DATA COMMUNICATIONS, EUROPE - WHERE NEXT?

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Abstract:

Data communications, a new and one of the fastest growing branches of telecommunications, now stands at the threshold of far-reaching developments. An attempt is made to summarize briefly the past, analyze the current situation and what is known about the future, and consider possible patterns of network development.

Introduction

In 1972 in Europe there were about 80,000 terminals. A terminal is here regarded as an input/output device connected to a distant computer by a telephone line. This includes separate devices connected via multiplexors, but not those connected via message concentrator computers which latter devices are themselves regarded as "the terminal".

It is expected that by 1985 there will be 814,000 terminals in Europe connected to telecommunication-authority (PTT) lines, with a further 600,000 in-house terminals. These figures are taken from the Eurodata Study referred to later in this paper.

The year 1985 is 13 years after the Study; 13 years ago in 1959 there were no P.T.T. connected terminals in Europe. At that time terminals probably did not exist in the current sense, input/output devices normally being located with the computer.

Telecommunications Authorities

Commercial data communications started in Europe in 1961. The basic requirement was to enable distant input/output devices to be connected to computers. Speed requirements prevented the use of the only existing digital circuits (the telegraph lines), so the telephone network had to be used.

Data communications posed two sets of problems to P.T.T's; technical problems of transmission techniques and speed, error rate, etc. which could be solved; and policy problems, which are more complex and still have a bearing on current thinking and attitudes. It is important to consider these problems but first it is necessary to examine the nature of the P.T.T's themselves.

The P.T.T's have three common characteristics:

1. They are all large organizations. (There are about 71 million telephones in Europe). Figures 1 and 2 show comparative data.

2. They are subject to a large degree of Government control particularly in respect of finances. Their organization varies in detail, but two main functions can be identified. The political function, carried out by a ministry usually referred to as "the Administration", involves interpreting government policy, in relation to financial control, equipment procurement etc., and the operational function; day to day running of the telephone business. France and Germany combine these two functions in one department of Post and Telecommunications, whereas in the U.K., Sweden and Belgium the political and operational functions are separated. In Italy, Spain and Greece the operational function is performed by a private corporation which might be partly state financed.

N.B. P.T.T. strictly means the government department providing Postal, Telephone and Telegraph services. It is commonly used to refer to the operational organization whether a government department or not.

3. Generally P.T.T's have a monopoly which gives them the exclusive right to provide certain communications services. This may be justified by considering telecommunications to be a service available everywhere rather than only in those locations which are profitable. The monopoly therefore has obligations to provide the service to all who require it. The monopoly may be relaxed in respect of some equipment connected to P.T.T. networks. Most P.T.T's provide both switched and leased circuits, but do not allow interconnection, nor do they allow sharing of leased circuits. However, licences to make interconnections may be granted in special cases.

The advent of data communications

Data communications began in the 1960's against the background just described. The devices to be connected to the networks were not made or designed by the P.T.T's but by the computer industry, thus raising policy questions such as provision of modems and terminals by P.T.T's or the industry and charging of special rates for data communication. The generally adopted policies in Europe are shown in Figure 3.

Services available in 1972/3

Figure 4 shows services currently available in Europe. Switched telegraph networks (Telex) generally provide 50 baud transmission, though special networks can give 200 bits/sec. Leased telegraph circuits offer speeds up to 300 bits/sec. Switched telephone networks provide services up to 2400 bits/sec with leased circuits giving 4800 or 9600 bits/sec. Wideband circuits are available giving 48k bits/sec.

Growth of data communications to 1972/3

Figure 5 shows the growth in the number of modems (not terminals) since 1970. This includes private modems which in the U.K. form about a third of the total number and where the rate of growth has now slowed to a reasonable 20-22%! The number of modems relative to computers installed is shown in Figure 6. Perhaps the surprising figure is that the number of modems per computer in the U.K. approaches that for the U.S.A.

Analysis of Current Users

The relative number of terminals installed in various industrial sectors in 1972 is illustrated in Figure 7a. Note that 10% of terminals are used in connection with air transport whereas universities, included in the education sector, have a relatively insignificant number and are included in the remainder.

The traffic generated by these sectors is shown in Figure 7b. Here the education sector contributes 11.6% of the traffic indicating a lot of input/output on very few terminals. Air transport disappears entirely; many terminals but little traffic. Perhaps most interesting is that D.P. services contribute over 21% of the total traffic.

Applications which contributed 60% of the total traffic are tabulated in Figure 8.

Limitation of existing networks

Existing telephone networks have limitations in their use for data transmission. First, the restricted speed range, though this is not now such a problem as it was a few years ago. A second limitation is error caused by noise and distortion. Existing telephone circuits produce distortions which can be corrected, but noise and interference arise mainly from the electro-mechanical switching equipment still in widespread use. Line-interference is not the sole source of error, so that error control routines are necessary in any case, therefore interference is not a significant limitation. The third and main problem however, is connect-time; on existing switched networks it may take up to 15 seconds to set up a call; this is why some users have been forced to adopt leased networks for applications requiring short response times.

