The Significance of the IBM Token Ring

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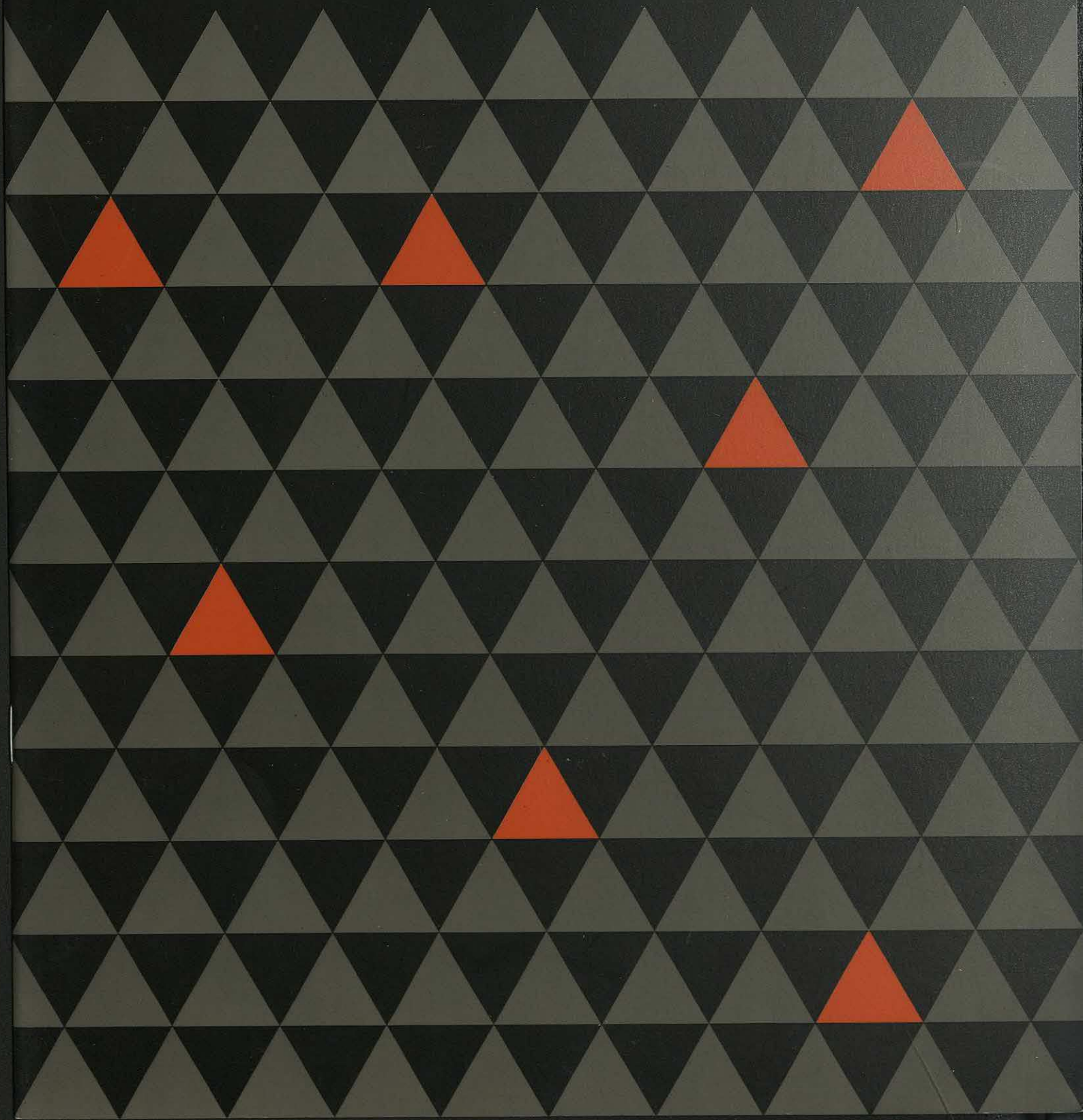
A Paper by David Flint



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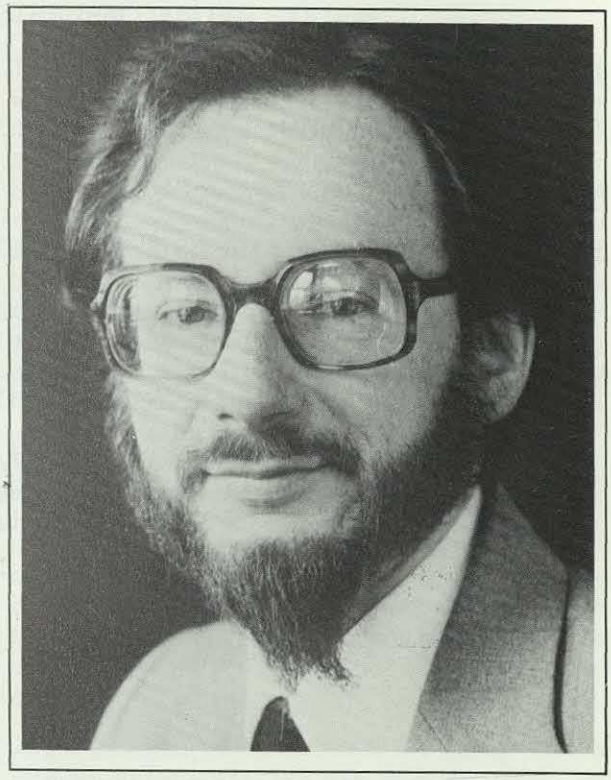
THE SIGNIFICANCE OF THE IBM TOKEN RING

DAVID FLINT



David Flint is a Senior Consultant with Butler Cox who specialises in local area networking technologies. His book on this topic, 'The Data Ring Main', was published by Wiley in 1983. In this paper, David evaluates the significance of IBM's long-awaited Token Ring LAN product.

