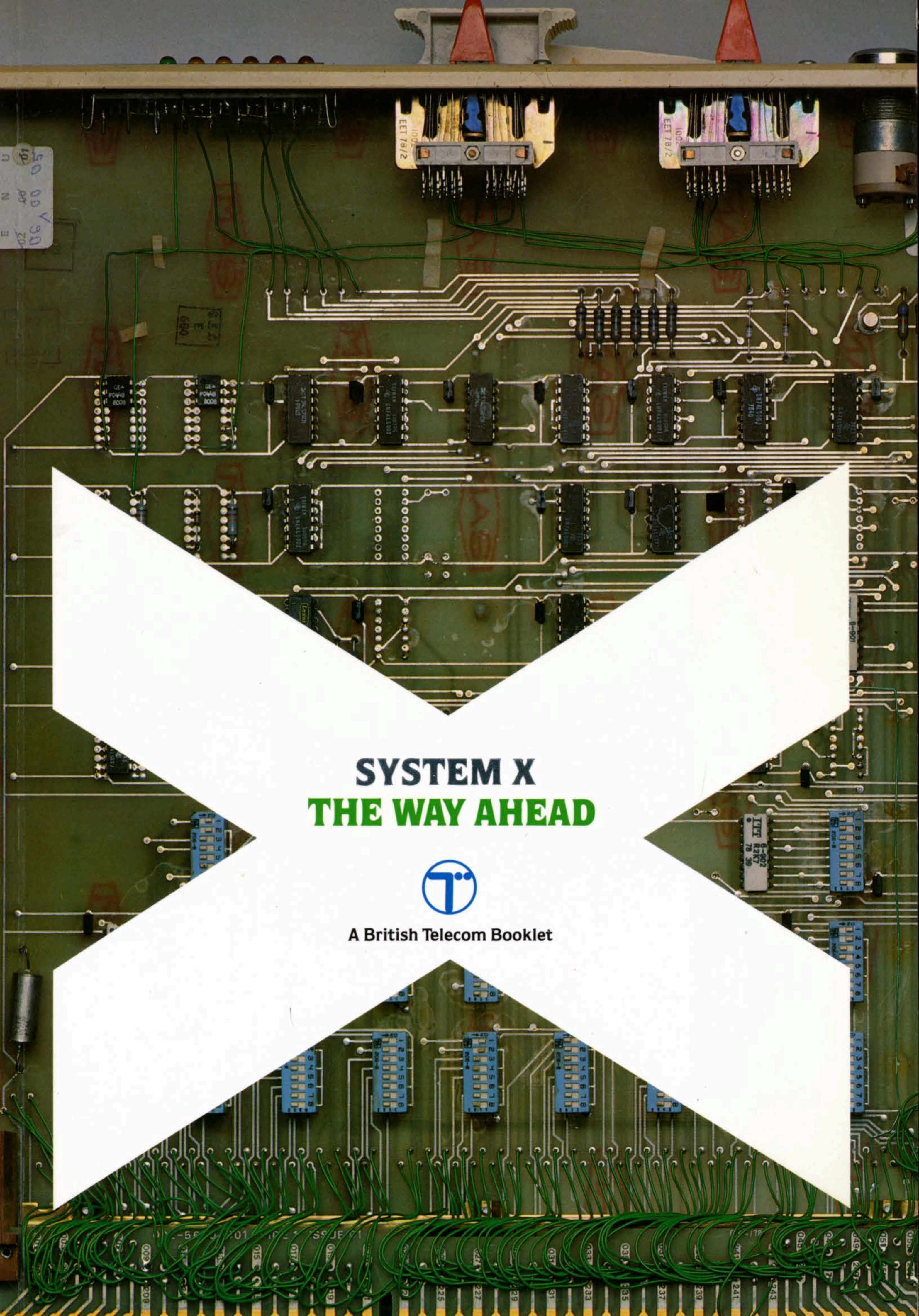
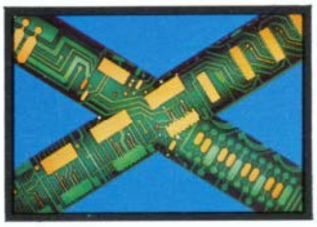


SYSTEM X
THE WAY AHEAD

A British Telecom Booklet

SYSTEM X



THE WAY AHEAD

A British Telecom Booklet

Contents

FOREWORD

British Telecom took over the telecoms system from the Post Office on 1 October 1981. This is a good moment to stand back and take a look at ourselves, the challenges we face and our plans to meet them.

Our business, unlike many others at present, is still growing, and prospects for Telecom are good. But for the first time we face competition, not just in customer apparatus but on the network. Other people want a piece of our action. Future jobs and opportunities depend on how we measure up to this.

A lot of our success in meeting and beating the competition – as I intend to do – will depend on the main exchange and transmission network, on the speed and skill with which we bring new technology into it, and in the efficiency with which we operate it. We are all in this together.

Many of you will recall the presentation "Modernisation – The Way Ahead" we made a year or two ago. This booklet and the presentation that go with it, carry the story of the network a stage further. Their aim is to tell you as much as we can about System X. As you read it and later watch the presentation and take part in discussions about it, I would ask you to remember one thing above all. These are the technical tools for you to create your own future. Make the most of the advantages they offer in terms of service and efficiency of operation and we will come out on top. Waste them, and we will only have ourselves to blame if we go under. It is up to you!

John Harper
Managing Director, Inland Division

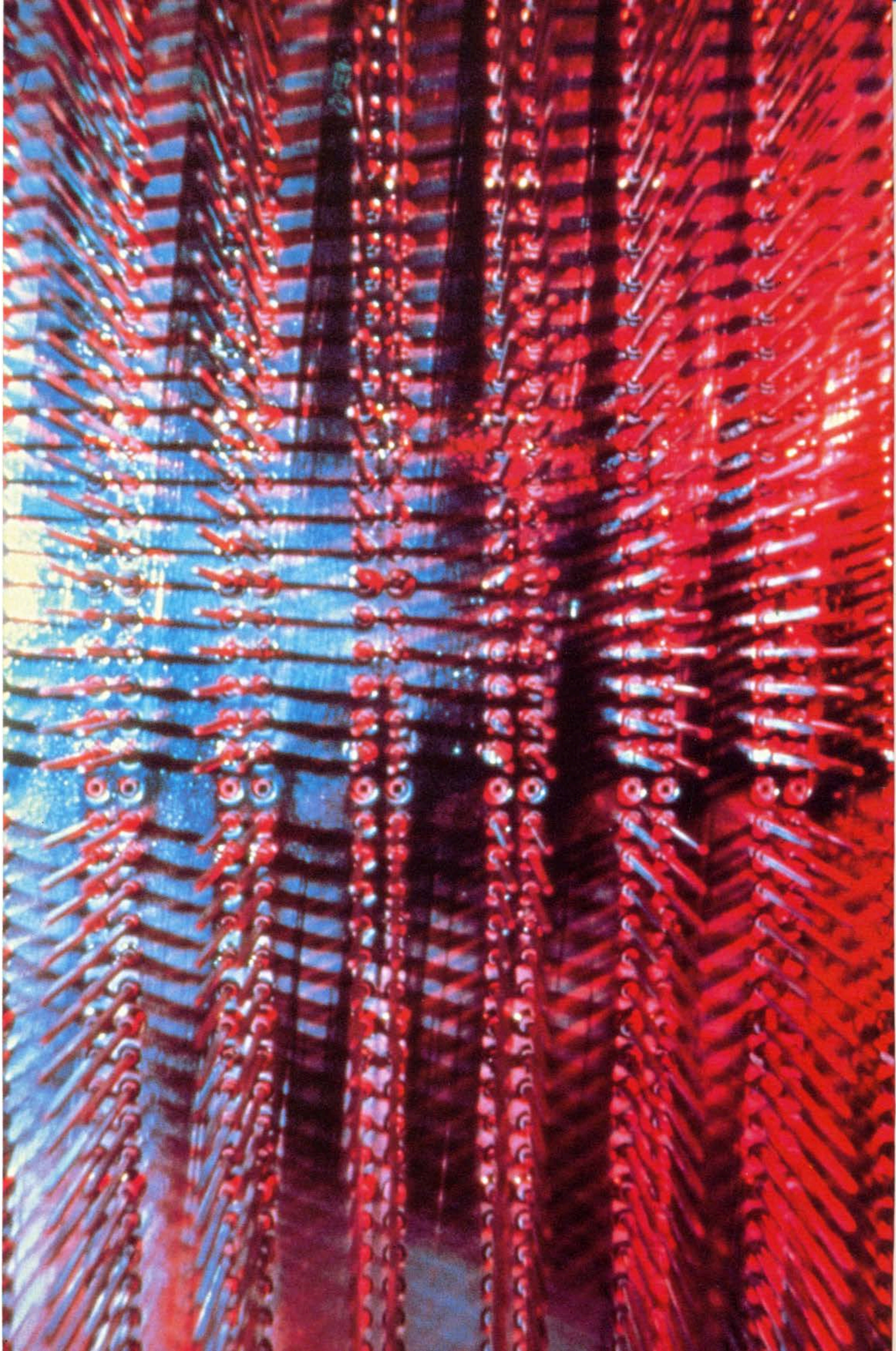
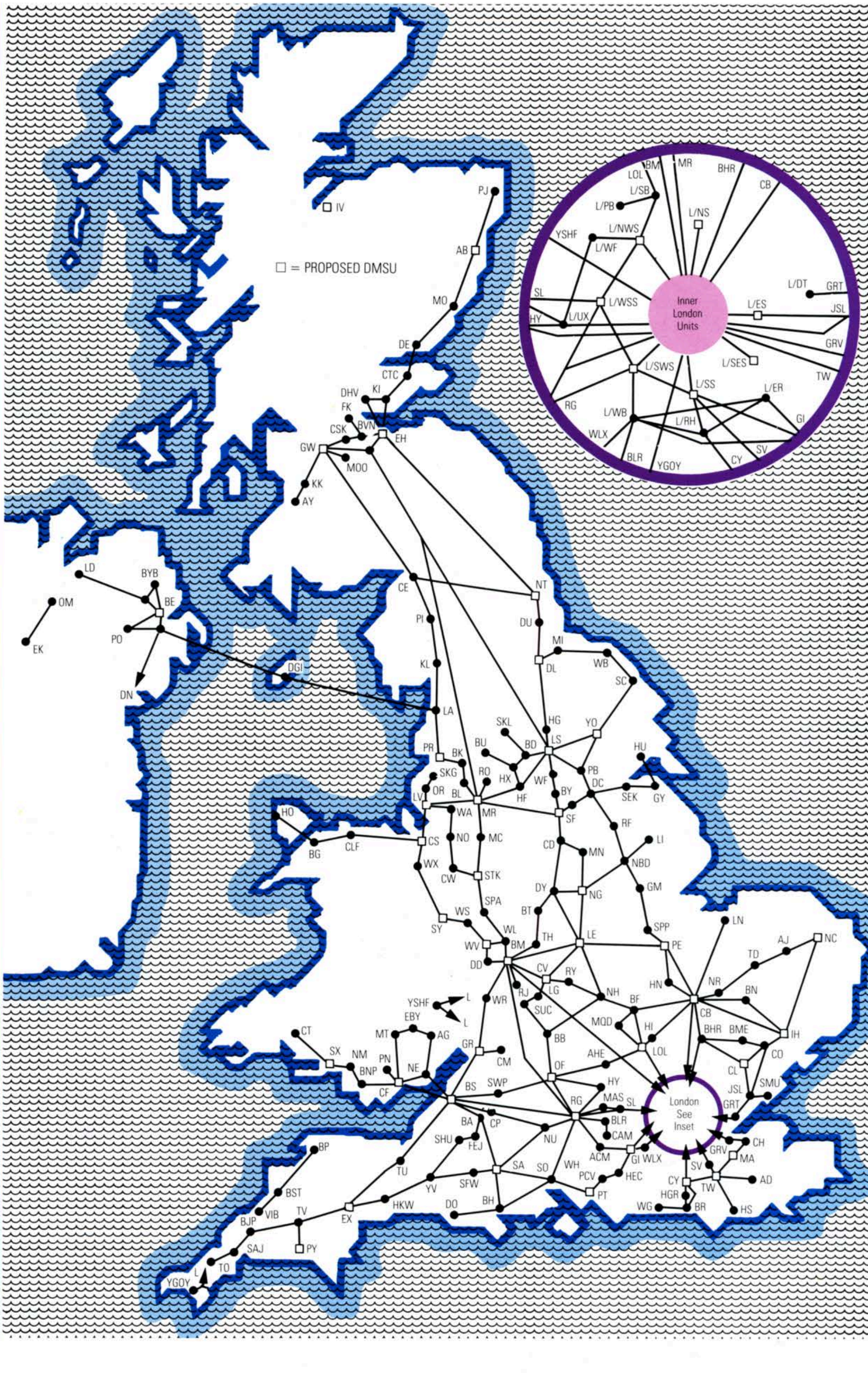


fig. 1



Main Network Digital Links Expected to be in service by August 1984

System X Strategy

SYSTEM X

In journalistic terms, the microprocessor, or silicon chip is yesterday's news. The public's taste for this subject has become distinctly jaded. Over the past decade or so, since market launch, an entire publishing industry has grown up around it; TV series, instant courses, White Papers, and major news items have followed every announcement, if not breathlessly, then with a good deal of heavy breathing. But facts rarely live up to expectations. Today, only the most optimistic pundit would deny that the 'chip' has failed to have the revolutionary impact forecast for it.

Against this background of anticlimax, it is probably fair to say that no industry is being more revolutionised by semi-conductor technology than telecommunications. Almost every aspect of our business is subjected to the pressures of high technology. The firm ground of the past is in a less than solid state.

British Telecom's response to these pressures, with the aid of British industry, is System X: a family of digital exchanges, with the capacity to absorb future improvements in micro-electronics, which together with digital transmission will form an integrated digital network (IDN).

An integrated approach to Telecommunications

A progressive telecommunications administration must provide its customers with a modern, economic service both now and in the future. Although the equipment at present used by BT allows basic service capability, it also imposes severe restraints especially in the development of a network which can offer the wider range of services that customers will increasingly demand.

The UK network as it stands is fully automatic allowing customers to dial their own trunk calls, with more than 90% of International traffic direct dialled to over 100 countries, and gives a comparitively good quality of service. It suffers however, from a number of constraints, common to existing networks throughout the world. These include:

Dominated by 2-wire switching and channel associated signalling.

Multiplicity of limited-capacity signalling system.

Relatively slow set-up time for multi-link calls.

Transmission loss varies with call routings.

Prone to noise and distortion.

Limited capacity for further evolution and provision of new facilities.

Mechanical switches prone to wear.

Manufacture and maintenance of equipment highly labour-intensive.

Out of tune with modern technology.

In the late 1960's a joint BT/Industry team (The Advisory Group on System Definition) was set up to study the fundamental criteria on which to base ongoing switching developments. The study resulted in the formulation of System X, a family of exchanges created around:

Micro-electronic technology.

Integrated digital transmission and switching.

Stored program control.

Common-channel signalling.

System X has therefore been designed from the start with a clear, deliberate plan in mind: the construction of a total telecommunications system which is capable of overcoming the limitations of existing networks, while forming the basis of the advanced networks that will be needed in the years to come. The characteristics of System X include:

2-wire or 4-wire subscriber switching.

4-wire junction and trunk switching.

Single signalling system with extensive capability.

Fast set-up time for multi-link calls.

Transmission loss independent of circuit length.

Low noise and distortion.

Extensive capability for evolution and provision of new facilities.

Interworking with digital international networks.

Digital switches that are inherently reliable.

Manufacture and maintenance of equipment partially automated.

Modern electronic techniques exploited throughout.

The full potential of the digital network to carry a sophisticated range of new services can only be realised by extending digital working to the customer's own premises using enhanced customer/network signalling, to form an Integrated Services Digital Network (ISDN). The most economic solution for the trunk network, it was decided, would be to link digital exchanges to digital transmission systems with common-channel interprocessor signalling. Figure 1 shows the proposed digital trunk network in 1984.

The BT team, produced a strategic study on the network modernisation policy. Its main recommendations were:

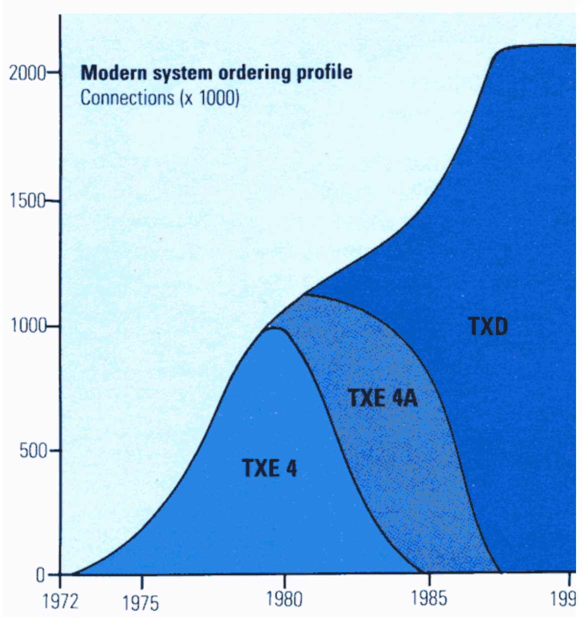
The deployment of System X equipment in such a way as to maximise the service capabilities to those customers who will put the highest value on them. The target is to interconnect the 30 principal city and urban areas by a high facility integrated digital network by the mid-1980s.

To replace all trunk and tandem exchanges with System X by 1992 with complementary digital transmission modernisation to give a totally integrated network.

To provide complementary System X local switching facilities coincident with the installation of trunk exchanges, taking account of marketing potential for new services, so that the service capability can be brought to customers most likely to use it.

To eliminate large Strowger local exchanges (TXS) from the network by 1992, and all Strowger equipment by 1995.

To launch a trial of an integrated services digital network in London in 1983 with the prospect of rapid national fig. 2



expansion. (Figure 2 represents the planned System requirement between 1979 and 1990).

To replace the remaining crossbar (TXK) and electron local exchanges (TXE) by the year 2014.

System X has been produced by a collaborati development utilising the expertise and experien available within:

British Telecom.

GEC Telecommunications Ltd.

Plessey Telecommunications Ltd.

Standard Telephone and Cables Ltd.

The underlying approach has been to develc switching systems of great evolutionary potenti that also give these benefits:

Substantial reduction in equipment cost.

Large reduction in equipment size.

Shorter procurement times.

Shorter installation and commissioning times.

Increased reliability and reduced running costs.

And, of course, these benefits apply to a sing System X exchange that is installed as a separate enti in an existing environment, as well as to large ne systems.

As new equipment is progressively installed, oth advantages follow, including:

New services for the customer (Refer to Figure 3).

New facilities for the administration.

Reduced overall cost and improved quality of transmission from the creation of integrated digital trunk and junction networks.

One of the most important features of System X is the collaborative nature of its development. This has meant that the definition of particular elements of the System has been carried out by whichever party is most appropriate, and has been agreed among all the parties. It follows that it is necessary to ensure that common standards are followed for the subsequent development and that all documentation and data is assembled and kept in a form which enables any manufacturer to produce an identical product.

At a later stage, when a network contains a significant proportion of digital exchanges interconnected by digital links, there will also be potential for:

Digital transmission in the local distribution network.

A common network for speech, data and other services.

Provision of new services at appropriate times.

Digital switching systems are under development in a number of countries, principally USA, Canada, Sweden, France, Germany, Italy and Japan. System X compares favourably with these other systems but will face fierce competition in the export markets. Its greatest virtue, however, is that it has been jointly developed by one of the largest administrations, in cooperation with UK Manufacturers, perfecting all operational and manufacturing requirements. It has also a full supporting package covering the whole spectrum of activities through individual exchange design, specification and manufacture, to software management and other operational aspects.

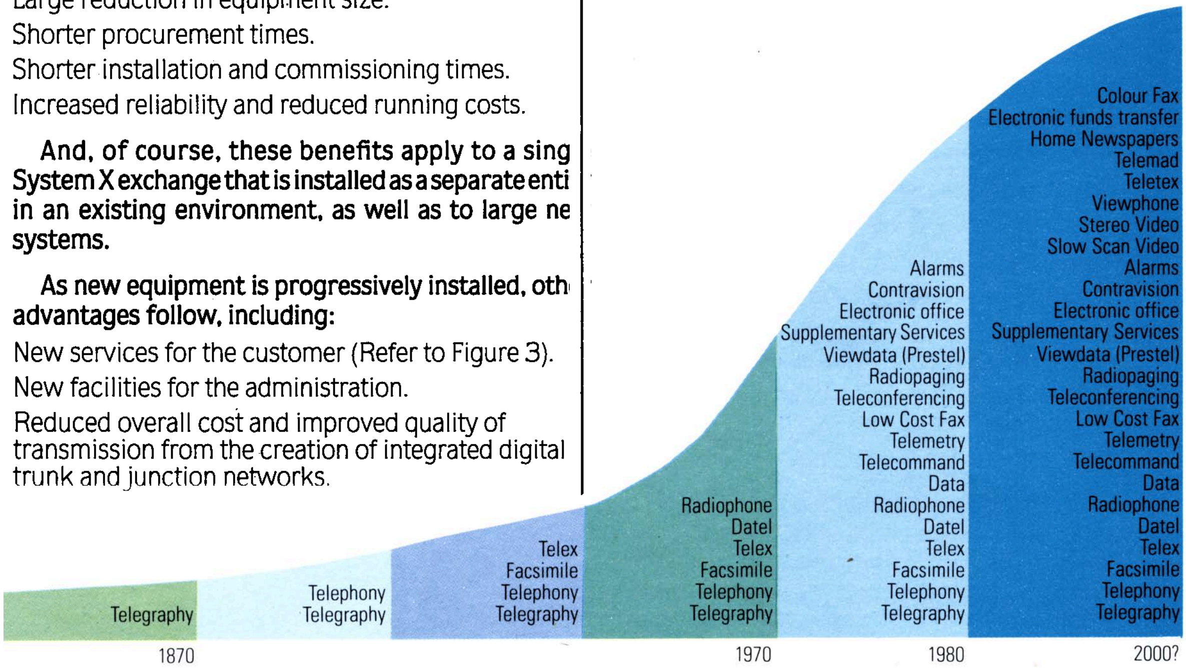


fig 3

The evolution of System X Exchanges

Exchange Design

BTHQ will determine planning standards and the ultimate network structure and, initially, all System X exchanges ordered up to and including ordering year 1981/2 will be dimensioned by BTHQ planning groups. At a later stage Regional planning groups will dimension their own exchanges guided by TIs. BTHQ will then perform a monitoring role and specify planning standards for new developments.

In the longer term, computer support is considered an essential requirement of the System X planning environment and Computer Aided Design (CAD) will remove the more tedious aspects of the planners work.

System X Exchanges

The family of System X exchanges includes Digital Local Exchanges (DLE), Digital Principal Local Exchanges (DPLEs) and Digital Main Network Switching Units (DMSUs). In order to assist in the understanding of the evolution of the digital network a brief description of the role of the DMSU and DPLE will be given here.

(i) Digital Main Network Switching Units (DMSUs). Approximately 60 in total and located at selected existing GSC sites, will serve a number of existing GSC Areas primarily switching traffic between GSC areas but also capable of handling junction tandem traffic.

(ii) Digital Principal Local Exchanges (DPLEs). Generally located at the remaining GSC sites and parented on an appropriate DMSU, will have a conventional dual role as a local exchange and as a local traffic tandem for digital local exchanges within its own DPLE area. In addition it will provide the primary interface for interworking between the analogue and digital networks via the co-sited GSC, as will the DMSU, and at a later stage in network evolution when all GSCs are replaced, to provide charge band determination and MOJ, and concentrate trunk traffic for all remaining analogue local exchanges until they themselves are modernized.

Digital Network Structure and Evolution

The digitally switched network will comprise a three tier hierarchy; the status within the hierarchy being defined as follows:

Top Tier	DMSUs
Middle Tier	DPLEs
Bottom Tier	DLEs

A network of mandatory routes will interconnect the various tiers as shown in Figure 8. The DLE-DMS route (physically routed via the digital distribution frame (DDF) at the DPLE (GSC) site) should be regarded as mandatory except for small DLEs.

A limited number of non-mandatory routes will also be provided where substantial savings can be realised in practice. However for clarity these routes are not shown. Similarly, for clarity, all mandatory DLE → DMSU routes are not shown in Figures 5-7.

There are of course many ways in which these System X exchanges can be introduced into the existing network. The method to be adopted is 'The Overlay Concept' in which the modernization of different parts of the network proceeds at different rates governed typically by local circumstances or by national policy; but where a complete backbone modernized network is quickly established.

Figures 5-7 highlight three phases in the gradual transformation of an existing analogue network (Figure 4) into the new digital network of the future (Figure 8).

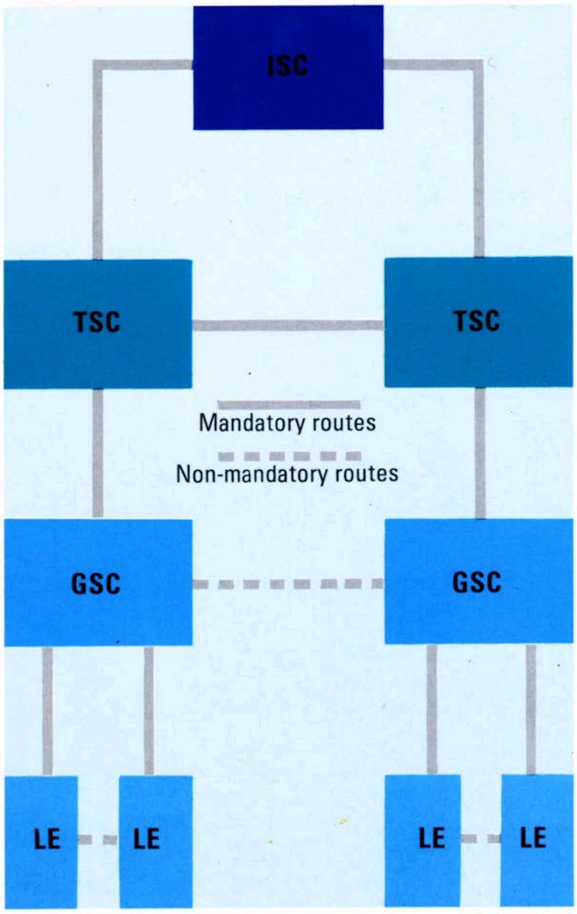
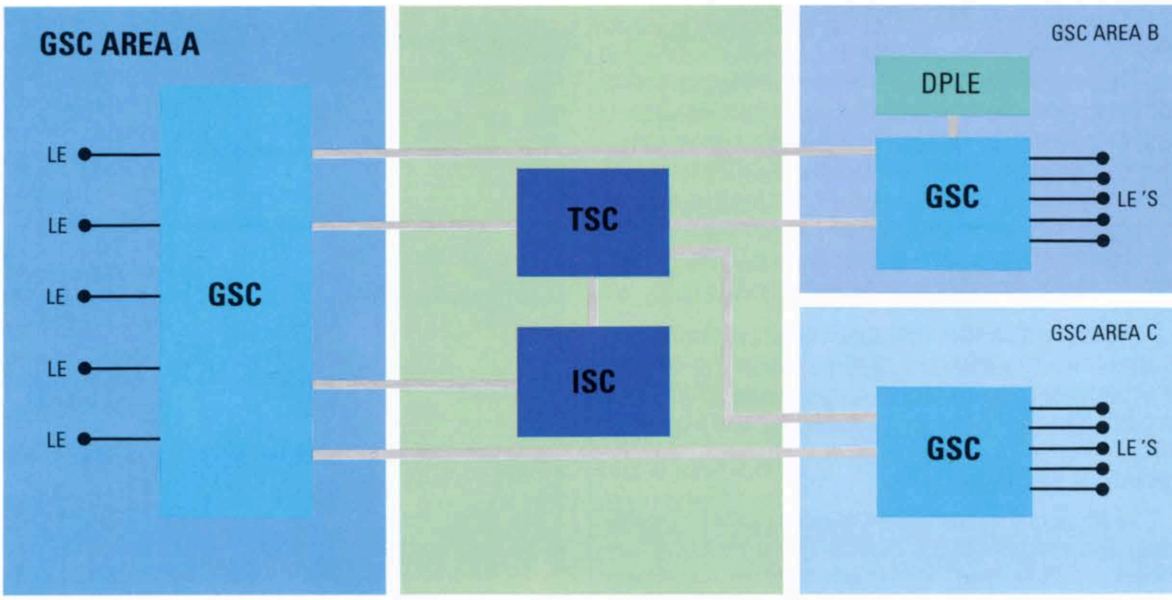


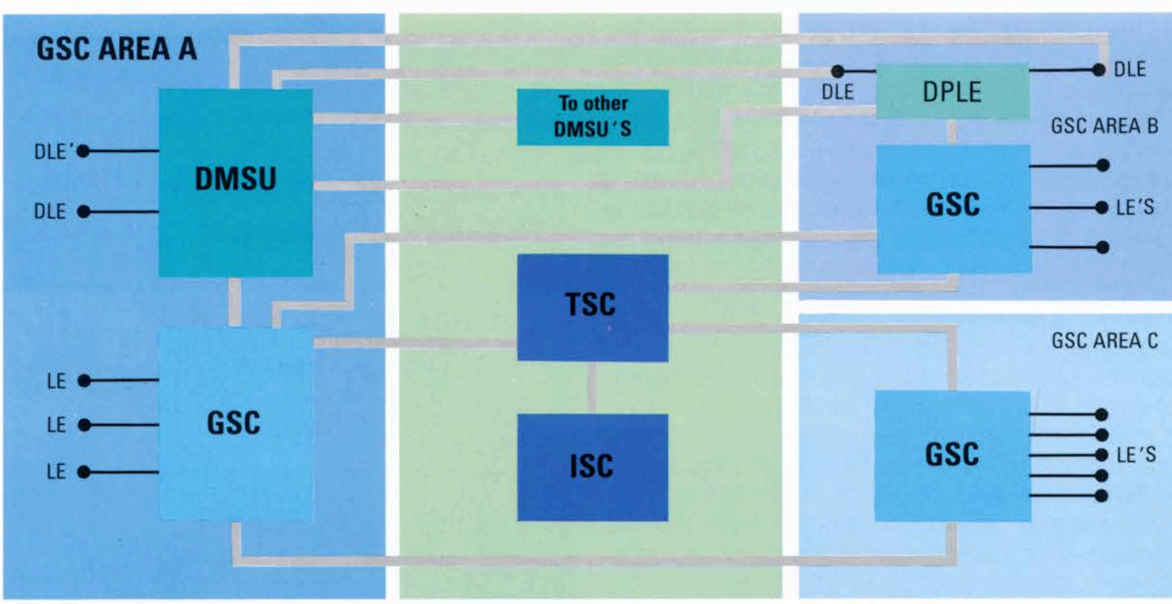
fig 4

fig 5



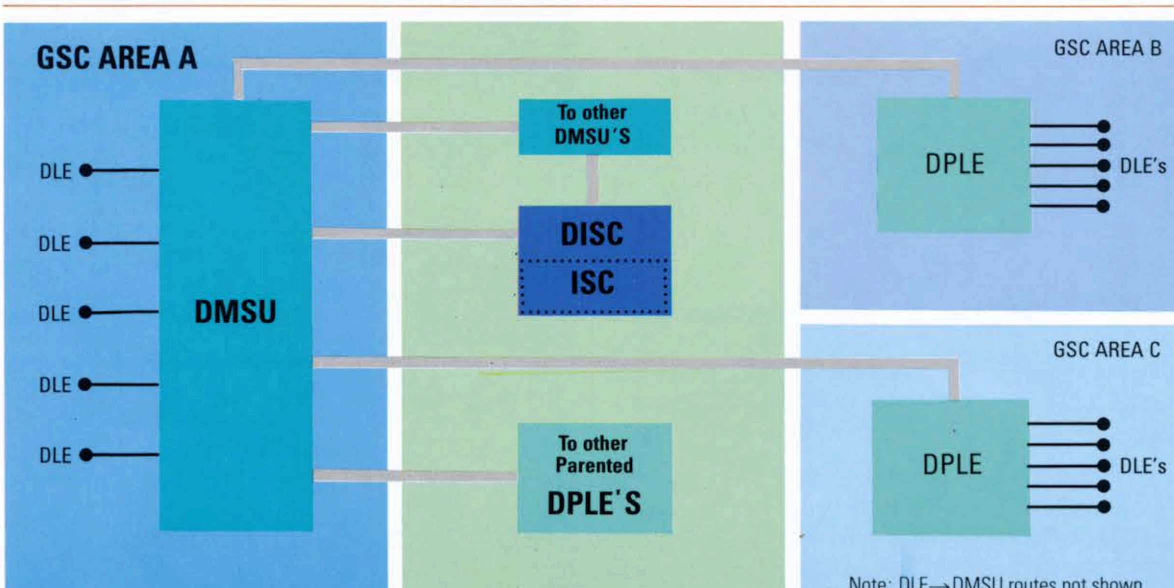
PHASE 1

fig 6



PHASE 2

fig 7



PHASE 3

Phase I

Existing local exchanges (LEs) and their Group Switching Centres (GSC) continue to service the areas and use the existing trunk transit network. The system X exchange provided in GSC B area, a DPLE in this instance, will originate and receive trunk and junction calls via the existing network. Own-exchange calls will however be wholly digitally switched and customers connected to the System X exchange will be able to take advantage of the independent System X facilities available (i.e. Star Services).