Leased networks

There are two reasons for the growth of leased networks. The technical problems of getting adequate transmission speed and response time etc, but also the management aspects. Some of the largest leased networks are used by banking and airline systems. In a large system which connects all branches to a central computer, management seem to prefer a dedicated network. With switched networks shared with many users they do not feel they have the same degree of operational control.

Costs are also significant, there is a break even point when leased circuits are cheaper than switched network calls. Large users tend to have elaborate networks for other telecommunication services and naturally wish to integrate their data traffic with these. For example, FORD of Europe have a network reaching as far as the U.S.A. which carries data, speech, telegraphy and facsimile.

From the P.T.T. point of view, the growth of large leased networks raises a number of problems. There will be pressure on the P.T.T's to permit interconnections which would infringe the monopoly. Taken to the extreme, many interconnected leased networks would undermine the financing of public switched networks to the detriment of the small user, and those who need a switched network, for example D.P. services, computer bureaux etc.

Standardization is another problem. If leased networks proliferate, each is likely to develop its own standards. All organizations agree on the need for standards but the D.P. industry is not noticeably to the fore in developing them. The present capability for international data transmission is due entirely to standards set by the C.C.I.T.T. (International Telephone and Telegraph Consultative Committee) and not to the work of the computer industry.

Another problem with leased networks is maintenance. In practice, even if users install leased networks with the majority of the equipment their own, the P.T.T. must still interface somewhere. As these networks become more complex, so do the problems of defining responsibility and delineating interfaces etc.

There is a good case therefore for the P.T.T's to provide a specially designed switched network for data communication.

New developments in telecommunications

The existing analogue networks represent too great a capital investment to be replaced overnight, although improvements are of course continually being made.

Pulse code modulation systems (digital transmission of speech) are being installed but are presently confined to short routes of about 25 miles. Long-distance digital transmission systems are currently being developed and also digital switching.

Processors are already in use within the telephone network, for controlling the present semi-electronic exchanges. They permit faster switching times and allow a wider range of facilities to be offered to users.

New data networks

In considering new data networks the P.T.T's have various choices open to them.

In transmission, the choice is between synchronous and asynchronous networks. The present analogue networks are asynchronous in that the required phase relationship between a transmitter and a receiver has to be achieved and maintained by those devices, the network playing no part. Sender and receiver maintain synchronization either by working in the start/stop mode, where essentially every character is synchronized, or by adopting the synchronous mode and sending synchronizing patterns before each block of data.

Either mode is possible with analogue systems but digital transmission will increasingly replace analogue transmission. With digital bearer circuits, means must be found for aligning the signal element timing in the transmitter with the network, and the network with the receiver; there must be synchronism throughout. However, timing signals for terminals could be derived from the networks and, given a synchronous digital transmission system, the signalling rates for terminals will be governed by the maximum rate of the system itself.

For the P.T.T's the choice between synchronous and asynchronous networks depends on what their plans for digital transmission are and how quickly they plan to introduce this. Some European administrations have a replacement program for their telex exchanges which are mainly electro-mechanical, they are planning to install modern switching systems with stored program control to allow telegraph (telex) services at a transmission rate of 200 bits/sec. Such a system could be used for data, and indeed the circuits could be upgraded since the switching equipment is capable of handling up to 2400 bits/sec. It would be asynchronous transmission and it is doubtful if the technique could be extended beyond 2400 bits/sec. Nevertheless, it is an attractive policy for an administration with capital investment problems.

If a telecommunications authority is planning to install digital bearer circuits in any case, the choice seems clear, a synchronous network would allow more efficient detection devices, hence more efficient terminals and the capability of very high speed transmission.

In terms of switching techniques, the two alternatives are circuit switching and packet switching. Circuit switching is similar to conventional telephone switching in which a discrete transmission path is set-up between transmitter and receiver and maintained for the duration of transmission. The path is almost transparent, though the need to recognise a disconnect signal prevents complete transparency. Modern techniques permit switching in a very short time, certainly much less than one second.

In packet switching, a discrete path is not maintained between transmitter and receiver. Instead data is divided into groups of characters called packets, typically up to 1040 characters. A head containing an address and identification is attached and the packet is terminated with a tail containing error control characters. It is then transmitted to the exchange from whence it is routed through the network to its destination according to the address in its head.

With circuit switching the line is maintained for the duration of the connection whether the terminals are actually transmitting or not. In packet switching however, the circuits are only occupied during actual transmission of data. It has been argued that as data tends to occur in bursts, packet switching must be a more efficient way of using the circuits, but, the cost of long distance digital transmission links in a network is not likely to be significant.

When comparing circuit switching and packet switching people tend to confuse the old and the new. The comparison is not packet switching with digital transmission against conventional circuit switching and analogue techniques. It is between fast circuit switching and packet switching both controlled by processors and both using digital techniques. From the P.T.T. point of view therefore, the choice is marginal. Any benefits or significant savings may lie in the way a network impacts upon the user.

In circuit switching a virtually transparent path is offered, whereas packet switching imposes certain disciplines on the user such as packet size, format etc.

