the FITCE Congress in Glasgow. It is expected that his paper will be published in the *Journal*.

Jose Herdade then presented his paper, 'The European Submarine Cable Network: A Fundamental Infrastructure for 1992 and Beyond'. Jose reviewed the various submarine systems already in position and the other systems due to be installed in European waters up to 1992. He pointed out that the high quality, reliability and design capacity of submarine systems allowed the submarine cable network to be used to convey, cost-effectively, virtually all types of telecommunications services, and, because of the long lives of the systems, Europe could rely on this network well beyond 1992. He then suggested that European telecommunications operators should perhaps consider further exploration of this potential, namely the establishment of an automonous, round-the-continent broadband submarine network.

The final technical paper was Graham Neilson's 'Centralised Exchange Management using Gateway Products', which was awarded the President's prize at the FITCE Congress in Lisbon. The paper was published in the October 1989 issue of the *Journal*.

The afternoon's proceedings were closed by Brian Wherry, a former Vice-Chairman of Council. Brian also mentioned about the next FITCE Congress, which would be held in Glasgow in August this year.

The generous support given by the District General Managers of the three Scottish Districts and the Regional Manager Scotland of Trunk Network Operations made this seminar possible. The superb organising ability of Lewis Shand, Secretary of the IBTE West of Scotland Centre, ensured its success.

TAPASH RAY
Assistant Secretary, IBTE/FITCE Group

29th European Telecommunications Congress, Glasgow

27 August–1 September, 1990

The Annual Congress of the Federation of the Telecommunications Engineers of the European Community will be held from 27 August–1 September 1990 in the Forum Conference Centre, the Forum Hotel, Congress Road, Glasgow. This will be the first European Telecommunications Congress to be held in the United Kingdom. It is being organised under the joint auspices of FITCE and the host organisation, the Institution of British Telecommunications Engineers.

The theme chosen for the 1990 Congress is:

Networks 2000: Developing telecommunications networks towards the year 2000 to meet customer needs, specifically in the fields of:

- Customer Services
- Personal Communications
- Network Architecture
- Operational Management Systems

The technical programme of the Congress has been spread over five half-day sessions and the final round table discussion. The first session has been designated as the keynote session, which will follow the formal opening ceremony on Monday, 27 August. The remaining four sessions are dedicated to the four sub-themes mentioned above. The last day of the Congress, Saturday, 1 September, has been set aside for the FITCE General Assembly. Some 29 technical papers have been chosen for the technical programme and these papers will be presented by authors from the various FITCE member countries.

IBTE members wishing to attend the Congress are requested to apply for the Congress registration forms from:

Tapash Ray
Assistant Secretary, FITCE Group of IBTE
BTUK/NPW8.1.3
2nd Floor, C Wing
The Angel Centre
403 St John Street
LONDON EC1V 4PL

The completed registration forms must be returned by **15 June 1990** to the Assistant Secretary, FITCE Group of IBTE at the address given together with Congress registration fees payable to the IBTE.

The scale of the Congress registration fee is as follows:

FITCE Member	£53
Member's accompanying person	£45
Non-Member	£105
Non-Member's accompanying person	£90

Various business units (Divisions, Districts etc.) of British Telecom may offer limited sponsorship to their staff for attendance at the Congress. Interested IBTE members should apply to their own unit managers for sponsorship.

TAPASH RAY
Assistant Secretary, IBTE/FITCE Group

On 6 May 1990 London's telephone code will change

New Code for London

London's telephone dialling code will be replaced by two new codes from 6 May 1990. The instructions below show you how to phone or send a fax to London using the new codes. Any equipment you have which stores 01 numbers will also need to be reprogrammed by 6 May.

Why the code is changing

There is a rapidly increasing demand for phone and fax numbers in London. By dividing London into two codes, we can create twice as many numbers, and so satisfy our customers' needs in the future.

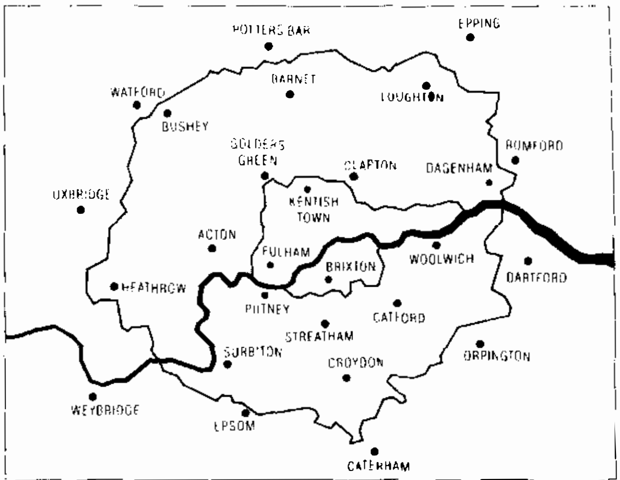
How to find the right London code

From 6 May 1990, the old London 01 code will change to 071 for numbers in inner London, and 081 for numbers in outer London.

To find the correct new dialling code (071 or 081), look at the first three digits of the seven-digit London number. Then check them with the table opposite.

For example, 01-**434** 0000 will become 071-**434** 0000, but 01-**666** 0000 will become 081-**666** 0000.

Not applicable for calls from the Irish Republic.



First 3 digits of the no.	New code	First 3 digits of the no.	New code	First 3 digits of the no.	New code	First 3 digits of the no.	New code
200	081	440-453	081	663-695	081	868-871	081
202-209	081	454	071	696	071	872-873	071
210	071	455-456	081	697-699	081	874-879	081
212-215	071	457	071	700-704	071	881-886	081
217-263	071	458-464	081	706-716	071	888-894	081
265-281	071	465	071	718-739	071	895	*
283-284	071	466-472	081	740-752	081	897-900	081
286-289	071	473-474	071	753	071	901	071
290-291	081	475	081	754-756	081	902-910	081
293-295	081	476-477	071	757	071	911-912	071
297-305	081	478-479	081	758-761	081	913-914	081
306	071	480-499	071	763-764	081	915-918	071
307-314	081	500-509	081	766-771	081	920-939	071
315	071	510-513	071	772	071	940-944	081
316-319	081	514	081	773	081	945	*
320-329	071	515-516	071	774-775	071	946-954	081
330	081	517-521	081	776-778	081	955-957	071
331	071	522	071	779	071	958-961	081
332	081	523-524	081	780-781	081	962	071
333-334	071	525	071	782	071	963-969	081
335-337	081	526-527	081	783-789	081	971-973	071
338	071	528	*	790-796	071	974	081
339-343	081	529-536	081	798-799	071	975	*
345-349	081	537-538	071	800-809	081	976	071
350-359	071	539-547	081	811	081	977	081
360-361	081	548	071	818-824	071	978	071
363-368	081	549-579	081	826	071	979-981	081
370-389	071	580-589	071	828-829	071	982	*
390-395	081	590-595	081	831-839	071	983--986	081
397-399	081	597-599	081	840-859	081	987	071
400-418	071	600-613	071	860	071	988-989	081
419-424	081	615	071	861-864	081	991-995	081
425	071	618-639	071	865	071	997-998	081
426-429	081	640-651	081	866	081		
430-439	071	653-661	081	867	071		

**These numbers have predominantly 071 codes with some 081 codes. In case of difficulty with these numbers please contact the Mercury Helpline on 021-625 3010.*

British TELECOM

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