The Token Ring and the IBM Cabling System and the software products that it requires are sound but unexciting products. Indeed, had these products been announced by anyone other than IBM, they would be worthy of little attention.

However, these are not just ordinary IBM products – they are a central part of IBM's thrust into the office. By setting new standards, they will lead to major changes in systems architecture and the systems market. They are therefore of vital importance to the whole industry.

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THE SIGNIFICANCE OF THE IBM TOKEN RING

CONTENTS

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THE SIGNIFICANCE OF THE IBM TOKEN RING

Towards the end of 1985, IBM finally put an end to speculation when it announced its local area network product – the Token Ring LAN. Some of the pre-announcement papers on the Token Ring had suggested that it would solve all the problems of device interconnection in the office, at least for IBM equipment. This is, however, far from the case – and not just because the product will not be available until late 1986. Instead of providing a universal solution, IBM has chosen to plug the most obvious gap in its product line – a LAN for PCs. Only PCs, PC Portables, XTs, and ATs are supported initially.

The initial product therefore competes directly with better-established micronets such as the Nestar PLAN, 3Com EtherShare, and Corvus Omninet, some of which are cheaper and provide better functions and software than the Token Ring.

Although the initial product is fairly unexciting, its significance in the long term is likely to be enormous. IBM has now given its 'seal of approval' to local area networking, and the Token Ring LAN is likely to be as significant for networking as SNA has been.

The significance of the Token Ring LAN cannot be discussed in isolation, however. It must be considered in conjunction with the IBM Cabling System (which has to be installed before the Token Ring LAN can be used) and two network software packages, NETBIOS and APPC. NETBIOS was developed by Sytek for the broadband IBM PC network and provides the resource sharing expected of a micronet. APPC (advanced program-to-program communications) is an implementation of SNA LU6.2/PU2.1 for the IBM PC. The Token Ring LAN has been designed to support both these software packages.

The strategic importance of these products, taken together, is very significant because they form a central part of IBM's thrust into the office. They define a new family of standards underpinning a new architecture and able to support a very wide range of applications. And, because of the open nature of the standards and their wide applicability, they will promote competition amongst a variety of other suppliers, eventually leading to a much wider choice of products.

THE IBM CABLING SYSTEM

The IBM Cabling System is a product for the complete wiring of buildings. Like telephone and power wiring, it is best installed during building construction, though this is not mandatory. By itself, the Cabling System is a passive product: it includes no switching, error control, or network management functions. It must be installed according to IBM guidelines, and it must be constructed from IBM-approved components. The main components are the wiring closets, intercloset wiring, station cables, faceplates, and device attachment cables (see Figure 1). Overall, the product is a star of cables that meet at wiring closets.

Each wiring closet contains racks and has a distribution panel for data. The distribution panel allows rapid and convenient reconfiguration with no need for cable pulling or splicing. The wiring closet may also contain a distribution frame for telephony, wiring concentrators for local area networks, cluster controllers, and other communications equipment. One closet is generally the origin for up to 250 station cables.

The intercloset wiring depends on the mixture of devices to be supported. For 327x terminals, for instance, coaxial cables will be needed if the cluster controllers are in the computer room, but coaxial cables, twisted pairs, or fibre-optic cables can be used if the controllers are in the wiring closets.

There are several alternative types of cable that can be used for the station cables, but Types 1, 2, and 3 are the most important. Types 1 and 2 were part of the original (1984) Cabling System announcement. Both are based on two shielded twisted pairs, intended for data transmission (Figures 2 and 3). Type 2, which is not currently available in Europe, also has four twisted pairs intended for telephony. These additional pairs are placed outside the shield but within the outer sheath. (AT&T Information Systems, AT&T-IS, now recommends the installation of four pairs to each desk and has products that use them for a mixture of voice and data.) Type 1 and 2 cables are thicker and stiffer than ordinary telephone wire and thus are more difficult to install. It may sometimes be necessary to install special conduits to accommodate these cables.

