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EDITORIAL

British Telecom's derived services network was brought into operation in July this year with the opening of the Linkline 0800 and Linkline 0345 services. These services allow calling customers to make calls at nil cost or local call charge fee, respectively. These facilities are particularly useful to organisations which rely on incoming telephone calls for their business; experience has shown that this type of Freefone service can increase telephone reponse as much as 40%. The derived services network has been provided initially as a Strowger-based overlay network, but will ultimately be replaced by a digital network giving enhanced facilities. An article on p. 129 of this *Journal* describes the technical and engineering aspects of the derived services network.

Distribution of the *Journal* to IBTE members and internal subscribers has now been changed over to a centralised computer-based system; this issue of the *Journal* is the first distributed direct to members' home addresses under these new arrangements. In future, recipients will need to notify changes of address to the editorial office by means of the amendment slip provided with each *Journal*.

To date, not all subscribers have completed the registration form and have therefore not received this issue of the *Journal*. A second 'gold form' has been distributed individually to subscribers and your help is requested in encouraging your colleages who have yet to complete their form to do so immediately.

Introducing Automatic Cross-Connection into the KiloStream Network

J. F. MARSHALL, M.SC., C.ENG., M.I.E.E., J. ADAMSON, and R. V. COLE†

UDC 621.394.4 : 681.327.8

In order to improve the operational and maintenance facilities of the KiloStream network, automatic cross-connection equipment (ACE) has been devised to replace the manual routeing flexibility points currently employed. Because ACEs can all be remotely controlled from a central computer incorporating a large database and processing capability, several other improvements to the overall administration of the network become possible.

INTRODUCTION

KiloStream is one of British Telecom's (BT's) fast-growing digital private-circuit services offering customers data rates from 2·4 kbit/s through to 64 kbit/s as well as multi-time-slot signals ($n \times 64$ kbit/s)[1]. A high quality of service is expected in terms of circuit provisioning/rearrangement times, maintenance and overall reliability.

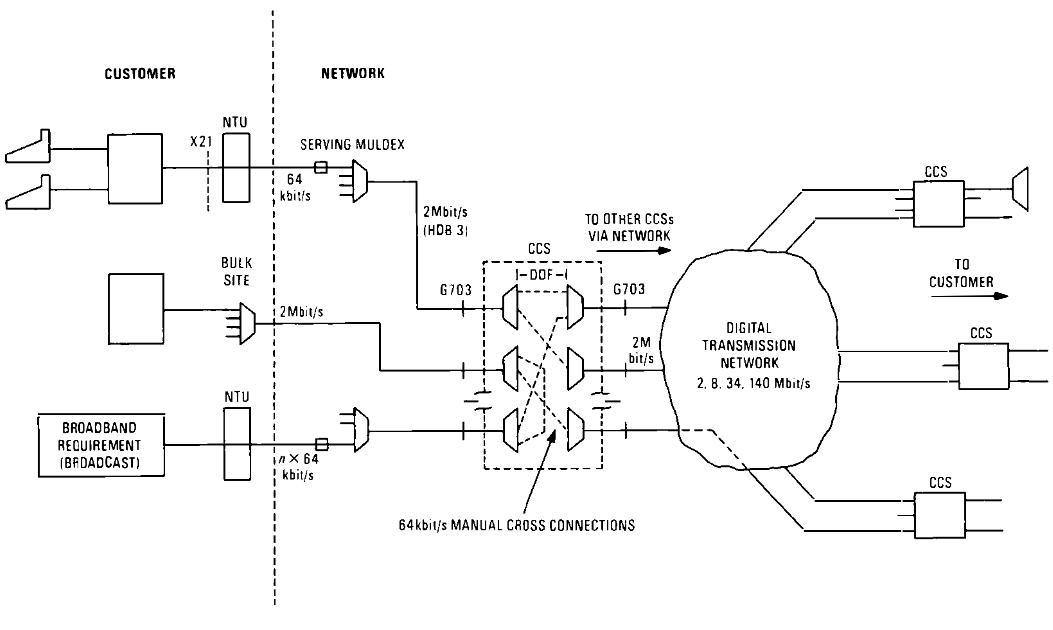
A characteristic of the KiloStream network is the routeing of customer channels over 2 Mbit/s bearers which concentrate at nodes called *cross-connection sites* (CCSs). These enable circuits at the 64 kbit/s channel level, to be connected, and thereby provide the necessary routeing flexibility requirements of the network. Synchronisation is also introduced at these points in order to provide a fully synchronous service. Prior to the availability of an automatic system, the cross-connection facility was provided by demultiplexing the 2 Mbit/s bearers to the 64 kbit/s channel level (co-directional interface) and interconnecting these by using a digital distribution frame. Fig. 1 illustrates the network topology involved.

† Systems Engineering Division, British Telecom National Networks

Because of their critical role in the operation and performance of the network, BT has been eager to automate and enhance the CCS function so that circuit provisioning and maintenance efficiency can be improved and operating costs kept to a minimum. Attention has therefore been focussed on the concept of an *automatic cross-connection equipment* (ACE) which could be remotely controlled from a central administrative point. This article describes the concept, and details the facility definition which has resulted in the development of equipment for the field.

THE CONCEPT OF ACE

ACE is equipment essentially capable of terminating concentrations of 2 Mbit/s bearers and automatically cross-connecting channels within them at the 64 kbit/s level. By replacing existing manual cross-connection sites with ACEs and remotely controlling them from a central point termed a *remote control equipment* (RCE), the potential is introduced for better co-ordination and efficiency of customer



CCS:Cross-connection site DDF:Digital distribution frame NTU:Network terminating unit

FIG. 1—Existing KiloStream network

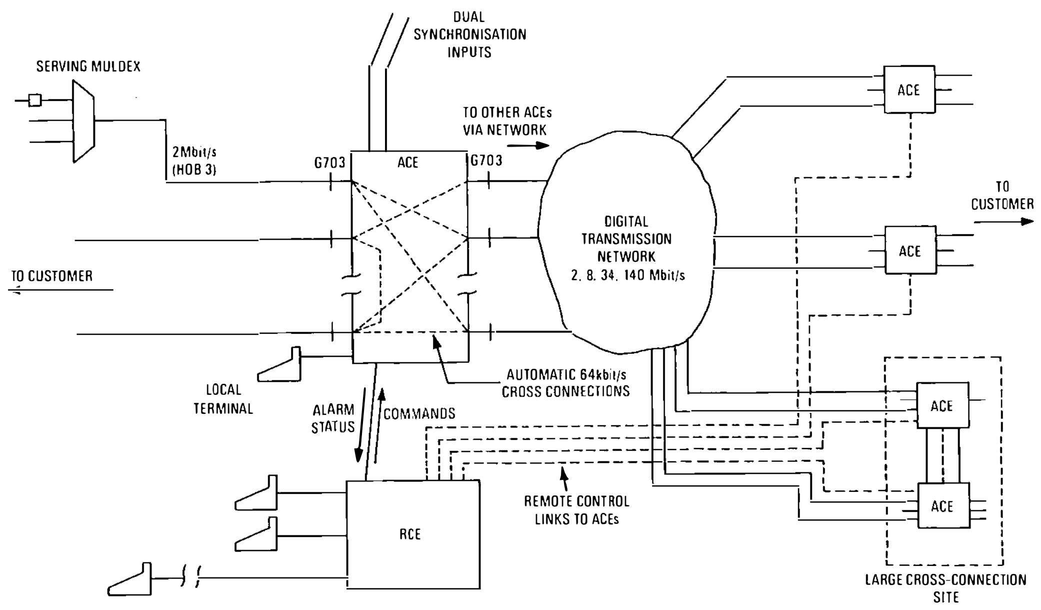


FIG. 2—Replacement of CCS by ACE

circuit provisioning. Fig. 2 illustrates the concept.

By incorporating additional facilities at the ACE, such as the monitoring and reporting to the RCE of circuit alarm status and utilising processing power at the RCE for data manipulation, a significant improvement in overall network management is also possible. The benefits to the main network that can be anticipated from such an arrangement are:

(*a*) circuit routes can be provided more rapidly by means of a single command, thereby eliminating the need for co-ordinated activity at a number of distant connecting points;

(*b*) more efficient monitoring of circuit performance can be achieved since ACEs can detect and report alarm status to the RCE;

(*c*) circuits can be remotely tested by cross-connecting sections of circuits to remotely-controlled test equipment and thus minimise the time to localise circuit faults; and

(*d*) administrative functions are improved by incorporating processing and database facilities in the RCE.

Optimum performance depends very much on the way the ACEs interact with the RCE and on the intercommunication links used. Thus, overall system parameters must be considered carefully in addition to those of the individual equipment.

ACE FACILITIES

The ACE has been specified to terminate a number of 2 Mbit/s digital bearers presented in accordance with CCITT† Recommendation G703 (for coaxial pairs). It is modular in construction, having a minimum equipped size of 16 bothway 2 Mbit/s ports and extendible in modules of 16 ports to a maximum size of 128, in order to meet the different concentration and growth patterns of nodes in the network.

Central to the ACE is a digital switching capability which enables any 64 kbit/s time-slot (other than time-slot 0 (TS0)) on any one 2 Mbit/s port to be cross-connected in the corresponding direction of transmission to any time-slot (other than TS0) on any 2 Mbit/s port. The switch provides full availability and is non-blocking. The switch also has

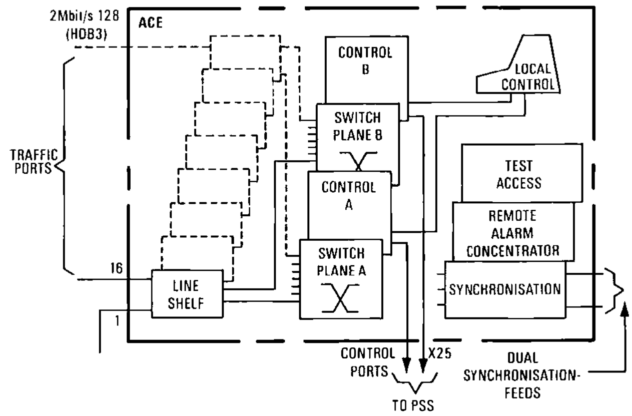


FIG. 3—ACE architecture

the capability of cross-connecting wideband ($n \times 64$ kbit/s) channels (subject to some rules on sequencing of time-slots) as well as configuring unidirectional multi-point circuits (fan-out type). To meet the synchronisation requirements of the service, ACE has facilities for accepting external synchronisation feeds from the network clock. Fig. 3 illustrates the main features of the ACE architecture.

The ACE is operated remotely by instructions entered at terminals associated with the RCE, the remote link interfacing with it at the X25 packet level[2].

A local terminal facility is also provided, primarily for diagnostic purposes. The ACE incorporates a non-volatile memory, which maintains an up-to-date record of the switch cross-connection map. This record is used by the RCE to check its own record of circuit routeings and is the means by which the ACE can reset itself in the event of a power failure.

Channel test-access facilities are achieved by instructing the ACE to cross-connect the selected channel to a designated 2 Mbit/s port terminated with appropriate test equipment (not part of ACE). The cross-connection for this purpose may be either a monitor type (channel not interrupted) or a split type (channel interrupted with both ends connected to the test equipment).

† CCITT—International Telegraph and Telephone Consultative Committee

The ACE incorporates extensive alarm-monitoring and reporting facilities which are intended to aid network maintenance functions. The types of alarm fall into three main categories:

(*a*) those specific to the 2 Mbit/s bearers (for example, the alarms in CCITT Recommendation G732; that is, fault conditions such as loss of signal, loss of frame alignment, excessive error rate etc.),

(*b*) those specific to the KiloStream service relating to remote muldex and customer circuit alarms which are registered on spare bits within TS0, and

(*c*) those specific to the ACE itself reflecting its general status.

All alarm conditions are reported to the RCE; in addition, local station alarms can be activated if this is appropriate to the maintenance strategy being employed.

RCE FACILITIES

The main function of the RCE is to enable personnel at associated terminals to remotely control the cross-connection functions of any ACE in the network so that circuit routeing and maintenance tasks can be efficiently carried out in a centralised manner. The RCE must therefore provide a control interface that is essentially orientated towards circuit administrative personnel whilst maintaining machine-to-machine efficiency.

In view of the size and complexity of the tasks, a significant amount of processor power must be incorporated together with substantial data storage. Remote-control links to the ACEs interface with the RCE at the X25 packet level. Alarm status reports from ACEs are processed by the RCE and recorded on hard-copy printers. Fig. 4 shows the architecture used.

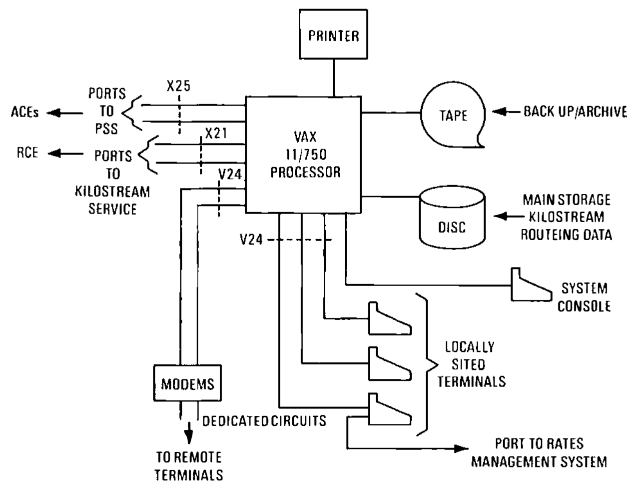


FIG. 4—RCE architecture

An important requisite of the RCE is that it should automate a significant part of the circuit provisioning routine and remove much of the paperwork traditionally involved. This is largely achieved by holding an up-to-date record on the RCE database of all network plant associated with the KiloStream network, including its state of utilisation and a record of all circuit routeings. This, in conjunction with a routeing algorithm, enables the RCE rapidly to plan and connect a route for a particular circuit with the terminal operator needing to input only the serving muldex end points. In the same way, a circuit can be taken out of service just as rapidly, and thus maximises plant utilisation.

The man–machine dialogue has to be flexible in order to adapt to a range of operator capability. This flexibility is achieved by an information prompting system aided by extensive help facilities. Whilst all terminals connected to the RCE have potentially the same level of access, there is a password discrimination system which allows operators to use only those facilities for which they have been authorised.

Suitable organisation and manipulation of stored data within the RCE make it possible for a number of attractive management functions to be performed such as the rapid listing of a circuit route, the listing of all circuits passing through a particular ACE, and the listing of all circuits on a particular 2 Mbit/s bearer, etc.

The alarm status of a particular circuit or 2 Mbit/s bearer can also be monitored dynamically (within the timing resolution of the ACE alarm scanning system and the RCE–ACE communications link).

SYSTEM ARCHITECTURE

ACEs will be located at most nodes in the network where, previously, manual cross-connection frames existed. The size of each ACE will clearly depend on the concentration of 2 Mbit/s bearers at that point. Most will be within the maximum design size of 128 ports. Where a larger size is required, one or more ACEs will be trunked together at the same site to meet the requirement, and this will incur a finite level of blocking depending on the trunking arrangements. Fig. 5 illustrates the system control architecture envisaged.

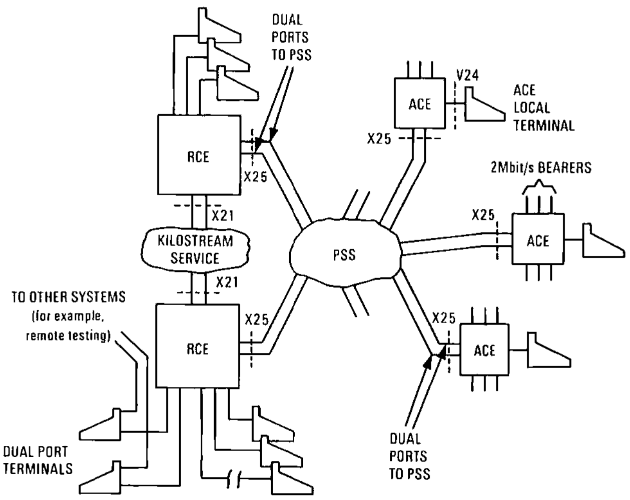


FIG. 5—ACE control network

ACEs communicate with the RCEs via the Packet SwitchStream service (PSS). PSS was chosen because of its fast call set-up times, its inherent rerouteing capability and its suitability for the type of traffic which needs to be carried; that is, frequent short transactions. Each PSS port on the ACEs and RCEs is planned to support up to six logical channels.

Terminals connected to an RCE can be either local or remote (over dedicated circuits). Some of the terminals have two feeds to enable single-point access to two separate systems. Such terminals are being considered for use by maintenance personnel who may need to co-ordinate ACE control with that of remote test equipment.

Although the network could be managed by a single RCE, BT has chosen to have a minimum of two in its architecture, working on a load-sharing basis. In this way, operational availability can be maintained at an acceptable level because a single RCE can take on the full load (at perhaps reduced efficiency) if the other fails. For organisational reasons, and to ensure single RCE working capability, it is necessary for the databases of both RCEs to be kept in step. This is achieved by update links between the RCEs, as shown in the system architecture, and these will be provided over dedicated circuits.

SYSTEM PERFORMANCE

A high standard of performance is required of the ACE system, and this has been specified at the system definition stage.

The operation of ACE must not cause noticeable interference to circuits passing through it. Important parameters associated with digital bearers such as jitter production and immunity[3] have all to be maintained within levels commensurate with CCITT overall circuit performance standards. The ACE must introduce virtually no errors and cause minimal transmission delay (a worst case of 371 μs including aligners is expected).

The switch function must ensure that both digit sequence and octet sequence integrity are maintained. The latter is of particular importance for $n \times 64$ kbit/s services if corruption of data is to be avoided.

Resilience to power failure is an important requirement of both the ACE and the RCE. On restoration of power, the ACE must re-establish the cross-connection pattern that existed immediately prior to the failure. This can normally be accomplished within a period of 15 minutes for a maximum size ACE.

If the external synchronisation feeds fail, the internal clock of ACE must be sufficiently stable to keep slips to an acceptably low level for a period of at least 24 hours (assuming that the rest of the network remains synchronised). Less than 3·5 slips/hour is the specified limit under all conditions of temperature and voltage.

