Integrated Networks

BUTLER COX
FOUNDATION

Research Report 54, October 1986

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Summary of research findings

This report focuses on the integration of different types of information within telecommunications networks.

So far, the willingness of user organisations to adopt integration has not matched the suppliers' aspirations to provide products. Indeed, network integration today is largely limited to using wide-band circuits for separate voice and data channels. However, there is a major new factor that may well provide the impetus for integration, and that is the impending introduction of ISDN (integrated services digital network) technology. Most European PTTs now have firm plans to introduce ISDN services (these are reviewed in Chapter 2), and Foundation members must take these into account when planning their own corporate communications policies. Moreover, some organisations will use ISDN technology in their own private networks.

Most of the material published about ISDN has concentrated on the technology and the public services that will be available. Very little thought has been given to how ISDN will actually be exploited by corporate telecommunications managers. User organisations must now begin to force this issue. If they do not, there is a danger that public ISDN will develop along paths not in the best interests of user organisations. There is still time to influence the way in which public ISDN services will develop, and Foundation members should make their voices heard on standards issues, on tariffs, on the arrangements for continuing existing telecommunications services and migrating to the new ones, and on the availability of products that can be connected to the public ISDN.

We believe that public ISDN will have three major impacts on corporate communications:

— It will reduce the cost of inter-site data communications.

— It will weaken the economic and technical justification for using private networks.

— It will enable a wider range of people and businesses to use data communications facilities.

These impacts will not be felt immediately, however, because it will be several years before national ISDNs provide nationwide coverage and a reasonable range of services. International ISDN links will take longer still. It will therefore be some time before the public ISDN can meet all (or even most) of an organisation's communications needs, so Foundation members need to be aware of the PTTs' plans for ISDN, and to interpret them in the light of their own communications requirements. The public ISDN will provide a range of services and facilities, and organisations will need to select those that are most appropriate for their needs and then plan how to make the best use of them as they become available.

There are two fundamentally different aspects of corporate network integration — local area and wide area. Each should be considered separately, and different timescales will apply. Wide-area integration is feasible today, but local-area integration should be approached with a great deal of caution.

Unless there is a specific applications requirement, we advise Foundation members to defer attempts to integrate their on-site systems. There are too many uncertainties at present, mainly because the different elements of on-site integration (the local network, workstations, and integrated office systems) are developing separately and rapidly. Chapter 4 describes the main developments, particularly in cabling systems, in data-switching products, in PABXs, and in integrated workstations.

The report provides guidelines for planning on-site networks, so that Foundation members will be best positioned to take advantage of on-site integration when it becomes feasible:

— Organisations about to select a new PABX should not be seduced by the suppliers' claims to provide integrated switching devices. They should select the PABX for its voice features, not for its data features.

— Organisations planning the local communications facilities for a new 'greenfield' site should install an ISPBX (integrated services PABX), together with separate wiring (shielded twisted pairs or a local area network) for non-voice communications. They should also consider using integrated switching in specific circumstances.

- Organisations that have already installed an analogue or second-generation PABX should use separate wiring for non-voice communications unless it is impossible (or extremely expensive) to install separate cables, in which case they could use data-over-voice techniques for transmitting data and voice signals over the telephone wiring. They should not consider integrated switching at the present time.
- Organisations that have already installed third- or fourth-generation PABXs should consider upgrading to digital feature phones that allow a data teminal to be plugged into the telephone, thereby providing on-site ISDN facilities.

Wide-area integration should be based on a 'virtual-network' approach that allows a mixture both of network technologies and of private and public facilities. We have identified three technical options for wide-area integration, each of which is discussed in Chapter 3:

- To keep corporate voice and non-voice networks distinct for the foreseeable future. For many organisations, this is the only practical option, because they have recently made considerable investments in corporate network facilities.
- To develop a private integrated network (sometimes referred to as a 'private ISDN').
- To use the public ISDN in conjunction with private network facilities. For example, the public ISDN could be used to provide integrated network facilities to the organisation's smaller sites.

Irrespective of the technologies used for local- or wide-area integration, the key to exploiting integrated networks is to establish an integrated communications management function. Those organisations that have not already done so should act immediately to bring the responsibilities for voice and non-voice communications under a unified management structure.

RESEARCH METHOD

This report was researched and written by consultants from Butler Cox's telecommunications consultancy practice. Significant contributions were made by Roger Camrass, Director of Telecommunications Studies, Ian Dewis, Associate Director of Telecommunications Studies, David Flint, the Foundation's Research Manager, Eirwen Nichols, and Edward Vulliamy.

The research team drew heavily on practical experience gained from a wide variety of telecommunications consultancy assignments for many different kinds of organisations. Their knowledge was supplemented by discussions with telecommunications managers, with equipment suppliers, and with PTTs.

Chapter 1
Preparing to exploit integrated networks

For the past ten years it has been technically possible to integrate the different forms of information (voice, data, text, image, and video). However, integrated products and services are not yet in common use, although we believe that this situation will change considerably in the next five years. The PTTs are preparing to launch new 'integrated' public network services (the ISDN — integrated services digital network), and equipment suppliers are producing a bewildering array of 'integrated' products.

In order to exploit the opportunities provided by integration and integrated networks, Foundation members must first understand what is meant by 'integration'. It is also necessary to understand the forces that are helping to shape the market for integrated products and services, the potential benefits that integration can provide, and the problems associated with integration. Finally, Foundation members must ensure that their approach to managing telecommunications is appropriate for integrated communications.

These are the issues that we explore in this first chapter of the report.

THE MEANING OF INTEGRATION

The word 'integration' is used loosely in telecommunications today to mean the combining of different forms of information — voice, data, text, image, and video — into a single, usually digital, system. At the simplest level, integrated systems can comprise nothing more than data and voice being transmitted over different twisted pairs within the same cable sheath. Or it can mean the ability to prepare an 'integrated' document using all the different forms of information.

The term 'integrated products' is used, especially by suppliers, to describe a wide variety of quite different devices. At one extreme, data-over-voice systems, such as the Case Grapevine, integrate data and voice by allowing data to be carried over PABX wiring concurrently with telephony. At the other extreme, advanced office systems like the Wang Alliance and ITL IMP allow the user to employ word processing, electronic mail, and voicegram services from a single workstation. The Datapoint Minx even integrates videoconferencing as well.

'Integration' is also used to describe combining different streams of the same form of information, for example to allow access to a variety of data applications from the same terminal. This type of integration can be difficult because of the different characteristics of applications and the lack of appropriate standards. Developments in data network architectures such as DECnet and SNA, and the ISO open systems interconnection model, are addressing the standards issues associated with integrating data applications, although these developments have not yet embraced the integration of voice communications. (Many of the relevant issues were discussed in Foundation Report 46 — Network Architectures for Interconnecting Systems.) The integration of different data applications is not addressed in this report; instead, we concentrate on the many issues raised by integrating different forms of information, in particular the integration of voice communications with the other forms.

The integration of text and data is the most common and technically the easiest type of integration. The same terminals may be used, and the loads on the network are similar. Data and text are integrated in personal computer packages such as Lotus 1-2-3 and in some office automation systems, and therefore, the networks used to connect these systems are themselves integrated.

Facsimile (which is a form of image communications) may be carried over telephony systems, though without integration with voice. Images are now supported by advanced personal computers, such as the Macintosh, by specialised publishing systems, and by some office systems. In these cases the images are integrated with text handling for document production. Hence, again, the networks that link these systems are integrated networks.

Voice annotation of text documents is another form of integration. In this report we use the term 'voice annotation' to mean the addition of a stored voice message that can be retrieved for audio playback as the document is read from a screen. It does not mean the ability to create or amend a document by voice input that is then converted automatically to text.

Voice communication poses the greatest difficulty to the would-be integrator because its technical characteristics are so distinctive. Voice integration has proceeded almost independently on three fronts:

- PABXs and the public telephone network, designed for voice, may be used to carry and switch other forms of information.
- Voice may be included in systems, notably office systems, whose main information forms are text and data.
- Workstations may physically combine the functions of a telephone and a data terminal.

We have identified two main types of integration, which we call network integration and workstation integration. Within both types there is a wide range of complexity, as we describe below.

NETWORK INTEGRATION

Network integration means the sharing of communications facilities by more than one form of information. It need not imply interaction between the different forms, and it is invisible to the end user. The most common examples today of network integration are the sharing of bandwidth on leased circuits by voice and data (with separate channels assigned to each form) and the sharing of local telephone wiring by voice and data using data-over-voice techniques.

An example of the lowest level of network integration is provided by the IBM Cabling System (described in David Flint's paper, The Significance of the IBM Token Ring, which was distributed to Foundation members in May 1986; it is also described briefly on page 27 in this report). In IBM Type 2 cable, separate voice and data wires are bound within the same sheath, though only the data wires are shielded. Another example of low-level network integration is the data-over-voice systems that use the same wires for otherwise independent voice and data transmissions (they are separated by frequency). Network integration is also provided by integrated PABXs and (in the future) by the ISDN, where a single signalling system is used to control channels that may be separately allocated to voice, data, text and image. All the channels use a common switching mechanism, however.

A higher level of network integration is provided when several forms of information are supported by a single network or by a transport service. For example, NEC's Nedix 510F private packet-switching system integrates voice with other forms at this level. The highest level of network integration currently available is provided by integrated office systems such as the Wang Alliance in which data, text and voice may all be included in a single composite document.

The different types of network integration correspond with the different layers of the OSI reference model, as shown in Figure 1.1. For example, data-over-voice systems provide integration only at layer 0 (the transmission medium) because the medium is shared by voice and data communications, but the two types of traffic use completely different signalling methods. To be integrated at layer 1 (which defines signalling methods), voice and data would need to use the same signalling method. ISDN will therefore provide integration at layer 1, but not at layer 2 (the data link layer). Data transmission usually requires a conventional data link protocol to handle error detection and control, whereas voice signals (unless they are packetised) do not require any further error control.

(Strictly speaking, the services aspects of ISDN, in particular the teleservices, may in the longer term provide integration at layers 4 to 7 of the OSI model. It is the physical network, the IDN — integrated digital network — that provides integration at layer 1. ISDN is, in effect, the IDN plus services provided on the IDN.)

Figure 1.1 Types of network integration compared with OSI layers

	Example of integration				
		Information forms integrated			
			Non-voice		
OSI layer	*Product or service*	*Voice*	*Image*	*Text*	*Data*
7 Application	Wang Alliance	Stored		✓	✓
6 Presentation					
5 Session					
4 Transport	Xerox Ethernet AppleTalk		✓	✓	✓
3 Network	X.25	Sometimes	✓	✓	✓
2 Data link					
1 Physical	ISDN bearer service	✓		✓	
0 Medium	Data-over-voice	✓		✓	

WORKSTATION INTEGRATION

Workstation integration occurs where several forms of information can be handled from the same workstation. This type of integration does not necessarily imply that the different forms are commonly controlled. Examples of workstation integration include a personal computer that is capable of handling data and word processing locally, and a device (such as ICL's One Per Desk, which is discussed further in Chapter 4) that can carry out both voice and data functions.

As with network integration, workstation integration exists in different degrees. Thus, early integrated workstations did little more than package a telephone and a data terminal in one unit, but with separate telephone lines for voice and data communications. More recent integrated workstations have exploited local processing power to assist the telephone user, mainly by dialling numbers from a directory. One product can even automatically dial the number of the sender of an electronic message that has just been received. The most advanced products, such as the Wang Alliance, combine data and voice in a single data stream that is interpreted dynamically by the workstation.

MARKET FORCES

The major impetus for integration to date has come from the suppliers and communications carriers. There is little user pressure at present because the user community is not yet convinced that integrated technology brings many benefits at a price it is prepared to pay. In our opinion, this situation will change, and by the end of the decade, user pressure for integrated products and services will have become a significant force in shaping integration developments. Indeed, we believe the time has now come for user organisations to play a more active role in the definition of public facilities (particularly ISDN) and standards.

THE IMPETUS FOR INTEGRATION

Suppliers and communications carriers are promoting integration for two reasons. First, the application of digital technology has made it possible to handle all information forms in the same basic way. Semiconductor prices have fallen dramatically, and are still declining, so that digital products are now often cheaper than their analogue counterparts. Furthermore, the use of digital technology results in products that are faster and more reliable than their analogue and electromechanical equivalents. Integration is the natural result of this technological drive, as it allows manufacturers to diversify into new markets. For example, traditional telephony suppliers are now able to move into the office systems market.

Second, deregulation has opened up potentially vast new markets for the equipment suppliers and has allowed the PTTs to sell their services and products in markets that were previously closed to them. The PTTs have therefore become more responsive to market opportunities, even in those countries where a communications monopoly still exists. In those countries, such as the United Kingdom, where deregulation has created a competitive environment, this has been necessary to protect their position. And in those countries where there is still a communications monopoly, the PTTs are fighting to keep deregulation at bay.

As a result, the telecommunications market is in a state of flux as traditional market divisions are broken down and suppliers and carriers seek to establish themselves in profitable market niches. For the carriers this has highlighted the need to provide new services and has added greater urgency to the development of the ISDN. (The PTTs' plans for ISDN are described in Chapter 2.) For the suppliers it has led to mergers of, and collaborations between, telecommunications and data processing companies to give them the skills needed to exploit wider markets, encompassing voice, data, text, and image systems. IBM/Rolm, AT&T/Olivetti, Wang/Intecom and STC/ICL are typical examples of such arrangements.

USERS ARE NOT CONVINCED OF THE BENEFITS OF INTEGRATED SYSTEMS

Organisational inertia has led to the continued existence of separate telecommunications and data processing departments in many organisations, resulting in the lack of an overall strategy for corporate communications. In turn, this has made it difficult for the manufacturers to market integrated products and has hindered the introduction of integrated networks. Even where the telecommunications regulatory environment permits it, shared use of cabling in a building, or of leased circuits, is difficult to achieve without an integrated approach to telecommunications management. One organisation that we know of has separate 2M bit/s wideband digital circuits for voice and data between the same geographic locations, each with spare capacity, because it has separate voice and data communications departments with separate budgets.

Even in an organisation with a combined

department, integrated networks have not always been selected, and this lack of market acceptance has been a major factor inhibiting the development of integrated products. We know of several organisations that prefer to keep their voice and data networks separate despite the savings that could be made by using an integrated network. They argue that telephony, or data communications, is so important to the organisation that they cannot afford the risk of degrading the service.

In general, however, organisations have been unwilling to make commitments to integrated systems because of their high costs and their novelty. They have been prepared to install integrated systems only where they offer clear, usually financial, benefits. As a result, integrated networks are largely restricted to the United States and the United Kingdom, where the regulatory environment is more liberal, and their principal purpose has been to reduce the costs of inter-site communications.

Where there is user pressure for integration it usually arises from a clearly identified benefit or a specific application requirement. In the United Kingdom, for example, the tariffs for 2M bit/s digital circuits are such that organisations with a requirement for more than approximately 16 voice circuits between two sites can lease 2M bit/s circuits and use the spare capacity for data, effectively at no extra cost. This situation has led to a demand for multiplexors that can interleave data and voice channels on the same wideband circuit. Similarly, application requirements in the financial business sector have led to the development of specialist workstations such as dealer boards, which incorporate voice and data facilities.

USERS SHOULD PARTICIPATE IN INTEGRATION DEVELOPMENTS

User participation in the definition and development of integrated products and services has so far been minimal. This is a dangerous situation because it could lead PTTs and suppliers to invest in services and products that are not attractive to users. Developments such as public ISDN have tremendous potential, but they will not gain the necessary rapid user acceptance if, for example, ISDN tariffs are too high compared to the tariffs for existing services, or if standards are defined in such a way that the potential market will not be large enough to enable manufacturers to produce the necessary equipment at an attractive price.

