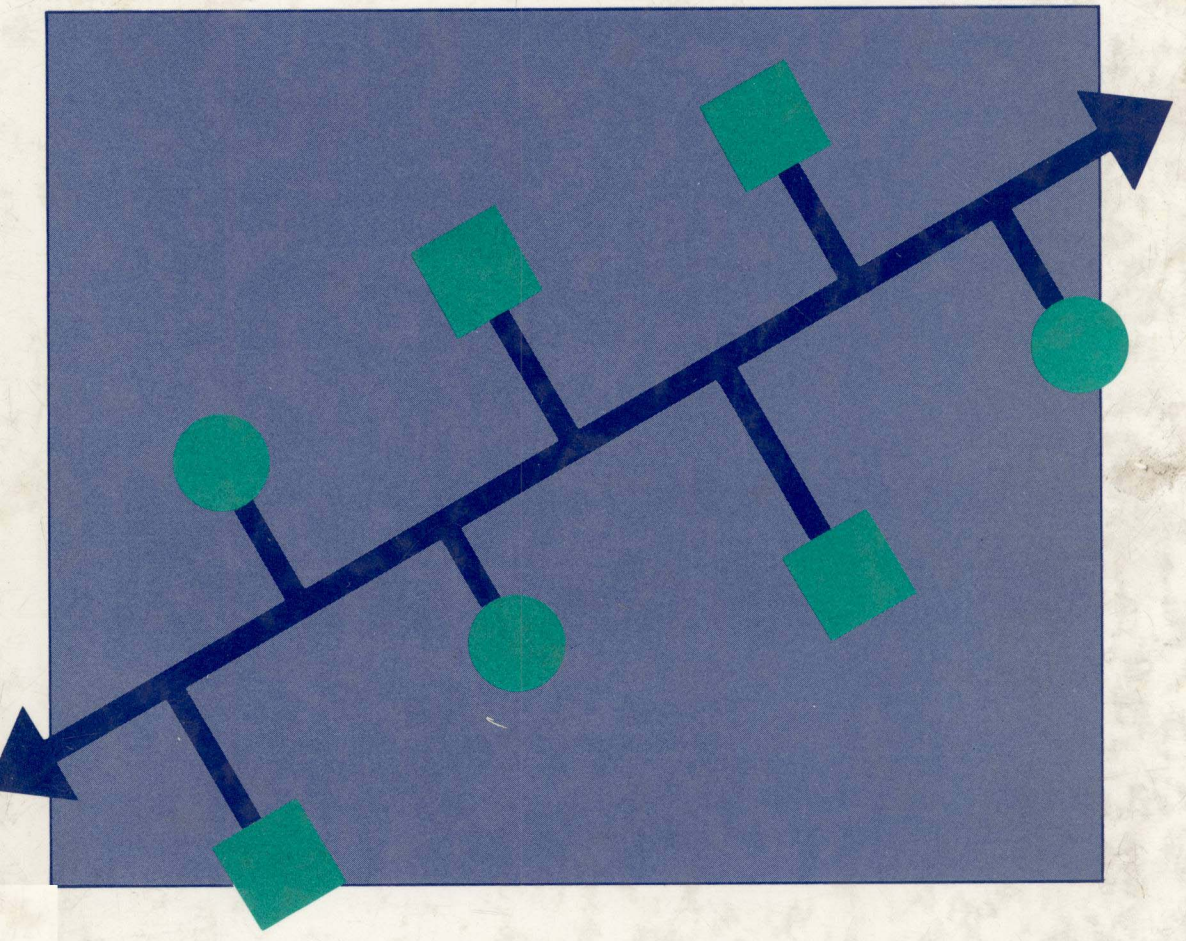
Local Networks in Practice

US and German Experience



U. Frenzel and I. Schubert

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SECTION 1
Introduction
to the English edition

1 BACKGROUND & AIMS

In terms of their telecommunications environment, Germany and the United States are at opposite ends of the spectrum, with most other countries somewhere in between. But although environments may vary, the communications needs of organizations in every developed country are essentially the same.

