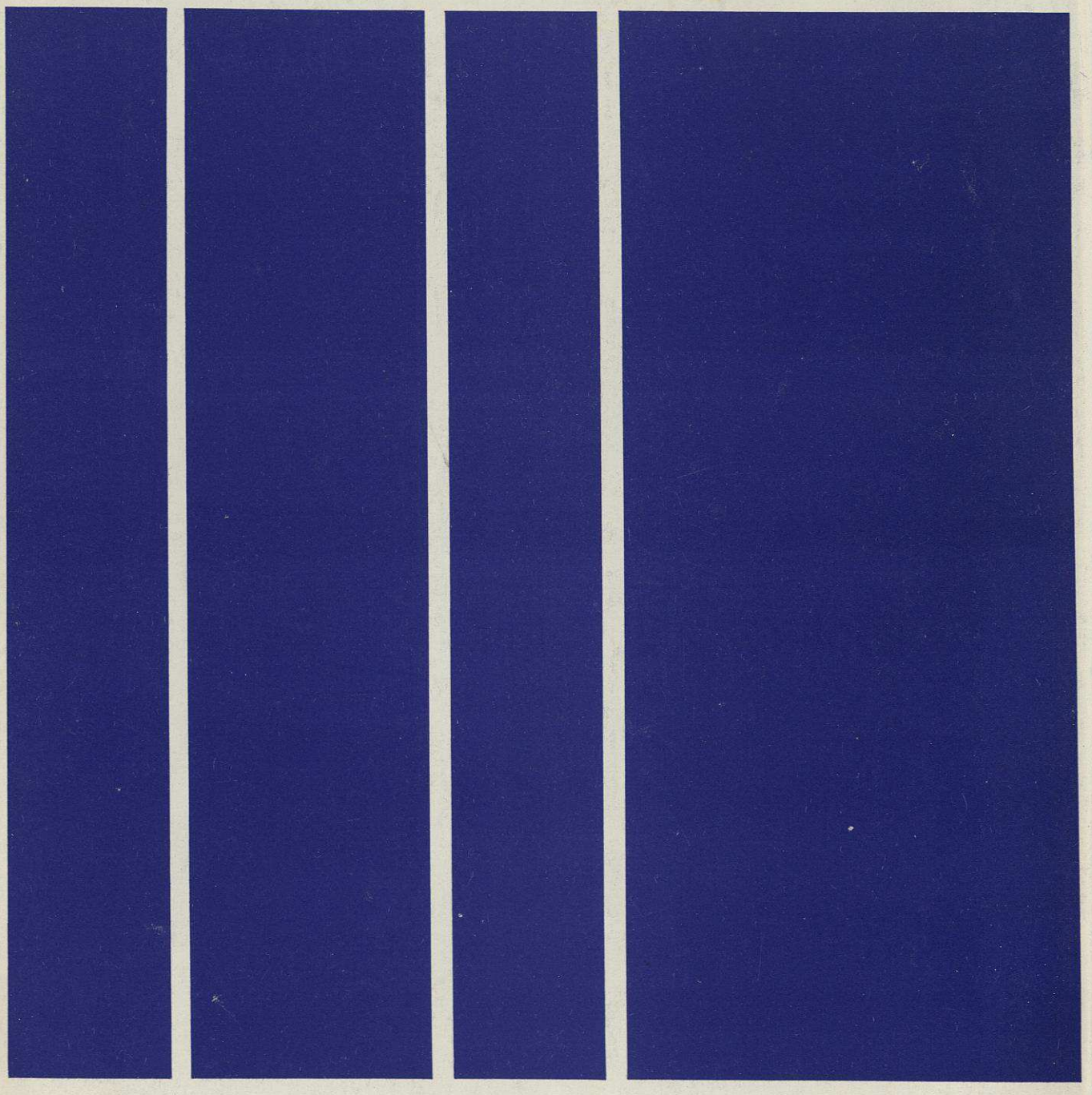
Report Series
No 7

Public Data Services

May 1978



The Butler Cox Foundation

Abstract

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Public Data Services

by Tony Gunton
and Roger Camrass

May 1978

As a result of the convergence of technologies, telecommunications is now subject to the same pressures which have promoted such rapid change in data processing in the past. This is most clearly apparent in the US, where communications policy has been drastically re-shaped and where there is now a tidal wave of new communication products and services which shows no sign of receding. The pace of change is slower in a more conservative Europe, but here too the signs of impending change are unmistakable, particularly in the new public services for data communications which are now being planned and which in some cases have already been introduced.

These may open up new applications such as information retrieval, electronic mail and electronic funds transfer to widespread use and exert a major influence on national economic life, and possibly on social and personal life also.

This report deals with the key issues underlying these developments. It reviews the plans of the European PTT authorities as a whole and those of the British Post Office in particular. It then describes the evolution of regulatory policy in the US and the range of services which will confront users there now and in the near future. This forms a striking contrast with the position in Europe; for some an example, for others a warning.

The report concludes by summarising the options which will confront users over the next few years and laying down specific policy guidelines. It is aimed both at managers with a direct interest in data communications planning and at those with a general interest in the implications of communications policy.

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I. INTRODUCTION

A Purpose and Scope Of The Report

In the near future users of data communications services will be faced with a wider range of choice than they have so far been accustomed to. In countries where the national telecommunications authority is the monopoly carrier, they will have a choice of alternative services; elsewhere they may also have a choice of suppliers offering competing services based on the common carrier's transmission network.

This report describes the data services available now and those likely to become available during the next decade. The United Kingdom is accorded most detailed treatment, but events in Europe as a whole and in the USA are also discussed. These reveal the trends in communications technology and developments in the market for communications services which are the background against which the British Post Office (BPO) must set its own objectives and policy.

The purpose of the report is twofold:

1. To help managers responsible for data communications to formulate realistic plans and policy for the use of present and forthcoming data services. For this purpose the report provides indicators as to the coverage, timescale and cost of these services and guidelines to planning.

2. To provide an understanding of the issues which underly telecommunications policy. The report does not attempt to predict how telecommunications policy will develop in the UK or any other country. The intention is rather to help those with an interest in policy matters to judge the significance of changes as they occur.

The report will therefore be of interest both to managers with a direct practical involvement in the planning and development of systems using data communications services, and also those with a more general interest including policy makers and market strategists.

B Terminology

The report pre-supposes some knowledge of the structure and general characteristics of the different data communications services which are discussed. The sense in which some key terms are used is defined briefly below:

PSTN
PSTN (Public Switched Telephone Network) data services are dial-up facilities using the analogue voice network.

Leased Lines
These are data lines leased for private use, at present analogue lines which are part of the PSTN transmission network. Shortly PCM (qv) lines will also be available.

Packet-Switching
Packet-switching is a sophisticated form of multiplexing. It combines the switching properties of message-switching systems with the improved performance characteristic of on-line dp

systems. A packet-switching service is in effect a quick-response message delivery service.

Circuit-Switching
Circuit-switching is used in the report to refer to forthcoming digital circuit-switching services, although the PSTN and the Telex network are of course also circuit-switched. Digital services will offer a faster call set-up time than the latter (milliseconds rather than seconds) and differ from packet-switching in providing a continuous, synchronous connection between subscribers rather than transporting messages asynchronously.

PCM
PCM (pulse code modulation) is a transmission technique involving the transportation of information in digital form. When used to describe a transmission line or service, PCM and digital are synonymous.

II. THE BACKGROUND – POLICY AND POSSIBILITIES

Although there are differences between the policies adopted by the national telecommunications authorities in Europe (referred to in the rest of this document as 'the PTTs'), to date there has been a broad similarity of approach. In this section we describe the main lines of PTT policy and contrast it with recent US practice.

Telecommunications policy will exert a significant influence on the shape, accessibility and cost of future public services. These in their turn will play an increasingly important role in national economic life, and possibly in personal life also. We illustrate this general point by reference to a recent French study and also describe the new business opportunities which may depend on the availability of satisfactory public telecommunications services.

A The PTTs' Position

The European PTTs enjoy a monopoly of telecommunications services in their respective countries. In the UK for example the Post Office Act (1969) states that:

> "the Post Office shall have throughout the British Islands, the exclusive privilege of running systems for the conveyance, through the agency of electric, magnetic, electrochemical or electro-mechanical energy of (a) speech, music and other sounds; (b) visual images; (c) signals serving for the impartation . . . of any matter otherwise than in the form of sound or visual images; (d) signals serving for the actuation or control of machinery or apparatus."

The basic principle that the state should exercise a high degree of control over the public switching network is generally observed, based on the view that this is a natural monopoly. In this respect the position in the US, where AT&T operates a *de facto* monopoly, is no different. The key difference lies in the disposition of regulatory power. In the US the Federal Communications Commission (FCC) exercises control over the extent of AT&T's monopoly and the manner in which it is operated, whereas in Europe the PTTs are both regulatory and operational bodies rolled into one. This arrangement has been called into question in the past, on the grounds that it restricts competition and stifles innovation. This is a view propounded particularly by private companies like ITT and IBM whose services or products depend on telecommunications, and hence on PTT approval. Later in this section we review developments which may again bring this issue to the fore.

The second central issue in telecommunications is line attachment policy. Rather than dividing the US from Europe, this distinguishes the US and part of Europe from the rest of Europe whose PTTs reserve wide rights to determine which devices may and may not be attached to the public networks. The British Post Office, though not the most restrictive of the European authorities, is firmly in the conservative camp. It is the monopoly supplier of all line attachments to the switched telephone and telex networks, except for large PABXs (> 100 lines), which require type approval and which are subsequently maintained by the BPO. Users may attach any devices they wish to private leased lines, but modems must be obtained from the Post Office except where a suitable model is not available, when they may be obtained instead from licensed private suppliers. These restrictions are justified by what is termed the 'integral

network policy'. The Post Office views most subscribers' apparatus as part of the integral network. Therefore, to protect the network, to protect other subscribers, and to minimise maintenance costs, the Post Office reserves to itself the right to supply or license and in most cases to maintain all such apparatus.

A more liberal policy is operated in the US, dating from the 'Carterfone' decision. In 1968 Carterfone, an independent telecommunications manufacturer, won a judgment against AT&T which enabled it to interconnect its own equipment to the AT&T transmission network. This has led to the growth of the so-called 'interconnect' industry in the US. Subject to approval by the FCC, any supplier can now connect devices to the AT&T network. In other words, the 'integral network' extends only as far as the plug in the wall, not right up to the terminal device.

B The Wind Of Change?

Telecommunications is already a pervasive aspect of both the economic and social life of the developed nations, and promises to become still more significant in the future. In such a climate no telecommunications authority can expect to avoid criticism of its approach and of its national role. Changes are also occuring in the market for telecommunications services and in telecommunications technology which might challenge PTT policy. The most important of these changes are summarised below.

1 The increased rate of innovation

The rapid technological change that has been characteristic of the computer industry is now affecting telecommunications also. Fibre optics, satellites and micro-circuitry are having a profound impact on both transmission and switching technology. The PTTs are used to long planning cycles and are now having to adjust to a much less stable and predictable world. In one sense this increases their value as a stabilising influence, protecting the telecommunications user from the uncertainty and risk of a highly competitive market. Others will argue that the PTTs tend to act more as a barrier to innovation than a stabilising influence.

However there is little doubt that the PTTs are eager to adapt. One sign of this is the greatly accelerated procedure for approval of standards adopted by CCITT. The X.25 packet-switching standard, for example, moved from draft to acceptance in just ten months. But can the PTTs successfully combine their traditional role as upholder of standards with the role of innovator which present circumstances appear to demand?

2 Enhanced role of the telecommunications network

Networks are increasingly seen as more than a means of transporting data from one point to another. Rather they have become a means of access to a variety of telecommunications-related services. This is best demonstrated by the Value-Added Networks which have sprung up recently in the US (discussed in Section V). At present similar networks cannot be established by private companies in Europe without PTT approval, which so far has not often been forthcoming and then tends to be hedged about with qualifications.

If the US experience is anything to go by, the market for such services exists and is a large one. If the PTTs themselves are to provide such services they will have to develop system skills which hitherto have been the preserve of the computer manufacturers. The voice network is itself a highly complex total system. Can the PTTs transfer these voice communications skills into other media such as data or must their monopoly be liberalised to allow others to do so?

3 Widening of the subscriber equipment market

The micro-circuit revolution has also dramatically reduced the cost of entry to the subscriber equipment market. Large numbers of enhanced telephone devices are appearing

on the US market. The range of choice of data terminals could well increase as quickly. Office equipment which has hitherto been stand-alone is quickly acquiring a communications capability. Can the PTTs which enforce restrictive line attachment policies continue to operate these without denying or delaying subscriber access to valuable new tools?

C The Future – Some Projections

A French study carried out between 1973 and 1976 illustrates the overriding influence of telecommunications policy in determining not only the shape of data communications in the future, but also its impact on the business community and hence the economy in general. Coherent descriptions of the future of data communications in France in 1985 were developed, based on differing assumptions. This resulted in four scenarios which were presented to different panels including businessmen, computer and telecommunications specialists, sociologists and journalists. The four scenarios and the responses they elicited were as follows:

Scenario 1: Past trends extended

This shows the situation arising if past trends in data communications continue unchanged: a proliferation of private networks; extensive use of data communications limited to government and large corporations; and no impact on domestic users.