ISDN is being promoted by the PTTs as a telecommunications service that will bring many benefits to user organisations. However, unless users make their views known, it is likely that the ISDN will develop along the path most beneficial to the PTTs, who are keen to protect and increase their revenue base. Organisations such as INTUG (International Telecommunications User Group) and the ICC (International Chamber of Commerce) are already making the users' voice heard. We believe Foundation members should use organisations like these to make their views known, particularly in the areas of:

- Number of options. Many previous communications standards (V.24, X.25 and the IEEE local area network standards, for example) have been less useful than they should have been because they include an excessive number of options. ISDN standards could easily suffer from the same drawback.
- National ISDN tariffs and services, which are still at an early stage of development.
- Arrangements for the continuation of existing services such as public data networks and leased circuits. Many users find leased circuits technically and economically preferable. They are concerned that these facilities may be withdrawn by the PTTs when ISDN is introduced, leaving them with no choice but to use switched services, whose tariffs are volume-dependent. In West Germany for example, the Bundespost's tariffs and policies appear to discourage the use of private networks.
- Availability of products with suitable interfaces at the same time as national ISDN services become available. Many suppliers have stated their intention to support ISDN but will not commit themselves to product development until the relevant ISDN standards have been finalised. User organisations should therefore press for standards to be defined well before the public ISDN becomes available. In the absence of fully defined standards, suppliers will make minimal modifications to their existing products to support ISDN, rather than design new ISDN products. This approach may result in products that cannot use many of the facilities of the service, that may not be fully compatible, or that may quickly become obsolete.

Participation in international standards development is a time-consuming and intellectually demanding task. Participants are usually from supplier organisations, and they often devote much of their time to this activity. It is very difficult for representatives of user organisations to make such a commitment, but user participation in standards development is vital if the standards are to be successful. For example, in the 1960s the Pentagon's involvement resulted in the definition of Cobol, and, more recently, General Motors has successfully promoted MAP as a standard for data communications in the manufacturing industry.

We believe that user pressure for integrated products and services will grow, and that a major factor in this growth will be the advent of the ISDN. Users will need products to access the ISDN, and the existence of the network itself will stimulate the development of new services, many of which could offer functional integration of several forms of information. Organisations that choose to implement a private ISDN will also want to use such services.

However, the rate at which users will embrace integration depends on the benefits that integration can provide as well as the rate at which suppliers and carriers announce suitable products and services.

BENEFITS OF INTEGRATION

Integrated networks will not provide universal benefits. Different organisations will benefit in different ways, depending on their communications requirements and the telecommunications environment in which they operate. In particular, the benefits will depend on the types and forms of information carried by the network and the degree of complexity necessary to achieve the required level of integration. Although integration may be technically attractive, it is important to consider the benefits it can bring to the business.

In later chapters we highlight the specific advantages and disadvantages of various integrated solutions. First, though, we discuss the general benefits of the two main types of integration.

BENEFITS OF NETWORK INTEGRATION

The main benefits of network integration are in the cost and operational areas. For example, telephone wiring within a building can be used to support both voice and data traffic, thus saving the cost of installing a separate cabling system and reducing the costs associated with relocating computer terminals.

In wide-area private networks, significant savings can be made, particularly in the United Kingdom, by using 2M bit/s digital circuits for voice and data. In the future, ISDN access is likely to provide economies of scale at sites that now have separate access to a range of voice and data networks and services.

Operationally, network integration provides several benefits, although those most commonly quoted (improved end-to-end performance, for example) are the result of digital technology, not integration. Integration at the network level, however, can result in a network that is easier to manage and control than several discrete networks. This benefit is a consequence of the size of the network, because a large network makes it easier to justify the cost of good network management tools and to adopt a coordinated network management approach. The need for effective network management is often overlooked, but it is becoming increasingly important as organisations become more dependent on their corporate communications networks.

A characteristic disadvantage of network integration is that the use of a smaller number of intersite links, each with greater capacity, makes the network more vulnerable to failures in the links. For example, if several low-speed lines are replaced by one 2M bit/s circuit that is used for all voice and data transmissions, the loss of that circuit will isolate the site from the rest of the organisation.

The business benefits of network integration come from the flexibility provided by an integrated approach. Today's rapidly changing technological and business environments make it difficult to anticipate future networking needs. Network equipment being installed today, particularly local cabling networks, will probably be in use for ten years or more, which is longer than the lifetime of many of the systems that will use the network, and longer than many business-planning horizons. An integrated network provides the flexibility to cope with the uncertainties ahead and also to respond quickly when new business needs arise.

There is, however, a potential disadvantage that may nullify the benefit of flexibility provided by network integration. To take full advantage of the higher levels of integration that will be provided by the ISDN will mean allowing the PTT more influence in an organisation's on-site networks.

BENEFITS OF WORKSTATION INTEGRATION

The main benefit of workstation integration is that it allows the user to access different forms of information (telephony, database access, personal computer functions, etc.) from one device. Generally, an integrated workstation will take up less desk space than separate devices. Examples of enhanced telephony facilities that can be provided by integrated workstations include a screen-based directory and screen-based dialling.

At present, most integrated workstations do not provide any functional integration between the different forms of information that can be accessed. Full functional integration, where the different forms of information can be used interchangeably in the same 'document', will require integrated workstations, however. Because of its embryonic state, it is difficult to be sure what benefits will result from functional integration.

PROBLEMS OF INTEGRATION

Several significant problems are inhibiting the move towards integration. Integration is technically difficult, which means that highly integrated products are complex and expensive. The lack of accepted standards is also inflating the price of integrated products. Moreover, suppliers have not yet produced integrated products that are acceptable in the marketplace, and the lack of suitable products is, to some extent, caused by the European telecommunications regulatory environment.

INTEGRATION IS TECHNICALLY DIFFICULT

The different information forms have very different communications characteristics, particularly with regard to transmission rates, 'burstyness' (as measured by the peak transmission rate compared with the average rate), and permissible error rates. These differences are shown in Figure 1.2.

It is technically difficult to construct a system that meets all these requirements in a cost-effective way. It is also impossible to integrate all the different information forms without providing excessive speed for everything except video, and lower error rates than are needed by the non-data forms (which currently dominate the traffic). The two most significant areas of technical difficulty are switching problems, and problems with transmission delay and error control.

Figure 1.2 Communications characteristics of the various forms of information

Information form	*Typical peak transmission rate (k bit/s)*	*Typical burstyness (peak/avg. ratio)*	*Permissible error rate*
Full-motion video	2,000 to 92,000	1	High
Speech	64	1.2	Moderate
Image (fax)	4.8	1	Moderate
Timesharing terminal traffic	2.4	100	Low
Transaction processing terminal traffic	2.4	200	Very low
Graphics terminal traffic	200	1,000	Low
PC resource sharing	500	300	Very low

Switching problems

In speech systems, the switch must provide a connection to another person or perhaps to a machine acting as a proxy for a person. Conversations are maintained for a few minutes, making a delay of a few seconds in completing the call quite acceptable. By contrast, an advanced workstation may need to interact with several processes, possibly located at several computers, and may need to switch between them many times per second. Some switching requirements are best met by packet switching, others by circuit switching. Switching systems combining the two techniques (the integrated packet/circuit-switch from Tran, for example) have been developed, but they are very complex.

Transmission-delay and error-control problems

In person-to-person oral communication, the human brain is intolerant of delays, and any delays that do exist must be constant. This means that transmission delays must normally be kept to a minimum. By contrast, image communications applications can tolerate much longer transmission delays. The delays that can be tolerated by data applications differ greatly, but in almost all cases it is preferable to delay the transmission to ensure data accuracy. Many data applications can tolerate variable delays caused by retransmitting data found to have been incorrectly transmitted. It is possible to build integrated systems that can cope with these different requirements, but the solutions tend to be expensive, or complex, or both.

INTEGRATED PRODUCTS ARE EXPENSIVE

Network integration products are more expensive to purchase than products for separate purposes. For example:

- Specialised mixed-media cabling schemes are more expensive than conventional voice cabling.
- Data-over-voice units are more expensive than short-distance modems dedicated entirely to data.
- Wideband multiplexors providing individual voice and data ports are more expensive than terminating the main bearer circuit on a PABX.

However, an integrated approach may be less expensive when the total costs of installing and maintaining, or leasing, the physical lines are considered. Thus, it may be cheaper to install a data-over-voice link, or to use the data-support features of a PABX, than to install new cables for the data equipment.

Similarly, it may be cheaper, and in some countries much cheaper, to dedicate to data transmission a few 64k bit/s channels from a 2M bit/s circuit (if the circuit is already required for telephony) than to lease separate lines for data. The savings, and the ability to reconfigure the links to deal with line failures, may be high enough to justify the cost of quite expensive multiplexors.

To date, another factor inflating the cost of network integration products has been the lack of accepted standards. Each supplier has had to design its own local distribution system, and many have used systems that stand no chance of being generally adopted, thereby cutting themselves off from a mass market for their products and the consequent lower costs of high-volume production. The CCITT recommendations for ISDN, the I-Series, address the problem of standards, but only at the lowest levels of the OSI hierarchy. It is important to remember that these recommendations are not (and were never intended to be) an alternative to the OSI model, and they do not integrate voice into the OSI architecture.

The cheapest integrated workstations, such as ICL's One Per Desk and the Minitel, package a telephone and a personal computer or terminal into a single unit. Even so, they are rather more expensive than separate devices, though they take up less space on the desk. They provide few, if any, integrated services, however. The most 'integrated' service is usually automatic dialling of numbers retrieved from a telephone directory. In France the Minitel has access, via videotex, to the public directory enquiry service and this provides a powerful retrieval facility for the telephone user.

A few sophisticated integrated workstations provide voice annotation of documents. These workstations, some of which require special shared servers in the local network, are much more expensive than comparable personal computers. As yet, few users have felt voice annotation to be worth the substantial extra costs.

THE RIGHT INTEGRATED PRODUCTS HAVE NOT YET BEEN PRODUCED

So far, the market for integrated products has been supplier-driven — both by the traditional telecommunications industry and by the data processing industry. The telecommunications industry has been particularly active, with traditional suppliers such as Northern Telecom and Plessey offering business communications packages or office systems centred around their PABXs. Obvious weaknesses in the data communications support provided, and high costs, have made this approach unattractive to most users. More recently, the telecommunications suppliers have begun to support a wider range of de facto data communications standards, including IBM 3270 and Ethernet. And a few suppliers have added protocol convertors to their PABXs, allowing, for example, IBM terminals to access asynchronous ports.

Standards for integration are still evolving, however. As a result, products based on current standards could quickly become obsolete or could provide only a limited interpretation of the standard and hence be of restricted use in the future. This is an inevitable difficulty with any major new technical development, but user problems can be minimised if the supplier undertakes to provide the necessary upgrades to ensure compatibility with the evolving standard. It will be interesting to see what happens in the United Kingdom, for example, when an international standard for inter-PABX digital working is defined. At present, an interim national standard (known as DPNSS — digital private network signalling system) is used, and this will be well entrenched by the time the international standard is defined. Many users, as well as manufacturers, may be reluctant to change to a new standard. On the other hand, users of products based on ISDN standards, especially teleservice standards, may find themselves cut off from the main line of development of other suppliers who are committed to a data architecture such as SNA.

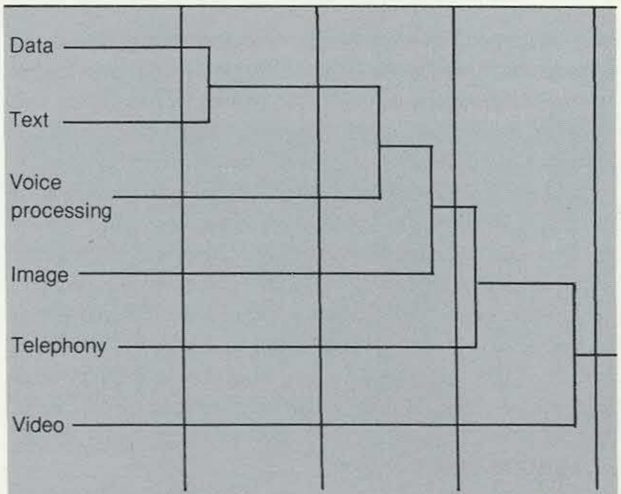
We believe that one of the reasons why the right integrated products have not yet been produced is that telecommunications suppliers have not yet understood the real requirements for office systems. By restricting their definition of office systems to systems used for interpersonal communications, they have ensured that their products can address only a small part of the users' real needs. Users may require processing power, access to data processing systems, and functional integration of data, text, and image systems, not just equipment that can serve several purposes independently. Equally, computer manufacturers have not succeeded in adding voice support to their office systems products.

Telecommunications and data processing manufacturers have not yet produced a balanced, cost-effective integrated product range. Instead, they have modified their existing products, with resultant unsatisfactory performance and cost compromises. The few genuinely integrated products are new on the market and are based on new technology and new design concepts. Such products can be unreliable, and performance figures quoted by suppliers can be over-optimistic. In addition, neither type of manufacturer has successfully adjusted to selling in the new markets opened up by integration.

Suppliers have been unable to produce the right products and services at a price acceptable to the market. The industry consensus seems to be that it will be several years before this problem is fully solved. Although the number of integrated products reaching the market is steadily increasing, it will be a long time before all the forms of information are fully integrated either at the network level or in integrated workstations.

Figure 1.3 shows the way in which we expect the integration of different forms of information to progress over the next decade. The dates indicate the times at which we see the development of integration between the different forms of information beginning to have a significant impact on user organisations. For example, voice communication is beginning to become a feature of some office systems, particularly in the network. The integration of voice with data and text imposes different requirements on the systems that support them, and for this reason we have differentiated in the figure between traditional telephony and the newer voice applications such as speech synthesis. These newer applications are allied more with data

Figure 1.3 Integration trends



The dates indicate the times at which the development of integration between the different forms of information will begin to have a significant impact on user organisations.

and text, and the integration of these forms of information could form the basis of functionally integrated products that would produce a more natural way of working for many professional, clerical, and managerial workers.

It is not yet clear whether the integration of telephony with data and text at anything more than the level of shared transmission is a wise course to follow. Integrating image communications, which requires much greater bandwidth, with other information forms will largely be confined to still image (freeze-frame video, for example) in the short to medium term. To integrate video communication successfully with other information forms requires either suitable bandwidth-compression techniques or an infrastructure of high-bandwidth transmission and switching equipment. These conditions are unlikely to exist generally within the next five years, although broadband local area networks can today provide the basis for integrating video communications within a site.

INTEGRATED PRODUCTS ARE SUBJECT TO REGULATORY PROBLEMS

In most countries all apparatus that is to be connected to the public network, or even to leased lines, needs prior approval from the PTT or a separate approvals body. In the past, the national approvals process has often been used to protect domestic suppliers from foreign competition. Thus, the European telecommunications market has been divided into national markets, each with its own approval regulations, and this has deterred the non-European makers of advanced systems from entering the market.

Even when the approvals process has not been deliberately used to protect national suppliers, it is slow and hinders the development of new products. The main difficulty is that the telephony engineers who operate the approvals process are being asked to evaluate unfamiliar equipment.

Thus, the approvals process inhibits the introduction of novel systems, including integrated systems. Large, well-established suppliers are obliged to adopt conservative technology, whilst small innovative suppliers are deterred from entering the market at all.

A further problem relates specifically to workstations. An integrated workstation must compete with personal computers, a market segment in which progress is extremely rapid and competition especially fierce. Personal computer suppliers can usually bring their products to market as soon as they are ready. The suppliers of integrated workstations, by contrast, should they wish to connect to the public network, have to wait for approval – by which time the market opportunity may well have been lost.

MANAGING INTEGRATED COMMUNICATIONS

The prospect of integration means that the traditional split between data processing and data communications, on the one hand, and telecommunications, on the other, may no longer be appropriate. Many organisations have already recognised this. Thus, many of the Fortune 500 companies in the United States now have one department handling all aspects of communications, and a recent survey showed that 60 per cent of large organisations in the United Kingdom have also established a single communications department.

Traditionally, responsibility for electronic communications in a typical large organisation was allocated as follows:

- The systems department handled data communications, generally on an applications basis.
- The administration department handled telex, word processing and telephony, if there was no private network.
- The telecommunications department handled voice networking and PABX/telephone procurement, although in many organisations, the managers of individual sites had responsibility for their on-site telephone equipment.

Thus, in general, the responsibility was spread across the organisation, with the different managers reporting through different parts of the company. This situation led to a number of problems, including:

- Lack of an overall perspective in long-term planning, which often inhibited innovation.
- Duplication of resources and manpower.
- Lack of control over the total communications expenditure.

By bringing the responsibility for all communications together into a single department, it is possible to:

- Make savings, through economies of scale, by rationalising the way in which communications facilities are provided.
- Emphasise that technology is a corporate resource that can be used to take advantage of opportunities to make the organisation more competitive, either by improving existing systems or by developing new ones.