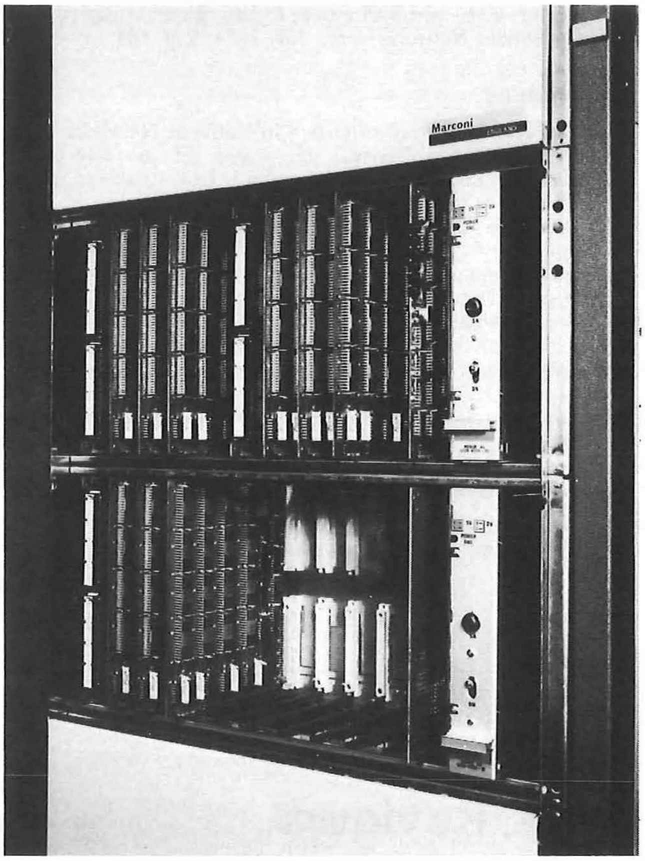
SYSTEM RELIABILITY

Reliability considerations divide into two main areas. Those aspects of the system affecting the performance and availability of the customer's circuit and those affecting system operational availability; that is, circuit provisioning and administrative functions of the network. The former requires a somewhat higher standard of reliability than would be acceptable for the latter. The mean time between failures (MTBF) of a maximum size (128-port) ACE, for example, must be of the order of at least 100 years (a failure being defined as loss of service to 50% or more of circuits). This figure is not unnecessarily harsh if it is borne in mind that an ACE of this size has a traffic carrying capacity commensurate with that of a medium-size telephone exchange in the busy hour. The ACE specification requires that no single component failure is allowed to cause loss of service to more than one 2 Mbit/s system connected to the ACE. This implies quite a high level of duplication within the ACE design including the switch plane itself.

Overall system operational availability is also supported to a significant extent by duplication of links in the architecture, as illustrated in Fig. 3. For example, each ACE is designed to take two independent X25 feeds, as is also the case with the RCE. External synchronisation feeds to the ACEs are also duplicated. Because the network is controlled from two geographically separated RCEs having identical databases kept in step by the inter-RCE links, the consequences of an RCE failing are minimised and database security is significantly improved.

SYSTEM REALISATION

Equipment aimed at meeting BT's performance and facility requirements has been designed and manufactured by Marconi Communication Systems Ltd. and early production



(Photograph courtesy The Marconi Company Ltd.)

FIG. 6—Part of ACE equipment showing the switch plane shelves

prototypes are currently being evaluated. Standard TEP-1E equipment practice is used to house the ACE, with a maximum-size unit taking up a total of four standard height racks. Fig. 6 shows pictorially the section of the ACE rack housing the switch plane. The RCE utilises a VAX 11/750 minicomputer with some 120 Mbytes of disc storage. Subject to satisfactory evaluation, it is anticipated that implementation in the field will commence in late-1985.

THE FUTURE

Enhancements to the existing system design are currently under consideration. These include sub-rate working (32 kbit/s) and suitable interaction with common-channel signalling systems such as the digital private network signalling system (DPNSS), improved statistics packages, and optimising requirements for interworking with other BT databases. A 2 Mbit/s ACE requirement is actively under study.

ACKNOWLEDGEMENTS

Acknowledgement is made to the Chief Executives, Trunk and Specialised Services for permission to make use of the information contained in this article. The authors also thank their colleagues in Marconi Communications Systems Ltd. who have made contributions towards the preparation of this article.

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Biographies

John Marshall is a Head of Group in National Networks Trunk Services Engineering Division. He joined BT in 1964 on the scientific grade at BT's Research Station at Dollis Hill and worked for some time on the development of high-reliability transistors for use in deep-sea repeaters. He was awarded a scholarship in 1966 for a full-time B.Sc. Honours degree in Electrical and Electronic Engineering and returned, in 1970, to the Local Line System Development Department where he was involved on early work with wideband television distribution systems. In 1972, he was awarded a scholarship for a one year M.Sc. course in Telecommunications Systems at Essex University and returned to BT's Transmission Systems Development Department, in 1973, where he worked on audio and miscellaneous repeater station equipment development. In 1981, he was promoted to his present position as Head of Group Network Management Systems where he is responsible for a number of major system development projects including ACE.

John Adamson is a level 2 engineer in National Networks Trunk Services Systems Engineering Division. He joined BT in 1967 as an Open Competition Assistant Executive Engineer and, after a year's training in Liverpool Telephone Area, he joined the FDM Terminal Multiplex Equipment Development Group. There he was largely concerned with the development of the terminal multiplex and carrier generating equipment for the 60 MHz FDM system. On promotion to Executive Engineer, in 1980, he transferred to his present group to work on the remote access and test equipment system (RATES). Two years later, he commenced work on the system definition of the ACE project and is currently working on the project in the prototype evaluation phase.

Roger Cole is a level 1 engineer in National Networks Trunk Services Systems Engineering Division. He joined BT in 1969 as an Improver on exchange maintenance and subsequently transferred to line transmission duties covering audio, HF and datel work. On promotion to Assistant Executive Engineer, in 1978, he was involved in the approval of first generation 30-channel PCM equipment and was later largely responsible for developing BT's requirement for the adoption of a digital sound programme transmission system based on the BBC NICAM equipment. More recently, he transferred within the division to work on the ACE project and is involved in the prototype testing of ACE.

Book Reviews

International Directory of Telecommunications. Edited by Steven Roberts. Longman Group. xv+282 pp. £49·00.

Topics from almost every area of the field of microwave devices have been concentrated into this well-presented book. It covers a broad range of microwave components, measurements and applications. The style of presentation is similar to a survey course, with concise paragraphs punctuated by derivations of relevant formulae and clear diagrams to assist readers in the speedy understanding of the pertinent facts; problems are included at the end of each chapter.

After an introductory chapter, a detailed theorctical analysis of waveguides is presented, and is followed by dielectric waveguides (optical fibres) and planar lines. It is a good example of the relative freshness of this review that planar lines, which include microstrip, receive a significant amount of coverage, as befits their increasing importance. The text of this chapter is liberally interspersed with formulae, most of which use vector notation. A mathematical appendix and complete glossary of symbols helps in making the derivations clear and logical. Resonant cavities are next analysed, and the author concentrates on waveguide and microstrip implementations and mentions dielectric resonators. Active devices described include klystrons, travelling-wave tubes, transistors, transferred electron generators and IMPATTs. Inevitably, some topics have been skipped over; for example, only the parametric type of amplifier is described, the author presumably leaving bipolar and field-effect-transistor amplifiers to the specialised works on those subjects.

Two chapters discuss the measurement of frequency, power, reflections, attenuation and noise figure, and introduce the Smith chart. Scattering parameters are demonstrated in the analysis and the measurement of networks with up to six ports. Scattering parameters are also applied throughout the chapter on passive microwave devices. The devices considered, mostly in waveguides with some in microstrips, include: loads; sliding shorts; attenuators; phaseshifters; reactive obstacles; power dividers; junctions; non-reciprocal devices; PIN diode attenuators and varactor circuits. A chapter on applications briefly reviews radar, communications, heating, material characterisation radiometry, power by satellite and particle accelerators.

This book is to be highly recommended for newcomers to the field of microwaves wishing for a clear and interesting overview of modern devices and the associated theory. The many practical, useful formulae and the directions toward authoritative references will also make this a useful book for the more experienced microwave engineer.

P. G. WILSON

International Directory of Telecommunications. Edited by Steven Roberts. Longman Group. xv+282 pp. £49·00.

This book fulfills well the object of its compiler: to produce a reference companion for use by managers and researchers who want a general overview of the international telecommunication and broadcasting organisations and industries; albeit the content is largely orientated to telecommunications.

The book has 12 chapters, and each relates to a geographical area; for example, Africa, Western Europe (EEC countries), the UK, and the USA. Each chapter contains national statistics on population, area, telephones, radio and television sets in use. The accompanying text to each chapter gives a useful insight into the regulatory bodies within a territory and includes market trends.

The directory section presents profiles of private and public telecommunication companies and authorities in most of the major countries of the world; the inclusion of addresses, telephone and Telex numbers is a welcome feature. As befitting a reference work, the indexing of product areas, registered trade names and names of senior personnel is well presented.

The directory is by no means complete in its listing of companies, nor would any one volume be able to claim such coverage. However, the coverage is fairly comprehensive and includes organisations in over 100 countries. On balance, the book will serve well those who have an interest in the international telecommunication scene, whether as a purchaser, seller or as a user.

D. J. HOLMES

An Introduction to the Analogue Derived Services Network

G. J. ROBERTS, T.ENG., M.I.ELEC.I.E., and R. F. BRUTNELL†

UDC 621.395.3

This article describes some of the technical and engineering aspects of British Telecom's derived services network. Primarily, it explains how the LinkLine 0800 and LinkLine 0345 services are initially provided.

INTRODUCTION

The American Freefone service was introduced during the late-1960s. It is generally referred to as the *800-Service* or *INWATS* (Inward Wide Area Telephone Service). The '800' refers to the three-digit code preceding all Freefone numbers in the USA. INWATS is currently available for both intrastate and interstate calls. In 1983, approximately 994 million intrastate messages were transmitted, together with more than 2000 million interstate messages. In excess of \$22M in goods were ordered over toll-free (Freefone) lines during 1983.

Freefone is now a very important part of what has become known as *telemarketing* in the USA. Telemarketing describes a system of placing or receiving telephone calls to capture orders, to generate sales leads or to provide service to existing customers. The purpose is to make or increase sales in a measurable and cost-effective manner. INWATS is used to receive order calls from direct-response advertising, mail-order advertising and direct mail. In addition, it is used both by individual companies directly for themselves (in-house) and by companies specialising in providing Freefone answering services for other customers. The choice generally depends on the volume and duration of the advertising campaign and the amount of interaction between the operator and caller.

Early market research in the UK during 1982 and the need to provide additional number ranges for network expansion lead to the proposal for British Telecom (BT) to introduce a network suitable to meet growing market requirements and to provide additional services which would be operational in 1985.

In order to meet the objective date, it was decided to introduce initially a Strowger-based network, particularly in view of the amount of spare equipment becoming available from the modernisation of the public switched telephone network (PSTN), which ultimately will be replaced by a digital network giving enhanced features, improved reliability and reduced overheads. In view of the proposed services planned for the new network, coupled with the fact that it would act as an overlay to the existing network, the new network was given the name *derived services network* (DSN).

The DSN was brought into public operation by the Trunk Services Division of BT National Networks (NN) on 29 July 1985 after a three-month network trial. The two services initially available are commercially known as *LinkLine 0800* and *LinkLine 0345*. Additional services are planned to be added at a later date. The LinkLine services allow calling customers to make calls at nil cost (LinkLine 0800) or local call charge fee (LinkLine 0345), irrespective of where they

† Trunk Services Planning and Works, British Telecom National Networks

SUMMARY OF ABBREVIATIONS USED IN THIS ARTICLE

ADSN:	Analogue derived services network	LU:	Low user
ADSSC:	Analogue derived services switching centre	MAC:	Measurement and analysis centre
AMSU:	Analogue main switching unit	MAR:	Miscellaneous apparatus rack
CLE:	Call logging equipment	MN:	Main network
CRPS:	Call record processing system	MSU:	Main network switching unit
DC:	Data collector	MTSS:	Management and traffic statistics system
DCC:	Data collector centre	MU:	Medium user
DDI:	Direct dialling-in	NBS:	National billing system
DDSN:	Digital derived services network	PDU:	Pollable data unit
DDSSC:	Digital derived services switching centre	PSTN:	Public switched telephone network
DEL:	Direct exchange line	RA:	Register access
DSN:	Derived services network	RAC:	Register access circuit
DSNOC:	Derived services network operations centre	RAFS:	Register access full supy
EOSP:	End-of-suite panel	RAPS:	Register access partial supy
FRP:	Fault reporting point	RT:	Register-translator
FS:	Final selector	SCC:	Signal conversion circuit
GOS:	Grade of service	SP:	Service provider
GS:	Group selector	SPLTC:	Service provider line test circuit
HU:	High user	SRS:	Subscriber recording system
IDF:	Intermediate distribution frame	TJF:	Test jack frame
LD:	Loop disconnect	TP:	Translation point
LE:	Local exchange		

are geographically located, with the balance of the call charge being billed to the called customer. LinkLine 0800 and LinkLine 0345 are being marketed via NN's Trunk Services Marketing Division.

This article explains some of the technical and engineering aspects of the analogue derived services network (ADSN) and how it has evolved. Ultimately, it will be replaced by the digital derived services network (DDSN). Primarily, it explains how the LinkLine 0800 and LinkLine 0345 services have initially been provided.

CALL ROUTEING PRINCIPLES

Network Configuration

The ADSN consists of eight Strowger switching centres located at Cambridge, London, Birmingham, Leeds, Manchester, Guildford, Bristol and Glasgow (see Fig. 1). The DDSN will consist of nine switching centres, eight at the analogue locations and a new unit at Liverpool.

FIG. 1—ADSSC catchment areas

Calling customers access the ADSN via their own local exchange (LE). The number dialled by the calling customer passes from the LE to the associated main network switching unit (MSU), where it is examined by register-translator (RT) equipment and then routed to Type 14 RT equipment at the home analogue derived services switching centre (ADSSC). These centres may sometimes be referred to as *LinkLine switching centres* (LSCs) for commercial purposes.

Access to the ADSSC from the originating MSU is either via a dedicated route from the MSU or via the MSU co-located with the ADSSC on a tandem route basis. The decision on mode of access will depend upon the amount of DSN traffic forecast from the MSU catchment area. In either case, the translator equipment at the originating MSU provides the routeing information necessary to access the ADSSC.

Number Examination

The translator equipment at the home ADSSC examines the number dialled, passed to it from the MSU, and determines the ADSSC to which the called customer, known as the *service provider* (SP), is connected. If the SP is connected to the home ADSSC, then the call is passed directly via the switchblock. In circumstances where the SP is served by a distant ADSSC, then the call is passed via a direct link from the home to the distant ADSSC and then onto the SP via the distant ADSSC switchblock. All ADSSCs are fully interconnected. See Fig. 2.

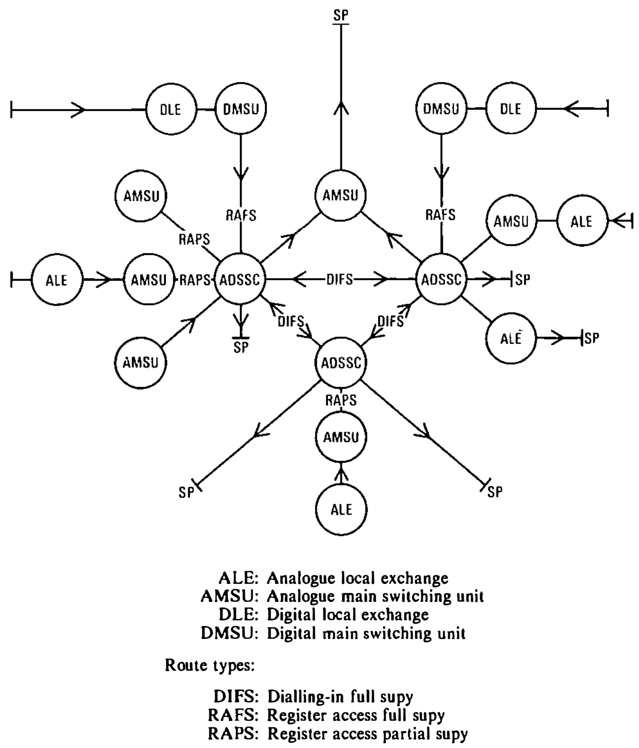


FIG. 2—Network interconnections

Most SPs will be connected directly to their home ADSSC, while some may be accessed from the LE switchblock via normal PSTN circuits. SPs served from a digital derived services switching centre (DDSSC) may be accessed either directly or indirectly.

SWITCHING CENTRE AND DATA COLLECTOR EQUIPMENT

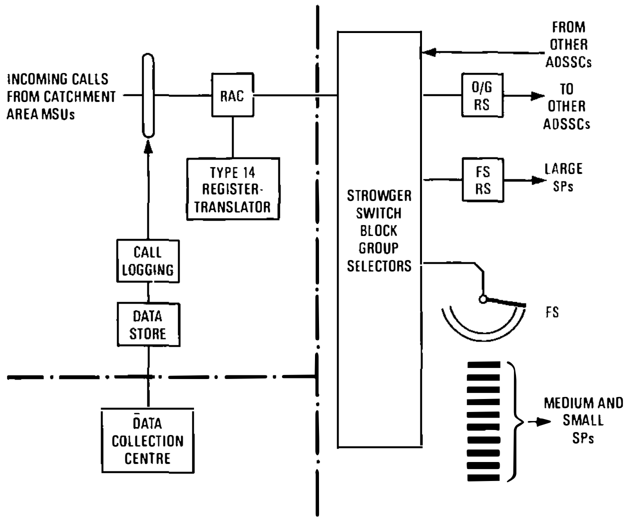
The initial DSN consists of an analogue 2-wire switched system. Each ADSSC comprises three main types of hardware (see Fig. 3):

(*a*) Strowger equipment,
(*b*) Type 14 RT and register access equipment, and
(*c*) call logging equipment (CLE) with a remote data collector (DC).

Strowger Equipment

Hardware

The Strowger equipment has been installed by BT direct labour staff. Essentially, each ADSSC is installed as a self-sufficient switching unit. It incorporates its own common equipment; for example, ringing apparatus and alarm control racks.



FS: Final selector
O/G: Outgoing
RAC: Register access circuit
RS: Relay-set

FIG. 3—ADSSC equipment

The ADSSC switchblock has been configured so that it is a cross between a trunk and a local exchange—an unusual arrangement. Trunk and '2-to-10' (2/10) final selectors (FSs) intermix with subscriber uniselector racks, a fault reporting point (FRP), and Signalling System AC No. 9 (SSAC9), SSAC14 and SSAC15C equipment. The standard Strowger exchange support equipment, namely routiners, traffic recorders, test jack frames and test numbers, have also been provided.