Phase II

Analogue local exchanges and their Group Switching Centres continue to serve many customers. In GSC area B existing exchanges are overlaid by System X exchanges; these exchanges being provided to cater for growth or to replace old equipment.

In practice the provision of the DMSU in GSC area A would generally be prior to or coincident with a digital local presence either in that area or any other GSC area the DMSU is planned to serve.

An interim position will exist in most cases whereby the existing GSC and a DMSU and/or DPLE will co-exist and both serve the GSC area for trunk and junction calls. The GSC load will be however gradually transferred to the DMSU/DPLE as System X penetration increases within the GSC area. The analogue and digital networks are kept as separate as possible with interworking restricted to calls which originate in one network and terminate in the other. Typically the interworking routes would be GSC → DPLE (or DMSU) and DPLE (or DMSU) → GSC to access the final junction link in a call only.

This overlay approach whereby the digital and analogue networks exist side by side with minimal interface or effect on one another, enables the digital network to spread early to those areas where the provision of enhanced customer services will be most profitable.

Phase III

All GSCs are now completely replaced either by DPLEs or DMSUs and as the transmission constraints associated with the analogue network no longer exist the transit network is not required. Existing ISCs will continue to serve the national network for many years supplemented by DISCs.

A proportion of analogue local exchanges will still remain in the network and these will be transferred to either a DMSU, if connected by TDM line plant, or DPLE as appropriate to provide charge band determination and MOJ, and trunk concentration until they themselves are modernized.

It should be borne in mind that in practice the three phases of network transformation illustrated in these diagrams will be less distinct and will merge from one to the other in a gradual process during the period of modernization.

Installation programme for System X Exchanges

Early in 1978, the then Managing Director Telecommunications agreed that a small number of operational System X exchanges should be installed earlier than previously planned. Fourteen exchanges were chosen, some due for replacement, and some with growth orders, to provide experience of several sizes of local, junction and trunk exchanges. The work was in locations which were not critical should delays occur, and there was an upper restriction on size until the systems were proved. The limit was later formalised at 3500 erlangs for a trunk exchange and 500 erlangs for a local exchange, for orders placed up to March 1981 and termed as 'Release 1'.

fig 8

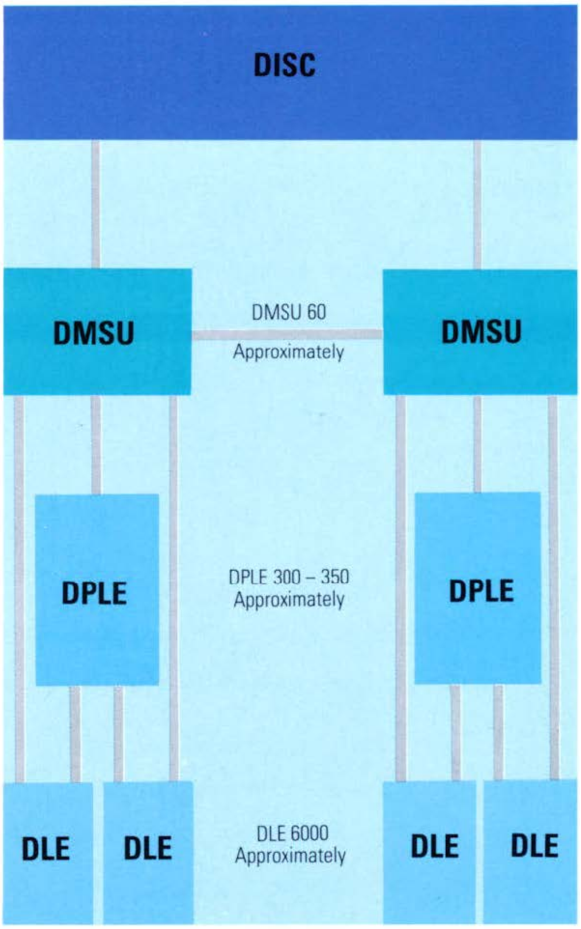


fig 9

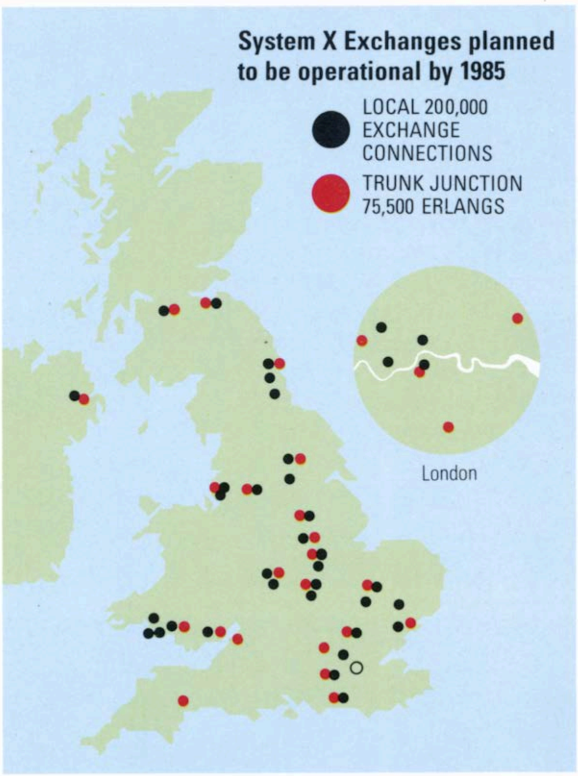
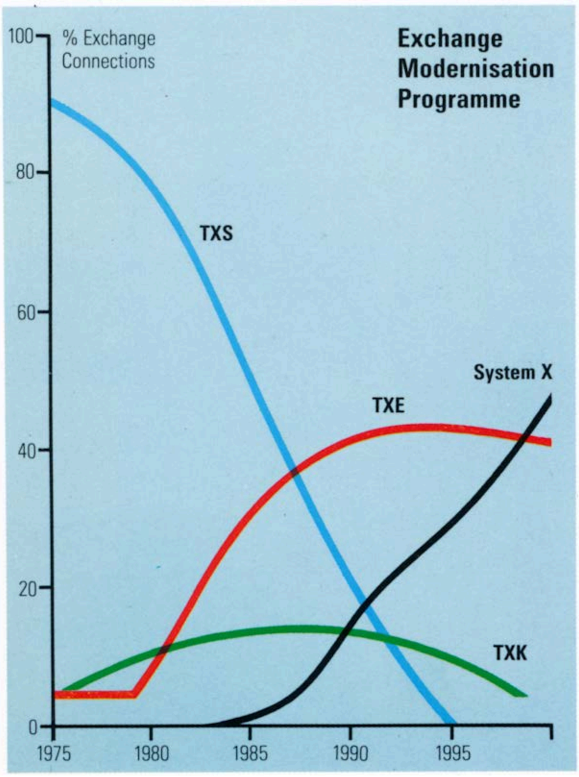


fig 10



The programme was expanded during 1979, to include orders up to March 1983 with several exchanges in most Regions. Exchanges ordered after March 1981 will use a new range of hardware and software packages, which will form the System Enhancement Programme (SEP).

A master plan for System X

In July 1980 the Board agreed that modernisation of the network using System X should proceed on the basis of a rapid strategy. BTHQ and RHQs then prepared the initial issue of the Network Master Plan. This considered, plans for every UK exchange, and projected the following targets:

1992 remove TXS from large local exchanges and digitalise all trunk and tandem exchanges.

1995 remove remaining TXS equipment.

1988/9 cease adding TXE and TXK equipment except for extensions to existing TXE2 exchanges using equipment from replaced exchanges.

2014 complete digitalisation of network. (Figure 10 illustrates projected targets for modernisation to the end of the century).

An analysis of the Network Master Plan prepared by BTHQ and RHQs during 1981 showed that insufficient emphasis had been given to meeting marketing criteria when deploying System X local exchange capacity. This had become particularly important, in view of the new competitive environment which BT was required to operate within, as a result of government legislation during 1981. A revised deployment strategy for local exchange equipment has therefore been prepared for application to the 1982 Network Master Plan. The implementation of this strategy will clearly lay heavy emphasis on the deployment objectives of System X.

The marketing requirements of modernisation are long standing, namely to deploy System X so as to make its unique facilities available to those customers most likely to benefit from them. However the advent of competition sharpens the need for a commercial approach that takes account of costs, potential revenue and the risk of loss to those competing networks, when planning the modernisation of the BT network. This is particularly important in the early stages when the supply of System X equipment is restricted by the constraints of Industry.

Studies have been carried out in BTHQ to identify the key parameters that will enable the distribution of System X local exchange capacity in the most effective manner. Regions will be required to identify those customers most likely to require the new services, which in essence comes down to finding the best locations, the priority/timing of the installation, and the appropriate size to be provided. Regions will remain accountable for their decisions, through the Network Master Plan procedure, in order that results are visible and the necessary facts available to influence future policy.

Location of System X Local Exchanges

The principal factors influencing the choice of location of System X Local Exchanges are the number of potential customers on an exchange for the new services and the risk of loss of custom to competing networks. The potential customers are judged to be business customers and high calling rate residential customers. Regions will be invited to compile a list of local exchanges based on this criteria and their local knowledge of premium customers that, for commercial reasons, should be provided with the capability for connexion to System X. Figure II shows the top 30 Marketing Areas.

Priority/Timing of Installation

The listing referred to above should be compiled in priority order and consideration given first to those cases with the highest priority. There may well be accommodation and other practical factors that affect the timing but in the event these would reduce to a cost element in the decision equation. To help Regions make this economic judgement, computer assistance is being prepared by BTHQ through modifications to the Single Exchange Renewal Evaluation programme. This will be made available as soon as credible revenue factors are obtained.

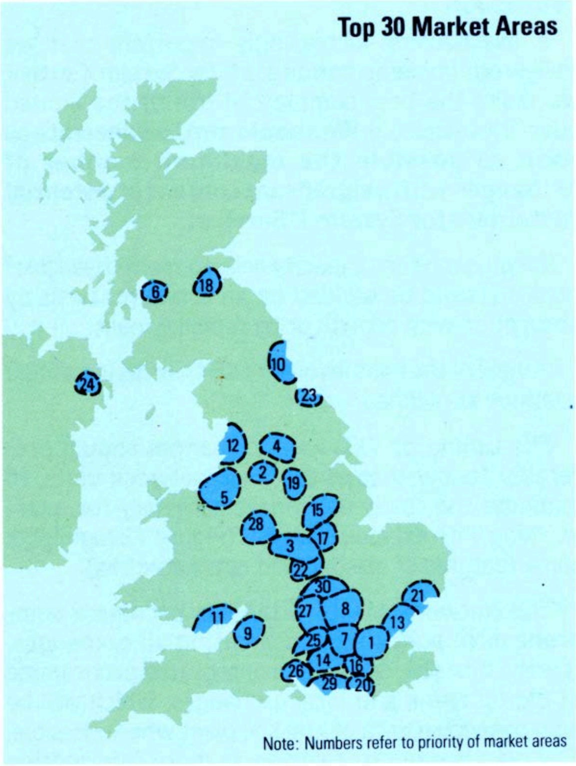


fig 11

Site of Installation

Ideally, the requirement is to spread the available capacity as far down the priority list as possible in order to penetrate the maximum number of potential "new services" customers, recognising that System X customers that do not pick-up new services represent a waste of this resource and minimise revenue contribution. However, practical considerations will need to be taken into account such as the number of open sites (and hence manpower resources), accommodation, number block availability (AFN codes) etc. A flexible approach will obviously be necessary to achieve maximum penetration calling for a departure from traditional planning and a closer liaison between the marketing and planning functions in Regions.

Allocation of System X Connection Capacity

The total available, year by year, System X Local Exchange capacity will again be divided between Regions by BTHQ. As for previous years the criteria is likely to be based on business customers but adjusted to reflect the concentration of business customers on the larger sized exchange units.

TXE4

Currently, the modernisation policy for local exchanges is based on the use of TXE4 to improve the quality of service given to customers. This is a continuing requirement where System X will not be available and is necessary to meet overall modernisation targets. The continuing deployment of TXE4 is also necessary to retain electronic production capability to prepare for the large scale production of System X. TXE4 capacity will therefore continue to be allocated to Regions as before. However, in order not to sterilize exchange areas where the potential for marketing of System X facilities is high, revised guidance will be issued on the deployment of TXE4 which is likely to direct this system towards residential areas. Studies are being carried out into the enhancement of TXE4 to provide some System X type facilities and information will be provided when it becomes available. System X development, production and commissioning aspects continue to exercise BTHQ on the side of caution. Thus taking these factors into account it is considered that the degree of risk is such that present ordering plans for TXE4A should stand.

Small Exchange Modernisation

It is most unlikely that small exchanges (UAX, SAX, small TXE2) will have sufficient business content to justify utilising System X capacity on the aforementioned criteria until 1986/87. Implied in those proposals therefore is the need to re-examine the logistics of the small exchange problem. NSD and selected Regions are actively considering this at the present time and will shortly be promulgating planning guidance. There will be a need to keep a small programme of SLEs in the early years but these should be primarily directed to service and growth needs.

Conclusion

It has become increasingly important that we review our implementation plans for System X so that we make the best commercial use of the limited quantities available. **We should aim to penetrate as soon as possible the maximum number of exchanges with a significant content of potential customers for System X Services.**

Surplus modern capacity arising from these proposals should be tackled on an economic basis by absorption with growth or by redeployment.

In view of the risks involved TXE4A ordering should continue as planned.

The timing of TXD local exchanges should preferably follow that of the main network units, to minimise the costly equipment necessary for interworking with existing systems. (Figure 12 highlights some features of existing and new networks).

The Network Master Plan has become a comprehensive policy for modernising all exchanges. It is the first step towards an integrated programme of digital trunk and local exchanges, which will be interconnected with digital line plant where possible. The plan is open to revision as more information becomes available on, for example, the relative costs of different types of small exchange.

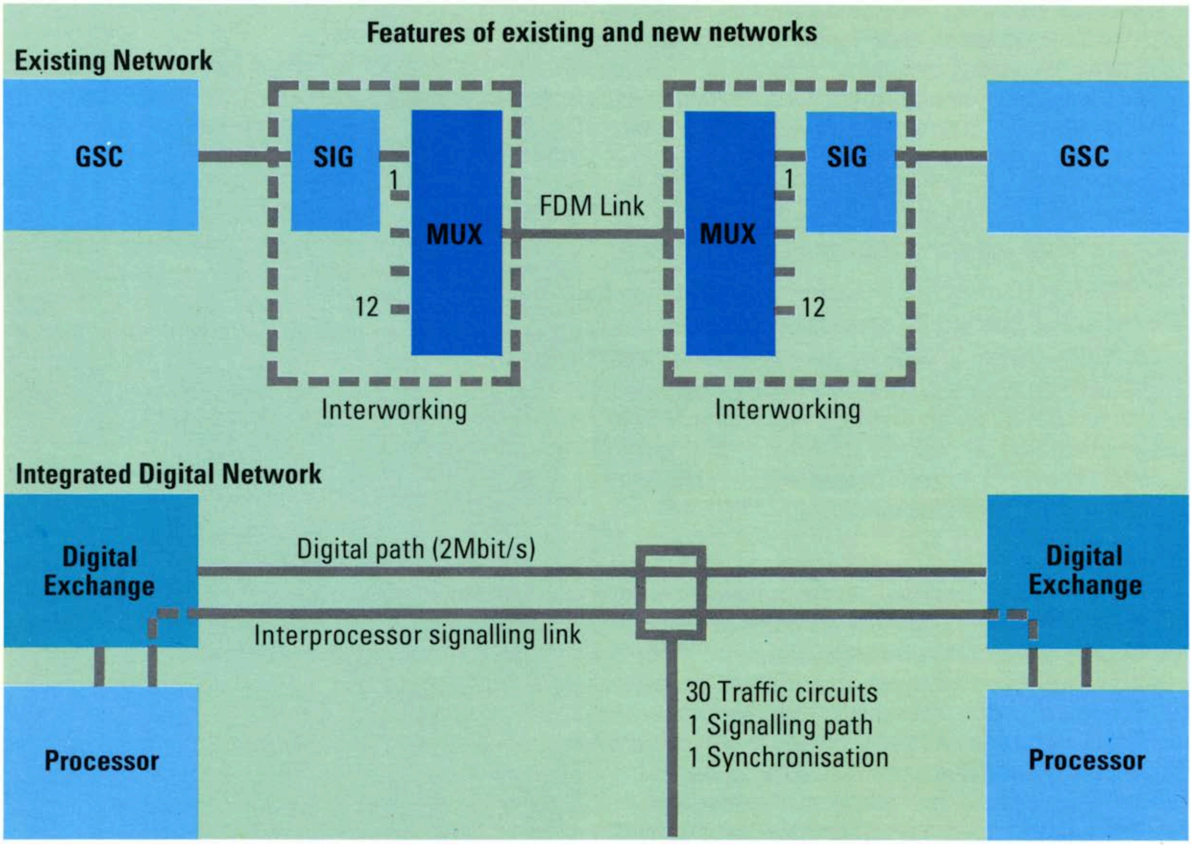
The Network Master Plan provides the basis for evaluating the practical implementation of the strategy. It also enables an assessment to be made of the financial and manpower consequences.

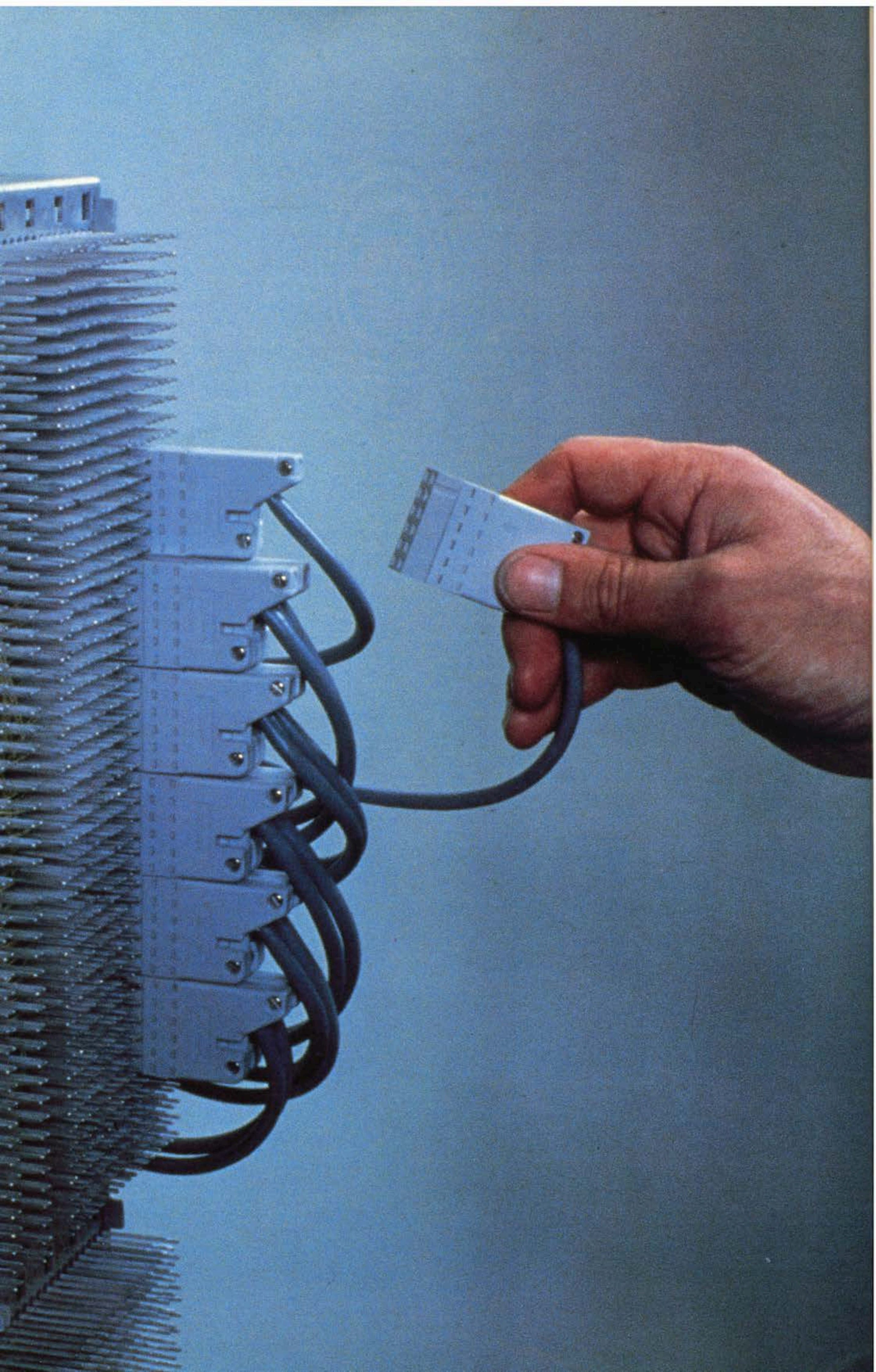
The practical realisation of modernisation targets relies not only on an installation programme geared to the output of industry, but also on how well individual Area problems can be overcome in the translation of these targets into practical work programmes. This will be a crucial aspect in the provision of digital exchanges, and work on this task has already begun through the medium of the Network Master Plan.

It is now clear that for many years ahead there will be a need for extra construction staff to cope with the increased level of activity required. Although System X exchanges will need less effort in terms of contract supervision work, we shall be incurring extra work overall because exchanges will be renewed before they are time expired. The largest work load however, will come from transferring all the existing customers' lines, junctions and trunk circuits from the old to the new exchanges. This is work done traditionally by BT staff and is expected to remain much the same in nature as at present.

Our success with the modernisation programme will be judged by the public mainly by the speed with which we bring System X exchanges into service. The targets set for the pace of modernisation are very testing. Ultimately, our ability to meet them will depend on how well we deploy and use our most important resource – our skilled staff – in improving the logistics of effort and materials.

fig 12





System X Exchanges

The existing UK telephone system is built around three types of exchange:

Strowger (Step by step)
Crossbar (Intermediate)
Electronic (Reed relay)

Each type is adapted according to application. For example, 'director' or 'non-director' working; 'local' or 'trunk.' The exchanges are connected by a whole range of signalling interfaces, which may include:

Loop disconnect
DC
AC 1VF
Multifrequency techniques.

Transmission may be over:

Simple cable
Circuit in FDM (Frequency Division Multiplexer)
Circuit in PCM (Pulse Code Modulation)
Radio link

At present, tandem junctions on FDM and PCM links must be de-multiplexed for switching and re-multiplexed for onward transmission. These switching and transmission systems have evolved in an uncoordinated way over many decades, and require complex interfacing to make them compatible.

Features of System X Exchanges

The basic elements within the new system of exchanges are:

High traffic capacity large exchanges
Intermediate traffic capacity medium exchanges
Small local exchanges

The large and medium exchanges are based on a multi-processor (cluster) configuration. They form the trunk and local exchange system providing a wide range of traffic capacity and, with adaption, the junction-tandem, international-gateway, and circuit-switched data exchanges. (Refer to Table 2).

The advantages build up progressively over the years and, at all times, System X equipment provides real, practical advantages of vital importance to both British Telecom and its customers. (Table 1 lists current System X operating objectives).

The digital system employs a number of modern concepts and techniques, including:

Stored Program Control

Stored program control involves the use of a digital computer or processor to control the operation of an exchange. The functions performed by the exchange are not controlled by the circuitry but by the program stored in the memory of the processor. The flexibility of the exchange to meet changing requirements is thus enhanced as the programs can be readily adapted to suit.

Common-Channel Signalling

Common-channel signalling is a method of signalling

Plug-in-cabling for interconnecting shelves and racks

Table 1 System X Operating Objectives

	Termination Capacity	Switch Capacity (Switched erlangs)	Processing Capacity (Busy-hour call attempts)
Concentrator	2,000	160	8,000
Small local exchanges	6,000	300	16,000
Medium local exchanges	60,000	2,000	160,000
Large local exchanges	60,000	9,000	500,000
Medium trunk exchanges	6,000	2,000	160,000
Large trunk exchanges	55,000	18,000	500,000
International exchange	55,000	18,000	400,000
Operator services	8,000	3,000	50,000
Operations and Maintenance Centre	NA	NA	NA

NOTE: The capacities shown in the above table are maxima. Processor type, and in some cases the ratio of analogue to digital circuits, will considerably reduce these figures.

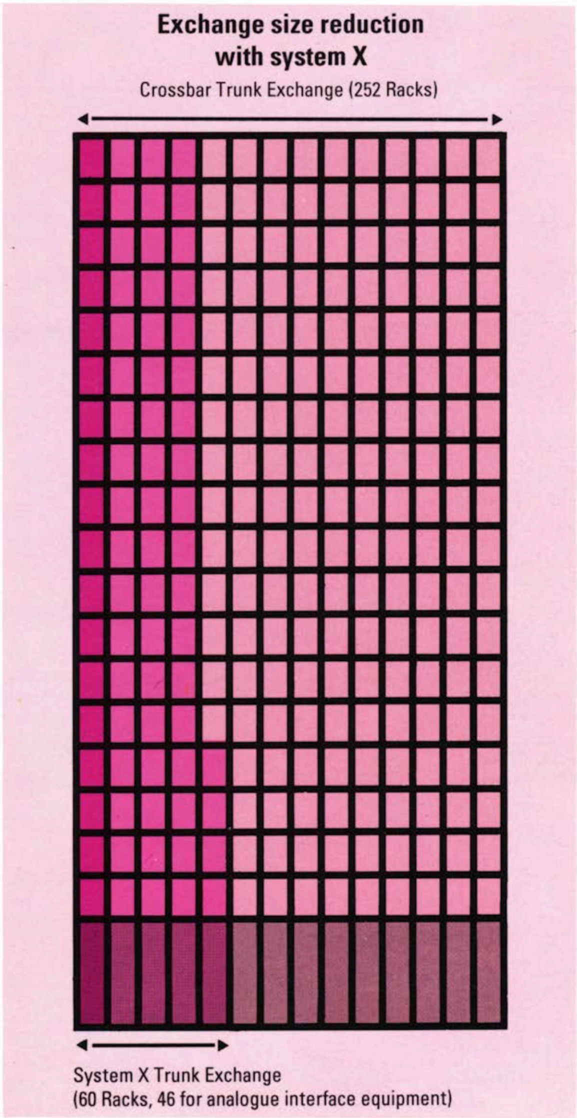


fig 13

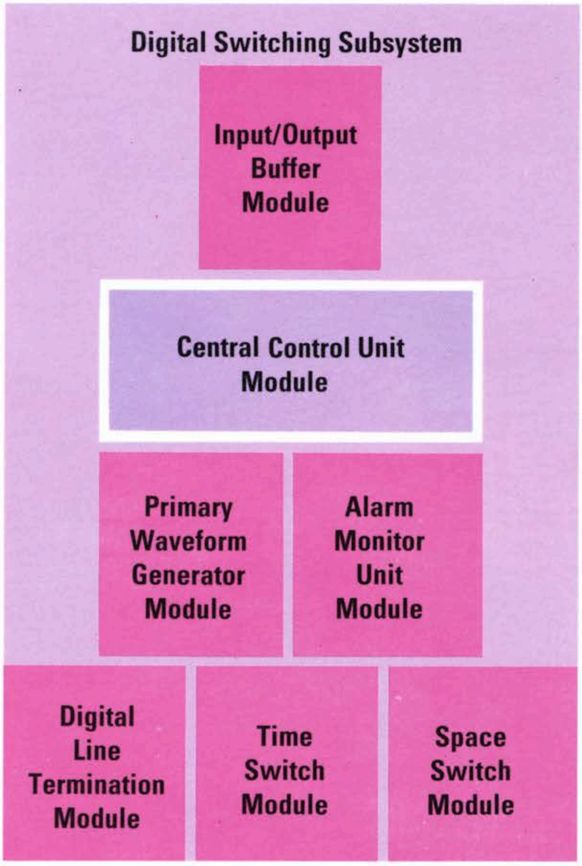
Table 2 Exchange Types
Equivalent Existing and System X Exchanges

EXCHANGE TYPE	ANALOGUE	SYSTEM X
LOCAL	TXS D + ND	LARGE LOCAL EXCHANGE (LLE)
	TXK 1 ND	
	TXK 3 D + ND	
	TXE 4 (A) D + ND	MEDIUM LOCAL EXCHANGE (MLE)
	TXS D + ND	SMALL LOCAL EXCHANGE (SLE)
	TXK 1 ND	
	TXE 2 ND	REMOTE CONCENTRATOR UNIT (RCU)
	UAX ND	RCU OR UXD5 OR SLE
		VERY SMALL LOCAL
	SAX ND	EXCHANGE (VSLE)
JUNCTION TANDEM	TXS D	MTE OR LTE WITH
	TXK 1 (SSC)	APPROPRIATE SIGNALLING
TRUNK	TXS D + ND	LARGE TRUNK EXCHANGE (LTE)
	TXK 1 ND + (SSC)	MEDIUM TRUNK EXCHANGE (MTE)
TRANSIT	TXK 4	NOT REQUIRED
INTERNATIONAL	TXS	
	TXK 2	DIGITAL INTERNATIONAL
	TXK 5	SWITCHING CENTRE (DISC)
	TXK 6	

KEY D Director Application
ND Non-Director Application

NB The analogies made in this table are approximate only and there will be exceptions in each category.

fig 14



between switching centres such that all of the required signalling is carried on a data link separate from the speech circuits. The arrangement is capable of providing a very adaptable and convenient means of signalling.

Microelectronics

The design of System X takes full advantage of up to date micro-electronic techniques and includes the extensive use of microprocessors. Figure 13 gives an example of exchange size reduction with System X.

Modular Design

The systems are built up from a range of subsystems which have a high degree of commonality.

Equipment Practice

New equipment practices are to be used. One of these will be in the use of plug-in cabling.

A Modular System Approach

System X is a modular system. This means that each switching element can be assembled from a selection of 'building blocks.' The modularity applies to both hardware and software and offers many benefits. For example, changes in requirements for service, operational, and traffic purposes can generally be met by the addition or modification of individual modules.

The modularity of the hardware will enable new generations of technology to be introduced into specific modules without disturbing the architecture of the system as a whole.

The modularity of the software has two aspects. First, when a particular exchange is being designed, it allows a central Software Generating Facility to select and assemble together exactly those modules of software that are required for that exchange. Second, when the modules are being run on a processor, message interfaces between them secure the data and prevent corruptions from being propagated.

The major modules, which are themselves built up from smaller ones, are the subsystems. (Figure 14 illustrates the modularity of the Digital Switching Subsystem (DSS)).

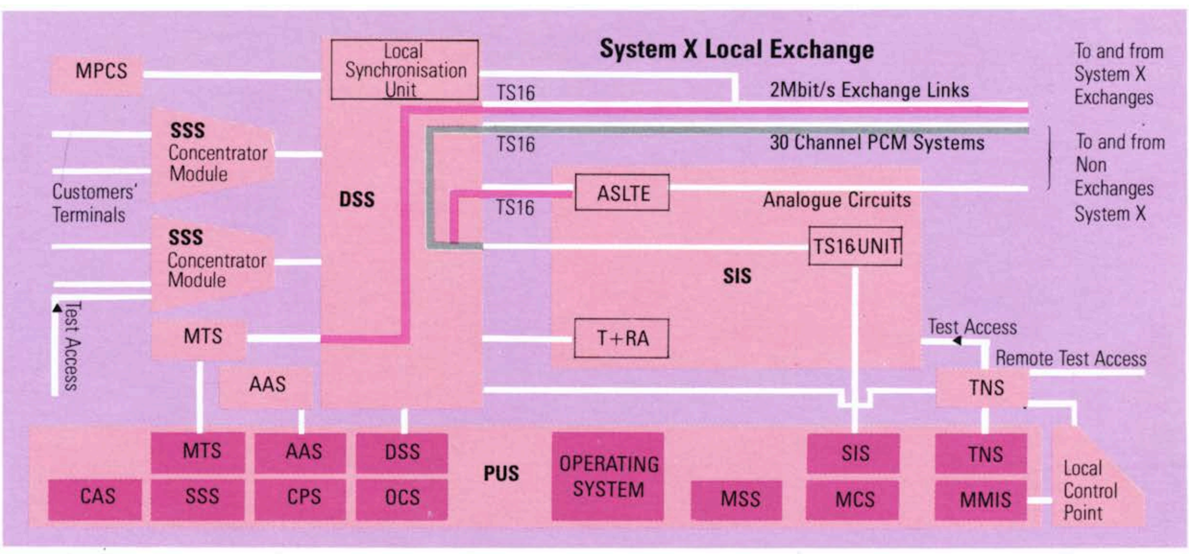
A subsystem, which may consist of hardware and/or software, is a chosen subdivision of a switching system. It performs specified functions, and interworks with other subsystems across enduring functional interfaces, which form its boundaries. These interfaces provide convenient points for growth and adaptability.