In preparing for the advent of ISDN, it is particularly important that centralised control or guidelines for distributed control are implemented for equipment procurement. ISDN will be most valuable for end-to-end communications. However, a network planner will not be able to provide all company sites with ISDN access unless guidelines are issued now to ensure that suitable PABXs and other equipment are installed in the next few years.

Establishing an integrated communications department does not necessarily imply a commitment to integrated technology, but without an integrated department, an organisation will not be able to make the most of the opportunities provided by integration. Organisations cannot afford to delay much longer before establishing an integrated communications function. We believe that integration will become widespread during the period 1988 to 1990. Planning and implementing a major reorganisation and then allowing the new department to become established usually takes several months.

There is no standard organisational structure that we can recommend for an integrated communications department. As we said in Foundation Report 52 (Organising the Systems Department), the structure adopted depends on the enterprise's objectives and culture. One approach we have seen in the United Kingdom that seems to work well is to set up a small team that provides communications support to the systems and project teams and reports to the same senior manager. This team consists of hardware and software specialists for both voice and data communications. Such a structure makes it possible for the network or networks to be viewed as a corporate resource, with consequent management and financial benefits.

Merging the responsibilities for voice and data communications can present problems in an organisation that has hitherto considered voice communications as unimportant (and has therefore provided no centralised control), but that has a well-established systems department. In this situation, the systems department often fails to see why it should take on the responsibility for voice communications. But if the organisation is to benefit from ISDN, this step must be taken.

An interesting organisational problem can also arise in a conglomerate company. It is common in such an organisation for there to be a shared voice network that is the responsibility of a telecommunications manager located at the head office. Data communications is handled at the operating-company level. There are usually very good reasons that make the centralisation of data processing totally unacceptable, whereas disbanding the centralised voice network would result in the loss of economies of scale provided by a corporate-wide network. In such an environment, the favoured option is therefore to create a centralised networking function that develops voice and data networks, either discretely or in an integrated way, as a service to the operating companies, who retain control of their own systems development function. Such an approach is now being adopted by many conglomerates and multinationals in the United Kingdom, where group networks run by information service subsidiaries have been established. In some cases, the subsidiary is a separate company, supplying technology-based products and services to the open market as well as to the companies in the group.

There is no unique formula for managing the merger of the data and voice communications responsibilities. Corporate culture, corporate structure, whether computing is distributed or centralised, the relative importance of voice and data communications to the organisation — these are only some of the issues that play a part in deciding how best to tackle the problem. However, it is essential to ensure that there is a common view of the new department's objectives and that people are discouraged from thinking of themselves as voice or data specialists. Those organisations that have successfully merged data processing and telecommunications professionals say that the top priority is to break down the cultural barriers between the two groups. For example, Northrop Corporation's Aircraft Division in the United States resolved this problem by running optional cross-training courses when it merged its departments. These proved highly popular and helped to create a cohesive department.

Today, there is a shortage of staff with the skills needed by an integrated communications department. These skills require an understanding of both voice and data communications and a problem-solving approach (rather than a technology-based approach) to communications issues. In the short term, organisations will compete for the small pool of suitable professionals. The only long-term solution is inhouse training, either by retraining existing staff or by recruiting and training new staff.

In conclusion, integration is many different things, all at varying stages of development, which makes it difficult to chart the best course for the integration process within an organisation. Important lessons are already being learnt from those few organisations that have adopted some integration in their networks. We believe that the next few years will see more and more organisations including integrated products and services within their communications networks.

Chapter 2

The impact of ISDN on corporate communications

We believe that, in the medium to long term, ISDN will fundamentally change the way in which corporate communications are provided. However, it will be many years before the PTTs complete the conversion of the public networks to digital technology and can make ISDN available to all their subscribers. There is, therefore, no immediate urgency to change the way corporate communications are provided. Nonetheless, organisations do need to take account of ISDN developments in planning for the future, so they can decide how best to make use of ISDN facilities as they become available.

For many years, corporate communications have depended on separate public networks for telex, telephony, telegrams, and, more recently, data communications. Many organisations have repeated this pattern in their private networks, with separate networks for data, telex, telephony and, more recently, video distribution. ISDN will eventually allow new services that could not be offered economically, sometimes even technically, on existing discrete networks. It will make advanced voice, data, and image services universally available via a single connection, under a single directory number. It will embrace all public networks and services and may, for some organisations, provide a viable alternative to private networking, depending on the service and tariff policies the PTTs decide to adopt.

During the 1970s, the PTTs realised that the telephone network would be cheaper to run and easier to manage if it were converted to digital technology, both for transmission and for switching. They also realised that such a network could meet users' needs for non-voice communications and could provide a basis for them to offer new communications services. These developments would also enable the PTTs to extend their influence into areas hitherto dominated by independent computer and office systems suppliers.

The CCITT therefore developed the concept of an all-embracing digital network — the Integrated Services Digital Network (ISDN). CCITT defined the ISDN as:

> "A network evolved from the telephone integrated digital network, that provides end-to-end digital connections to support a wide range of services, including voice and non-voice, to which users will have access by a limited set of standard multipurpose customer interfaces."

In the intervening decade, the PTTs and equipment suppliers have worked to turn the concept of ISDN into reality. Today, the ISDN has entered a vital stage of its development, as the focus moves from definition to market trials and implementation. It is therefore important for Foundation members to understand the ISDN concept and its implications for corporate communications. It will soon be a reality.

In this chapter we look first at the nature of ISDN and the PTTs' plans for implementing it. We then consider the impacts that ISDN will have on corporate communications.

THE NATURE OF ISDN

ISDN is based on the digital transmission systems that the PTTs have been installing over the past ten years. It also requires digital exchanges, installation of which started more recently. ISDN comprises two main elements:

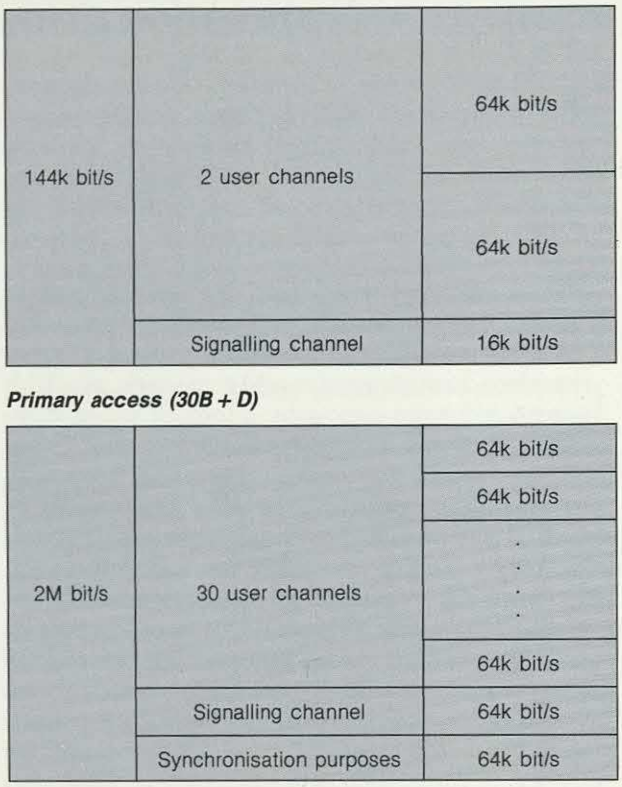
- The PTT's own digital network (the IDN — integrated digital network), linking telephone exchanges and other public equipment such as packet-switching exchanges and network servers.
- Telecommunications services, which are based on the use of the digital network.

The 'services' element of ISDN can be broken down into three main types of service — bearer services, supplementary services, and teleservices.

Bearer services provide basic transmission services — telephony (the public switched telephone network), telex, packet-switching data services, and leased lines. Bearer services use the IDN

Figure 2.1 ISDN basic and primary access

Basic access (2B + D)



transmission facilities to provide end-to-end switched 64k bit/s channels, which are linked to customers' premises by digital links. The customers' equipment has an integrated-access interface. The ISDN standards (the CCITT I-series) define two access services — basic and primary. As Figure 2.1 shows, basic-access service provides two 64k bit/s channels plus a signalling channel (known as 2B+D) through a 144k bit/s interface. Primary access provides thirty 64k bit/s channels plus a signalling channel (30B+D) through a 2M bit/s interface (the remaining 64k bit/s is used for synchronisation purposes). Basic access is intended for telephones, data terminals, and key systems. Primary access is intended for PABXs, computers and multiplexors. Thus, ISDN will be able to cope with all forms of information transmission except for full-bandwidth video.

Supplementary services are 'optional extras' provided by the PTT in addition to bearer services. Examples include call-diversion and calling-station identification. Supplementary services will be equally applicable to voice and non-voice communications, and they will be charged for either on a subscription basis or on a usage basis. They will be available to all ISDN users.

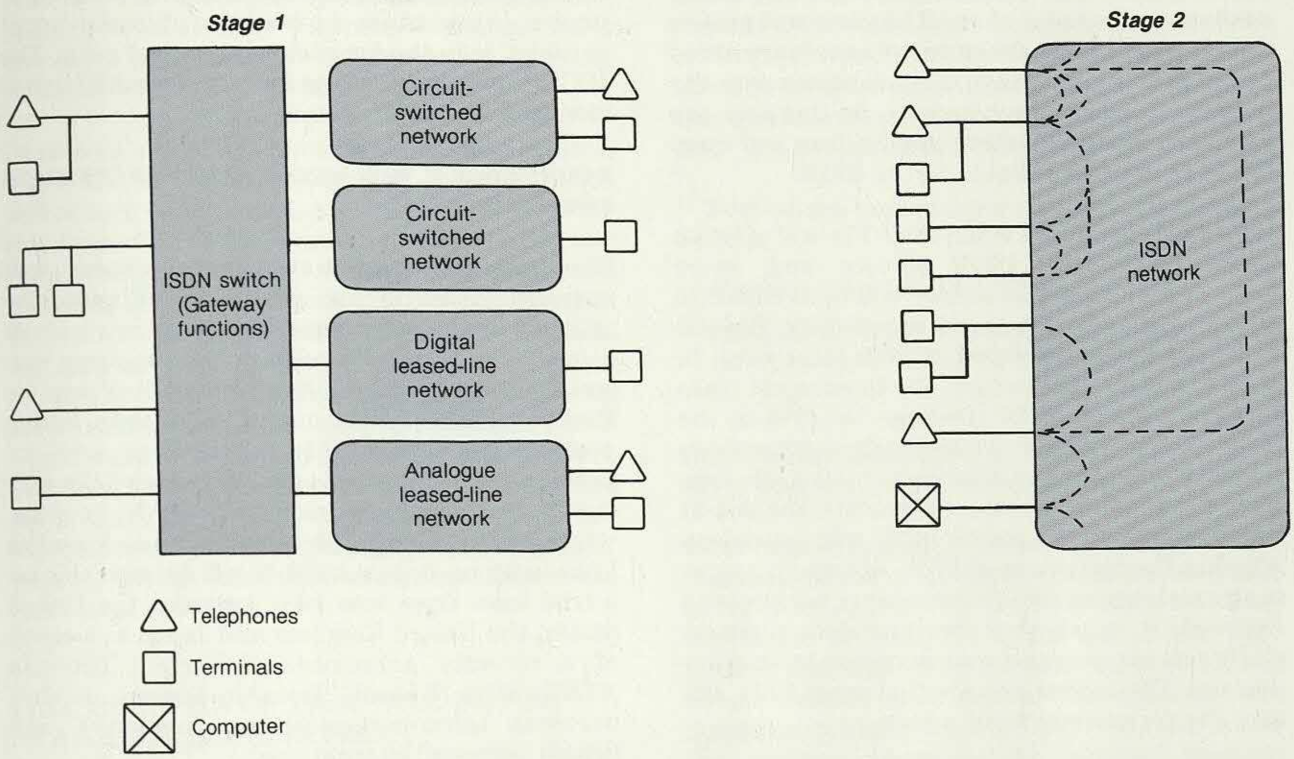
Teleservices are applications services such as electronic messaging, voice messaging, store-and-forward facsimile, and videotex. In many respects they are similar to today's value-added network services, because they provide some form of additional service on top of basic transmission and switching, usually store-and-forward and/or processing facilities. Teleservices will be provided by the PTT, who will see them as an additional source of revenue, and, in some countries, by licensed third-party service providers (although the PTT will still provide the bearer services). Teleservices may be restricted to specific user groups. Note that teleservices may make use of the supplementary services mentioned earlier.

PTT PLANS FOR ISDN

A PTT's first step in developing its ISDN is to begin to convert the analogue telephone network into an integrated digital network (IDN). Most PTTs are in the process of doing this because of the cost advantages provided by a fully digital network, but it will be well into the next century before this task is complete. However, the slow progress towards fully digital public networks need not retard the development of the ISDN. The PTTs are planning to introduce ISDN in an evolutionary way — either by developing the ISDN as an overlay network that will provide ISDN services to selected customers, or by developing ISDN 'islands' around digital switches in the network and eventually merging these into a national ISDN. In the long term, with either approach, the ISDN will replace the analogue telephone network as digitisation spreads throughout the public network.

Experience has shown that PTT plans for new services should be treated with a considerable amount of scepticism. Nevertheless, we believe that the PTTs will do their utmost to ensure that their ISDN plans are not delayed significantly. The PTTs are committed to implementing a fully digital telephone network because it provides them with major operational benefits. In addition, they will be able to use the digital network to provide ISDN services that will, they believe, provide them with access to a potentially huge market for new telecommunications services for a relatively small investment over and above that required to digitise the network. (A study carried out in 1985 for the European Commission estimated that the total investment over 10 years in EEC countries in ISDN-specific projects would be $6 billion, whereas the investment in digitising the telephone network will be ten times as much during the same period.) The PTTs are therefore anxious for the ISDN to be a success. As a consequence, we expect to see a degree of flexibility in the PTTs' plans as experience is gained and the service develops. The user

Figure 2.2 Two stages in the evolution of ISDN



community therefore has the opportunity to influence the PTTs before they finalise their full-service plans and tariffs.

PILOT TRIALS FOLLOWED BY COMMERCIAL SERVICES

In the initial stage, ISDN will, as shown in Figure 2.2, provide users with common access to a variety of public and private wide-area networks. Most PTTs are now beginning the stage 1 pilot ISDN systems. In stage 2, the mature ISDN is intended to replace the separate networks, providing unified communication from end to end. However, the PTTs' plans for fully mature ISDNs have not yet been finalised.

Figure 2.3 shows the ISDN plans of several PTTs. All plan to offer a pilot service, initially covering a limited geographic area. In France, for example, a pilot service with 300 subscribers will be provided

Figure 2.3 Planned availability of some national ISDNs

	Pilot service	*Commercial service*	*Service to more than 50% of business community*(1)
Belgium	1988/89	Evolve from pilot service	Not known
France	End 1987	1990	1990
Italy	Late 1987	Evolve from pilot service by 1989-90	1990
Netherlands	1988/89	From 1990	From 1990
Sweden	1989(2)	Not known	Not known
United Kingdom			
— BT	(3)	1987	1987
— Mercury	Not known	Not known	Not known
West Germany	1986	1988	1988
Japan	1985	1987	Before 1995(4)

Notes
(1) Primary access only. Basic access will follow one to two years later, depending on the network digitisation programme.
(2) Depends on outcome of internal field trial in 1987/88.
(3) Limited commercial service using non-standard access was introduced in 1986 and will be extended into full commercial service.
(4) 85 per cent of subscriber equipment will be digital by 1995.

by the Direction Générale des Télécommunications (DGT) in Brittany. The pilot is aimed at small to medium-sized groups of small business and professional users and is designed to encourage these users to carry out a range of applications with the support of telecommunications. In this way the DGT aims to identify those applications and users that will be most suitable for its ISDN.

Figure 2.3 also shows when the PTTs will offer an initial commercial ISDN service and, more importantly, when this service will be available to 50 per cent of the business community. Beyond these dates, the projected growth rates vary. In West Germany, for example, the Bundespost plans to have national ISDN coverage by 1993 at the latest, and it forecasts some 3 million subscribers by 1995, whereas Sweden has not yet made firm plans for an initial service. In practice, the rate at which users migrate to the ISDN will depend on whether the carriers treat ISDN as a major opportunity and devote significant market resources to exploiting it, or whether they introduce commercial bearer services and wait to respond to market demand. The indications are that most PTTs will take the former course of action.