Equipment Quality

Most of the Strowger equipment used is recovered equipment that has been extensively restored. This renovation has involved changing vast quantities of relay coils, spring sets, wipers and wiper cords. In situations where the demand for Strowger equipment cannot be met by reuse, the outstanding needs have been met by ordering new equipment from manufacturers. All Strowger equipment has been installed to existing high BT standards using current documentation.

Type 14 RT Equipment

Processor Hardware

The Type 14 RT installation at each ADSSC consists of processor and register access circuit (RAC) racks mounted in TI0000 equipment practice. Each ADSSC has been provided with a minimum of two processors connected together for operational purposes. Each processor constantly communicates with adjacent processor racks via a left and right highway. In a two-processor ring installation, the left and right highways from one rack are connected to the other processor. At sites with three or more processors in one ring, the left and right highways from one rack are connected to different adjacent racks. A ring can consist of a maximum of 15 interconnected processors.

Each processor rack houses 96 signal conversion circuits (SCCs) and the associated support equipment including the RAC routiner and access relays. Initially, the processors were supplied with 64 Kbytes of memory store (stage 1) to be used for the real-time operating system (RTOS), code examination/expansion and routeing store.

System Enhancement

A stage 2 processor enhancement was added prior to the opening of the network. This increased the memory store to 128 Kbytes. The additional memory is used to increase the code-expansion and call-routeing store capacity of the processor. Stage 2 enhancements increase the numbering range of the network and improve flexibility.

Teletypewriters

Each processor ring has remote and service teletypewriter access points. The remote position receives all print output from the system, while the service position is used for general man–machine communication, including RAC routiner control, and system faulting.

Power Requirements

The processors at each ADSSC are installed in a separate suite to the RAC equipment. Each suite has its own end-of-suite panel (EOSP) where all rack −50 V power and alarm cables are interfaced with the main exchange system. Processor suites operate from a −50 V power supply, all other rack supplies being internally derived from −50 V. RAC suites also operate from a −50 V supply, with all other rack supplies being derived from −50 V. Additionally, RAC racks are provided with +50 V cabling to the EOSP so that positive battery metering can be introduced if required.

RAC Rack Hardware

Each RAC rack houses 128 RACs and associated equipment including access switches. The access switches, of which a maximum of 16 are provided per rack, are grading cross-points, whereby the common equipment (SCC) outlets from the RAC (coded *AA* to *AF*) are connected through to the processor SCC grading (see Fig. 4). Each RAC has 64 access switch outlets which are graded to processor SCCs via jumpers on the ADSSC intermediate distribution frame (IDF).

The operational identity of each RAC, for example, 2- or 3-wire access, partial or full supervisory (commonly referred to as *supy*), is provided by discrete strapping on each circuit edge connector. A software bit map in each processor contains details of each RAC edge connector strapping for routiner test purposes.

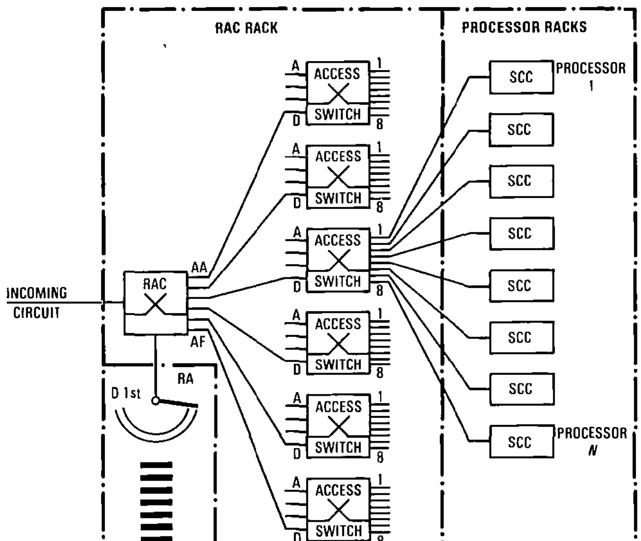


FIG. 4—RAC-to-SCC grading principles

Call Logging and Data Collector Equipment

The call logging and billing systems for the ADSN comprise three major subsystems:

(*a*) the call logging system, comprising the ADSSC call logging equipment (CLE) and the data collector centre (DCC), which were provided by Telesciences Inc. of New Jersey, USA;
(*b*) the call record processing system (CRPS), which was developed by Cincinnati Bell Information Systems of Cincinnati, USA; and
(*c*) the national billing system (NBS).

Call Logging Equipment

The CLE is mounted on three miscellaneous apparatus racks (MARs) and consists of Subscriber Recording System (SRS) 2020A terminals and Pollable Data Unit (PDU) 20 equipment. Each SRS 2020A is directly connected to a maximum of 400 incoming analogue main switching unit (AMSU) or digital main switching unit (DMSU) circuits and monitors the incoming positive, negative and tariff control signal (TCS) leads of the RACs at the ADSSCs. See Fig. 5.

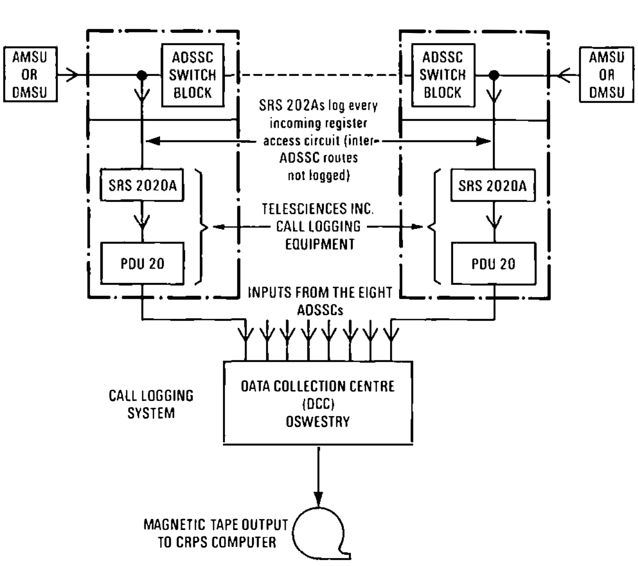


FIG. 5—ADSN call logging system

The SRS terminals compile individual call events into call records. Call records contain 23 fields with information on call type, recording office, answer indicator, answer time, terminating number, chargeable duration etc. The SRSs perform certain vets on all records, and, if a field is out of range or corrupt, it is marked as invalid. In addition to assembling call records, the SRS terminals constantly execute self-diagnostic routines and generate error messages if any anomalies are detected.

The SRS terminals are equipped with a maintenance port to allow DSSC staff to monitor SRS port traffic, isolate hardware failures etc. The SRSs are duplicated for security. Each SRS has a memory storage capacity for 2000 call records and can handle a throughput of at least 9000 calls per hour. The data is retrieved from the SRSs, via the appropriate PDU, on a 2400 bit/s serial communications link.

PDUs are duplicated for security, and polling commands which are sent automatically and continually by each PDU cause the download of data from the SRSs to both PDUs. A PDU can cater for a maximum of four pairs of SRS terminals and hence control polling of data from up to 1600 circuits. The PDU blocks and compresses the data received from the SRSs prior to storing the call records on its 80 Mbyte Winchester disc. This allows for a maximum of three days data storage of the Year 2 (1986/7) forecast of call records.

The PDU teletype allows staff to perform certain PDU and SRS administrative functions as well as printing out alarm messages, long duration calls, abnormal events etc. for maintenance action. The data stored on the PDUs at the eight ADSSC sites is downloaded to the centralised data collector (DC) on command from the DC. Communication links to the DC are duplicated: the primary link is a dedicated line with a synchronous transmission speed of 4800/9600 bit/s, and the secondary link is a 1200 bit/s asynchronous PSTN dial-up line. Modems for these links, which were provided by BT Business Systems, are fitted on a fourth MAR, adjacent to the CLE.

The DC, which is located at NN's Trunk Services Operations and Maintenance Division headquarters in Oswestry, is also duplicated. It can poll each PDU from once every 24 hours up to a maximum of once every 15 minutes depending upon how much data is to be retrieved (polling normally takes place hourly). The data is stored on the DC's 400 Mbyte discs. The DC performs vets on the incoming data, and the system administrator (SA) at the DCC has the facility to correct call records which have been written to the DC's error file. The SA is responsible for polling schedules and a host of functions which control data acquisition and process collected data.

Once the DC has collected a full day's output from all ADSSC sites, it reformats the SRS call records, adding details such as recording office (for example, ADSSC) code, and writes these formatted call records to the primary tape (one or more tapes depending upon DCC procedures or data levels). An archive copy is created and the primary tape(s) is dispatched to the CRPS computer.

SWITCHING CENTRE DESIGN CRITERIA

Traffic Levels

Three categories of SP have been identified, known as *low*, *medium* and *high users*. Low users (LUs) have a maximum of five LinkLine circuits, medium users (MUs) have a maximum of 60 LinkLine circuits and high users (HUs) have in excess of 60.

The Type 14 RT equipment installation, number of processors and RACs, and the associated Strowger switchblock dimensioning at each ADSSC are based directly on the forecast. This includes group selectors (GSs), FSs, SP signalling equipment, MSU-to-ADSSC, and inter-ADSSC circuits.

Traffic Recording

Traffic Recorders No. 8A (TR8As) are provided at each ADSSC to provide time-consistent-busy-hour traffic-recording (TCBHR) facilities. All main switching equipment within the ADSSC is connected to the traffic recorder. This includes the SCCs and RACs to the Type 14 RT which have a separate traffic recorder (TR) lead. Facilities are provided to permit traffic recording on individual SP circuits.

Grading

All ADSSC Strowger switchblocks are provided with standard O'Dell gradings by using the appropriate traffic capacity tables, with consideration being given to the switch outlet capacity; for example, 20 or 24 etc.

Each combination of Type 14 processor racks and associated RAC racks, for example, two processors to five RACs or three processors to 10 RACs, has a specially designed common equipment grading. These gradings are unique to a particular installation due to the varying number of SCCs and access switches available. See Fig. 4.

Traffic Meters

Each ADSSC is provided with the usual configuration of overflow meters; for example, GS and '11-and-over' (11/-) FS levels. Additionally, RAC call count meters (CCMs) are provided in order to register the number of LinkLine 0800, LinkLine 0345 and ineffective calls.

Intermediate Distribution Frame

All Strowger equipment within the ADSSC is cabled directly to the exchange IDF and interconnected via jumpering in order to provide maximum equipment flexibility. In addition, conections from the penultimate selectors to the FSs are via the IDF—a change to Strowger LE practice. Type 14 processors and RAC equipment are all cabled to the IDF for grading flexibility and interconnection.

SIGNALLING SYSTEMS

Main Network Signalling Systems

Each ADSSC has incoming and outgoing loop-disconnect (LD) signalling systems similar to those provided in MSUs; for example, SSAC9, SSDC2 and pulse-code modulation (PCM). The ADSN does not have inter-register SSMF2 capability.

Incoming and outgoing main network (MN) ADSN circuits can be either 2-, 3- or 4-wire presented to the ADSSC. The signalling system chosen will depend on the hardware available at each terminal switching node, the line plant and the circuit transmission loss, considering networking standards.

Incoming MN ADSSC circuits are generally configured as P-wire forward holding within the switchblock and outgoing MN circuits as backward holding. The incoming-circuit forward holding condition is provided by the signalling system unit/relay-set or the RAC.

Analogue Service Provider Signalling Systems

SPs are accessed from ADSSCs by using either direct dialling-in (DDI) principles or direct exchange line (DEL) signalling conditions; for example, AC ringing, loop answering, loop calling, and earth calling.

Various arrangements are available at each ADSSC to cater for DDI facilities. If the SP requiring DDI is within unamplified LD signalling range of the ADSSC, then junction guard or DDI relay-sets can be used. A maximum of 70 DDI relay-sets can be mounted on a standard 1372 mm (54 inch) Strowger relay-set rack. In situations where the SP is outside the unamplified LD range, the individual requirements are examined and arrangements made or equipment supplied as necessary.

SPs that use DEL accessing principles can be served from the ADSSC via a direct 2-wire circuit to their premises, provided that they are situated within the catchment area for unamplified signalling systems, considering network transmission standards. The DEL can be provided with loop or earth calling capability.

In situations where the DEL SP is outside of the ADSSC unamplified signalling area, then initially SSAC14 or SSAC15C can be used. If the SP requires loop calling, then SSAC14 or SSAC15C can be used, but, if the SP requires earth calling, then modified SSAC14 serves the purpose. In some exceptional circumstances, 4-wire amplified circuits can be provided by using DC phantom signalling. Ultimately, SSAC15E will be used to meet the needs of SPs which cannot be met by SSAC15C.

SSAC14 equipment is mounted on a standard 1372 mm Strowger relay-set rack, and comprises Part 1 and Part 2 relay-sets. A maximum of 40 circuits can be mounted on a single rack.

SSAC15C equipment is mounted on a standard Type 62 rack. Each circuit comprises one slide-in-unit. A maximum of 72 circuits can be mounted on a single rack. SSAC15E equipment, which is expected to be available in early-1986, will be mounted on TEP1E rack practice.

Digital Service Provider Signalling Systems

It will be possible to transfer SPs connected to an ADSSC via a particular signalling system to the DDSSC with the same type of signalling system. DDSSCs are being planned to support all SP signalling systems that are being introduced with the ADSSC. Additionally, as the PSTN is modernised, SPs may be accessed via the digital public network, from the DDSSC, in preference to specifically dedicated SP-to-DDSSC links.

TRANSMISSION STANDARDS

The ADSN has been planned to operate within the present 1960 analogue transmission plan. In most circumstances, since the SP will be directly connected to the ADSSC, the limiting transmission loss will be well within the maximum permitted by the plan. A loss of 1·5 dB has been allowed for each switching node.

The planned loss between the analogue calling customer and the home ADSSC, considering each separate link and including the loss within each switchblock, is shown in Fig. 6—a maximum of 22 dB. Calling customers that access their home ADSSC via digital exchanges will experience a lower loss.

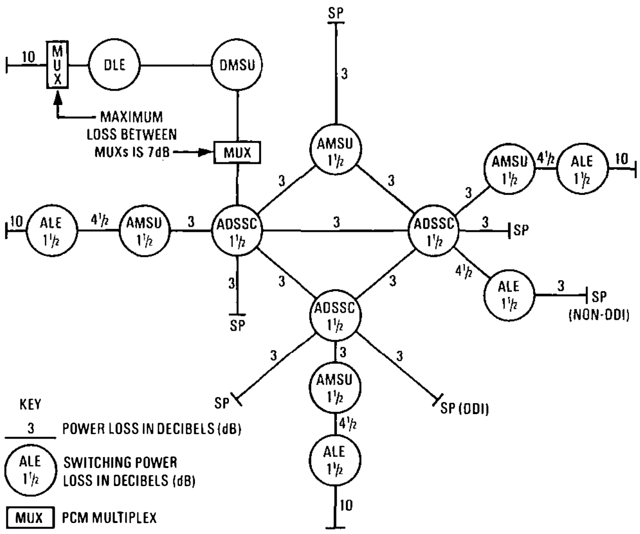


FIG. 6—Transmission plan

If the SP is connected directly to the home ADSSC, then this link adds another preferred maximum loss of 3 dB. Where possible, most ADSSC-to-SP links have a loss of not greater than 3 dB.

In some circumstances, SPs may be accessed via their own LE multiple on special links between the ADSSC and their LE. The loss between the SP and the ADSSC may exceed 3 dB in these situations, but still be within the maximum end-to-end link loss of 42·5 dB. This method of serving SPs from their home ADSSC is used only in expedient situations.

SPs accessed by DDI principles must be served by a 3 dB link from their home ADSSC, thereby allowing for a margin of transmission loss within the SP's network.

All MSU-to-home-ADSSC and inter-ADSSC links use trunk circuits with a link loss of 3 dB.

NETWORK NUMBERING

Initially, only national number group (NNG) codes 800 and 345 are being used by the DSN, for LinkLine services.

Service Provider Numbering

The three categories of SP can be related to the type of access they are given from the ADSSC switchblock as follows:

SP CATEGORY	ACCESS
High user	GS level (DDI or non-DDI)
Medium user	11/- FS
Lower user	2/10 FS

All SPs are identified by nine-digit numbers, excluding the initial digit 0. Calls to a particular HU SP switchblock access point can be routed without examination of the full nine-digit number. This is highly desirable in order to reduce post dialling delay (PDD) times and to minimise the requirement for Type 14 RT code expansion store (the area in which codes are translated into routeing information), since it is limited in size and directly relates to the number of SPs the ADSN can accommodate.

The switchblock access points for SPs are termed *translation points* (TPs) and are identified by significant codes derived from the SP's numbers; for example, 800 262 XXX for an LU. To meet this requirement, certain ABCDEF digit combinations have been made applicable to TPs at specific ADSSCs. See Fig. 7.

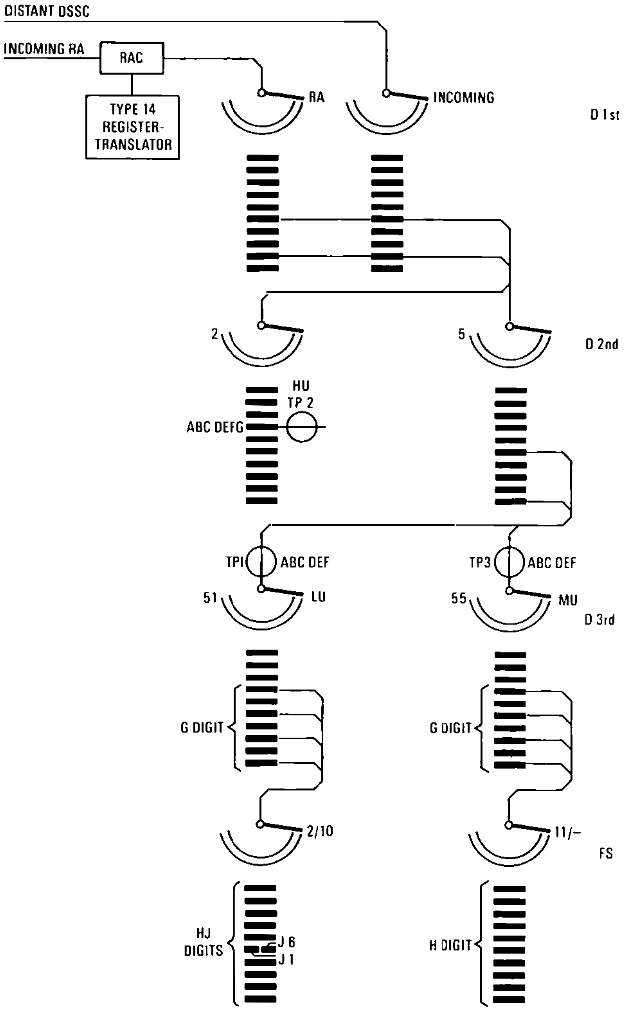


FIG. 7—ADSSC trunking arrangements for terminating calls

Low-User Service Providers

All LU SPs are served from 2/10 FSs, with their TPs being at the rank of the third selectors serving the FSs on which the SPs are terminated. This means that the call can be routed to that TP by examining the ABCDEF digit combination only.