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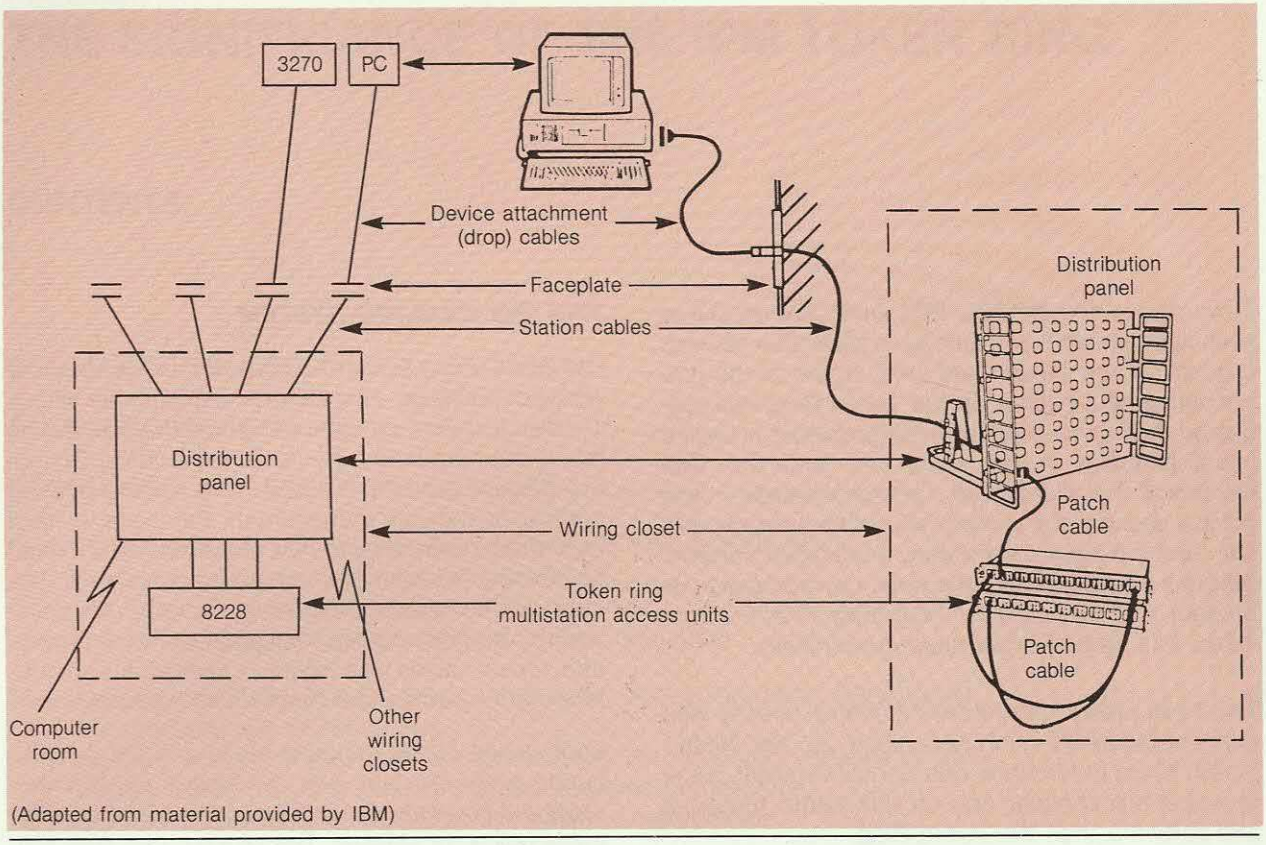
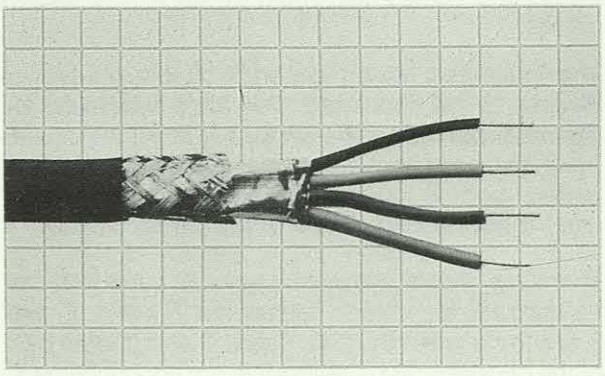
Figure 1 Components of the IBM Cabling System



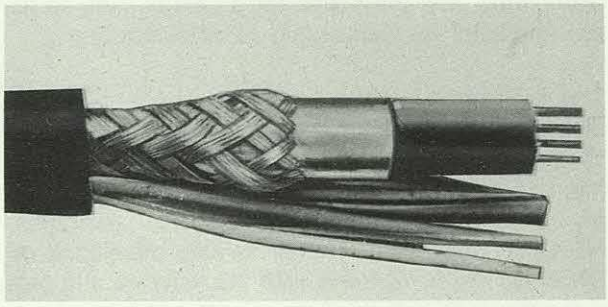
(Adapted from material provided by IBM)

Figure 2 IBM Type 1 device attachment cable



IBM Type 1 cable is based on two shielded twisted pairs.

Figure 3 IBM Type 2 device attachment cable



IBM Type 2 cable (not currently available in Europe) has two shielded twisted pairs and four additional twisted pairs intended for telephony.

Type 3 cable is defined as 'good-quality' telephone wire. The term quality refers both to the electrical specification and the existence of documentation describing where the cables are installed. Type 3 cable was included in the Cabling System only in 1985 as a competitive response to AT&T-IS's Premises Distribution System (PDS, which provides data and voice support over telephone pairs and fibre optics). Type 3 cable is cheaper both to buy and to install than the other types, but its signalling properties are not as good, so it can be used only for short distances and low transmission rates.

An appropriate device attachment (or drop) cable is needed to attach a device (terminal or host) to the Cabling System. At the terminal end, drop cables terminate in a Cabling System faceplate in each office or next to every desk. (Fewer faceplates could be installed, and this would save money, but it would then be more difficult to move or add equipment.) If

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Figure 4 Some network alternatives that can be supported by different types of cabling schemes

	Cabling scheme					
	Conventional			IBM Cabling System		
Network alternative	Twin-ax loops	Coaxial star	Telephone wire	Type 3	Type 1	Fibre-optic
Token ring						
40M bit/s	X	X	X	X	X	✓
10M bit/s	X	X	X	X	✓	✓
4M bit/s	X	X	X	✓	✓	✓
3270 screen	X	✓	X	✓	✓	✓
Series 1 loop	✓	X	X	✓	✓	✓

type 2 cable is used, a second faceplate for telephony will also be needed.

Every drop cable terminates in an hermaphrodite plug that is inserted into the faceplate to mate with a similar plug behind it. In the case of a 327x terminal, the cable includes a red 'balun' that interfaces the balanced signal on the Cabling System with the unbalanced signal on the coaxial cable (hence the name – *bal*anced-*un*balanced convertor). Appropriate drop cables are available for 327xs, PCs, Series 1 loops, and 5520s.

Figure 4 shows some of the network types that can, and cannot be, supported by various cabling schemes.

THE IBM TOKEN RING LAN

The IBM Token Ring LAN, as initially announced, is a micronet – that is, a LAN designed for IBM PCs. It is intended for use in buildings that have been prewired with the IBM Cabling System, but it can also be used with Cabling System components installed on an ad hoc basis.