A subsystem may be suitable for use in a number of switching systems. However, variations of the basic subsystem may be needed, mainly to cope economically with the range of sizes and with variations in the detailed facilities required. (Fig. 15 and Fig. 16 shows how different subsystems may be assembled to form a Local exchange and a Trunk exchange).

Most of the differences arise from the functions to be performed by the different applications and these are largely defined by the system software. The modular approach to software will enable basic software modules to be used together with specialised modules for a wide variety of applications.

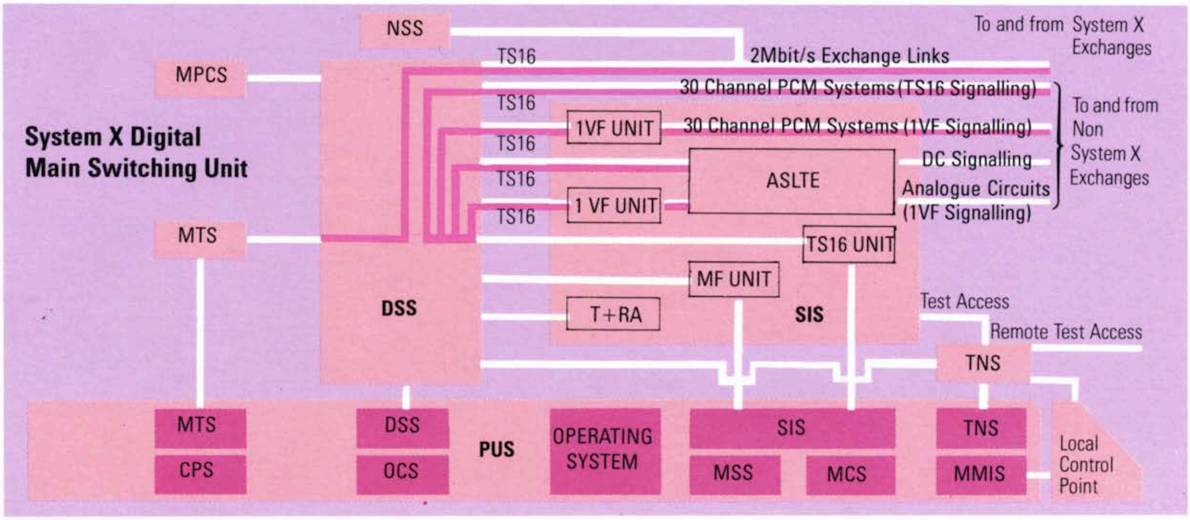
The overall picture is therefore of a system with some hardware differences arising from size-range requirements, signalling variety, and the presence or absence of a customers' concentrator stage, but otherwise of a system catering for many applications by software variations applied to largely common hardware configurations. A complete list of subsystems can be found in Appendix 1.

fig 15



Hardware Subsystems	SSS	Subscribers' Switching Subsystem	CAS	Call Accounting Subsystem
	DSS	Digital Switching Subsystem	CPS	Call Processing Subsystem
	MTS	Message Transmission Subsystem	MCS	Maintenance Control System
	SIS	Signalling Interworking Subsystem	OCS	Overload Control Subsystem
	ASLTE	Analogue Signalling Line Termination Equipment	MSS	Management Statistics Subsystem
	NSS	Network Synchronisation Subsystem	MPCS	Multi-Party Connection Subsystem
Software Subsystems	PUS	Processor Utility Subsystem	MMIS	Man/Machine Interface Subsystem
	TNS	Test Network Subsystem	OS	Operating System (an integral part of the Processor Utility Subsystem)
	TS16	Time Slot 16	T+RA	Tones and Recorded Announcements
	VF	Voice Frequency	MF	Multi Frequency

fig 16

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New services for the customer

SYSTEM X

In any business, one person stands above all others in the order of priority. His needs are fundamental to any plan; his wishes paramount. He is, of course, the customer. In what ways will System X benefit our particular customer? There are firstly the purely technical improvements:

Faster call set-up time

Better transmission

Fewer faults

Important as they are, it is doubtful whether the huge investment proposed for System X could be justified on these improvements alone. New services will be necessary, and will constitute the visible aspects of System X from the customer's point of view.

The initial penetration of System X exchanges, however, will be limited. The customer services will develop in the following way:

1. There will be immediate benefits to customers connected to the early System X exchanges.

2. The initial range of facilities will be expanded once a reasonable proportion of the network is digital.

3. New services will apply mainly to telephone customers but System X potential for supporting existing and new non-voice services will be developed.

4. The massive investment in System X will give us a network which promises a much more reliable service and the ability to offer an expanding range of services to our customers.

The use of digital techniques, distributed micro-processors and stored program control offers a powerful and flexible means of controlling the operation of the exchanges, as well as providing for the performance of such functions as compiling records of call charges, and collecting traffic data. The exchanges are completely compatible with the existing network, interfacing on customer and exchange sides to both digital and analogue lines. One of the many advantages of stored program control is the freedom it gives for the development of new services.

On transmission, BT is already installing a range of high capacity digital links, which are being used to support its existing network, as well as forming an integral part of the new system. These extend from 2 Mbit/s to 140 Mbit/s with optical fibres allowing expansion to 560 Mbit/s in the near future. In response to customer needs, design changes will be necessary both in telephone instruments and local links to the exchange.

There is an urgent need to provide modern telephone instruments with a faster signalling system than the 10 pps which is obtained from the 'make or break' dial. Keyphones using MF tones will become nationally available following successful public trials at Chislehurst and Leatherhead.

Four of the new range telephones

The existing local cable system using 2wire circuits is an adequate medium for speech, but for data transmission the maximum bit rate is too low. BT are experimenting with various techniques to bring 64 kbits per second (and more) to customers' premises at a low cost. Demand dictates that this must be achieved despite substantial problems in handling the many different cable types in the local network. For digital PABXs, there exists the prospect of linking them to their serving System X exchange using 30-circuit TDM links, which give a 2 Mbit/s data capability.

Presently on trial is a method, called 'Remote Concentration,' for serving areas which have a need for System X capability but which for various reasons can not immediately be equipped with a System X local exchange. These concentrators will be linked to the nearest System X exchanges with 2 Mbit/s links.

Also planned is a corresponding provision of group switching centres to connect these digital local exchanges together by digital links to form a high-speed integrated digital network, and ensure that the maximum possible level of traffic travels over the enhanced network.

The New 'Star' Services

In the early years of System X there will be eight new services available to the customers connected to System X exchanges. These services, known as Supplementary Services, are often referred to as the 'Top 8.'

The Star Services are all those voice services which are technically feasible in a network which for a period of years, will contain a majority of non-TXD exchanges. Market research has also shown them to be the most potentially profitable. These services, which can be accessed by the user from his telephone, can be operated on stand-alone exchanges and as a higher proportion of the network becomes TXD, some of them may be extended or superseded by others. The initial Star Services are:

Short Code Calling

Reminder (Alarm) Call

Call Waiting

Call Diversion

Three-way Calling

Charge Advice

Call Barring

Repeat Last Call

An explanation of each service follows:

Short Code Calling

This service allows a user to call numbers by means of a one or two digit short code. The full number is stored against the code in the exchange memory. Users may allocate codes for any frequently used numbers. The various types of call maker provide this service, but the advantage with System X is that no special instruments are required. The stored code information is held at the exchange. 'Seven-code' and 'twenty-seven-code' versions will be marketed.

fig 17

Reminder Call

For general reminders and alarm calls. Customers may program the exchange to call back at any time. Single alarm calls of programmed regular alarms will be available. In the future, users will be able to record personal messages on the exchange's central recorder. The exchange will ring back and replay a message at the specified time and date.

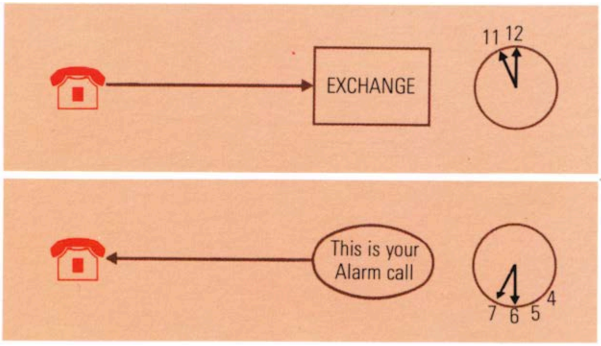


fig 18

Call Waiting

For the customer who may be engaged on a relatively unimportant call and wishes to be informed of an incoming call. The 'Call Waiting' signal (a short bleep) is received by the subscriber only. He can hold and take the new call, cease the first call, or ignore the second, in which case the second caller receives an announcement. The service may be switched on or off.

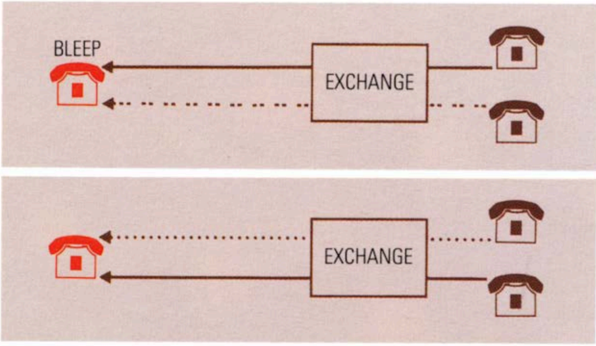


fig 19

Call Diversion

This service allows users to redirect incoming calls to other locations. Initially in the local call charge area only, but eventually nationwide. The new number is simply keyed to the exchange. Three forms of service are available:

All calls diverted

Diversions on no reply

Diversion when line engaged.

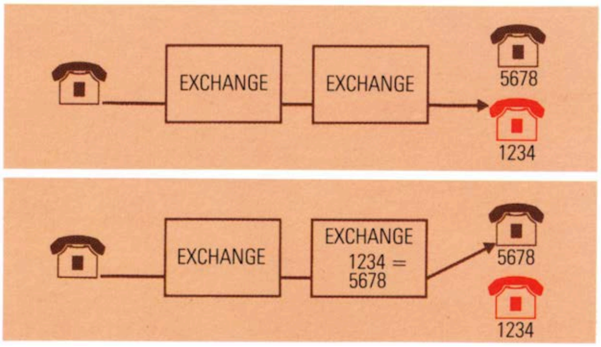


fig 20

Three-Way Calling

Three terminations may be connected in a three-way conversation. A customer already engaged on a call, will be able to hold, obtain dial tone and call another number. He will then be able to connect the third party into the conversation. When System X is fully established, he can drop out of a conversation for one of the other users to take over the call charge.

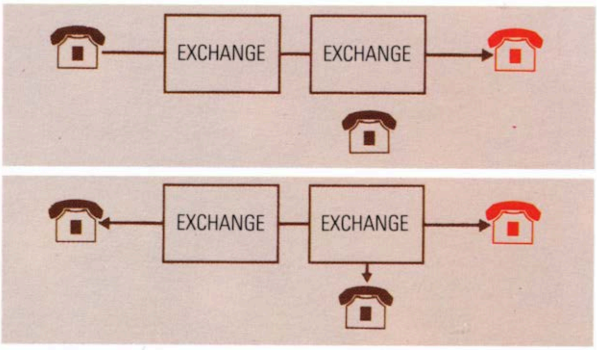


fig 21

fig 22

Charge Advice

Market research has shown that many customers would like to obtain a statement of the cost of either a single call or a series of calls. System X provides for this need with its charge advice service. By inputting a simple code either before or during a call, the caller can initiate the service. Itemised call statements are also available.

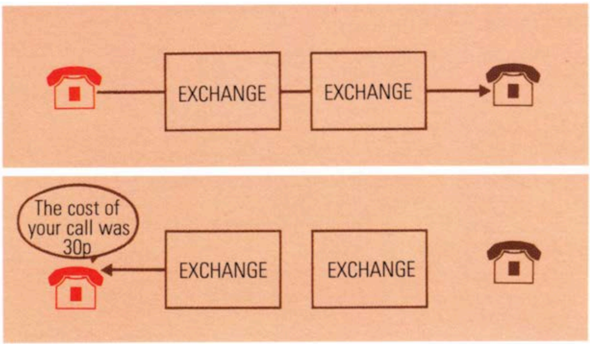


fig 23

Call Barring

There are numerous uses for this service and BT are making it as flexible as possible. Uses include:

Barring all international calls

Barring all outgoing calls (except 999)

Barring all outgoing calls using NND or IDD

Barring all calls except to a particular charge band area

Barring all operator calls

Barring of incoming calls is also an option. Barring could be removed by using a personal code allocated to the subscriber by BT.

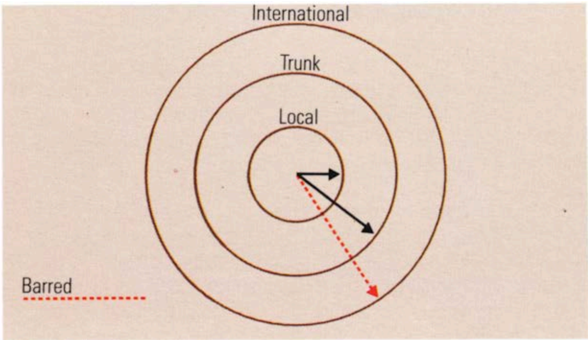
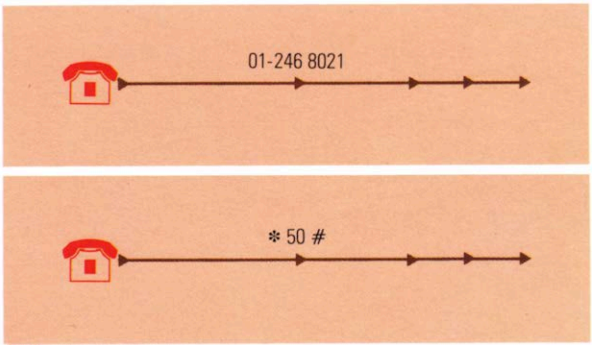


fig 24

Repeat Last Call

This allows customers to call the previous number keyed by inputting a short code. This is useful for calling a number which is frequently engaged. The numbers may also be stored for later use when other calls have been made. This is a form of code calling with a single code capacity.



Independent Services

Quite apart from the need to provide services which our customers will want to use, there is also a need for us to provide them as soon as they become available. Independent services, such as the 'Star Services,' require nothing more than a push button MF4 Telephone connected to a System X local exchange. They will be available because the operation of these services is between the user and the local System X exchange, and as previously stated all the Star Services have been designed to operate in this stand alone form.

Co-operative Services

These require a digital network. For the reverse charge facility, for example, there is a need for the call charge information to be passed over the network from the caller's exchange to the exchange serving the person paying for the call – providing of course that they have agreed to accept the charges in the first place. In order to do this, all parts of the network involved in setting up the call (the exchange and line systems interlinking them) must be System X, using common-channel signalling. Some calls may use only one link, but others could use up to five in which case, in the short term, there are obvious problems in offering services of this type.

The potential for offering these co-operative services is inherent in the System X software, but there is no point in offering them to the public until they can make an effective contribution to customer satisfaction. The important question for the Marketing Executive is, 'which of these services do people really want?' BT are currently involved in a continuing programme of Market research aimed at sorting out the services which should be provided as soon as possible after the 'Top 8.'

Longer Term Star Services

Telephone services planned for the future include:

Credit Call

Automatic Freephone	Diary Service
Ring Back	Universal Access Number
Conference Call	Selective Accounting
Message Bureau	Message Call

An explanation of each service follows:

Credit Call

The present manual Telephone Credit Card service is planned to be automated when sufficient System X exists. The user would still have a credit card number, but all he would have to do is dial a special code for the service followed by his personal credit card number, and the required number. The call charge would be totted up by the System X exchange being used at the time and passed on to the System X exchange holding their special credit account when they had finished. The number being called would not have to be on a System X exchange, but the calling number would need to be so that details can be recorded.

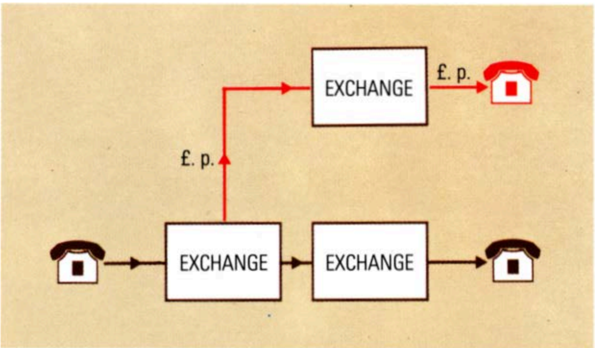


fig 25

Automatic Freephone

System X Freephone service will operate wholly automatically and users will make arrangements to pay for calls from specified areas of the country, and any caller wishing to contact a Freephone customer will dial a simple number. The call will be connected automatically and the charge debited to the renter of the service. The Operator will not need to be involved. The problems with providing this service (and some other new services) is that it is co-operative, which means that the exchanges and line systems used in setting up the call will have to be System X from start to finish. For this reason, BT will not be able to provide the System X version of the service for quite a while in some parts of the country.

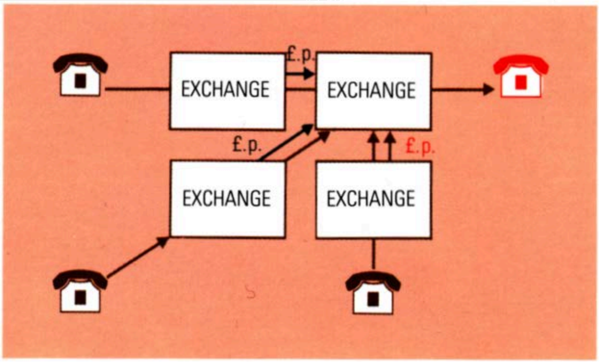


fig 26

Ring Back

This service is aimed at busy customers who find the numbers they call are frequently engaged and want to avoid dialling or keying the whole number again. After dialling and getting the engaged tone, all the customer has to do is to key a simple service code, and his System X exchange will continue to try the wanted number. When it is free, the exchange will set up the call to both ends with an explanatory message to each.

The service relies on common channel signalling to monitor the line conditions at each end before setting up the call path, which means that both calling and called telephones have to be on System X exchanges.

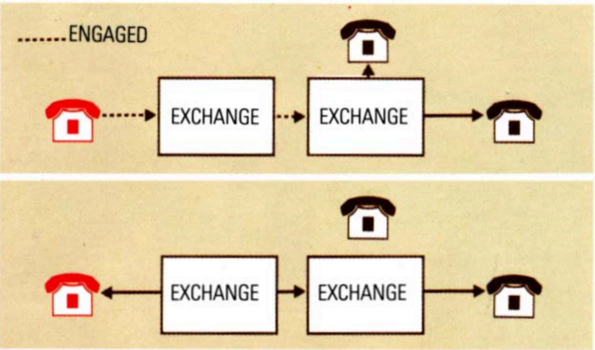


fig 27

Conference Call

BT have been aware for some time of the need for various forms of audio-conferencing facilities, and until recently these have been available only via the operator. System X is expected to add flexibility in the form of a reliable, simple-to-use, dial-up audio conference service, requiring no special customer-end equipment. This will be possible because the System X exchange becomes the centre of the 'star' formation, and control of the setting up procedure is from the originating telephone. In this way a single telephone line with a standard telephone could be used to set up and control a conference of up to 10 participants, all on different exchanges, if required.

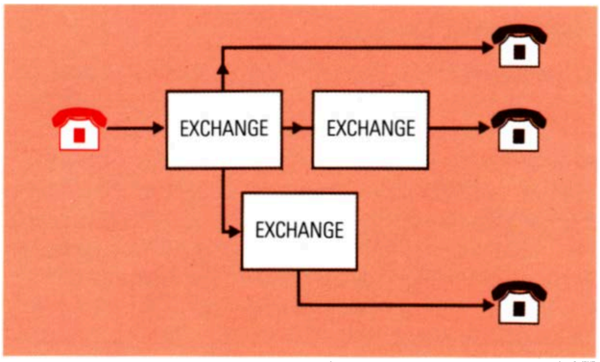


fig 28

Message Bureau

This service will be useful for customers when they are away from the phone but expecting important incoming calls. This might not happen often enough to justify renting an answering machine, and even with System X, there might not be a convenient number to which calls could be diverted.

For these customers BT are expecting to provide a dial-up Message Bureau service. Customers would be able to record a short message to play to callers and record any message from them to play back when they return home, or even from another phone while they are still away.

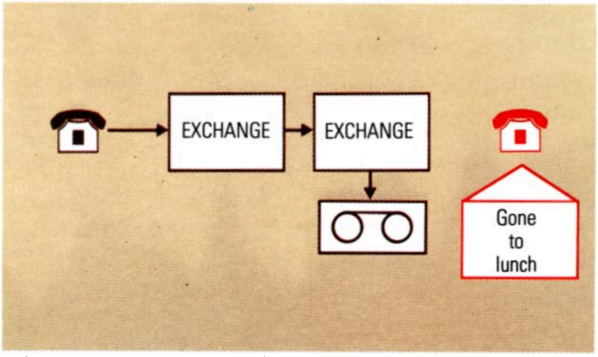
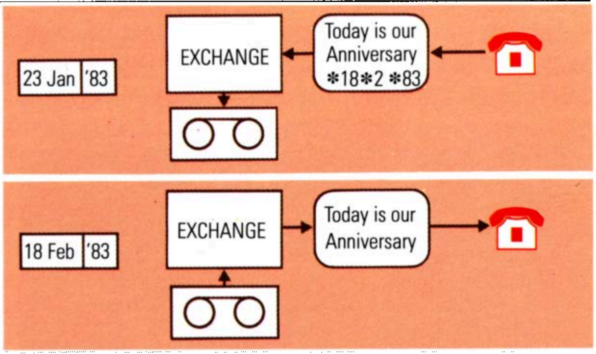


fig 29

Diary Service

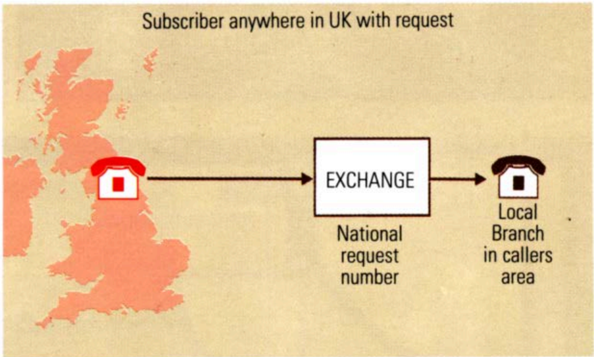
This is another refinement of a 'Top 8' service, the Reminder Call Service. Customers can arrange for previously recorded messages to be replayed to them on particular days, to remind them of an important event.



Universal Access Number

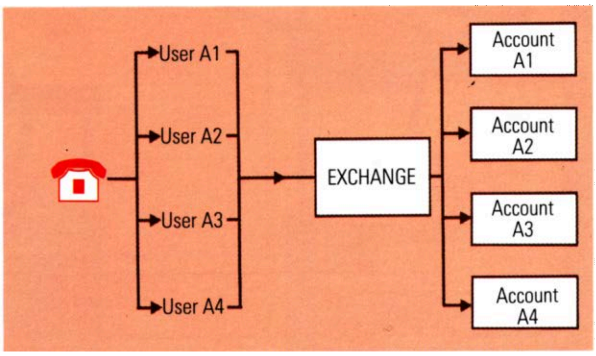
With the Universal Access Number service, a business with several branches could advertise with a single telephone number. Calls from customers on System X exchanges would be forwarded automatically to the local branch serving their area.

This facility would be extremely useful for car rental firms, discount warehouses, chain stores, etc. as their advertisements could make a strong feature of the ease of remembering and calling one telephone number (UAN). Two versions are envisaged, one free to callers, a sort of multi-destination Freephone, and the other raising call charges in the usual way.



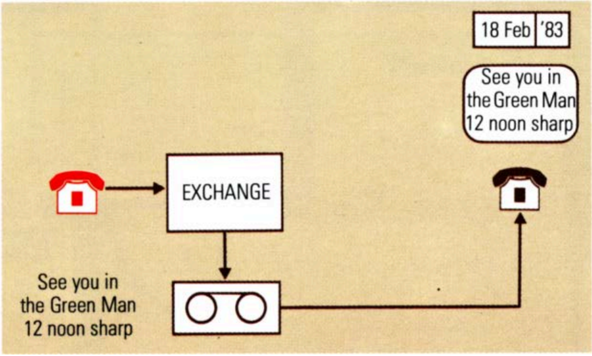
Selective Accounting

A number of small businesses such as solicitors, accountants and so on, have the job of maintaining separate accounts for their clients. One of the problems is keeping accurate records of telephone charges for each client. The Selective Accounting service will enable users to set up a number of sub-accounts on a particular telephone number, and then key in the appropriate account code whenever a call is made on a particular clients behalf. Separate accounts would be sent out to the renter. This service will also have a considerable appeal in the residential sector, both for shared flats and within family households. A security measure will ensure that customers only use their own codes.



Message Call

With this service a caller could arrange for a short message to be passed onto another telephone number by a specified time or date. The user would record the message at the time of booking using storage at the exchange. We hope this could be used as an automatic phonogram service both for sending greetings and for urgent messages when there is no opportunity to speak directly to the person wanted.



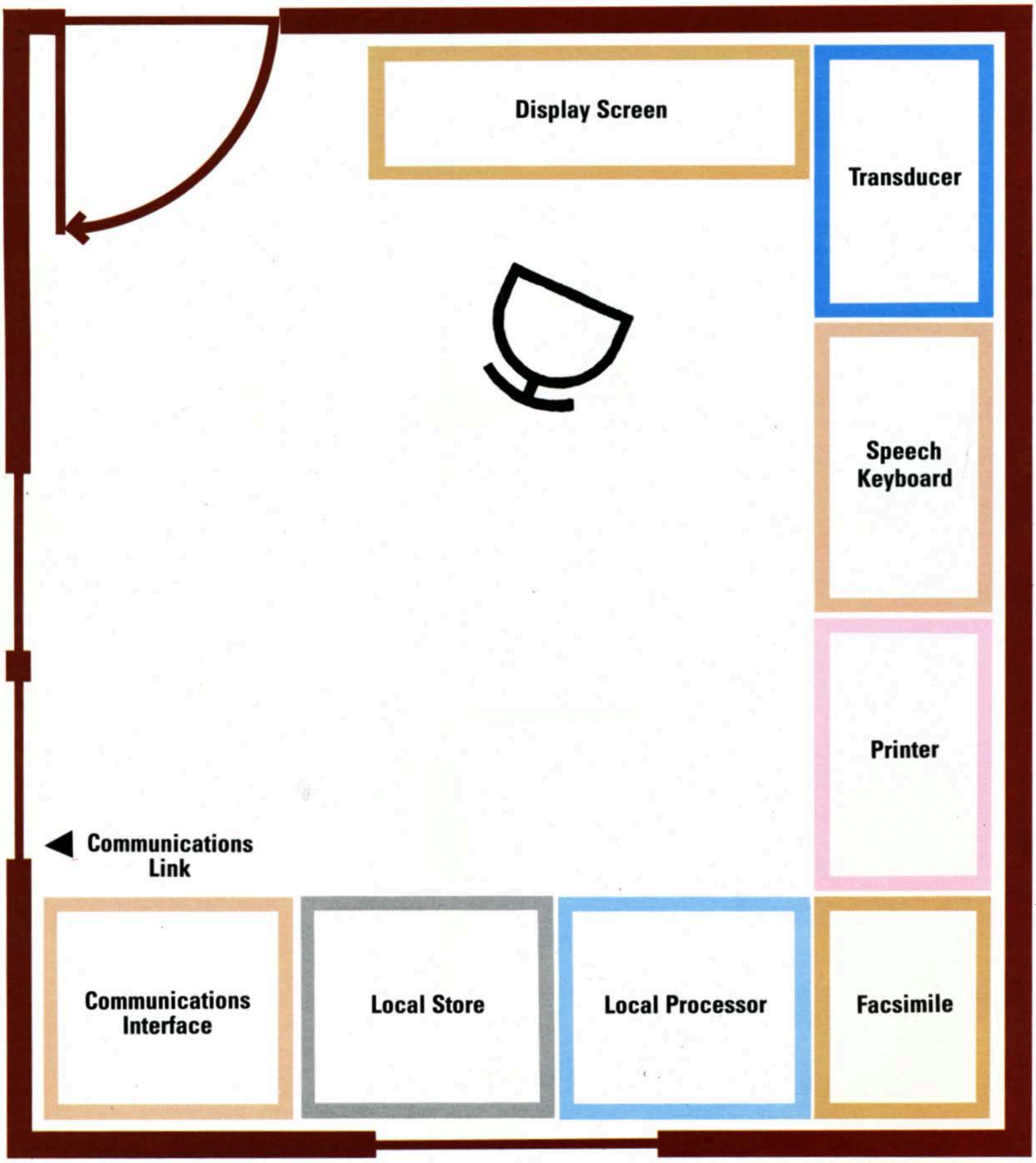
Non-Voice Services

So far we have concentrated on telephony. However, an increasing proportion of the traffic is 'non-voice': Datel and Facsimile use the telephony network and convert information to analogue form for transmission over the existing network at rates of up to 1 200 bit/s. For data at higher rates than this, or where fast call set-up is required, 4-wire private circuits, or a separate network such as PSS, are used and, of course, Telex also has a separate network.

Many of the non-voice services are adapted (some might say limited) to the constraints of the telephony network which is adequate for speech but not for data.

System X however, provides 64 kbit/s digital channels from exchange to exchange, and provides this capacity nationwide: in terms of a digital capability this spread of service is far greater than any separate specialised network could hope to be. The plan, therefore, involves the extension of digital

fig 34



capability to the customer's premises as a logical development of System X, using one high-capability network to support existing non-voice services and enabling new services to be developed and provided quickly at whatever point demand may arise, through the creation of an integrated services digital network (ISDN). This single network would be ideally suited to serve the 'office of the future' concept of multi-function business terminals, enabling simultaneous transmission of voice and 'non-voice'; for example, speech plus facsimile, or very high speed facsimile plus low-speed data.

The office of the future (see Fig. 34) will make widespread use of word processors, data processing facilities and electronic mail. Many technologies will converge within the office including computers, telecommunications and office machines, and the aim will be an integrated paperless system for data acquisition and all usual functions.

Microprocessor-based systems will also be used extensively in the home (see Figure 35). Using a television set as a means of displaying information, many facilities will become available. These will include shopping from home, automatic billing of utility services, new interactive forms of entertainment and education, electronic mail, electronic newspapers and information retrieval. Information access already exists in BT's Prestel view data service, but a rapid extension of this type of retrieval service will be expected.

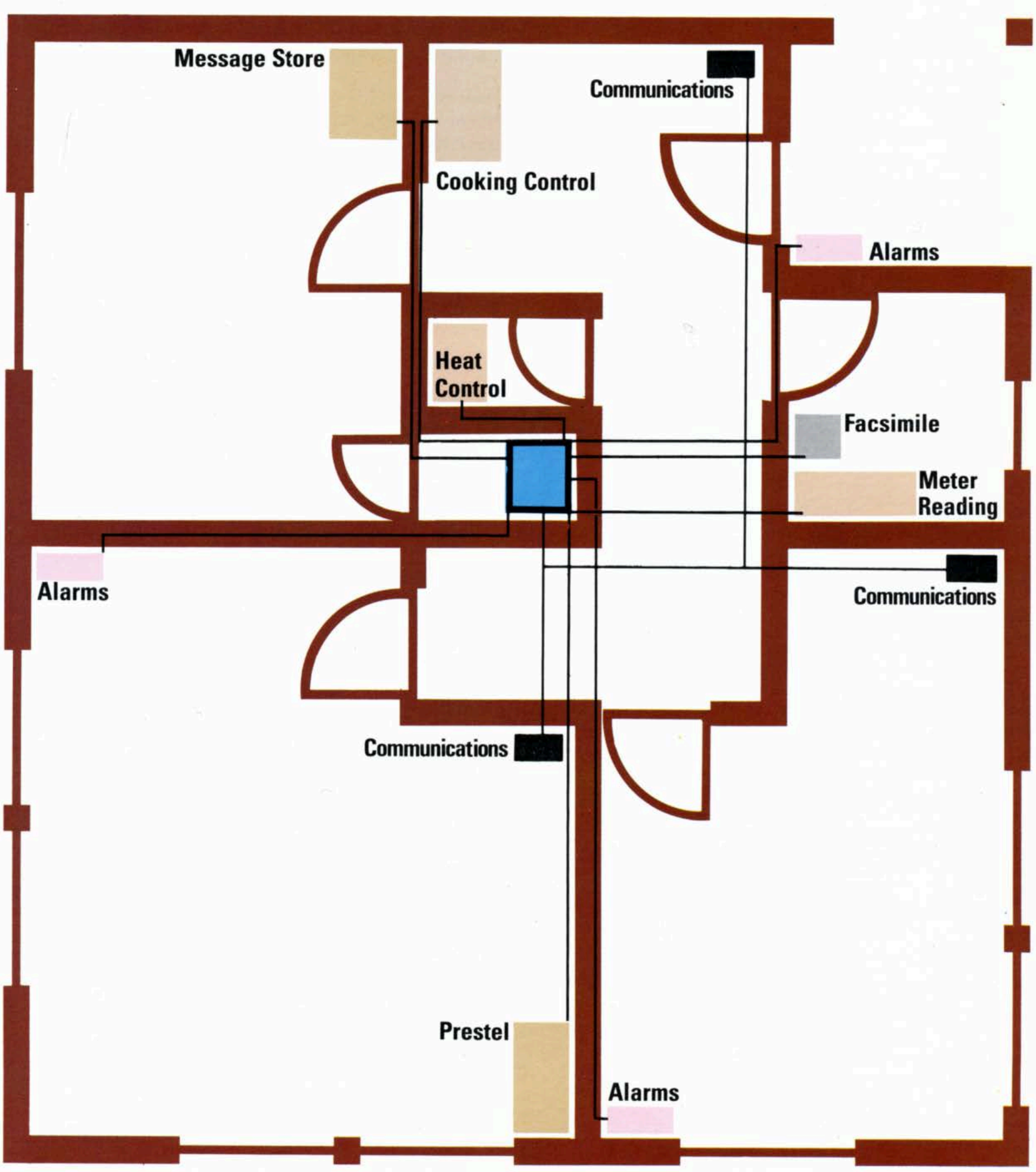


fig 35

The network of the future will therefore need to handle a wide range of voice, data and visual services (Figure 36). It will deal with information communication, in addition to telephony, and, as a result, the traditional functions of switching, transmission and signalling will need to be supplemented by information recognition, processing and data retrieval.