As the level from the third selector to the 2/10 FS needs to be identified, in addition to the FS level and outlet which serves the SP, it is necessary to use the GHJ digits. The GHJ digits must, by definition, equate to the third selector levels and FS outlet required since they are repeated beyond the TP. For example, an SP served from third selector level 511, FS level 5 outlet 6 must have GHJ digits of 156. Consider the following example:

SP's Number	800 584 156	Full nine digits
Significant Code	800 584	Translated to reach TP1
Repeated Digits	156	Repeated beyond TP1

Since an LU SP can have a maximum of five lines, then, considering the principles applied to the switchblock design, two LU SPs can be served from an FS level by using outlets 1 and 6. All J digits for LU SPs are 1 or 6.

Medium-User Service Providers

These are treated in exactly the same way as LU SPs for routeing purposes and number allocations with one small difference. Since an MU SP is served by 11/- FSs, the J digit is not required for outlet selection and is used purely as a filler digit.

High-User Service Providers (Non-DDI)

HU SPs are served from second or third group selector levels within an ADSSC switchblock and hence do not require repeated-digit techniques needed for LU and MU SPs. Under these circumstances, the TP for an HU SP is the level serving that SP and is identified by a significant code comprising the ABCDEFG digits.

Consider the following example:

SP's number	800 200 200	Full nine digits
Significant code	800 200 2	Routes to TP2
Filler digits	00	Absorbed

This allows an ABCDEF combination to be used at all ADSSCs for HU access, providing the G digit differs. Consider the following example:

800 200 200 routes to ADSSC A level 27
800 200 300 routes to ADSSC B level 218

A typical trunking diagram is shown in Fig. 7.

Universal Access Numbers

An HU SP can have a maximum of eight individual answering points, one per ADSSC catchment area, all associated with the same number; the digits dialled to access the appropriate SP answer point are known as a *universal access number* (UAN). This is achieved by examining the HU number at the home ADSSC, by the Type 14 RT equipment, and routeing the caller to the SP answer point within the network.

An SP may wish to have two regional answer points, situated at London and Manchester, both served with a UAN; for example, 345 110110. Calling customers served by the ADSSC at Bristol, Cambridge, London or Guildford would be routed to the London answer point, while those served by Birmingham, Glasgow, Leeds or Manchester would be routed to the Manchester answer point.

Each ADSSC is provided with two test UANs which terminate on equipment within the home switchblock.

High-User Service Providers (DDI)

A DDI SP is, by definition, an HU since access is provided from a GS level. The SP's TP is identified by a significant-digit code based upon either ABCDE, ABCDEF or ABCDEFG digit combinations. The remaining digits FGHJ, GHJ, or HJ are repeated beyond the TP to the SP as required. An ABCDEXXXX code gives a 10 000 DDI number group, while an ABCDEFXXX code gives a 1000 DDI number group. Each specific DDI SP number requires individual network engineering.

MAIN NETWORK SWITCHING UNIT REQUIREMENTS

Each AMSU and DMSU resides within an ADSSC catchment area and has access via a single link MN route to its home ADSSC.

AMSU

The AMSU access is from selector levels or, in the case of crossbar units, from router switch B (RSB), office route switch or junction route switch outlets.

Route Configuration for Strowger Exchanges

Each AMSU has two access points from its switchblock to the ADSSC route. These access points, known as *main* and *peak routes*, are made up of circuits which form the access to the ADSSC. In the case of a Strowger unit (TXS) having 30 circuits to its ADSSC, the main route consists of 20 circuits specifically for the main route, and the peak route consists of 10 circuits shared with the main route. In order to facilitate this, two levels must be allocated at each TXS, one for the main and one for the peak. The main level has access to all circuits on the route to the ADSSC, and the second level allocated, the peak route, is graded with the specified number of outlets tied to the 'backend' of the main level.

Route Configuration for Crossbar Exchanges

In crossbar units (TXKs), it is not possible to tee outlets directly and therefore the configuration of the routes differs from the TXS variant. In the TXK situation, the main route is allocated a specified number of circuits to the ADSSC which are connected to discrete switch outlets in the TXK. The peak route is allocated its own number of outlets in a similar fashion to the main. The main route is then allowed to 'alternative route' to the peak route thus allowing the main to access all circuits available on the route to the ADSSC.

Derived Services Network Route Access Control Facility

The routeing configurations described above allow implementation of the DSN route access control facility (DRACF). Since NNG codes 800 and 345 are initially being used, all SP numbers are derived from these two codes. If a particular SP generates very high levels of traffic, it may cause access problems to all other SPs. In consequence, it is necessary to try and restrict this type of traffic to improve the resilience of the network. By expanding the NNG code to fifth-digit expansion at the AMSU, it is possible to route specific 800DE and 345DE digit combinations to either the main or peak access points. Thus, if a particular SP's traffic is causing congestion or other access problems to all other traffic from a particular unit, then that SP's ABCDE code will be translated to route via the peak access point, and this improves the grade of service (GOS) to those codes still routeing via the main access point.

3–6 Minute Time-Out at AMSUs

On a LinkLine 0800 ADSN call, a supervisory answer condition is not returned to the originating RT unit; therefore, the *called subscriber answer* (CSA) condition, even though the call has been successful, does not reach the originating AMSU switching equipment, which would time-out and release after 3–6 minutes. It has been necessary to modify all AMSUs so that the time-out facility for unanswered calls is removed.

Fourth- and Fifth-Digit Expansion

Because of the requirement for fourth- and fifth-digit expansion at all AMSUs, it may be necessary to enhance the existing translation expansion capacity at Type 2, 3 and 5 RT units. This is achieved by the provision of Equipment Code Expansion No. 2A, or equivalent, which augments the existing capacity by providing additional fourth- and fifth-digit expansion relays.

SERVICE PROVIDER AND NETWORK FACILITIES

Service Provider Line Test Circuit

Each SP non-DDI line terminates on a subscriber's uniselector circuit within the ADSSC. Outlets of the uniselector grading are connected, via the ADSSC IDF, to a service provider line test circuit (SPLTC) which, when seized, returns continuous ringing tone to the SP. Nine SPLTCs are mounted on a single strip mounted set with a maximum total of 378 circuits on a single Strowger MAR. This facility enables the SP to make a seizure test of its circuit and ensure that communication with the ADSSC is possible.

Testing Arrangements

Each ADSSC has an associated fault reporting point (FRP) test desk. The test desk has access to all SP links connected to the ADSSC for testing purposes. Test access may be provided via

(*a*) trunk test FSs,
(*b*) ordinary test FSs for 2/10 and 11/- ranks, and
(*c*) test jack frames (TJFs),

depending upon the type of SP (LU, MU or HU) and method of connection to the ADSSC; for example, directly on an unamplified 2-wire circuit or via an amplified carrier system such as SSAC14.

CALL CHARGING AND BILLING

LinkLine call charging can be divided into two main areas:

(*a*) calling-customer charging, and
(*b*) service-provider charging.

Calling-Customer Charging

Normal Strowger call answer supervisory conditions, for example, line polarity reversal on answer, are used within the ADSN. An answer condition is extended from the ADSSC equipment directly serving the SP, for example, final selector, at the appropriate point during the call sequence. This answer signal is detected by the RAC at the home ADSSC via the dialling in full supy (DIFS) circuit from the distant end if appropriate.

If the call requires charging at the calling customer end (for LinkLine 0345 traffic), then the answering supervisory signal is repeated by the RAC to the originating AMSU via the register access partial supy (RAPS) circuit. The AMSU then applies the appropriate metering rate, as determined

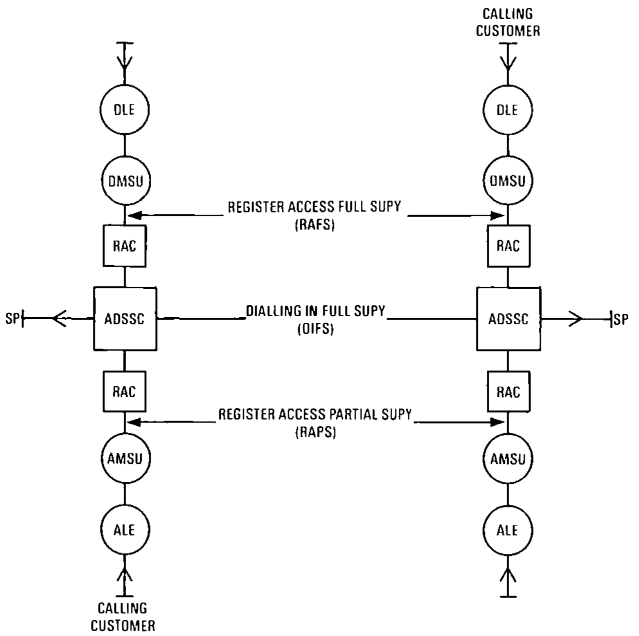


FIG. 8—Principles of call charging

by the RT at the unit: local for LinkLine 0345 to the calling customer. See Fig. 8.

If the call is free to the calling customer, and it originates via an AMSU, then the RAC at the home ADSSC suppresses repetition of the answering supervisory signal to the AMSU via the RAPS circuit, the 3–6 minute time-out facility for unanswered calls having been removed at the AMSU. The calling customer is not charged for the call. Additionally, the RAC has a three-minute time-out facility which clears forward equipment on unanswered calls. This prevents long-duration unanswered calls from congesting the network.

If the call originates via a DMSU, then the RAC at the home ADSSC repeats the answering supervisory, via the register access full supy (RAFS) circuit to the originating DMSU. The digital network then inhibits, as necessary, the metering signal from being passed on as a charge to the calling customer.

All calls within the ADSN are set up under control of the calling party via appropriate translator equipment. First-party clearing is not provided as a feature of the network.

Service Provider Charging

All MSU incoming register access (RA) circuits to the ADSSC are connected to an RAC. Additionally, the incoming circuit positive and negative leads, are connected to the CLE. A third lead, TCS, directly connects the RAC to the CLE. The incoming digits to the RAC are monitored and recorded by the CLE for billing purposes. Line supervisory conditions, namely incoming speech pair polarity, do not effect CLE operation. The RAC applies a full earth condition to the TCS lead whenever it detects a line reversal, SP supervisory answer signal, condition. This earth is maintained throughout the duration of the line reversal condition, and is removed in sympathy with the SP answer condition. The CLE monitors the TCS lead to determine billing details via the SRS port.

Call Record Processing System (CRPS) and National Billing System (NBS)

The primary function of the CRPS is to price calls and to pass SP charging information to the NBS or to BT Local Communications Services' customer services system (CSS) so that the SP can be billed.

As mentioned earlier, the call-logging system DC writes call records, after processing and formatting, to a primary magnetic tape. A copy is kept at the DCC and the primary tape is dispatched to the CRPS computer.

The tape(s) from the DC is read into the CRPS computer and the call records are priced by using a set of tariff and charge-band tables etc. appropriate to the day's data being processed. Once all call records have been priced, they are sorted and accumulated according to the SP's telephone billing number (there may be more than one if the SP has specified a different billing number for each of its operating centres), and the SP NBS or CSS summary records are sorted into the appropriate billing areas. Once sorted, this data is written to tape and then transported to the relevant billing centres. See Fig. 9.

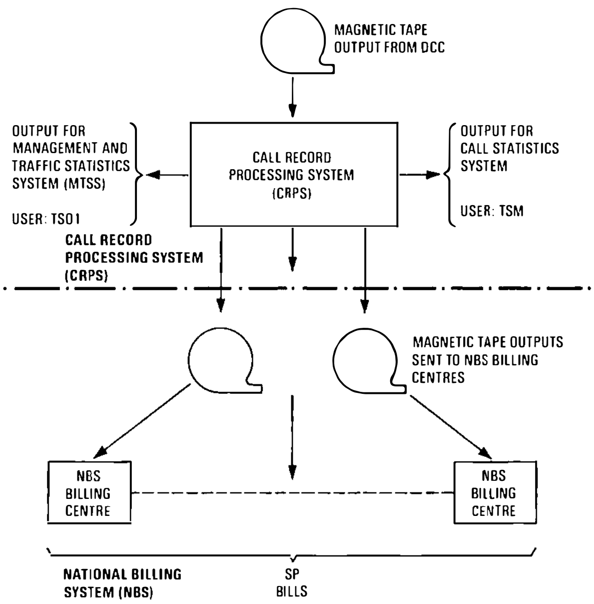


FIG. 9—ADSN billing system

This data is read into the CSS or the NBS, is processed by the system and appears on the SP's next telephone bill. Errors detected by the NBS are sent back to the CRPS system administrator and stored on a reinput file to have the error corrected, or to be purged if this is not possible.

All inputs and amendments to tables connected with call pricing have to be verified by the tariff duty and all transactions produce an audit output.

The CRPS performs many other functions. SP provision is dealt with from the initial number allocation, where marketing staff interrogate the system to reserve an SP number and enter the customer's details. This process is flagged to the Operations and Maintenance Division headquaters staff, who then input all the engineering information for the SP, and commence with the provision of service.

Once the SPs are operational, their traffic is monitored by using the management and traffic statistics system (MTSS). The MTSS allows monitoring of an individual SP's traffic, effective and ineffective calls etc. down to hourly blocks and, if these are outside preset limits, reports are generated and displayed, on request, at specified visual display units. The MTSS allows for simultaneous reporting on all DSN-related MN routes, and all statistics are available within 32 hours of the day's data being collected by the DCC. This is the first time that this has been possible and allows Operations and Maintenance Divisison staff to respond very quickly to changes in the network or to an individual SP's traffic problems.

Another sub-system within CRPS is the call statistics system, which is used to produce call statistics on individual SPs, national averages of call durations and percentage effective or ineffective calls for the production of ongoing forecasts for the network. This system can also produce revenue-based statistics, from monthly overviews of the whole network down to individual SP profiles. This system is installed on NN's IBM 3083J mainframe.

MAINTENANCE FACILITIES

Special Fault Control

Each ADSSC has its own special fault control (SFC), which is equipped with PSTN and LinkLine 0800 lines. The SFC acts as an interface point between the ADSSC equipment floor and other parts of the DSN/PSTN.

Measurement and Analysis Centres

Measurement and analysis centre (MAC) test traffic is passed via the ADSN. ADSN test traffic has been incorporated as part of measurement sequence (MS) 9. Each ADSSC has 400/1004 Hz test number equipment installed, and LinkLine 0345 numbers are allocated to this equipment. Currently, MAC access is restricted to LinkLine 0345 traffic. This results in MAC test calls to the ADSN being charged at local call rate to the originating equipment. Proposals are in hand to extend MAC access to LinkLine 0800 traffic at a later date.

Test Numbers

In addition to the MAC test numbers at each ADSSC, several 400 Hz test numbers are provided; these numbers are connected to 2/10 FS outlets and are allocated LU numbers.

Additionally, GS test numbers are provided. These are accessed by either LinkLine 0800 or LinkLine 0345 codes by using discrete numbers or UANs consisting of seven or nine digits. Access to these test number equipments can be direct from a GS level, an answering supervisory applied on seizure, or via a 1–6 digit absorption relay-set from the GS level.

The 1–6 digit absorption relay-set examines the test number digits and checks for possible corruption of the pulse train. If the received number is correct, connection is made to the interrupted 400 Hz tone and a line answering supervisory is applied.

Routiners

Each ADSSC is provided with the normal Strowger routiner access and test equipment appropriate to the installed hardware. All circuits from AMSUs to the ADSSC and inter-ADSSC circuits are connected to the appropriate trunk and junction routiner equipment. Trunk and junction routiner test number equipment is installed in each ADSSC.

The RAC equipment is fully tested by a routiner which is controlled from the Type 14 RT processor rack. All communication with the RAC routiner is via the Type 14 RT service teletypewriter.

FAULT REPORT POINT

Service Provider Fault Reporting

Each ADSSC has an FRP associated with it. The test desk connected to the FRP can be used for SP fault reporting, administration and control. SPs are given a UAN which routes the caller to the home ADSSC test desk. There is no charge for the call.

Fault reports from the general public are handled by repair service controls (RSCs) (151) and auto-manual centres (AMCs) (100) in the normal way. Reports are then passed to the appropriate DSN FRP for investigation.

SP faults are entered onto the computer-aided maintenance for special services (CAMSS) system, via a terminal at the test desk, to enable fast and efficient progressing of all SP problems. Each ADSSC test desk has access to the CAMSS network.

The test desk is fitted with a number of LU-category LinkLine 0800 lines to enable field engineers to contact it for testing purposes.

Service Provider Circuit Testing

All amplified SP circuits are routed via the FRP associated with the ADSSC. The test desk is fitted with standard Type 56 testing facilities, inluding level measuring sets, oscillators, attenuators and various SP signalling system substitution test relay-sets. Each test desk is fully capable of testing, and fault locating at, both the incoming and outgoing ends of an SP circuit.

Main Network Circuit Testing

The test desk also deals with MN circuit provision and maintenance requirements. Suitable TJF and CIRCUIT BUSY keys/lamps are also provided.

NETWORK OPERATIONS CENTRE

The DSN is managed centrally through the Derived Services Network Operations Centre (DSNOC). The DSNOC is an NN network management facility that is responsible for co-ordinating all aspects of service provision and for maintaining the GOS given by the network.