The IBM Token Ring runs on twisted-pair cables laid in a star-shaped ring through IBM 8228 multistation access units located in wiring closets. A special bit pattern, the token, circles the ring continuously. When a station holds the token, and only then, it can transmit a single packet of data. It must then release the token for use by the next station.

The announced Token Ring product has a signalling speed of 4M bit/s, but products operating at 16M bit/s are promised. Even higher speeds, over optic fibres, can be expected in the future. Because the initial product operates at 4M bit/s and uses packet technology, it is primarily a data transmission product. It supports neither voice nor full-motion video (though support for freeze-frame video is likely in the future).

The Token Ring complies with IEEE 802.5 and 802.2 standards, but it has many additional management features. It probably has better network management than any currently available LAN. The Token Ring's network management functions continually monitor the ring's operation. When a ring segment fails, the station receiving from that segment detects the loss of signal and transmits an error message round the ring to the preceding station – the station that should be transmitting onto the failed segment. That station then removes itself from the ring and tests its link to the wiring closet. If that link is defective, the station remains off the ring, enabling the ring to operate correctly. If the sending station's link is operating correctly, the receiving station then removes itself from the ring and tests its own link to the wiring closet.

At present, the network management functions are defined for a single ring and are not integrated with SNA network management in a wide area network, even an SNA network accessible from a Token Ring. In the future, this shortcoming is likely to be removed, allowing networks to be managed on a centralised, decentralised, or hybrid basis.

So far, there are no independent performance measurements for the Token Ring LAN. However, IBM's own statistics show that data can be transferred between Series 1s on a Token Ring LAN at speeds of up to 300k bit/s. The responsiveness falls as the total load on the LAN increases, but at high loads (over 70 per cent, say) the performance is markedly better than that of a contention LAN running at the same speed. LANs, however, normally operate at relatively low loads, where the performance advantage lies with contention networks. And, in almost all circumstances, the overall performance of a LAN depends more on the speed of the PC and the efficiency of its software than on the characteristics of the network.

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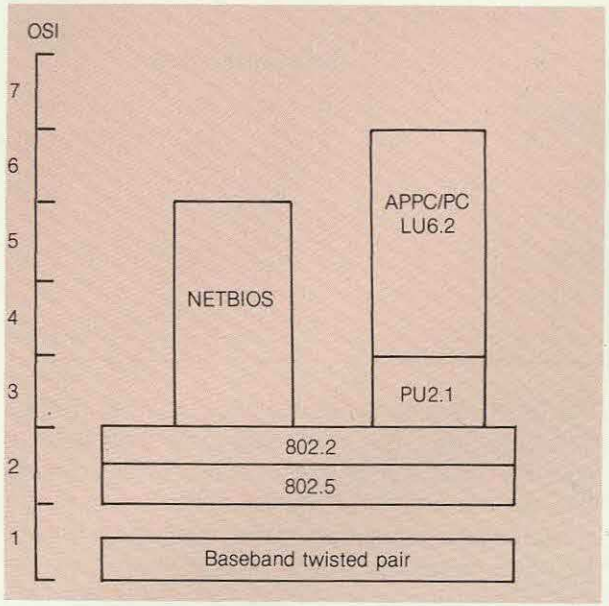
Figure 5 Relationship of NETBIOS and APPC to the OSI layers



(Source: IBM)

NETBIOS AND APPC SOFTWARE PACKAGES

The IBM Cabling System and the Token Ring LAN correspond to the physical and data link levels (layers 1 and 2) of the OSI model. Above these levels, IBM has implemented proprietary, rather than open, standards. There are, in fact, two distinct and independent software environments above the data link layer – NETBIOS and APPC. Figure 5 shows how NETBIOS and APPC relate to the OSI layers.

The NETBIOS environment, which requires IBM's PC NETWORK Program, provides economies by allowing the sharing of peripherals and the exchange of information on the LAN. The main services provided by the NETBIOS environment are:

— File service: PC files can be transferred across the network and applied to a shared disc unit. Files, directories, and data volumes may thus be shared by several PCs.

— Print service: Output for printing is written to a spool file and may be printed later by another PC.

— Message service: This service provides an inter-PC message mechanism. It is purely local and is not compatible with anything else in the IBM range.

NETBIOS can be used in conjunction with separate software that allows the LAN to access IBM 370, System 36, and System 38 computers and with special hardware and software for access to Series 1 computers.

The environment provided by NETBIOS has its roots in the 'open architecture' of the PC. It was developed by Sytek for the broadband IBM PC network, and the protocols are proprietary to Sytek. Applications using NETBIOS may be transferred between broadband and Token Ring LANs.

APPC

APPC (advanced program-to-program communication) is an implementation for the PC of the most recent SNA standards. The two key standards are:

— PU2.1, which provides peer communications, rather than master-slave working.

— LU6.2, which defines a clean interface with higher-level protocols such as DIA and includes advanced functions such as synchronisation.

In effect, these standards have created a new version of SNA that provides peer-to-peer working, inter-program communication, and a layered architecture free of the 'device dependencies' that IBM now admits were included in previous versions of SNA. Together these standards allow an SNA network to operate without either a 37x5 controller or an IBM host computer – in the way that, for instance, Hewlett-Packard and DEC networks operate. The SNA network can now be seen as a system in its own right and not merely as an adjunct of a mainframe computer. Furthermore, the new version of SNA can be used to build very small networks.

SHORTCOMINGS OF THE CABLING SYSTEM AND THE TOKEN RING

The IBM Cabling System and the Token Ring are sound products, but they are unexciting, and they do have some serious shortcomings. The Cabling System is expensive to install. The Token Ring does not support 327x terminals – the IBM terminal with the largest user base – nor does it at present support voice/data integration, though this remains a long-term goal. Each of these shortcomings is worth discussing in more detail.