BT intend to mount a pilot ISDN service, centred on Baynard House in the City of London, in 1983/4, (see Figure 36). This service is being planned to encompass:

Telephony, including digital telephones with integral codes.

Circuit-switched data at current standard rates.

Digital connection to PSS at X1 user rates, plus 64 kbit/s.

Digital facsimile at 64 kbit/s or 8 kbit/s.

Teletext at 2·4 kbit/s duplex (to CCITT Recommendation Fx).

SSTV monochrome: 4 seconds refresh at 64 kbit/s, 32 seconds at 8 kbit/s.

Support of analogue terminal devices.

Digital ABC (Alarms-By-Carrier).

The evolutionary capability of System X – attributed to its modular construction – means that demand for increased ISDN capacity can easily be met, making it possible to react quickly to the communications needs of business customers.

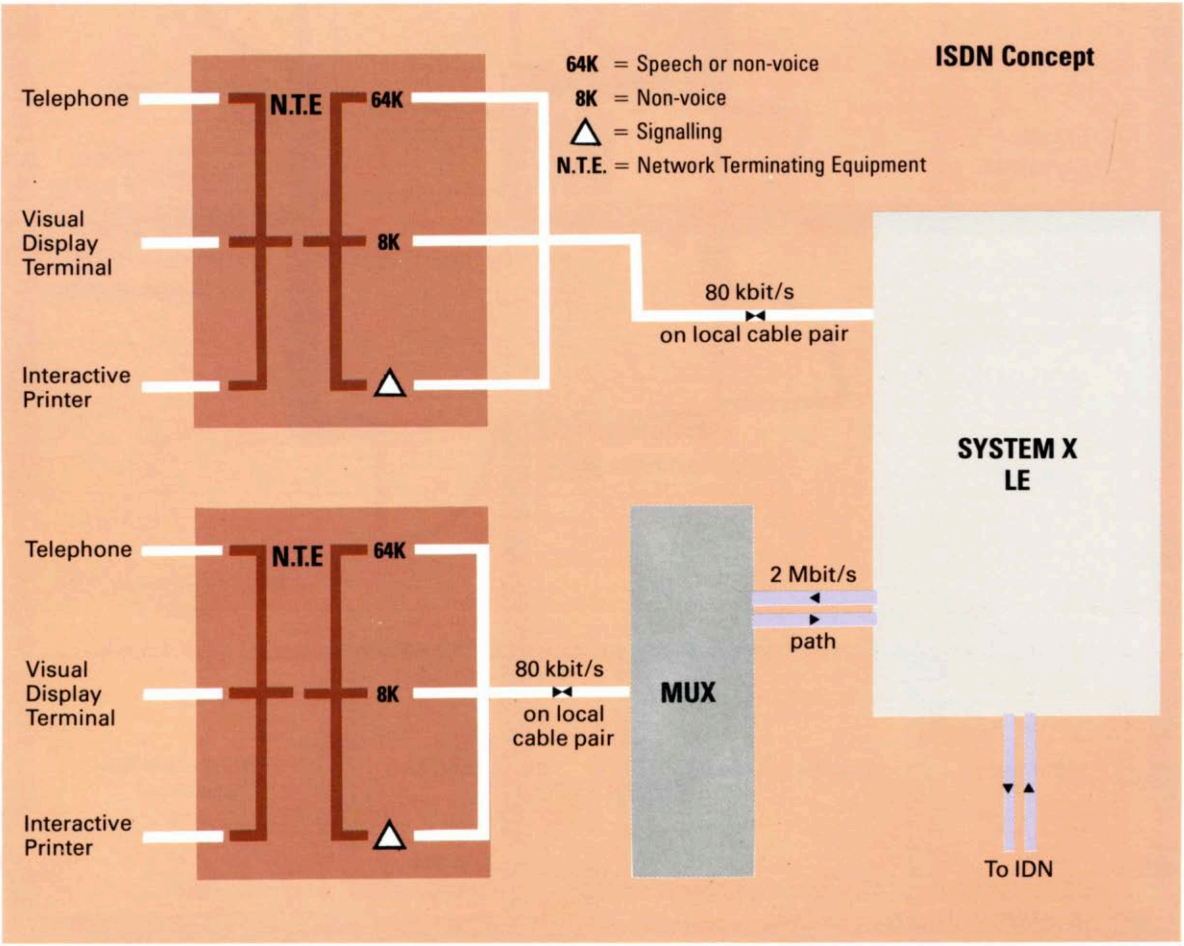
By 1986 System X will be operating in 30 principal city and urban areas and by 1990 this figure will have risen to 200. ISDN access will be via local System X exchanges or by means of remote concentrators which will bring full ISDN capability to some customers far more quickly than would otherwise be possible.

Provision of ISDN does not imply 100% changeover to digital working, however. System X local exchanges and the network will continue to interface with analogue equipment for a considerable time.

Until there is widespread demand for local digital access, or until digital equipment costs fall to the point where it is economical to provide it for mainly telephony purposes, ISDN will form an 'overlay' network, serving the relatively small proportion of our customers who have immediate need for the services it provides. The majority of customers, whose needs can be met with analogue services will require no changes to their installations.

Modernising the telecommunications network is a colossal project which will require enormous capital investment over a period of 30 years. Providing ISDN in the network during this period of technological change will prove a challenging task. Many of the services the network will be required to support in the future are still as yet, no more than ideas in designers' minds, but it is now that we must plan network capability so that they are available when and where they are needed.

ig 36



Planning, Installation and Commissioning

SYSTEM X

System X equipment is manufactured using the latest automated production techniques. As well as ensuring greater speed of assembly, this also eliminates to a large extent, the possibility of human error. (See Appendix 3 for a discussion of manufacturing techniques).

Planning

DIMENSIONING is the process by which the full traffic data prepared for a new unit or an extension is translated into equipment quantities, racks, wired shelf groups and in many cases slide in units, to satisfy the design date requirements.

The design dates are:

Accommodation – 20 years
Equipment – 4 years

Dimensioning is done on a subsystem basis using the latest equipment release available for each subsystem. The subsystems required for an exchange type and their constituent parts will be laid down in TIs.

Planning documentation

The full traffic data – Exchange Design Form (EDF9), is the base document from which the information required for dimensioning is obtained. The Area traffic staff produce a list of routes and circuit numbers and send the EDF9 to the Regional design group. Regional line plant planners insert line plant, transmission and signalling information.

Main network circuits are dealt with by the 'Regional Liaison Group' at THQ who liaise with Transmission planning groups in THQ to determine the transmission medium. The 'Regional Liaison Group' provide the signalling information and check that the requirements tie up with the:

ANNUAL SCHEDULE OF CIRCUIT ESTIMATES (ASCE)
ANNUAL SIGNALLING AND TERMINAL EQUIPMENT REVIEW (ASTER)

The EDF9 is returned to the Region where the Regional design engineer dimensions the exchange using TIs. The output from the dimensioning process is used to produce:

Rack and Power requirements
Floor plan
Details for Specifications (DFS)

The DFS is a standard format document used for all System X exchange systems and is used to convey exchange equipment requirements derived in the dimensioning process to the exchange specification writer. The specification is divided into sub-systems and provides for the inclusion of all dimensional equipment quantities on a wired shelf group/slide-in unit basis. Other sections in the DFS cover total rack quantities. Standard provision items are left for the specification duty to include.

Typical System X rack layout and construction practice

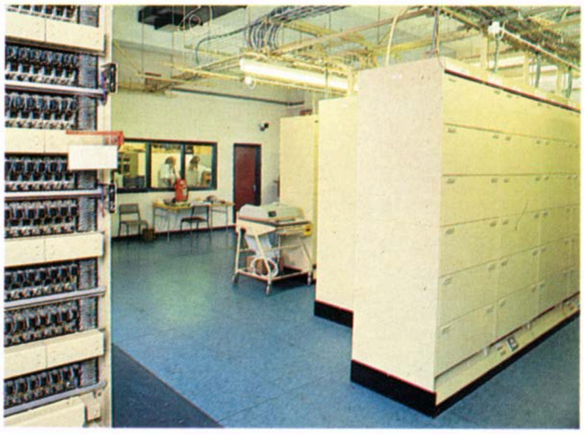
A THQ group will provide information about contractual arrangements and responsibilities in the form of 'Technical Appendices.' However the need for these will later diminish when standard specifications are available.

Documentation detailing non-standard requirements for an exchange is called Exchange Name Documentation (END). The ENDs required when the Regional Contract Order (RCO) is placed give details of:

Exchange floor plan, MDF, AC specifications and building ancillary services.

Signal Conversion Relays (SCRs) to Analogue Junction Groups (AJGs) and Internal System to Digital Line Terminations (DLTs).
(NB This does not include line plant).

The first System X exchange to be brought into operation was at Woodbridge in Suffolk. (Pic 36a shows this exchange with Strowger equipment on the left and TXD System X on the right).



Pic 36a

SYSTEM X

Exchange Design Computer Aided Design (EDCAD)

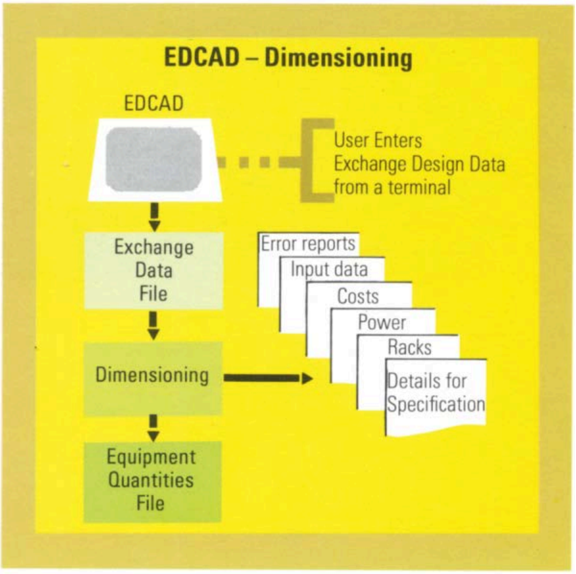
EDCAD is a computer application which has been developed to support procedures for exchange planning, design and engineering and capable of dealing with exchange extensions as well as new installations. It allows BT to reduce lead times and permit planning to occur closer to the point of need. Interchange of information between the participating firms (PF's) and BT will be by data files, eliminating huge quantities of paper, and ensuring a consistent quality of exchange documentation.

EDCAD consists of several computer packages which form an integrated system, and interact by passing data files between them. The capability for manual interaction at all stages is a feature of the design.

A more detailed discussion of the computer support for System X takes place later in this book.

Figure 37a illustrates in more detail one of the packages that form EDCAD (Figure 37b).

fig 37a



New Exchanges

Figure 38 depicts the principal activities involved in the installation of new exchanges. These are:

Preparation of new exchange equipment isolated from the transmission network.

Preparation of the transmission network (local and trunk) isolated from the new exchange.

Preparation of suitable transfer arrangements, as it is likely that part of the transmission network will be carrying existing revenue-earning traffic.

Acceptance of the new exchange from the participating companies or direct labour installation staff.

Pre-transfer testing of the interworking of the transmission network, new exchange equipment and transfer arrangements.

Transfer.

Post-transfer testing to monitor the early revenue-earning traffic and to protect the BT customers from any teething problems.

Maintenance.

You will see that the principle of parallel activities for the preparation of the network, exchange equipment and transfer arrangements is used to reduce installation lead times, and that the aim is to protect BT customers from any interference by installation activities.

Preparation of New Exchange Equipment

The equipment installed on site is the end product of a chain of interlocked activities:

Design

Manufacture

Installation

Testing

All these activities are vital to the task of bringing an exchange into service. Failure in any one area will cause failure of the whole project. Consequently, whatever their specific duties, everyone concerned with System X has a vital role to play.

fig 37b

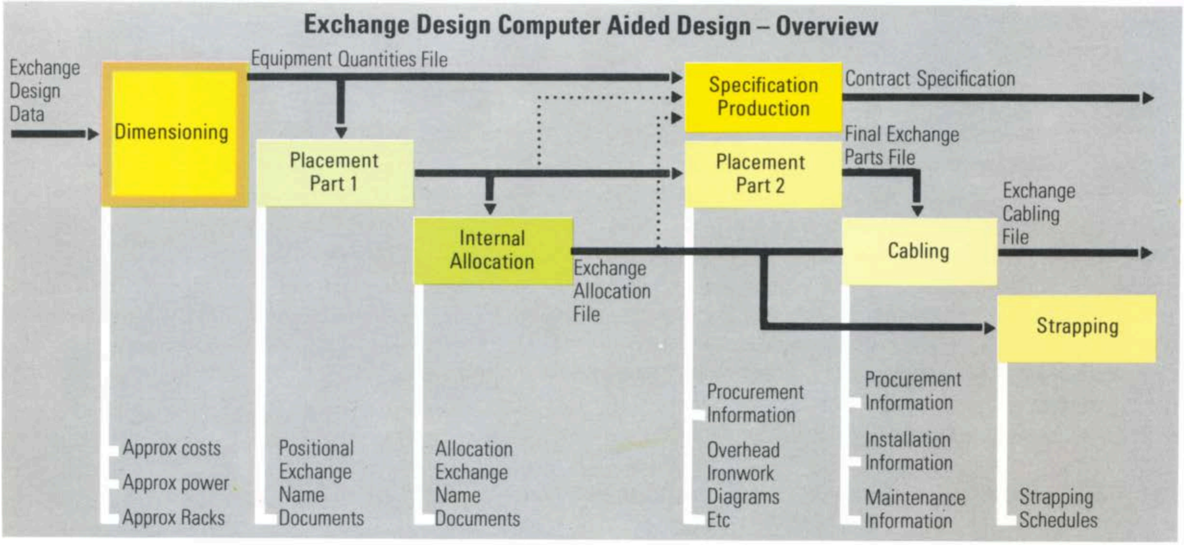
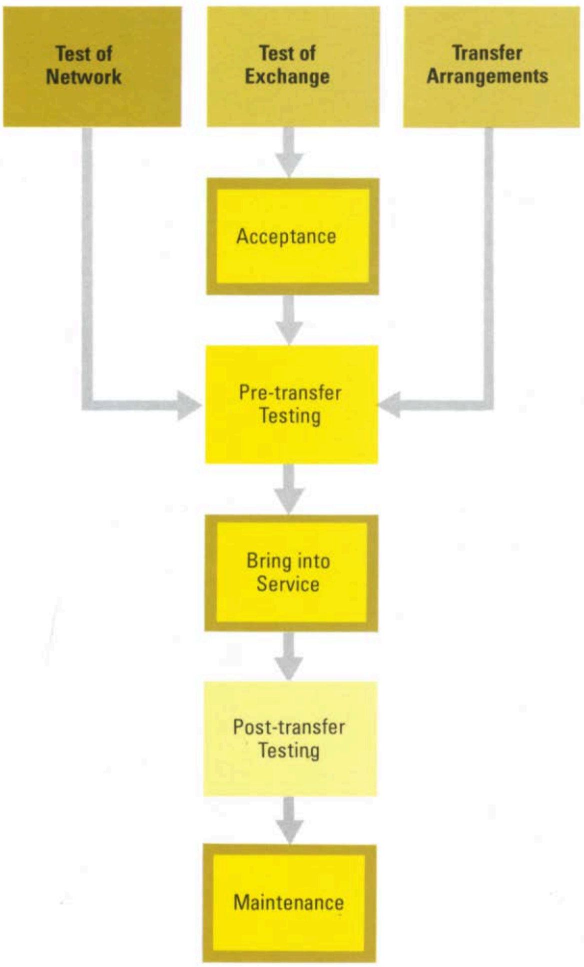


fig 38



Testing Policy and Strategy

The testing policy and strategy outlined here have been agreed between BT and the three manufacturing companies. The policy is that all necessary testing activities should be performed to ensure conformity with design, contract and ordering documentation. The strategy is designed to oversee the policy and see that the aims are met.

Before discussing implementation of the strategy, two definitions may be useful:

COMMISSIONING

'Commissioning' is the generic term describing the activities other than manufacturing and installation (whether carried out in the factory or on site) which are necessary and sufficient to make the equipment ready for the Exchange Demonstration.

EXCHANGE DEMONSTRATION

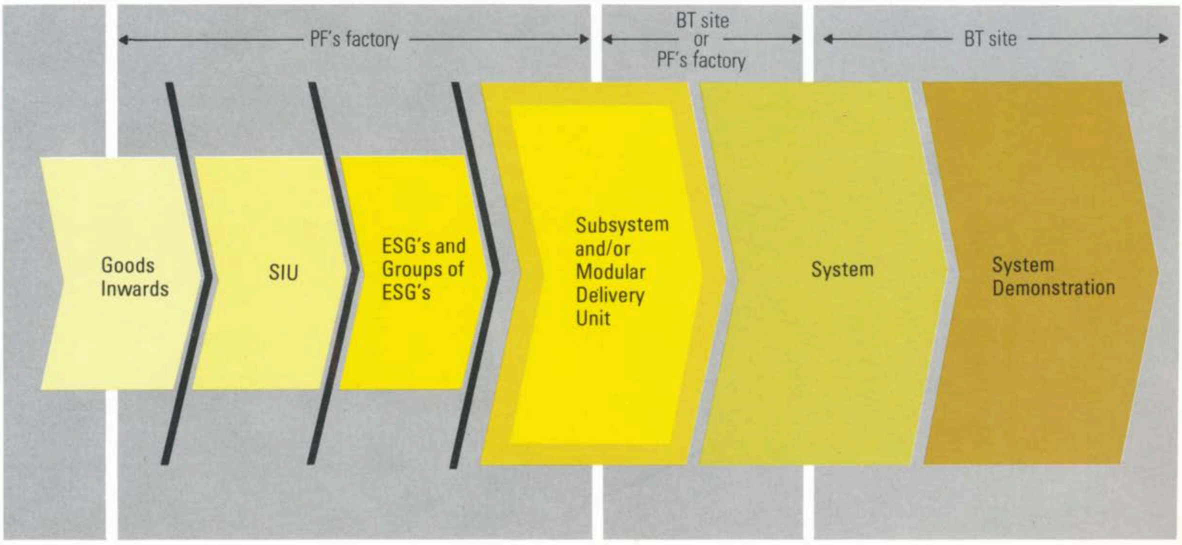
'Exchange Demonstration' is the term which describes the tests and procedures which shall be carried out after the completion of manufacture, installation and commissioning, to show that the exchange is in accordance with the contract.

Successful implementation of the testing strategy will require industry to prepare and agree with BT a standard sequence of activities covering manufacture, factory commissioning, site commissioning and Exchange Demonstration for each type of TXD exchange. Each standard sequence must clearly indicate the essential stages of testing (an essential stage of testing being one which is sufficient and necessary to ensure a satisfactory end product).

Each sequence should require minimum time to be spent on the British Telecom site. At this time, each sequence should make adequate arrangement for the fact that some subsystems, in particular the Processor, may be supplied by contractors other than the main system contractor. Technical Appendices to TXD works order contracts state the conditions for transfer of responsibility for subsystems.

Each sequence should include the removal of all defects found at each stage of testing before the item is passed to the next activity. Under controlled and documented conditions it may be permissible to effect temporary repairs to remedy some defect conditions – permanent repairs being made at a later stage of an approved QA scheme. Figure 39 depicts the scope of the testing strategy.

fig 39



The three manufacturing firms must also prepare and agree with BT, test specifications containing the test standards, test procedures and test methods to be used at each stage of essential testing. The test specifications must be written so that unnecessary duplication of testing is avoided. Agreement is also required on the items of test equipment to be used in these procedures. In addition, each firm will supply all items of test equipment for their own use.

The firms involved will use the agreed standard sequence, test specifications and test equipment (unless otherwise agreed with British Telecom) at each essential stage of testing during the manufacture, factory commissioning, site commissioning of subsystems and systems, and during Exchange Demonstrations. They must demonstrate that each exchange is fit for its purpose before offering the installation for acceptance by British Telecom. The demonstration should provide confidence to British Telecom that:

Gross call failures will not exceed 0.17%.

Revenue earning facilities of the installation are fully provided and operationally correct.

Maintenance facilities are fully provided and operationally correct.

Management facilities are fully provided and operationally correct.

Finally, the manufacturing firms must prepare and agree, between themselves and with British Telecom, procedures to ensure that experience gained from early orders is carried forward into standard sequences, test specifications, test procedures and test methods for subsequent work.

Automated Testing Techniques

A necessary consideration in any testing strategy is the need to reduce installation lead times. For this reason, it is pertinent, wherever possible to use automated testing techniques. (Pictures 40 and 41 illustrate).

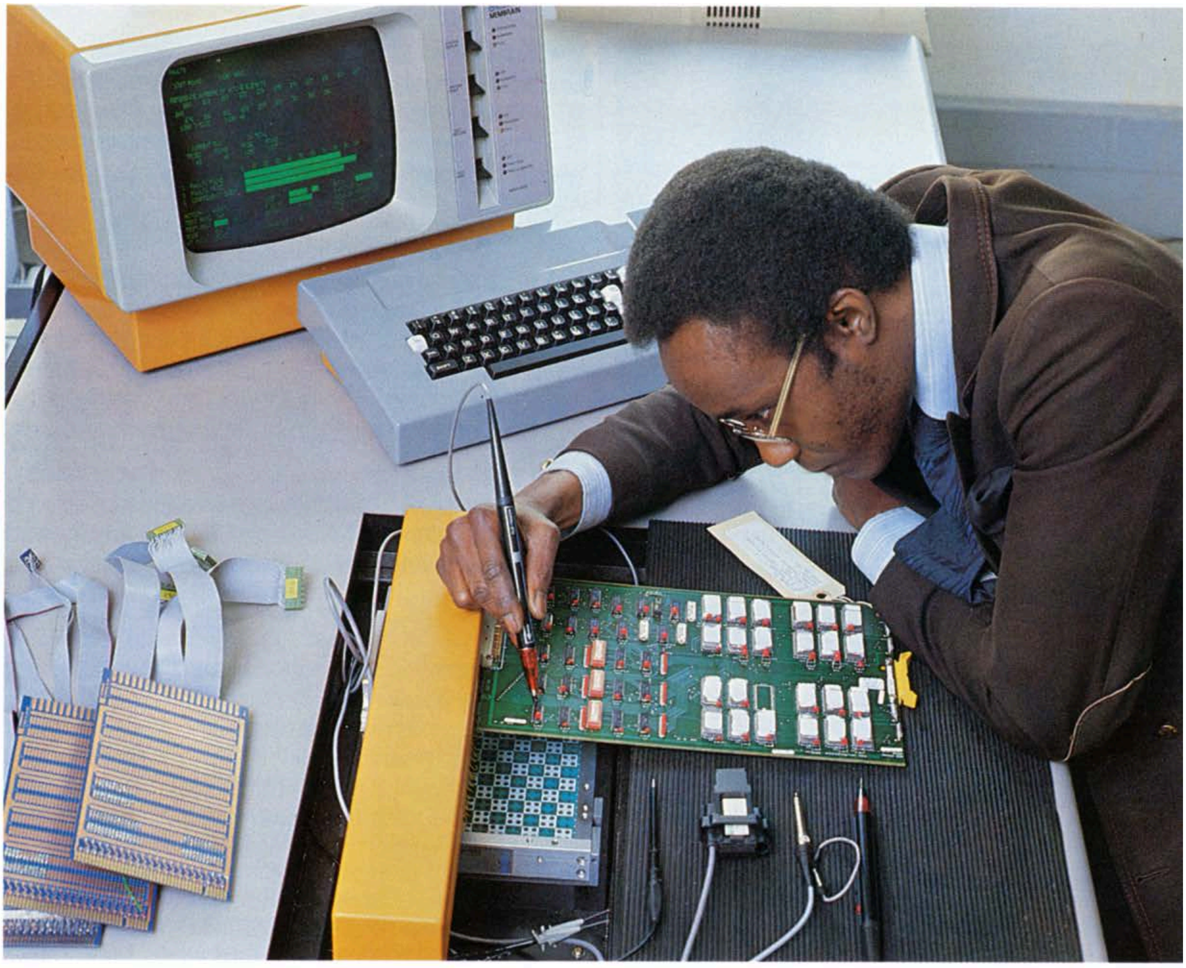
Currently, microprocessor-based test equipment is being developed by the companies involved. This equipment, known as an Integrated Test System (ITS) will be used initially for the testing of ESGs. It is intended that the ITS should be further developed to include a subsystem capability.

In the meantime, factory and site commissioning of some subsystems e.g. SIS/ALTS, and complete exchange systems are being tested by means of Cescom Call-Senders and Automatic Response Units/ Answering Circuits. As these items of test equipment are essentially analogue, the devices are interfaced with the inputs and outputs of the equipment under test by means of PCM multiplex equipment.

That, then, is the current situation regarding automated test equipment. In the long term other devices will be designed and developed. For example, a self testing capability as an integral part of the exchange has obvious attractions for provision and maintenance. Ways and means of realising such a facility are currently being studied.

c 40

pic 41



pic 42

Quality Assurance

The participating companies operate a total Quality Assurance system at all stages from design through manufacturer and installation. System X exchanges are installed under an agreed Quality Assurance system. The system must be capable of ensuring and demonstrating that the installation conforms to the specified requirements. This is achieved by the effective application of documented procedures that define the methods, controls and disciplines necessary for the provision of an installation of the required quality.

The Quality Assurance system must:

BE APPROVED BY BT. The documented procedures are assessed for their ability to control all stages of the installation activity and assure the final quality of the exchange.

PERMIT BT TO CARRY OUT SURVEILLANCE on all aspects of its implementation and to verify its continued effectiveness and correct functioning.

PERMIT BT TO CONDUCT QUALITY AUDITS and to verify that the exchange complies with the required quality.

USE AGREED TEST SPECIFICATIONS at all stages to ensure a successful demonstration of the exchange facilities.

Factory Testing

To minimise the time spent on site, the manufacturers will need to maximise the amount of testing performed in the factory. This testing will cover four main areas:

Incoming goods and components.

Slide-in-units.

Wire shelf groups.

Equipped shelf groups.

Tests of systems and subsystems are at present carried out on site but these may be also be capable of being factory tested.

INCOMING GOODS AND COMPONENTS

Semiconductor components are tested using well established procedures. All integrated circuits (ICs) are fully tested. Hewlett Packard 5045A test equipment is used for SSI and MSI devices and Fairchild Sentry 7 automatic test equipment is used for digital LSI devices. (See Picture 40)

SLIDE-IN-UNITS (SIUs)

SIUs are functionally tested, using suitable signals applied to the inputs of the unit while the outputs are monitored for the correct responses, using automatic test equipment such as the Membrain 7776 universal test system. (Picture 41).

In-circuit testing of components through a 'bed of nails' fixture accessing the items to be tested in situ on the printed circuit boards. (Picture 42).

WIRED SHELF GROUPS (WSGs)

The aim is to produce zero error backplane wiring. Automated wiring machines will eliminate human error but cannot guarantee zero defects. Thus testing of completed items is required and test equipment, such as the Teradyne N123 and N161 is used for this purpose.

EQUIPPED SHELF GROUPS (ESGs)

The current method of testing ESGs is based on substitution testing. The ESG to be tested is temporarily integrated into a model system or subsystem of known quality. The special procedures used by each company may vary, but eventually the use of the ITS will become the common test method for ESGs.

The objectives of the ITS development is to provide a range of testers capable of functionally testing and diagnosing faults, initially on ESGs and subsequently on larger functional entities such as sub-systems within the factory.

The testers will be modular and make use of about 16 defined System X interfaces for access to the equipment under test. The tester designs will be based on a microprocessor (AMZ 8000) programmed in high level language (PASCAL). The test programs will provide a complete functional test of the equipment and diagnostic information to assist in the location of any faults.

The tests will be carried out before contractual strapping is applied, and must prove that the equipment is operational. The purpose of the development is to achieve standardisation of test systems between the companies.

Installation

The installation of a telephone exchange consists of an ordered sequence of activities. These include:

Positioning and alignment of the racks and overhead ironwork

Cabling

Termination of wiring

Mounting of the equipment on the racks.

There are two methods of installing System X Exchanges:

Conventional Installation

Modular delivery

CONVENTIONAL INSTALLATION

Individual System X racks are transported to the site and positioned with 'unistrut' overhead ironwork and cable trays in the exchange configuration. Pre cut, plug-ended and tester cables are connected to their appropriate rack sockets (see Picture 43).

Site integration and testing of the exchange are followed by an Exchange Demonstration carried out by the manufacturing company.

Modular Installation of Telecommunications Equipment Racks (MITER)

Modular delivery is an air cushion transportation system which allows complete exchanges to be assembled and fully tested in a PF's factory. Picture 44 shows a TXD exchange being assembled at the factory.

After successful testing, the exchange is divided into suitably sized modules (not exceeding 14 TEP 1H racks) and supported on three air cushions for ease of manoeuvre. The exchange is shipped to the site on a low loader road transporter. Picture 45 shows the racks being lifted onto a transport loader.

When all the modules are positioned in the exchange building, the intermodule cables are reconnected to the appropriate rack sockets and tests are made to detect possible malfunction due to transportation and installation activities. Picture 46 shows racks being positioned using the air cushion.

Some BT buildings may not be suitable for this method of installation, but the number of such buildings is expected to be small.

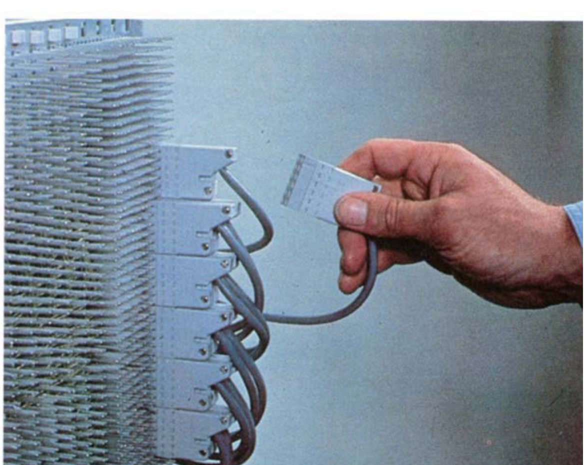
SITE TESTING

The amount of on-site testing performed will depend upon the method used to install the equipment. If the exchange equipment was fully assembled and tested before modular delivery, it will normally only be necessary to carry out a system-level re-commissioning. Following conventional installation, however, it is first necessary to test at subsystem level, to prove the correct integration of ESGs forming that subsystem. System commissioning will then be carried out on the integrated subsystems.

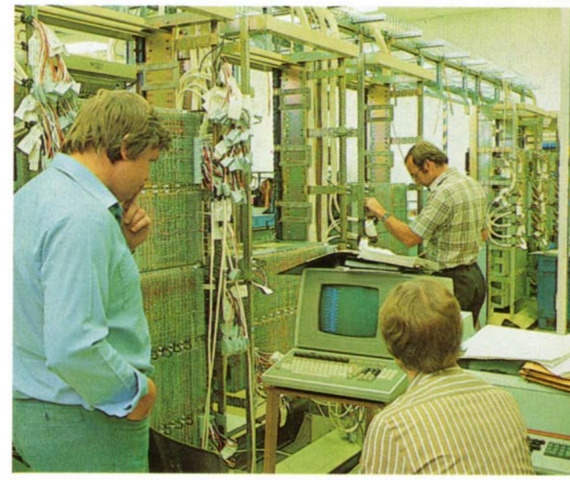
SUBSYSTEM COMMISSIONING TESTS

These tests are carried out to agreed (BT/PF) specifications by the sub-system supplier. The tests are devised to prove the satisfactory performance of the sub-system and thus the correct integration of the component ESGs. Most of the tests require the use of the main processor (PPUS/PUS) but otherwise the subsystems are tested in isolation from their system environment.

pic 43



pic 44



pic 45

pic 46

SYSTEM COMMISSIONING TESTS

The system level commissioning tests are, again, carried out to an agreed (BT/PF) specification but by the main (system) contractor. The exchange is commissioned at system level by integrating the various subsystems to build up a complete system. 'Integration' requires the application of tests which show that the basic facilities of the subsystem are operating correctly in their system environment. Successful completion of the system level commissioning tests ensures that the exchange is acceptable to BT.