Outside Europe, Japanese and North American carriers also have plans for introducing ISDN services. In the United States, both AT&T and MCI plan to introduce full commercial ISDN services in 1987, and seven of the Bell operating companies are introducing pilot projects within the next 18 months. This burst of activity has come after a period during which the American carriers saw ISDN as having little relevance to them. However, there is serious concern that the systems of the different American carriers will not interwork. Several suppliers, including Fujitsu, Siemens, Ericsson, and Northern Telecom, have been selected to provide the equipment needed, and each is developing equipment on the basis of its own interpretation of existing standards and its anticipation of future standards.

EXISTING NETWORKS WILL EVENTUALLY BE ABSORBED INTO THE ISDN

Specialist networks, such as telex and X.25 packet switching, will coexist with the ISDN for many years. The analogue telephone network will eventually be superseded as digitisation spreads, but each PTT will decide, given its own special circumstances, how and when it is going to handle the delicate problem of absorbing the existing data networks into the ISDN. It is possible that this may never happen and that stage 2 shown in Figure 2.2 will never be reached because it may be in no one's interests to do so. If the user demand for service choice persists, this may well be the case. Organisations such as the International Chamber of Commerce (ICC) do not believe that the removal of choice, in particular the abolition of leased-circuit services, is in the long-term interest of users. The ICC is therefore pressing for a very gradual transition to a single ISDN network.

INTERNATIONAL ISDN LINKS WILL NOT BE AVAILABLE IMMEDIATELY

The timescale for international interconnection of national ISDNs is not yet clear, although the ultimate aim is for a ubiquitous telecommunications service like today's international telephone network. International ISDN services will depend on the availability of international digital links. Within continental Europe this requirement will not present a problem. However, European links with the United Kingdom and with North America, which have relied on submarine cable and satellite links, may be delayed. ISDN will be available on a trial basis from late 1987 between the United States, the United Kingdom and Japan as a result of a recently announced agreement between AT&T, KDD (Kokushi Denshin Denwa, Japan's overseas telecommunications company), and British Telecom International.

Nonetheless, it would be unwise for a user to believe that an international 64k bit/s digital path will always be available because it may be necessary to use compression techniques to make the best use of that limited resource — international bandwidth.

International ISDN links may also be delayed because insufficient attention is being given to the harmonisation and connection aspects of ISDN within Europe. CEPT and the EEC are active in this area, although in reality their influence is not great. The EEC is particularly concerned that ISDN should develop rapidly in a standard implementation so that European telecommunications manufacturers will be in a strong position to supply ISDN products to worldwide markets.

POSSIBLE FUTURE ISDN DEVELOPMENTS

The basic unit of transmission capacity provided by the ISDN is 64k bit/s, which is the transmission rate selected for digital voice communications. Many data communications specialists believe that this basic unit of transmission will not provide adequately for future data applications, in particular for video transmission. As a consequence, the CCITT has begun to consider the need for a broadband ISDN. In addition, several European suppliers are cooperating under the Eureka research initiative to develop broadband switching products.

(Eureka — European Research Coordination Committee — is managing technological research projects on behalf of 18 European countries.) Their aim is to demonstrate the feasibility of such products within four to five years.

At present, most PTTs have no plans for broadband ISDN, and it is likely to be well into the 1990s before such plans materialise. The exception is the Bundespost in West Germany, which sees the framework of ISDN as suitable for broadband switching services. By about 1990, the Bundespost expects that the development of broadband switching systems and the use of optical fibre transmission systems will make it possible to provide broadband switched services, in particular videoconferencing services, as part of the overall ISDN. The Bundespost plans to integrate television and radio distribution into the ISDN, based on the experience it has gained through its Bigfon project, which provides experimental optical fibre broadband local networks.

FULL BENEFITS OF ISDN WILL NOT BE AVAILABLE IMMEDIATELY

The full benefits of ISDN will be realised only when an end-to-end ISDN connection can be established. However, it will be many years before a typical geographically dispersed organisation will be able to achieve this for all its sites and thus can rely on ISDN for all its communications needs. In most countries, the initial ISDN service will provide only primary access, which is suitable for larger sites. Provision of basic access requires the local loop (and local exchange) to be digital, and small digital exchanges have only recently become available at an economic price. Because of the large number of local exchanges in a typical national network, this means that it will take many years for digitisation to be complete at the local level. In the United Kingdom, for example, 50 per cent of local exchanges should be digital by 1991, but in many other European countries it will be well into the next decade before this happens. In some countries, out-of-area ISDN access will be available, but at a price. British Telecom currently offers this facility as part of its IDA service, for example. (IDA is British Telecom's non-standard ISDN service, available on a limited basis since 1985.)

The impact of ISDN, in particular the rate at which it is adopted by the user community, depends critically on PTT decisions about services, investment, and, most importantly, tariffs. (In many countries these decisions are, in fact, made by governments and imposed on the PTTs. However, the PTTs have a major influence and are the channel whereby the decisions are made effective.)

The impact of ISDN on corporate communications, and when that impact is felt, will therefore vary considerably between countries. However, we believe there will be three major changes brought about by ISDN and that these changes will alter the way in which corporate communications are provided. The availability of ISDN will:

- Reduce the cost of inter-site data communications.
- Weaken the case for private networks.
- Broaden the range of people and businesses who use data communications facilities.

ISDN WILL REDUCE THE COST OF INTER-SITE DATA COMMUNICATIONS

ISDN will eventually make inexpensive data communications at speeds up to 64k bit/s available to all subscribers. The reduced costs and easy access will promote the wider use of data communications, especially for those services such as image transfer that require transmission rates significantly higher than the 4800 bit/s that is now the practical maximum for switched analogue circuits. The cost of inter-site data communications consists of the circuit charges and the costs of the equipment. Both of these elements will be changed by the introduction of the ISDN.

COST OF CIRCUITS

The cost of ISDN circuits will depend on the level and structure of the tariffs adopted by the PTTs. CCITT began deliberations on ISDN tariffs during 1985. By mid-1986, a preliminary set of general tariff principles had been drawn up. These principles define a general tariff structure, although national carriers are free to set tariff levels as they wish. CCITT's preliminary discussions propose a simple tariff structure, comprising a traffic-dependent and a traffic-independent element. The latter relates to type of access and the resources required, and the former to the cost of providing the service. In principle, charges will be independent of the type of information transmitted. Indeed, it will be difficult for the carrier to know what forms of information are being transmitted. It is likely that CCITT will restrict its deliberations to tariffs for bearer services because supplementary services and teleservices may well be competitive products in some countries, with their tariffs subject to market forces.

Until recently, there was a possibility that ISDN would be tariffed as a premium service. However, the limited evidence so far available indicates that this is unlikely to be the case and that ISDN tariffs will be related to those for existing telephony. For example:

- British Telecom and the Bundespost have already announced ISDN tariffs. British Telecom's tariffs are based on the tariffs for its non-standard IDA service (which provides the user with one 64 k bit/s and one 8k bit/s user channel and one signalling channel). For basic access, both will charge a monthly rental approximately equivalent to two business exchange lines, and a usage charge that is the same as for analogue telephony. Only British Telecom has announced a tariff for primary access. It is equivalent to the rental charge for 16 business exchange lines for a subscriber within an IDA exchange area.
- In the long term, as the progressive replacement of the analogue network is completed, ISDN tariffs will have to be telephony-based, because revenues from voice communications will continue to dominate the PTTs' finances.
- In the short term, a competitive pricing policy makes more sense for the PTTs because it will generate revenue from the ISDN more quickly than high pricing.

Thus, users may expect to obtain two 64k bit/s digital circuits for the cost of about two analogue telephone circuits, and one 2M bit/s digital circuit for the cost of about sixteen 64k bit/s circuits. If all of the available capacity were to be used for data transmission, these tariffs would mean that the cost would be only 10 per cent of the cost of providing equivalent data transmission capacity today.

A serious issue upon which which we can shed no light at present is how the PTTs will deal with tariffs in the transitional period. It is important that users of existing services, and those with no access to ISDN during the buildup period, should not be penalised during the transition period, and that migration to ISDN is not forced by artificial tariffs. Some observers have suggested that, during the transition period, one charge would be levied for a guaranteed digital path and a lower one would be levied where the only guarantee was of adequate speech quality. Except in the liberalised United Kingdom, there is little to prevent the European PTTs from doing as they like, although it can be argued that the threat of liberalisation will ensure they behave in a responsible manner.

User groups such as INTUG and the ICC are pressing for tariffs that will not be biased towards ISDN usage. In West Germany, the process of harmonising tariffs has already begun. From January 1988, tariffs for leased circuits and fixed-connection data circuits will be based on those for switched connections.

COST OF ACCESS EQUIPMENT

To access the ISDN a user will need suitable on-site equipment that can provide the appropriate basic-access or primary-access interface and signalling. This will mean buying new equipment, upgrading existing equipment, or buying adaptors. Use of ISDN does not imply on-site integration, only that the separate information streams are brought together at the entry and exit to the network.

For primary access it is envisaged that an integrated services PABX (commonly referred to as an ISPBX), a data switch, or a multiplexor will be the gateway to ISDN. ISPBXs are now available from traditional telecommunications manufacturers such as Plessey, Siemens, and Philips. (These developments are discussed further in Chapter 4.) In many cases, manufacturers are adopting a total ISDN approach, using the ISDN 2B+D basic-access structure for the telephones and workstations that the ISPBX will support. So far, no ISDN data switch or multiplexor has been announced. However, the development of this type of product must be under consideration by the major data communications companies, such as Timeplex, Racal, and Case. Without ISDN products, their markets will inevitably be eroded.

In order to use the basic-access service, telephones and workstations must be able to support the 2B+D interface. Alternatively, adaptors could be used to interface existing analogue telephones and X-series and V-series terminals. There is a general lack of such products at present, although in the United Kingdom British Telecom is, of necessity, providing network termination equipment for its IDA customers. This equipment terminates local transmission circuits, provides maintenance features, and supports standard CCITT X- and V-series analogue interfaces. There are, as yet, no 64k bit/s terminals available, although this is not surprising at this early stage of ISDN development.

Some manufacturers are working closely with the carriers during the pilot ISDN stage to develop suitable products. In the United Kingdom, for example, STC and British Telecom have collaborated on the testing of an ISDN terminal using a modified ICL One Per Desk workstation. Similarly, IBM has participated in equipment trials with British Telecom, and Siemens is working with the Bundespost in West Germany. Despite this activity, it is likely to be 1988 at the earliest before a reasonable choice of suitable devices appears on the market. This lack of products could hinder the early growth of ISDN, unless the PTTs are able to influence manufacturers, in particular their national manufacturers, to make products available at a reasonable price and in time for the commercial introduction of ISDN.

It is likely that, initially, PTTs and manufacturers will charge a premium for ISDN-compatible equipment. But as volumes rise and ISDN becomes the standard for telephony, this premium will largely be eliminated.

Overall, then, ISDN users will pay a modest premium for telephony, but their data communications costs (which will include the transmission of text and image material) will be reduced substantially.

THE CASE FOR PRIVATE NETWORKS WILL WEAKEN

Almost all of the reasons for using private voice and data networks will be greatly weakened by the introduction of the public ISDN.

In many European countries, regulations and economics have resulted in a proliferation of private voice and data networks based on circuits leased from the PTTs. Typically, a large organisation will have several private networks, and the motivations for creating each type of private network are quite different. Voice networks are justified mainly on cost-reduction grounds, although additional factors such as desk-to-desk dialling, faster call connection, better speech quality and fostering a corporate identity can have some influence. A private voice network usually only interlinks an organisation's larger sites, because it is only these sites that generate sufficient traffic to make a leased line economic. Data networks, on the other hand, are usually justified on technical grounds because for many applications there is no alternative. The size of a site is not usually a major factor in justifying a private data network.

We believe that the advent of the public ISDN will have a considerable impact on corporate communications and may change the economic and technical justifications for private networking. Nevertheless, private circuits will remain an option in most countries for many years, and private networks do therefore have a role in corporate communications in the medium term, albeit a role somewhat different from today's. Some organisations, for example, may choose to build their own private ISDN based on leased digital circuits.

There is an increasing trend towards inter-organisational (or 'community') networks involving many small organisations (insurance brokers with links to insurance companies, for example). ISDN should be appropriate for these type of links, and many organisations will find that the ISDN opens up new ways of communicating with customers, suppliers, and partners.

VOICE NETWORKS

The cost justification for installing a private voice network depends critically on the cost of leased lines compared to the cost of public switched connections. In fact, the setting of tariffs for digital leased lines is best seen as a political issue, and the PTTs seem determined to raise leased-line tariffs. The cost savings available from private voice networks are therefore likely to fall over the next few years.

There is no doubt that the digitisation of the public network will weaken most of the other advantages of using a private voice network. For example:

- Call setup times on the public network will be reduced.
- Digital transmission will improve speech quality.
- A common channel signalling system will allow the transfer of value-added features (such as call redirection and recall-when-free) between PABXs, or even between a PABX and the (digital) public telephone network.

A digital public network will therefore enable users to obtain the functional advantages of a private voice network (desk-to-desk dialling, for example) by using a mixture of leased and switched circuits. However, this possibility will only be realised if the signalling systems are technically satisfactory. Although the ISDN signalling systems will allow a mixture of private and public circuits to be used for voice communications, this may not be the case for data communications.

Some organisations with special requirements will continue to use private voice networks even though ISDN will weaken the case for such networks. Bank dealing rooms, for example, keep a voice circuit open all day long, even though it is used only intermittently. Such organisations require the circuit to be available at all times for immediate use, and will pay whatever it costs to have this facility.

DATA NETWORKS

Data communication has been based on leased lines because of their greater effective bandwidth (9600k bit/s is available on leased lines, compared with a practical maximum of 4800 bit/s on the public network) and the inability of much computer equipment to interface effectively with a circuit-switched analogue network. ISDN will remove the first problem by delivering a 64k bit/s circuit to any location. Computer suppliers seem likely to eliminate the second problem themselves by building ISDN support into their products, as they have already done for X.25 and X.21 support.

The cost advantages of private data networks will also be reduced by the tariffing policies for the ISDN. Although leased digital lines may still be cheaper in some countries than switched connections, the price differential between leased and switched circuits will diminish, and a higher volume of data traffic will be required to cost-justify a leased line.

The existence of the ISDN will also make it easier for the PTT to provide network management services, and some organisations may be prepared to 'subcontract' the management of their private data networks to the PTT. In other words, their 'private' corporate network would become an integral part of the public ISDN. The PTTs are certainly interested in offering such services, but we doubt that many users will, in the end, be prepared to trust any outside body with their corporate data networks.

In time, the PTTs will offer public mail, image, and data-transfer services that exploit the ISDN. Users with extensive inter-organisation communication requirements may prefer to use these public services, and may then find it attractive to use the public ISDN for the rest of their data communications, including inhouse communications.

A WIDER RANGE OF PEOPLE AND BUSINESSES WILL USE DATA COMMUNICATIONS FACILITIES

ISDN will encourage the development of a wide range of new telecommunications services, provided either by the PTTs or by value-added service companies (depending on the regulatory environment). So far, however, few ISDN services have been developed. Moreover, the lack of international standards for teleservices and supplementary services is forcing PTTs to develop their own national standards, and, as a consequence, there are likely to be considerable differences in similar services developed in each country. Progress with ISDN-based videotex services, for example, will be hampered by the different standards already in use in different countries. Thus far, Group 4 facsimile is the only well-defined candidate for an international teleservice.

The availability of the ISDN will extend the range of people and businesses able to access data communications services. By providing data communications as a public service, similar to telephony, the ISDN will also encourage inter-business and interpersonal use of the new services. The use of Minitel terminals in France and of domestic facsimile equipment in Japan has already shown what can be achieved in bringing non-voice services to people outside large organisations.

Individuals and smaller businesses will also benefit from the new services designed to support the relatively unexploited area of inter-organisational telecommunications. In the United Kingdom, for example, British Telecom has announced a message-handling service (MHS) based on the CCITT X.400 series of recommendations. These recommendations are receiving considerable support from PTTs and suppliers. MHS is not dependent on ISDN, but could well be an early national (and international) ISDN teleservice.

A second factor that will influence the type of services offered on the ISDN is the target market identified by the PTT for the initial service. In France, for example, small to medium-sized professional and service companies are likely to be the early target, whereas in the United Kingdom, British Telecom is concentrating on its larger customers. Large users may, in fact, be able to create their own inhouse ISDNs and may seek little more from the PTT than digital bearer services.