DSNOC Functions

The main DSNOC functions are:

(*a*) to receive requests for service—this is a paperless transaction using the electronic mail facility of the CRPS;

(*b*) to ensure that the reserved SP number is suitable for the customer's requirements in terms of ADSSC switchblock design and any constraints that it may impose on equipment availability and traffic carrying capacity;

(*c*) to allocate the signalling equipment (SSAC14/SSAC15) for the customer's (SP) line;

(*d*) to initiate circuit provision activities by the issue of private service customer requirement form(s) (PSCRFs), which are forwarded to the appropriate LCS Area Sales Special Services Department via the NN Private Service Management and Control at Stanmore;

(*e*) to initiate via the national subscriber trunk access record (STAR) group any necessary RT translation changes at PSTN MSUs (RT translation changes will be required at MSUs when the new DSN route access control facility (DRACF) is used.);

(*f*) to determine any necessary ADSSC Type 14 RT translation changes and forward details directly to the ADSSC;

(*g*) to monitor all aspects of provision of service to ensure that the 'customers required by dates' are met, including entering details of progress towards completion in the CRPS SP database and the CRPS SP statistics profiles;

(*h*) to set up statistics within the CRPS MTSS for monitoring SP and network performance;

(*i*) to analyse exception reports and statistics generated by the CRPS MTSS and other traffic records (PMTR, FMTR, PTAE, MSS, overflow meter reading, data queue enquiry) in order to identify service degradation and its causes, and to determine and initiate the course of action required to maintain or restore the GOS;

(*j*) to liaise with District Office staff engaged on circuit provision, monitoring the performance of the network, and relieving internal congestion in ADSSCs;

(*k*) to liaise with maintenance staff on SP and network maintenance;

(*l*) to maintain all necessary databases, that is, CRPS SP number allocation, CRPS ADSSC tables, ADSN route state records, DCC route allocation and NNG tables;

(*m*) to investigate and reply to customers' complaints about network performance; and

(*n*) to produce management statistics.

NETWORK EVOLUTION

Future Plans

Fast growth and high traffic levels are forecast for the DSN, and Strowger extensions are under way at most sites. In addition, modernisation of the DSN as soon as possible is essential. A programme of replacing ADSSCs with DDSSCs has already commenced. London, Cambridge and Guildford will be the first sites to have a DDSSC installed, with the remaining sites, including Liverpool, completed by April 1987. These installations will be designated *preliminary* (*Phase 0*) and *Phase I* of the digital contract to be installed by AT & T and Philips Telecommunications UK Ltd. A national replacement program has been produced so that ADSSCs which exhaust on traffic capacity grounds are replaced by digital units prior to their exhaustion dates.

Enhanced Features

The provision of a DDSN will give improved transmission, shorter post-dialling delay times and far greater flexibility of routeing and translation. The smaller SPs will also be accessed via the PSTN digital network, thus reducing line plant requirements, provided that they can be served from a digital local exchange (DLE). In the digital environment, many additional services will be provided in addition to the existing LinkLine 0800 and LinkLine 0345 services.

The DDSN will be provided and introduced in a phased manner spread over several years. Each phase will progressively expand on the range of customer services available together with network administration and maintenance features. The evolution will include the introduction of centralised call management techniques using intelligent network databases.

Biographies

Gerry Roberts joined the then Post Office in 1968 direct from full-time education. After completing a three-year Trainee Technician's apprenticeship in the London North Centre Telephone Area, he worked on subscriber apparatus maintenance in Holborn, London, for a short period and then on trunk exchange maintenance in a London unit. In 1978, he moved to the Network Planning Division of Telecommunications Headquarters, dealing with the production of direct-labour planning-and-works documents related to switching for the trunk network. This work also involved the full national introduction of international direct dialling. In 1982, he moved onto work on the Type 4 RT replacement project, which involved installation, planning, commissioning and contractual assistance related to the installation of Type 14 RTs. He joined the DSN project team when it was established in April 1983 and dealt with planning-and-works aspects of the project. He dealt with the DSN Type 14 RT contract and other equipment, with specific interest in enhancements and adaptive engineering necessary for the network testing, commissioning and integration with the PSTN. He now works on the network testing and commissioning aspects of the DDSN, with a continuing involvement in the completion of various aspects of the ADSN.

Bob Brutnell joined the then Post Office as a Trainee Technician Apprentice in 1966. After completing his apprenticeship, he spent from 1969–1981 working as part of a maintenance team on a non-director exchange. This involved local trunk and international subscriber dialling equipment. In 1981, he transferred to a Regional office and joined a direct labour Strowger works group. When the business was split into LCS and NN, he joined the NN side and moved to the District Office, retaining the same duties. After spending a year in the District Office, he transferred to Head Office and joined the DSN project team. Initially, he was involved in network commissioning for the ADSN, and subsequently his involvement has been with the DDSN, with a responsibility for testing and commissioning.

Time Assignment Speech Interpolation Systems

A Review of the Circuit Multiplication Systems Used by BTI

D. A. BARDOULEAU, C.ENG., M.I.E.R.E., M.B.I.M.†

UDC 621.395.43 : 621.315.28

Time assignment speech interpolation (TASI) systems were first introduced in 1960 for use on the TAT1 transatlantic submarine cable. These early systems used analogue techniques, but modern circuit multiplication systems using digital speech interpolation techniques have now been brought into service. This article reviews the systems at present used by British Telecom International.

INTRODUCTION

A previous issue of this *Journal*[1] described the time assignment speech interpolation (TASI) circuit multiplication system (CMS) operated by British Telecom International (BTI) on routes between the UK and the USA, and explained the principle of speech interpolation (see Fig. 1). This article reviews and makes some comment on the CMSs brought into service since that time.

The circuit multiplication equipment (CME) that forms the terminals of the CMSs (see Fig. 2) used by BTI can be split broadly into two groups depending on the type of traffic they handle. For the public switched telephone network (PSTN) traffic, the TASI-E, CELTIC 2G, CELTIC 2GE and COM2 equipment is used, while, for leased-circuit traffic, TLD and COM2 equipment is more suitable.

† International Lines Executive, British Telecom International

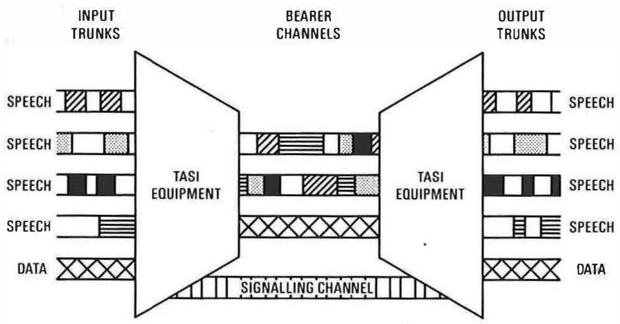


FIG. 1—Principle of speech interpolation

PSTN CIRCUIT MULTIPLICATION SYSTEMS

TASI-E is of American origin, designed by Bell Laboratories and manufactured by the Western Electric Co. BTI are exercising their option to purchase ten of these CMEs, and the majority of them will be installed in Mondial House international transmission switching centre (ITSC) in London (see Fig. 3). There are currently 13 CMEs of various types in this ITSC and the final figure could well be as high as 25.

The CELTIC 2G CME is designed and manufactured by CIT Alcatel of France, and a previous version was used extensively on submarine cable systems across the Mediterranean before being re-engineered into the present form. The name is an acronym of *Concentrateur Exploitant Les Temps D'inactivité Des Circuits*. CELTIC 2G has been designed around existing production equipment, namely 30-channel pulse-code modulation (PCM) digital multiplexing equipment (PMUX) and an electronic switch which is widely used in France for exchange applications. Further specialised circuitry has been digitised and assembled using TTL logic circuits of proven reliability. The equipment can work in a frequency-division multiplex (FDM) or time-division multi-

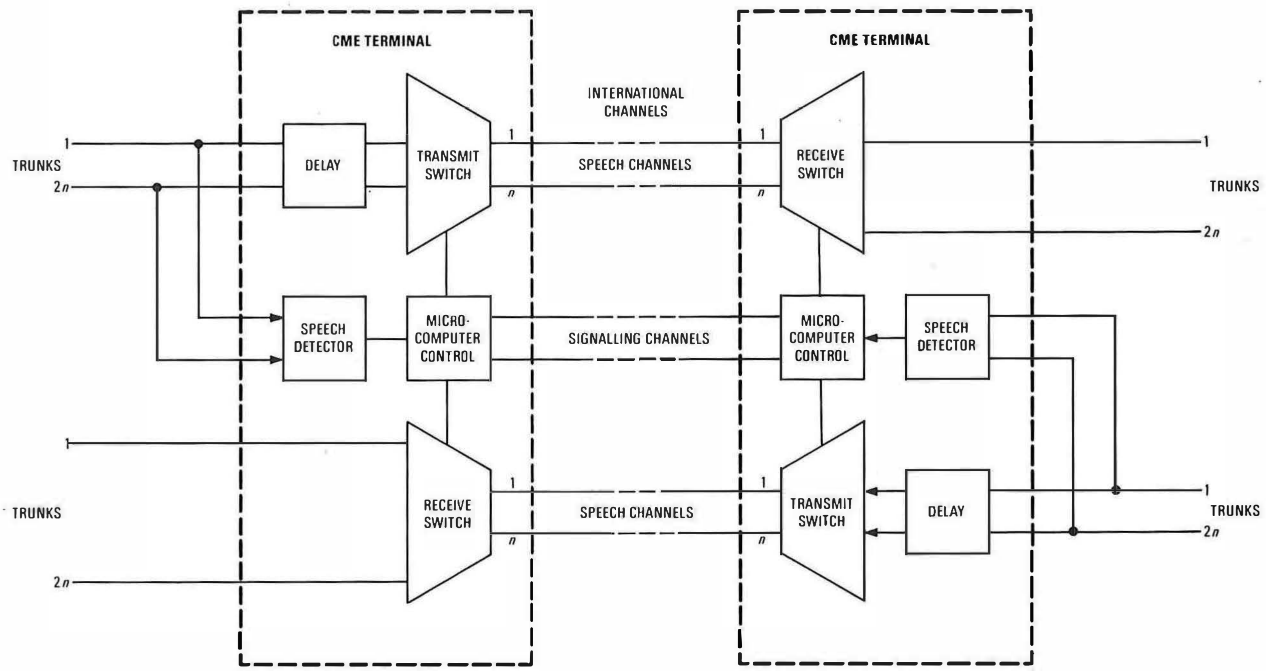


FIG. 2—Basic structure of circuit multiplication equipment

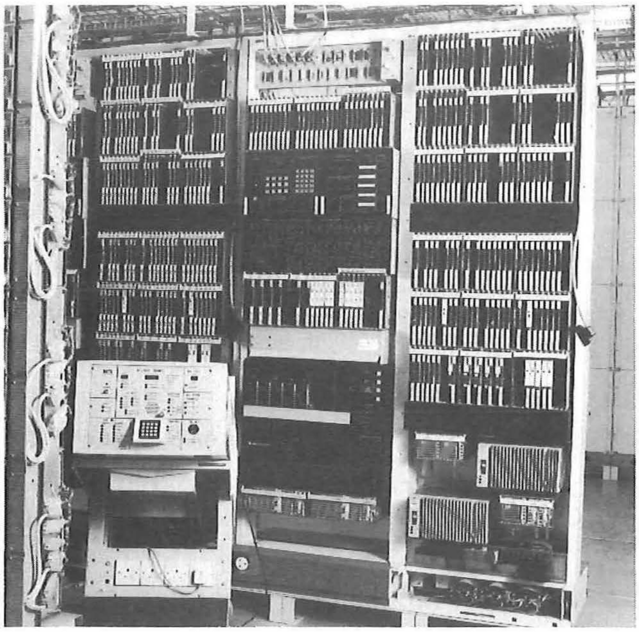


FIG. 3—TASI-E terminal with a digital access test set (DATS tester) in the foreground. Digital-to-analogue conversion equipment is not shown

plex (TDM) environment, but uses digital techniques for all the internal multiplexing and switching operations.

Under normal circumstances, the CME terminals used to make up a CMS are of the same type. However, CIT Alcatel has produced a version of the CELTIC 2G CME which they call the *CELTIC 2GE compatible*. It was developed in conjunction with the Western Electric Co. and, although substantially the same as the CELTIC 2G, does incorporate some modules supplied by Western Electric. This enables the CIT Alcatel equipment in Europe to interface directly with the TASI-E equipment in the USA.

The configuration ratio (ratio of speech trunks/available connect channels (that is, excluding signalling channels)) used by BTI for PSTN traffic is normally 240 trunks/120 connect channels giving an advantage of 2:1. The configuration ratio of 2:1 (240/120) for the CELTIC 2GE is the same as for the TASI-E, but, since present policy is to increase that ratio to 2·6:1, it will be necessary for the CELTIC 2GE installation in Keybridge House to follow suit. The provision of CMSs terminating in Keybridge House is expected to follow the pattern set at Mondial House, and in due course will probably comprise 25 terminals (see Fig. 4).

At Stag Lane ITSC and Mondial House ITSC, the CELTIC 2G CME is used in an FDM mode by utilising PMUX equipment, but at Keybridge House ITSC, the CELTIC 2GE interfaces with an Ericsson AXE10 digital switch. The exchange terminating circuits (ETCs) receive eight 30-channel PCM inputs at 2·048 Mbit/s in HDB3 line code from the CME.

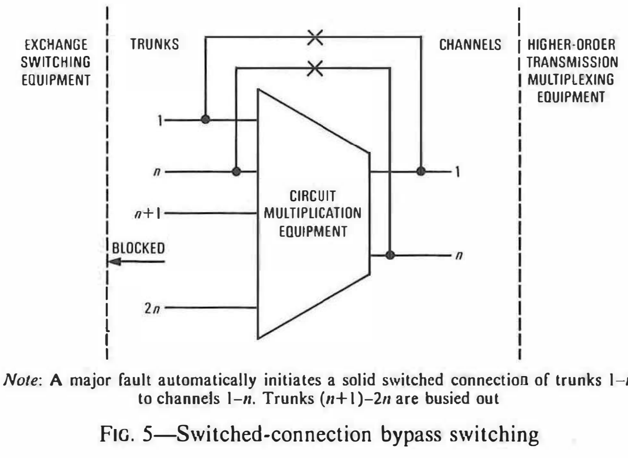
Where a small route needs to be expanded at short notice, circuit multiplication systems can be used. An example of this is the use of COM2 equipment on the route between the UK and Bermuda. COM2, which is manufactured in the USA and marketed in the UK by TCCL Ltd., has a configuration ratio of 31/16, and can thus significantly increase the capacity of small routes. It has proved extremely sucessful and several follow-up enquiries have been made.

Another CME that can be used for PSTN traffic is the telephone line doubler (TLD) equipment marketed by ECI (UK) Ltd. It is built in modular form and is currently used by BTI for private circuits. It can be scaled up from the basic configuration of 48/24 to the normal configuration for use on the PSTN of 240/120. Although there is no specific need at the moment, BTI have evaluated it as satisfactory for use in the PSTN.

FIG. 4—Celtic 2G terminal with associated teleprinter

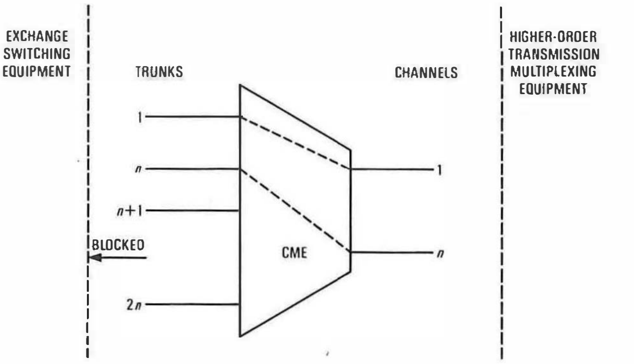
CMS Fault Procedure

A CME that fails while carrying PSTN traffic is dealt with in two ways. Firstly, a fault that affects service on more than a predetermined number of circuits automatically causes half the circuits (the derived circuits) to be busied out, while traffic continues to be carried via switched connections over the non-derived circuits. On the TASI-E CME, this switching action is a single operation that can be automatically or manually induced (Fig. 5). On the CELTIC equipment *bypass switching* is achieved differently on the two terminals of a system. The faulty terminal uses relay contacts (switched connections) that operate in the same way as for the TASI-E CME. The non-faulty terminal makes use of the CME software and is thus able to revert to a normal operating condition as soon as the fault condition on the distant terminal has been cleared and the imposed bypass switching removed (see Fig. 6). The second way relies on the interrogation of the fault-diagnostic printer output which will have been initiated by the alarm condition. The printout guides a trained maintenance engineer to use programs to identify, normally unambiguously, the faulty card, which can then be changed for a spare card normally held on site. Because the whole process can be accomplished sufficiently quickly, no restoration plans have been agreed to take account of PSTN CME failure.



Note: A major fault automatically initiates a solid switched connection of trunks 1–n to channels 1–n. Trunks (n+1)–2n are busied out

FIG. 5—Switched-connection bypass switching



Note: Switching occurs automatically when the far terminal goes to BYPASS mode. Trunks 1–n are connected through the CME to channels 1–n respectively. Trunks (n+1)–2n are busied out.

FIG. 6—Electronic bypass switching

Configuration Changes

Changes to the configuration ratio of a CMS depend on the type of CME being used. The TASI-E configuration is changed by fitting new electrically-programmable read-only memories (EPROMs) into the terminals at each end of the system, and therefore requires co-operation between both sets of staff. The CELTIC 2G and 2GE CME terminals are reconfigured by inputting the new information via teletypewriters into each terminal, either in turn or at the same time. When each terminal has accepted the new configuration, it outputs a new paper tape at both the local and distant terminals upon request. This tape is retained for system security purposes because, in the event of the CELTIC CME failing and having to be depowered, the memory may revert to an earlier configuration; it will therefore need to be reprogrammed, by using the latest tape, when the equipment is restored after the fault has been cleared.

As far as circuit line-up is concerned, the TASI-E equipment can be requested to provide a continuous path between any speech trunk and a connect channel. However, a more useful facility for circuit line-up is one that provides a canonical lock (that is, 1–1, 2–2 etc.) for the non-derived circuits only. This second facility is also available on the CELTIC and TLD equipment. BTI use circuit line-up procedures which are based on this method of obtaining a repeatable defined path through a CME terminal.

VOICE-ONLY LEASED CIRCUIT SERVICE

A service currently being offered to customers wishing to increase the number of leased circuits that they have without proportionately increasing their expenditure is the voice-only leased circuit (VOLC) service. This service can be offered to customers who require leased circuits, but who do not need to transmit data over them, because the international private leased circuits (IPLCs) can then be provided over CMSs. A reduced tariff is charged, unlike an exclusive IPLC, but customers have to realise that the CME is programmed to reject data calls and that, since all IPLC users are regarded as being of equal status, no form of bypass switching is possible if a CME fails. If it were provided, bypass switching, or *restoration switching* as it is sometimes known, would effectively give some customers a priority service; the VOLC service relies on prompt maintenance action to provide an acceptable availability.