Demonstration

When the main system contractor is satisfied that the exchange is acceptable, he must demonstrate this to the Clerk of Works. The exchange demonstration is an integral part of the manufacturers testing. It is not a BT controlled test. BT requires assurance that all the facilities of an exchange offered for acceptance are 100% functionally correct. However, in view of the high degree of testing from goods-inwards inspection to system commissioning, it is not necessary to re-test every facility during the demonstration. The demonstration therefore includes tests of a representative sample of the facilities provided by the exchange.

It is the responsibility of the appropriate manufacturer to prepare and agree with BT suitable samples and tests for each type of installation. The four categories covered by the demonstration are:

Call handling capability. This will be demonstrated using a multi-call sample. Conventional test call sending equipment, e.g. CESCOM, will generate an agreed number of test calls in an agreed traffic pattern. The exchange will handle these calls with less than an agreed fault rate. For System X this rate is 0.17%.

Customer facilities.

The maintainability of the exchange.

Management facilities.

A successful demonstration of these aspects will indicate that the functional performance is acceptable. There may, of course, be other constraints, such as the availability of adequate maintenance documentation which will need to be satisfactory before complete acceptance of the exchange.

Transfer Testing

Transfer testing consists of pre- and post-transfer testing and is the responsibility of BT.

PRE-TRANSFER TESTING

Pre-transfer testing is carried out by BT staff following exchange acceptance and is the final activity immediately prior to BIS (Brought into Service). The tests are designed to check subscribers' facilities, call routing and charging, testing of incoming and outgoing circuits to ensure that the exchange will interwork with the existing network correctly. The tests are as follows:

Engineering Frame to Switch tests of all incoming and outgoing circuits.

Engineering pre-trial tests of all outgoing circuits (distant station tests).

Joint Engineering/Traffic tests. These form a clerical check of exchange data, customers'/exchange facilities, routing and charging.

POST-TRANSFER TESTING

Post-transfer tests are applied after the exchange is brought into service and are a simple check of incoming and outgoing access, emergency facilities and E-lines. During the early in-service period the overall exchange performance and traffic aspects are monitored closely. This process protects our customers from any early teething problems.

In the main, the existing TIs will be applicable to System X exchanges but instructions will be required for the new facilities of System X. Draft instructions for local exchange, DJSUs and DMSUs have been prepared and are available for field use. It is intended that these instructions will be issued in TI form in late 1982.

BT Staff Involvement

The installation and commissioning processes for System X exchanges place the emphasis on factory testing by manufacturers' staff and a demonstration to Clerk of Works (COW) staff that the product functions correctly on site. Throughout commissioning the supplier must use agreed specifications for each test. Picture 47 shows BT staff involved in the commissioning process.

This does not mean that BT has abdicated responsibility for safeguarding its interests. It will continue to set the standards and influence the suppliers activities by means of contractual documentation. BT staff, at all levels, will ensure that the supplier meets his contractual obligations by means of meticulous surveillance of their activities.

pic 47

System X Maintenance

SYSTEM X

The maintenance of a radically new telecommunications system, such as System X, is certain to provide many problems. This is especially true in the first years of operation when experience is still being gained and new methods tried. For this reason BT and the relevant unions have been engaged in a series of discussions on how exchange maintenance will be organised. (Picture 48 shows one of these discussions taking place).

Initially, System X exchanges will be maintained under interim agreements. At an appropriate stage there will be a joint review of the practical experience of maintaining System X which will then be incorporated into a final agreement.

All the activities necessary for the in-service operation and maintenance of System X exchanges have been identified and in the majority of cases theoretically quantified, but as yet there has been no study or negotiation with the POEU on grading of the work. By mid-1984 a joint review of grading based on in-service experience will have been completed. Until that time only TOs and TOs-in-Training (TOiT) will be engaged on System X equipment maintenance duties.

The interim maintenance organisation set out to:

Satisfy efficiency and customer service objectives.

Provide job satisfaction for maintenance officers.

Accommodate maintenance requirements during low, medium and high System X exchange penetration phases.

Provide an effective framework within which trained relief for maintenance staff and training of future staff can be organised.

To ensure that all parties were familiar with the terminology used in any discussions several definitions were quoted. To avoid possible misunderstanding the definitions should not be used or quoted in any other context than the interim arrangements for the System X maintenance organisation.

Unstaffed exchanges – those which do not require full time attendance during normal working hours.

Staffed exchanges – those which do require full time attendance during normal working hours.

Normal working hours – those weekday hours (Monday to Friday) when Maintenance Officers are normally on duty.

The Maintenance Officer – is a member of the Engineering Technical Grades (ETG) employed on System X maintenance and support duties. The Maintenance Officer responsible for a Section will, in all cases, be a Technical Officer (TO). It is expected that, in the main, the maintenance work on System X equipment will be at a level appropriate to the TO grade, however, since there has been no study or negotiation with the POEU on the grading of the activities required for the operation and maintenance of System X exchanges, the role of the T2A has yet to be defined.

pic 48

A Maintenance Section is the workload with which a TO is identified and may comprise:

Two or more unstaffed exchanges.

A single one man staffed exchange.

Part of a large staffed exchange.

Additionally the following duties of the Operations and Maintenance Unit (OMU) are incorporated into the total workload of the section maintenance officer by the rotation of these officers through the OMU.

Exchange maintenance control.

Technical support.

Operations support.

Rear view of Equipment rack showing typical shelf wiring

Day-to-Day Maintenance Activities

The day-to-day maintenance activities, irrespective of where they are carried out, are:

Control

Routine maintenance

Corrective maintenance.

These categories can be broken down as follows although their content will vary over the years:

CONTROL

Co-ordinating the efforts of exchange maintenance officers including on-site and technical support.

Providing means of communication with individual maintenance officers as necessary.

Surveillance of local network performance from measurement, Quality of Service data, plant alarms, exchange system outputs and historical data.

Maintenance of data files for documentation, stock control, and software management purposes.

Re-configuration of any part of the local network to restore customer service.

Supervision/monitoring of remote terminal user access.

ROUTINE MAINTENANCE

Periodic routine attention to exchange peripheral equipment, automatic fault detection equipment, etc.

Checking the validity of stored data and satisfactory operation of exchange software functions for maintenance purposes.

Obtaining and interpreting results of system performance information for maintenance purposes.

Checking the inventories and integrity of maintenance spares.

CORRECTIVE MAINTENANCE

Attention of maintenance officers to service-affecting faults in their sections.

Attention of maintenance officers to non-service affecting faults and other planned or unplanned work.

Diagnosis and clearance of faults using documentation and manuals, exchange processor diagnostics, and analytical methods including programs on the OMC processor.

System re-start and recovery.

Initiating fault escalation procedures.

A theoretical approach to Exchange Maintenance staffing levels.

A System X exchange consists of racks of Slide in Units (SIUs) and each SIU comprises a mixture of various components. These components can be integrated Circuits, resistors, transformers etc., and predicted failure rates have been established for them.

As each component that fits into a particular SIU has its own fault rate, it is possible to determine a failure rate for each SIU. The SIUs form modules which themselves form subsystems. A predicted failure rate can therefore be determined for each subsystem. The subsystems make up the complete exchanges, so that given the quantity of equipment within an exchange, its total SIU failure rate can be predicted.

In addition, allowances are made for faults on racks, peripheral equipment, etc., and the inevitable unlocatable faults FNFs or RWTs and for software corruptions.

At present, the view is that, with extensive penetration of System X it should be possible to achieve, for System X equipment maintenance only, a level of one man per 15,000 exchange connections for local exchanges and one man per 10,000 switched erlangs for a DMSU/DJSU. This is for equipment maintenance only and in practice additional manhours will be required for such things as OMU staffing, peripheral maintenance, routines, network cooperation, travelling time, system familiarisation, etc. These figures have not yet been agreed with the relevant staff unions.

Figure 49 indicates how the exchange fault rate can be obtained.

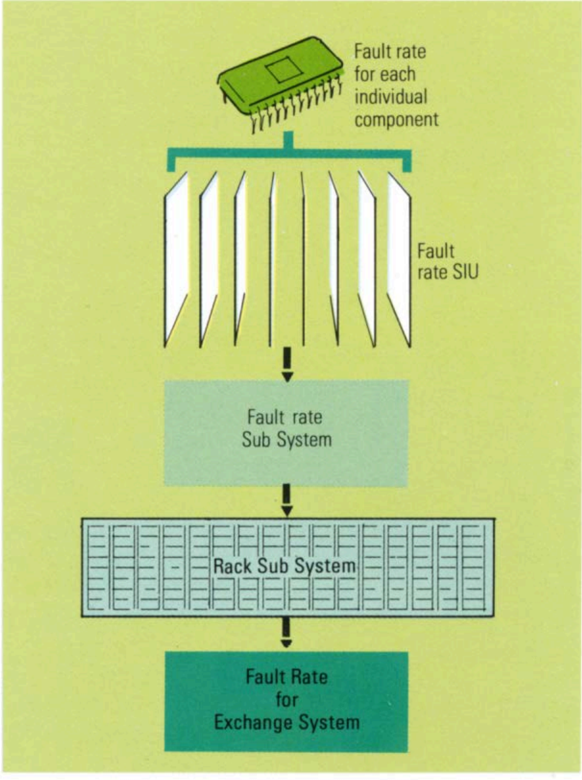


fig 49

The Operations and Maintenance Centre (OMC)

One of the most important features associated with modern Stored Program Control (SPC) exchange systems is the ability to carry out support work off-site by remotely manipulating data stored in the exchange processor. In order to maximise the use of facilities offered by System X exchanges employing SPC techniques, an OMC is required. The OMC is connected to exchange processors via a Message Transmission Subsystem (MTS) link which enables various tasks to be carried out on exchange data files from terminals located at the OMC, or from terminals connected but located at remote sites.

The OMC is a point within a Telephone Area (TA) from which various operational and maintenance tasks could be administered. It would enable most of the day-to-day operations associated with:

Service Management.
Network Management.
Call Charge Accounting.
Maintenance (exchange and transmission plant).

to be performed remotely for all System X exchanges lying within its territorial catchment area.

The Operations and Maintenance Unit (OMU)

The engineering base within the OMC is called the Operations and Maintenance Unit (OMU) and comprises the following duties:

Maintenance Control.
Technical Support.
Circuit Maintenance and Provision.
Operations Support.

MAINTENANCE CONTROL (MC)

The MC function is to provide overall surveillance of and co-ordinate day-to-day maintenance activities for the System X exchanges within the OMU catchment area. Picture 50 shows a technician working in the OMU.

The duties of MC staff include:

Receive and acknowledge alarm information (use of ATS). Collate this with the complementary exchange MCS message (use of VDT and message waiting indicator).

Interrogate and receive fault information (active and passive faults) stored at the OMC.

The ability for initial analysis/diagnosis of reports.

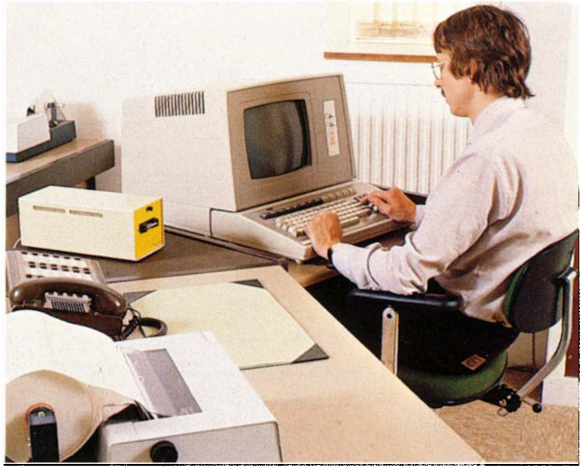
Fault report handling – general management of Fault Servicing Process files, lists, registers etc.

Assignment of work to field technicians.

Making a periodic check of equipment out of service, and investigating equipment with excessive outage time.

Supervision of OMU concentration/alarm extension procedure.

Initiation the running of diagnostics, if possible, whilst the field technician is travelling to site.



pic 50

Progressing reports, acknowledging and following up ATS 'reminder' reports, checking 'pending' fault reports.

Checking fault clearance information on fault record and finally clearing faults from work list when the fault record is complete.

Receiving ad-hoc work requests from other sites, accepting agency tasks and other support work. Recording information and assigning work as required.

Manually-inputting, to Fault Servicing Process (FSP), routine maintenance work for assignment to field technicians.

Updating allocation registers associated with FSP, when required.

Liaising with other OMU staff – Circuit Maintenance and Provision (CMP) for circuit faults, Technical Support (TS) when technical support is required and if separate staff perform these functions.

Receiving quality of service information (in man-readable form) from the Management Statistics Subsystem (MSS) at System X exchanges.

TECHNICAL SUPPORT (TS)

The TS function is to assist in rapidly analysing fault symptoms at System X exchanges using available diagnostic aids.

The duties of TS staff include:

Providing support to field staff attending to difficult faults.

Liaising with MC staff (if different duties) when technical support is required.

Preparation of Statistics.

Documentation management.

Co-ordinating escalation of faults.

CIRCUIT MAINTENANCE AND PROVISION (CMP)

The CMP function is to provide testing and maintenance control of main, junction and private circuits. Allowance has also been made for circuit provision duties to be carried out in the same area.

The duties of CMP staff will include:

Maintenance of accurate records of the circuits which terminate on the exchanges for which the OMU is responsible. This will include basic information and fault information.

Use of a VDT and associated items and a knowledge of man-machine language.

Programming the trunk and junction routiner via a VDT and interpreting the results of routine testing.

Interpreting unsolicited outputs concerning circuits, e.g. fault reports, produced by the maintenance control sub-system.

Acceptance of fault reports from other centres, e.g. TMCC, AMCs.

Testing circuits using the exchange test network and the automatic test break access auxiliary controlled via a VDT, and interpreting the results of these tests.

Co-ordinating the efforts of other staff in the clearance of faults.

Monitoring the state of that part of the network for which the OMU is responsible, and co-operating with the network management centre in overcoming short term problems, (e.g. congestion caused by failures).

Identifying circuits and equipment with recurrent faults and instigating action to improve their serviceability.

OPERATIONS SUPPORT (OS)

The Release 1 OMC is equipped with rack mounted tape cartridge decks on which bulk dumps of fault information transmitted from exchanges is received. (see Picture 51) Cartridges containing this information are dispatched to a processing centre. A Visual Display Terminal (VDT) is also provided to enable the cartridge tapes to be off loaded.

The bulk data tapes described may be located in a dedicated area known as the Operations Support Unit (OSU).

One set of rack mounted bulk data tapes are provided, for Operations Support, per OMC regardless of the number of OMUs, and must be co-sited with the OMC equipment.

pic 51

Release 1 OMC

The original concept of an OMC has resulted in the development of the Release 1 OMC. There will be only six Release 1 OMC's introduced into the field at the following sites:–

Baynard House in the London Region.

Cambridge in the Eastern Region.

Lancaster House in the North West Region.

Coventry in the Midland Region.

Edinburgh in the Scottish Region.

Leeds in the North East Region.

The experienced gained in developing and operating the Release 1 OMC's will be used to refine OMC 2 – the next stage of development.

Release 1 OMC Equipment Area

The OMC equipment area accommodates the OMC processor in an environment suitable for exchange equipment. The equipment will be mounted on TEP 1H racks and besides the processor the following hardware and software subsystems are accommodated:

Alarm Terminating Subsystem (ATS)

Terminal Interface Subsystem (TIS)

OMC Message Transmission Subsystem (OMC/MTS)

OMC Maintenance Control Subsystem (MCS)

User Processes Subsystem (UPS)

OMC Man-Machine Interface Subsystem (OMC/MMIS)

OMC Common Services Subsystem (OMC/CSS)

Figure 52 illustrates how these subsystems interwork.

The OMC forms an important part of the System X administrative network and Figure 53 illustrates the communications links between the exchanges and the OMC.

OMC Message Transmission Subsystem (MTS)

The MTS provides the means by which communications takes place between the reporting exchanges and the OMC, using a combination of hardware and software resident on the exchange Processor Utility Subsystem (PUS).

The OMC-exchange MTS link may be provided by a 4-wire analogue path terminated by modems and operating at 4.8 k bit/s. When an exchange is co-sited with the OMC processor and distance limitations are not exceeded it will be possible to operate at 64 k bits/s.

The MTS link can be routed directly from an exchange to the OMC, alternatively a facility of DMSU's and DJSU's is to act as a Signal Transfer Point (STP). By utilising this facility messages can be relayed between local exchanges and the OMC via the DMSU or DJSU which act as an signal transfer point. (Figure 53).

fig 52

The Release 1 OMC Subsystems

MTS	Message Transmission Subsystem
ATS	Alarm Termination Subsystem
TIS	Terminal Interface Subsystem
UPS	User Processes Subsystem
PPUS	Pre-Processor Utility Subsystem
MMIS	Man Machine Interface Subsystem
MMCS	Mass Memory Control Subsystem
MCS	Maintenance Control Subsystem
ADCU	Alarm Display & Control Unit
CSS	Common Services Subsystem

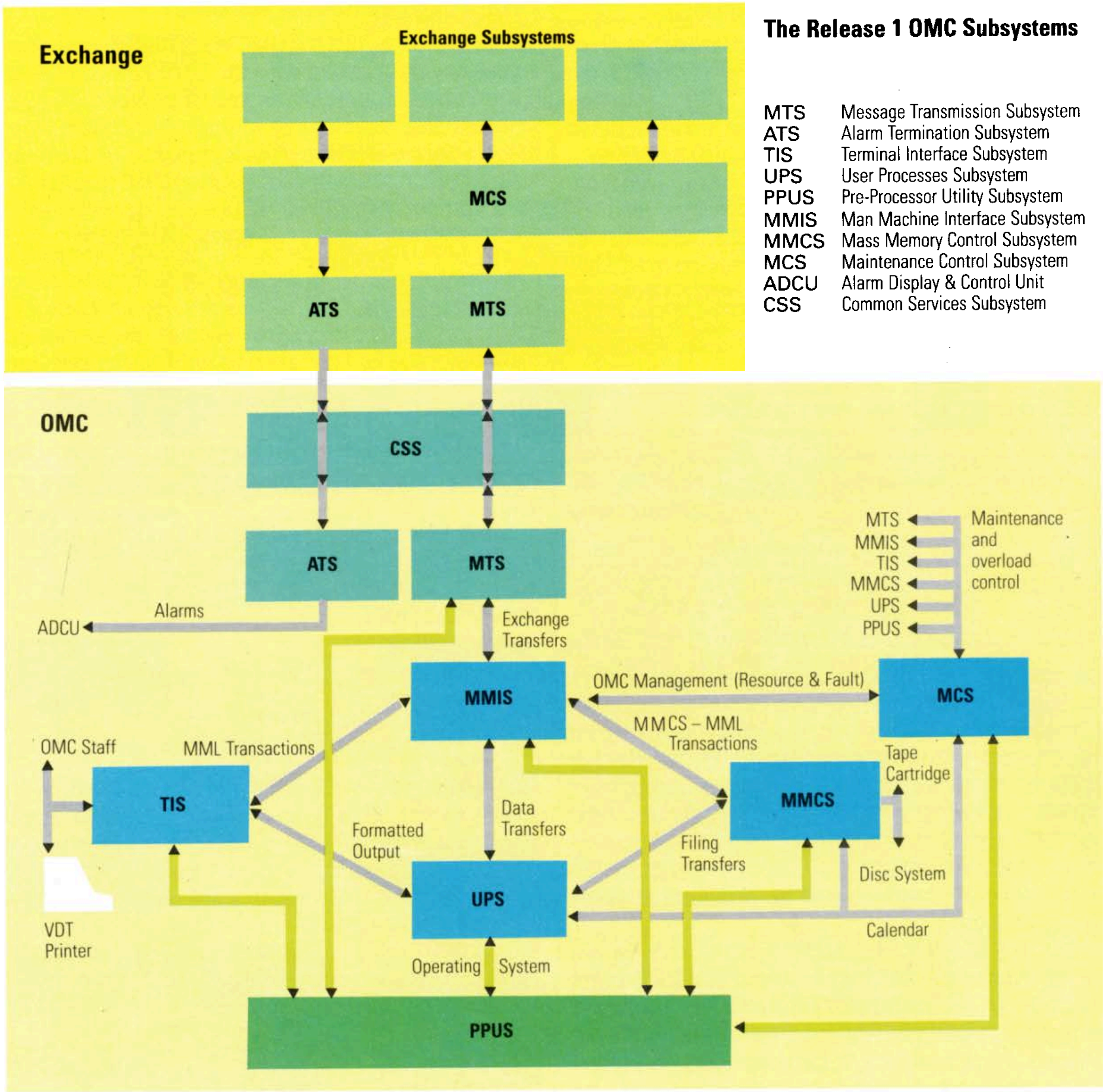
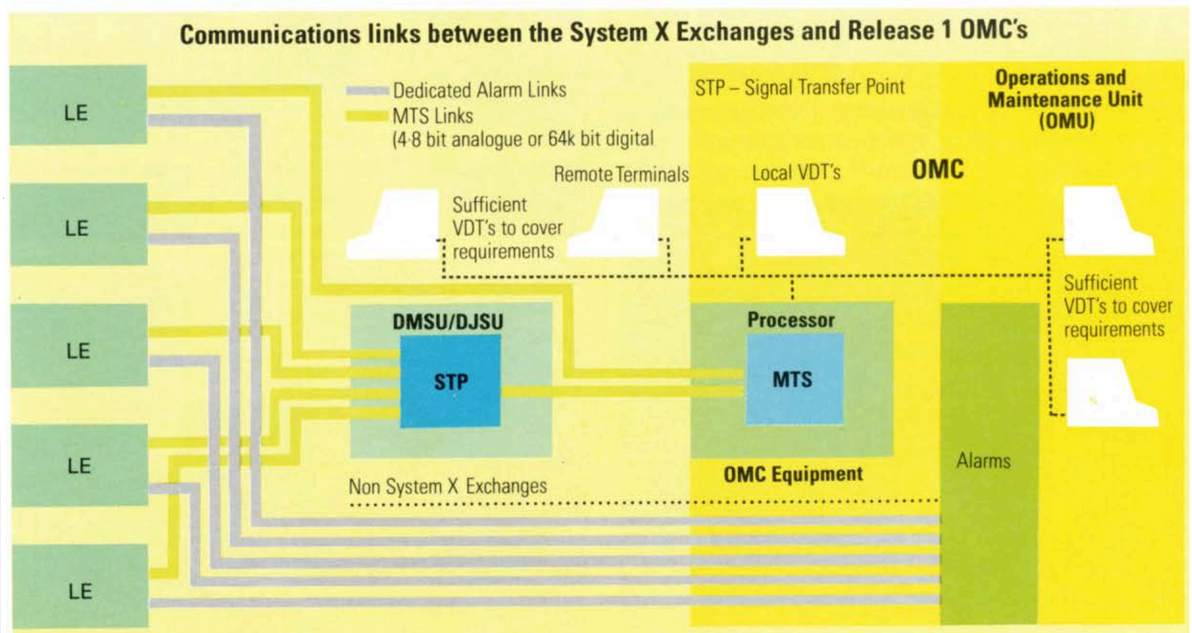


fig 53

Communications links between the System X Exchanges and Release 1 OMC's



ALARM TERMINATION SUBSYSTEM (ATS)

The ATS gives visual and audible alarms from signals received over separate physical circuits from exchanges. Alarms from up to 100 reporting locations, including the OMC, may be accommodated on ATS. There are 15 categories of alarm (plus a 'self-check'), and they can be extended to or received from another OMC as required. If more capacity is required an additional ATS can be provided. Alarms from non-System X exchanges can also be connected to ATS but these will have different fault categories. The System X categories are listed below:–

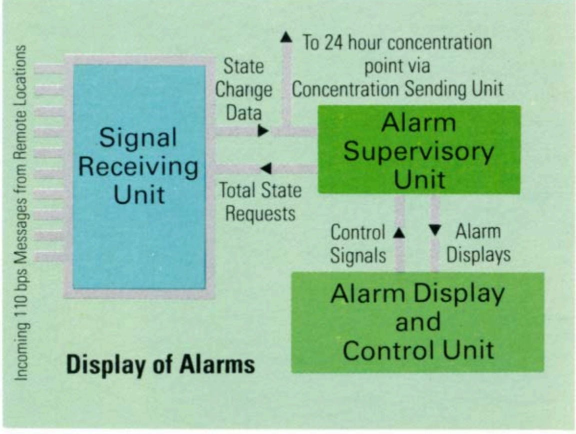
Table 3 Alarm Categories

ALARM CLASSIFICATION NO.	FAULT CATEGORY
1	PRIORITY 1 ALARM
2	PRIORITY 2 ALARM
3	PRIORITY 3 ALARM
4	PRIORITY 4 ALARM
5	PROCESSOR FAILURE
6	OTHER SX FAILURE
7	SX DETECTED TRANSMISSION FAILURE
8	TRANSMISSION EQUIPMENT ALARM
9	UNAUTHORISED MML ATTEMPT
10	POWER ALARM
11	FIRE ALARM
12	INTRUDER ALARM
13	GAS ALARM
14	CABLE PRESSURISATION ALARM
15	ENVIRONMENT ALARM
16	ATS SELF CHECK

Note: Not all categories will be provided at every System X unit.

The ATS supplements the MTS. Alarm reports will be received in the OMU on an Alarm Display Control Unit (ADCU) as illustrated in Figure 54. The alarm may be audible as well as visual and draws the maintenance officers attention to a fault. Detailed fault information will be displayed on a visual display terminal (VDT) at a work position either automatically or in response to interrogation of the system by the maintenance officer. The ATS and MTS links are routed in separate cable ducts, for security, enabling ATS to act as an alternative method of system monitoring if MTS should fail.

fig 54



Future development of the OMC

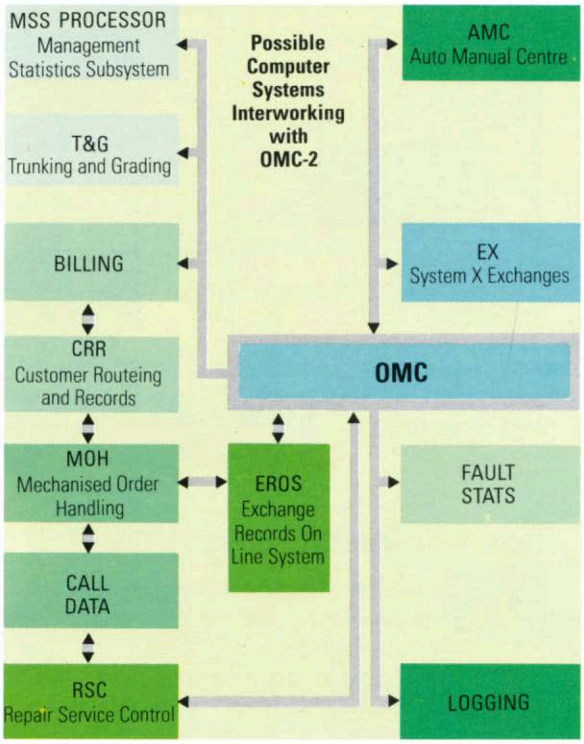
The role for which the OMC was originally developed has now broadened with the introduction of Area Computing facilities, and as a consequence the way in which an OMC is configured will need to change in order to incorporate and integrate mutual communication. As it is not easy to adapt the existing OMC to cater for Area Computers, a new OMC is under development.

The new OMC will be built around a commercial processor and is being designed to fit into an "office type environment". As this new development will also provide an opportunity to review the OMC as a whole, full advantage will be taken to enhance its facilities and enable future flexibility which may result in some procedural changes for operating the new OMC.

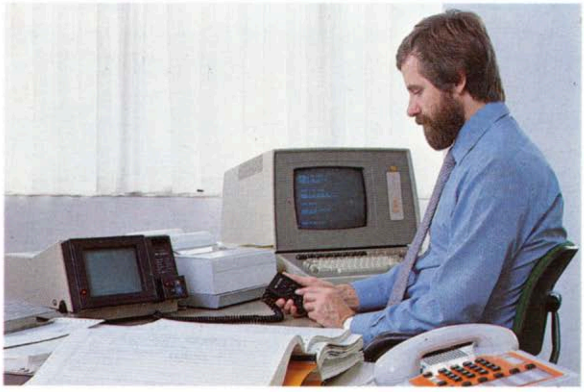
It will enable authorised users to gain access to the complete range of data bases from a single desk top VDT.

Some idea of how the different support computer systems will interwork is shown in Figure 55. These are only initial ideas and changes will take place over the coming years

fig 55



pic 56



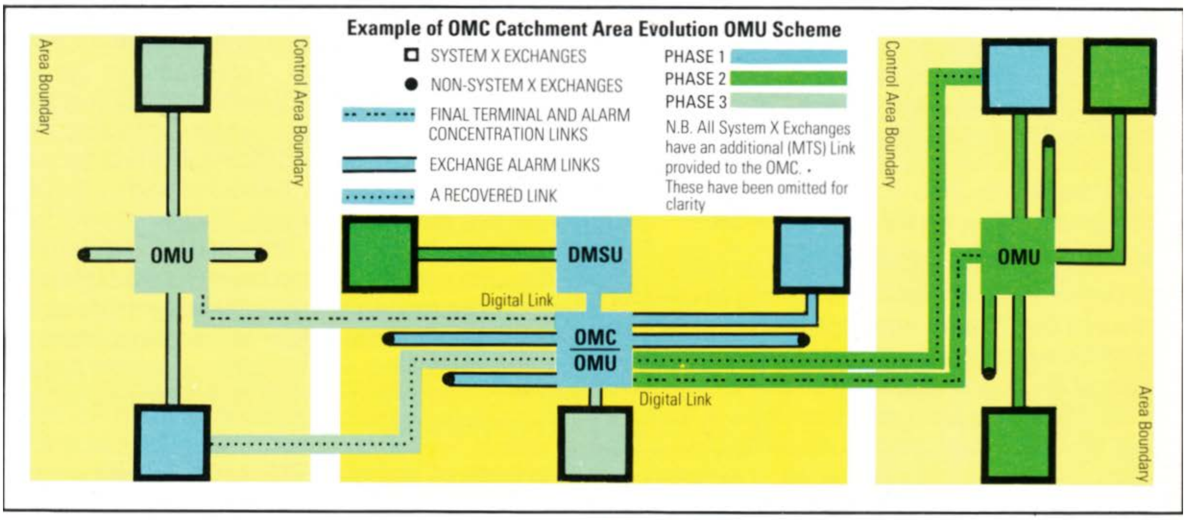


fig 57

The Maintenance Organisation within a telephone area

To demonstrate how the proposed organisation will operate can best be done by considering the way in which System X will gradually build up in a Telephone Area.

First Installation

The first System X installation is unlikely to be provided with an OMC to which it can be connected.

In order to provide adequate cover for maintenance, sufficient staff will need to be trained, above that which is calculated, to operate and maintain the system. This extra, though very necessary, staff in the early days of System X penetration will then be available as exchange numbers increase so this situation will gradually rectify itself.

At these exchanges (i.e. not connected to an OMC) the maintenance staff will also be responsible for the equivalent OMC duties carried out at their exchange. (See Picture 56).

Subsequent Installations

As System X penetration increases there comes the need for some form of remote surveillance before the cost of an OMC processor is justified. Where the distance, topography and area organisation permit, alarms from the exchanges may be concentrated onto an Alarm Termination Subsystem (ATS) and terminals from each of the individual exchanges sited at a convenient maintenance point. This maintenance point is known as a "Basic OMU."

The Basic OMU itself is a self contained unit wherein a number of peripheral devices are located. Each device is connected to a particular exchange (node) and serves to provide a degree of remote maintenance and surveillance of that exchange. It is anticipated that a Basic OMU will serve between 2 and 10 exchanges.

The point at which the OMC processor is justified will be determined by the provisioning rules prevailing at that time.

The OMC as part of the Local Maintenance Organisation

When sufficient System X exists within an Area to justify the capital investment an OMC will be provided. Our best estimate at this stage of development suggest that there may be some 200 OMC's nationally.

The processing capability of OMCs will give maintenance officers a powerful tool by which support can be provided. Remote surveillance of exchanges can be performed and analysis of faults, both short term and long term, can be carried out. It will also be possible for remote terminals in other buildings in the Area to gain access to exchange information via the OMC. This means that a more immediate service can be provided to the customer.

The OMU associated with the OMC will carry out the functions previously described but its primary aim will be to co-ordinate the maintenance of its System X exchanges.

OMU working

The OMC processor is capable of supporting more than one OMU and efficient use is made of this processing capability.

When an OMU exists it will enable the immediately local maintenance officers to provide a more effective service. They will concentrate on the maintenance of their sections and benefit from the support of the OMU. Outside normal hours the alarms may be extended to a 24 hour concentration point. Maintenance officers whose sections are supported by an OMU would carry out their appropriate tour of OMU duty in the normal way.

OMU working is required:

To provide the local maintenance organisation with flexibility in numbers and locations of OMUs in order to align the plant maintenance control function with local constraints (e.g. topography and distance).