The Cabling System is expensive to install

The high cost of the Cabling System is due to the expense of the components (which are available from only a few suppliers), to the use of a star topology and to the need for wiring closets.

The use of a star topology requires up to ten times as much cable as a simple ring. Moreover, cable needs to be carried to every desk. Prewiring every desk means that, for example, if the terminal penetration is only 20 per cent, 80 per cent of the cables will not be used.

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Each wiring closet contains a distribution frame and patch cables and may contain other equipment. It is often necessary to find a spare room for each closet, and one closet is typically needed for every 250 desks served.

One of the first organisations to install the Cabling System, Carnegie-Mellon University in Pittsburgh, estimated the cost of equipping 10,500 outlets at between $7 and $8 million – about $700 per outlet. More recently, Standard Oil of Ohio evaluated the Cabling System and found it to be two-and-a-half times more expensive than twisted pairs. As a result, Standard Oil will only use the Cabling System for about 10 per cent of its connections.

The high initial costs of the IBM Cabling System are offset, to some extent, by the relatively low additional costs for moving and adding terminals. But for most organisations this advantage will not justify the high initial outlay.

Figure 6 shows the comparative costs of wiring a hypothetical office block with alternative cable types – IBM Type 1 cable installed in an existing building; IBM Type 1 cable installed in a new building; IBM Type 3 cable installed in an existing building; and the conventional alternative of using ordinary coaxial cable for 3270s together with Ethernet for interconnecting PCs, again in an existing building. The figure shows both the initial installation cost and the total cost over a five-year period of growth and change.

The figure clearly shows the cost advantage of the conventional alternative in these particular circumstances. We believe that this cost advantage will hold in most other cases. Even when the 3270s remain attached to existing coaxial cable until they need to be moved (instead of all being reconnected to the IBM Cabling System when it is installed), the cost advantage of the conventional alternative will still be substantial.

In practice, some organisations will probably decide to replace their 3270s with PCs during the five-year period. Assuming that the 3270s are replaced over three years, Type 3 cable then costs about the same as the conventional coaxial cable/Ethernet alternative over five years, but the other Cabling System options cost more. However, if the replacement programme is combined with a much higher terminal growth rate or a much higher rate of device movements, then the Cabling System may become the cheapest alternative.

These calculations are meant to provide only a general guide to the comparative costs of the various cabling schemes. In practice, the cost of wiring will be affected by considerations such as variations in network topology, availability of ducts, availability of space, and the desired level of decoration. Moreover, we have taken no account in our calculations of the falling cost of electronics.

IBM has suggested that the costs of a wiring scheme should be evaluated over a period of 15 to 30 years. In theory, this is not an unreasonable proposition, but some features of IBM's own Cabling System make such a timescale inappropriate. For instance, Type 3 cable is not recommended for operation above 4M bit/s, whereas IBM envisages higher speeds. And for operation above 16M bit/s, IBM envisages the use of fibre optics, yet there is no fibre-optic station cable in the initial product range.

Figure 6 Comparative costs for various cabling schemes

Cabling scheme	*Initial cost ($'000)*	*Five-year cost ($'000)*
IBM Type 1 installed in an existing building	710	750
IBM Type 1 installed in a new building	420	440
IBM Type 3 installed in an existing building	220	290
Conventional alternative of a combination of coaxial cable and Ethernet installed in an existing building	100	200

The costs are estimated for an office block housing 1,000 people. There are 200 3270s and 50 PCs to start with, both increasing at 15 per cent a year. Moreover, 20 per cent of the devices are moved each year.

The Token Ring does not support 327x terminals

We believe the most important omission in the Token Ring announcement is the lack of support for the IBM terminal with the largest user base – the 327x range – even though support for this type of device is completely feasible technically. (Network Systems Corporation and others have demonstrated this by supporting 327x terminals on their own LANs.) However, for an organisation that has invested in a Cabling System, the benefits of connecting 327xs to the Token Ring would be modest. It would be much more expensive to connect a 327x to the Token Ring than to use the Cabling System directly via a red balun. Also, because the 327x is an unintelligent device, the user would not benefit from all the Token Ring facilities.

IBM will want users to see intelligent devices (based on PCs and their successors) as their future standard workstations. It is therefore quite possible that IBM

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will continue not to support 327x terminals on the Token Ring. This may not matter because other network suppliers are rushing to fill this gap. Ungermann-Bass claims that it is already able to support 3278 screens on the Token Ring.

However, IBM will certainly provide Token Ring interfaces for more of its equipment in the years to come. In particular, we expect support for the System 36, System 38, and the 5520 Administrative System.

The Token Ring does not support voice/data integration

The difficulty of integrating voice and data on the Token Ring LAN as initially announced has serious implications for the timescale used to justify the installation of an IBM Cabling System. A Cabling System installed today may have to be replaced completely in a few years in order to accommodate voice/data integration.

For integration to be achieved, voice and data have to be brought together at several levels. At the most basic (physical) level, a single cable must be able to carry both voice and data, but not simultaneously. At the next level of integration, a single physical connection must be able to carry separate voice and data connections in parallel. Next, there is the need to coordinate independent voice and data calls. Finally, there is the need for functional integration of data transmission with telephone calls and of voice information with data processing transmissions.

IBM has now made several commitments that make it unlikely that voice and data will be integrated fully in the Token Ring LAN in the short to medium term. For example:

— In the United States, IBM recommends Type 2 cable for the Cabling System; this cable has separate twisted pairs for voice and data (see Figure 3).

— IBM's clear intention to produce a Rolm CBX as an IBM product commits IBM to circuit switching for voice products. Data equipment, and intelligent workstations in particular, require the functionality of packet switching for error control and to support multiple concurrent connections.

— The choice of 4M bit/s as the speed for the Token Ring excludes all but a very modest amount of telephone traffic.