VOLC CIRCUIT MULTIPLICATION SYSTEMS

The VOLC service is concentrated on two types of CME located in Mondial House:

(*a*) *TLD Equipment* The normal configuration of the TLD equipment is 48 speech circuits on 24 connect channels (48/24). Different versions of the TLD equipment exist for use in an FDM or TDM environment, but in Mondial House the former is used. The equipment is housed in a free-standing cabinet, but two can be mounted one above the other to economise on floor space. All normal alarm facilities are provided, along with a comprehensive range of management reports and fault-diagnostic programs (see Fig. 7).

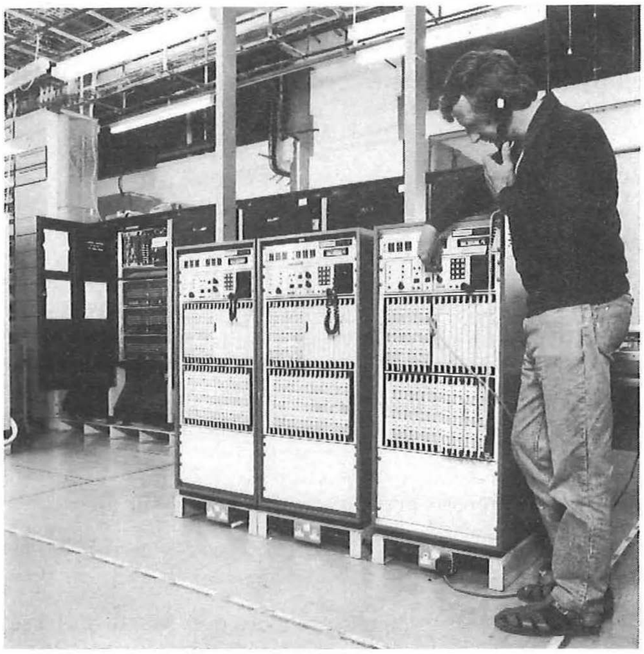


FIG. 7—Suite of three TLD terminals in the foreground with associated teleprinter, and a suite of COM2 terminals in the background. The floor tape marks the boundary of the electrostatic protection (ESP) area within which technicians must use protective wrist bands and connecting cords

(*b*) *COM2 Equipment* This equipment is physically much larger than the TLD equipment, although it is also housed in a free-standing cabinet. Configuration ratios range from 31/16 to 5/3; so it is suitable for use by a wide range of customers. The physical size of the equipment is independent of configuration ratio, but two equipments can be stacked one above the other. Based as it is on computer technology, the COM2 differs from the CMEs produced by manufacturers normally operating in the field of telecommunications (see Fig. 8). For example, maintenance staff have to take extra care when interrogating diagnostic programs while investigating circuit faults. This is because the speech trunks/connect channels start their numbering sequence with an '00' notation followed by '01', '02' etc. These numbers have to be related to the information on the circuit record card which conventionally numbers circuits from '1'. This problem is also met in digital transmission systems.

A facility that maintenance engineers find very convenient for locating faults is the ability, by calling up the appropriate program on the associated printer, to gain access to the distant-end terminal and use its fault-diagnostic capability as if it were their own. The alarm indications on the COM2 are very comprehensive. They include a visual indication as to whether a fault is located to the near-end terminal, far-end terminal or to the interface connect channels between them. This latter indication is sometimes ambiguous in that it can also apply to the signalling interface equipment on the customer side of the CME terminal. However, the

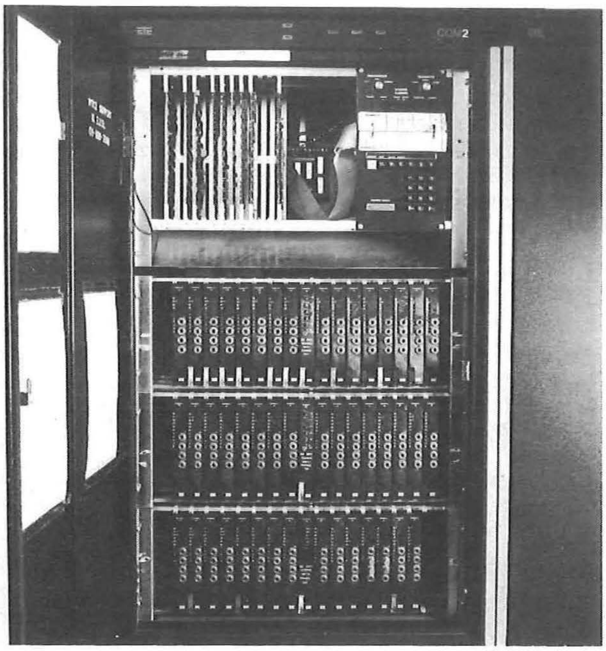


FIG. 8—Interior of COM2 terminal showing flip-down programming charts (top right-hand corner)

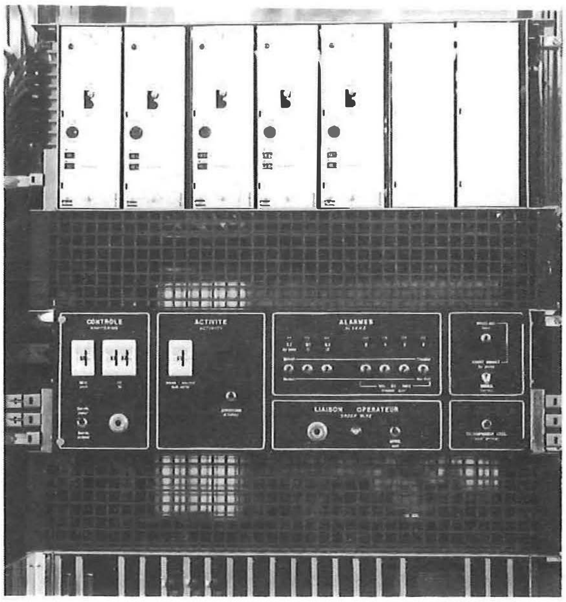


FIG. 9—Celtic 2G monitoring panel showing time-slot monitoring facility (extreme left) and the activity, alarm and bypass facilities

management reports are sufficiently good for the ambiguity to be easily resolved.

CMS MONITORING

Most of the CME terminals are located in Mondial House and Keybridge House international repeater stations (IRSs), although there is still a sizeable installation at Stag Lane IRS. Mondial House and Keybridge House have been provided with computer-controlled alarm-handling systems (AHSs). Each system is able to accept up to 10 000 alarm inputs, but the quantity of transmission equipment in each station is such that the number of alarms that can be extended from individual pieces of equipment has to be strictly controlled. Thus, service-affecting alarms only from each CME are extended. Additionally, all the CME terminals are connected to a CME-monitor system located close to the AHS terminal in the IRS fault reporting area. Maintenance staff are able to interrogate all the CME types, with the exception of the TASI-E terminals, and request management reports and alarm and system status reports, and to initiate fault diagnostic programs. By means of these programs, a faulty card can usually be identified quickly. Since the CME terminals in Mondial House are located separately from the fault report point, this monitor facility represents a very real saving in maintenance response time. A further advantage is that the syntax used to obtain the management and faulting programs for the various types of CME can be stored in the monitor memory and called up as necessary and displayed on a visual display terminal, thus eliminating the possibility of programming error. Fig. 9 shows the CELTIC 2G monitoring panel. TASI-E terminals have to be interrogated via an alpha-numeric keypad, which is mounted on the front of the equipment; however, alarm and system status reports are automatically provided on the main CME monitor (see Fig. 10).

IPLC CIRCUIT DESIGN

An important area of concern that has been revealed during recent maintenance investigations on CMEs carrying IPLCs is the need for circuit designers and marketing personnel to have a full understanding of the customers' equipment (Fig. 11).

Since CMSs are fairly new to the market, they are often blamed by customers for faults which are more often to do with the customer interface than with the CME. An example is the difficulty which can be caused by the signalling protocols used by customers' PBX installations interfacing with sophisticated transmission equipment located in the IRS. False calls, false seizures and misdialling can occur and it is important for staff who market VOLC services to ask sufficiently detailed questions in order to advise circuit designers of any problems that may arise from the use of the increasingly wide range of customer equipment.

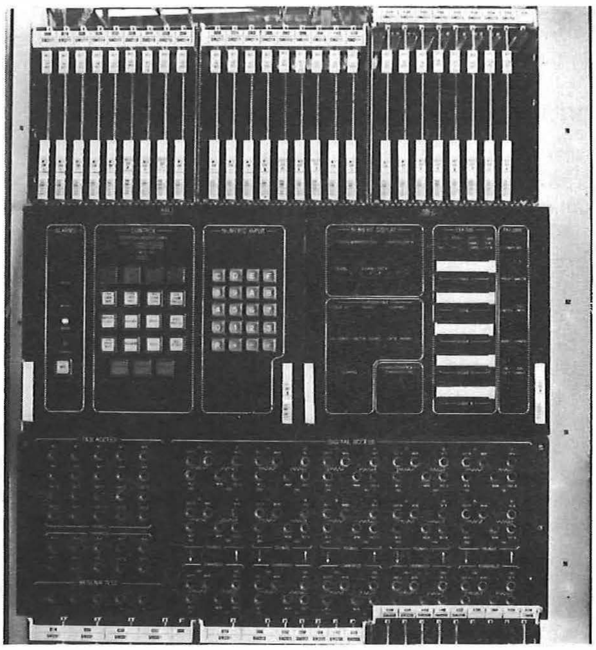
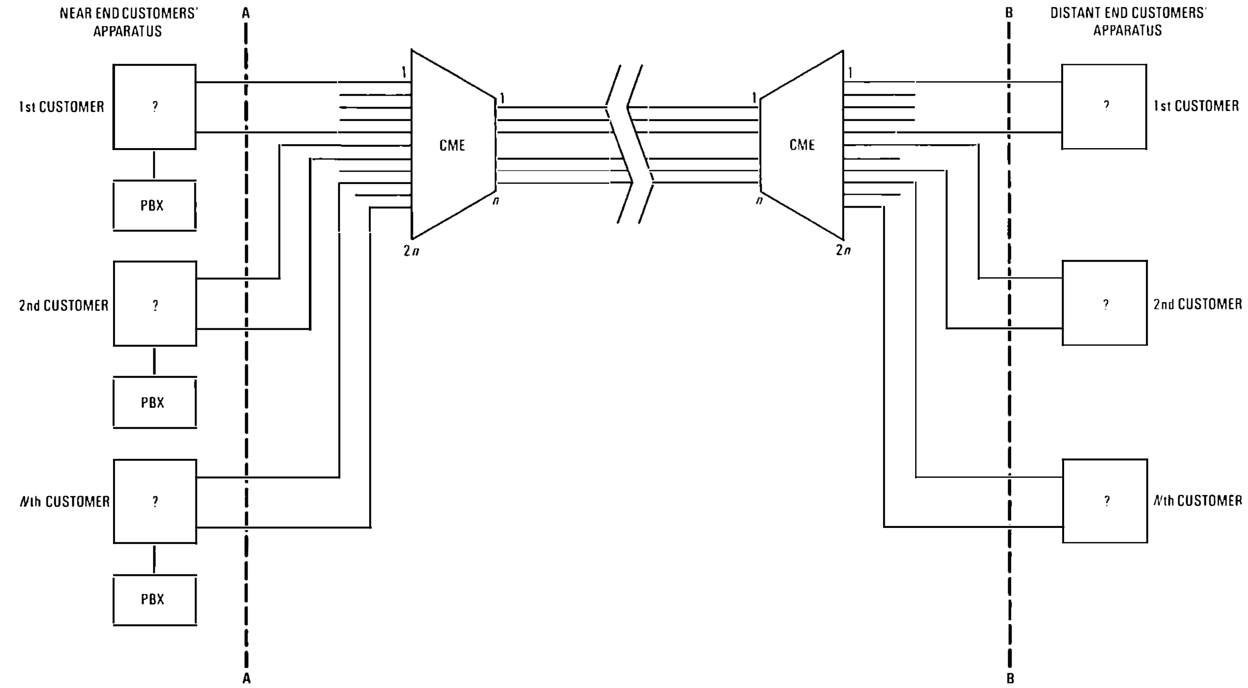


FIG. 10—Close up of TASI-E control panel showing the facilities available



Notes: 1 A variable number of customers will be connected to the CME until all the trunks are utilised
2 Care must be taken to obtain as much information as possible about the protocols appearing at points A and B. Some CMEs are transparent to signalling information, others need conversion units
3 Some money or commodity dealers require a continuous open line between their offices. A simple shoutdown service with press-to-talk handsets is therefore required. Under no circumstances should the circuit be left continuously open because background noise will provide enough activity on the circuit to cause a trunk/channel lock, thus invalidating the use of the CME for this service.

FIG. 11—Voice-only leased circuit service

The Inner London IRSs are not the only locations for CMS terminals used by BTI. BTI's International Business Services also use COM2 in their service centre in St Botolphs House for private leased circuits.

FUTURE INSTALLATIONS AND DEVELOPMENTS

Tender adjudication is currently taking place for the supply of a digital circuit multiplication system (DCMS) for use over the TAT8 digital submarine system due to come into service in 1988. As far as BTI are concerned, 22 of these terminals will be required for installation in the Kelvin ITSC. They will operate in a digital environment and, because they will use both digital speech interpolation (DSI) and adaptive digital PCM (ADPCM), the CMS gain will be at least 5:1. The term *CMS gain* in this context has the same meaning as configuration ratio; that is, ratio of speech trunks to connect channels. By careful selection, it will be possible for the CMS to carry groups of circuits which terminate in centres that have non-coincident busy hours. The CMS gain can thus be increased still further, possibly to 8:1.

The new time-division multiple-access (TDMA) service[2] due to come into operation over Major Path 2 (MP2) of the Atlantic Ocean satellite in the Autumn of 1985 and over the Indian Ocean Satellite primary path in 1986 will use a new version of DSI equipment manufactured by the Digital Communications Corporation of Milton Keynes. This equipment will be located in the satellite earth stations. The CME circuitry is an integral part of the time interface module (TIM), which accepts $8 \times 2{\cdot}048$ Mbit/s digital streams from the terrestrial network and transmits them over the satellite link as 2 ms bursts at 120 Mbit/s. The number of circuits that are processed by the CME (that is, DSI) or bypass it (that is, digital non-interpolated (DNI)) has to be decided by the governing body of INTELSAT (the global International Telecommunications Satellite organisation) acting on inputs from individual administrations. The precise number of circuits of all types are written into a burst time plan (BTP) which is mandatory on all participating administrations. The TDMA CME contains all the alarm, management and fault-diagnostic facilities normally associated with circuit multiplication systems.

CONCLUSIONS

CMSs are being used increasingly as a key element in network growth. They offer scope both on main routes and for special applications. On main routes they are being used to defer the provision of new systems needed to cater for growth. On particular routes, the ability to provide additional circuits at short notice when extra capacity is hard to find is extremely useful; and this was shown in the case of the Bermuda installation. Their economic viability has been proved as has their reliability. No outstanding maintenance problems should be experienced providing due attention is paid to the customer interface and, although bandwidth will be more readily available in the network of the future, the continued use of CMSs would seem to be assured.

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Biography

Derek Bardouleau started his career with BT at Dollis Hill in 1948 working in the transmission laboratories. From 1958 he worked in the Submarine Systems Division, but in 1980 he moved to the International Lines Executive of BTI where he is responsible for the provision of maintenance support for new transmission equipment in IRSs.

Then and Now—A Review of PO Stamp-Selling Machines

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UDC 656.835

Stamp-selling machines have been in use in the UK for well over 100 years. During this period, the machines have had to cope with increases (and decreases) in the postal rates as well as the change-over to decimal coinage in 1971. This article reviews the general history and development of stamp-selling machines used by The Post Office.

IN THE BEGINNING

The idea of selling stamps by machine has been around almost as long as postage stamps themselves. The Penny Post was introduced in 1840 and 17 years later, in 1857, what is thought to be the first patent for a machine specifically for selling postage stamps was applied for. There then followed a multitude of designs, some of such complexity that engineering skill was required to operate them, with others so crude as to render them useless in service. Most of the machines were manually operated, although clockwork and electric motors were used to drive some machines and, in another, pneumatics was incorporated for the issuing of the stamp.

However, it was not until 1907/8 that the Post Office (PO) began to use stamp-selling machines with the introduction of what was to become known as the *Type A* machine. Prior to this date, the PO had allowed private companies to operate machines for the sale of stamps under licence. In what can be assumed only as an expression of their lack of faith in these designs, the machines had to carry an inscription stating that the manufacturing company had no connection with the PO!

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THE FIRST TYPE A MACHINE

In 1906, a Mrs. G. Kermode submitted to the PO for approval a machine designed in New Zealand by a Messrs. Dickie and Brown. This machine, like most of its predecessors, was of the coin-freed type; that is, the introduction of a coin only freed the mechanism—a further action (in this case the raising of a sliding knob) was required to obtain the stamp. The stamps were in a strip and not perforated in the usual way, but there was a series of large holes along the strip for the engagement of a drive sprocket which fed

(*a*) Manufactured by Copley, Turner & Co., Middlesbrough, 1892

(*b*) 'Penny in the slot box', 1907

Examples of machines used under licence

the stamp to the customer. A guillotine then separated the purchased stamp from the strip.

However, this design showed more promise than its competitors, and so it was redeveloped to meet the needs of the PO by the British Automatic Stamp and Ticket Delivery Co. The redeveloped machine issued perforated stamps from a roll and were fed to the customer by means of a feedwheel. This wheel was fitted with small pointed pins at a pitch around its circumference which lined up with perforations in the stamp roll and thus gave a positive drive. A serrated plate fitted at the stamp aperture allowed the stamp to be severed from the roll by a pulling action, and thus eliminated the need for the guillotine. A further requirement was for the action of issuing the stamp to be automatic following the insertion of a correct coin. When the coin was inserted, it lifted a weight and primed the machine. The coin, on being accepted by the machine, released the mechanism and allowed the weight to drop. The weight was linked to the feedwheel which rotated sufficiently to issue a stamp.