It may be possible with packet switching, to consider extending the role of the network, utilizing its processors to provide some user protocol, thus giving the potential for different systems to interwork. How much interworking is needed, or the value of such systems to users are questions still needing to be answered.

Users' future requirements

In 1970 European P.T.T's were starting to plan for the future, they had accepted the need to provide new data networks but wanted the best possible information with which to plan. They agreed that an intensive market study was needed, that a joint European-wide study was more effective than separate national studies and that the study was best undertaken by a third party. Hence the Eurodata Study in which 17 countries co-operated, the only two of any industrial significance not participating being Austria and Yugoslavia.

The objectives of the Eurodata study 1972, were to determine "Why is data transmission needed?", "What are the factors which will cause demand for it to arise?" and to forecast the quantity of traffic which would be likely to arise. Thirdly, the P.T.Ts wanted as much information as possible about terminals.

The study was carried out by consultants and occupied one and a half years. A large program of field interview work with major organizations was supported by parallel programs of research into economic factors, technology, and business applications.

Main Results of the Study

In 1985, 813,000 terminals are expected in Europe. The breakdown among countries is shown in Figure 9.

Figure 10a shows the sector demand for terminals in 1985. Note the decrease in banking, finance and air transport, and the quite large increase in D.P. services compared to the 1972 figures.

In the traffic breakdown for those sectors (Figure 10b), the change is even more marked. It is expected that 44.1% of traffic will arise from D.P. services by 1985.

Data networks - the current position in Europe

France - A network called Caducée opened in 1972. It is a star type network centred on a special exchange in Paris which employs crossbar switching and analogue transmission. If demand is sufficient, regional exchanges may be opened, and concentrators will be installed where several users are located together outside Paris. Transmission is at a maximum rate of 4800 bits/sec but users in Paris will be allowed to go up to 72,000 bits/sec utilizing base band transmission. The French P.T.T. regard Caducée as an experimental network. It also supplements their existing telephone network.

Longer term plans are centred on the Hermes network, which is planned to be installed by 1980. It is hoped that Hermes will provide the infrastructure for a system which will continue throughout the 1980's. Hermes will use digital transmission with special time division switches at the nodal points and will offer both circuit and packet switching. For economy, more modern portions of the existing telephone network will be used to gain access to Hermes. It is intended that its design should specifically permit interworking with other European systems.

Germany - The Electronic Data Switching (EDS) system is already installed; the first exchange opened in Munich in 1972 for the Olympic Games. It represents the other extreme to the French systems, being based on an extension of telegraph switching techniques with the exchanges designed to match the characteristics of data traffic rather than telegraph traffic. It will ultimately replace their telex network and will take over the function of the Datex network. The circuits use analogue techniques and operate asynchronously. The network cannot therefore interconnect with any synchronous system. The speed range is from 50 to 4800 bits/sec with a planned increase to 9600 bits/sec.

Sweden - The Swedish P.T.T. is very interested in packet switching, but is still looking for a definite lead to follow. They are planning to install a network of leased digital circuits for certain major user groups, with a limited interconnection. The purpose of the network will be to evaluate packet switching in terms of user benefits.

United Kingdom - An Experimental Packet Switched System (EPSS) will be installed by the end of 1974, to evaluate the benefits of packet switching to user systems. This, it is hoped, will be followed by a leased digital service in 1976 and, still later, by the ultimate switched network!

Where next?

The title poses the question, 'Where next?', but so far no clear cut plan has emerged for future data networks; P.T.T's are faced with all the problems described above. The Eurodata study gave the P.T.T's what is probably the best and most comprehensive view of users' future needs, but it was never intended to advise P.T.T's how those needs should be met.

There are two major questions which P.T.T's, users and the computer industry must answer. The first is "What future pattern of interconnection is required?" for example is full interconnection between users necessary or does the future lie with a series of closed networks having only a limited interconnection. The second question concerns the role of the P.T.T. network in relation to users systems. If only limited interconnection will be required in the future, the P.T.T's should perhaps concentrate on the simplest links at the most economic cost. On the other hand, if full interconnection is required, either packet or circuit switching would satisfy the basic transmission requirements. Full interconnection implies inter-working between different systems, so that the P.T.T. network may become the only common denominator among systems. Economies might then be possible through sharing of costs between all users if the network undertook some of those functions presently carried out in users' processors and terminals. The monopoly of European P.T.T's may thus, in the long run, turn out to be an advantage.

In the short term, the pattern of development can only be one of experiment, mainly with packet switching, to evaluate its potential in public networks. Until both users and the computer industry can contribute more information based on experience, it is not possible for P.T.T's to make firm decisions.