The Deutsche Bundespost exerts strong monopoly rights over what services will be provided, what use can be made of them, and what devices can be attached. Since deregulation and the divestiture of AT&T, the American scenario has become one of open, pragmatic competition.

There are also differences in business culture. In Germany organizational structure tends to be more formal and more centralized, while in America individual functional departments are believed to have stronger influence on their business support systems. This, plus the more liberal communications environment, has lead to a perception that there is a greater penetration of communications–based office automation in the USA than in Germany, and a greater general acceptance of such systems. Most other countries are somewhere in between.

It was to investigate these differences, and the lessons that could be learned from them, that a comparative survey and analysis was commissioned by the RKW (the Rationalization Committee of the German Trade & Industry Association) on which this book is based.

As a starting point, it was observed that within manufacturing in Europe, as well as in the United States, considerable progress had already been made in the application of information and communication technologies. These were initially applied in the field of process automation (with automatic measurement and control devices), then extended to upsteam and downstram operations (such as job scheduling and warehousing) and more recently to comprehensive computer integrated manufacturing (CIM) or flexible manufacturing systems (FMS). The 'factory of the future' was fast becoming a reality of the present.

In contrast, despite all the discussion and attention since the mid–seventies, the 'office of the future' was still very slow in emerging. Even more importantly, whereas surveys had shown that manufacturing productivity had increased by 90% in the previous 20 years, office productivity had only increased by 5%. Although this estimate was based on German companies, the same is generally true for other European countries.

The slower progress in office productivity was not for lack of potential or economic incentive. Office and administrative costs have been rising steadily over the years and increasing attention has been directed to the degree to which office and administrative work could be formalized and consequently automated.

Influential studies had indicated that, depending on the type of office, between 35% and 65% of office work could be formalized and 15% to 40% could be automated. On average it was estimated that there was an automation potential of around 25%, achievable in a ten to fifteen year time–frame. Although these were derived from German surveys, similar results have been obtained in other countries such as the Netherlands and the United Kingdom.

Extrapolating from the relative economic size and workforce of Germany, it can be estimated that in excess of 50 million workers in Europe, with a similar number in America and Japan, could be affected by the new technology between the late 1980s and the end of the century.

Since 'information workers' in office environments are increasingly the largest single sector of workers within developed countries, the implications for corporate productivity and organizational structure, as well as for employment levels generally, are obviously very significant. If the USA was indeed ahead of other countries in exploiting information and communications technology, then it would be of great value to study and learn from that experience.

The survey was commissioned to investigate American experience in industry, finance, banking, insurance, consultancy, research and education (and comparable organizations in Germany) and in–depth interviews were carried out into their use of 'In–haus Netz'. This term, as used in the German edition, has two main meanings for the English reader.

Firstly it is used to distinguish the communications facilities implemented and operated by an organization for its own use, as

opposed to the public facilites provided by carriers such as the Bell Operating Companies in the USA, British Telecom or Mercury in the UK, the Deutsche Bundespost in Germany, or the various PTTs in other countries.

Secondly it covers the general applications of communications–based information technology in support of office automation, including wide area data networks, PBXs, and local area networks (LANs).

The main technical components in the evolution of in–house systems and local area networks were seen to be a convergence between the traditional form of office and organizational technology, plus the more conventional business communications technology (word processing, filing systems, telephone and telex) together with on–line data processing and digitial information tranmission systems.

At the time of the investigation, decentralized departmental systems were beginning to overcome the performance and response limitations of monolithic centralized data processing organizations too often experienced in the 1970s and early 1980s. In parallel, the rapid growth of intelligent workstations and personal computers were attacking the same problem. More recently a new generation of personal systems and hierarchical, interconnected local area networks has become available, while more powerful and reliable wide area networks have enabled organizations to take advantage of the economics and technical support advantages of central mainframe–based solutions as well.