To maximise OMC processor use by only providing one OMC per Telephone Area initially, allowing OMUs to deal with local matters. (Fig. 57 depicts Area evolution involving OMUs).

The OMU would function normally during the working day but outside normal hours the alarms are extended to a fully trained staffed unit. System X exchanges have a data link to the OMC processor, and the OMU can carry out interrogation of the exchange via its own data links to the same OMC processor. Should this fail, the OMU would monitor the System X exchange alarms via the separate alarm link.

The need to ensure a high quality of service for our customers may eventually justify staffing an OMU for 24 hours a day, 7 days a week. In the situation of high System X penetration, Areas could have several OMCs and one of the associated OMU's could be continuously staffed. The alarms from any other OMCs in the Area would then be concentrated on the staffed OMU. The 24 hour OMU would then be staffed by maintenance officers on a 24 hour rota basis.

Repair Procedures

Five basic failure types have been identified:

Individual components mounted on, or part of, a printed wiring board which, together with an edge-connector, form a Slide in Unit (SIU).

Items of fixed System X Hardware – racks, shelves, cables, connectors etc.

Parts of system software and data due to corruption or design deficiency.

Peripheral equipments (terminals, printers, modems etc).

Non-System X equipment (power, environmental control equipment etc).

Components

The majority of System X faults will be due to failure of components in SIUs. Service will be restored by changing the faulty SIU for a spare unit. The complexity of each SIU will require equally complex fault diagnostic equipment. This equipment costs approximately £80 000 and clearly cannot be provided on a 'per exchange' basis. It has been proposed therefore, that one Tester is provided at a Repair Centre (RC). The maintenance officer will dispatch the faulty SIU to the RC where repair can be carried out.

In a few cases it will be possible to correct a faulty SIU at the exchange, this is provided that the return of the SIU to service without validation does not put serviceability of the exchange at risk. As various design changes occur during the life of System X it will be necessary to carry out modifications to SIUs. The RC is in an ideal position to carry out these modifications in the most efficient manner.

All faults located in fixed items of equipment (including plug-ended cables) will be dealt with in-situ by the maintenance officer.

Maintenance Support

Any exchange maintenance officer may be called upon by the OMU to provide technical support or assistance to another exchange Section Maintenance Officer dealing with a serious fault. All exchange Section Maintenance Officers will give priority to responding to such calls and will travel to other exchanges as necessary. Arrangements for determining which Section Maintenance Officers will be called upon at any time to render such support will be made at the OMU. The officer called will normally be drawn from one of the Sections served by the OMU concerned but, exceptionally, may be drawn from elsewhere. In all cases the Section Maintenance Officer responsible for fault clearance will initiate the national escalation procedure if this is warranted. The Section Maintenance Officer will be responsible for initiating or dealing with the consequences of system-reconfiguration and the use of system re-start and recovery facilities.

Provision of Technical Officer Pool Posts

In accordance with the current general requirements and national agreement on Pool TO provision, and to meet the needs during the early and middle phases of System X penetration, additional TOs will be trained for System X maintenance duties. When not required for relief of section TOs in his/her own OMU area a System X Pool TO may be loaned to another OMU area or exceptionally to a Non-System X exchange within his/her own OMU area.

Technical Support and Maintenance investigation from the OMU

At the OMU the duty officer has use of the OMC and exchange processor resources to provide initial and follow-up support to exchange section maintenance officers in the case of difficult or recurring faults.

pic 58

Maintenance Support Agency (MSA)

If specialist assistance is required to rectify a serious fault the Maintenance Officer responsible for the clearance of that fault can call upon the services of the MSA which will be on call 24 hours a day. This group has been formed in THQ to deal with those faults which threaten to effect service, or those faults which resist diagnosis. (Picture 58 shows the MSA at work).

The MSA will be based at Martlesham with access to the Switching Systems Testing Facility (SSTF).

Within the SSTF there is:

Equipment used for the development of System X.

A library containing the current program for every System X exchange in the country.

A model of every configuration of System X exchange in the field (Field Support Units).

A model of, or access to, every type of non-System X Switching System currently in use.

Using these facilities the MSA, perhaps after giving some short term advice, will be able to have the problem recreated and diagnosed.

The Maintenance Officer, confronted with a serious fault, will have the facility to initiate escalation to the MSA in accordance with local instructions. It must be stressed that an Officer in this position should not feel inhibited when considering escalating a fault to the MSA. Both in the early days of System X and in the future, if difficult software problems occur, the use of the MSA as a specialist tool of the field staff should be encouraged.

Operational Procedures

The responsibility for escalating a fault will rest within the local maintenance organisation (LMO). On receipt of an escalated fault, staff in the MSA will first check to see if the fault had occurred previously at any other installations and whether a known clear exists. If no known clear exists the fault is classified on the basis of its urgency/non-urgency and whether it was due to a design deficiency. This leads to four possible classifications and the methods of dealing with them are described below.

Urgent: Non-Design

Faults of this type are dealt with by the Maintenance Support Agency without the assistance of any other organisations. They will take priority over any other work in progress at the time and are followed through continuously until they are resolved. In this context the term 'urgent' applies to any non-transient service-affecting fault.

Urgent: Design

On receipt of this type of fault the MSA passes it initially to the Testing Function. The Testing Function is a BTHQ development group responsible for the SSTF at Martlesham, and is able to analyse the fault on System X exchanges installed within the SSTF. The result of the analysis is passed back to the MSA who then suggest remedial action to staff in the field. In certain circumstances where there is severe degradation of service, the MSA will ask the Testing Function to send the Flying Squad to site to deal with the problem at source.

A permanent solution to the problem may require a design modification which would have to be properly documented. When this is available it is applied in the normal manner. The overseeing of a design change is carried out by a separate BTHQ group designated Operational Control Function (OCF).

The 'Flying Squad'

The Flying Squad is a group of engineers drawn from the Testing Function at Martlesham. They are available at short notice to travel to any in-service exchange with fault conditions giving rise to a serious degradation of service.

Non-Urgent: Non-Design

Faults of this type are dealt with as 'Urgent: Non-Design' but are not given the same priority.

Non-Urgent: Design

Faults of this type are dealt with as for faults in 'Urgent: Design' except that it is not necessary to involve the Testing Function on every occasion. Faults which do not require the assistance of the Testing Function (e.g. documentation errors) will be passed directly to the Operational Control Function.

Interfaces

The Maintenance Support Agency will interface primarily with the Local Maintenance Organisation, the Testing Function and the Operational Control Function. This does not preclude contact with other groups if the need arises.

MSA – Local Maintenance Organisation

This is the main interface and will be open on a 24 hour, seven days basis. The LMO will carry faults escalated from the field in one direction and resolutions to these problems in the other. Control will be exercised by the exchange of a fault serial number from the Local Maintenance Organisation and an escalation reference number from the Maintenance Support Agency. This will allow easier reconciliation of faults and clears at a later date and will be useful to the Operational Control Function in keeping track of faults sent to other functions for resolution by design modification. Apart from any site visits which may be necessary on the part of the Maintenance Support Agency all communication through this interface will be by telephone. Only in the most urgent cases will the LMO escalate direct to the MSA all other contact will be via the Regional service organisation. When a fault is escalated the RHQ must be kept informed of the situation.

MSA – Testing Function

This interface will carry design/suspected design faults from the Maintenance Support Agency for analysis and will carry reports on those faults back to the Maintenance Support Agency. It will not be necessary for this interface to be open out of normal business hours except when it is necessary to contact the Flying Squad.

MSA Operational Control Function

This interface will carry details of faults requiring design modifications, to the Operational Control Function and details of the modifications, when they are available, to the Maintenance Support Agency.

Other System X Support

Some functions undertaken by section maintenance officers involving the modification of software, file dumping etc., may justify the involvement of another section maintenance office in terms of carrying out a check and monitoring role.

In the case of staffed exchanges with 2 or more staff, such support will be provided by a second section maintenance officer in attendance at the exchange. In other cases, support may be provided by a duty officer at the OMU. All other forms of support provided under normal and permanent arrangements will be that offered by the THQ Field Support Organisation and its agencies.

This strategy for System X Maintenance provides scope for development and change in the light of experience and the progressive penetration of TXD exchanges into the network.

The Switching System Test Facility (SSTF)

The SSTF has been provided, at considerable expense, to act as a test centre for the development testing of equipment and to give support to field operations. A model of each member of the System X family, called Field Support Units, will be installed at the SSTF. The first models, currently being installed, are a digital main network switching system (DMNSS), a medium local exchange (MLE) and an operations and maintenance centre (OMC).

Traffic Tester

The Traffic Tester makes it possible to find design deficiencies, monitor the effect of maintenance or modification procedures and gain experience of a system carrying varying realistic loads under normal and fault conditions. It generates calls on the incoming circuits of a system, receives calls on the outgoing circuits monitors for correct operation, including timing, detects any misoperations, and produces a comprehensive analysis of calls. (Picture 59 shows the traffic tester and DMSU in the SSTF building).

Interworking Testbed

To enable the testing of signalling interworking, routing protocols and administrative facilities between System X exchanges and the present network, a representative sample of existing systems has been installed. The switching systems installed are:

Strowger	UAX 12, 13
	TXS Non-Director, Director and GSC.
Crossbar	TXK1 Local and GSC.
Reed Relay	TXE 2.
Manual Board	Sleeve control (AMC/SCS).
	Cordless (AMC/CSS1).

Private Manual Branch Exchange No. 2, No. 3 and No. 4.

Private Automatic Branch Exchanges – No. 1 and No. 5.

Test Position – Trunk/Local

In addition, there are 30-circuit and 24-circuit PCM transmission systems and a variety of analogue units.

Objectives

The Switching System Test Facility exists to perform the following functions for System X equipment:

Design validation tests, to ensure that equipment described in the documentation meets all requirements and operates in the environment for which it was designed.

Tests on any new versions of software and any significant hardware changes prior to their introduction into in-service installations.

Provision of maintenance support and back-up facilities for in-service System X installations when required.

Maintenance Support and Back-up

The System X exchanges have a number of in-built facilities to aid the local maintenance staff and, in most cases, these will prove to be more than adequate. However, it is possible that faults of service difficulties will arise for which the local maintenance organisation will not be able to find a solution, and will therefore need assistance. This assistance can be given through established procedures by the staff at the MSA and the SSTF, who are in an ideal position to provide this assistance because of their practical knowledge of the system, the facilities at their disposal, and their close contact with the development teams.

pic 59

TECH ID TOTAL ALARM NON-ALARM AGENCY ROUTINE
1 111 4 2 2
3 112 5 1 4
2 115 17 9 4 4
4 116 23 8 13 2
5 119 22 12 6 4
0000099 03 0018 82-02-26 0905
LI-TWP:111;
0000099 03 0018 82-02-26
TECHNICIANS WORK PROGRAMME - 111
LOCATION FAULT S/NO DATE TIME CATEGORY PTY
1 0001002 00143 82-02-24 1905 EQU ALM
2 0001002 00157 82-02-25 0926 EQU
3 0001005 00163 82-02-25 1723 EQU ALM
4 0001004 00170 82-02-25 1735 MNT
0000099 03 0019 82-02-26 0906
C:004;
LYNWOOD

Computer Support and Software Management

SYSTEM X

Introduction

Computers have had widespread use within British Telecoms for a number of years. Initially, usage concentrated on the more traditional data processing applications such as billing and payroll systems, using large nationally controlled and operated mainframe computers. Associated with this stage was the development of a variety of somewhat smaller programs covering typically Regional or Area planning requirements with perhaps a supplementary national requirement for statistical information. These programs also tended to be run centrally to take up spare capacity on the expensive mainframe computers.

The consequences of this were that control of such programs was remote from the prime users, considerable volumes of input data tended to require to be submitted by the users and turnround times, particularly if an error-correction run had also to be carried out, were unsatisfactorily long.

Advent of new computer systems

Recent advances in microelectronic technology have led to drastic reductions in the cost of both processing power and computer storage. Although the large mainframe computer is still viable for specific applications, computer manufacturers have spent considerable development resources on two other main classes of computer, the Small Business Computer (SBC) and the larger Minicomputer.

SBCs offer reasonable processing power with limited storage capacity at a very low cost. In recent years they have been taken up enthusiastically at Area and Regional level, offering the advantage of direct control over programs and data files.

When considering the use of minicomputers the following points became clear:

Minicomputers now offer a very considerable processing power with very extensive storage capacity, equivalent to a mainframe computer of about a decade ago, at a moderate start-up cost.

These factors provide an opportunity to decentralise certain large programs currently run centrally. This will be beneficial particularly for those programs where only processing costs have previously enforced a National solution.

Spare capacity on these Minicomputers can be used to meet the requirements currently being met by the SBCs. Use of Minicomputers would still enable local control to be provided, but a greater degree of standardisation, where appropriate, and a greater portability of these small programs can be attained.

Concentration of program development onto a common machine would naturally give benefits with respect to computer maintenance requirements, making it easier for BT to undertake its own computer maintenance.

Visual Display Terminal to be used in the OMC

System X – General Requirements

Before examining the computer strategy and its implications, it is worth looking briefly at the requirements of System X for computer support, concentrating primarily on support for the planning and administration of System X exchanges as they are introduced into the Telecoms Network. System X requirements differ in several fundamental respects from those of existing exchange systems in that:

There is a need to capture data relating to the existing network environment (subscribers, junctions, routings, tariffs, etc), and to convert it into computer form for loading into the exchange processors store. This data has then to be maintained.

There is a need to manage the generation, issue, loading and up-date of the exchange program software.

The exchange output records (faults, traffic, billing, security, etc), are all computer media and require processing before they can be utilised by BT.

The design, planning and procurement stages have to be integrated closely with the manufacturing processes

The totality of the support systems (whether normally proper to BT or Manufacturers' operations) have to be available to support export work.

These factors lead to the conclusion that computer support is an essential integral requirement for planning and operating System X. Additionally, the need to make support available multilaterally calls for implementation on a common basis, ideally using standard languages to give portability to the programs.

Computer Strategy

In view of the present technological environment, the decision has been made to base System X computer support on a network of minicomputers. The main objectives are:

To develop nationally the full range of support programs, but to devolve them at an early stage to the appropriate Regional or Area based minicomputer system.

To restore control over source data and the running of operational programs to the prime users.

To minimise network problems by concentrating program development on the equipment of a single computer manufacturer, as far as this is realistically attainable.

Recognising the export potential of System X support software, to seek a UK computer manufacturer for the equipping of that network.

To use existing facilities arising from the development stage of System X as much as possible in order to minimise network costs.

The network structure is naturally a function of the application programs that it has to support. The overall development is a long term objective, as indeed will be the full creation of the supporting computer network. However, in order to provide support for

System X within an acceptable timescale, to meet the demands imposed by the System X Works programme, a restricted range of facilities will be made operationally available and introduced progressively from the end of 1981 onwards. (Table 4 shows the range of support applications planned to be run on various computers).

A basic requirement for the network is that it must be flexible, capable of extensive growth and rearrangement as development proceeds.

A key factor in the acceptability of the computer strategy will be the selection of an appropriate computer system. The two most important aspects in view of the structure proposed, are the user interface facilities and the communications capability necessary to support that network.

User Interface Facilities

The main features expected of the computer system in this area are:

A Multi-purpose System – able to operate simultaneously in a variety of modes, e.g. transaction processing, interactive program development, batch processing, remote job entry.

A User-Friendly Operating System – providing a high level of support to workstation/terminal users.

Ample Processing Power – sufficient to provide users with a good response time for the varied tasks being processed.

Good Program Development Aids, e.g. a powerful Editor, and support for the main programming languages, e.g. Cobol, Fortran, Algol, Basic, PL1, etc.

Ability to function in a normal office environment, with very low routine maintenance requirements.

A Workstation Oriented System – with high quality VDT screen and keyboard, backed by a high capacity Disc storage system to minimise system operation requirements. See Picture 60.

Ability to support Databases.

Hardware Modularity – allowing the system to grow in easy stages.

Communications Capability

The main requirements expected to be satisfied are:

Ability to support an adequate number of workstations and remote terminals.

Capability of operating in a distributed processing environment.

Availability of line protocols enabling secure data communication between the minis and the existing mainframe computers, e.g. ICL2900 series.

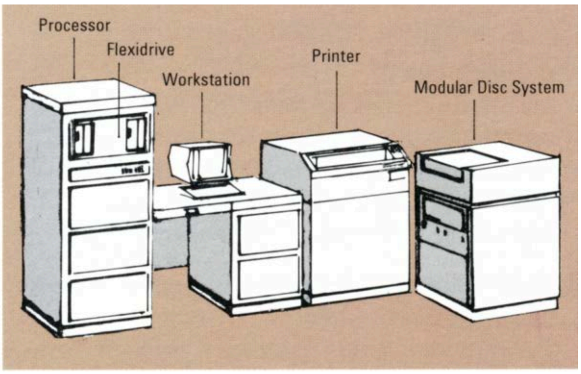
Table 4 Planned Support Applications

APPLICATION		DEVELOPED BY
1	Dimensioning	THQ
2	(Data Loading (DAIV) (Data Compiler	(THQ (Plessey
3	Cartridge Writing (CWACS)	THQ
4	Allocations	THQ
5	Placement	GEC
6	Cabling	Plessey
7	Remote Cartridge Writing	THQ
8	Exchange Name Documents	THQ
9	On-Line Data Capture	THQ
10	Item Inventory	THQ
11	Cartridge Reading (CRACS)	THQ
12	Software Master Library	THQ
13	Documentation Data Base	THQ
14	Contract Specification (CESS)	THQ
15	Transaction Log Processing	THQ
16	Fault Analysis	THQ
17	Repair Centre Records	THQ
18	Traffic Recording Scheme	THQ
19	Call Sample Analysis	THQ
20	Revenue Forecasting and Traffic Planning Stats	THQ
21	Supplementary Service Statistics	THQ
22	System X Interchange Mechanism	THQ
23	Exchange Software Generator	THQ
24	CAD Manufacturing Information Interchange	THQ
25	Exchange Records Database	THQ
26	Works Order Progressing (PERT)	THQ
27	Operational Exchange Software Library	THQ
28	Fault Records Database	THQ

pic 60

In view of the range of minicomputer systems currently available from computer manufacturers, THQ are carrying out studies to select an appropriate system for BT's use. Fig 61 illustrates the layout of an ME29 computer system manufactured by ICL.

fig 61



Operational Activities

It will initially be necessary to run certain programs nationally but it is BT's explicit intention that all programs appropriate to Regional or Area levels be devolved as quickly as possible.

At the Regional level support falls primarily in the exchange design and specification functions. The range of packages being developed is very extensive, covering virtually all procedures from the initial dimensioning (DFS) stage right through to the Contract Specification and associated Exchange Name Documentation. With the location of these programs on Regionally based minicomputers, Regions should obtain a much better service than experienced previously and, coupled with the communications facility allowing efficient interchange of data between Regions and Contractors, a considerable reduction in lead times for Works Order Planning should be achievable.

None of this is likely to lead to a radical change in the pattern of work of the design and specification staff. Their work is already extensively computerised for existing systems, with staff having ready access to workstations terminals for their direct use.

It is within the Area that the implementation of the computer strategy, particularly in the long term, will have most effect. System X requires a considerable volume of detailed information about the existing network to be collected, converted for loading into the exchange processors, and subsequently maintained. A significant proportion of the early System X Works Orders will be for replacement exchanges and the data collection conversion requirements would impose a very considerable work load on the Areas in the absence of computer support. The provision of local computing power will enable this data to be collected and updated using terminals workstations with VDT-displayed formats for assistance. (Pic. 62).

This information forms the Exchange Record Database which is essentially a continuously updated master record. It is envisaged that this database will subsequently be linked to a marketing provision of service system to allow customer demands to be rapidly met.

Of course, these are all new concepts which do not exist in this form for current switching systems and will be introducing new working methods requiring detailed discussions with the representatives of the staff concerned.

Implementation Plan

The provision of Regional and Area computers for System X support is a multi-million pound project and it is important that overall costs be minimised. It is intended to achieve this by spreading the provision of hardware into the field over a number of years. A study of the penetration of System X exchanges into the network has shown that although all Regions will quickly be involved in pre-Order Data planning activities, the spread of exchanges into the Area takes place much more slowly. This is a natural consequence of the System X implementation plan, where small groups of exchanges, a DMSU, an OMC, and independent local exchanges, are generally provided.

The System X Works Ordering programme is planned to 'take-off' very quickly. It is imperative therefore that computer support is made available in good time. The software for the initial packages is well under development and will start to become operationally available during 1981. The objective is an integrated suite of programs requiring minimum user intervention.

Whilst these facilities will be made available in the very short term from computers based in London, it is intended that Regions and Areas will begin to acquire their own computer power during 1982. In the main this will be achieved by providing minicomputer systems in Regional offices with Area support being given through terminals parented on these machines or the London computer. Subsequently, when Area requirements justify provision of independent systems these will be made available.

pic 62

Data Management

As an illustration of these principles, an example of a planned computer application will be considered in more detail. The example considers data management.

System X brings with it a new aspect of exchange management – namely Installation Data. By Installation Data we mean information held in the processor memory which tells the programs about the particular subscribers, network, equipment, etc., with which they have to work on a particular site.

All previous systems have also had to be set up for each site, but generally this has been achieved using hard wired straps and jumpers. Where systems have required some data, eg., processor controlled TXK1 and TXE4A, the approach has been ad hoc and uncoordinated.

The difference in System X is that as Figure 63 indicates, a lot more detail is held as data and the data can easily be altered using a terminal or by loading a magnetic cartridge. Because of this, the information has to be prepared in a particular way and several previously separate tasks have come together under the heading of Data Management.

Data Management is a local responsibility. Headquarters will only be involved to set up the necessary procedures and systems, and to give help and advice to local staff as necessary.

fig 63

DATA MANAGEMENT

What do we mean by data?

Subscriber Information	Class of service, Equipment Number, Facilities
Information Circuit	Signalling systems, timeslot allocations
Network Information	Routes, Decode structure translations
Hardware configuration	Equipment interconnections, timeslot use
Call Accounting Data	Tariff rates, Tariff program

Much of this data was wired into previous systems

System X Data is alterable – entered by magnetic cartridge tape or terminal

Much of this data was wired into previous systems

System X Data is alterable – entered by magnetic cartridge tape or terminal

Data Quantities

System X installations need a lot of data. It is also important to realise that the service offered by the installation depends directly on that data – so it has to be correct in every detail.

Typical amounts of data are:

LOCAL EXCHANGE
– one million characters for a 1000 line exchange

MAIN JUNCTION EXCHANGE
– 2 million characters for a 200E exchange.

OPERATIONS AND MAINTENANCE CENTRE
– Half a million characters, 90% common to all sites.

Data Management Functions

a. Collection Purification

The required data is found on a range of existing manual records and computer systems. These records are often inaccurate, so the first job is to collect the data together and check its accuracy and consistency.

b. Preparation

Once collected, further work is required on the data. For example, routing information has to be converted into digit decode structures, subscribers and circuits have to be allocated to equipment. Once all this is complete, the data has to be converted to a form recognisable by the installation processor.

c. Loading Archiving

Data can be loaded in 2 forms, either as Man Machine Instructions (MMI) on a terminal or cartridge, or as a direct image of the processor memory (loadable Hexcode).

d. Records

Clearly, various people need to know, for example, what facilities each subscriber has, what equipment is used etc. It might also be necessary to reload the data from scratch one day. Consequently detailed records of the loaded data have to be kept and carefully maintained.

e. Validation

An installation will only perform correctly if its data is absolutely correct. To guard against data corruption or accidental errors it is necessary periodically to check the loaded data against the appropriate records.

f. Day to day changes

These changes are input to terminals, initially on the exchanges and OMCs. The changes will be for a wide variety of reasons; subscriber changes, routing or tariff changes, for example. It will be necessary to keep a detailed log of exactly what changes are made, and also to update the affected records.

Computerisation

The need to input data to installations in computer form, the need for accuracy and the large amounts of data involved dictate computerisation of the Data Management processes.

Because this is a large complex system which cannot be introduced quickly, an interim scheme (Figure 64) will be made available early in 1982.

The system will run on local minicomputers and data is collected on a formatted Visual Display Terminal (VDT) and held in a master file. From this file data can be checked or added to – for example, allocations of subscribers and circuits to equipment positions can be worked out and added back into the file.

Eventually a full set of checked data is held in the master file and can be converted to either Man-Machine Instructions or directly loadable Hexcode. A cartridge is then produced at the local computer and loaded at the System X installation.

The long term system (Figure 65) is similar to the interim system, but with one vital difference. The temporary Master Record is replaced by an on-line-data-base. This will be a record of all data loaded on the installation and can be updated or asked a question at any time, using a VDT. Again, this will run on a local mini-computer and will provide for:

a secure record of the exact data – giving added system security.

early access for staff needing to know the state of the installation. The information will be accurate because the database will always be updated first, with the installation processor being updated from it.

direct capture of data needed for the Exchange Design CAD (EDCAD) system.

automatic comparisons of the data on the installation and the database to check for errors.

fig 64

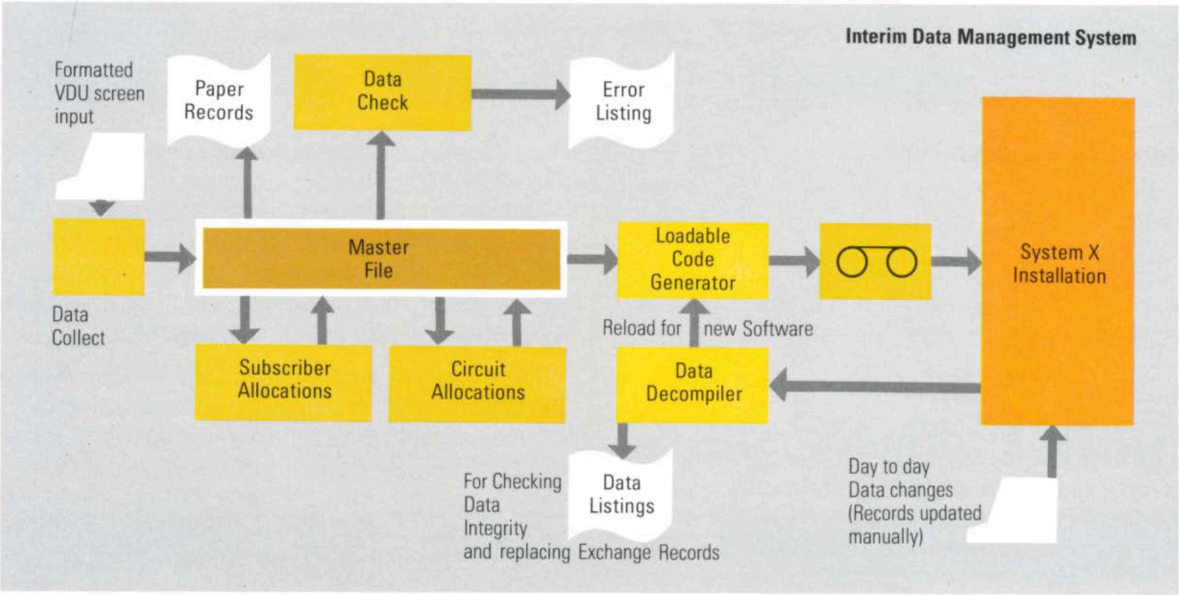


fig 65

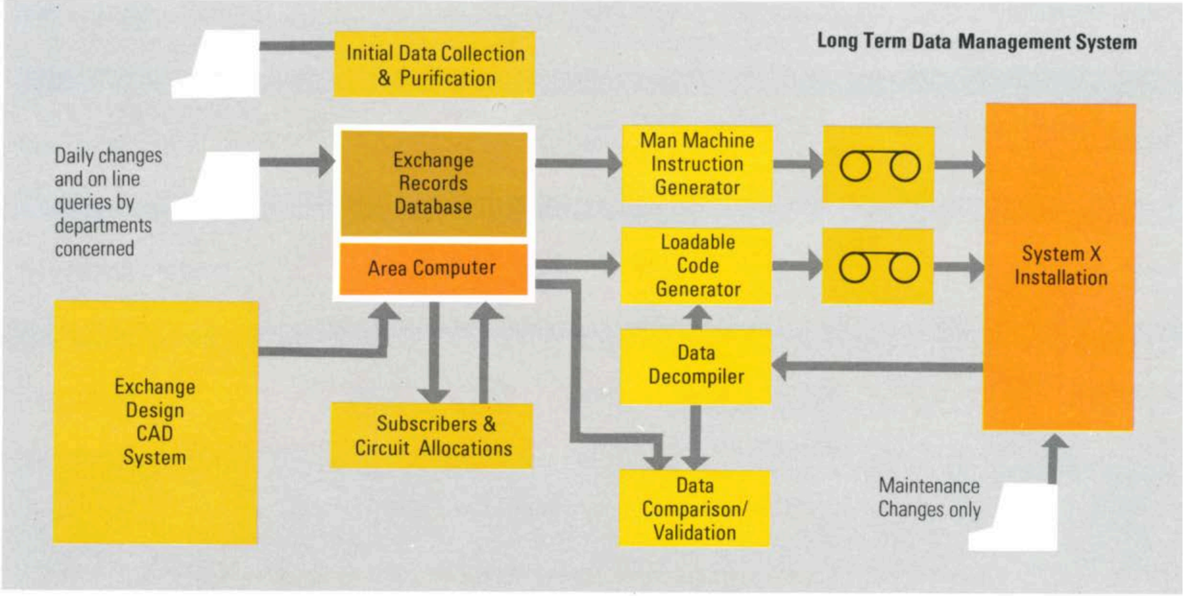
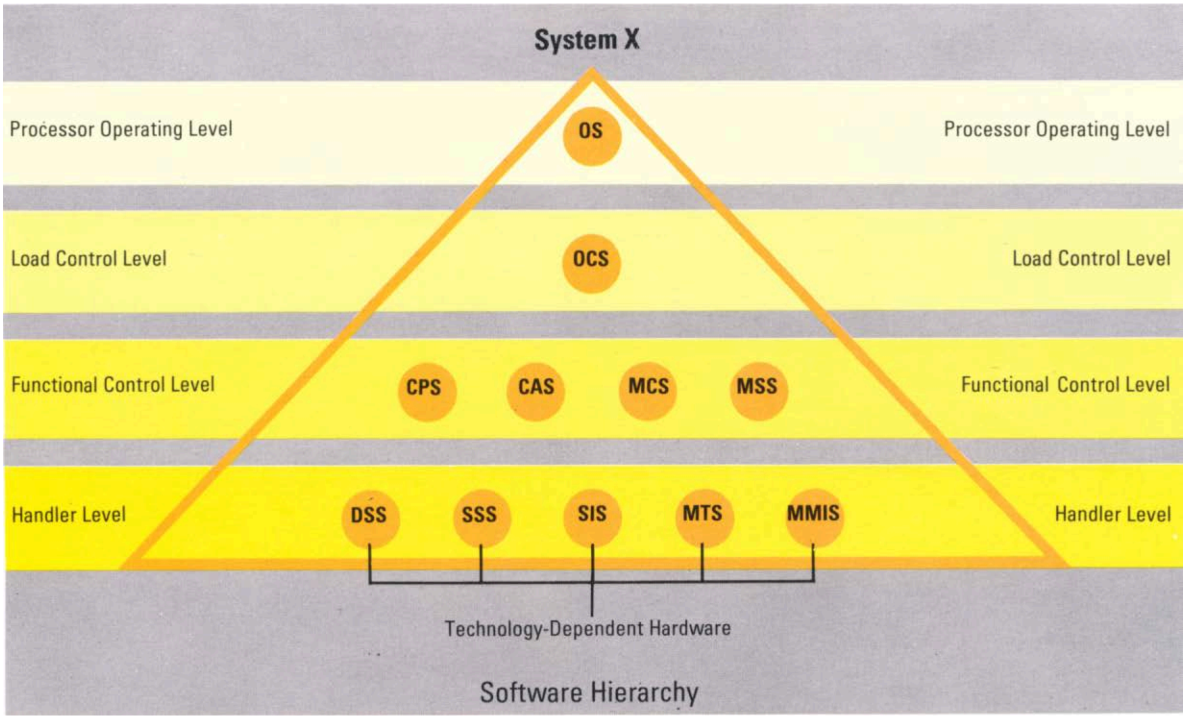


fig 66



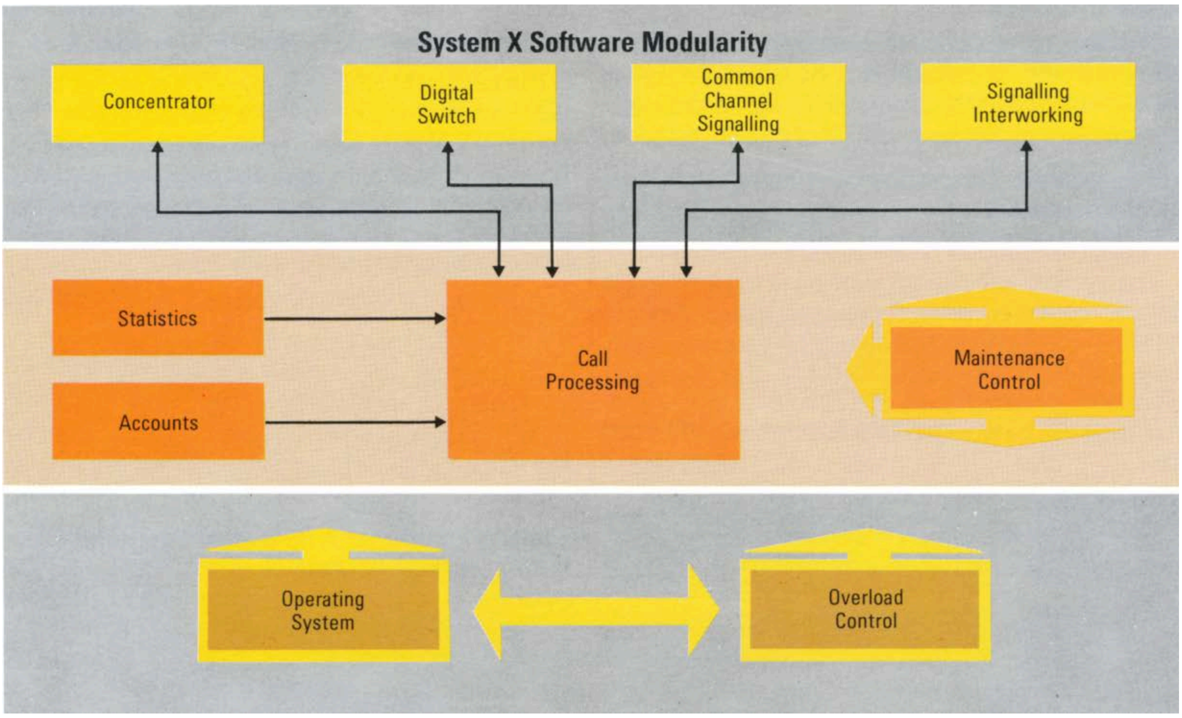
Software Management

The use of software for telecommunications switching applications in the BT inland network is relatively new. Software is a whole new dimension in telecommunications and the need to devise and agree new procedures within the Business to operate and manage software, must be recognised.