The main effects of this include:

- increased centralisation for public administration
- increased market leadership for IBM
- difficulties for large corporations in choosing between teleprocessing and local processing using mini-computers.

This was regarded as the least attractive scenario, but was generally used as a reference against which to compare the others.

Scenario 2: Absolute priority to telecommunications

Assigning absolute priority to the development of telecommunications would probably lead to the appearance of public networks for cable and computer communications; separation of operational and regulating authority in the PTT and development of its marketing capability; and the emergence of new services for business and private use.

The consequences would be:

- wider use of computers in business including an impact on management methods
- the spread of home terminals
- political debate about privacy.

This was seen as the most attractive and at the same time the least probable scenario – the collective economic effort required was considered far too great. It also aroused the greatest diversity of reaction, some seeing it as the ideal and others as akin to Brave New World and other visions of a de-humanised future.

Scenario 3: Integration of private networks into the public network

A policy which directed efforts towards integration of existing private networks into a public

network would entail provision of a public data network with a good service level; promotion of data communications services to corporate users; and separation of operational and regulating authority on the public network, leading to competition between the PTT and private dp firms (value-added carriers) for services.

The main consequences would be:

- general access to data communications for corporations irrespective of size, with some consequent impact on management methods
- no home terminals but access to computer-based utilities like data banks.

This was regarded as both the most acceptable and the most probable scenario; an improvement on the first and reassuringly less radical than the second.

Scenario 4: Concentration of facilities in 'computer utilities'

This final scenario pre-supposes that the PTT will develop a public network connected to large dp facilities operated by the PTT and a few large organisations; both the processing services offered by these 'utilities' and data communications services would be promoted to corporations; and there would be protective regulation for the PTT based on a national plan for telecommunications.

The main effects of such a policy could be:

- dominance by the organisations operating 'utilities'
- increased centralisation of administration
- planned development of the telecommunications market.

This was the most controversial scenario, rejected by many for moral or political reasons as too authoritarian.

General conclusions drawn from the study were that data communications are widely regarded as an important factor in the development of organisations, and that data networks will play a key role in that development. While larger firms were sceptical about the economic advantages of public networks, smaller users saw them as a unique opportunity to gain access to new management techniques. The study also revealed a lack of knowledge about government policy, hand in hand with real concern that none existed. Particular fears expressed were that privacy and security of data transmission would not be maintained, and that IBM would assume quasi-monopolistic power if not contested by public power.

The study was of course conducted in France and took particular account of French economic, political and social realities. Compared with France there are major differences in the state of development of the PTT networks in other countries, described later in this report. These differences will persist for some time yet, but increasingly the European nations are harmonising their plans, and there are underlying fundamental similarities. Thus one could regard these scenarios as valid in their overall thrust for all the European countries, though with differences in timing and emphasis.

What is clearly demonstrated is that telecommunications policy will have a profound effect on the development of data communications. It will determine not only what form future services take but also their cost to the user and hence his freedom to take advantage of them.

D The Business Opportunities

The growth of new public data services will both be stimulated by and will itself stimulate new

applications which require different facilities from those available now. Three in particular are likely to prove significant:

1 **Information retrieval**
By this we mean access to large data banks, such as are now widely available in the US and are starting to be made available in Europe. Many of these are highly specialised, and only of marginal interest to many business organisations. Growth into other more familiar areas could happen quickly once a simple and more cost-effective means of access is provided.

2 **Electronic mail**
The rising cost of physical mail and the increased use of electronic means of creating and reproducing documents combine to make electronic transmission of mail an attractive proposition. It is likely to be used first of all for internal mail, because this poses fewer system problems. Both system and political problems need to be solved before external (i.e. inter-company) electronic mail becomes widespread. Since it would probably use off-peak network capacity it promises major economic advantages for both carriers and users.

3 **Electronic Funds Transfer System (EFTS)**
An EFTS linking retail outlets and banking systems for credit verification and automatic credit transfer is a vast potential market for data communications. For the commercial banks it would mean a reduction in the cost of their present paper-based systems; for the retailers, simplified accounting and less risk of bad debts. For the carrier it could mean a substantial base load for a public data network.

These are all applications which require a flexible means of connection, rather than the dedicated, pre-planned data network typical of most dp systems. They also demand a level of service which the present switched networks cannot provide.

III. AN OVERVIEW OF SERVICES IN EUROPE

The European PTTs are busy formulating and in some cases have already embarked on plans for future public data services. A wide measure of agreement has been reached on transmission and interface standards, which should make longer term co-operation possible. There is also some agreement on general aims.

Nonetheless the overall picture is somewhat fragmented. A major determinant of progress tends to be the need of each PTT to safeguard its existing massive investment in the voice system. In this section we summarise the options which are open, progress made so far and plans for the future. We also look at an important supra-national development, Euronet.

A The Options

In many European countries the first steps are already being taken towards the all-electronic, digital networks which may carry the bulk of both voice and data communications before the end of this century. Some view that as an unrealistic dream, and in any event it is too far ahead to be of direct interest to the user of data communications. In the meantime the user will be faced with a range of alternatives, while existing and outmoded services are progressively phased out and replaced by new ones. In some cases interim solutions will be needed where these two processes do not dovetail closely enough or where demand exceeds earlier PTT expectations.

As the voice system constitutes by far the major portion of PTTs' business, and will continue to do so for the foreseeable future, plans for its development tend to influence the options for data and, to a certain extent, timescales for development. Thus the Federal German Republic (FGR) with a good electro-mechanical voice network and no capacity problems, is planning to invest heavily in a separate data network based on a modernised telex system. Countries like France and Britain, on the other hand, have an urgent need to modernise their voice networks. Since digital transmission will be achieved on trunk routes by the mid-1980s, they see no reason to disturb the traditional relationship between voice and data, hitherto both carried on the same analogue network. The trunk network will therefore remain a common resource, with local lines of appropriate quality providing access to the different services offered.

Some PTTs also face the problem of bridging a gap between the present time, when there is already a shortage of line or switching capacity, and the introduction of digital networks. For this, packet-switching offers a possible solution, since it can now be regarded as a proven data switching technique and also makes good use of line capacity. The cost for the user is more expensive terminal equipment, and therein lies the problem. For a packet-switched service to be cost-effective it must attract enough traffic for the benefits of its sophisticated multiplexing techniques to be felt. Yet the threshold cost of packet-switching for the user is still high compared with traditional methods using leased lines or the PSTN.

In summary, the alternatives which are likely to confront the user in the medium term (say to 1988) are as follows:

1. Dial-up lines on the public telephone network, with a maximum speed of 2400 bit/s now, extending to 4800 bit/s in the UK and FGR shortly.

2. Private leased lines, now on the analogue network but later over PCM links, with speeds ranging from 50 bit/s to 48K bit/s in most countries. Broad band circuits of 240K bit/s and 2.048M bit/s will be available on some routes.

3. The switched telex network, also carrying start/stop data traffic up to 300 bit/s and possibly linking with PSTN services in some countries.

4. Packet-switched services; access will be at speeds from 2400 to 48K bit/s for packet terminals and at lower speeds for character devices like teletypes.

5. Circuit-switched digital services on a synchronous network with speeds from 50 bit/s up to 48K bit/s.

The following table shows classes of service for public data networks corresponding to alternatives 4 and 5 above, contained in CCITT recommendation X.1.

Service Class	Terminal Mode	Data Rate (bit/s)
1	Start-stop	300 (22 units/char.)
2	Start-stop	50-200 (7.5 to 11 units/char.)
3	Synchronous	600
4	"	2,400
5	"	4,800
6	"	9,600
7	"	48,000
8	Packet	2,400
9	"	4,800
10	"	9,600
11	"	48,000

Notes:
1. Address selection and call progress signals will be at the highest speed shown in each case. International alphabet no. 5 will apply for classes 1-7, recommendation X.25 for classes 8-11.

2. Terminals in different service classes may communicate in packet mode; in synchronous mode they must belong to the same class.

Classes of Service for Public Data Networks (CCITT Recommendation X.1)

B Planned National Services

The differing plans of European telecommunications authorities for public data services are reviewed below.

The review is divided into three sections, dealing with services 3, 4 and 5 listed above – telex, packet-switched and circuit-switched synchronous.

1 Telex networks

The telex network was designed to handle information in message format. Thus there would appear to be scope for it to handle data traffic at a more economic rate than the telephone network, designed for real-time speech communication. In practice though two factors in particular erode this potential advantage. Firstly, the methods of call set-up differ from those used on the PSTN, which means that most users would need a separate set of ports on their computer systems for PSTN and telex access. Secondly, without major investment in new plant, speed is limited to 300 bit/s or less. For most modern applications this is not enough.

For reasons already explained, the Bundespost has nonetheless based its plans for data communications on the telex network, starting with class 1 and 2 start/stop services and moving on to higher speed synchronous services. The new network is called Integrated Telex and Data Network (IDN), and data users are being encouraged to use it in preference to the PSTN. Other countries in Europe, also faced with the need to modernise their telex networks, are introducing data services, but none on the scale planned by the FGR.

2 Packet-switched networks

Spain was the first European country to offer a public message switching service, although not at first using packet-switching techniques. The CTNE network was introduced in 1973 and is now being modified to conform to international standards for packet-switching (CCITT recommendation X.25).

In France the Transpac network is scheduled to open in June this year. It will have 12 packet-switching exchanges and 13 additional access points. Many of the latter will be upgraded to full exchanges by 1980 and further access points will be added. The objective is that no user should be more than 100 km. from the nearest access point. Tariffs for Transpac will be distance-independent. This will make them price-competitive with PSTN tariffs over 150 km, and with private leased lines averaging less than 20 hours use per month.

Other European administrations, including the British Post Office, have announced their intention to introduce a packet-switching service. All are expected to conform to the X.25 interface standard, but there are differences in the facilities to be provided:

Country	Date of Service	Service Classes	Network Name	Forecast no. of Terminals (1980) Character	Packet
Belgium	1979 (experimental) 1980 (public)	8-11 8-11		750	50
FGR	1979 (limited)	8-11		-	-
France	1978	8-11	Transpac	3000	-
Italy	1980 or later	8-11		-	-
Netherlands	1979	8-11	DN-1	0	300[1]
Nordic Group	1980 or later	8-11		-	-
Spain	1973[2] 1978	8-10) 11)	RETD	8500	400

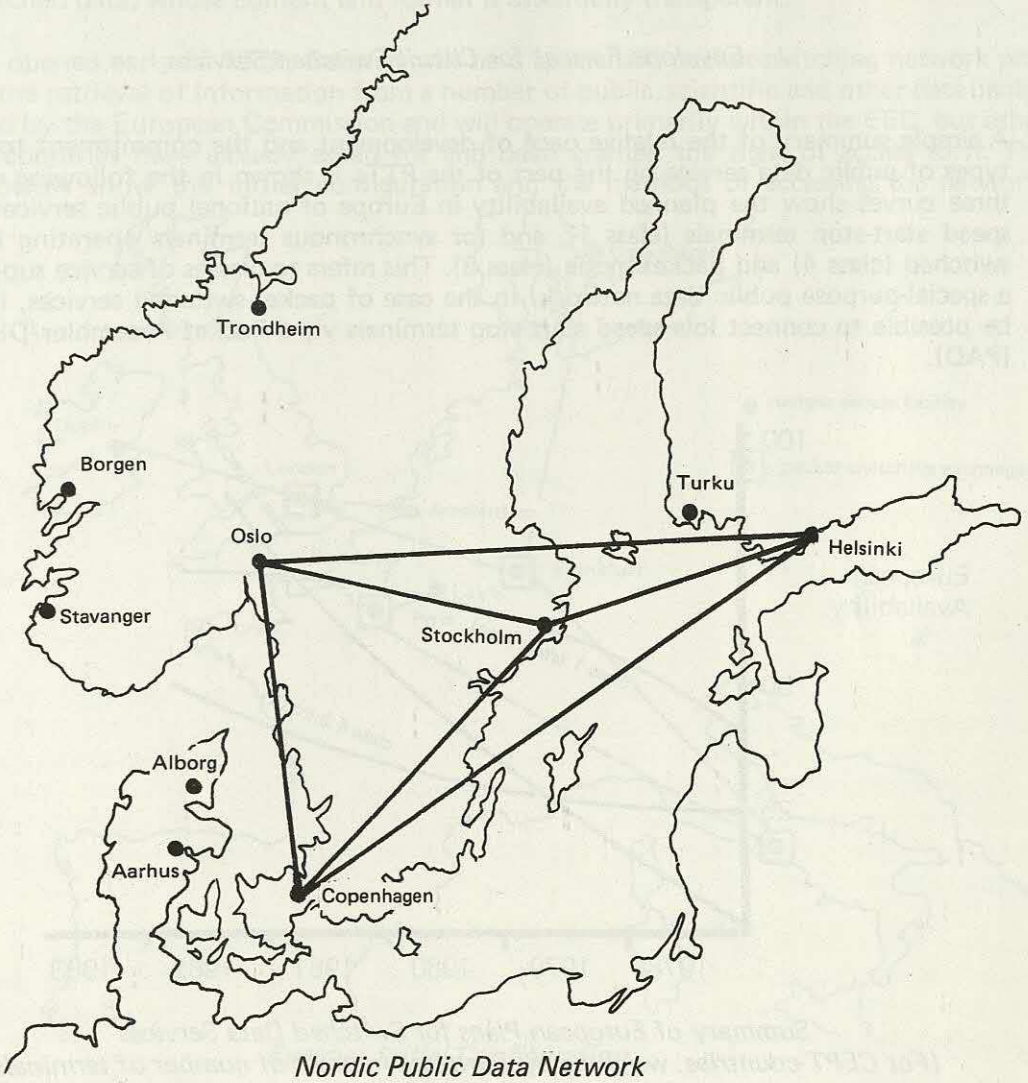
Switzerland	1978	8-10		500-2000	-
UK	1979/80	8-11	PSS	1350	150

Notes:
1. This represents the number of packet mode interface processors through which between 3000 and 4000 terminals and 13 host processors will be connected.
2. Now being converted to X.25 standard.