Discussion

After the talk Professor Galler asked if there were plans to introduce the touch-tone telephone into Europe. The touch-tone telephone can be used as a terminal with restricted capabilities and is being used more and more in the U.S.A. In particular, the banks find it economical to give each teller in a branch a touch-tone telephone so the teller can check a customers credit, put a hold on an account when a large cheque is presented, etc. Mr. Dale replied that touch-tone telephones are already being introduced as replacement for the conventional rotary-dial telephones. They are more expensive however because of the need to include conversion equipment to make them work with the mass of electro-mechanical switching equipment that will exist for some time yet. The utility of the touch-tone telephone as a data-entry device is still questionable. Even the simplest use demands a voice reply so that digits entered can be checked. Banks in the U.K. have said that they are not interested in the touch-tone telephone as a terminal at present. Conditions in the two countries are widely different. Banks in the U.K. are nationwide organisations with very large networks and highly centralised D.P. systems whereas the U.S. banks are chiefly local organisations. The touch-tone telephone probably has a place as a simple terminal but, so far, users have indicated that they want additions like badge-readers, hard copy etc. Although the basic problem is the old slow switching equipment, some European countries with large waiting lists for ordinary telephones would much rather not spend the money on what could be regarded as relative luxuries.

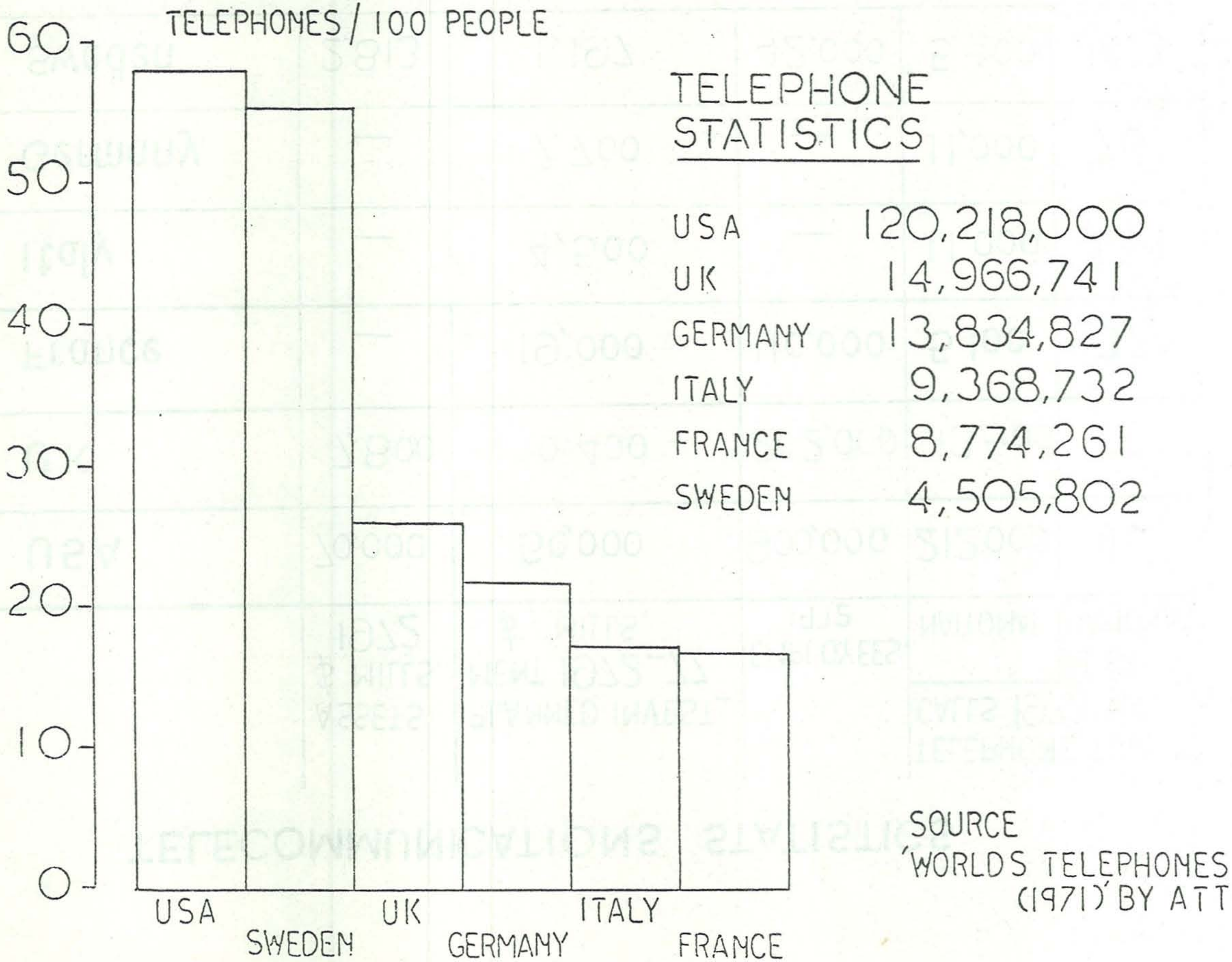

TELEPHONES / 100 PEOPLE
60
50
40
30
20
10
0
USA
SWEDEN
UK
GERMANY
ITALY
FRANCE
TELEPHONE STATISTICS
USA 120,218,000
UK 14,966,741
GERMANY 13,834,827
ITALY 9,368,732
FRANCE 8,774,261
SWEDEN 4,505,802
SOURCE
'WORLDS TELEPHONES (1971)' BY ATT