System X uses application software programs to carry out the required logic functions of each system. These programs run on a processor utility subsystem which has its own complex operating system software (Figs 66 and 67). For a typical system, the application software and operating system software is of the order of several hundred thousand words of object code stored in the processor. To cater for various system capacity sizes a number of standard software suites are being defined for each application.

The language that early System X exchange software is written in is PO Coral but this will eventually change to an agreed international language for this type of application.

fig 67



For non-programmers a few basic definitions may make the following section more understandable.

SOFTWARE	The programs, subroutines, executives, and compilers and their documentation, of a computer system. Any part of a computer system not defined as hardware.
HARDWARE	The mechanical, magnetic, electrical and electronic components of a computer.
PROGRAM	A group of instructions plus data which defines the rules for deriving the solution of a problem, if it exists, to be executed by the computer.
APPLICATIONS SOFTWARE	Programs written in a computer language for a particular application.
OPERATING SYSTEM	Programs, resident in the computer processor, which provide the interface between the computer and operators for the purpose of normal operation. They schedule the work load and allocate the processor and peripherals to tasks.
SOFTWARE LANGUAGE	A set of code elements and rules defining their permitted combination to form words or expressions for communicating information between people and computers.
A FIX	An expedient solution to a software defect.
A PATCH	A fully tested and documented solution to a software defect. It would replace a fix if previously applied.

Software cannot go wrong or wear out. It can, however, be corrupted from an external source, either by hardware, or by human intervention, (the programmer). Despite careful testing it will not be possible to eliminate all defects. To test a small program package through all the possible paths under all possible circumstances, including hardware faults, would take many years of testing. Thus as the System X family increases, an increasing amount of software in the field will need to be tracked for defects (bugs), subsequent correction, testing and re-issue: this is software management.

Software Management Functions

Software controlling an exchange is an internal part of the exchange design. The software must meet high quality standards and it is necessary that a software management organisation must be founded when SPC systems are introduced on a large scale.

It has already been stated that software defects will exist but there will also be changes due to evolutionary or adaptive designs to the exchange system. Strict discipline of the change mechanism is carried out by standardising the software, documentation, and centralising and controlling access to configuration and change records.

The management organisation functions necessary for software support of both the SPC switching systems and the interactive and off-line computer support facilities are broadly defined by:

change control
Operational control and software generation
maintenance support
redesign support.

Change Control

The Change Control organisation maintain the compatibility records of the system hardware and software elements and records the changes to them. It is also responsible for controlling access to the design databases and the Software Master Library, on which all System X operational software is held. It is therefore, a key element in the management of software during its life cycle.

System X is a collaborative project between BT and the three participating companies with design and development spread throughout them. It is therefore, necessary to have a means of information interchange between these organisations and this is handled via the Software Master Library held by BT. The design information produced by each manufacturer to the central database held by BT and from there it is passed on into the individual databases of the other manufacturers.

Operational Control and Software Generation

The appropriate software construction and the selection of the generic software suite is performed by the Operational Control function on receipt of the performance specification for new exchanges, extensions and enhancements.

New software load tapes are generated from the software master library files together with any relevant exchange documentation for distribution. Operational Control thereafter maintains a record of the software build states of the field systems and controls any subsequent release of software changes to the field. Overall software performance is monitored and any relevant information is fed back for subsequent redesign.

Maintenance Support

The local maintenance organisations will load new software releases, carry out tests, and monitor exchange performance. As operational defects are observed these are reported via the field organisation to the Maintenance Support Agency. This agency will assist the local maintenance personnel to take corrective action with reference to a centralised fault history database. Field Support Units (Captive Installations) will be available to assist the Maintenance Support Agency in obtaining a more detailed location of the fault. The Field Support Units will be situated in the Switching System Test Facility (SSTF) at Martlesham which forms the Testing Function.

Only exceptional faults which cause severe degradation of exchange service be progressed on site. Under these conditions a team of experts, called the 'Flying Squad,' under the control of the testing function will produce and load an emergency software patch.

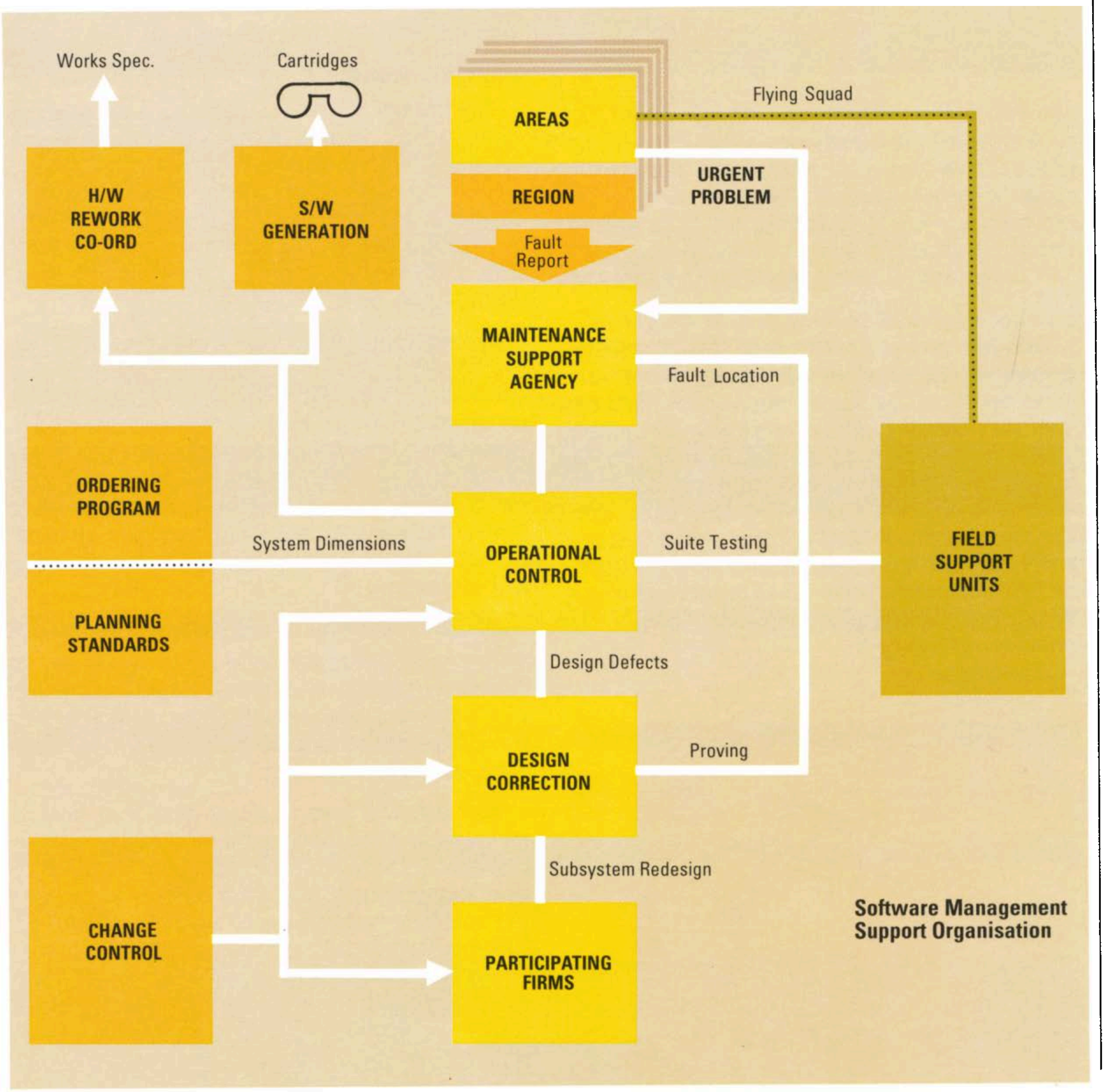
Redesign Support

If a design defect is proved, the fault is referred to the Redesign Support Team (via Operations Control) with an indication of its priority classification and location.

New, enhanced or corrected software would be independently tested on a Field Support Unit of the appropriate type to verify that the new product was satisfactory, before being listed on the software master library by Change Control.

When an existing piece of software has undergone several patches it will be necessary to carry out a redesign. This exercise results in a 'clean build' which is the replacement software rewritten to integrate all the patches in the most economical way. (The Organisational structure to support these activities is shown in Figure 68).

fig 68



INSTRUCTION ONE SHOT
RESET J/P
AP OPEN
TRACE CLEAR
TRACE INC/DEC
TRACE O/S
LOAD TRACE OP WORD
CHECK PARITY CHECKS
INSTRUCTION RUN
CLEAR SCRATCHPAD
FLAG 3
FLAG 2
FLAG 1
FLAG 0
CLOCK RUN
CONSOLE SOURCE
INH PLI
INH AP T/O
INH TRAP
INH INT
EN CPU No DISPLAY
CLOCK O/S
DATA LOAD
INH AIF
INH T/O
INH PTY
INH IC T/O
CLEAR
F
E
D
C
LOAD REG ADDRESS
B
A
9
8
LOAD SINK
7
6
5
4
LOAD CPU ADDRESS
3
2
1

Manpower requirements and training

SYSTEM X

pic 69

pic 70

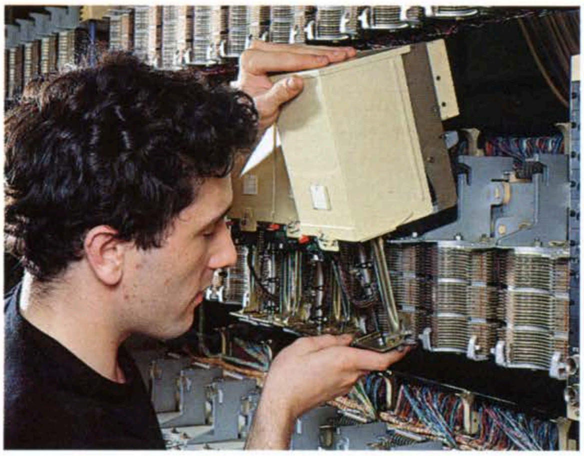
To complement the information given in the rest of this book on the hardware and software features of System X, this Section will make some projections into the future on the crucial questions of manpower requirements and the level and type of training that will increasingly be needed.

Perhaps we should begin by dispelling a popular misconception: that new technology means fewer jobs. It is a truism that in countries which have adopted new methods at a faster rate than we have (ie Japan, USA, Germany) unemployment is considerably less than here in the UK. In general, it is usually the out-of-date who face unemployment.

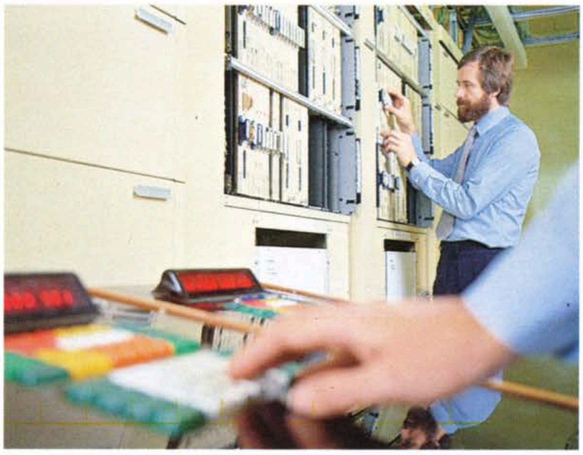
Seen against this background British Telecom's planned training programme is impressive. A number of staff – in areas which already have System X installations, or where establishment of them is imminent – have already benefited from specially-structured courses. And as System X implementation gathers momentum, places on courses will be offered to all technical staff who need to – or would like to – grasp the opportunity to equip themselves with the knowledge and expertise which will soon be an essential requirement in the rapidly evolving telecommunications industry.

But job security for technical staff and indeed, all BT staff – will depend to a large extent upon our ability to attract and retain a high proportion of new business. And it is System X, with its innovative new facilities and services that will be the strongest weapon in our armoury as we meet tough commercial competition.

Console Unit. This is used for system initialisation, start-up and subsequent diagnostic checks pic 71a



pic 71b



pic 72a

Installation and Clerk of Works (COW) Staff

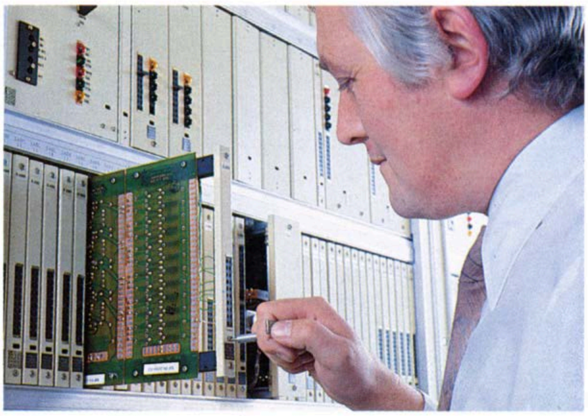
BT staff involvement in the equipment modernisation programme will be substantial in accordance with the nationally agreed policies on direct labour work. Nevertheless, the level of contract installation will be considerable. By nature of the changing equipment technology, installation practices and techniques will also change as will contract supervision requirements. Some changes, such as reduced installation times, changes in acceptance testing techniques and reductions in equipment volume will reduce installation labour requirements.

Other factors, such as the extra effort associated with premature replacement of exchanges and transmission equipment, system and network rearrangements, and the general introduction of digital working into the existing network will produce an increase in labour needs. In general, staff on planning and installation may need to be increased above present levels dependent upon the programme and the timescales. Beyond that point, forecasts are uncertain since manpower requirements needed to meet provision of new services and facilities cannot be accurately foreseen, however nationally agreed policies in the exchange installation field will be operated throughout the modernisation period and will affect manpower requirements in those later years.

Picture 71a and 71b illustrate the different installation techniques between Strowger and System X.

Maintenance Staff

Modern systems require less maintenance effort than electromechanical systems and the level of maintenance staff at a specific location will change. There will be need for some organisational change too; System X in particular generates some difference in approach to organisation and, as the System X and digital transmission environment develops and predominates, a need to emphasise coherence in the maintenance of the network as a whole will emerge. The maintenance staffing levels of modern exchanges will be determined by what is needed to give a good quality of service to our customers.



pic 72b

Other Groups of Staff

The introduction of modern technology will also affect other smaller groups of staff employed outside the main streams of equipment installation and maintenance. In particular, the techniques for changing customer facilities and controlling Trunk and Junction routings may result in reduced staffing levels for TMCC, CPC and jumpering staffs. However, in power groups there is likely to be an initial small rise in staffing levels to cater for the introduction of stand-by power equipment at small exchanges, before staffing drops to the maintenance requirements for modern power plants and solid state supply devices.

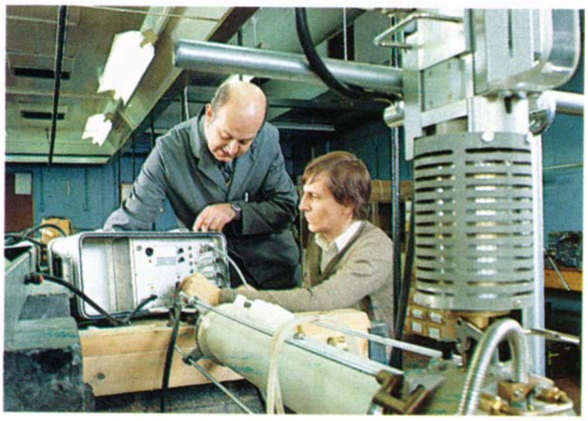
It is expected that staffing in these smaller groups will remain fairly constant in the short term after which the lower staffing levels resulting from the penetration of System X and, for example, the completion of the stand-by power programme may necessitate some retraining and redevelopment.

POEU and Staff Involvement

In the planning of a modernisation programme generally and for a specific site, it is essential that the staff implications are defined at local level and made subject to discussion between the General Manager and local POEU Branches at the earliest practicable time. Any aspects involving staff implications and requiring negotiation will be subject to normal arrangements and procedures. Within this, the future position of installation, maintenance and other groups of staff affected by modernisation plans will need to be jointly considered in respect of the Area as a whole, parts of the Area and, as appropriate, on a specific site basis.

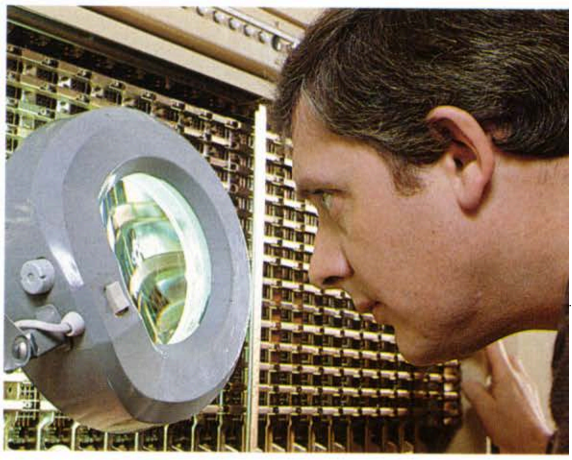
It must also be an objective to ensure that all staff affected by modernisation are appraised of the proposals and of how they, as individuals, will be affected. This should be undertaken by local management as early as is practicable, generally after the programme is firm (ie. when the order for the new exchange has been placed) and before the installation starts. Options that are available to staff must be discussed and their preferences should be acted upon and met whenever this is reasonable and possible.

pic 73a

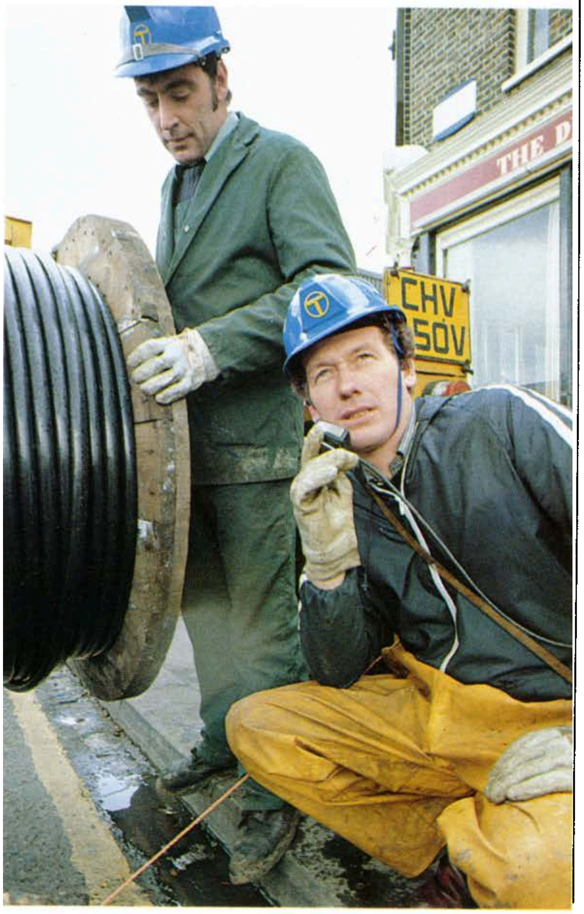


pic 73b

pic 73c



pic 73d



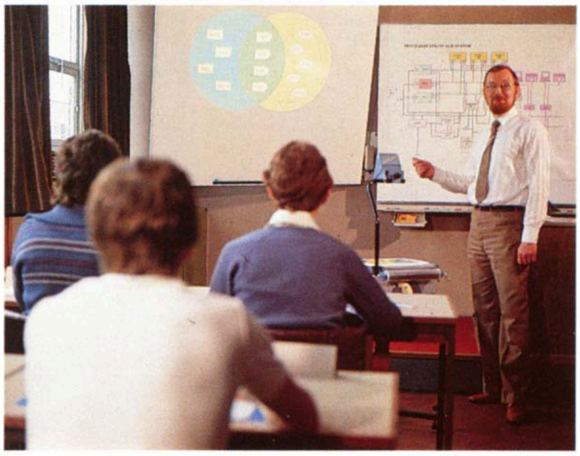
Training

To meet the training requirements of System X, BTTC Stone and other training colleges are assigning a large proportion of their effort to System X. Courses currently planned include:

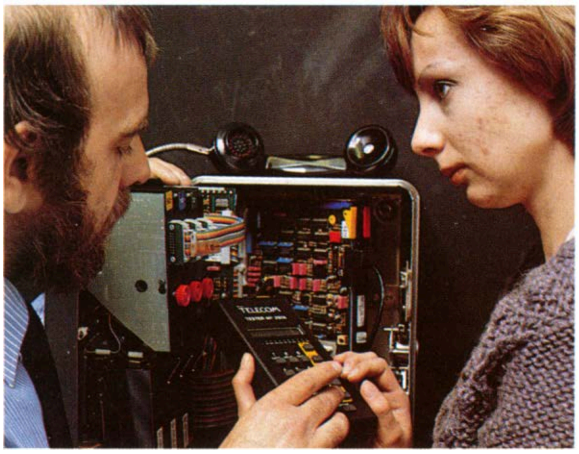
Engineering Clerk of Works
Engineering Maintenance
Circuit Provision
Engineering Planning
Engineering CSO
Engineering Repair Centre
Line Managers' Course

Looking to the future, there is a distinct possibility that some, or even all, of these, plus the new System X courses, will use 'distant learning' techniques. This will mean that training can take place locally – perhaps at the OMC. Visual Display Terminals will be used to access a central computer, which has the learning program in memory. Discussions are continuing with the unions involved. Picture 74 shows a course in progress, and picture 75 shows a technician receiving training.

pic 74



pic 75



Details of courses:

Engineering Clerk of Works

Information about the individual courses may be obtained from the Area training Officer. This sequence of courses, spread over twelve months, is available to nominated staff in the twelve months prior to the start installation date of their exchange or OMC. These courses are available to TOs and AEEs.

Engineering Maintenance

This sequence of courses, spread over twelve months, is available to nominated staff in the twelve months prior to the contract completion date of their exchange or OMC. These courses are available to TOs, AEEs and EEs. An additional exchange management course for exchange AEEs and Area/Regional AEEs and EEs is under consideration.

Circuit Provision

It is expected that existing circuit provision staff will perform CP duties in System X exchanges. The need for training in this area is under consideration but progress is held up by lack of detailed information on circuit provision procedures, required in System X exchanges.

Engineering Planning

Two planning courses are currently available: E1-1-987 System X for TSLTPs and E1-1-980 System X appreciation for planners. Details of these courses can be found in the Training Brochure. Currently System X exchange and medium term planning is being done at BTHQ. It is hoped to devolve this work to Regions beginning some time in 1981. BTCC are therefore intending to begin development of a three week course in 1981 and it is hoped to run the first one early in the Autumn programme.

Engineering CSO

The work of the contract supervising officer is presently done at BTHQ and it is not yet known when this work will be developed. It is expected that the relevant TIs will be made available sufficiently in advance of the development for a training course to be prepared.

Engineering Repair Centre

Engineering repair centre courses for System X equipment will be available nationally some time after the repair strategy is agreed. In the meantime where automatic test equipment (ATE) is provided specifically to repair System X equipment training will probably be provided by the supplier of the ATE.

Line Managers' Courses

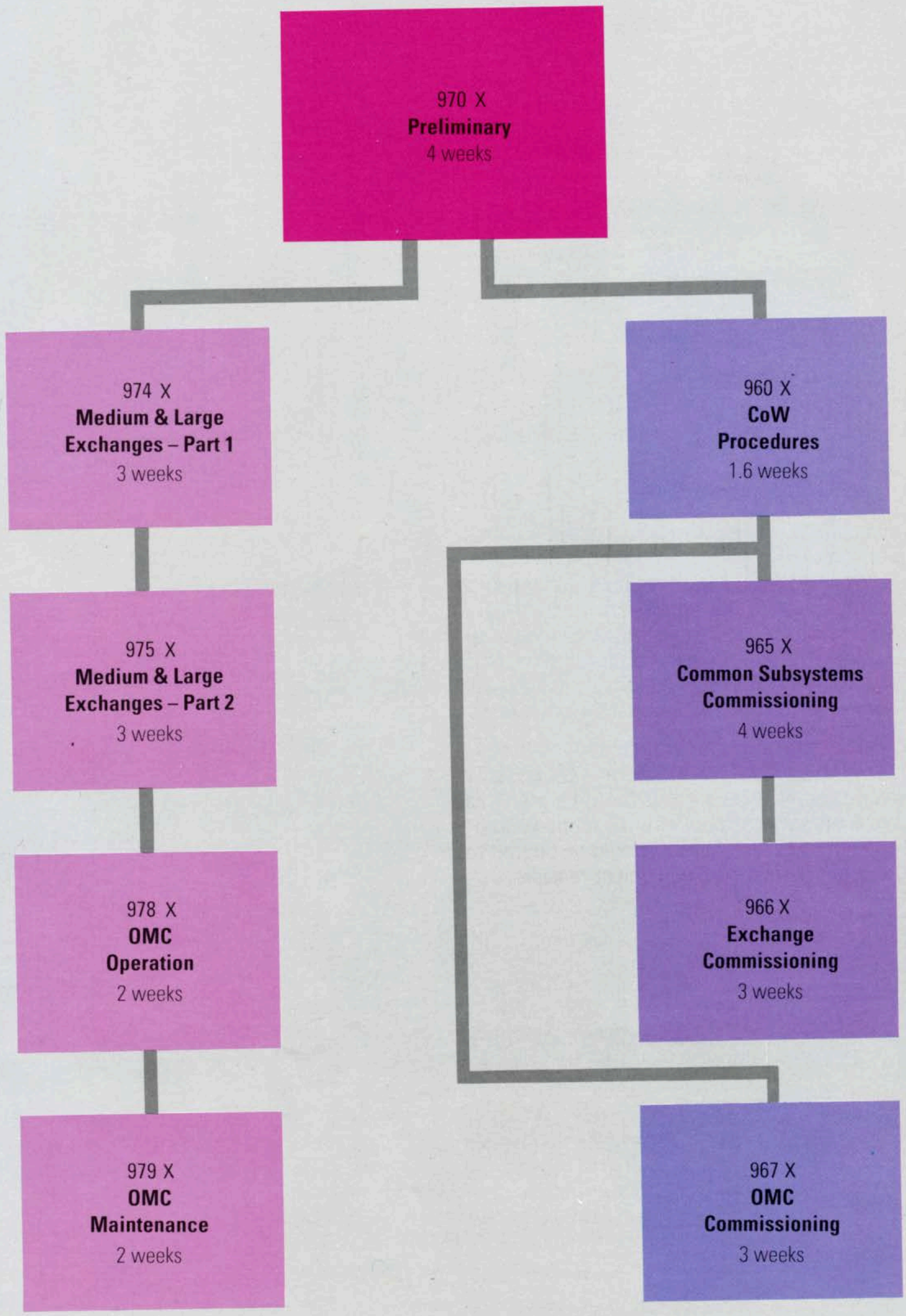
The demand for these courses is high, and the resources limited. It is therefore incumbent on local managers and training officers to determine that only those personnel who genuinely need courses are nominated. The courses are:

a. E1-1-961 SYSTEM X INTRODUCTION. A 1.6 week course intended for new development staff in SXDD and SXLD. Further details are given in the Training Brochure.

b. E1-1-962 OUTLINE OF SYSTEM X FOR SOs. A one week course intended for level 1 and 2 staff in Areas, Regions and THQ with a direct involvement with System X. Further details are given in the Training Brochure.

fig 76

System X courses (SEP Exchanges)



NOTE – Training for Small Local Exchanges to be arranged.

c. E1-3-963 SYSTEM X (SYSTEMS AND SUBSYSTEMS). A course intended for staff at level 3 and above in THQ, Regions and Areas. This course can either be run at TIC or at an RHQ. At TIC it runs two days allowing for travelling and at an RHQ it runs for 1½ days. As with the above courses this is directed at staff who will have direct involvement with System X. Further details are given in the Training Brochure.

d. E3-1-67 TRUNKING AND GRADING. This is an established job conference which now contains specific System X sessions. They cover network design and management aspects with particular reference to programs which occur in the introductory phase.

e. E3-1-66 SWITCHING MAINTENANCE. This is an established job conference which is currently being restructured to take account of the introduction of Operations and Maintenance Centres and the problems of the early phases of the introduction of System X. The restructured course is expected to be available in the 1981 series of job conferences.

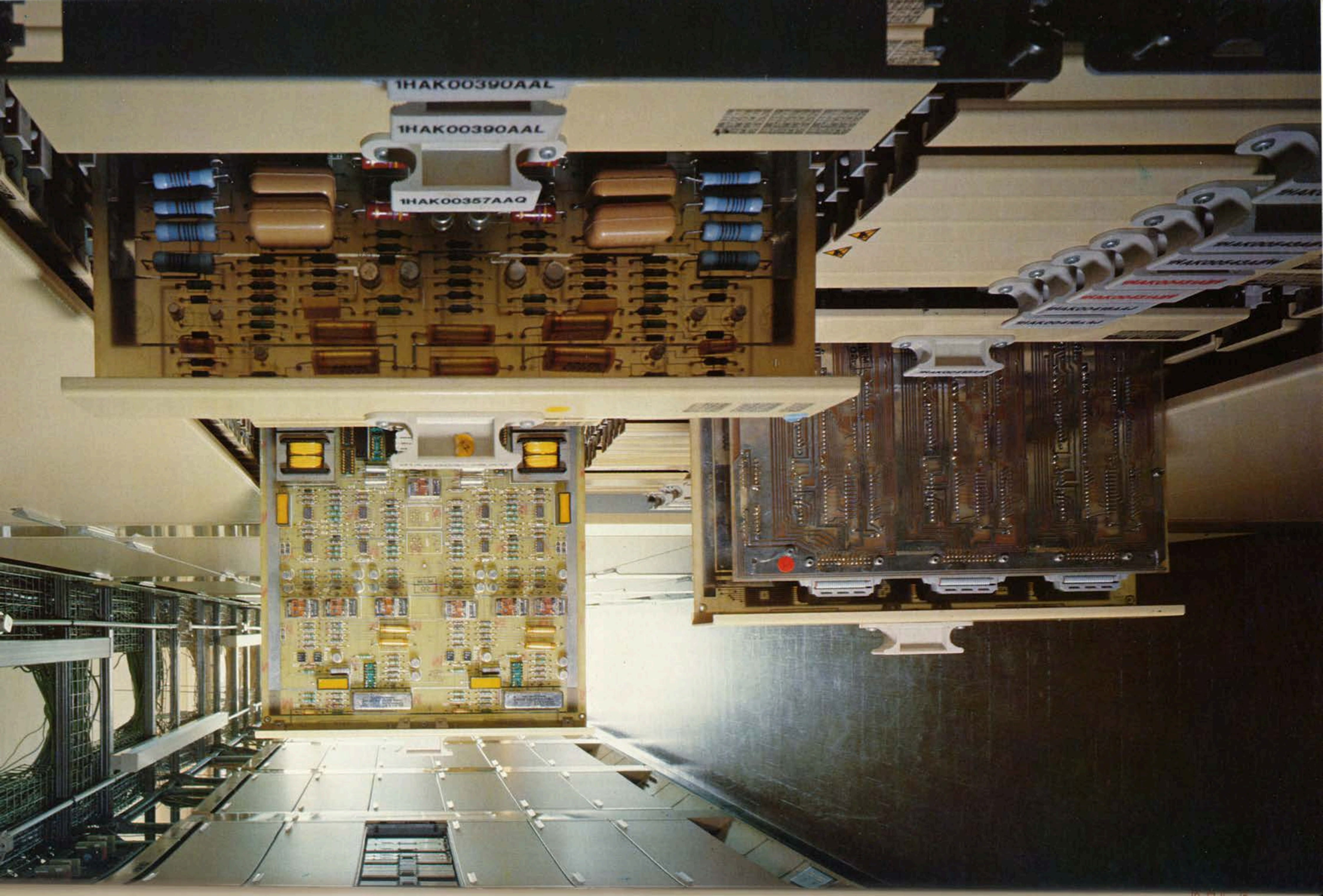
f. E1-1-987 SYSTEM X FOR LONG TERM PLANNERS.