Chapter 3

Integrated wide-area corporate networks are feasible now

The demands made on wide-area corporate networks will continue to increase as data processing systems are expanded and office automation systems are introduced. The increasing use of graphics and images within data systems will also place new demands on corporate networks, as will the increase in electronic interbusiness communications. (We will explore this latter area in a forthcoming Foundation report — Electronic Data Interchange.) The new demands will certainly require greater flexibility in corporate networks, and wide-area integration will provide the flexibility to meet the changing communications needs.

Nevertheless, those organisations faced with a major voice or data network upgrade in the next few years should not automatically assume that they must integrate their different networks. Unless there is an overriding application reason to do so, they should consider instead an approach that allows integration in the network as and when it makes sense. For example, they should, where possible, choose the same sites for the nodes of the different networks.

We have identified three main technical options for integrated wide-area corporate networks that will be available during the next few years. Every large organisation will need to choose between these options — and different options may be appropriate in different cases. Although the technical choice may appear to be complicated, we believe it can be simplified by adopting what we term a 'virtual-network' approach to corporate wide-area networking. Before describing the technical options we therefore describe what we mean by a virtual-network approach.

ADOPT A VIRTUAL-NETWORK APPROACH

A virtual-network approach separates the provision of the network services from the technologies used to create the network. In particular, it allows different communications technologies to be mixed in a way that provides a consistent user interface. A virtual network may therefore consist of a series of linked networks, possibly using different technologies, but all supporting the same services through the same service protocols. It may also consist of a mixture of public and private networking facilities.

In the past it has not been necessary to differentiate between the network, the service provided by the network, the protocols used on the network, and the devices attached to the network. This situation arose partly for technological reasons and partly for reasons of engineering tradition. For example, until relatively recently telex was the principal electronic mail service, with the PTT supplying both the terminal and the switching service, and there was no distinction between the protocol and the way in which the telex machines happened to operate.

Liberalisation of the telecommunications environment requires a distinction to be made between the network and the equipment used to access the network. Network integration requires a separation to be made between the switching network and the various data and voice services that will operate over it. For example, 64k bit/s channels may be derived from a single 2M bit/s wideband ISDN bearer circuit, with each channel carrying a different communications service (voice, facsimile, teletex, videotex, etc.).

This philosophy, sometimes called 'divide and rule', is exactly the same as underlies layered data communications architectures such as OSI and SNA. We believe that the same principles should be applied to all communications — voice and non-voice.

VIRTUAL VOICE NETWORKS

In the case of telephony, a vast virtual network — sometimes described as "the largest machine in the world" — already exists. It consists of all, or almost all, of the world's public and private telephone networks. Despite the wide range of different national services, the world network is covered by a single international numbering scheme, and almost any attached telephone can communicate with any other.

The price that is paid for this exceptional connectivity is a very uncertain level of speech quality and a minimum level of functionality. Thus, most national networks do not provide support for the call-management features, such as camp-on-busy and call redirection, that have been such vital sales features of modern PABXs.

We do not suggest that corporate users should abandon such features. Instead they should pressure the PTTs and suppliers to provide these facilities within the public network, as well as within leased-line networks, and even between public and private exchanges. It would then be possible to construct a corporate voice network consisting of leased-line and public facilities. Figure 3.1 shows how this might work in a large organisation.

VIRTUAL DATA NETWORKS

The virtual network concept can also be applied to data communications. In fact, it is easier to apply in this field because the principle of layering is better established than it is for voice communications.

As with telephony, there is a historical association between certain data services and certain network technologies. Thus IBM 3270 terminals require coaxial connections to their cluster controllers, and the original Ethernet protocols were specific to a particular grade of coaxial cable. In recent years these associations have been weakened, however. 3270s can now be connected directly to a variety of local networks including Ethernet and some PABXs, and the Ethernet protocols can now be implemented using cheaper coaxial cable, or broadband networks, or optical fibres, or some PABXs.

It is relatively easy to define a virtual-data network for terminal support. A terminal-support service can be defined in terms of the network interface (V.24, for example), the protocol, the permissible error rate, and the addressing scheme. The virtual network can then be implemented using a mixture of local and wide-area network technologies. Shell in the United Kingdom, for example, uses broadband local area networks at most of its main sites and links these with digital circuits.

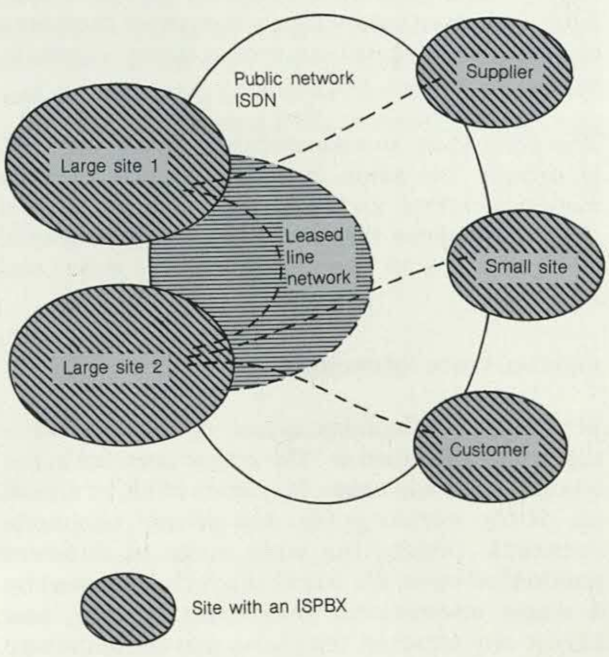
In the future, virtual-data networks could be extended beyond the provision of terminal support services to support high-speed communication between computers as well. At present this style of communication is available only by using local area networks or specially engineered direct links, and is usually restricted to single sites, or even to small areas such as the computer room. Low-cost inter-site circuits, provided by the public ISDN, will allow these services to be extended between sites. The role of the user organisation will be to select the protocols or architectures that will be used. Without a clear policy on protocols, the resulting network will provide no better communication than an Englishman and Frenchman, who cannot speak each other's language, achieve via an international telephone link.

We have identified three main technical options that can be used for a virtual-network approach to corporate wide-area networking over the next few years. These are:

- Keep the voice and non-voice networks distinct.
- Develop a private ISDN.
- Use public ISDN facilities as they become available.

The first and second options are available now, and the third will be available in 1988 or later, depending on national ISDN plans. In choosing one or another of these options, an organisation will inevitably have to make some compromises. Some communications requirements will be best met by one option; others by a different option. Each option must therefore be evaluated in the light of the organisation's total communications needs and the telecommunications regulatory environment in which it operates.

Figure 3.1 A virtual private voice network



KEEP THE NETWORKS DISTINCT

Many organisations will wish to keep their voice and non-voice wide-area networks distinct for the foreseeable future, particularly those organisations that have recently made a considerable investment in network facilities. A large number of organisations have in the past few years installed voice networks based on analogue PABXs, and they will be reluctant to make any major changes in the immediate future.

However, in most countries it will be less expensive to carry data over the public ISDN than it is to use today's analogue circuits. ISDN links will therefore be included progressively, even in discrete data networks. It will not be difficult to recognise where costs can be reduced by using an ISDN access channel for both data and voice, and most organisations will exploit this new opportunity for cost reduction.

DEVELOP A PRIVATE ISDN

It is technically feasible for an organisation to build a private integrated digital network that provides end-to-end digital communications for all or part of its internal communications requirements. Such an integrated network need not necessarily be based on the CCITT I-series recommendations; instead, it could be based on a proprietary telecommunications or data network architecture. The availability of digital transmission facilities varies from country to country, but is increasing rapidly. Thus, while many organisations would experience problems in implementing such a network today, it will soon be perfectly feasible to plan a national, or even an international, private network using only digital circuits.

The Midland Bank Group in the United Kingdom is a typical example of an organisation that has built its own digital network. The group, which spends in excess of £50 million annually on telecommunications services, consists of the Midland Bank, Thomas Cook travel agency, Samuel Montagu merchant bank, W Greenwell stockbrokers, Forward Trust Leasing and Finance Group, and the Northern and Clydesdale banks. Before 1982, voice and data communications were managed separately. There was an extensive data network, and Thomas Cook made heavy use of the public telephone network for viewdata. There was no group voice network, although there was a wideband leased circuit linking the PABXs at the London and Sheffield headquarters, and small star networks radiating from several key locations. Recognising the strategic importance of telecommunications, the group reorganised in 1982 to set up a single point of accountability for telecommunications and set out to implement a shared-resource network, known as Midnet.

Midnet meets nearly all of the group's voice and data networking needs and is also used for the group's videotex value-added network service, Fastrak. At present, integration is limited to using the sixteen 2M bit/s digital circuits in the core of the network for both voice and data. The predominant traffic is voice, so the data is effectively carried at no additional cost. Multiplexors separate the data and voice bit streams, data being switched by packet switches and voice being switched by Plessey IDXs. The network is managed from a single point, with a team of specialists covering both voice and data applications. An additional eighteen 2M bit/s digital circuits provide voice-only links between head office switches. These circuits are interfaced direct to Plessey ISDXs (which are third-generation ISDN PABXs) using the United Kingdom's DPNSS signalling standard to create a private ISDN.

The Midland Bank is now trying to determine the best way of achieving greater integration within its network. The packet-switched data network that carries most of the data traffic is likely to be retained for the foreseeable future. At major sites, however, the plan is to upgrade more PABXs to Plessey ISDXs. This will provide the group with the flexibility to develop new applications, or to handle existing applications, using whatever form of information is most appropriate, with whatever type of switching is most appropriate. For example, it is likely that integrated workstations will be installed at some bank branches and travel agency offices; these workstations could be supported by the ISDX network.

It is convenient to classify the options for building a private integrated digital network according to the degree of voice/data integration provided. We describe three options:

— A network based on wideband multiplexors.

— A network based on digital PABXs.

— An integrated packet network.

In the future, we believe that suppliers will introduce systems in which telephony and stored voice are integrated into a data network architecture, such as SNA or OSI. Such systems are likely to offer substantial new benefits, but they are also likely to be very expensive. Although some prototypes have been built, no such systems are currently available as commercial products, so we shall not attempt to evaluate them here.

A NETWORK BASED ON WIDEBAND MULTIPLEXORS

The most common example of integration in use today is shared transmission over leased lines. This is particularly common in the United Kingdom, where the availability and favourable tariffing of 2M bit/s digital leased circuits has made this an economic option. Voice and data are each allocated a fixed number of 64k bit/s channels on the 2M bit/s link. The channel allocation can be done in one of two ways. The first option (shown in Figure 3.2) uses a technique called drop-and-insert multiplexing. It allows the 2M bit/s digital leased circuit to be terminated on the PABX and for 64k bit/s data circuits to be extracted and submultiplexed if necessary. The multiplexors are relatively inexpensive devices, costing in the United Kingdom about £8,000, where the typical rental for a 2M

Figure 3.2 Drop-and-insert multiplexors

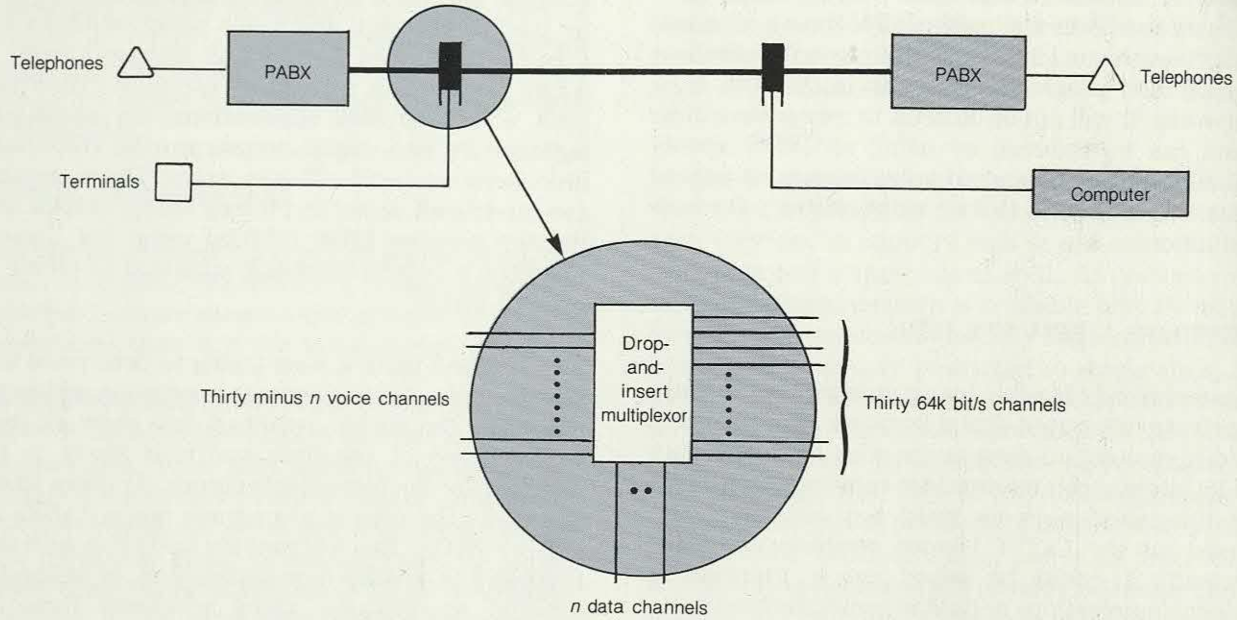
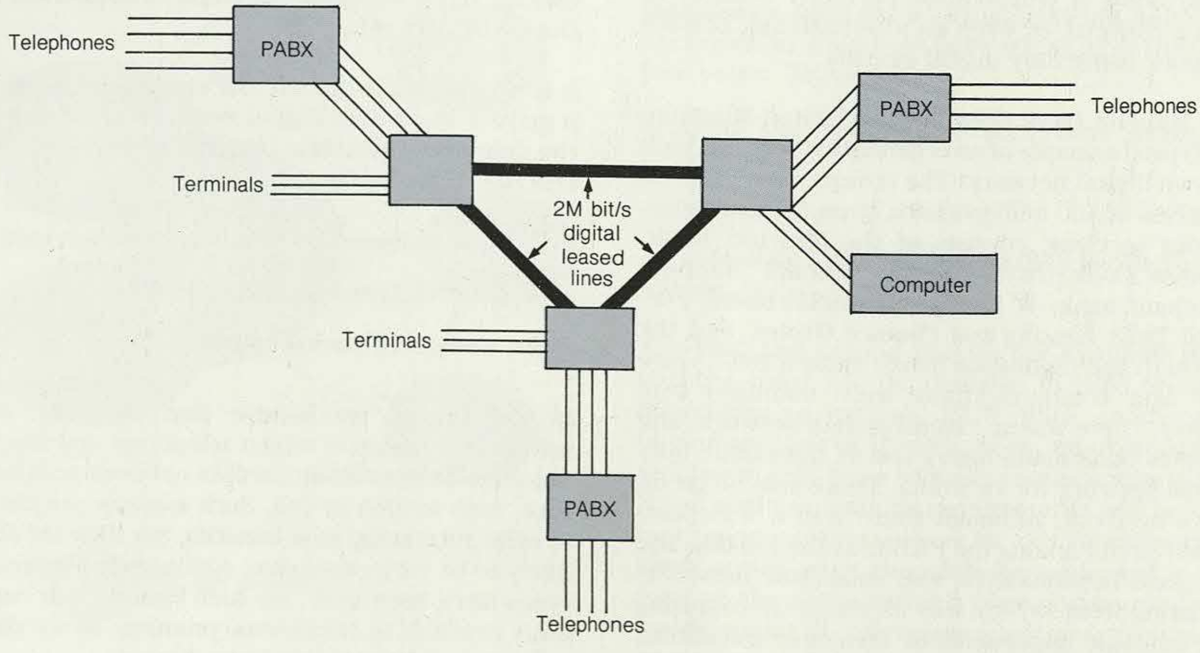


Figure 3.3 High-bandwidth switching multiplexors



bit/s link is equivalent to that of 16 separate analogue circuits. Because of the cost-savings that can be realised, many organisations with heavy traffic between two sites have chosen this option.