PTT Plans for Public Packet-Switched Services

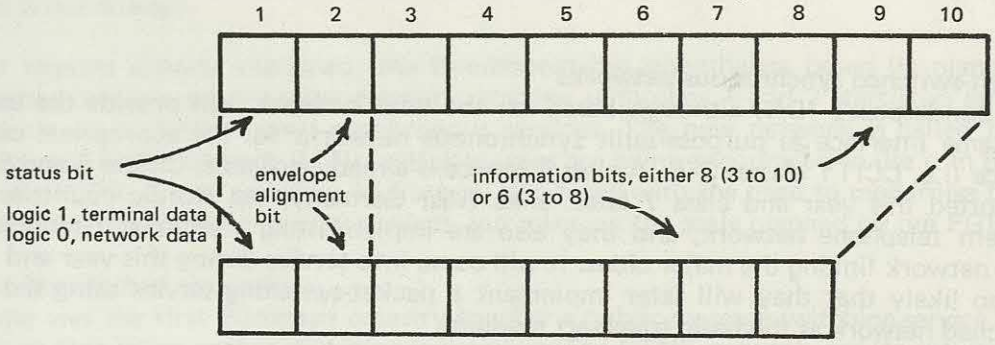
3 Circuit-switched synchronous networks

The Bundespost's IDN, although based on the telex network, will provide the user with the same interface as purpose-built synchronous networks for the appropriate classes of service (i.e. CCITT classes 3-7). A class 4 service is already available. Classes 5 and 6 will be supported this year and class 7 later. Like West Germany, the Nordic countries have a modern telephone network, and they also are implementing a separate circuit-switched data network linking the major cities. It will come into service during this year and next. It is also likely that they will later implement a packet-switching service using the circuit-switched network as the basic transport medium.



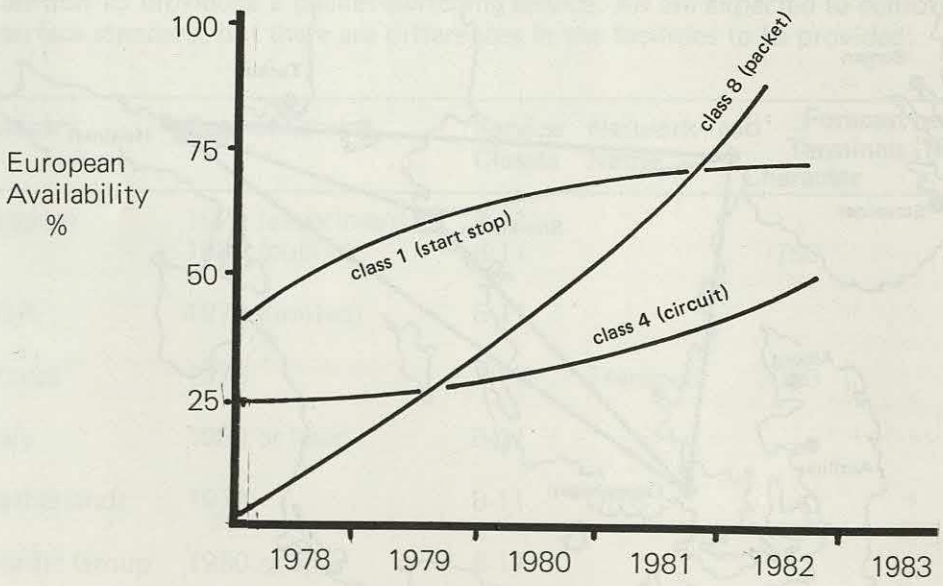
Nordic Public Data Network

Other countries including the UK, France and Italy, while acknowledging the need for circuit-switched services, have left their precise options open. They will no doubt wait until the spread of digital telephone transmission has made such services more attractive economically. One clear indication that this is so is the expressed preference of the three countries mentioned for an 8-bit envelope structure, which is what is used for digital telephony. Both the Bundespost and the Nordic groups on the other hand have opted for a 10-bit envelope, which is more attractive on purely technical grounds but incompatible with telephony. Unless it is resolved this divergence may lead to later difficulties in inter-working between national systems using different standards.



Envelope Format for Circuit-Switched Services

A simple summary of the relative pace of development and the commitment to different types of public data service on the part of the PTTs is shown in the following chart. The three curves show the planned availability in Europe of national public services for low-speed start-stop terminals (class 1), and for synchronous terminals operating in circuit-switched (class 4) and packet mode (class 8). This refers to classes of service supported by a special-purpose public data network. In the case of packet-switched services, it will also be possible to connect low-speed start-stop terminals via a Packet Assembler/Diassembler (PAD).



Summary of European Plans for Switched Data Services
(For CEPT countries, weighted by Eurodata forecast of number of terminals)

What the curves illustrate is the almost universal commitment to packet-switching, stemming both from its present popularity and relative ease of development. Circuit-switching on the other hand attracts lip-service but few definite plans as yet. Although relatively well-established there is less certainty still about low-speed data services, both because packet-switching competes with these and because of low forecast demand.

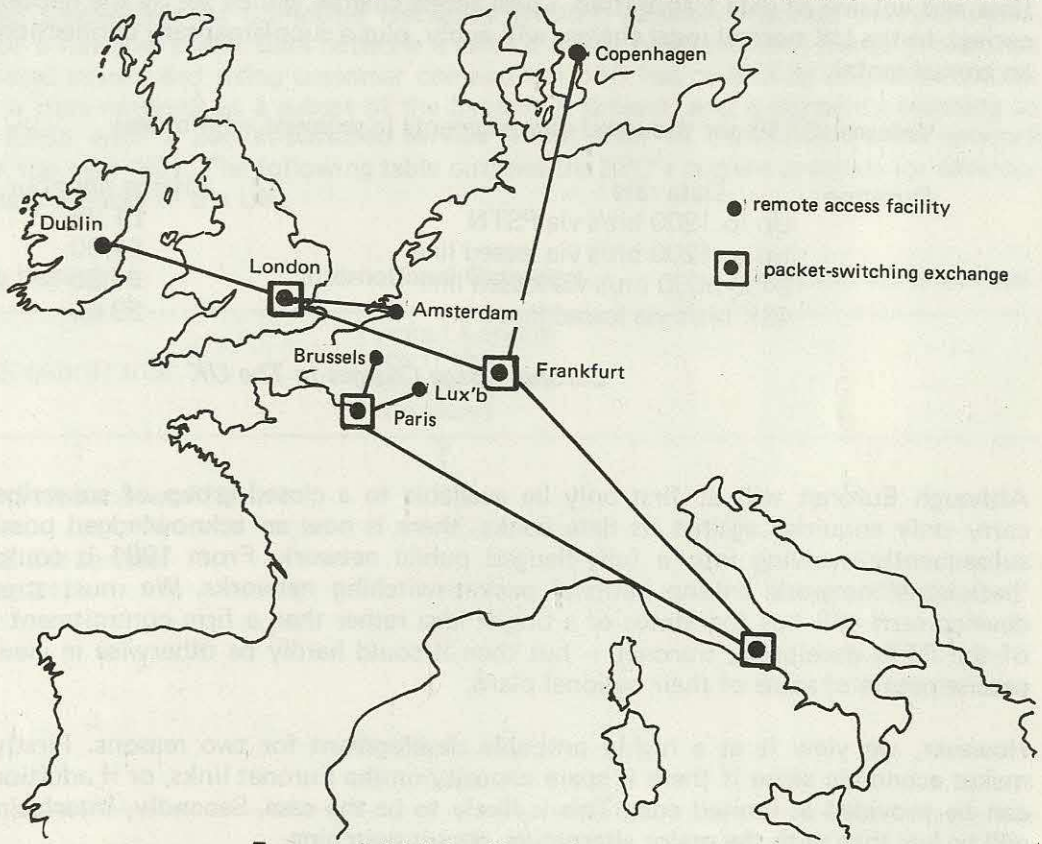
C International Services

There are few clear indicators of the form which future international data communications services within Europe will take. Users can expect to continue to rely for some time on existing services for most purposes using switched or leased lines on the analogue network.

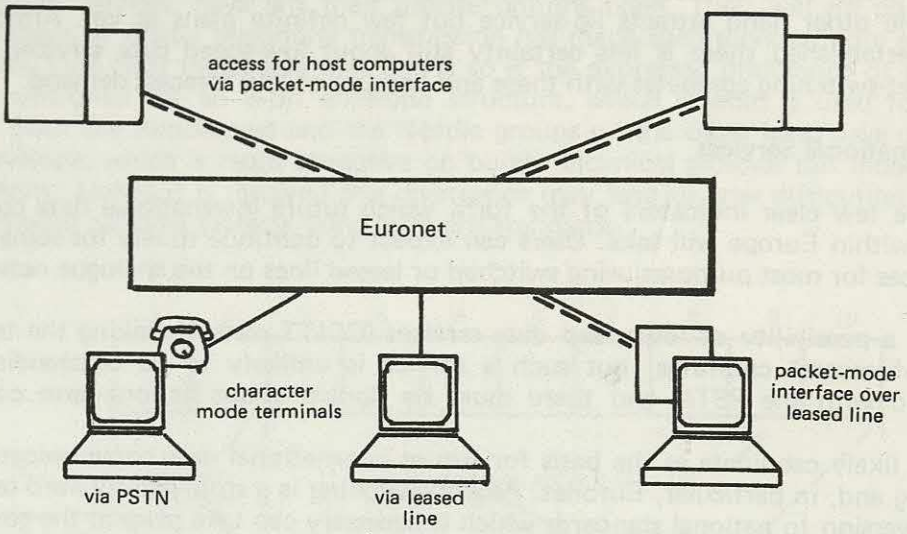
There is a possibility of low-speed data services (CCITT class 1) linking the telex-based networks of several countries, but such a service is unlikely to be outstandingly attractive compared with the PSTN and there must be doubts about its long-term competitiveness.

A more likely candidate as the basis for future international data communications is packet-switching and, in particular, Euronet. Packet-switching is a store-and-forward technique. Thus any conversion to national standards which is necessary can take place at the gateway between two national systems, rather than having to be achieved 'on the fly' in real time as with circuit-switching. This could also be an advantage if interworking is bedevilled by national differences in data protection legislation. Data packets can more easily be inspected or accounted for than circuit-switched data, whose content and format is essentially transparent.

When it is opened early in 1979, Euronet will be a specialised packet-switching network providing for the retrieval of information from a number of public, scientific and other data banks. It is funded by the European Commission and will operate primarily within the EEC, but other European countries have already asked for and been granted the right of access to it. The diagrams below show the initial configuration and the methods of accessing the network.



Euronet Initial Configuration



Euronet — Access for Terminals

There will be packet-switching exchanges in London, Paris, Frankfurt and Rome, and five other access points. Protocols and access procedures will be similar to those for the French national packet-switching network Transpac, and are based on the CCITT X.25 standard. Connection can be by dial-up or by private leased line, at speeds up to 1200 bit/s. Tariffs for Euronet have just been announced and follow the same general principles as Transpac. The usage charge will be standard throughout Europe. It is distance-independent and depends on both connection time and volume of data transmitted. Local access charges will be set by the national PTT concerned. In the UK normal local charges will apply, plus a supplementary connection charge and an annual rental.

Volume: £1.15 per thousand data segments (a segment = 64 bytes)

Duration:

Data rate	Charge per hour
Up to 1200 bit/s via PSTN	£1.35
Up to 1200 bit/s via leased line	£1.00
2400-9600 bit/s via leased line	£1.35
48K bit/s via leased line	£3.60

Euronet Usage Charges In The UK

Although Euronet will at first only be available to a closed group of subscribers and will carry only enquiries against its data banks, there is now an acknowledged possibility of it subsequently evolving into a fully-fledged public network. From 1981 it could serve as a 'back-bone' network linking national packet-switching networks. We must stress that this development still has the status of a bright idea rather than a firm commitment on the part of the PTTs developing Euronet — but then it could hardly be otherwise in view of the imprecise nature of some of their national plans.

However, we view it as a highly probable development for two reasons. Firstly, it clearly makes economic sense if there is spare capacity on the Euronet links, or if additional capacity can be provided at limited cost. This is likely to be the case. Secondly, interfacing problems will be less than with the major alternative, circuit-switching.