The first machine was tried for a short period in 1907. This was followed, in 1908, by an extensive in-service trial of 12 machines. Again the caution of the PO was shown in that these machines were hired, not bought, and the contractor was responsible initially for maintenance. By 1911, a contract had been placed for 100 pairs of ½d and 1d machines with the contractor receiving a payment in proportion to the number of stamps sold through the machines. This arrangement, in fact, continued until 1920.

After increased postal charges in 1918, a number of machines were modified, and after a further increase in 1920, the PO purchased 106 pairs of ½d and 2d machines. Machines were mounted in pairs to allow flexibility of purchase. However, these machines were designed only for indoor use and, while experiments had been conducted with them outdoors by both the PO and the British Automatic Stamp and Ticket Delivery Co., this experience showed that further development was required to reduce the trouble caused by dampness; both the stamp roll and the feeding mechanism had to be housed in an enclosed chamber. In 1921, the PO placed an order for 240 pairs of ½d and 2d machines. This was the first PO general-purpose machine and was designated *Type A*.

INTRODUCTION OF THE TYPE B MACHINE

In 1922, the postal charges went down and the Type A machines were reverted back to ½d and 1d. It soon became apparent that the operational conditions outdoors were considerably more onerous than those imposed on indoor machines and, although further work was done particularly in internal access to the machine for loading, a redesign was therefore required.

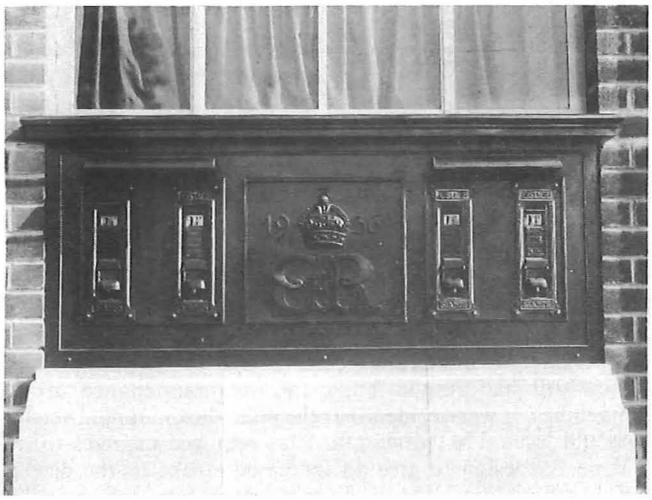
In 1924, the *Type B* was introduced. It incorporated all the improvements thought necessary from the experience gained with the previous machine. Some 1500 pairs of ½d and 1d machines were purchased in the next 4–5 years.

In 1928, the British Automatic Stamp and Ticket Delivery Co. was reformed to become Hall Telephone Accessories Ltd., and changes in the method of manufacture began. Previous machines had made great use of brass castings and the working parts had been polished and lacquered. Now they were fabricated from sheet steel or produced as stampings, and generally were nickel plated. Design improvements to the loading of the machine and the mechanism were made and the machine was adopted in 1929; it was known as the *Type B1*. One thousand pairs of ½d and 1d machines were purchased over the next 2 years.

RAPID DEVELOPMENT

The next 5 years can best be described as the Golden Age of stamp-selling machines: new applications, the stimulus of a new manufacturer which resulted in numerous variations of the Type B1 machine, the establishment of a PO standard machine, the introduction of a stamp-book machine and the rapid increase in the number of machines in service to some 9000 testified to this description.

Up to 1930, PO stamp-selling machines had been mounted in close proximity to Post Offices on the walls and doors or built into the structure. Attention was now given to a pillar-



An elegant bronze panel housing 2 pairs of ½d and 1d Type B machines with overhead lighting. There can be few offices with this particular Royal Cipher

Pedestal-mounted cast-iron case (Type K) housing ½d and 1d Type B machines. Door to cash boxes is separate from machines

Two Type B machines wall mounted in cast-iron case (Type F)

box mounted version. The manufacturer had gained valuable experience with mounting cases at Sub Post Offices, where they still had responsibility for the maintenance of the machines. It was decided that the pillar-box mounted version should issue 2 × ½d stamps. This required changes to the Type Bl design to give an increased stroke to the driving bar and modifications to the escapement wheel. Some 1000 machines were purchased and installed, and were known as *Type Cl*.

A further value-analysis exercise on the design was completed by Hall Telephone Accessories Ltd. which resulted in only the front plate and lift flap remaining as castings. Further purchases of what was now the *Type B2* and *Type C2* machines were made.

In 1932, a new manufacturer, Messrs. Bracknell, Munro and Rogers, a firm well known in the automatic vending machine trade, came into the field. They submitted a machine similar to the Type B1, but with a much improved coin tester, a forerunner of today's testers. The machines were accepted, purchased and designated *Type B3* and *Type C3*.

Spurred by this challenge and using their experience of the performance of their machines at Sub Post Offices, Hall Telephone Accessories made further changes to the mechanism and produced the *Type B4* and *C4* machines. These were adopted as a PO standard and full PO manufacturing drawings prepared. This standardisation was not intended to prevent further changes if considered desirable; it would, however, ensure that they were introduced in a more systematic manner. Consideration could be given to the wider aspects of any change, which could then be made as far as possible without the interchangeability of parts for maintenance purposes being affected.

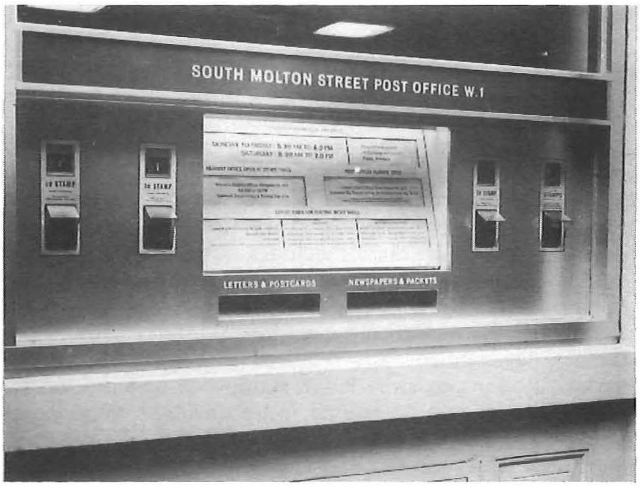
During this period Bracknell, Munro and Rogers also produced a machine for the sale of a 2/- (10p) stamp book, and 25 were put into service as an experiment. These machines were operated by a single 2/- piece or two separate shillings (2 × 5p). However, there was in circulation at this time a large number of coins from various Victorian issues of both denominations with varying diameters and thicknesses. These variations made this machine unreliable and its popularity, which was small from the beginning, became non-existent. This was followed up by a 6d stamp-book machine, [illegible]h did not prove successful, and it was not until the [illegible]0s that the public took to this type of machine.

SUSTAINING THE DEVELOPMENT

The remaining pre-war years were a period of consolidation for the stamp-roll machines. More machines were installed in service and a number of accessories produced mainly to combat the effect of dampness on the operation of the machine. This effect varied from the perforations on the stamp roll getting out of register with the pins on the feedwheel and resulting in the delivery of torn stamps, to the complete stoppage of delivery due either to the sticking up of the stamp roll or the adhesion of the stamps to the feedwheel. Hoods, heating devices and silica-gel dehydrators were tried with limited measures of success.

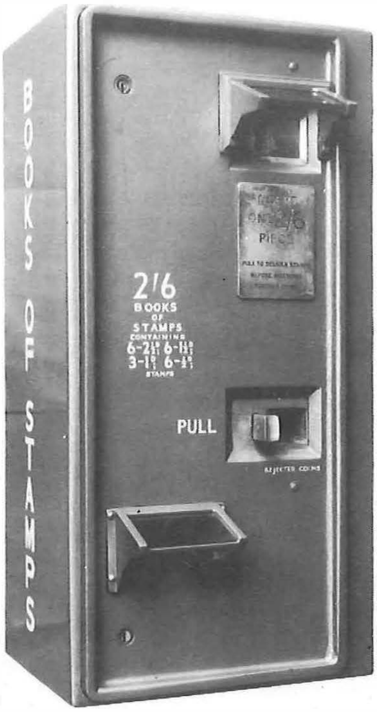
POST-WAR PROGRESS

The early post-war years saw a major step forward in the design of the stamp-roll machine; a coin tester and chute were designed to take the 12-sided bronze 3d coin. A large number of these models were purchased and installed at offices alongside the ½d and 1d versions to give more flexibility of purchase. Further modifications to the Type B mechanism produced the *Type B5* (issued ½d or 1d stamp for the appropriate coin) and the *Type D6* machine (issued 2d stamp for two pennies), but they had very limited success.



Hitchin-type panel housing a range of machines

One shilling Type F1 book machine



The ill-fated 2/6d book machine

At the same time, further work was undertaken on a book machine and, between 1950–56, 200 machines, known as *Type F1*, operated by a 1/- coin were introduced. This machine was of the coin-freed type, the delivery of the book being effected by the operation of a pull bar. The books were stacked in a chute and held down by a weight. When the correct coin was inserted in the machine, the pull bar could be operated. A plate attached to this bar pushed the bottom book in the stack into the feed rollers. On release of the pull bar, which was spring loaded, the rollers rotated and delivered the book to the customer. Although this machine was reasonably successful, no further purchases were made, mainly because of the shortage of 1/- coins in circulation. The domestic electric and gas meters were making increasing use of this coin and rises in postal charges made the value of the book too small a stock to hold. A 2/6d book machine was considered and had a successful field trial. It was, however, physically very large and could not be accommodated on a standard stamp-selling machine mounting.

Work had been going on to convert the Type F1 to take a 2/- coin. In 1957, a prototype was produced and, in 1959, a successful field trial resulted in the purchase over the next few years of some 2500 machines to be installed at Post Offices.

NEW CONCEPT IN STAMP-ROLL MACHINES

In the mid-1960s, with over 20 000 stamp-roll machines and a further population of stamp-book machines all giving good service, it was considered time for a reappraisal. Because of the more frequent changes in postal charges and in anticipation of decimalisation to be introduced in 1971, a more flexible stamp-roll machine was required to meet the needs and the new image of the Post Office.

Development of the new machine was undertaken on behalf of the PO by Associated Automation Ltd. (formerly Hall Telephone Accessories).

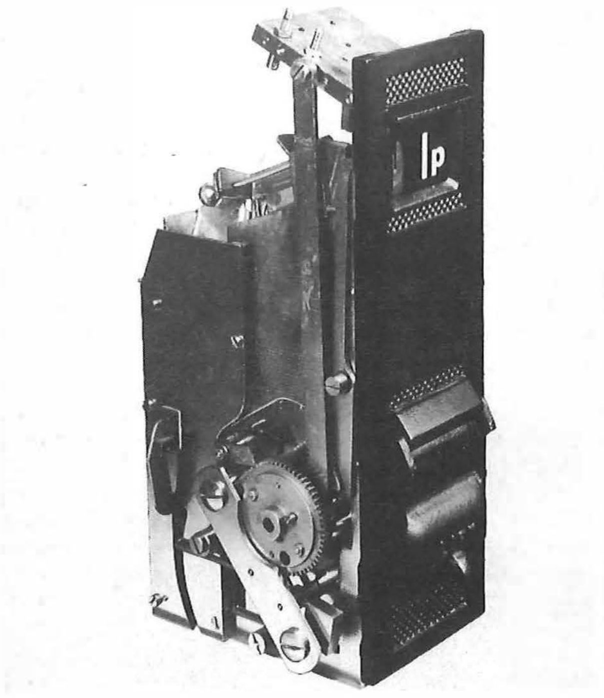
As the new machine would be introduced over a period up to Decimalisation Day, it was essential for it to be operated by a coin that would be in common use before and after that day. The coin chosen was the shilling (1/-), to become 5p after decimalisation. The machine, unlike the Type B4, would not operate automatically on insertion of the coin, but the stamps would be issued by a feedwheel from a roll. A strip of up to five definitive stamps of mixed values would be issued long edge first for ease of use. There was an internal facility to preset the number of stamps issued. However, the initial issue of five stamps was never changed during the life of the machine. This first issue allowed three second-class letters to be posted. By the time the last of these stamp rolls was produced in 1980, only one second-class letter could be posted, and this was after a conversion to a 10p coin operation in 1975—a clear indication of the rapid increase in postal charges during the inflationary period 1970–1980.

Pillar-box mounted case (Type U) housing Type G stamp-roll machine

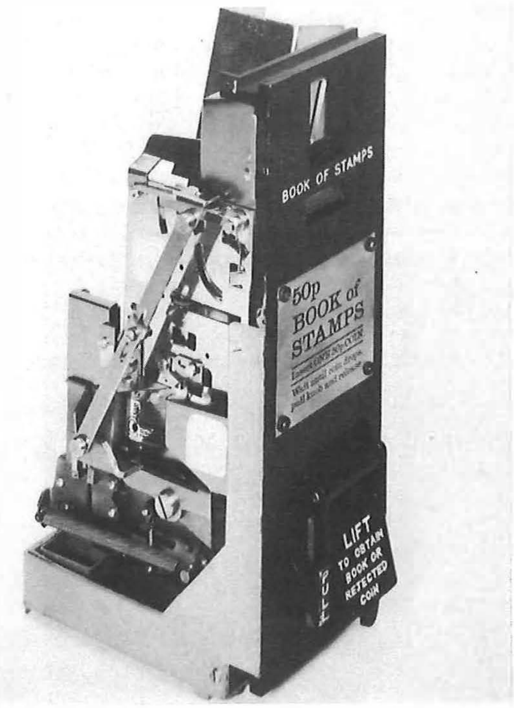
The machine was operated by first inserting a coin which, if accepted, fell into the mechanism and formed a part of it for the next operation to be carried out. This was to raise the stamp aperture flap which, in turn, lifted a weight and primed the feedwheel. These conditions were held until the further raising of the flap applied a force to the top of the coin by a lever which pushed it into the cash box. In doing this, the coin tripped a toggle to release the weight which fell and operated the feedwheel to issue the stamps.

This machine was a product of a less law-abiding age than the Type B4 and had numerous anti-fraudulent devices built into both the coin tester and mechanism. It also incorporated modern materials and manufacturing techniques, and ISO† metric threads were used throughout the assembly. The new machine was the *Type G* and was field trialled in August 1969. The plan was to produce over 10 000 machines by the end of 1970, and thus replace a pair of B4 machines with a Type G. However, design and production problems caused delays and it became clear that there would not be an adequate number of machines in service after Decimilisation Day; by then, the Type B4 would be obsolete and only the book machines would be available. A plan was devised to convert 2700 Type B machines to operate with a 1p coin. This programme was undertaken by Barber Weston Ltd. who incorporated expertise from the now defunct stamp-book machine manufacturer Bracknell, Dolman and Rogers. Once more the faithful Type B machine was pressed

† ISO—International Standards Organisation



The faithful Type B machine converted to decimal coinage



Type F book machine converted to 50p working

into service, and this situation prevailed until the 1p stamp rolls were discontinued and finally used up in the late-1970s.

From its introduction, the Type G machine was plagued by problems caused by dampness, and, while a programme of material changes to parts of the mechanism was undertaken to reduce its effect, the real problem was the adhesive used with the stamps. The machine used to perforate the stamp rolls required a natural gum on the roll for this operation to be successful. This gum in turn was very sensitive to humidity, and it was not until a new perforating machine using a different method of operation was installed at the manufacturer's works that a man-made adhesive (Polyvinyl Alcohol/ Dextrin) could be used and the problem controlled.

The machine now went through a more stable period with a reduced fault rate. An analysis of the faults at the time showed more than half were due to petty vandalism, a malaise of our present society. By 1975, with increased inflation, it was necessary to convert the machine to 10p coin working, but it was clear that despite its flexibility the machine would not cope with these ever increasing costs for much longer. The popularity of the machine had never been high. The change in method of operation to obtain stamps took time to be accepted and surplus stamps left over from a posting were not as convenient to store in a purse or wallet as was a book.

NEW BOOK AND CONVERSION OF THE PRESENT BOOK MACHINE

Meanwhile, a cheaper book had been produced. Up until then the book had virtually been hand built. Forty books at a time were made up by assembling in order two cardboard covers, sheets of stamps and advertising and information literature. These were then stitched together on a sewing machine and guillotined to make the 40 books. By the new method, they were machine made on a production basis, resulting in a folded cardboard cover, thinner than its predecessor, incorporating stamps stuck to the inside of the cover at the stamp selvedge. This change not only lowered the production cost of the book, it also increased the storage capacity of the books in the machine. This in turn reduced reloading costs.

By the late-1970s, work was in hand to convert the Type F book machine to 50p coin working. After a field trial in early 1979, a programme of converting all these machines, which were sited in Crown Offices, was instigated. The work involved replacement, alteration and adjustment of some parts, while other parts had to be returned to contractors' works for modification. This programme required careful monitoring and control for it to be successful.

TWO NEW BOOK MACHINES

At the same time as the conversion was underway, it was decided to replace the Type G machine with a new type of book machine. The book was considered more versatile than the stamp roll for use with the current inflation rate and the resultant increases in postal charges. Three manufacturers' designs were considered, but only two could meet the proposed time-scale for the design, and neither of these two could, if successful individually, produce machines at the rate required.

After a field trial, contracts were placed for the production of 5000 machines from a British concern, Bellings Production Techniques, a company which included experience from Associated Automation Ltd., and 1500 machines from Sterners Specialfabriks AB, a Swedish company with a proven record of having produced stamp machines for a number of European postal administrations.

The machines, which were to issue a book for one 50p coin initially, were to be mounted both on pillar boxes and in the fronts of Sub Post Offices. The Type G machine had been mounted on a pillar box in a case specially made for it (Type U). The new machines would be designed to fit this case, but the door required considerable modification to mount the new machines and fit their operational requirements. For the Swedish company, with a more acute transport problem, complete new doors would be supplied with the machines. However, with the British Company, an initial batch of new doors and converted surplus ones were produced to form a float. An exchange system was then established by which the correct door was fitted to the machine and case, and the replaced door returned to the company for modification. This modification also included parts of the lock mechanism. In addition, plates similar to the Type U case doors, but for stud mounting to Sub Post Office fronts were to be supplied. All these items were supplied in quantities predetermined for each region. Again, as with the Type F machine conversion, careful monitoring and control were required to meet the needs of both the contractors and the postal engineers on installation.