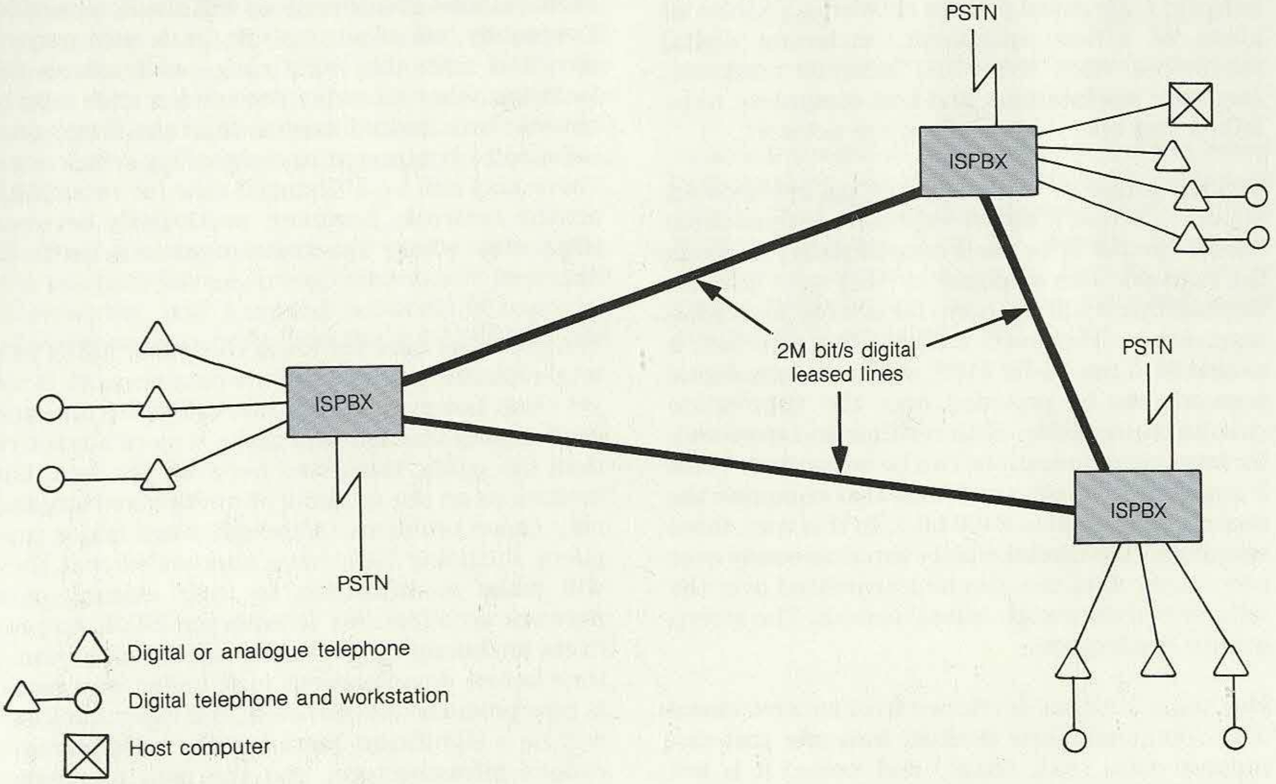
The second option (shown in Figure 3.3) is to use high-bandwidth switching multiplexors that are capable of handling several 2M bit/s links and that have a wide range of circuit boards for splitting the link into individual voice and data channels. This approach is appropriate where there is a high proportion of non-voice traffic and where comprehensive network management is needed. Typical multiplexors are the Timeplex Link 1, which costs about $30,000. Such devices are capable of handling 32k bit/s (and even 16k bit/s) digital voice, thereby allowing extremely effective use of the available bandwidth.

A NETWORK BASED ON DIGITAL PABXs

The use of digital PABXs provides integration at OSI layer 1 (see Figure 1.1 on page 2). PABXs, linked by digital wideband circuits, provide channels that may be used either for voice or data communications. In addition, if all the PABXs use compatible inter-exchange signalling, then call-management features may be networked. A private ISDN can therefore be built using PABXs linked by wideband digital circuits, and Figure 3.4 shows the type of network that can now be constructed. Such networks are now being built in the United Kingdom using PABXs like the Ericsson MD110 and the Plessey ISDX. The PABXs are linked by 2M bit/s circuits using either a proprietary signalling system or the United Kingdom's DPNSS standard. The signalling system provides for fast call set-up across the network and a variety of PABX supplementary features (such as ring-back-when-free) to be available between telephones attached to different PABXs. It also supports the setting up and control of data calls, but, in general, it does not provide as much support for data calls as would a data PABX (such as the Gandalf PACX).

Using PABXs to build a private ISDN requires a well-defined signalling system, and outside the United Kingdom, there is as yet little standardisation in this area. DPNSS is a common-channel signalling system developed in the United Kingdom for interworking between digital PABXs. All major PABX manufacturers in the United Kingdom support DPNSS, and several organisations (Glaxo and the Civil Service are two examples) are already using it on their private networks. DPNSS has its origins in telephony and is consequently more relevant to the needs of voice than of data networking. However, DPNSS is seen as an interim measure that will be replaced in the early 1990s by the appropriate CCITT standard.

Figure 3.4 Private ISDN based on PABXs



Building a private ISDN using the PABX approach suffers at present from three drawbacks:

— Small sites cannot be connected to the network. Few digital PABXs or digital key systems suitable for small sites are yet available. Thus, small sites will continue to be served by analogue signalling systems, and the benefits of features such as fast call set-up cannot be extended to them.

— A PABX is designed to optimise its voice-switching capabilities. Although it may be able to handle limited amounts of data traffic as well, a PABX is not the best vehicle for switching large volumes of data. This shortcoming of PABXs is discussed further in Chapter 4.

— Bandwidth allocation is too rigid for non-voice traffic. The 64k bit/s unit of bandwidth is not suitable for all non-voice applications and would preclude applications such as full-motion video-conferencing and high-speed data transfer.

INTEGRATED PACKET NETWORK

An interesting, although expensive, approach to private ISDN switching uses digital voice and packet-switching technology. The voice traffic is digitised using voice-compression techniques and is then packetised before it is transmitted over the network. This approach is used by NEC's Nedix 510F packet-switching system. The Nedix system, which is used by several international Japanese banks in their global private networks, enables all kinds of office equipment, including digital telephones, telex terminals, facsimile machines, computer workstations, and host computers, to be linked and operated on the same network.

The advantage of the integrated packet-network approach is that it allows expensive international leased circuits to be used economically, although the network uses analogue circuits with modems because this is still the norm for international communications. However, a digital line interface is available to the Nedix 510F, so that a fully digital network can be provided once the appropriate circuits are available. Both realtime and store-and-forward communications can be supported. Voice is supported by using vocoders that compress the digital voice signal to 2400 bit/s. In this way, three telephone calls can take place simultaneously over one circuit; data can also be transmitted over the same circuit during the 'silent' periods. The speech quality is adequate.

The Nedix 510F has developed from a conventional data communications product into one that can support data, text, image, and voice. It is not designed to accommodate either large numbers of telephone conversations or high-speed terminals, but it functions effectively in a mixed-mode environment. A typical large packet switch with several hundred lines costs about $4 million; a small switch with tens of lines typically costs $375,000. These prices make the Nedix 510F an unattractive product for national networking, but for an international network, where the transmission costs form a very significant part of the annual running costs, it can be an attractive proposition.

NEC tells us that a Mark II version of the Nedix will be available in 1987. It will provide voice transmission at 9600 bit/s, giving much higher quality, and Group 4 facsimile.

USE THE PUBLIC ISDN

The public ISDN will provide good-quality switched digital transmission paths that are better than those provided by analogue private networks today. Financially and technically, it may be advantageous for an organisation to consider dismantling its private voice and data networks and to use the public ISDN for all its wide-area corporate communications.

Technically, the public ISDN will provide better voice communications than today's private voice networks, and certainly better than the public analogue telephone network, which it will eventually replace. Supplementary services (such as calling-station identification) will also be available. Eventually, all of an organisation's sites may be provided with the same range of features and facilities, whereas today the smaller sites tend to have a more limited service than the larger ones because of equipment and signalling restrictions. There may still be a financial case for retaining a private network, however, particularly between large sites where the communications traffic is heaviest.

The technical case for using the public ISDN as a total replacement for a private data network is not yet clear, however. ISDN's fast call set-up time and good-quality transmission make it more attractive than the public telephone network for data, but limitations on the routeing of multiplexed streams may cause problems. Although some major suppliers, including IBM, have announced that they will make modifications to their existing data network architectures to embrace ISDN, no products are currently available, and it will be some time before developments now under way result in new products. Nevertheless, it is clear that ISDN will be a significant factor in the telecommunications infrastructure, and the data processing suppliers cannot afford to ignore it. The financial case for using the ISDN instead of a private data network may not be attractive because many data networks carry very high traffic volumes over long periods of the day.

In practice, most organisations (except those in countries such as Sweden, where public ISDN will not be available until 1990 or later) will be using ISDN links with their private networks by the end of the decade, if it is financially sensible to do so. ISDN basic access is expected to be the norm for telephony in many countries by the early 1990s.

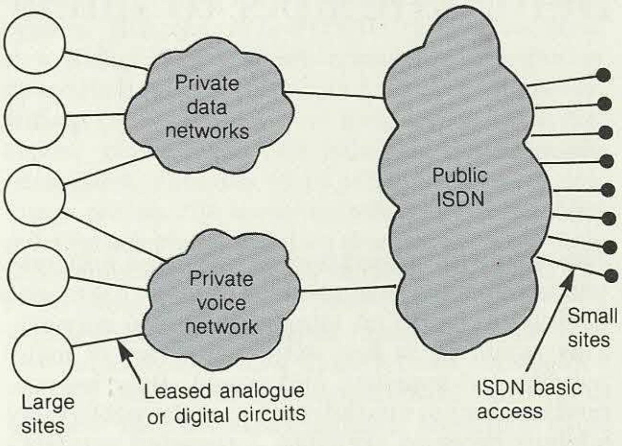
In practice, most large organisations today base their approach to wide-area networking on a mixture of public and private networks. This situation is unlikely to change with the advent of ISDN, provided that digital leased circuits are not prohibitively expensive. Figure 3.5 illustrates the two main alternatives for incorporating the public ISDN into a mixed approach to corporate networking. The first is to retain the separate data and voice networks that serve major sites and to use the public ISDN to provide access into these networks from the smaller sites. With this arrangement, different forms of information can be integrated at the transmission level if it is sensible to do so.

The second alternative is to develop a private ISDN linking the larger sites, and to use the public ISDN for smaller sites. This overcomes one of the problems of private ISDN today, namely its inability to serve small sites. Both alternatives do, however, require public ISDN basic access to be available at the smaller sites. As we mentioned on page 15 when discussing the PTTs' plans for ISDN, the initial thrust will be to provide primary-access links, so it may be some time before all of the small sites can be provided with access to the public ISDN.

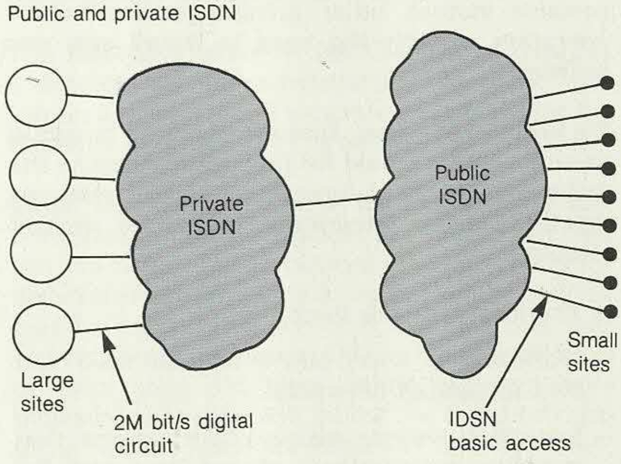
Many of the organisations we spoke with during the research have a strong commitment to private networking, and a mixed networking approach allows them to benefit from the public ISDN whilst retaining control of their network. Indeed, many organisations would be reluctant to relinquish control to a PTT they do not totally trust. A mixed approach allows them to benefit from any economies offered by leased circuits on those routes with heavy use while incurring usage charges only on lightly used routes.

Figure 3.5 Mixed approach to private networking

Separate data and voice networks and public ISDN



Public and private ISDN



Chapter 4

Defer attempts to integrate on-site systems

The growth of integration in wide-area networks will tempt many organisations to make a strategic decision to install an integrated on-site network. This would be in line with the advice of many pundits and suppliers and would, they believe, position them to take advantage of the public ISDN when it becomes available. Integrated networks promise various other advantages for on-site operation, notably the need to install only one network.

We believe, however, that a decision to integrate on-site systems would be premature because the technology of local integration is still evolving rapidly. On-site integration has three distinct elements:

- The local network itself.
- Workstations, which may or may not need their own integrated networks.
- Integrated systems, mainly office systems, that combine workstations, shared resources (or servers), and network equipment.

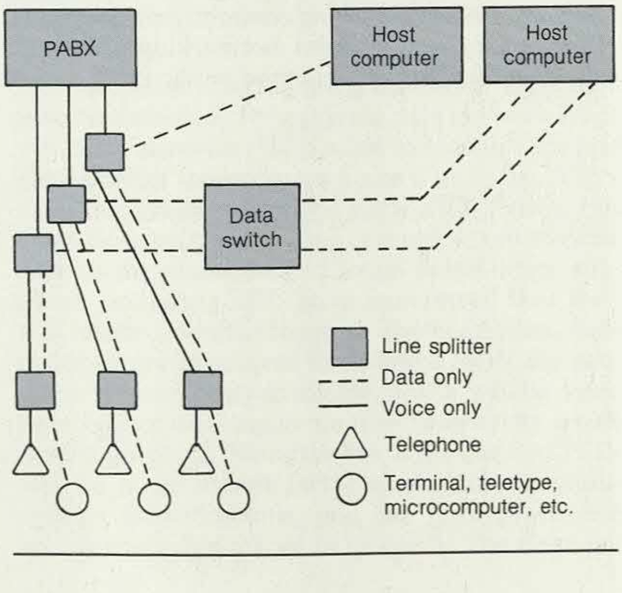
Each of these elements is evolving separately — and rapidly — and from different origins. As a consequence, no one can be sure of the future direction that integrated local networks and systems will take. Organisations should therefore defer attempts to integrate their on-site systems until this complex area has been clarified. In this chapter we predict the likely evolution of the different kinds of on-site networking products (cabling schemes, data switches, PABXs, PABX-based office systems, and integrated workstations). We review the products available today, and those that will appear in the next few years, and describe their ability to support an integrated on-site network. We also comment on the remaining uncertainties and offer some practical guidelines.

DEVELOPMENTS IN CABLING SYSTEMS

Almost all business locations have a star network of twisted-pair cables that are used for telephony. For many years, telephone wiring has been used in conjunction with modems or line drivers to provide on-site data communications. More recently, simultaneous transmission of voice and data has been achieved using data-over-voice techniques. A typical data-over-voice configuration is shown in Figure 4.1. Voice is transmitted without modification on the 4 kHz band, while data is transmitted as an analogue signal at a higher frequency over the same line. The two analogue streams are then separated at a line splitter, with data being routed into a data switch, or directly to a computer, and voice into the PABX. A typical data-over-voice product is Case's Grapevine. The data-over-voice technique limits the bandwidth available to data, but it has provided, and will continue to provide, a useful and economic way of supporting low-speed data over telephone twisted pairs.

In addition to telephone wiring, an increasing number of business locations also have data networks based on coaxial cable, screened twisted pairs, or optical fibres. These cabling schemes have been devised by the suppliers of computers and office systems, usually without regard to the practices of the telecommunications industry.

Figure 4.1 A typical data-over-voice configuration



There has been an almost complete lack of standards in the area of on-site data networks (although the situation is now improving). Furthermore, installation convenience, network changes, and network management have rarely been important design considerations. Cabling for data networks has, in fact, often been installed on an ad hoc basis as a solution to a specific problem, and this approach has usually led to excessive expense and to operational problems. The disadvantages and problems associated with on-site data networks are increasing in parallel with the rapid increase in non-voice communications equipment that many organisations are now experiencing.

Indeed, on a large site with significant communications requirements, such as a financial organisation or a research establishment, the selection and design of a suitable cabling scheme is becoming a more critical exercise than the selection of the associated switching devices and terminal equipment. Cabling is expected to last for 10 to 15 years. Although many modifications to the basic network can be expected during that time as staff and equipment are relocated, the infrastructure of cables and patching equipment must prove durable. Thus, the cabling scheme selected today is likely to need the flexibility to support the applications, as yet unimagined, of the late 1990s.