From the office systems viewpoint, this all means that the need for a corporate communications and office architecture to pull together the various departmental 'islands of office automation' into a cohesive overall system has become even more critical for the 1990s – but fortunately evolving technology has also made it more practical.

The main lessons drawn from the American experience relate to the following areas:

business motivation and justification
responsibility and decision making
success factors, problems and risks
management acceptance
end–user training and support skills
work environment and social implications.

The survey, published in 1986, was based on interviews with leading–edge organizations that had implemented their systems during the first half of the 1980s. As such, the general experience and analyses provide a good basis for other organizations in the second half of the 1980s and into the 1990s.

The book also aims to provide an introduction and reference base for the technology and architecture available. These are, of course, areas that are advancing very rapidly, and the following recent developments and directions are particularly significant to the planners and designers of corporate communications networks for the 1990s.

Local area networks
the availability of additonal options such as the token passing ring and modern cable management systems

Wide area networks
the additional capabilities becoming available for integrating voice and data over circuits operating in the megabit range.

Documentation architectures
the evolution of document content architectures for handling multi–media electronic documents, and document interface architectures to provide the basis for communication between different systems.

1.2 RECENT DEVELOPMENTS IN LOCAL AREA NETWORKS

In addition to providing connectivity between devices, a LAN should provide a solution to the general problem of wiring the workplace in a flexible and easily maintainable fashion and also address the question of bridging between the hierarchy of LANs that will undoubtedly be required in a building or campus of any complexity and size.

In this respect, probably the most significant recent development has been in the area of token passing ring architecture and the cabling systems that support it.

The standards for the token passing ring are defined in IEEE 802.2/ 802.5 and ECMA 82/89 and are draft ISO standards DIS 8802.2/ 8802.5. It is an 'open' architecture in that technical specifications are published and available to manufacturers generally and component

chips are becoming available for implementation in a variety of devices and adaptors.

In the past, the inherent simplicity and predictable performance of ring topographies tended to be overshadowed by the concern that if one of the devices on the ring failed it could break the continuity of the ring and interrupt the whole community supported. This problem has been overcome by providing implicit detection of a failing or inoperative device plus self–healing capabilities that automatically remove the device from the ring and by–pass it, leaving the rest intact. By these techniques, devices can be added or removed from an 'active operating' ring without disrupting other users.

Bridges are becoming available so that individual rings can be interconnected into a hierarchy of networks allowing connectivity between devices across different rings. This is particularly important for large buildings so that individual floors can be wired and managed as separate entities but integrated into a total location–wide network of considerable complexity – via one or more higher level rings, for instance in the risers of the building – at the same time ensuring a high degree of resilience and practical manageability.

The physical cabling medium normally uses screened twisted pairs or optical fibre, the choice being primarily one of cost. Speeds for twisted pair technology are typically in the range of four to sixteen megabits per second, which should provide sufficient capacity for most office applications. In addition to the basic medium itself, modern cabling systems have a range of standard adaptors and racking facilities that dramatically reduce the work involved in adding and moving users and devices and reconfiguring networks.

1.3 ADDITIONAL CAPABILITIES IN WIDE AREA NETWORKS

In all major countries of the world, ISDN (integrated services digital network) facilities are starting to become available, initially in pilot mode in limited geographical areas. These public network facilities will increase in power through to the end of the century. However, the various PTTs in many countries have started in parallel to provide leased digital facilities to organizations to build their own private integrated services (voice/data/image) wide area networks. Within Europe, two megabit per second circuits have a significant