IV. BPO PLANS FOR THE UK

Increasing activity in international data communications elsewhere, together with market pressures at home, have led the BPO to bring forward its plans for public data communication services in the UK. As a consequence the last two years have seen a significant number of announcements by the BPO in data networking. In this section we review both current services and future BPO plans.

A. The Demand for New Services

Data communications networks are appearing both in North America and Europe. Access to both timesharing bureaux and data bases may be made via such networks. To offer UK customers the latter services, it has been necessary to extend the data networks into London (Tymnet, Telenet, Euronet). In turn this has stimulated demand for our own UK data network, compatible with the overseas networks.

At the same time, the UK has the largest installed base of terminals in Europe, with 45000 connections to the telephone network in 1977. There are moves towards text processing and communication, with over thirty equipment vendors in the UK market. The banks and retailers are discussing the introduction of EFTS in the near future. And the advent of Viewdata (see Report Series No 6) may lead to a greatly increased demand for data transmission.

The National Committee on Computer Networks (NCCN) recently reported that the implementation of a national public data network is critical to our economic well being. In response to international events and rising customer demand the BPO has revised its original intention to develop a data network as a subset of the System X project, and is currently planning to follow up EPSS with a packet-switched service (PSS), prior to a circuit-switched network planned for the mid '80s. The following table outlines the BPO's current program for developing public data services in the UK.

	Data Networks	International Gateways	Datel and other services
1977	EPSS (April) trial	Tymnet London node (Feb) Telenet London node (July)	
	PSS announcement (Jan)		
	EPSS full service (June 24)		Datel 11a Modem 4800 bit/s
1978			Dataplex intelligent line multiplexor
		Euronet London node (Dec)	

(continued)

1979	PSS installation	US gateway to common carrier networks	Viewdata public service
	PSS in service		9600 Modem bit/s
	Telex SPC network		
Early 1980s	PCM trunk routes		
	Single circuit switch trial		
	System X field trials		
Mid 1980s	Circuit switch network		
	PCM links down to local exchange		

Programme for Public Data Services in the UK

Users faced with network planning for data traffic over the next five years will naturally be concerned with the following key aspects of the new or planned BPO services (we emphasise these in the review which follows):

— the geographic coverage of the service

— the tariff structure

— the timescales for introduction and growth

— the standards under which the network will operate.

B Point-to-Point Services

Point-to-point services are highly flexible in the sense that they have full geographic coverage (anywhere there is a telephone line), and they require equipment which is relatively inexpensive. However the facilities for line control (error detection, speed conversion) are minimal and there is no switching capability.

The two main point-to-point services offered by the BPO are Datel and Dataplex.

1 Datel

The BPO provide a range of their own modems up to speeds of 1200/2400 bit/s for use on both the public and private networks. By mid-1978 it will be offering a 4800 bit/s modem, Datel 11, capable of public and private line operation in the UK and international networks. A 9600 bit/s modem will become available in 1979 (not specifically designed for the BPO) at a rental of approximately £1300/annum, compared to around £1000 for the Datel 11.

Demand for the Datel service is growing at an annual rate of 17% from an installed base of over 45,000 units presently. The major requirement is still for low speed Datel 200 (300

bit/s), indicating that most organisations are not seeking to minimise line costs by multiplexing remote teleprinters together (see the Dataplex service below). Recent increases in the numbers of intelligent terminals with local store and synchronous communication at 2400 bit/s is beginning to shift the modem population towards the higher speeds with consequent benefits for the user in terms of line utilisation.

Future offerings will concentrate on simpler switch-over between line speeds, with plug-in boards to determine the transmission rate. Full duplex will become available at higher speeds. The units will become physically more compact as more circuit integration takes place. All these additional facilities will be charged for in increments to a basic annual rental charge.

2 Dataplex

This service provides a particularly cost-effective approach to point-to-point communications where several low speed terminals are connected remotely to a common dp centre. For example, ten teletypes may be multiplexed over a single 4800 bit/s private line thereby minimising line costs for remote timeshared services. Difficulties with equipment have meant a temporary halt to this service. However the BPO will be introducing a considerably more advanced system this summer based on an intelligent line multiplexor. This unit will provide local storage, error correction, tolerance to line breaks, and a higher throughput capability (operating at 4800/9600 bit/s). The new equipment is programmable, and advanced features will be offered at a higher cost. An estimated rental for a node serving ten terminals will be £2,500 per annum.

The integration of microprocessors into such line equipment is presently providing the network user with many new options. It is likely that Dataplex will shortly become more than a point-to-point service, if the commercial success of such systems as the Codex 6030 'Intelligent Network Processor' is any guide.

C Data Networks

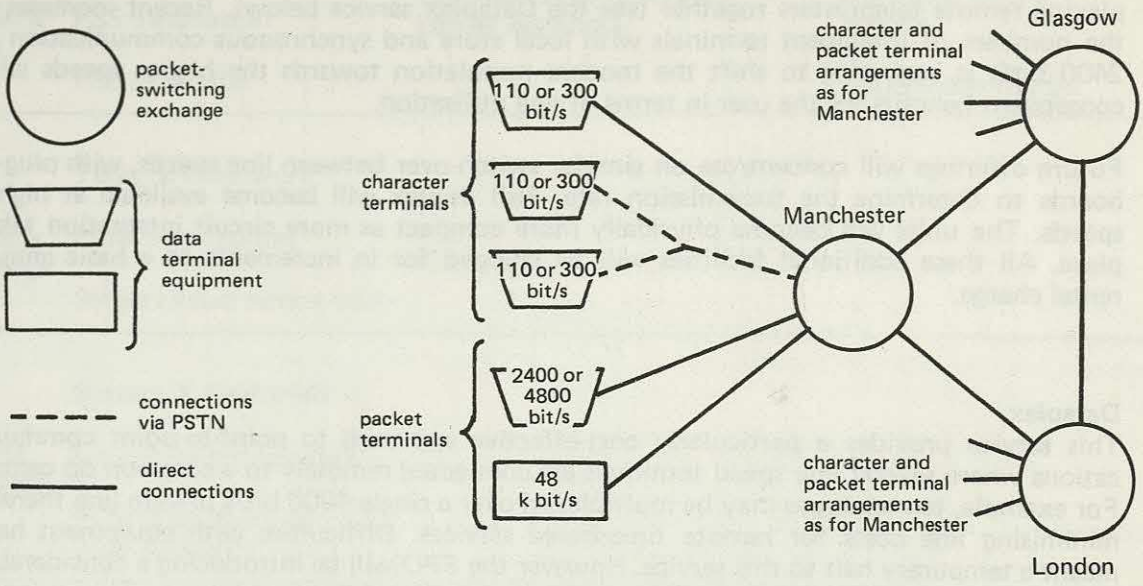
Compared with point-to-point services, data networks offer both increased line control and switching to alternate destinations specified by the data source.

The BPO's involvement in data networks began when they were still at an early stage in their development. Consequently, the design of the Experimental Packet Switched Service (EPSS) pre-empted the arrival of international standards such as X.25. As a result, international events have overtaken the BPO's planning and brought it to the stage where it is being driven by progress on external networks such as Euronet and Telenet. It is therefore likely that the structure of the proposed new packet-switched service will evolve directly from networks developed outside the UK, in terms of both technology and standards. One important consequence will be that users in the UK will be better able to gain access to data bases held overseas.

In this subsection we expand on this brief outline by discussing the BPO's involvement in data networks under three headings: EPSS, PSS, and international connections.

1 EPSS

Data traffic on EPSS began on a trial basis in April 1977. The network now has three nodes, in London, Manchester and Glasgow, interlinked by 48k bit/s lines. Character terminals of 110/300 bit/s and packet terminals of 2400, 4800 and 48k bit/s are connected to the nodes either by dial-up or leased lines. The main users include government, universities, the BPO, the NPL, the CCA and some of the mainframe manufacturers.



EPSS network, current configuration

A formal tariff structure which will be introduced this June is outlined in the following table:

	rental £pa			connection £		
basic charge	2400 bit/s	4800 bit/s	48k bit/s	2400 bit/s	4800 bit/s	48k bit/s
distance of connection 4km	220	220	1890	40	40	450
distance of connection 16km	450	450	2845	40	40	600
distance of connection 32km	600	600	3615	60	60	600
modem charge	(Datel 7) 330	(Datel 15) 900	(Datel 8) 1260	(Datel 7) 100	(Datel 15) 100	(Datel 8) 150 short 300 long
post access charge for dial-up connections	600	750	3800	100	120	200

distance independent charge for packets of data
transmission — 95p for 1000 packets of 255 bytes each
virtual connection — 10p for each half hour connected

EPSS tariff structure

EPSS is freely admitted to be less than ideal. The software controlled line protocol requires considerable user investment in interfacing equipment. Compatibility with X.25 cannot be achieved easily, and although the network was designed to give a high throughput which is at present well in excess of the needs of most commercial organisations, the high incremental cost of increasing network capacity with rising demand makes EPSS unsuitable for future commercial use.

However both the BPO and users have benefitted in practical network experience through the introduction of EPSS, and some higher level protocols developed for the network could find an application in future services. One of the major lessons learnt from it is the need for modularity to allow future networks to be expanded inexpensively to meet rising traffic demands.

2 PSS

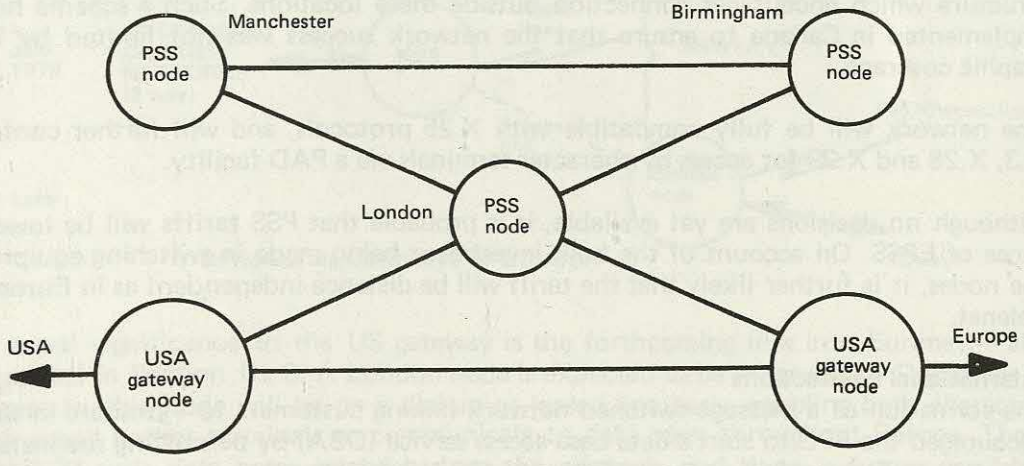
The public announcement of PSS was made in February 1978. It has yet to receive full BPO board approval, but if adopted it should be installed in mid 1979, with a user service commencing in either late 1979 or in the first quarter of 1980. As explained earlier, the decision to pre-empt the planned circuit-switched service associated with System X is largely due to events on the international scene, and also to the belief that packet switching is the currently favoured means of data communications.

The urgency of providing such a service has further constrained the BPO and UK manufacturers to look for proven technology, in order that a two year time-scale can be achieved. It is yet to be decided whether this technology is to come from Europe or North America.

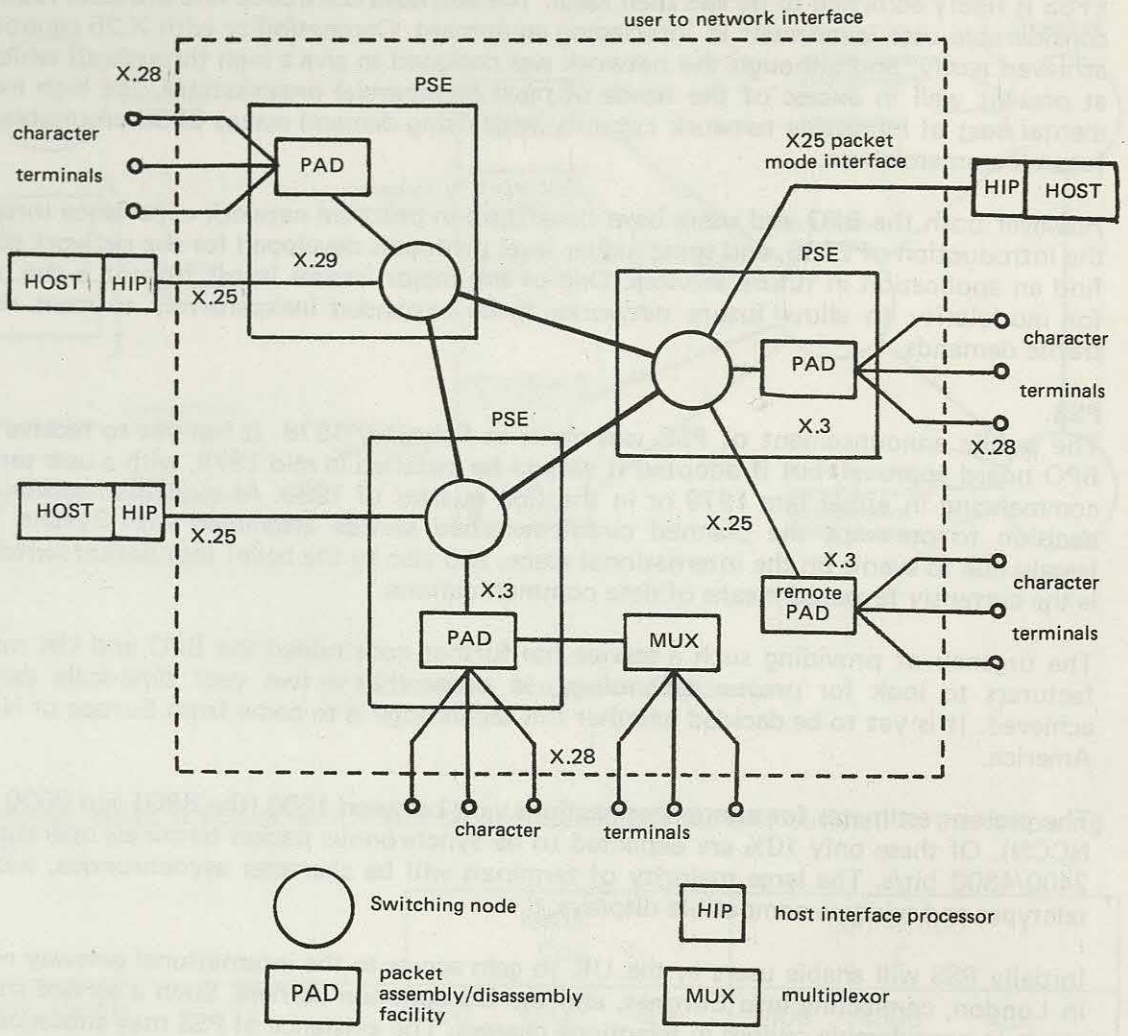
The present estimates for annual connections vary between 1500 (the BPO) and 3000 (the NCCN). Of these only 10% are expected to be synchronous packet terminals operating at 2400/4800 bit/s. The large majority of terminals will be character asynchronous, such as teletypes and teletype-compatible displays.