Figure 1

TELECOMMUNICATIONS STATISTICS

	ASSETS $ MILLS. 1972	PLANNED INVESTMENT 1972-77 $ MILLS.	EMPLOYEES 1972	TELEPHONE TRAFFIC CALLS 1972 MILLS.	
				NATIONAL	INTERNATIONAL
USA	70,000	60,000	900,000	212,000	40
UK	7,800	10,400	242,000	13,500	53
France	—	19,000	110,000	5,100	37
Italy	—	4,500	—	11,000	17.5
Germany	—	7,700	—	11,000	75
Sweden	2,813	1,197	42,000	5,400	14.3

Figure 2

PTT Policy on Data Transmission Equipment

	PUBLIC SWITCHED NETWORK			LEASED TELE LINES		TELEX		LEASED TELEGRAPH (50 BAUD)	
	TERM'L	MODEM	ACOUST C'PLER	TERM'L EQUIPT	MODEM	TERM'L EQUIPT	INTERFACE	TERM'L EQUIPT	INTERFACE
FRANCE	A	P or A	A	A	P or A	A+P	P	A	NR
WEST GERMANY	A	P	A	A	P or A	A+P	A or P	A	NR
ITALY	A	P	A	A	P	A+P	P	A	NR
SWEDEN	A	P	NP	A	P	A+P	P	A	NR
UK	A	P	A	A	P or A	A+P	P	A	NR

P = PTT EQUIPMENT, A = APPROVED PROPRIETARY EQUIPMENT

NP = NOT PERMITTED, NR = NOT REQUIRED.

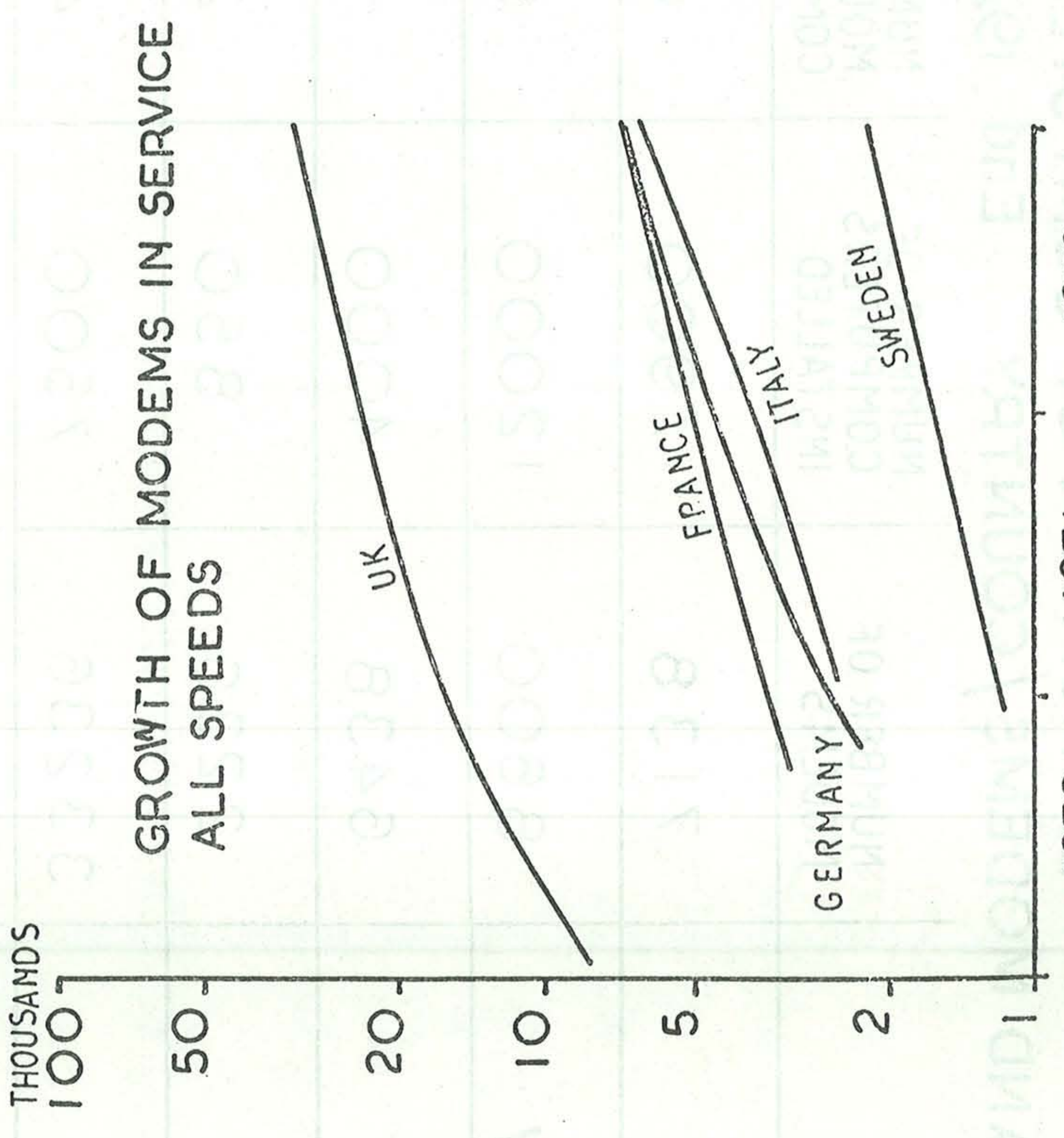
Figure 3

AVAILABLE SERVICES (as at Aug 73)