As digital voice technology improves, the requirements both for signalling speed and for error rate will converge with those of data. Because data network architectures are more advanced, an architecture for full functional integration must be based on data, rather than voice, principles. In practice, this means using packet technology for voice – a technique that remains expensive. Although a token ring is a reasonable basis for a LAN-PABX hybrid network, 4M bit/s is too low to support many concurrent calls if today's digital voice techniques are used.

It is for these reasons that IBM is unlikely to proceed quickly to full voice/data integration in the Token Ring LAN. But other factors, including the logic of convergence and some aspects of the Token Ring announcement, suggest that this is the direction in which IBM will move in the longer term.

The process of convergence has taken longer than many people expected, but the trend continues. IBM will need to integrate voice and data more fully in order to meet market expectations, to offer users new services such as voice annotation of documents, and to support its own moves into voice networking.

The Token Ring standard contains, in addition to the packet functions used for PC networking, a 'synchronous mode' that provides priority communications with the short delays necessary for telephony. This mode might be used to overcome some of the difficulties of mixing data and voice operation in a single network. Another way of approaching voice/data integration would be to use signalling at 16M bit/s (which IBM has indicated will be available in the future), or the even higher speeds made possible by the fibre optics that eventually will be available for the IBM Cabling System.

With the exception of a few highly specialised computer-room applications, we can see no real reason for IBM to make these higher transmission rates available, unless it expects the Token Ring LAN to carry large volumes of voice traffic.

All this has serious implications for the planning periods used to justify the installation of an IBM Cabling System. Unshielded (Type 3) cable is not suitable for use above 4M bit/s. Migration to a voice/data integrated LAN based on 16M bit/s signalling (and the need for such a move could appear within five years) would therefore require the complete replacement of Type 3 cabling. Similarly, a move to fibre optics for signalling at the even higher speeds that might be required within ten years would require the replacement of any of the cable types available today.

The alternative to the wholesale replacement of cables would be to retain separate voice and data networks – probably for the indefinite future.

THE CABLING SYSTEM, TOKEN RING, AND APPC ARE STRATEGIC PRODUCTS

Despite their shortcomings, these three products, taken together, are strategic both from IBM's point

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of view and from the point of view of user organisations. The individual product standards have been designed to make it easy to enhance and extend the products. But more importantly, the individual standards form a family that defines a new architecture that neither possesses nor requires a central computer. Furthermore, the standards themselves are open to adoption by others, and they are able to support a very wide range of applications. As a result, they will promote competition from a wide variety of suppliers.

The combination of new architecture and open standards will eventually result in a marketplace where user organisations will have a much wider choice of equipment and suppliers. We discuss the strategic implications of the products in more detail in this final section.

The products will be enhanced

The LAN products embody a coherent set of standards that have been designed to make it easy to extend and enhance the products. Each of the standards has been designed to have a very wide range of application, though at the price of considerable cost and complication. Enhancement can occur in several ways:

—The Cabling System has extensive spare bandwidth and uses a topology that would be very appropriate for fibre optics.

—The token-passing principle maintains its value when transferred to rings with much higher operating speeds, even under heavy load. This provides the capacity needed for image and voice transmission.

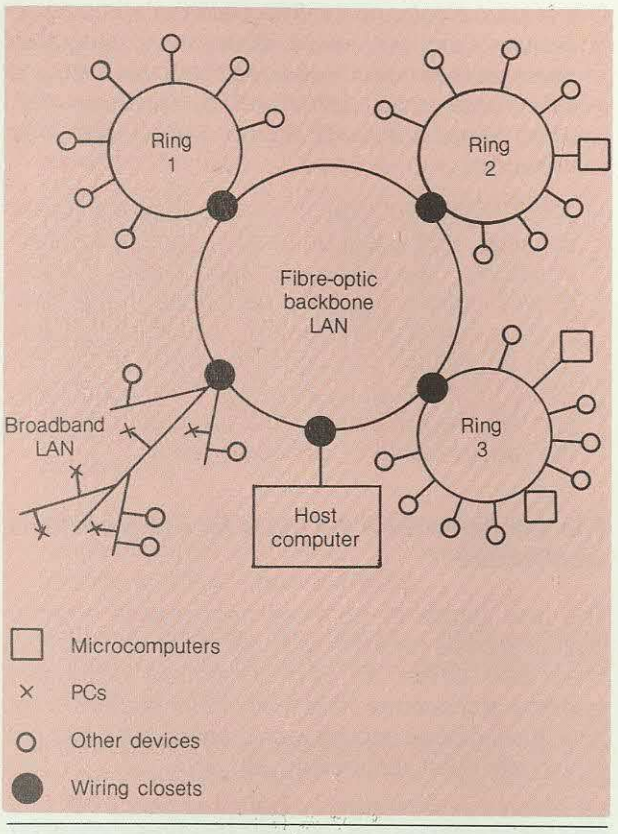
—Interconnected LANs are envisaged by IBM, with a fibre-optic ring as the backbone, and 'local' (possibly departmental) LANs usually operating at 4M bit/s (see Figure 7). LANs other than rings, including the broadband PC Network and Industrial LAN, could also be attached to the backbone LAN.

—APPC is part of a layered architecture and has cleaner interfaces with the higher layers of the network architecture than earlier versions of SNA. It therefore allows new services using APPC facilities to be added.

The new standards provide more functionality than previous versions of SNA

The new set of standards addresses many of the problems that SNA was supposed to solve ten years ago. It also addresses the wiring problem. It is likely to be more successful than earlier versions of SNA because it builds on better basic knowledge, some of it gleaned from the more dubious areas of SNA itself.