Initially PSS will enable users in the UK to gain access to the international gateway nodes in London, connecting into Euronet, and the US common carriers. Such a service should result in considerable savings in telephone charges. The existence of PSS may subsequently encourage organisations to introduce packet switching into their dp networks, and may in addition spawn new services such as EFTS and inter-company electronic mail.

PSS will initially be contained in three major city codes, with a further six remote access locations.



PSS Packet Switched Network (1979-80)



PSS Interface Procedures

By serving a limited number of high traffic regions, PSS should prove economic to install whilst also satisfying the majority of users. It may however be feasible to introduce a tariff structure which encourages connection outside these locations. Such a scheme has been implemented in Canada to ensure that the network success was not limited by its geographic coverage.

The network will be fully compatible with X.25 protocols, and will further conform to X.3, X.28 and X.29 for access by character terminals via a PAD facility.

Although no decisions are yet available, it is probable that PSS tariffs will be lower than those of EPSS. On account of the bulk investment being made in switching equipment at the nodes, it is further likely that the tariff will be distance-independent as in Euronet and Telenet.

3 International connections

The formation of a message switched network linking customers to Tymshare in the USA encouraged the BPO to start a data base access service (DBA) by permitting the installation of a node to Tymnet in London in February 1977. Subsequently a second node connecting UK customers to Telenet was opened in July 1977. These two nodes are accessible via the

dial-up or leased line networks, using Datel 200 (300 bit/s) modems.

Each user must obtain a password by joining a club. There are now over 100 club members, with weekly traffic to the USA exceeding 10 million characters. The service is surpassing all expectations in popularity.

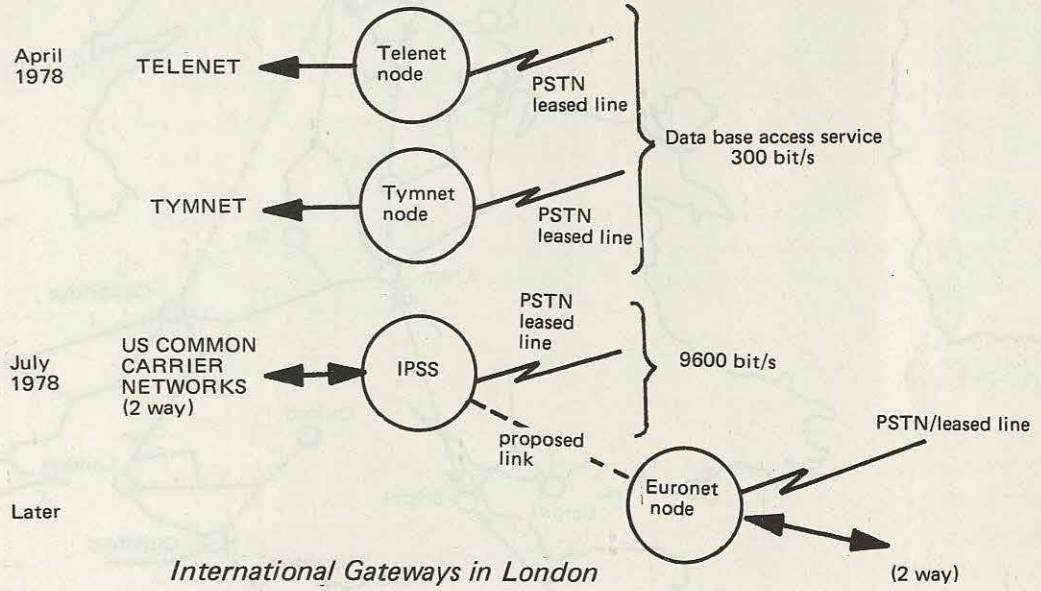
The present network license agreement prohibits point-to-point message communication beyond its use for direct access to data base services. However DBA has acted as an important catalyst for an international gateway service to other networks.

With this in mind, the BPO now intends to establish an international gateway node between the UK and USA. The purpose is to offer a common carrier service between networks located in either country, with full data communications facilities beyond simple data base access.

The BPO is seeking the necessary FCC approval for such a venture as it will use gateway exchanges in the USA as well as the services of international carriers such as Western Union and RCA. Negotiations are also proceeding with the latter organisations. It is reasonable to predict that the service will be introduced late this year or early next. The gateway will be X.25 compatible, and will permit the following means of access:

- dial-up or private wire
- asynchronous terminals at 110, 300, 1200/75 and 1200/1200 bit/s
- synchronous terminals at 2400, 4800 and 9600 (packets) bit/s
- CCITT recommendations: X.1, X.25, X.7x, X.3, X.28 and X.29.

The configuration of nodes in London is shown below:



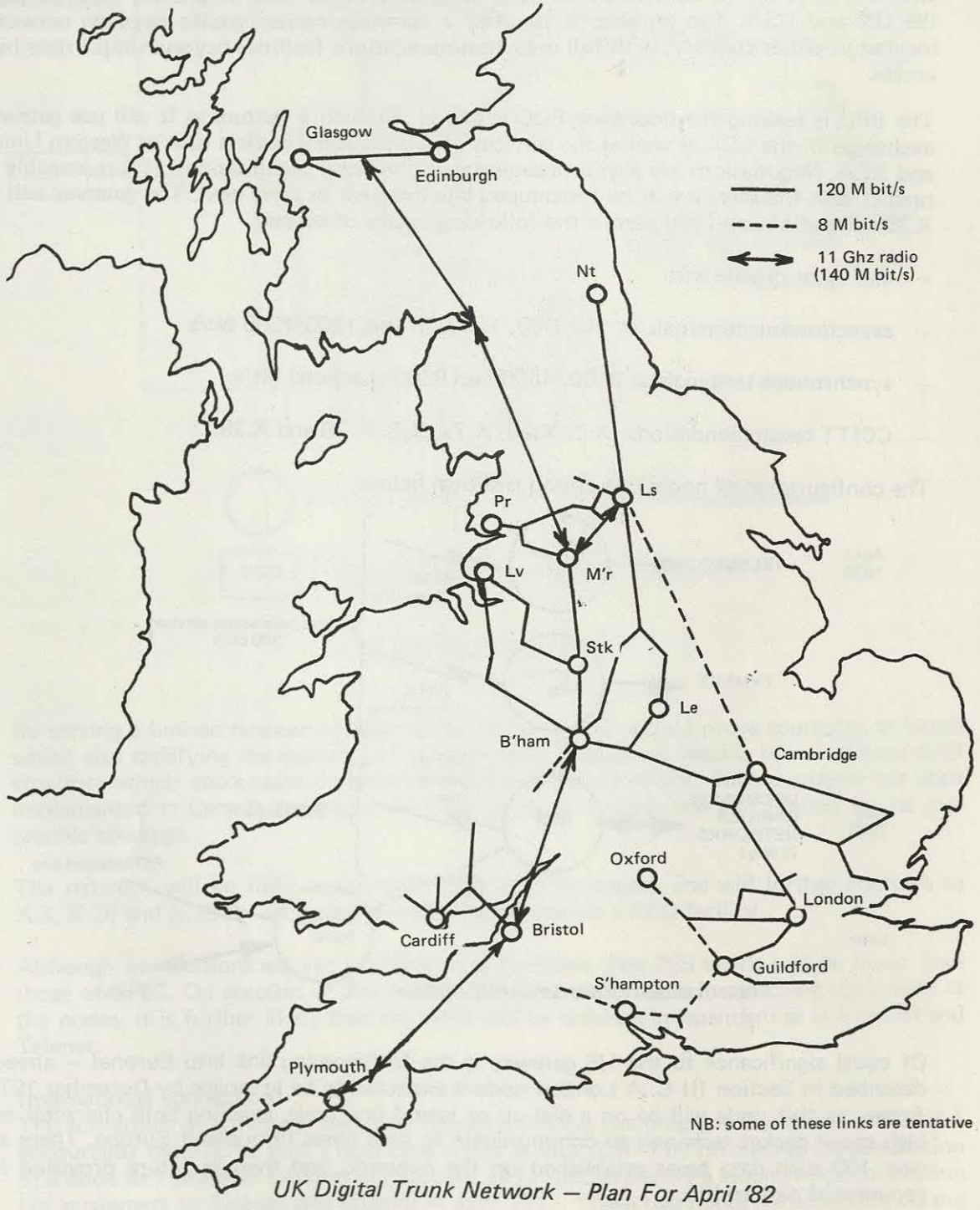
International Gateways in London

Of equal significance to the US gateway is the forthcoming link into Euronet – already described in Section III C. A London node is expected to be in service by December 1978. Access to this node will be on a dial-up or leased line basis, enabling both character and high speed packet terminals to communicate to data bases throughout Europe. There are over 100 such data bases established on the network, and there is future provision for commercial data traffic.

D Longer Term Plans

The BPO's longer term plans are built around the digitisation of the UK telephone network. This is scheduled to take place from the late '70s until the early '90s.

Short haul PCM trunk links are now being installed at the rate of 1000 per year, with a capacity up to 140 M bit/s. These links are between major exchanges, and will not extend out to local exchanges until the mid '80s. A limited number of private PCM lines will be available shortly between five major cities: London, Birmingham, Manchester, Leeds and Bristol. The expected coverage of PCM links by 1982 is shown below.



UK Digital Trunk Network — Plan For April '82

A single circuit switched exchange will be installed by the mid '80s to link these five cities and a further sixteen towns. Although such a switch is linked to the System X programme, sufficient demand in the near future from customers could bring the installation date forward. The procurement of proprietory equipment before the appearance of System X is a strong possibility in the light of the PSS announcement.

These developments are aimed primarily at improving the voice network. But in addition the telex network provides considerable potential for improvement. Already some organisations are expanding its usefulness by front-ending the public lines with a store and forward network. The BPO have initiated a replacement programme for SPC telex exchanges, commencing in 1979. The new network will be able to support low speed data up to 300 bit/s by the early '80s. Services such as Teletex which expand the character range of telex may be with us in this time period.

Another important network for business traffic may emerge through Viewdata. If this service is successful, it may be linked into PSS. It is also intended to be linked with the telex network to provide message store-and-forward facilities.

V. DEVELOPMENTS IN THE US

Following the Carterfone decision in 1968, data communications in the US have undergone some dramatic changes. Both value-added network services and the interconnect industry have grown rapidly and are now substantial markets. Meanwhile the convergence of telecommunications and data processing is demonstrated by the FCC's difficulty in establishing a clear distinction between the two and by the struggle between AT&T and IBM. These two giant corporations are now measuring up one another's markets. It is difficult to see how the FCC can devise a form of words which will prevent a direct confrontation between them.

In this section we describe these developments in the US, and outline briefly the lessons which might be learnt from them in the UK. We review first the regulatory climate because this sets the framework in which the carriers can manoeuvre. Next we examine the variety of existing data services offered both by AT&T and its competition, and finally we discuss developments which are likely to be influential in the near future.

A Regulatory Policy

Unlike the self regulated European PTTs, the USA regulates its common carriers through a Federal Agency, the FCC. All the common carriers are either completely or partially owned by AT&T, so in this context regulatory control means control over AT&T.

Control is necessary for two main reasons: to guard against the possibility that AT&T could cross-subsidise its competitive services, leading to an unfair market advantage; and to prevent the monopoly from restricting access to local distributors by squeezing out competition. So the FCC aims to prevent AT&T from creating unfair advantages and from imposing excessive tariffs.