	TELEX	SPECIAL TELE_GRAPH	LEASED TELE_GRAPH	PSN	LEASED TELE_PHONE	WIDE BAND
France	200	—	200	1200	9600	72 K
West Germany	50	200	200	2400	9600	48 K
Italy	50	—	200	2400	4800	—
Sweden	50	300	300	1200	4800	40.8 K
UK	50	—	110	2400	9600	48 K

MAXIMUM TRANSMISSION SPEED POSSIBLE IN BIT/S

Figure 4



GROWTH OF MODEMS IN SERVICE
ALL SPEEDS
THOUSANDS
100
50
20
10
5
2
1
1970
1971
1972
UK
FRANCE
ITALY
GERMANY
SWEDEN

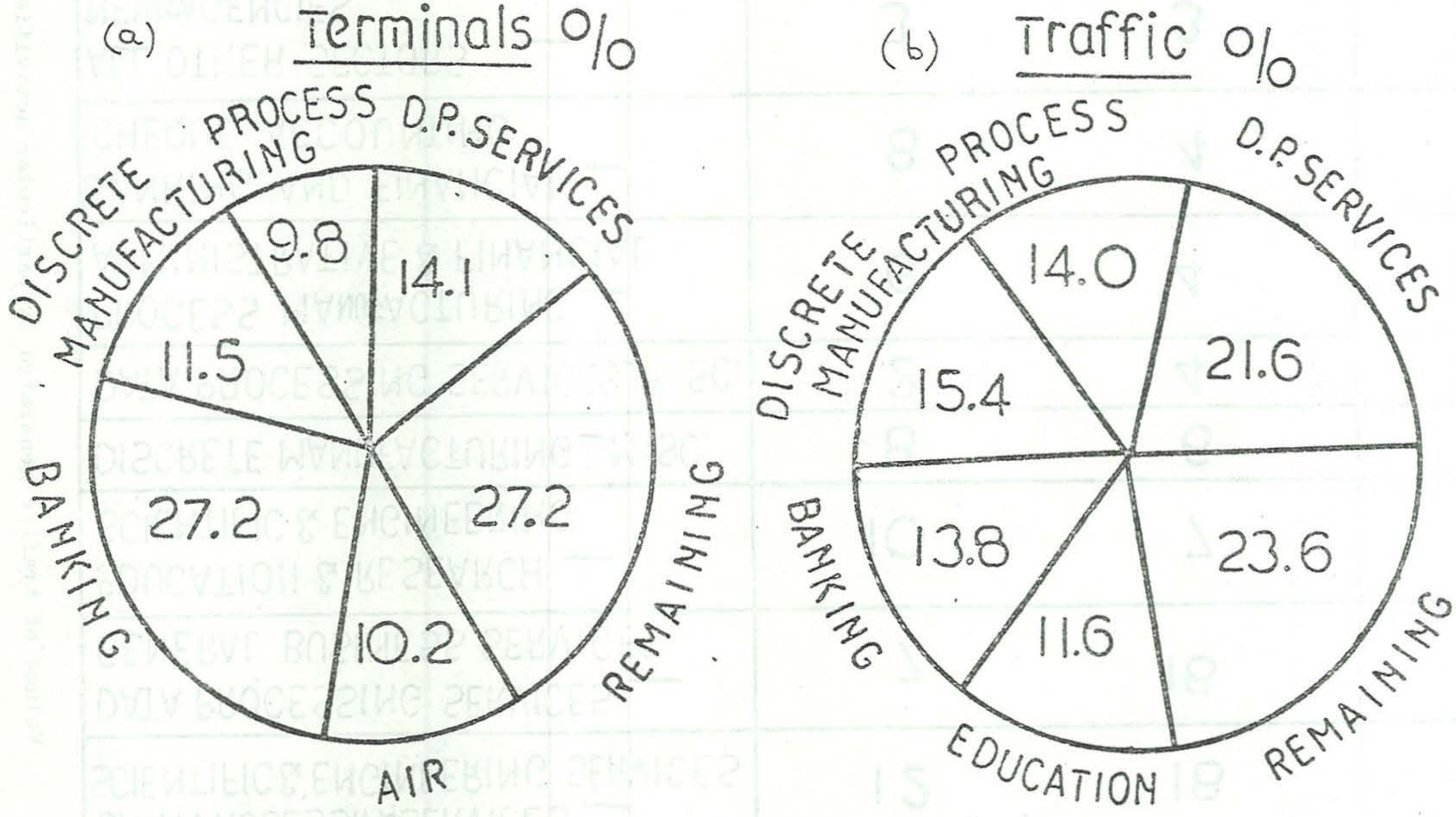
Figure 5

ESTIMATED NUMBER OF COMPUTERS AND MODEMS/COUNTRY End 1972

	NUMBER OF MODEMS	NUMBER OF COMPUTERS INSTALLED	NUMBER OF MODEMS/ COMPUTERS
France	7138	7900	0.9
Germany	8600	12000	0.6
Italy	6438	4000	1.61
Sweden	2236	850	2.63
UK	33236	7500	4.43
USA	490,000	108,000	4.54