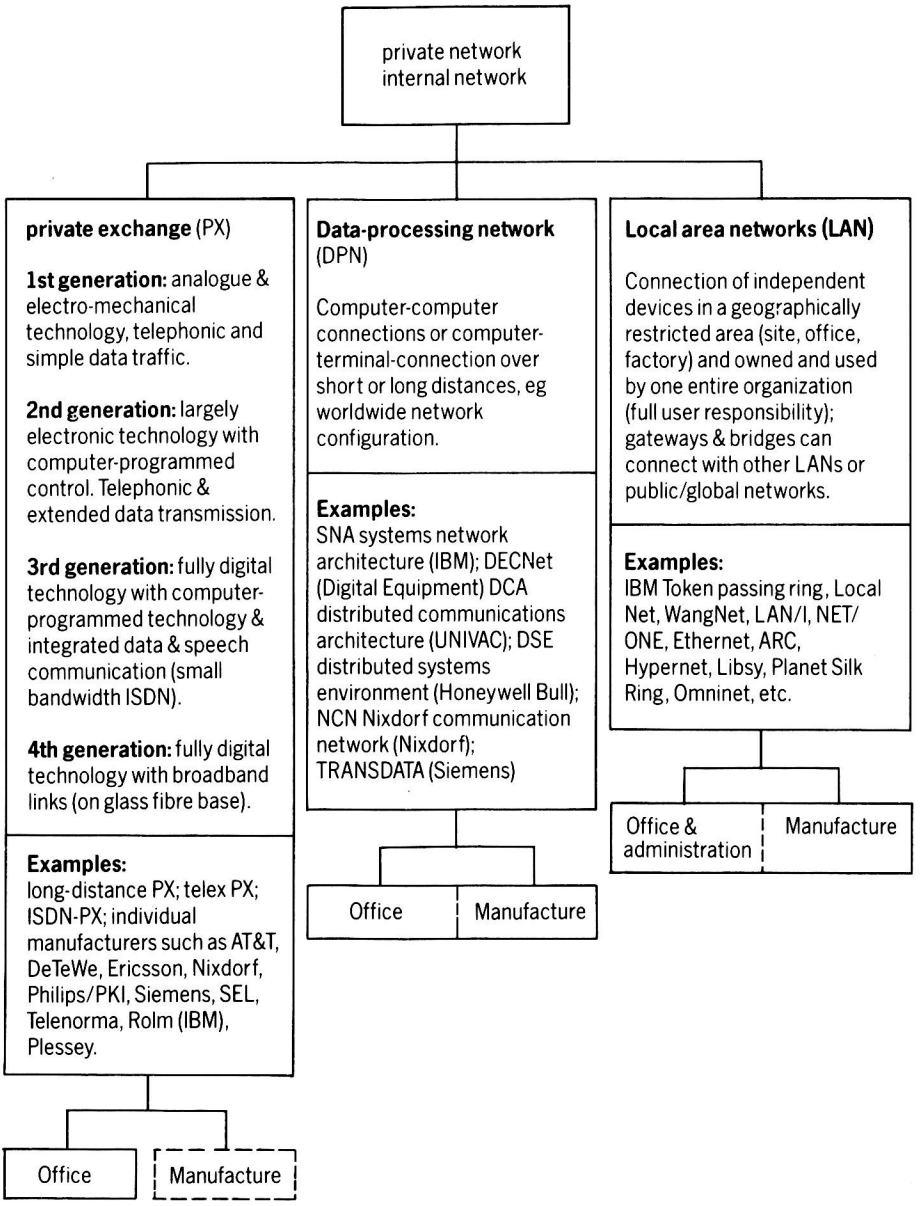


Figure 1: Private networks: types & fields of application

price advantage over lower speed circuits and are particularly attractive for organizations with a high level of voice traffic between locations. In many cases it is possible to use the economics of voice alone to justify megaspeed circuits and at the same time provide additional capacity for wide area data transmission at little extra cost.