In practice the FCC is by no means devoid of power. For example a company called Microwave Communications Inc. (MCI) was able to challenge and reverse AT&T's attempt to deny it access to local loops – through the FCC's intervention. AT&T might have used its position to prevent MCI or other common carriers from linking to their customers via the local distribution network. (AT&T has a major investment in the local distribution of telephone circuits; direct competition here is effectively denied because of the high cost of entry into the market).

The following table shows a history of recent FCC regulatory policy decisions:

Date	FCC Decision	Implications
1968	Carterfone	Connection allowed to AT&T's network of competitor's terminals
1970	Hybrid Services	Integrated data and message processing services only, under regulation if primarily a message service
1971	Specialised Common Carrier	Entry of new carriers offering specialised services i.e. high speeds

1972	Interconnect	Type acceptance of terminals handled by FCC
1972	Domestic Satellite	Multiple entry into domestic market, with AT&T and COMSAT directly excluded
1976	Resale and sharing	Recognition of the existence of value added carriers.

Before the advent of data communications the FCC had little difficulty in determining regulatory boundaries within voice communication services. However in the early '60s when data communications advanced into the voice network the FCC launched its first Computer Inquiry. It subsequently concluded that:

- data processing was to remain unregulated
- common carriers (other than AT&T) could provide data processing services through 'arms length' subsidiaries
- if the message communicated remained unaltered in information content then the service was defined as being exclusively communications (this included computer controlled packet switching) and was therefore to be regulated.

The recent trends towards distributed processing and the emergence of intelligent terminals prompted the FCC into a second Computer Inquiry in 1976. The outcome was a restatement of the earlier inquiry concerning what constituted a pure communications network, i.e. what was to be placed under regulatory control: those networks specifically concerned with control, routing and input/output processing, whereby the information content remains unaltered during transportation.

The second inquiry could be crucial to AT&T's strategy to enter the 'end-to-end' communication systems market. AT&T's Dataspeed 40 terminal, marketed in 1973, was declared by the FCC to be a direct move by the company into data processing and thereby illegal according to the 1956 Act prohibiting AT&T from such activities. However, the change in FCC policy together with AT&T's determination to enter the area of data systems could mean that such decisions as Dataspeed 40 will be short-lived.

The move towards combining data processing and communications to form an integrated service caused the FCC to issue a ruling on Hybrid Services in 1970. The ruling inferred that providing the communications network was incidental to the data processing service, the integrated service would remain unregulated. An example was Tymshare, which offered its customers entry to its bureau computers via a message switched network. A further ruling in 1973, concerning Composite Data Services Vendors, enabled common carriers to offer data processing services only through 'arms length' subsidiaries.

The FCC has also felt it necessary to improve customer service by encouraging specialised common carriers to compete with AT&T in prescribed areas of the market.

It first introduced a specialised common carrier ruling in 1971. This permitted other carriers to supply intercity high bandwidth services in competition with AT&T. As a result both MCI and DATRAN were encouraged to introduce microwave data links. The issue of local distribution was resolved by the FCC through the MCI case mentioned above.

In 1972 it introduced the Interconnect decision. The Carterfone decision in 1968 enabled competing terminal manufacturers to connect their equipment to the AT&T voice network. The condition imposed was an examination of the equipment by AT&T to ensure line compatibility, and no potential hazards for the network. Sensitivity by IBM and others to disclosing commercial information concerning the equipment has led to the Interconnect Decision of 1972 which calls for an FCC type approval certificate relating only to line characteristics and not equipment design.

Of increasing importance in the USA is satellite communication. Both AT&T and Comsat have been directly excluded from the domestic market due to their respective monopolies in US telephony and Intelsat. The Domestic Satellite Decision of 1972 has given several other satellite carriers, such as DOMSAT, WESTAR and Satellite Business Systems (SBS), the right to supply domestic network services.

More recently, in 1976, the FCC continued its policy of liberalisation by extending the specialised common carrier ruling. It recognised, through the *resale decision*, that specialised carriers who resell common carrier services after introducing added value should be considered to be a legitimate public service.

Such added value relates entirely to data communications, and includes error correction, alternative routing, load levelling, speed conversion, and distance-independent pricing. The latter implies that the major cost of the service lies in the switching as opposed to transmission.

Amongst the value added carriers, which include Telenet and Tymnet, there is a facsimile service called GRAPHNET which is classed as a 'facilitation'. It is directed principally at resolving line protocol incompatibilities between different facsimile machines.

Although the FCC has introduced several regulatory decisions in the '70s, the real issue of convergence of communications and data processing technologies is yet to reach major proportions. The advent of SBS, which we discuss later in this section, could provoke a head-on collision between AT&T and IBM, the former presently suffering under tight FCC control and the latter almost completely immune from it.

B Existing Data Services

Compared with the UK there are a multitude of data services offered competitively in the USA, adding considerable complexity to the planning of data networks. For example, the choices for switching include either packet or circuit switching; the transmission of information may take place over either terrestrial or satellite links; value added services can offer a range of features such as error correction. And in addition there are other familiar design factors to be considered such as the cost of bandwidth, the quality of service (in terms of error rate and availability), growth potential and flexibility.

Thus the task of optimising a network for business use in the US must involve a careful analysis of the location and nature of data traffic both now and in the future, together with a review of data processing requirements in terms of response times, reliability, terminal compatibility and so on.

The evolution of similar services in the UK will probably be less fragmented due to the BPO's monopoly. But the US experience can provide some meaningful indicators of the directions which may be followed. To this end we describe in this subsection the roles of the US common carriers, specialised carriers and value added networks (VANs), noting the latest trends.

1 Common carriers

The dial-up network in the US is dominated by two major common carriers — AT&T itself, and its Western Union subsidiary. In addition there are ten other common carriers all of which are either partially or completely owned by AT&T. The lines in the dial-up network offer data communication up to 4800 bit/s using modems.

AT&T is actively engaged in the introduction of digital PCM voice lines and dedicated data lines into the network, able to transmit at up to 56K bit/s. This latter service, called the Dataphone Digital Service (DDS) currently operates between 96 cities, forming a medium speed data transmission backbone for the nation.

Western Union itself offers a competitive data communication service to DDS called Data-Com. It operates between 60 cities, and is generally aimed at rather lower speed traffic.

2 **Specialised carriers**

The cost of entering local distribution in competition with AT&T has kept most suppliers out of this market. Instead, competition is focused on the long haul transport network. There are now several specialised carriers offering both analogue and digital intercity lines. Examples include Microwave Communications Inc (MCI) at speeds up to 56K bit/s; Southern Pacific Communications at up to 100K bit/s; and Satellite Companies (owned jointly by Western Union and RCA) renting line capacity of up to 36 MHz on one transponder, providing capacity generally up to 230K bit/s between individual cities.

Specialised carriers must offer either higher reliability or higher data rates than the common carriers to be rated competitors under the FCC ruling of 1971.

3 **VANs**

The VANs offer the use of common carrier lines for data transmission, primarily using store and forward techniques, with added services such as speed conversion and error correction.

A good example is TELENET. This is a packet-switched service operating between 40 cities which has recently been expanded into Europe through a node in London (see Section IV). Various data bases and timesharing bureaux are attached to TELENET.

Tymnet is another example. It is a timesharing bureau, but with a message switch incorporated in the front end allowing customers free communication access. Under the FCC's Hybrid Service Ruling Tymnet has been considered to be a data processing service and until recently has not been subject to regulation. However, it may soon offer pure communications services in addition to data processing.

The tariff structures for VANs generally include a dial-up access charge (or leased line rental charge), an access port charge and a charge related to data volume. The tariffs for TELENET are typical:

- $2 per hour dial-up charge at 2400 bit/s, or $3.5 at 4800 bit/s.
- $50 per month for port access at speeds up to 9.6K bit/s
- $1.25 per 1000 data packets, each up to 255 bits.

How does the cost of using a VAN compare with that of a conventional network? A study undertaken in 1978 offers some guidance. The study compares the cost of connecting a few hundred terminals, distributed sparsely across the US, to a host on the East Coast. The first alternative solution is to connect the terminals via the dial-up network to time-division multiplexors for the purpose of concentrating local terminal traffic, with rented private lines to carry the concentrated traffic. The second alternative is to use TELENET.

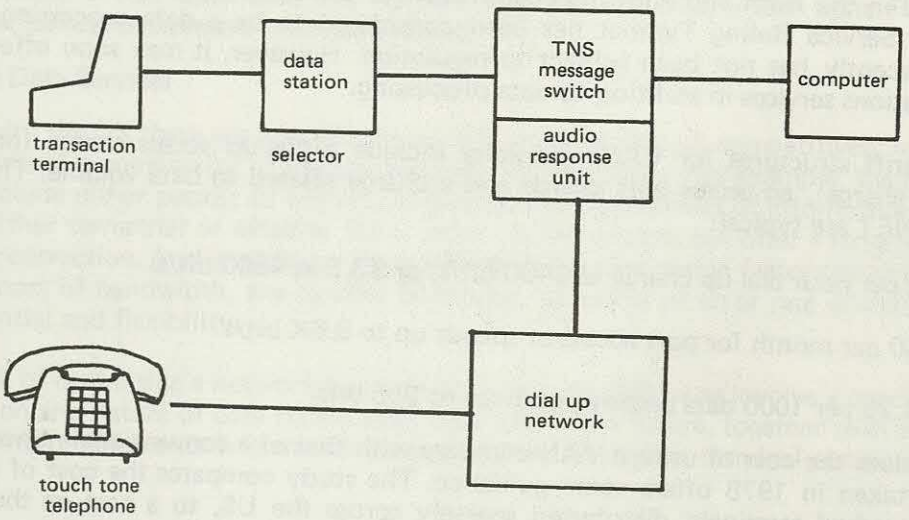
	$/Month	$/Month
First alternative, using private lines:		42,000
Second alternative, using TELENET:		
– cost of local access from terminals to TELENET entry points	21,500	
– cost of port access	2,600	
– cost of data transmission	1,300	
– cost of connecting terminals directly to the host	800	26,200

(Source: NCC 1978, Gerla and Eckl, Network Analysis Corp.)

At the moment, TELENET compares very favourably. However, it should be noted that AT&T has filed a tariff structure amendment with the FCC requesting differential rates on all private lines between high and low density areas of traffic. Such a differential pricing policy will impact the economics of a private line network adversely.

The situation in the US is far from static. For example the suppliers of existing services are moving rapidly towards the provision of so-called 'end-to-end' services. These are complete communications processing networks for data which enable the suppliers to capitalise on the large emerging terminal market, and to increase their revenues beyond those gained from transmission tariffs alone. This step is a natural outcome of the convergence of computing and telecommunications technologies (see Report Series No 5).

AT&T itself has for long been concerned with its relative weakness compared with IBM in the marketing of systems. To help correct this deficiency and to exploit its advantageous position in local distribution it has introduced a new service aimed primarily at data collection and retrieval on local loops, called Transaction Network Service (TNS). It is a response to optimistic predictions of the market growth of applications such as POS, EFTS, credit validation and reservations. TNS presents a systems solution. It includes terminals (touch tone telephones and card readers), line multiplexors, message switches, audio response units and computer interfaces.



Transaction Network Service (TNS)

The similarity to IBM's 3750 PABX, which is offered in Europe but not in the US, is striking.

AT&T is intent on displacing a proportion of the terminal market – which is much bigger business than data communications hardware. The Keyphone in conjunction with a simple eight character display becomes an economic and flexible data entry station. Audio response to enquiries is again compatible with the voice network, and provides an effective output. A more complex transaction terminal directed at supermarket cheque validation, offers card recording, printed response and keyboard entry.

TNS is only now beginning to appear with a few banking customers, and at present messages are limited to 128 characters. However it could provide AT&T with a powerful entry into the data systems market.

C Future Prospects

The convergence of voice and data into a common information processing network is a prospect which could be realised by the mid '80s, especially within large corporate networks. To achieve a strategic stronghold over the total market of the '80s in information processing IBM and AT&T are now attacking one another's markets.

1 IBM and SBS

IBM has formed a partnership with Comsat and Aetna Life Insurance to establish Satellite Business Systems (SBS). Initiated in 1975, and approved by the FCC in 1977, SBS is scheduled to provide service for 30 customers by 1981. And by 1983, SBS plan to be able to support 375 distributed ground stations.

The present estimate for the cost of each ground station is as low as $20,000 for a 5 meter roof-top antenna, but will include a more expensive satellite communications controller (SCC) which attends to signal encoding, multiplexing and demand assignment tasks. Analogue terminals such as telephones, modems and PABXs will interface directly into the SCC, which will support bit rates of 600-19.2 K bit/s (low speed) and up to 6 M bit/s (high speed).

SBS will enable voice and data to be integrated into a single transmission system, based entirely on digital techniques. The high bandwidth will encourage wider transmission and electronic mail between business sites.

Other carriers involved in satellite communications – for example AT&T/GTE's COMSTAR and WU/RCA's AMERICOM – are preparing to offer private network services in advance of SBS. However, IBM's existing base leaves it well placed to exploit the new market. The Justice Department does not share the FCC's eagerness to support SBS, and a major confrontation between the carriers and the government could develop, thereby slowing down the start of the new service.