Other Training Currently Available

Two week-long courses will be available at Regional Training Centres: 'System Modernisation Appreciation' (part 1 and part 2). Attendance is voluntary and open to all TOs and technicians employed on Strowger switching systems who have not attended TXE courses. The aim is to give a general description of the latest electronic and digital switching systems and will furnish practical experience of integrated circuits (ICs).

The content of some of the courses will have changed to reflect more recent information, and that additional courses will be in the design state. This situation is unlikely to stabilise until about 1984 or 1985 when changes in courses should be limited to taking account of improved equipment releases.

Picture clearly shows the easy assembly and accessibility of slide in units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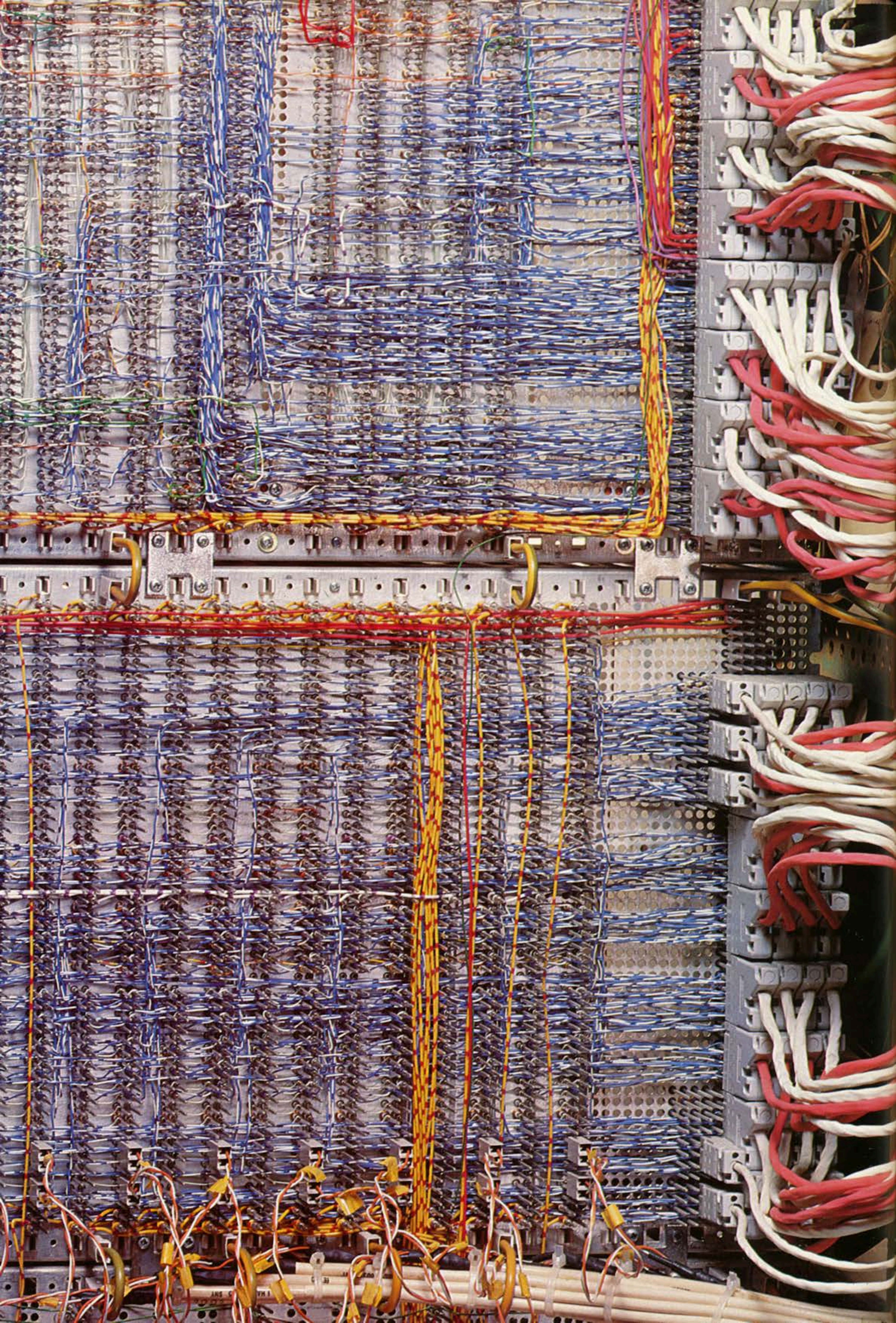


Appendix 1

SYSTEM X

List of subsystems

Automatic Announcement Subsystem (AAS).
Synthesises announcements as required from digitally recorded segments of speech to facilitate customer/exchange interactions, particularly those for certain supplementary services.

Analogue Line Terminating Subsystem (ALTS). (Analogue Junction Group AJG).
Converts analogue transmission signals – speech and other waveforms – into digital form, and vice versa.

Call Accounting Subsystem (CAS).
Derives the charging information relating to each call.

Call Processing Subsystem (CPS).
Controls the progress of each call on the basis of instructions sent by the caller.

Common Services Subsystem (CSS).
Brings together hardware aspects of the exchange chronometer, alarm systems, ringer, and ancilliary equipment.

Digital Switching Subsystem (DSS).
Interconnects digital channels, with high traffic loadings, at interfaces that conform with internationally agreed standards.

Digital Subscriber Switching Subsystem (DSSS).
Performs concentration of traffic from a number of infrequently used subscribers' lines onto heavily used common circuits at a local exchange.

Input Output Utility Subsystem (IOUS).
Provides a hierarchical means of connecting the hardware and software parts of call handling subsystems.

Maintenance Control Subsystem (MCS).
Diagnoses the cause of system malfunctions and provides guidance, as required, to the maintenance staff.

Mass Memory Control System (MMCS).
Provides storage and access to, management, servicing and accounting information at the OMC.

Man-Machine Interface Subsystem (MMIS).
Provides facilities for communication between the administration's staff and the processor subsystem for monitoring, controlling, and maintaining an exchange.

Multi-Party Connection Subsystem (MPCS).
Enables three or more parties to participate in a telephone conversation.

Management Statistics Subsystems (MSS).
Collects the basic traffic data needed for short and long term planning purposes.

Message Transmission Subsystem (MTS).
Performs common channel signalling functions, with error correction.

Network Synchronisation Subsystem (NSS).
Ensures that an exchange operates at the same average bit rate as the synchronised network as a whole.

Overload Control Subsystem (OCS).
Monitors the load imposed on the processor subsystem by other subsystems and, when necessary, attempts to avoid or minimise overloads by modifying the modes of operation of some or all of them.

Operating System (OS).
Integral part of the Processor Subsystem, which controls the software subsystems and the software handlers stored and run on the processor.

Processor Subsystem (PS).
Provides the data processing facilities required for handling traffic and for controlling local and remote switching subsystems.

Signalling Interworking Subsystem (SIS).
Provides facilities for interworking with existing exchanges that use a diverse variety of channel-associated signalling systems; also provides tones and recorded announcements.

Close-up of plug-in connectors
on rear of equipment racks

Appendix 2

List of abbreviations

A

AAR AUTOMATIC ALTERNATIVE ROUTING
AAS AUTOMATIC ANNOUNCEMENT SUBSYSTEM
ACU ALARM CONCENTRATION UNIT
ADCU ALARM DISPLAY AND CONTROL UNIT
AIU ALARM INTERFACE UNIT
ALM ALARM
ALT ALTERNATIVE
ALTS ANALOGUE LINE TERMINATING SUBSYSTEM
ALU ARITHMETIC AND LOGIC UNIT
AMSU AUTO-MANUAL SWITCHING UNIT
AMU ALARM MONITOR UNIT
AP APPLICATIONS PROCESS
APS APPLICATION PROCESS SUBSYSTEM
APO ADVANCE PRODUCTION ORDERS
ARR AUTOMATIC RE-ROUTING
ARU ARITHMETIC UNIT
ASSS ANALOGUE SUBSCRIBERS SWITCHING SUBSYSTEM
ASU ALARM SUPERVISORY UNIT
ATBA AUTOMATIC TEST BREAK ACCESS
ATS ALARM TERMINATING SUBSYSTEM

B

2BL PROCESSOR 2B LARGE
BBDF BULK BILLING DATA FILES
BDTS BULK DATA TRANSFER SUBSYSTEM
BIS BROUGHT INTO SERVICE

C

CAD COMPUTER AIDED DESIGN
CANAL COMMAND ANALYSIS PROCESS
CAP CPU ACCESS PORT
CAPM CPU ACCESS PORT MONITOR
CARP CALL ACCOUNTING RECONCILLIATION PROCESS
CAS CALL ACCOUNTING SUBSYSTEM
CCD CONTRACT COMPLETION DATA
CCU CENTRAL CONTROL UNIT
CH CHANNEL
CGOM CENTRAL GROUP ON MAINTENANCE
CL COMPATIBILITY LIST
CMOS COMPLEMENTARY METAL OXIDE SEMICONDUCTOR
CNI CHANGED NUMBER INTERCEPTION
CODEC CODER/DECODER
CONC CONCENTRATOR
CONFG CONFIGURATION CONTROL PROCESS
COP CODE OF PRACTICE
CPI CALL PARTY INDICATION
CPS CALL PROCESSING SUBSYSTEM
CPU CENTRAL PROCESSOR UNIT
CRU CONCENTRATION RECEIVING UNIT
CSS COMMON SERVICES SUBSYSTEM
CSU CONCENTRATION SENDING UNIT
CTSI CENTRAL TERMINAL SIGNALLING INTERFACE

D

DCS DATA COLLECTION SUBSYSTEM
DCP DISTRIBUTION COMMON POINT
DCU DRUM CONTROL UNIT
DDF DIGITAL DISTRIBUTION FRAME
DIL DUAL IN LINE
DISC DIGITAL INTERNATIONAL SWITCHING CENTRE
DIO DIRECT INPUT/OUTPUT
DJSC DIGITAL JUNCTION SWITCHING CENTRE
DL DOCUMENT LIST
DLE DIGITAL LOCAL EXCHANGE
DLT DIGITAL LINE TERMINATION
DMA DIRECT MEMORY ACCESS
DMS DIGITAL MULTIPLEX SUBSYSTEM
DMNSC DIGITAL MAIN NETWORK SWITCHING CENTRE
DMNSS DIGITAL MAIN NETWORK SWITCHING SYSTEM
DMSU DIGITAL MAIN SWITCHING UNIT
DN DIRECTORY NUMBER
DOC DOCUMENT
DPLE DIGITAL PRINCIPLE LOCAL EXCHANGE
DSE DATA SWITCHING EXCHANGE
DSS DIGITAL SWITCHING SUBSYSTEM
DSSS DIGITAL SUBSCRIBERS SWITCHING SUBSYSTEM
DTU DATA TRANSFER UNIT
D/U DELAY UNIT

E

ECD EXCHANGE CABLING DATA
EN EQUIPMENT NUMBER
END EXCHANGE NAME DOCUMENTATION
ESD EQUIPPED SHELF DATA
ESG EQUIPPED SHELF GROUP
ESS ECHO SUPPRESSION SUBSYSTEM

F

FET FIELD EFFECT TRANSISTOR
FIFO FIRST IN – FIRST OUT
FSP FAULT SERVICING POINT
FDO FAULT DISTRIBUTION OFFICER

G

GOS GRADE OF SERVICE
GSC GROUP SWITCHING CENTRE

H

HDB3 HIGH DENSITY BIPOLAR 3
HWY HIGHWAY
HW HARDWARE

I

IAC INTERNATIONAL ACCOUNTING CENTRE
IBF INDIVIDUAL BULK BILLING AND ITEMISED BILLING RECORDS FILE
I/C INCOMING
IC INTEGRATED CIRCUIT

ID	IDENTIFICATION
I/F	INTERFACE
IIP	IRREGULAR INPUT PROCESS
INTIM	INTERRUPT AND TIMING
I/O	INPUT/OUTPUT
IOB	INPUT OUTPUT BUFFER
IOC	INPUT OUTPUT CONTROLLER
IOUS	INPUT OUTPUT UTILITY SUBSYSTEM
IPP	INTERFACE PACKAGE PROCESS
IRSPP	INFORMATION RETRIEVAL AND SCRATCH PAD PROCESS
IS	INTERNAL STOP
ITSC	INTERNATIONAL TELECOMMS SERVICE COMPLEX
IWU	ISOLATION WORKING UNIT
J	
JCL	JOB CONTROL LANGUAGE
JUNC	JUNCTIONS
K	
K-BITS/S	KILO BITS PER SECOND
L	
LCP	LOCAL CONTROL POINT
L/D	LOOP DISCONNECT
LDD	LOGIC DESIGN DATA
LDR	LINE DRIVER RECEIVER
LE	LOCAL EXCHANGE
LED	LIGHT EMITTING DIODE
LS or LSTTL	LOW POWER SCHOTTKY TTL
LSI	LARGE SCALE INTEGRATION
LSM	LOCAL SYSTEM MODEL
LSU	LOCAL SYNCHRONISATION UTILITY
M	
MAC	MEASUREMENT AND ANALYSIS CENTRE
MAC-PROC	MACRO PROCESSOR
MAC-ROS	PORTIONS OF SOFTWARE
MAR	MEMORY ADDRESS REGISTER
MBIT	MEGA BITS PER SECOND
MCS	MAINTENANCE CONTROL SUBSYSTEM
MCSP	MAINTENANCE CONTROL AND STATISTICS PROCESS
MF	MULTI FREQUENCY
MH	MESSAGE HANDLER
MICRO-PROC	MICROPROCESSOR
MKR	MARKER
MMCS	MASS MEMORY CONTROL SUBSYSTEM
MMIS	MAN MACHINE INTERFACE SUBSYSTEM
MOD	MODULE
MOJ	METERING OVER JUNCTION
MOS	METAL OXIDE SEMICONDUCTOR
MP	MAIN PROGRAM
MPCS	MULTI PARTY CONNECTION SUBSYSTEM
MPTS	MICRO PROCESSOR TIME SWITCH
MRC	MALFUNCTION REPORTING AND CONTROL
MSS	MANAGEMENT STATISTICS SUBSYSTEM
MSL	MASTER SOFTWARE LIBRARY
MSU	MAINTENANCE AND STATUS UNIT
MTBF	MEAN TIME BETWEEN FAILURES
MTS	MESSAGE TRANSMISSION SUBSYSTEM
MTU	MULTI TERMINAL UNIT
M/U	MONITOR UNIT
MULP	MULTI PROCESSOR LOAD PROGRAM
MUX	MULTIPLEX
N	
NMOS	N CHANNEL METAL OXIDE SEMICONDUCTORS
NMSP	NETWORK MANAGEMENT STATISTICS PROCESS
NSS	NETWORK SYNCHRONISATION SUBSYSTEM
O	
OCS	OVERLOAD CONTROL SUBSYSTEM
O/G	OUTGOING
OMC	OPERATIONS AND MAINTENANCE CENTRE
OMU	OPERATIONS AND MAINTENANCE UNIT
OOR	OPERATOR OVERRIDE
O/P	OUTPUT
OP-AMP	OPERATIONAL AMPLIFIER
OPS	OPERATING SUBSYSTEM
OS	OPERATING SYSTEM
OCS	OPERATORS SERVICES COMPLEX
OSU	OPERATIONS SUPPORT UNIT
P	
PA	PROCESS ALLOCATOR
PAR	PROGRAM ADDRESS REGISTER
PC	PERIPHERAL CONTROLLER
PCM	PULSE CODE MODULATION
PF	PARTICIPATING FIRM(S)
PIO	PRIVATE INPUT/OUTPUT
PIPO	PARALLEL IN PARALLEL OUT
PISO	PARALLEL IN SERIAL OUT
PLO	PHASE LOCKED OSCILLATOR
PLL	PHASE LOCKED LOOP
PMOS	P CHANNEL METAL OXIDE SEMICONDUCTOR
POPUS	POST OFFICE PROCESSOR UTILITY SUBSYSTEM
PP	PRE PROCESSOR
PPU	PRE PROCESSOR UTILITY
PROG	PROGRAM
PROM	PROGRAMMABLE READ ONLY MEMORY
PSU	POWER SUPPLY UNIT
PU	PROCESSOR UTILITY
PV	PRIVATE VENTURE
PWB	PRINTED WIRING BOARD
PWFG	PRIMARY WAVE FORM GENERATOR

Q

QA QUALITY ASSURANCE

R

RAM RANDOM ACCESS MEMORY
RB ROLL BACK
RBV ROLL BACK VERSION
REGST REGISTER
REGEN REGENERATOR
REQ REQUEST
RFA RECURRENT FAULT ANALYSIS
RLSE RELEASE
R & M RELIABILITY AND MAINTAINABILITY
ROM READ ONLY MEMORY
RTC REAL TIME CLOCK
RTOS REAL TIME OPERATING SYSTEM
RX RECEIVE

S

SA STORAGE ALLOCATOR
SABRE STORE ACCESS BUS RECORDING EQUIPMENT
SAR STORAGE ADDRESS REGISTER
SCC SIGNAL CONVERSION CIRCUIT
SCE SIGNAL CONVERSION ELECTRONICS
SCM SUBSCRIBERS CIRCUIT ROUTINE TEST
SCR SIGNAL CONVERSION RELAYS
SCRT SUBSCRIBERS CIRCUIT ROUTINE TEST
SDF SOFTWARE DEVELOPMENT FACILITY
SFM SYSTEM FEASIBILITY MODEL
SH SWITCH HANDLER
SIG SIGNALLING
SIPO SERIAL IN PARALLEL OUT
SIS SIGNALLING INTERWORKING SUBSYSTEM
SIU SLIDE IN UNIT
SLT SLOT
SMG SOFTWARE MESSAGE GENERATOR
SMLE SMALL MEDIUM LOCAL EXCHANGE
SMU SUPER MODULE UNIT
SP SCRATCH PAD
SPM SUBSCRIBERS PRIVATE METER
SPT SYSTEM PAGE TABLE
SQA SUPPLIERS QUALITY ASSURANCE
SRU SIGNAL RECEIVING UNIT
SS SPACE SWITCH
SS SUBSYSTEM
SSFMS SUBSYSTEM FEASIBILITY MODELS
SSS SUBSCRIBERS SWITCHING SUBSYSTEM
STP SIGNAL TRANSFER POINT
STU SIGNAL TRANSMISSION UNIT
SU SIGNALLING UNIT
SUPER-OM SUPERVISORY READ ONLY MEMORY
SUPY SUPERVISORY
SVI SERVICE INTERCEPTION
SW SOFTWARE
SWFG SECONDARY WAVEFORM GENERATOR
SYNALR SYNTAX ANALYSER
SYNC SYNCHRONOUS
SYS SYSTEM

T

TBU TERMINAL BUFFET UNIT
TEGAS TEST GENERATION AND SIMULTATION SYSTEM
Tep-1 TELECOMMUNICATIONS EQUIPMENT PRACTICE 1
T GEN TRAFFIC GENERATOR
THP TERMINAL HANDLER PROCESS
T/I TEST INDEX
TIS TERMINAL INTERFACE SUBSYSTEM
TKO TRUNK OFFERING
TLU TERMINAL LOGIC UNITS
TOS TEMPORARY OUT OF SERVICE
TPL TERMINAL PROCESSING LOGIC
TS TIME SWITCH
TS 16 TIME SLOT 16
TSAU TIME SLOT ACCESS UNIT (NOW DIGITAL MULTIPLEX)
T/SET TEST SET
TSI TERMINAL SIGNALLING INTERFACE
TSO TELEPHONE SERVICE OBSERVATION
TTL TRANSISTOR TRANSISTOR LOGIC
TX TRANSMIT

U

UEP UPDATE EDIT PROCESS
ULA UNCOMMITTED LOGIC ARRAY

V

V24 CCITT INTERFACE SPECIFICATION
VCO VOLTAGE CONTROLLED OSCILLATOR
VDT VISUAL DISPLAY TERMINAL
VDU VISUAL DISPLAY UNIT
VF VOICE FREQUENCY

W

WRT WRITE

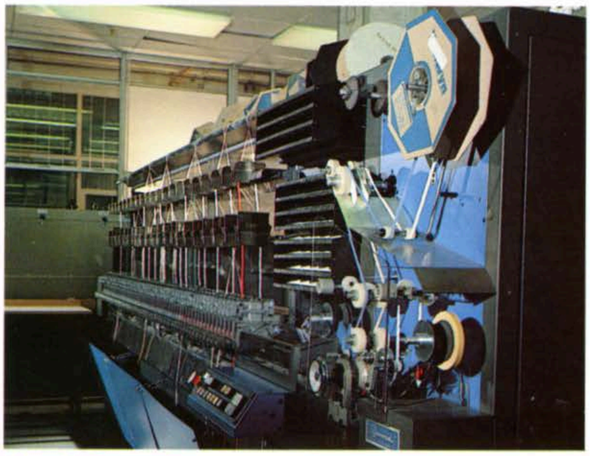
X

X25 CCITT INTERFACE SPECIFICATION
XOS CROSS OFFICE SLOT
X POINT CROSS POINT

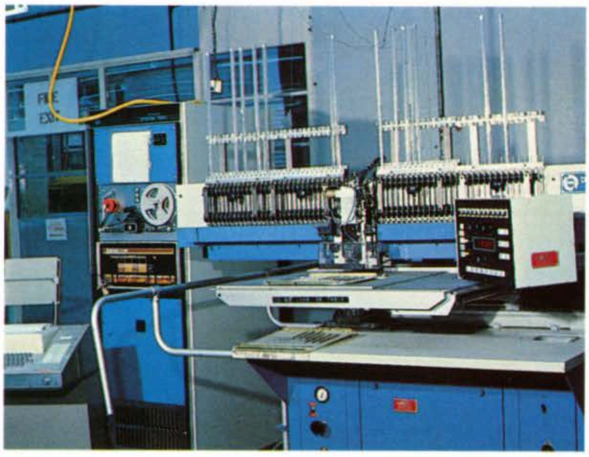
Z

ZSMG Z SOFTWARE MESSAGE GENERATOR

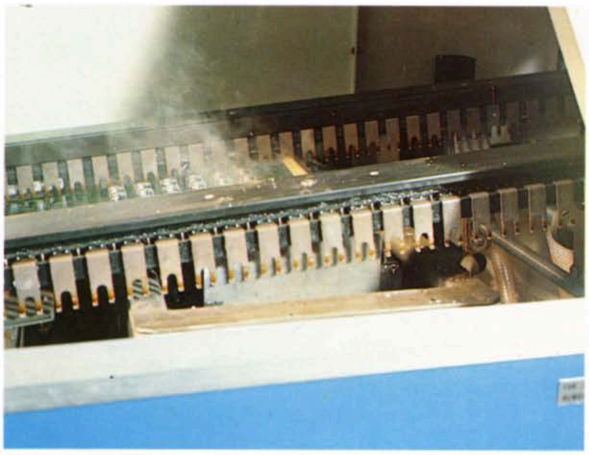
SYSTEM X



Loading axial component onto a sequencing machine prior to component insertion
pic A1



pic A2



Illustrates sliding units soldered using the flow soldering technique
pic A3

Testing of individual sliding units before assembly into sub systems
pic A4

Manufacture of System X Equipment

Components are automatically sequenced by producing a sequential bandolier from the individual component bandoliers received from suppliers. A 60 position sequencer is used for the manufacture of System X equipment. (Figure A1 illustrates this process).

Digitally-controlled automatic component-insertion equipment is used to insert axial lead components into printed boards. The system allows:

Full digital control.
High insertion rates.
Minimum operator intervention
High accuracy
Very low defect levels.
Rapid changeover.
Repeatability.
Minimum operator training.
Rapid updating.

DUAL IN-LINE INSERTION

Approximately 19% of System X components are dual-in-line. Insertion of these components is digitally-controlled and is verified for correctness by sensors at the insertion head. (Picture A2 illustrates this process).

Manual Assembly

Components which cannot be automatically inserted are assembled by means of a semi-automated technique using a computer-controlled machine and information derived from design stages.

Automatic Wiring Machines

With the exception of twisted pairs and power wires, wiring is carried out on fully automatic digitally-controlled machines. This is achieved by software conversion of design information on to paper tape and the system has, therefore, a rapid response to change information. Two types of machine are used: horizontal and vertical.

Semi-Automatic Wiring

Semi-Automatic wiring machines are used in those areas where it is uneconomic or impractical to use more sophisticated machines. They can handle twisted pairs and be altered to different wire gauges with minimum effort.

INSTALLATION AND COMMISSIONING

System X is an evolving system. Five points have emerged from past experiences:

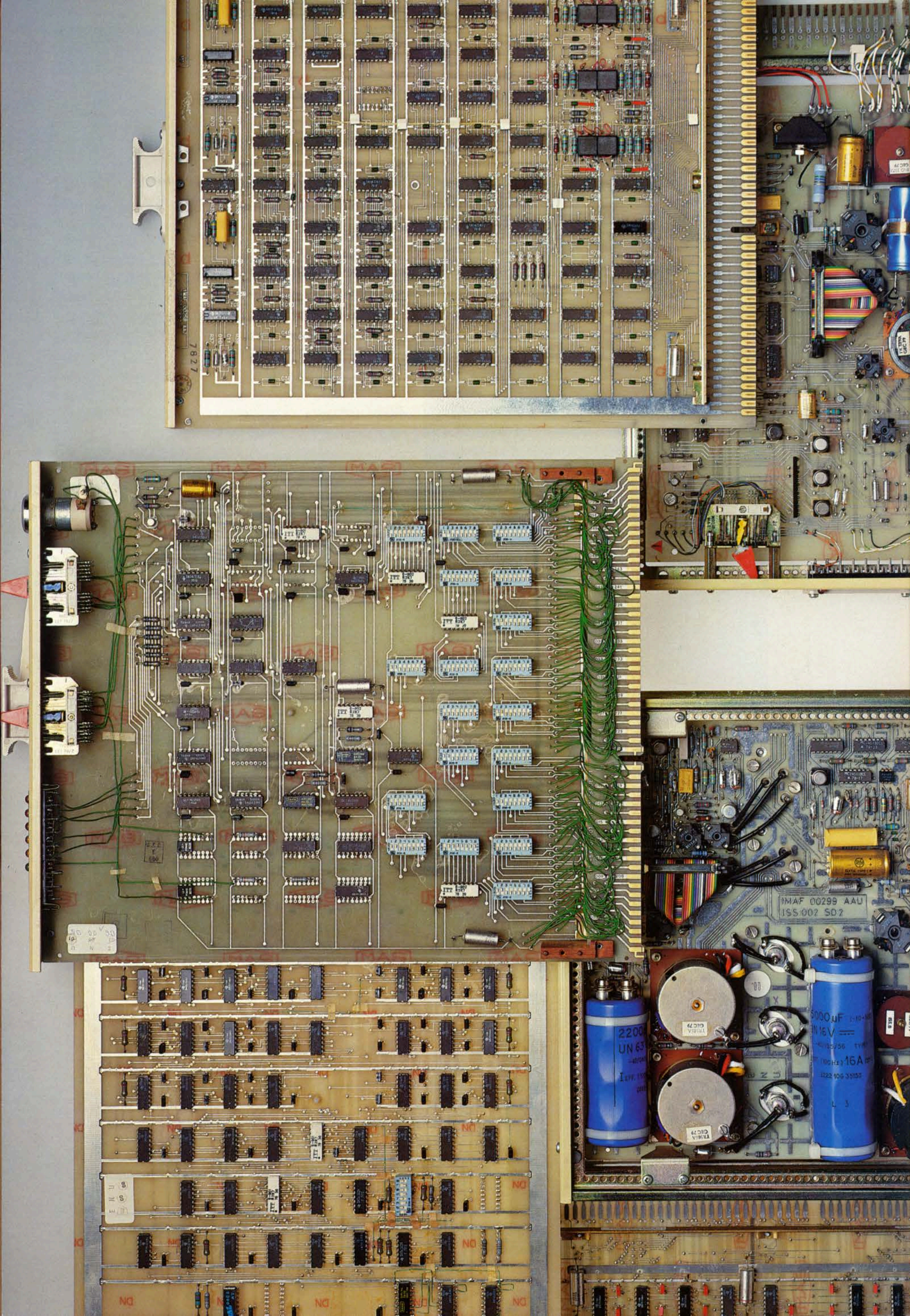
There is a need to reduce installation lead times.

Recognition that provision of a new or extended exchange is a continuous process of activity from the start of manufacture to the bringing into revenue-earning service of the particular exchange equipment.

There is a need to avoid duplication of effort by BT and industry.

That automatic testing techniques are essential.

The application of approved quality assurance scheme is vital for the success of the project.

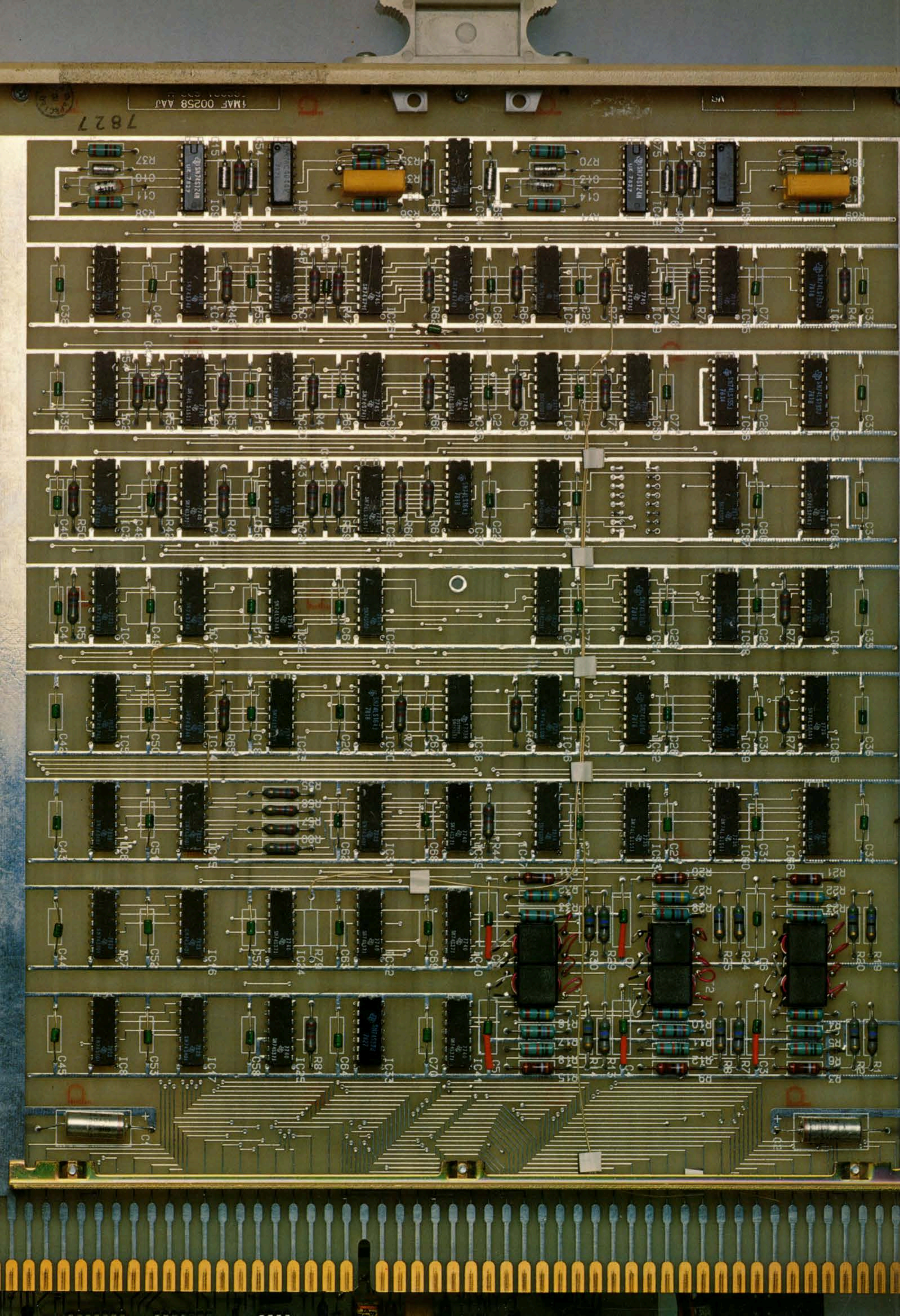


Selection of System X
slide in units

Designed by Richard Downer FSIAD FSTD
Produced by PRD/IC for BTSXL1

Printed in England by Exallprint Ltd, Tunbridge Wells, Kent

PR106 (9/82)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