To take advantage of these opportunities, multiplexors capable of handling megaspeed transmission are required. To start with these were relatively simple 'channel banks' which divided a two megabit cicuit into 30 equal circuits of 64 kilobits, which could then be used independently for voice, for data, or for slow scan video. More sophisticated multiplexors are becoming available that can divide the circuit into a variable number of channels of differing speeds, often under software rather than hard–wired control. For the 1990s we can expect this evolution to continue towards truly dynamic bandwidth management in which individual transmission needs can increase and decrease as necessary within an overall multi–megabit circuit, without operator intervention.

In effect, the wide area network and the local area network are aproaching the same objective from different directions and the result will be a merging of the two at multi–megabit speed. Thus in addition to the bridges required to link individual LANs together within a building or a campus, gateways between the local area and wide area networks are also required. Fortunately these too are now becoming available.

1.4 TOWARDS THE COMPOUND ELECTRONIC DOCUMENT

Even in the late 1980s the majority of corporate networks are text–oriented. However since the mid–eighties there has been a very rapid growth in the installation of facsimile transmission machines, initally and predominantly in the Asia–Pacific area, but more recently in Europe and the United States as well. In most cases these are stand–alone systems but there is clearly a need to integrate image capture and transmission within the overall corporate communications network.

Even with sophisticated data compression techniques, image requires between 20 and 100 times the capacity required for text. As well as the implications for increased storage and transmission capacity, document content architectures need to recognise and

Types of data Basic functions	Speech	Data	Text	Image
Input/output	Speech coding & decoding Speech digitization Speech output (announcements operator guidance) Release/amplification	Data logging Data encoding Data display (on screen or printer) Information tracking	Text logging Text display (on screen or printer)	Image input Image scanning Image coding & decoding Image display (on screen, plotter or printer)
Processing	Speech recognition Voice recognition Noise suppression Speech distortion correction	Data processing	Word processing (editing, text elements) Text analysis Type identification Text translation	Image processing Image conversion Spreadsheet CAD Pattern recognition
Storage	Voice annotation Voice mail	Data sotrage (databank)	Text storage Electronic document entry & control Electronic mail	Image storage (video disc)
Communications	Telephone Radiotelephone Telephone conference Calling Public address	Line/packet transmitted data communication (remote data processing) Data distribution Teleoperation Telecontrol Computer dialogue	Teleprinter Office teleprinter Screen text Radio broadcasting Videotext Teleprinting	Telecopying (including textfax) Telegraphics Picture finding Image distribution Video supervision Videophone

Source: Jaskulke, Gerhard; Drullmann, Reiner: Integratrion schmal-und breitbandiger Dienste fur die Burokommunikation in lokalen Netzen. In: Kailer Wolfgang (ed): Integrierte Telekommunikation, Springer-Verlag, Heidelberg/Berlin, 1985, p 391

Figure 2: Relation of office communication functions to forms of information and basic functions

incorporate non–text formats such as graphics, speech filing, electronic signature and image generally. These architectures have already been implemented to varying degrees within proprietary products, and international standards are also evolving.

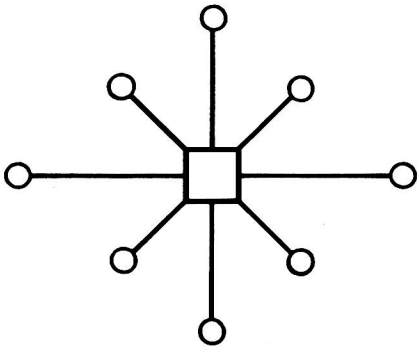
This move towards the 'compound electronic document' will accelerate as we approach the 1990s and provide a futher major impetus to the wider penetration and acceptance of corporate communications networks. There are similarly very effective proprietary document interchange architectures already available within a given range of manufacturers' equipment, and the growing support for the OSI 7 Layer standard, X400, will enable interworking between dissimilar systems. This will be particularly important to meet the growing demand for inter–enterprise communications and electronic data interchange.