Figure 7 Interconnected LAN architecture envisaged by IBM



The set of standards is firmly based on the use of intelligent devices. Dumb devices can be supported on the Cabling System but cannot participate in the Token Ring APPC communications regime. The Token Ring provides the speed that intelligent devices need to exchange data and to coordinate their work. It also allows one device to address several others without separate connections. APPC allows applications to manage several concurrent connections – a file server, for example, supporting several PCs, or a PC accessing CICS and DISOSS on different hosts. APPC also contains synchronisation functions that could be used to maintain the integrity of a genuine distributed database. LU6.2 has already been used to integrate data, text, and images in the Scanmaster product, the IBM scanner that captures images for DISOSS. This points the way to LU6.2's use for further integration in the future.

The new standards will also be implemented on long-established products, including cluster controllers. But the set of standards is more important for the additional functions it can support. By way of illustration, and in the absence of any private information from IBM, here are two enhanced products that IBM might introduce: 'SuperDisplayWriter' and 'PC Data Workstation'.

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—The SuperDisplayWriter product would be a package for a future PC. It would allow authors to mix text, tables, graphics, and images to produce integrated documents. The package's communications functions would allow these integrated documents to be retrieved, modified, and filed, and to be received and despatched by electronic mail, using either corporate SNA or public wide area networks.

—The PC Data Workstation would also be a software package, and would be used in conjunction with structured data processing applications. It would allow functions currently performed in the host, such as screen management, data validation, and user assistance functions, to be run in the PC. Paper forms could be emulated more accurately, and the presentation of data could be tailored to the requirements of individual users.

The standards form the basis for a new systems architecture

The new standards do more than provide a better technical basis for existing styles of communication. They also define an SNA-compatible distributed systems architecture. This kind of architecture is not new, having been implicit in micronets, but it has not previously been reconciled with SNA.

Micronets have come into use because they allow sharing of expensive peripherals (such as discs and printers) and specialised processors (such as SNA gateways). This sharing is achieved by dedicating particular PCs to specific tasks, thereby distributing the responsibilities for specific functions throughout the LAN. Dividing the responsibilities in this way can be seen as a new architecture in which functions are divided between intelligent workstations, print servers, file servers, network bridges, and gateways (see Figure 8).

This new type of systems architecture has several distinctive advantages:

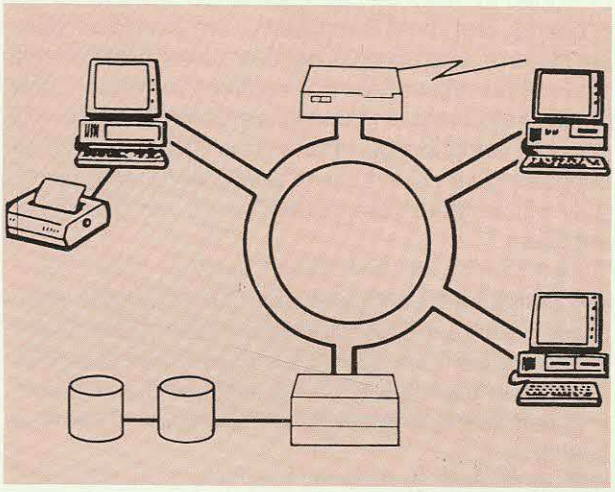
—It is modular. The system will continue to work if some of the units are not operational, and the faulty units can easily be replaced.

—It is flexible. The number of stations may easily be increased or decreased. Furthermore, because extra processing power is added with each new workstation, addition of stations should have little effect on response times.

—Locating intelligence in the workstation is especially appropriate for the graphics and document-management facilities that are a central part of modern office systems.

These advantages have already been demonstrated on specially designed systems such as the Apollo Domain and Xerox Network System (XNS). As yet, they have been only partially realised for PCs because of the lack of processing power (and especially because of the lack of multiprogramming capability) in the computers and because of the primitive nature of the workstation/server protocols. The lack of power has been cured by the 16-bit and 32-bit chips now in use, and LU6.2 provides an IBM standard for more sophisticated intercomputer communications.

Figure 8 New LAN-based architecture



Functions in the architecture will be divided between different, specialised, devices.

Significantly, the new architecture neither possesses nor requires a central computer. In the past, central shared computers have been installed to provide sufficient processing power, large-scale filing, co-ordination of work, and compatibility with previously installed computers. The need for such provision has now been reduced because:

—Single-chip processors now have the power of yesterday's minicomputers.

—Filing can be provided by a file server.

—Although coordination is still difficult, the synchronisation functions of LU6.2 provide a suitable technical base.

—Compatibility with previously installed computers is still important, but the availability of personal versions of popular minicomputers, such as IBM's System 36, DEC's Vax, and the HP3000, makes it unnecessary to provide this through a central shared computer.

We are uncertain about the pace of migration to this new architecture. IBM is committed to the System 36 as a departmental computer, and in order to justify the System 36 will try to restrict the functionality of LU6.2 to a lower level than is strictly necessary.

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The new standards will transform the systems marketplace

Other suppliers will have to adopt the new standards in order to compete with IBM. This will make the IT market more competitive. But, because the new standards are sophisticated and open-ended, they will allow competition for the functions currently reserved for 'departmental computers'. In this way the whole market for the supply of corporate IT products will be transformed over time and will come to resemble a commodity market. This means that user organisations will have a much wider choice of off-the-shelf products that all operate to a common standard.

Some suppliers have already recognised the importance of the new standards – Ungermann-Bass, Excelan, Nestar, and 3Com have all announced support for the Token Ring. There has also been considerable interest in LU6.2. In the United States, seven companies are offering LU6.2 consultancy and implementation support for suppliers other than IBM.

It is possible, and indeed quite common, for suppliers to implement standards in such a way as to make direct interworking impossible. This is unlikely to happen for the new IBM standards because workstation suppliers will want their products to be able to access IBM hosts, and the suppliers of IBM-compatible hosts will want IBM PCs to be able to use their services.