2 AT&T's Response

AT&T's position contrasts sharply with that of IBM. AT&T has a major strength in its investment in the telephone network, but it lacks experience with data, text and image processing, and it lacks the system selling capability of IBM. Certainly it is responding to the challenge with products such as its TNS end-to-end system and Dataspeed 40, but as yet it has no significant market base.

In addition to TNS it is developing a data network called BDN directed at resolving incompatibility in protocols between different terminals. This is a market which IBM will naturally be excluded from, and could be a strong tactical move for AT&T.

In the coming decade data traffic in the USA will remain a small proportion of AT&T's revenue, forecast to reach only 7% by 1986. Of the total investment in data communications hardware, the ratio between terminal and communications equipment is estimated to be 4:1. Hence AT&T's concern to enter the end-to-end business.

The introduction of an electronic range of 'Dimension' PABX by Bell is also a sign of latent voice-plus-data integration at the site level for a wide range of businesses. The PABX becomes a communications controller in this context.

A recent study by SRI concluded that point of sale, electronic funds transfer, and electronic mail would account for some 90% of all data traffic by 1986. The data traffic in total would amount to 0.67×10^{15} bits, providing revenue of $12.7 billion. By comparison, voice traffic would be equivalent to 1300×10^{15} bits (ie if all the signals were digitised), providing a revenue of $177 billion – almost fourteen times as great. What makes the data sector attrac-

tive, however, is the investment in terminal and communications equipment. For the three applications mentioned above, this is expected to exceed $100 billion by the mid '80s.

D Comparison with the UK

Users in the USA have a wide, if not chaotic, variety of data services offered to them by a large number of competitive vendors. In contrast, users in the UK have only a limited number of services, primarily point-to-point modem connections, offered by a single monopoly supplier, the BPO.

The difference in regulatory control accounts in the main for this discrepancy. Since the Carterfone decision the FCC has progressively liberalised the AT&T monopoly, thereby encouraging active competition across the full range of communication services. No such liberalisation has taken place within the UK, nor Europe in general.

There are two benefits for the UK user arising from the above discrepancies. Firstly, the BPO monopoly will ensure a more orderly introduction of data services than we have seen in the USA. Secondly, the innovative environment of the USA has brought both successes and failures in new services. By being second in the field, the BPO can learn by the mistakes of its North American counterparts.

The market opportunities created by the need for data and text communication are also seen differently by AT&T and the BPO. AT&T is in control of a market comparable in size to that of US data processing. Either it expands into data processing to maintain business growth, or it will find itself threatened by IBM in its traditional communications market.

Thus AT&T is offering end-to-end data systems such as TNS. The BPO is not under the same commercial pressure to expand its business horizons, and it already has a major task in finding the investment capital to modernise the existing voice network, without seeking new investment opportunities.

The logical entry for the BPO into data services is through extending its transmission facilities rather than entering the unfamiliar terminal market. Such new facilities would include packet and circuit switching corresponding to the value added carrier services in the USA. The market forces behind such a move are again different between the countries. The BPO is reacting to customer demand for such services, whereas the VANs are exploiting new business opportunities by satisfying latent needs.

The most fundamental decision for the BPO is whether to follow AT&T into the end-to-end systems market, or to concentrate only on transmission facilities whilst liberalising its monopoly on terminal attachments. The increasing speed of innovation in the latter market, coupled with the BPO's traditional lack of familiarity with data processing, makes a move towards liberalisation highly likely in the next five years.

VI. THE CASE FOR AND AGAINST PUBLIC DATA SERVICES IN THE UK

Data communications networks can provide increasingly sophisticated facilities which have been designed into only a very few UK private business networks, such as at British Steel. The high investment and diverse skills required to implement these facilities into other private networks suggest that a public data service is a more viable alternative both for the short and long term. We discuss the pros and cons in this section.

A Private Data Networks

The business which opts for a private data network is inevitably faced with a number of problems:

- high cost of initial investment, which increasingly includes software development
- constraints on its ability to exploit new advances in technology once the network is designed, assuming a three to five year depreciation period on installed equipment
- the risk of being locked in to a particular mainframe manufacturer's equipment, with adverse consequences for local applications flexibility
- limitations on the growth of intercompany services such as EFTS, as each network will have its own peculiar interfacing requirements.

In addition, existing private business networks based on leased lines and tandem voice exchanges show deficiencies when shared between voice and data communications:

- low bandwidth utilisation for low activity data terminals such as Teletypes
- no line control e.g. error correction and self diagnostics
- limited flexibility, with minimal concentration or multiplexing capabilities, no variable routing and limited line speeds.

Extensive data processing facilities, common to value added US carriers, are required within the network to overcome these difficulties.

There is no doubt also that a multitude of private networks would slow down the development of valuable national services, as well as international network access.

An alternative for the future might be for private businesses in the UK to make use of value added carriers, in the US style. Value added networks could help to overcome the deficiencies of shared voice and data communications channels cited above by providing a range of sophisticated data processing equipment within the network. Such facilities are common to value added networks in the US. However, for this to happen there must be some liberalisation of the BPO charter (1969 Act) which defines the provision of a communications service as the BPO's exclusive privilege.

Such liberalisation seems unlikely in the light of the recent PSS announcement, which indicates that the PBO itself will attempt to fill the role of the value added carriers.

B Public Data Service

The alternative to a go-it-alone approach is for a business to subscribe to a public data service. This offers both benefits and disadvantages to the user.

First, the benefits. The investment cost of a private network is large, and liable to restrain company operations for years ahead, in order to ensure a reasonable ROI. A public service in contrast provides:

- shared investment in plant and operational costs between all users (especially significant for small users)
- payment according to volume usage (avoids issues of spare capacity in a private network)
- traffic load averaging (increases line utilisation, and ensures an economic rate for the service).

A cost-based tariff structure should therefore realise considerable savings for users compared with the private network alternative.

Next, there could be significant benefits from standardisation. Central planning of a public data communications network by the BPO could ensure:

- common network interfaces between all users, facilitating inter-company services
- conformity to international standards which the BPO could influence (UK users would then have access to European networks such as EURONET)
- protection against the dominance of any single computer manufacturer's network architecture, which could lock out other suppliers.

Ideally, the BPO would act as a broker between interested parties rather than necessarily dictating its own standards exclusively.

Finally, the development of a nationwide digital network for voice could provide the basis for a cheap data network overlay, using the PCM lines and digital switching facilities of System X.

However, there are also powerful arguments against a public data service.

First, the scale of investment in a new service together with the complex design issues involved necessitates caution on the part of the BPO and consequently a slow pace of development (though the danger of long time scales may be partially overcome by buying in proven technology from the US or Europe). Once implemented, a public service may be inflexible to increasing demand and change in customer needs, unless it is highly modular in construction.

The cost of providing total geographic coverage from the outset might make the service uneconomic. However, the fact that traffic density in the UK is concentrated in a few major areas minimises this problem, since London, Manchester, Leeds and Birmingham account for over 80% of the traffic. A dial-up connection would enable other locations to gain access, without a high cost penalty.

Next, a public network must necessarily ignore the characteristics of individual user's traffic in order to provide a universal service. The large variation between low level data capture

and bulk data transfer traffic implies a loss of overall efficiency both in network design and operation. However the marginal loss of performance is compensated by the gain in network flexibility. Neither do all needs have to be met by a single public network – the BPO has acknowledged the need for both packet-switched and circuit-switched services in the future.

A major commercial question concerns the lack of choice of a public service operated by a monopoly. The USA exemplifies the benefits of competition in terms of innovative services. The BPO has the advantage that it can learn from the US experiences without creating the chaotic conditions of such competing services. Providing the BPO can respond to customer demands in an acceptable timescale, it can ensure an orderly transition into an era of widespread data communications.

Finally, there must be doubts about the reliability of a public data service. Large organisations may prefer to make high investments in private networks in order to maintain full control over the network. For such a critical part of business operations, users may not wish to entrust operational control into the hands of a third party such as the BPO.

The combination of customer and manufacturer pressure on the BPO together with the latter's commitment to providing new services will ultimately determine the success or failure of a public data communications service. The signs are that the BPO is responding to the challenge.

VII. TOWARDS A STRATEGY FOR DATA COMMUNICATIONS

In this section we summarise the main data communications options which will confront UK users over the next few years. We then present our conclusions on the two issues which dominate data communications planning — tariffs and choice of service. Finally we put forward other guidelines which might be followed.

A The Options Summarised

Private Leased Lines

There is a shortage of transmission capacity on some trunk routes, particularly those between London and other major centres. Since the voice and telex networks are given priority, leased lines are either unobtainable or subject to long lead times on these routes. The position is unlikely to improve before 1982-3 when PCM trunk installation should begin to make an impact. Beyond this point there should be no shortage of line capacity although the availability of leased lines may be constrained for strategic or political reasons.

Public voice and telex networks

The data facilities of both voice and telex networks will be enhanced, the former by the introduction of Datel 4800 and 9600 services and the scope of the latter extended to carry Class 1 data as well as telex traffic. Initially the telex service will be for international use only, linking with similar facilities already available between France and Germany, and may be extended for national use later. The limitations of both these networks, which were designed for purposes other than today's data traffic, will continue to restrict their use. But until they are superceded by purpose-built data networks they will continue to offer the advantages of universality and low entry costs.

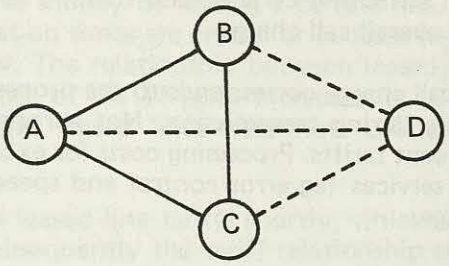
Packet-switching service

We expect PSS to carry mainly time-sharing and bureau business at first, together with information retrieval traffic, both national and via Euronet and US links. This will be supplemented towards 1985 by the beginnings of inter-company electronic mail.

EFTS/POS is potentially an enormous market but it still has to make its way through commercial, political and technical problems, and this might not happen before the mid '80s. The major imponderable is the amount of bread-and-butter dp traffic which PSS will attract. Firstly, much of this traffic does not have the characteristics which suit packet-switching. Secondly, compatibility problems are likely to remain a major deterrent for some time (see Report Series no 3). The user is faced not only with changes in the terminal interface, but also in timing, error handling and network management — sensitive aspects of many of today's online systems. Even without this, PSS seems assured of a big enough market to make it commercially viable and it will certainly ease the strain on the PSTN.

B The Economics of Data Networks

To illustrate the relative costs of employing leased lines, packet-switching, circuit-switching or the voice network, consider a simple three node business network:



Circuit-Switched Exchange

It is assumed that the nodes are located in major cities outside London, and traffic originating at A (predominantly a manufacturing site) is directed to either B or C (both having dp facilities).

Leased line (LL)

By renting private lines between A and B, and A and C, the business is only paying for transmission facilities. On average 40% of the cost of a long distance call is incurred at the switching centre, and only 21% through the use of transmission facilities. In reality because of the tariff structure considerably higher cost savings than 40% can be realised through using private lines, providing that utilisation is between 8-12 hours per day.

Leased lines are advantageous when:

- traffic is both high volume and continuous (achieved by line multiplexing up to speeds of 2400/4800 bit/s.)
- traffic is predominantly single destination.

As high bandwidth digital intercity links become available, leased line costs should reduce yet further, because the BPO is obliged to charge a rental on leased lines based on their economic cost alone.

Circuit-Switch (CS)

Looking ahead to a single node circuit-switch (based in London) in the early '80s, and high bandwidth intercity digital links, a call between A and B (or C) will be routed via D. Assuming that transmission costs A to D to B for a link between A and B are comparable to the leased line cost of the direct link AB, the customer will be expected to pay an incremental charge for the switching facility at D. The simplicity of circuit-switching compared with packet-switching should make this alternative only marginally more costly (eg 10-20%) than leased lines again assuming high volume traffic.

The benefits of circuit-switching will be most apparent when

- traffic is high volume and continuous
- changeover between destinations B and C for traffic originating at A occurs periodically (say a few times a day) rather than frequently (say every few minutes).

Packet-Switching (PS)

With packet-switching the line multiplexing necessary to achieve high line utilisation is performed within the network. The customer may attach a number of asynchronous terminals directly to the PS nodes. The network, when shared between many users, ensures a very high bandwidth utilisation between switching centres, and thereby reduces the transmission costs to a minimal percentage of the overall call charge.

The major component in the call charge corresponds to the processing time necessary to store, route and acknowledge packets during transmission. Not surprisingly then, packet-switched networks use distance-independent tariffs. Processing costs far exceed those of circuit-switched networks by providing wider services (eg error control and speed conversion) which all contribute to the added value charge.

Packet networks are advantageous when:

- traffic originates from many low speed terminals at intermittent rates (at A)
- traffic is multi-destination (i.e. B or C).

Another significant saving can arise at the host interface. A single port can carry packets from many terminals between the network and computer, whereas each circuit-switched or leased line connection will require a separate port.

Voice network (VN)

The public switched network will always be the most expensive option because of the high switching costs, and the low utilisation of bandwidth by bursty traffic. In addition, it is unable to provide any line control facilities and hence is least preferred as a network option for data traffic.