Figure 6

SECTOR DEMAND FOR TRAFFIC & TERMINALS 1972



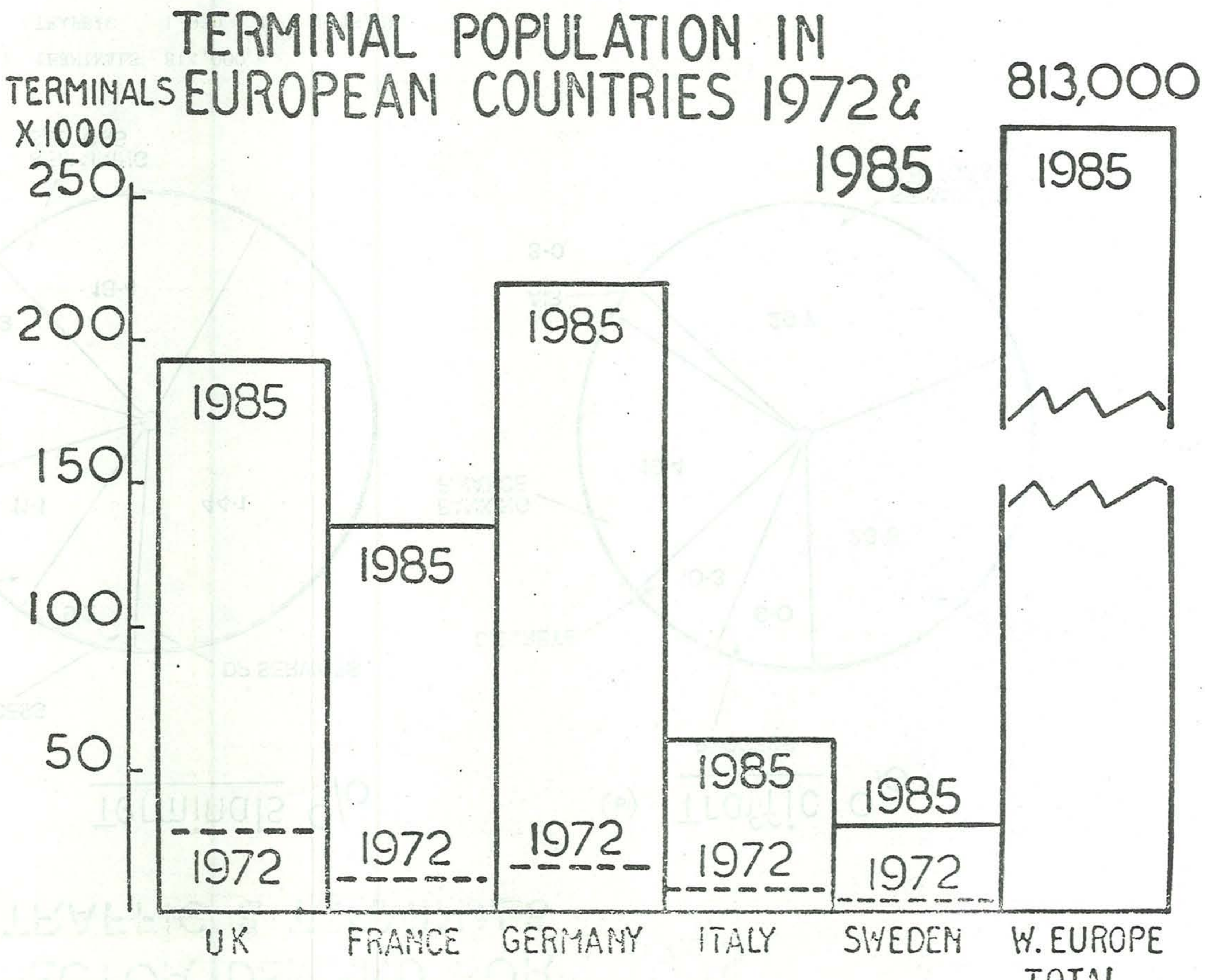
1972 : TERMINALS 80,000

TRAFFIC 154×10^9 BITS/ DAY

Figure 7

Sector/Application	Data Traffic Volume % 1972	1985	Annual Growth
DATA PROCESSING SERVICES — SCIENTIFIC & ENGINEERING SERVICES	12	18	26
DATA PROCESSING SERVICES — GENERAL BUSINESS SERVICES	7	18	31
EDUCATION & RESEARCH — SCIENTIFIC & ENGINEERING	10	7	18
DISCRETE MANUFACTURING — MISC.	8	6	19
DATA PROCESSING SERVICES — MISC.	2	4	28
PROCESS MANUFACTURING — ADMINISTRATIVE & FINANCIAL	6	4	17
BANKING AND FINANCIAL — CHEQUE ACCOUNTING	8	4	14
ALL OTHER SECTORS — NEWSAGENCIES	3	3	21
PROCESS MANUFACTURING SALES PLANNING & CONTROL	4	2	19
TOTAL	60	66	