1.5 THE STAKES ARE HIGH

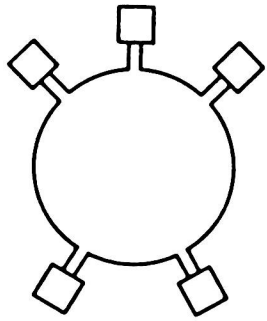
During the early 1980s it was primarily a few leading–edge organizations who were exploiting networking technology for automating and improving conventional office systems. By the early 1990s it will only be the trailing–edge organizations that are not.

It was also around the start of the 1980s that European countries realized just how far they had fallen behind Japan in manufacturing technology. It has recently been noted that cash–rich Japanese companies are now starting to use their past profits from manufacturing to increase dramatically their investment in network–based office systems.

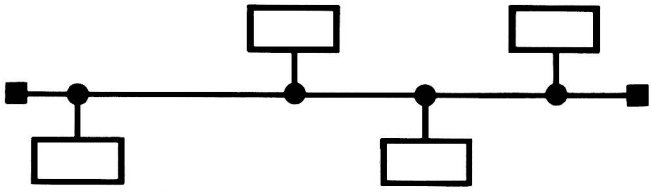
Hopefully we will not be taken by surprise a second time.



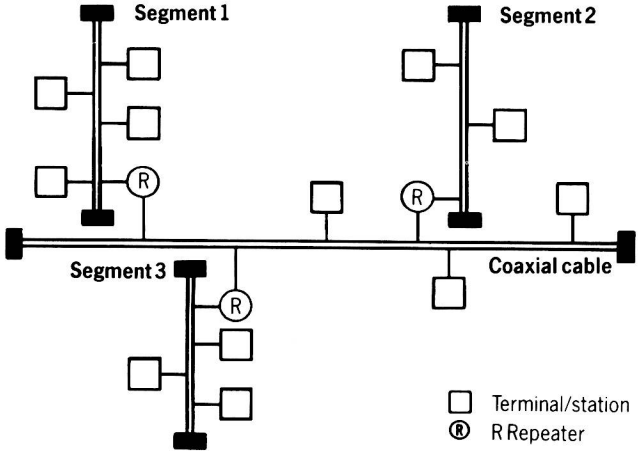
Star structure



Ring structure



Linear structure



Tree/bus structure

Figure 3 Topologies of private networks

SECTION 2
Classification of private networks

2.1 DEFINITION OF TERMS

As a rule the overall term 'private networks' or internal networks comprises three types of network (*Figure 1*):