There is a recent precedent for suppliers adopting an alien standard in their 'office' products. Xerox promoted Ethernet as a standard but also published details of the higher-level protocols in the XNS architecture. Other suppliers adopted these protocols in order to be able to use the Xerox Print Server. As a result, there are now many Ethernets running under XNS protocols that contain no Xerox components at all.

We expect a wide variety of suppliers to support the new IBM standards, which will form a firm base that will allow considerable scope for innovation. Some of the innovations we expect to see include:

—Specialised workstations: In the future, we expect to see Token-Ring-compatible workstations with CAD and full-motion video capabilities (but using a separate network for video).

—Filing and database machines: File servers are widely available, and many of the existing products will be re-engineered for use with the Token Ring. Most existing file servers are very limited in function because of the need to remain compatible with the original single-user, single-tasking PC operating systems. But the higher standard set by LU6.2 will allow specialised database machines to be used with LANs. At least three distinct kinds of machine will emerge. The first is the file archive, providing filing, retrieval, and security for complete files, normally using a mixture of storage media. The second is the document archive, providing filing and retrieval of mixed-mode documents. Associative retrieval might be provided, as in ICL's Content Addressable Filestore (CAFS). The third distinct kind of machine to emerge will be the relational database machine, as pioneered by Britton-Lee. It will provide access to and allow manipulation of large, shared, structured databases.

—Print servers: Print servers will be available for a range of printer and plotter technologies and for various levels of paper handling.

—Network bridges: Specialised communications processors will provide interworking with LU6.2 devices on other networks.

The great benefit of established standards is that they allow competition to flourish. The ASCII-asynchronous and 3270 standards led to competitive markets for terminals and terminal clusters. Similarly, the IBM PC set a standard that other suppliers have been obliged to meet. As a result, the PC user is presented with a wide range of PCs, software, and add-on boards, all working to an IBM standard.

Increasing competition leads to prices being reduced, often quite sharply. For example, ASCII terminals (other than home computers) are now available for as little as $450. And towards the end of 1985, Alltek Computers of Taiwan announced an XT-compatible microcomputer for just $850.

The pressure to reduce PC and LAN costs is likely to lead to domination of the market by low-cost manufacturers based in Taiwan, Korea, and Hong Kong. In turn, this will leave IBM casting about for market segments that can be made to yield the handsome returns that it expects. With plug-compatible manufacturers competing across almost all of IBM's product range, it is far from clear what these market segments will be.

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THE BUTLER COX FOUNDATION

Butler Cox & Partners

Butler Cox is an independent management consultancy and research organisation, specialising in the application of information technology within commerce, government and industry. The company offers a wide range of services both to suppliers and users of this technology. The Butler Cox Foundation is a service operated by Butler Cox on behalf of subscribing members.

Objectives of the Foundation

The Butler Cox Foundation sets out to study on behalf of subscribing members the opportunities and possible threats arising from developments in the field of information systems.

New developments in technology offer exciting opportunities — and also pose certain threats — for all organisations, whether in industry, commerce or government. New types of systems, combining computers, telecommunications and automated office equipment, are becoming not only possible, but also economically feasible.

As a result, any manager who is responsible for introducing new systems is confronted with the crucial question of how best to fit these elements together in ways that are effective, practical and economic.

While the equipment is becoming cheaper, the reverse is true of people — and this applies both to the people who design systems and those who make use of them. At the same time, human considerations become even more important as people's attitudes towards their working environment change.

These developments raise new questions for the manager of the information systems function as he seeks to determine and achieve the best economic mix from this technology.

Membership of the Foundation

The majority of organisations participating in the Butler Cox Foundation are large organisations seeking to exploit to the full the most recent developments in information systems technology. An important minority of the membership is formed by suppliers of the technology. The membership is international with participants from Australia, Belgium, France, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom and elsewhere.

The Foundation Research Programme

The research programme is planned jointly by Butler Cox and by the member organisations. Each year Butler Cox draws up a short-list of topics that reflects the Foundation's view of the important issues in information systems technology and its application. Member organisations rank the topics according to their own requirements and as a result of this process members' preferences are determined.

Before each research project starts there is a further opportunity for members to influence the direction of the research. A detailed description of the project defining its scope and the issues to be addressed is sent to all members for comment.

The Report Series

The Foundation publishes six reports each year. The reports are intended to be read primarily by senior and middle managers who are concerned with the planning of information systems. They are, however, written in a style that makes them suitable to be read both by line managers and functional managers. The reports concentrate on defining key management issues and on offering advice and guidance on how and when to address those issues.

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Butler Cox & Partners Limited
Butler Cox House, 12 Bloomsbury Square,
London WC1A 2LL, England
☎ + 44 1 831 0101, Telex 8813717 BUTCOX G

France
Butler Cox SARL
Tour Akzo, 164 Rue Ambroise Croizat,
93204 St Denis-Cedex 1, France
☎ (1) 4820.61.64, Telecopieur (1) 48.20.72.58

The Netherlands
Butler Cox BV
Burg Hogguerstraat 791
1064 EB Amsterdam
☎ (20) 139955, Telex 12289

United States of America
Butler Cox Inc.
115 East 57th Street, New York, NY 10022, USA
☎ (212) 486 1760

Australia
Mr John Cooper
Business House Systems Australia
Level 28, 20 Bond Street, Sydney, NSW 2000
☎ (02) 237 3232, Telex 22246

Italy
SISDO BDA
20123 Milano – Via Caradosso 7 – Italy
☎ 498 4651, Telex SISBDA 350309

The Nordic Region
Statskonsult AB
Stortorget 9, S-21122 Malmo, Sweden
☎ 46-401 03 040, Telex 127 54 SINTAB