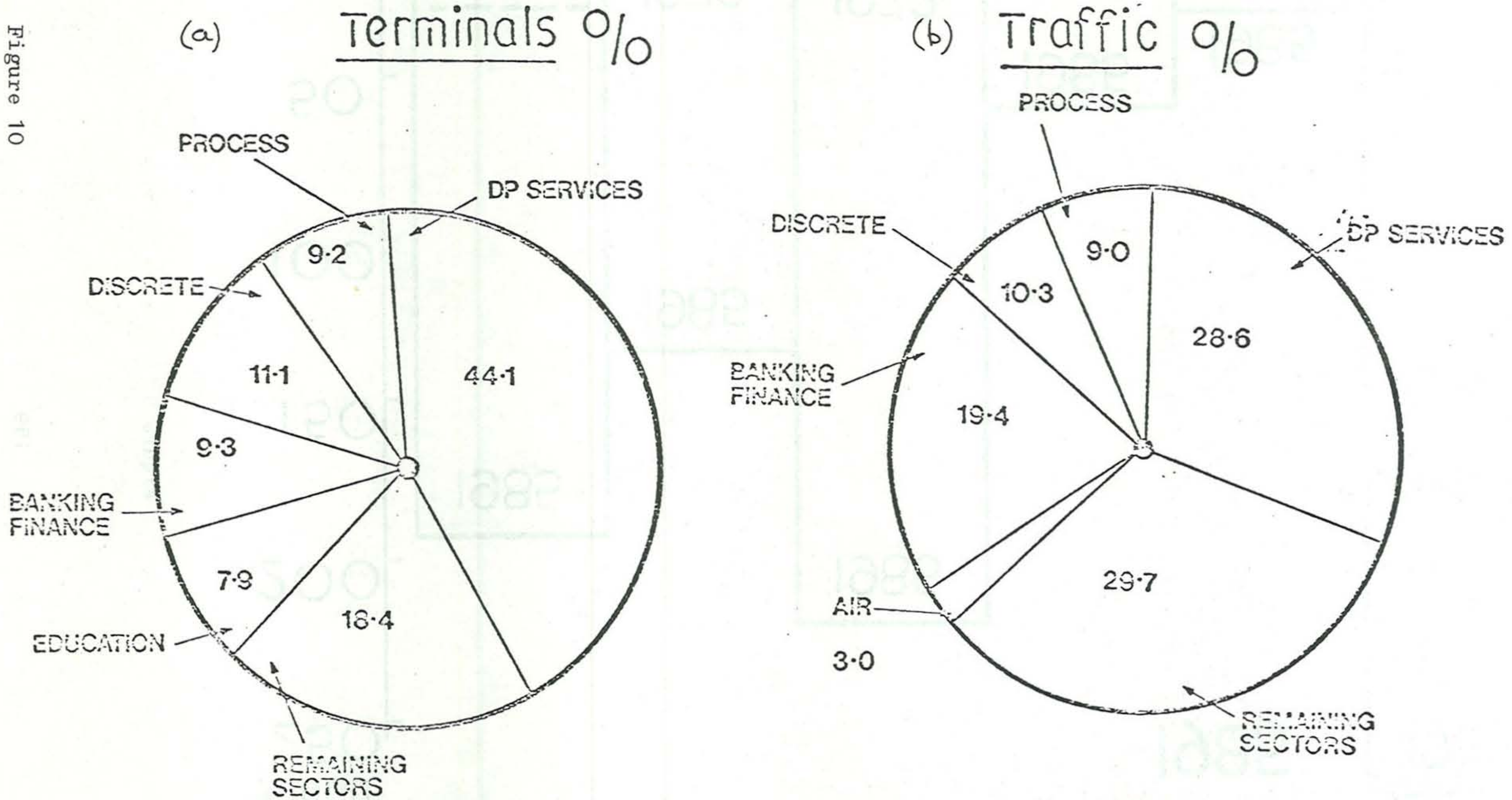
Figure 8 Volume of traffic generated by particular activities



TERMINAL POPULATION IN EUROPEAN COUNTRIES 1972 & 1985
TERMINALS X 1000
250
200
150
100
50
813,000
1985
1972
UK
FRANCE
GERMANY
ITALY
SWEDEN
W. EUROPE TOTAL

Figure 9

SECTOR DEMAND FOR TRAFFIC & TERMINALS 1985



1985 : TERMINALS 814,000

TRAFFIC $1,930 \times 10^9$ BITS/DAY

Figure 10