We know of some organisations who now install two cable networks in their buildings when they rewire. One network is used immediately for telephony, but the other lies in reserve waiting for the anticipated growth in data communications traffic. These organisations obviously are not prepared to use their telephony networks for integrated networking.

There is clearly a need for a universal cabling scheme (comprising cable types and physical layout) that can support all information modes. Such a scheme would result in an easily managed system that minimises rewiring costs (and disruption) when staff and equipment are relocated. A universal cabling scheme would be largely passive and would be independent of the switching technology used. Before 1984, the only universal cabling scheme was broadband cable, and this was in most cases an expensive option both for data and voice support. Since then, AT&T, IBM, and DEC have all announced their own cabling schemes.

In the United States, AT&T offers a universal cabling system, the Premises Distribution System (PDS), that provides data and voice support over twisted pairs (such as already installed telephony pairs) and optical fibres. AT&T also offers a personal computer micronet (Starlan) and a sophisticated data switch (ISN) in conjunction with this scheme. PDS is offered in some European countries through Olivetti.

Another universal wiring scheme is IBM's Cabling System. This system is a star of cables that meet at a wiring closet, which contains a distribution frame for data, a distribution frame for telephony, wiring concentrators for local area networks, cluster controllers, and other communications equipment. Announced in 1984, the system provides, within the same sheath, four unshielded pairs for telephony and two shielded pairs for data, all terminating on separate sockets. The Dutch PTT is planning to offer a wiring system based on a similar approach in 1987/88. However, in late 1985 IBM announced a new Type 3 cable (unshielded twisted pairs) that can support data rates up to 4M bit/s. In some cases, existing telephone cable could qualify as IBM Type 3 cable.

The DEC alternative — DECConnect — requires four cables (telephone twisted pairs for speech and terminal support, and separate coaxial cables for Ethernet and cable TV) to be taken to each desk.

Thus, the world's largest data processing and telecommunication suppliers are now promoting the use of unshielded twisted telephone pairs for data rates up to 4M bit/s, even though only 12 months earlier the accepted wisdom was that twisted pairs were unsuitable for transmission rates of more than 1M bit/s. Other suppliers have indicated that they will follow the trend towards using twisted pairs, moving away, in some cases, from the cabling schemes that they previously preferred. Using telephony twisted pairs as the basis of a physically integrated on-site network is therefore now technically feasible. One of the main advantages of using twisted pairs in this way is that the cost per device connected to the network is lower than for alternative wiring schemes.

However, the early experience of using unshielded twisted pairs for data communication has been mixed. We know of one installation where there were major difficulties, particularly when terminals were connected directly to unshielded twisted pairs. It was necessary to install additional equipment (line drivers), and this equipment can be relatively expensive.

Nor is it yet certain that unshielded twisted pairs can provide adequate transmission rates for future communications requirements. Packet voice, for example may require rates significantly higher than 4M bit/s if a substantial number of users is to be supported. The required rates can be provided on coaxial cable or shielded twisted pairs, however. If data transmission rates greater than, say, 20M bit/s are needed, then optical fibres provide the only long-term solution, but one which is not generally an economic alternative today. And it is not yet clear what grades of fibre should be laid in what topology to cater for future requirements and systems.

For the time being we recommend that Foundation members treat the suppliers' claims for the data transmission properties of unshielded twisted pairs with a great deal of caution. Shielded twisted pairs may well be a better alternative for the foreseeable future.

DEVELOPMENTS IN DATA SWITCHING

The most basic kind of data switch is the so-called data PABX. These devices provide a switched transparent circuit and can be used by a variety of different terminals. Usually, they do not support data transmission at more than 19,200 bit/s. Most data PABXs are optimised to support networks of dumb asynchronous terminals, such as DEC VT100s. Recently, a new generation of data switches has been developed. These are often referred to as matrix switches, and they provide increased functionality and much greater throughput without much increase in the cost per port.

Local area networks also provide data-switching facilities. The first local area networks were designed more than ten years ago as a means of allowing terminals, host computers, and, above all, intelligent workstations to intercommunicate. A local area network is primarily an on-site networking product for data and text communications (although broadband products also support video communications). Local area networks use a variety of transmission media laid in a variety of configurations — optical fibres configured as a ring, coaxial cable configured as a star, twisted pairs configured as a bus, and so forth.

In theory, local area networks could handle all forms of information, provided the information is digitally encoded. However, they use packet-switching techniques to ensure high connectivity and high throughput for data communications, and packet switching is not well suited to the needs of voice communications. Delays of more than a few tens of milliseconds in a voice packet results in unacceptable distortion in the speech heard by the user. There are two ways in which this difficulty can be overcome, both of which have an adverse effect on the network's primary data-switching role. Either packets containing voice need to be given priority over those containing other information modes (as in the Nedix 510F), thus affecting the response time for data, or all the packets have to be short (as in the Hasler Silk), thus imposing extra overheads on packet data.

Because of these difficulties, most major manufacturers are not yet attempting to integrate voice and data on local area networks. IBM's Token Ring, for example, operates at 4M bit/s, and this precludes all but a modest amount of telephony traffic. For at least the next five years, IBM will probably continue to use PABX technology, based on Rolm PABXs, for its voice-switching products. An important exception may be AT&T, whose researchers have recently been awarded several patents in the complex area of using packet-switching techniques for voice communications. We believe that, despite the considerable difficulties, AT&T is actively pursuing the use of packet switching for telephony. Certainly, AT&T has demonstrated an Ethernet-like local area network that can support several hundred concurrent telephone conversations.

A few smaller manufacturers are also following AT&T's example and building voice switches based on local area network technology. The most noteworthy of these is the CXC Rose, which is usually classified as a fourth-generation PABX (the Rose is described in greater detail on page 32). This product illustrates that, for integrated switching purposes, it will become increasingly difficult to differentiate between local area networks and fourth-generation PABXs.

The use of local area networks for voice switching will become more practical as speech compression reduces the bandwidth requirements, and as networks with more flexible (and therefore complex) priority schemes come into use. To use a voice-switching network as an alternative to a conventional PABX will, of course, require type approval from the PTT (or the approvals body). Approval for local area networks to be used in this way is, we believe, more likely to be given in those countries where the PTT no longer has a monopoly over the supply of PABXs. The technical and regulatory difficulties mean that it will inevitably be a long time before local area networks are used widely for voice switching.

DEVELOPMENTS IN PABXs

The voice PABX was designed to permit both on-site communications and communications via the public telephone network. Almost all PABXs are optimised for voice communications over the public network and use circuit-switching techniques over a star network. The PABX has evolved through several 'generations', each one enhancing its abilities as a voice switch.

Although telecommunications experts disagree about the characteristics of a PABX generation, it is clear that each successive generation has used more digital subsystems than its predecessors. One possible classification of PABX generations is shown in Figure 4.2. Thus, today's third generation supports digital end-to-end communications between two locally attached devices. Most PABXs can support data devices with V.24 (RS232) interfaces, and some can support common proprietary interfaces — of which IBM 3270 is the most common and the most important. Usually, data transmission can be no greater than 64k bit/s, the same as digitised speech. This limitation shows clearly that these PABXs were designed with voice switching as the primary function and that this remains uppermost in the minds of their suppliers.

The traditional telecommunications suppliers are eager to move into the office systems market and are positioning their latest products as integrated 'business communications systems', rather than as voice switches. This trend was first seen with products such as the Rolm CBX, which appeared on the market in the early 1980s. Most large PABXs marketed today now claim to support at least some degree of integration. For small PABXs (less than 64 lines or so), the use of digital techniques has only recently become economic. As a result, small digital PABXs (such as Dellfield Digital's product, which is marketed in the United Kingdom by GEC as the Reliance Digilink) are only now beginning to appear in significant numbers, and the availability of integrated features is not promoted so much by the suppliers.

Typical large 'integrated' digital PABXs that have appeared on the market in recent years are the Ericsson MD110, Mitel's SX2000, the Philips Sopho S2500, and Plessey's ISDX. The more recent European products use ISDN standards for the local-access channel. Other products use proprietary standards for supporting local devices. Support for analogue devices is still available, however, and a modern large PABX may support both analogue and digital devices.

Figure 4.2 Increasing digitisation of PABXs

Generation	*Control*	*Line*	*Examples*
1	D	A	IBM 3750
2	D	A	Northern Telecom SL/1
3	D	A or D	Jistel 6000, Philips Sopho S, Plessey ISDX
4	D	D	Intecom IBX, DV-1

A—analogue
D—digital

PROBLEMS WITH USING A PABX AS AN INTEGRATED SWITCH

There are several well-known arguments against using a PABX as an integrated switch. First of all, a PABX is a costly method of providing data-switching facilities. For example, a data PABX, such as the Gandalf PACX, costs only one-third as much as the integrated PABX solution. A data PABX is less expensive to build because it is designed for one purpose (data switching) and so does not require sophisticated software for telephony and can use an established technology. However, the costs of providing support for data switching on a digital PABX are falling. A terminal need only be plugged into a V.24 or X.21 interface on a digital telephone (often called a feature phone) connected to a digital PABX. The cost of such telephones is falling as the mass market begins to develop, reducing the incremental cost of providing terminal support to an acceptable level of $500 or less if the site is already equipped with digital telephones.

The second argument against using a PABX for data switching concerns the inflexible allocation of bandwidth (most PABXs provide 64k bit/s channels). For many data applications, 64k bit/s is wasteful because many terminal-to-host applications operate at speeds of 19.2k bit/s or less. On the other hand, 64k bit/s is not sufficient for resource sharing and locally distributed systems.

The third argument concerns the circuit-switching nature of PABXs, which makes it more difficult to provide protocol or speed conversion for data transmission. Furthermore, in order to establish a connection through a PABX, a data terminal must first set up the call and thus encounter the delays associated with the dialling process itself and with the sharing of common equipment in a high-traffic environment. This delay is unacceptable to many data processing applications.

PABX manufacturers have been working to overcome some of the objections to using a PABX for data switching, but it is difficult for them to do so because they need to modify devices that were designed specifically for telephony. Some of the desired changes are not possible, and others can only be done in a way that makes the integrated PABX package too expensive.

DATA FEATURES PROVIDED BY THIRD-GENERATION PABXs

The main data support features offered by third-generation PABXs are:

— Support for asynchronous/ASCII devices over V.24 interfaces.

— Support for synchronous devices over V.24 interfaces.

— Support for IBM 3270 (and compatible) terminals.

— Protocol conversion between 3270 and ASCII devices.

— Emulation of Ethernet interfaces.

The Philips Sopho S2500 is a typical third-generation PABX. Its design illustrates the way in which PABX manufacturers are trying to move their products into the area of data support. The Sopho S2500 is a traditional centralised circuit switch. The local distribution network is based on CCITT's 2B+D structure, and voice and data transmission can thus be carried out simultaneously from a single extension. Analogue devices are still supported, however. Philips has overcome many of the problems of using a PABX for text and data support by using the 'server' concept. Centrally resident software packages on dedicated computers, known as servers, provide:

— Protocol and speed conversion.

— X.25 PAD (packet assembly/disassembly) functions for access to a public data network.

— Bridging to a broadband local area network.

— Support for message-service protocols such as teletex.

These facilities are in addition to the PABX's usual functions of interfacing to the public switched telephone network and to private voice or data networks.

Despite its many data features, the design of the Sopho S2500 is based on voice-switching principles. Although it supports data transmission well enough, it is more expensive (for data switching) than a specialised data switch, and its data-switching facilities are inferior to those of a local area network. Interestingly, Philips also manufactures a network product, Sophonet, with which it is aiming to break into the data networking market. Even though Philips positions Sophonet and the Sopho S2500 as part of its 'Sophomation' concept, it appears that the two products do not yet fit together as part of an overall approach to integration. It is clear that Philips does not regard the Sopho S2500 as suitable for high-volume data switching.

A typical example of an organisation using an integrated third-generation PABX is the Hertz organisation in France. Hertz's head office uses a Jistel 6000 PABX from Jeumont Schneider for voice and data switching. The Jistel 6000 is an ISDN PABX (ISPBX) that supports the CCITT 2B+D local-access arrangement for attached devices. Simultaneous voice and data working is therefore possible from an extension.

When Hertz moved into its new head office building in 1985, it wanted a single wiring system for the building because it would be more economic and would provide the company with the flexibility to move devices around as required. In addition, Hertz needed to provide terminals with switched access to several minicomputers. The company therefore decided to select a PABX that could act as a data switch, and to use the telephone cabling for local voice and data transmission.

Figure 4.3 shows the current system configuration. Forty terminals, operating at 9600 bit/s over the fixed 64k bit/s channels, 190 telephones, three Texas Instruments minicomputers and several Minitel terminals (which access a videotex application) are connected to the Jistel 6000.

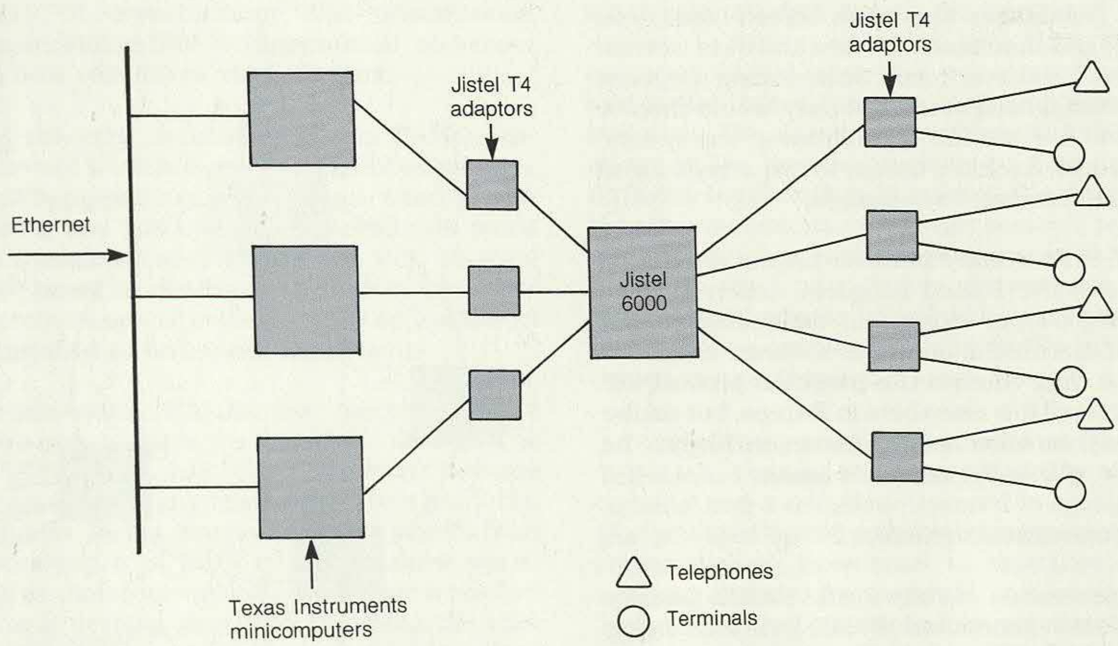
Hertz is very satisfied with its integrated switch because it was simple to install, it allows new equipment to be connected easily, and it has minimised cabling problems. The company plans to extend the facilities of the Jistel 6000 in 1987 to include an X.25 gateway to Transpac. There are also plans to install a PABX at each of the regional headquarters and to interconnect the PABXs using digital links to form an integrated private network.

PABX-BASED OFFICE SYSTEMS

Many PABX manufacturers are now developing office systems packages around their basic PABXs. As a result, a new type of product has evolved — the server, or PABX-attached processor, in which the applications needed to support office systems (as opposed to traditional PABX applications) are resident. These applications include protocol conversion, gateways to public data networks, electronic messaging, and so on, as well as facilities (such as voice storage and retrieval and directory dialling) that are on the way to being functionally integrated. For example, Siemen's Hicom office system allows data and text to be displayed and edited simultaneously on the screens of the two parties in a telephone conversation.

The servers may be an integral part of the PABX design, or they may be attached as an independent device, accessible via the PABX. They may be purchased as part of the PABX package, or they may be acquired from independent companies. For example, more than 20 voice-mail servers are now

Figure 4.3 Third-generation PABX at Hertz in France



available in the United States, many of them from non-PABX manufacturers. At present there are no standards in this area, however, and the best approach for the time being will almost certainly be to use the server products offered by the PABX manufacturer.