The ranking of the four network alternatives described above, based on their *basic costs* and *not allowing for switching and interfacing needs* is likely to be as follows:

- high volume traffic and high line utilisation (continuous)

$$LL > CS > PS > VN$$

- high volume traffic and low line utilisation (bursty)

$$LL > PS > CS > VN$$

The *tariffs* of the packet and circuit alternatives are as yet unavailable, and therefore prevent an accurate comparison. However the above guidelines are borne out by experience in the USA.

C Tariffs

The basic costs of a particular service will ultimately determine the tariffs which that service bears. But of course there are a number of other factors which impinge on the determination of a tariff structure:

1 Short-run marginal cost pricing
The BPO now operates a policy of short-run marginal cost pricing. An example of this is the standard rate introduced for afternoon telephone calls, which had the effect of spreading the morning peak and thus reducing overall plant requirements. This policy will no doubt be used to limit the investment needed to meet demand before System X is operational.

In other words the BPO will use tariffs to encourage the optimum use of existing facilities and particularly of the analogue switching network which System X will supercede first.

2 **Leased line vs. switched network**

At present, a UK user needing a point-to-point connection for as little as an hour a day during peak time will save money by leasing a private line. He may also choose to do so when reliability or call set-up times are crucial or because he needs a higher speed line than is available on the PSTN. The relationship between leased line and PSTN tariffs was distorted by the last round of PSTN price increases in 1973, when PSTN charges were increased substantially and leased lines were not. UK leased lines are now among the cheapest in Europe.

We expect an increase in leased line tariffs shortly, which will re-establish the relationship existing before 1973. Subsequently the tariff relationship should remain constant, at least until digital leased lines become available in 1982-3.

3 **PSS**

Packet-switching makes very good use of line capacity, given a certain base load. The BPO will of course wish to recoup the investment in the PSS switching equipment and possibly in EPSS also. Nonetheless PSS should offer substantial cost savings over PSTN rates for traffic now using the voice network.

It will support both medium-speed (2400 and 4800 bit/s) and high-speed (48K bit/s) packet node devices and asynchronous terminals such as teletypes via a PAD facility.

4 **General Trends**

PCM and new transmission technologies like fibre optics promise startling economies. James Martin predicts a reduction of at least an order of magnitude in the cost of transmission capacity. Bandwidth will therefore become relatively cheaper (i.e. less discount for slower lines) and the emphasis will shift from distance-based charges towards usage and access charges. Distance-independence is being established as a principle for packet-switching (Euronet, Transpac). With circuit-switching, switching capacity and local connection will be limiting factors, which points to a similar principle.

D Choice of Service

There is a prospect of improved and cheaper data communications services ahead, but first of all users have to face a difficult interim period while the foundations for these are being laid. The primary objective of a strategy for data communications must be to navigate this interim period successfully, both by preserving any existing investment in data communications applications and by laying realistic plans for new developments. A worthwhile secondary objective might be to take full advantage of new facilities as and when they become available.

We present our conclusions on the best choice of data communications service in the form of a selection matrix, shown below. Each entry in the matrix shows the service or services likely to offer good value for a particular data communications application in the year shown. The entries represent the main transport medium. Local access to services such as packet-switching will normally be via dial-up or leased PSTN lines to the nearest node or access point. The services shown in brackets are likely to be cost-effective but suffer from a major disadvantage which may disqualify them in particular circumstances, e.g. high conversion cost, high risk, or limited coverage and availability.

This cannot, of course, be an infallible guide. Sometimes there will be compelling reasons for continuing to use outmoded services despite a cost penalty and the matrix does not, for example, cater for situations where facilities are shared between a number of applications. Its purpose is to show the alternatives which should be considered for future use and which should be evaluated when precise tariff information is available.

DATA COMMUNICATIONS APPLICATION					SERVICE CHOICE				
	Characteristics								
CATEGORY	Time of day	Hrs/ Day	Turn round time	Alt. Destns.	1978	1980	1982	1984	1986
Transaction Processing / On-line data entry	P	8	3-8 Sec	No	LL	LL	LL	LL	LL
Information Retrieval	P	0.5-2	5-10 Sec.	Yes	VN	VN (PS)	PS	PS	PS
Information (high Transmission (volume	0	0.5-4	Over-night	Few	LL	LL	LL	LL	CS/LL
(low volume	0	0.5-4	Over-night	Yes	VN/TX	VN/TX (PS)	VN/TX (PS)	PS/TX	PS
Timesharing	P	0.5-4	3-10 Sec.	Few	VN/LL	VN/LL (PS)	VN/LL (PS)	PS/LL	PS/LL
Remote Job Entry	P	4-8	1 Hr.+	No	LL	LL	LL	LL	CS/LL
Message Switching	P	8+	5-10	Yes	LL	LL	PS/LL	PS	PS

Legend:

Time of day
P = Peak (0800-1800)
0 = Off-peak

Service choices
LL = Private Leased Line
VN = Switched Voice Network
PS = Packet-switching Service
TX = Telex Network
CS = Circuit-switching Service

Service choices shown in brackets will be attractive on cost grounds but may be disqualified by temporary limitations e.g. inadequate coverage.

Service Choice Matrix

The applications are defined in terms of line usage, turn-round time and need for switching. These characteristics are not necessarily invariant — typical values have been chosen on which to base a choice of service. A summary of our thinking follows:

1 **Transaction processing/on-line data entry**
These are classified together, both bearing the characteristics of heavy usage during peak hours, short response times and no switching requirement. Systems of this type are now designed to make good use of leased lines. Developments in terminal and line control equipment can be expected to maintain this situation as bandwidth becomes cheaper, so we select leased lines throughout the period covered.

2 **Information retrieval**
This will consist principally of data bank access. Usage is intermittent during peak hours. Currently only the voice network provides access to all the possible sources of information.

By 1982 packet-switching will have adequate coverage and will offer advantages of cost and reliability thereafter. Viewdata is a further option not shown on the chart. Special distance-independent tariffs for access to Viewdatabases may preserve a cost advantage for the voice network for longer than is shown on the matrix.

3. **Low-volume information transmission**
This category includes inter-company electronic mail. It is assumed to require overnight turn-round and will therefore be transmitted off-peak. As with information retrieval, wide coverage is needed. Currently, only the voice and telex networks provide this. Packet-switching will progressively obtain the necessary coverage as more and more organisations connect to the service. As terminals become more intelligent, packet-switching will supplant the voice network on grounds of quality. Telex will maintain its appeal slightly longer, helped by store-and-forward facilities introduced along with SPC exchanges. Eventually it too will lose its cost-effectiveness compared with packet-switching, as intelligent terminals become cheaper.

4 **High-volume information transmission**
The majority of this traffic will be intra-company and will be transmitted between a limited number of sites. For this purpose leased lines are best suited now. As it becomes available, the circuit-switched service will offer an alternative and will eventually be the best choice.

5 **Timesharing**
Timesharing terminals tend to be used intermittently during peak hours, often to only one site but sometimes to more than one. At present either the voice network or a leased line will be used depending on how much the terminal is used and whether it does need to access more than one machine. Packet-switching becomes more attractive than the voice network as it gains coverage, but a leased line will remain cost-effective for terminals which are heavily used towards a single destination.

6 **Remote Job Entry**
RJE has similar characteristics to high-volume information transmission except that it normally occupies peak hours. Again, heavy use of a point-to-point line makes leased lines best value, until a circuit-switched network becomes available.

7 **Message switching**
Message switching applications such as the SITA or SWIFT networks or a future EFTS have similar characteristics to transaction processing, plus a need for switching. Now, such a system would be implemented with leased lines and private switching equipment. A packet-switching service will offer both cost savings and greater flexibility when it has adequate coverage, from about 1983 on.

E Other Guidelines to Planning

Other considerations which should influence data communications planning are:

Optimisation of leased line use

At the same time as bandwidth becomes progressively cheaper, intelligent communications equipment will also be getting cheaper, as a result of micro-circuiting and as the market widens. Measures to concentrate more traffic onto fewer, faster lines are therefore likely to prove cost-effective. Intelligent multiplexors which are capable of this and which also provide additional network management facilities are already available. The planned BPO Dataplex service for low-speed terminals demonstrates the case for such an approach.

Off-peak working

Off-peak capacity on the public telephone network already attracts a substantial discount – a

600/1200 bit/s modem for a 'midnight line' (midnight – 6 a.m.) costs only £200 p.a. and permits dialled access anywhere on the PSTN. Future public data networks can be expected to offer similar concessions for off-peak use. Terminals are quickly gaining enough intelligence to take advantage of such concessions, e.g. local memory on remote batch terminals for overnight spooling of output, and local editing with overnight transmission of files. Operational procedures and working habits may also need to be changed.

Siting of nodes

It is already good policy to consult the BPO well in advance about the siting of network nodes or concentrators, since trunk lines are easier to come by on certain routes than on others. This is unlikely to change for some years yet.

Voice/data integration

It is outside the scope of this report to give any detailed attention to the question of integrated voice and data networks. We merely reiterate here the conviction that benefits will derive from joint planning of voice and data communications facilities.

F Policy Issues

We have restricted ourselves in this report to drawing attention to the major issues in telecommunications policy, rather than expressing our own views as to what should and might happen. For those interested, the report of the Post Office Review Committee (the Carter report), Cmnd 6850 and its appendix, Cmnd 6954, provide both a considered opinion and a summary of many of the arguments.

In concluding, we draw attention to some positive signs of the BPO's will and ability to adapt to the changing circumstances which confront it, namely the (provisional) decision to implement PSS quickly, the development and planned public launch of Viewdata, and improvements in the BPO's general marketing capability.

On the other hand, a user in the US already has a far wider choice of telecommunications services and equipment than is available here, resulting to a large extent from the liberalisation of AT&T's carrier monopoly and its attachment policy. (As far as the latter is concerned, the BPO decision to allow Viewdata terminals to include integral modems is a sign of flexibility on the issue). We have also pointed out two warning clouds which, if they do not yet overshadow the telecommunications scene, are at least clearly visible in the sky. These are:

1. The difficulties which face users in selecting and optimising the use of services, because of the variety of choice.

2. The difficulties facing the FCC in defining the demarcation between communications and data processing, so that it can carry out its appointed regulatory function.

What remains open to debate is whether the US or the European approach results in more efficient information processing overall.

APPENDIX 1

CCITT X Series Recommendations for Public Data Networks

Packet-Switched

X.25 Interface between data terminal equipment and data circuit-terminating equipment for terminals operating in the packet mode on public data networks.

(for asynchronous devices).

X.3 Packet assembly/disassembly facility (PAD) in a public data network.

X.28 Interface between data terminal equipment and data circuit-terminating equipment for terminals operating in the start-stop mode when accessing a packet assembly/disassembly facility (PAD) in a public data network.

X.29 Procedures for the exchange of control information and user data between a data terminal operating in the packet mode and a packet assembly/disassembly facility (PAD) in a public data network.

(for international working).

X.7X* Terminal and Transit Call Control Procedures for data transfer on international circuits between public data networks operating in the packet mode.

Circuit-Switched

X.21 General purpose interface between data terminal equipment and data circuit-terminating equipment for synchronous operation on public data networks.

(for asynchronous devices):

X.20 Interface between data terminal equipment and data circuit-terminating equipment for start-stop transmission services on public data networks.

(for V-series interfaces):

X.21bis Use on public data networks of data terminal equipments which are designed for interfacing to synchronous V-series modems.

X.20bis V.21 – compatible interface between data terminal equipment and data circuit terminating equipment for start-stop transmission services on public data networks.

* at the time of writing, this recommendation was subject to ratification by CCITT.

Abstract

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No 7

Public Data Services

by Tony Gunton
and Roger Camrass

May 1978

As a result of the convergence of technologies, telecommunications is now subject to the same pressures which have promoted such rapid change in data processing in the past. This is most clearly apparent in the US, where communications policy has been drastically re-shaped and where there is now a tidal wave of new communication products and services which shows no sign of receding. The pace of change is slower in a more conservative Europe, but here too the signs of impending change are unmistakable, particularly in the new public services for data communications which are now being planned and which in some cases have already been introduced.

These may open up new applications such as information retrieval, electronic mail and electronic funds transfer to widespread use and exert a major influence on national economic life, and possibly on social and personal life also.

This report deals with the key issues underlying these developments. It reviews the plans of the European PTT authorities as a whole and those of the British Post Office in particular. It then describes the evolution of regulatory policy in the US and the range of services which will confront users there now and in the near future. This forms a striking contrast with the position in Europe; for some an example, for others a warning.

The report concludes by summarising the options which will confront users over the next few years and laying down specific policy guidelines. It is aimed both at managers with a direct interest in data communications planning and at those with a general interest in the implications of communications policy.

The Butler Cox Foundation

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The Foundation collects its information in Europe and the US, where it has offices through its associated company. It transmits its findings to members in three main ways.

- as regular *written reports,* giving detailed findings and substantiating evidence.
- through *management conferences,* stressing the policy implications of the subjects studied for management services directors and their senior colleagues.
- through *professional and technical seminars,* where the members' own specialist managers and technicians can meet with the Foundation research teams to review their findings in depth.

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