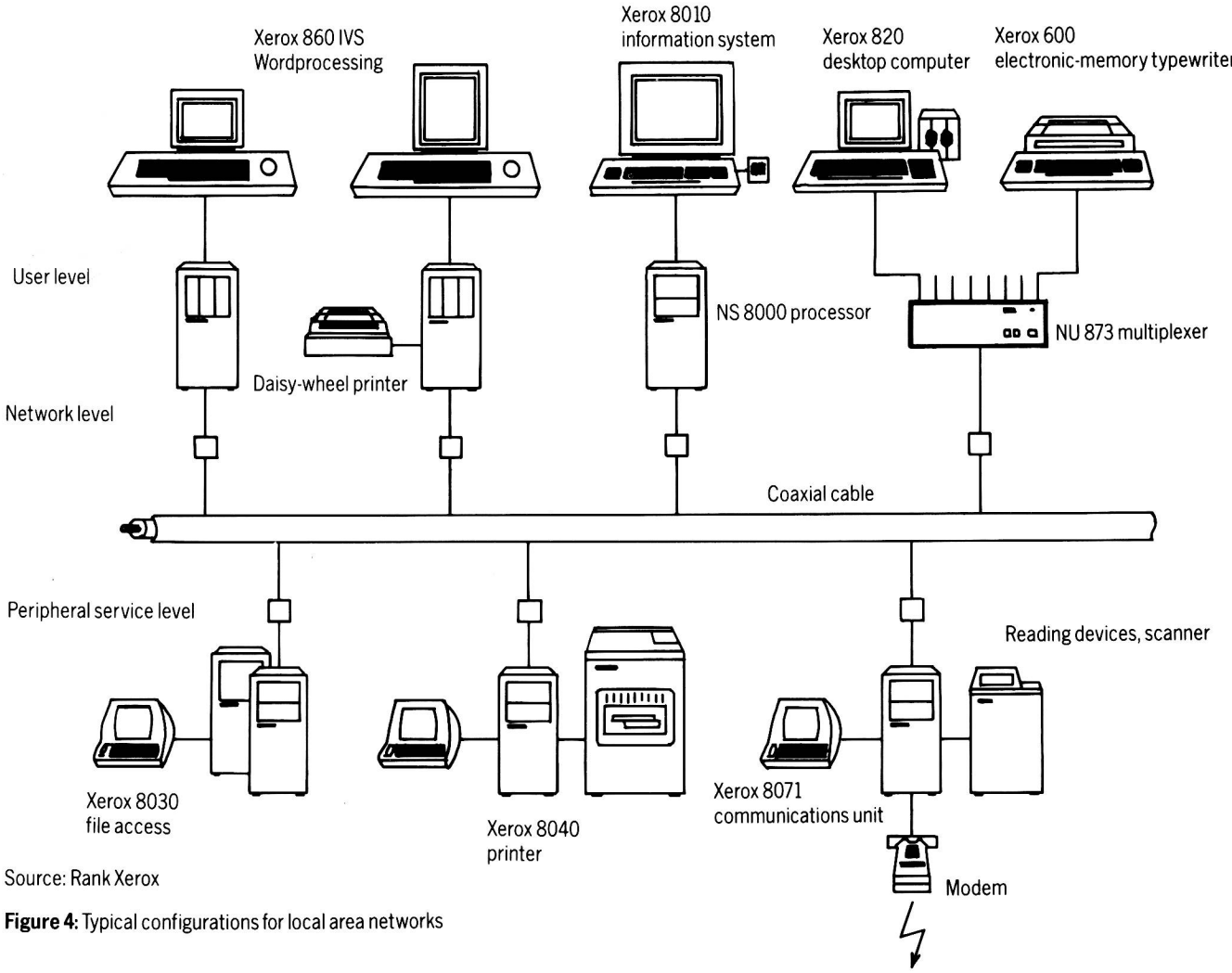
data processing networks
networks with a transmission (telephone/PX) exchange local area networks (LANs)

Data processing (DP) networks are usually computer–computer/terminal interconnections which can extend all the way from a local to a worldwide field. They are used for speedy data and/or text transmission. The term LAN is often used erroneously to include such systems and this has led to something of an over–estimation of the spread of LANs.

Private telephone exchanges are a second form of network. They were conceived initially only for the transmission of spoken data and were connected by PT&T lines with the public telephone network. In this form they have been around for decades. In the English–speaking world, according to the degree of technology, these exchanges are designated as private branch exchanges (PBX) or private automated branch exchanges (PABX).

It has become customary to divide PX into generations, with such qualifications as electronic, programmed, or automatic. At present most PX being manufactured are of the second generation. In contrast to the first generation, they no longer depend on an electromechanical technology, but rely on electronics and computer–programmed control as a result of the introduction of microelectronics into telephones. In both generations it is possible to develop a form of data transmission in addition to voice, though in the first generation the data traffic is necessarily more primitive in form.

Since 1984 all the top manufacturers have marketed the third generation of PX. This generation features for the first time fully digital devices and computer–programmed control as well as the possibility of integrated – that is, simultaneous – speech and data communication at a high transmission speed and with improved transmission quality. In order fully to exploit the intelligence and



Source: Rank Xerox

Figure 4: Typical configurations for local area networks