There are few, if any, integrated servers available at present, but many products are under development. Although it is too early to say for sure, the server concept may well be the way in which integrated local-area products will develop. We recommend that Foundation members monitor the suppliers' plans in this area.

A pointer to future developments in PABX products has come from Northern Telecom, whose Meridian range was announced in early 1985. This range includes:

— The Meridian SL1 and SL100 PABXs, which are major enhancements to Northern Telecom's SL PABX family.

— The DV-1, a new product designed to handle computing and networking within a department or small branch office.

— The M4000 series of workstations.

The Meridian family has three features that differentiate it from other PABX products:

— A 40M bit/s bus in the SL1 and SL100 that provides dynamic bandwidth allocation for voice, data, text, and image. In the DV-1, 20M bit/s is assigned to voice and 20M bit/s to non-voice.

— A multiprocessor architecture that supports applications, such as voice messaging, as required.

— A 2.56M bit/s twisted-pair distribution system, known as Lanstar. In this system, 64k bit/s is allocated to voice, the rest being available for non-voice communications. Within the central switch, voice is carried on a circuit-switched bus, whereas non-voice traffic is packet-switched.

The DV-1 is designed to serve the voice and data needs of a small department or branch office. It functions as a normal PABX (or key system) and can support up to 100 users using analogue telephones as well as digital telephones and workstations. The DV-1 can interface to other larger PABXs or directly to the PSTN through analogue exchange lines (though, as yet, it does not support a 2M bit/s interface to the public network). The product is marketed not just as a voice switch, but also on its strengths as an integrated office system.

Northern Telecom sells the DV-1 as a package of generic office tools, and users are encouraged to customise the system to their own requirements. To this end, the DV-1 servers, which are Unix-based, can run multiple processes and multiple systems, and Northern Telecom is adding to the range of third-party software that can be supported. Those organisations requiring data and voice communications can use the M4020 workstation, which provides a digital telephone and personal computer facilities in a single unit. The M4020 allows telephone calls to be controlled from a screen (sometimes known as screen-based telephony), and simultaneous voice and data communications. Users may retain their existing telephone and personal computers, but they would then be unable to use the full capabilities of the system. They would not have access to the screen-based telephony feature, for example.

The DV-1 is currently available only in the United States and the United Kingdom, where it costs about $2,000 per extension, depending on the configuration and applications software chosen. It is not yet clear whether this particular product will be made available elsewhere in Europe, but similar products from other manufacturers are likely to be available within the next few years.

FOURTH-GENERATION PABXs

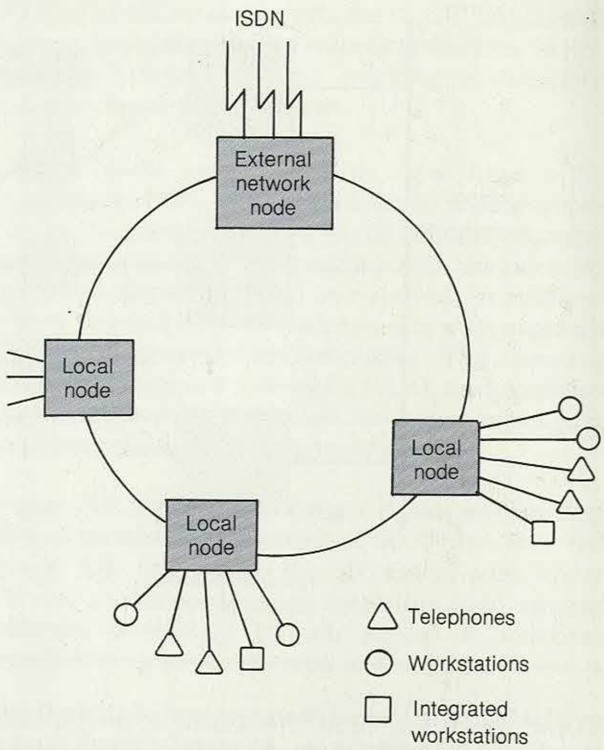
A new generation of fully digital PABXs (usually called fourth-generation PABXs) is now being developed (see Figure 4.2). These products will be radically different from earlier PABXs and will provide much greater potential for integration. They will provide flexible allocation of bandwidth and will use distributed switching through the use of local area network techniques within the PABX, as well as conventional time-division switching. The trend toward a distributed architecture is already evident in third-generation PABXs, and it will be taken a stage further in fourth-generation products. Figure 4.4 shows in schematic form the likely structure of a PABX in the 1990s. Early fourth-generation products are already available in the United States, and include CXC's Rose, Intecom's IBX, and Ztel's PNX.

The Rose's distributed architecture uses dispersed 'processing nodes' that are connected by two local area networks, one optimised for data and the other for voice. Each node can support up to 192 telephones. CXC's own telephones include a V.24 socket through which existing terminals can be supported. The key workstation, however, is the CXC Personal Teleterminal. The Teleterminal combines the functions of a telephone, data terminal and personal computer. It also provides the user with a number of functionally integrated services.

Intecom has for several years been promoting its IBX family of exchanges as the basis for integrated voice/data switching. The IBX family has a distributed architecture and is based entirely on digital technology.

Since 1984, PPG Industries in Pittsburgh has been using an IBX S/4 equipped with 2,400 extensions and 600 trunks. PPG set out to install an integrated switch in its new headquarters building and was convinced that in 1984 the IBX best met its requirements.

Figure 4.4 Schematic of a fourth-generation PABX



The PABX is used as a tandem switch on the company's private network, and is also used for local voice and data switching. About 1,000 of the extensions are equipped with Intecom voice/data sets into which PPG's staff can plug their data terminals to gain access to the switch. By providing terminal emulation, the IBX has allowed PPG to retain its existing 3270-compatible terminals and personal computers, which access several host computers through the IBX.

PPG believes that the IBX S/4 is flexible enough to allow the communications facilities to be enhanced as necessary. At present, not all of PPG's data terminals communicate through the IBX, however. Some terminals are connected in the conventional way to cluster controllers via coaxial cabling. PPG is considering an upgrade to a larger Intecom PABX, the S/80. This would make it possible to support more than a thousand 327x terminals, using LANmark, the S/80's alternative to a local area network.

The IBX range of PABXs is also available in Italy, where it is proving attractive to large organisations, such as the Banco San Paolo, which is in the process of installing a 6,300-line IBX S/80 to support voice and data switching. It will be used to allow a variety of asynchronous and synchronous devices, including IBM 3270 terminals, to access several host computers via LANmark.

Most of the early fourth-generation PABXs use non-standard interfaces to their digital telephones and require proprietary workstations, although the telephones and workstations generally do work over conventional telephone wires. But, because they are based on distributed architectures, they usually require special cables (usually optical fibres) to be installed to link their components.

Fourth-generation PABXs may become widely available only towards the end of the decade. The third generation has only recently become established, and many third-generation products, like Siemens' Hicom, are positioned to benefit from the introduction of ISDN in two or three years' time. It is therefore unlikely that their manufacturers will develop new PABXs before the mid-1990s. The take-up of fourth-generation products will also be retarded in Europe by the large, and recently installed, base of second- and third-generation products. Many organisations will not wish to consider replacing these products for at least five, or maybe even ten, years.

DEVELOPMENTS IN INTEGRATED WORKSTATIONS

Most industry observers expect multifunction workstations to become the norm in the next ten years, replacing today's separate terminals and personal computers. These workstations will integrate voice, data, text, and image. Within each range of products, workstations will vary in complexity and function, however, and will address the specific needs of different types of workers. For example, some may include substantial processing and data-storage capabilities, while others might include facsimile scanners and printers. They will have common network interfaces (the ISDN basic-access interface, for example). In other cases, however, they will use proprietary interfaces, based on existing network architectures, such as SNA. Even where the ISDN network interface is used, it is likely that most suppliers will use proprietary protocols at the higher levels, which means that integrated workstations from different suppliers will not interwork very well at the applications level. Some suppliers may reduce this difficulty by using standard protocols for services such as facsimile and electronic mail.

The trend towards integrated workstations began in the early 1980s with the appearance of the first integrated voice/data terminals. Since then, suppliers and market analysts have been predicting spectacular market growth for integrated workstations. In reality, sales have been slow, with an estimated 50,000 integrated voice/data terminals sold in the United States in 1985, and fewer still in Europe. The slow growth reflects both the limitations of the devices available to date and the difficulty suppliers face in marketing a device that the telecommunications manager sees as a terminal and the data processing manager sees as a telephone. In the United States, for example, Sydis went out of business because its voice/data integrated office automation workstation was perceived as an expensive feature phone.

An early 'integrated' device, such as Northern Telecom's Displayphone, was basically a dumb terminal and a telephone encased in a single unit that provided limited additional functionality. More recent devices have tried to capitalise on the booming market for personal computers. They have been either personal computer adaptors that add integrated voice/data functionality to a personal computer (a typical example is Rolm's Juniper) or personal computers with added communications capability (such as ICL's One Per Desk).

Although these more recent devices provide some additional functionality, such as text messaging and autodialling from a directory, they do not provide full integration (most do not provide voice annotation, for example). The cost of an integrated voice/data terminal is continuing to fall, and a One Per Desk, for example, now costs about £1,200.

Even so, ICL and its distributors have found it difficult to sell the One Per Desk. The main difficulty has been the traditional split between telecommunications and data processing in user organisations. Nevertheless, the One Per Desk has been well received by those organisations who have bought it. It has proved to be a particularly attractive tool for financial salesmen. A salesman can use the One Per Desk to ring a customer from the directory, call down policy details from a mainframe or other details (from a value-added network service, for example), carry out complex calculations during the call, and, when the sale has been made, record the details on the One Per Desk and transmit them to the mainframe. The salesman can also use the word processing software to write to the customer confirming the deal. Another advantage of workstations with this degree of integration is that they do not require integrated networks.

Except for specialised applications, such as the one just cited, users have been reluctant to pay for a device that offers them little more than reduced clutter on their desks. In a recent study carried out by Butler Cox in the United States, the majority of the Fortune 1000 companies ranked voice and data integration as being of low importance in their criteria for selecting workstations.

We believe that integrated voice/data terminals will not be able to provide major benefits until they can provide functional integration between voice and data/text (and later image). Workstations such as Northern Telecom's M4020 and CXC's Personal Teleterminal are beginning to provide functional voice/data integration, but these products are proprietary to the particular PABXs. They derive many of their capabilities from the PABX itself, and, as part of an overall systems concept, they can provide much more integration than earlier workstations.

The systems approach to workstation integration has also been taken by some office systems manufacturers, such as Davox in the United States, which manufactures minicomputer-based office systems that can link to a variety of PABXs. This approach begins to demonstrate the benefits of integrating voice and data. For example, it is possible to provide voice annotation of text documents, and on-screen visual support for desk-to-desk teleconferencing can be provided through facilities such as shared text and graphics that can be viewed and edited jointly. And, because these applications are supported at the systems level, it will not be necessary to replace the workstation when a new application becomes available.

The general trend suggests that integrated workstations will be based on personal computers. This view presupposes that integrated workstations will contain sufficient memory and processing power to provide a voice and data capability independently of a central system, although they will also be able to draw on the resources of a central system as necessary. The debate over where the applications intelligence should be located is yet another example of the centralised/telecommunications versus distributed/data processing approach to systems. Both are valid approaches, and there are likely to be workstations with varying degrees of intelligence in use over the next few years.

In our view, organisations should not consider replacing standalone personal computers and telephones with integrated voice/data terminals until the workstations can support functionally integrated applications. If a standalone device is then chosen, we believe it would be unwise to select a product that does not have, or cannot be upgraded to have, an ISDN basic-access interface.

Today, the most sophisticated integrated workstations available form part of integrated systems that also include network servers. One model for this is the ITL IMP office automation system. IMP workstations are connected to a shared computer through a 1M bit/s high-speed switch. The workstation provides word processing and some data processing facilities. The shared computer provides a filestore and some other support facilities for the workstations. Documents created on the workstations can include speech, which is input via a telephone handset, as well as text. The speech is held at a particular point in the document, which is indicated by a distinctive symbol (icon). To hear the speech, the recipient must select the icon on the screen. For both regulatory and technical reasons the IMP's handset cannot be used as a telephone.

With this type of integrated system, the workstations and servers are linked by networks that are themselves integrated. However, because the systems are integrated at the higher levels of the OSI reference model, they do not necessarily (and most do not) look like ISDN nor ISPBX integrated networks.

GUIDELINES FOR LOCAL NETWORK INTEGRATION

Those organisations about to select a new PABX may be tempted to believe that a modern third- or fourth-generation PABX can provide on-site integration. Indeed, it is becoming increasingly difficult to find a PABX that is not promoted as an integrated switch. However, unless there is a foreseeable and known requirement for these capabilities, a new PABX should be selected for its voice features. By the end of the decade, there will be a far wider choice of products supporting local integration, and decisions about the most appropriate products should be deferred until that time. In the meantime, though, there are some basic guidelines that can be used in planning your on-site network, and paving the way for the integrated world of tomorrow. The guidelines are different depending on whether the site is established and already has a PABX, or whether on-site communications for a new 'greenfield' site are being considered.

ORGANISATIONS WITH A GREENFIELD SITE

Those organisations with a greenfield site should select an ISPBX. However, they should also install separate shielded twisted pairs, or a local area network, for non-voice communications. Integrated switching based on the ISPBX should be considered only if:

- The majority of data use is ad hoc and there is a need for switched access to several host computers, external services, etc.
- There is a requirement for an integrated office system to support staff in their work.

ON-SITE INTEGRATION AT AN EXISTING SITE

The guidelines offered below for on-site integration at an existing site are, of necessity, general in nature. Most organisations have very specific needs that will require specialised cabling and switching schemes. The most appropriate level of integration will therefore be different for different organisations and different physical environments. (More detailed discussions about on-site communications can be found in Foundation Report 38 — Selecting Local Network Facilities and in Roger Camrass' book *Wiring up the Workplace*, published in 1986 by IBC Technical Services Ltd.) The general guidelines depend on the type of PABX that is already installed at the site.

Organisations with an analogue or second-generation PABX

We recommend that, wherever possible, organisations with an analogue or second-generation PABX should use separate wiring for non-voice communications. However, if there is a need to install new on-site data communications facilities and it is impossible (or prohibitively expensive) to install separate cables, the telephone wiring could be used for integrated transmission, using data-over-voice techniques. It would be unwise, though, to consider integrated switching, with the exception of providing access through the PABX to the public telephone network for dial-up terminals.

Organisations with a third- or fourth-generation PABX

Those organisations that have already installed digital third- or fourth-generation PABXs should consider upgrading to digital feature phones, which allow a data terminal to be plugged into the telephone. Such telephones are now becoming available, but they are proprietary to a particular PABX (Plessey's ISDT — integrated services digital telephone — can be used only with Plessey's ISDX, for example). This type of equipment will provide private ISDN facilities, within a site or over the organisation's private network, provided that all sites use the same equipment. However, the ISDN standards are not yet fully defined, and any feature phone purchased in the immediate future may not conform to the final ISDN standard. Thus, they may not be able to interconnect either with the public ISDN or with feature phones from other suppliers.

BUTLER COX FOUNDATION

Butler Cox
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.

The Foundation not only provides access to an extensive and coherent programme of continuous research, it also provides an opportunity for widespread exchange of experience and views between its members.

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. Half of the research topics are selected by Butler Cox and half by preferences expressed by the membership. Each year a shortlist of topics is circulated for consideration by the members. 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.

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Butler Cox & Partners Limited
Butler Cox House, 12 Bloomsbury Square,
London WC1A 2LL, England
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Fax (01) 831 6250

France
Butler Cox SARL
Tour Akzo, 164 Rue Ambroise Croizat,
93204 St Denis-Cedex 1, France
☎ (161) 48.20.61.64, Fax (161) 48.20.72.58

The Netherlands
Butler Cox BV
Burg Hogguerstraat 791
1064 EB Amsterdam
☎(020) 139955, Telex 12289 BUCOX NL
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United States of America
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Australia
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Consultants (Computer and Financial) PLC
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☎(02) 237 3232, Telex 22246 MACBNK
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Italy
SISDO
20123 Milano – Via Caradosso 7 – Italy
☎ (02) 498 4651, Telex 350309 SISBDA I

The Nordic Region
Statskonsult AB
Stortorget 9, S-21122 Malmo, Sweden
☎ (040) 1030 40, Telex 12754 SINTABS