The British machine, which was called *Type H*, was a new design. The Swedish machine (*Type J*) was an existing design with minor modifications. The operation of both machines is similar: a coin enters the coin slot and falls into a coin tester, which carries out a series of checks so that only valid coins of the correct denomination are allowed through to the book issue mechanism. All other coins or discs are rejected immediately into the reject chute or held in the tester. In the case of the Type H machine, the tester is scavenged and the coin falls into the reject chute when the pull bar is operated. With the Type J machine, a REJECT button must be pressed to scavenge the tester and reject the coin. The valid coin falls into an escrow† unit, where it lodges on the coin rail holding up the release lever and latch. The pull bar can now be pulled to its fullest extent and a book issued. The pull bar is held in its intermediate positions by a full scale rack and can be released only when fully extended. With no coins in the escrow unit, the release lever, which is attached to the latch, allows the latch to engage when the pull bar is operated a short distance; this stops both further movement and the issue of a book.

A feature of both the Type H and J machines is that they can be set to take up to four 50p coins and issue a book to the corresponding value. The term *escrow* is therefore applicable only if the machine is set to take more than one coin. In this case, the unit in which the coins are lodged is the 'third party' and the customer is free to reject and thus regain the coins up until the correct number are accepted.

† Escrow is a legal term meaning to be held in custody by a third party until some condition has been fulfilled; it is used in the vending-machine industry to describe a holding of a number of coins before a transaction is completed.

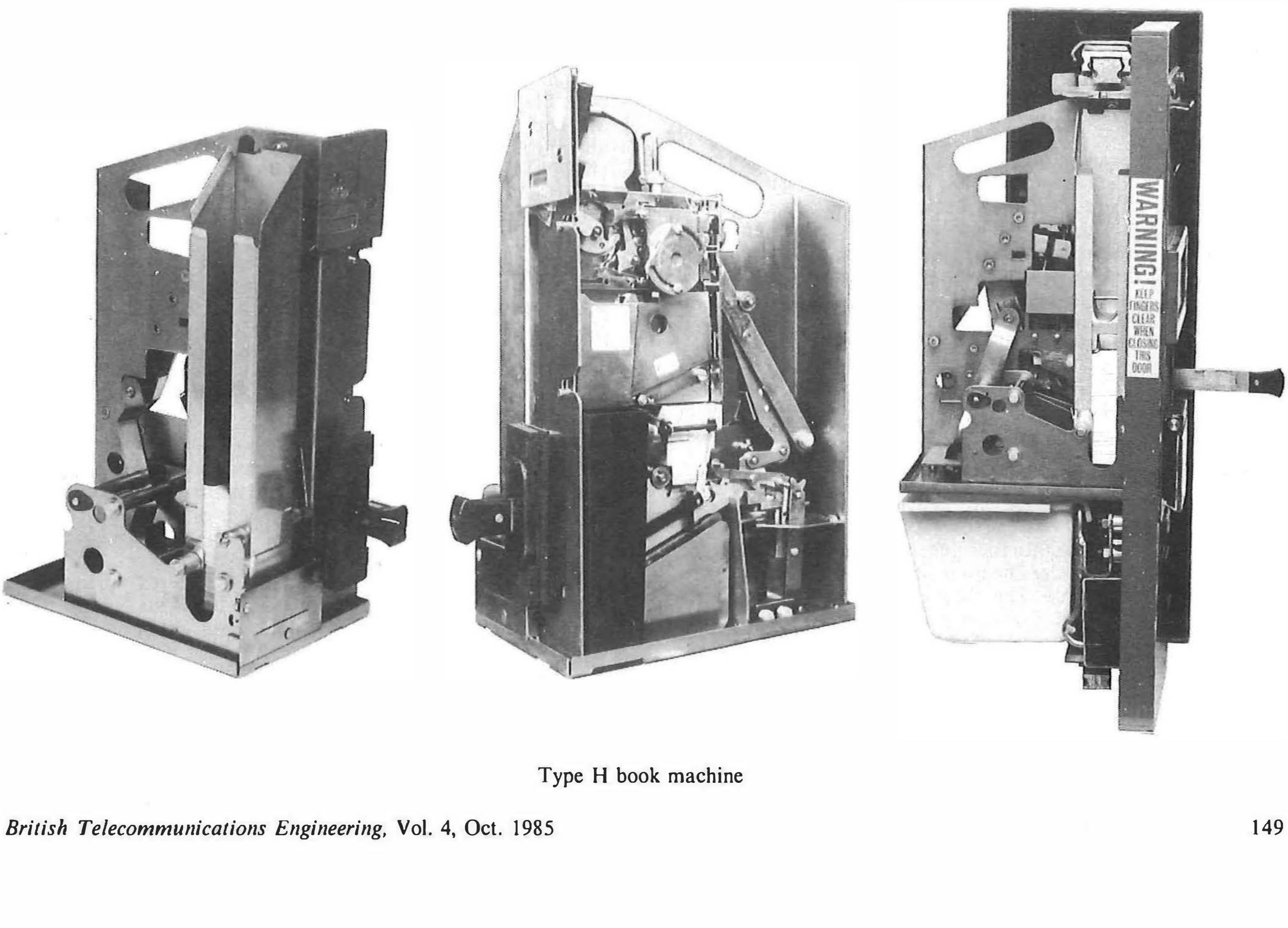
By the Autumn of 1980, production machines were becoming available. However, many Regions were still involved with the conversion programme for the Type F machine, and engineering resources did not allow initially for rapid progress on the new installations. This, in turn, caused problems with the door modification programme for the Type H machine.

With there being two different machines, their allocation was restricted to one type per Region: the total requirements of the North East, North West and Northern Ireland were met from the 1500 Type J machines, and all other Regions had the Type H machine. Early problems varied from gaining speedier Customs and Excise clearance for the imported Type J machines to modifying the Type H machine in production following experience gained in service subsequent to the field trial. However, production and distribution ran reasonably well and by the spring of 1981 were completed. The late start due to the conversion of the Type F machine combined with the amount of work involved particularly in siting machines in Sub Post Office fronts meant that a further 7–8 months passed before installation was complete. However, in about two years, a major conversion, installation and resiting programme had given the business a range of machines all issuing books to a current monthly sales value of over £0·5M. These machines have proved to be more reliable and, particularly in the case of the Type H and J, capable of meeting the PO's needs for many years to come.

THE FUTURE

A common feature of the PO stamp-selling machines in this review is that they have all been manually operated mechanisms capable of being positioned anywhere and not requiring an additional power source. They have been simple devices designed and manufactured to a competitive price.

Over recent years, however, interest has been shown in



Type H book machine

an electrically operated microprocessor-controlled franked-label issuing machine developed and manufactured by FRAMA AG, a Swiss company. The British version of the machine is capable of taking the following coins: 1p, 2p, 5p, 10p and 50p.

The coins are checked and, if valid, the amount inserted is held in credit and shown on an electronic display. The customer can select to purchase a first- or second-class label (up to the 60 g first weight step) by pressing the relevant button. The label, which shows the price of either a first- or second-class posting, is gummed on the back and affixed to a letter in the same way as a stamp.

There is a third button which would normally be used when the credit displayed is less than the amount required for a further posting; for example, if the customer has inserted two 10p coins and purchased a 17p first-class label, the 3p now shown in credit would be issued as a 3p label if the third button was pressed.

If the amount in credit was above the first-class post and the third button pressed, a first-class label or labels would be issued plus the amount of remaining credit. For example, if the customer has inserted a 50p coin and a 2p coin and pressed the third button, three 17p first-class labels will be issued plus a 1p label. Four of these machines went on field trial at different sites on the 1 May 1984 and their performance was monitored. Its method of operation and issue and the need for a power source makes this machine a radical departure from all previous types, and its sophistication is reflected in a much higher purchase price than the present manually-operated mechanical devices.

It is early days to speculate on the future use of this machine. Installations at prime and prestige sites come immediately to mind. With its versatility, a modified label-issuing machine could become an important element in a 24-hour self-service packet and parcel posting position alongside an electronic weighing machine and a secure packet-and-parcel acceptance system.

ACKNOWLEDGEMENT

Acknowledgement is given to the numerous papers covering in more detail a number of the machines referred to in this article. The author is also grateful for the help and advice given by both past and present members of the Post Office Engineering Department's Stamp Selling Machine Development Group.

Biography

Allan Hagger joined the Post Office as an open competition Executive Engineer in 1969. He has worked on the maintenance of Office machines, which include stamp-selling machines, and also on postal mechanisation. He is currently Head of the Field Support Group for parcel and bulk-mail machinery and Office machines.

Book Review

Data Transmission via PABXs. P. Marcham. John Wiley and Sons Ltd. 66 pp. 25 ills. £6·95.

This slim volume aims to provide general management with an overview of how a PABX can be used for data transmission. It is also intended to give sufficient information to enable informed decisions to be made on the PABX and its position in a company's strategy for information technology.

A typical PABX installation is examined initially; then extension wiring and distribution frames, the hardware of the communications distribution system, are described in considerable detail. The diagrams and text are clear, but reflect a typical integrated cable distribution scheme provided by British Telecom (BT) prior to the advent of liberalisation. Issues such as the need in many cases to separate BT's monopoly-service wiring from PABX internal wiring are not mentioned. The names used for the various distribution frames do not reflect the nomenclature current in the relevant British Standards and interim standards.

A brief review is given of the evolution of PABX technology, starting with electromechanical systems and moving on to digital and distributed systems. The book provides a reasonable classification of PABXs into four generations or stages, and the criteria used for this classification are those which currently have general acceptance. The chapter includes a useful block diagram of the elements of a stored-program control (SPC) PABX and concise discussions of pulse-code modulation (PCM) and other coding systems.

Having laid the groundwork for the subject, the author then considers the various options for data transmission via a PABX. The implications of switch 'blocking' are discussed, particularly with reference to the variations in call-duration distributions between voice and data calls. The problems of transmitting data via various PABX technologies are then examined with reference to analogue non-SPC and SPC switches and digital switches. The chapter includes guidance on data transmission rates likely to be achieved and the use of separate and built-in modems. Brief mention is made of the use of digital extensions and interconnection with the integrated services digital network (ISDN). The chapter is concluded with a brief examination of why a PABX should be used to provide a company's data transmission capability.

Finally, the author overviews other data transmission options including local area networks (LANs) and private data switches. Some potential developments, including the integration of the PABX and LANs, are briefly discussed. An appendix giving some information about the ISDN and the data transmission options available in its provision is also included.

This book attempts to cover a wide and complex area briefly and simply. It succeeds in giving the general reader an overview of the subject, and would certainly be of use to managers wishing to know something of their company's communication facilities and the issues involved in their provision. It does not, however, provide sufficient depth to enable a manager to make informed decisions, particularly purchasing decisions, on what may be a major capital investment. It points out some of the technical issues involved, but in no way replaces the sort of informed advice which could, and should, be obtained from a communication manager or consultant. In particular, the issues involved in integration of voice and data communication, an area where technological evolution is taking place very rapidly, are given only a cursory examination. In summary then, this is a book which provides a useful general briefing on the subject of data transmission via the PABX, but it achieves no more than this.

S.E. Brady

ISDN—Interworking with other Networks

K. E. GLEEN, C.ENG., M.I.E.E.†

UDC 621.395.34

This article presents an overview of the means of interworking British Telecom's (BT's) pilot integrated services digital network (ISDN) with major existing networks. It identifies some of the main requirements for interworking equipment. It then amplifies one of the methods used for interworking to the BT packet-switched network as an example of the problems and solutions that need to be adopted in interworking between networks that may have very different characteristics. A section follows on the probable method of providing ISDN packet access in the future, given the emergence of the appropriate international standards. The possible ramifications on exchange (both voice and data) design are outlined in the light of packet access based on the 16 kbit/s D-channel.

This article is based on a paper presented at the Networks '85 Conference organised by Online International Ltd. and held in London in June 1985.*

INTRODUCTION

British Telecom (BT) is creating the first stages of an integrated services digital network (ISDN) based on the use of System X exchanges. The first step to be introduced is integrated digital access (IDA), which allows a customer to make two simultaneous connections to two independent destinations. Often those destinations will be terminals on existing non-ISDN networks. IDA must therefore offer interworking (digital and/or analogue) to these existing networks and the services they offer.

The requirements of interworking can involve

signalling conversion
call validation
speed, code and format translations
number translations
routeing
charging and tariffing
management procedures

These interworking requirements can be satisfied in two ways:

(*a*) as an integral part of the IDA/ISDN network, or
(*b*) via separate interworking equipment.

For various reasons, not least costs, complexity and time-scales, BT has chosen to employ the second method of providing the ISDN interworking capabilities for the IDA pilot service.

OTHER NETWORKS AND SERVICES

Public Switched Telephone Network

Interworking with the public switched telephone network (PSTN) for telephony is an inherent feature of IDA. No special arrangements or interworking equipment are required. The ISDN numbering scheme forms part of the UK PSTN numbering scheme and no translation or prefix is necessary.

KiloStream

It is possible to provide interworking connections between IDA and KiloStream to extend and enhance a customer's private digital circuit network.

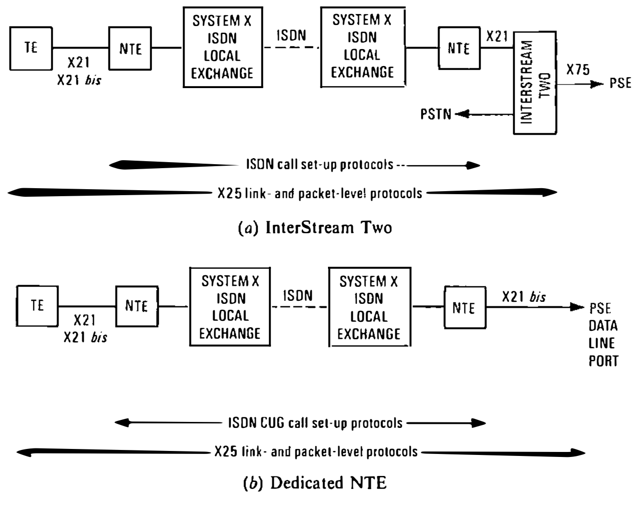
Packet SwitchStream

Interworking between the pilot ISDN and the Packet SwitchStream (PSS) network, a circuit-switched network and a packet-switched network, respectively, requires a two-stage call set-up. Firstly, a call must be made across the ISDN (using ISDN call-control procedures) to an ISDN interworking port on the PSS network. Secondly, a call must be set up across the PSS network (using PSS call-control procedures) to the destination address.

Two methods of access are available, both of which allow high-speed access with full CCITT‡ X25 protocols between terminal points.

InterStream Two

InterStream Two (see Fig. 1(*a*)), also called the *packet network adapter* or *PNA*, has been installed primarily to act as a PSTN/PSS gateway for the Teletex service. However, it



(*a*) InterStream Two

(*b*) Dedicated NTE

NTE: Network terminating equipment
TE: X25 dial-up terminal

FIG. 1—Packet SwitchStream interworking

† System Evolution and Standards Department, British Telecom Development and Procurement

* GLEEN, K. E. ISDN—interworking with other networks. Networks '85 Conference, London, June 1985, pp. 579–595.
Proceedings of the conference are available from Online Publications, Pinner Green House, Ash Hill Drive, Middlesex HA5 2AE.

‡ CCITT—International Telegraph and Telephone Consultative Committee

can also be used to interwork between the ISDN and the PSS for both Teletex and non-Teletex applications.

Calls from ISDN network terminating equipments (NTEs) to PSS terminals are made by a two-stage set-up procedure. Initially, a digital call from the customers' NTE to InterStream Two is set up. Once this has been established, the call is completed by using X25 call-request procedures between the customer's X25 terminal connected to the NTE, and InterStream Two.

Calls originating on the PSS network are completed by InterStream Two, which performs an ISDN call set-up across the ISDN to the called NTE. Once the link across the ISDN has been successfully established, InterStream Two forwards the X25 *incoming call* packet to the X25 terminal connected to the called NTE.

The connection across the ISDN, originated from the NTE, can be provided by either the fixed-destination call feature of the NTE or by normal dial-up procedures appropriate to that NTE and terminal.

This method of interworking can use either the 64 kbit/s or the 8 kbit/s channel as a bearer, but InterStream Two currently only supports a data rate of 2·4 kbit/s.

Dedicated NTE

For high-usage access to PSS, an NTE dedicated to the customer is provided at the packet-switching exchange (PSE) (see Fig. 1(*b*)). Calls may be originated across the ISDN only in the direction towards the PSS network and, unless this connection is already established, no incoming calls may be set up between PSS and the ISDN customer. Connection to the PSE from the ISDN customer is either by leased-line access or by utilising the closed-user-group (CUG) facility on dial-up access. (Both methods prevent fraudulent use of this facility by other customers.) With the ISDN connection established, normal PSS X25 protocols complete the connection across the PSS network.

All PSS data line rates up to and including 48 kbit/s will be available by this method on the 64 kbit/s channel. PSS data line rates up to 2·4 kbit/s will be supported on the 8 kbit/s channel.

Access to PSS also allows interworking to packet-switched services in more than 30 other countries, by means of the link between the PSS network and the international packet-switched service (IPSS).

International Circuit-Switched Data Networks

Methods of providing access between the ISDN and international circuit-switched data networks (CSDNs) are currently being investigated by BT International. An international CSDN gateway using CCITT Recommendation X71 will become available during the IDA pilot service. It is likely that first connections will be to the Datex-L CSDN in Germany.

Telex

ISDN-based terminals may interwork with the Telex network via the PSS network, with access to PSS by one of the methods described above (see Fig. 2). Two interworking units are provided between the PSS and Telex networks. InterStream One, or the Telex network adapter (TNA), provides interworking between the Telex network and the PSS network for character (asynchronous) or X25 terminals. InterStream Three allows ISDN- (and PSTN- or PSS-) based Teletex terminals to interwork with the Telex network.

Teletex Service

Whilst Teletex is not in itself a network, being a multi-network 'service', it is of sufficient interest to merit special

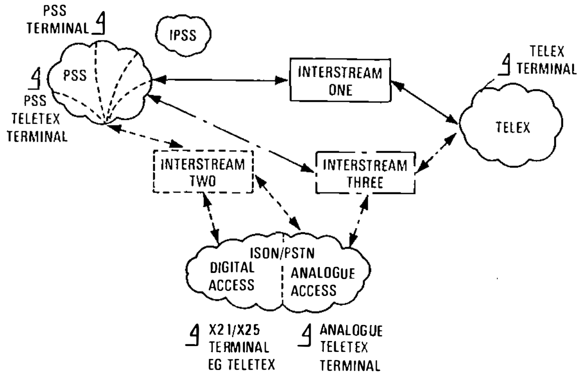


FIG. 2—InterStream One, Two and Three

interworking arrangements. Three types of Teletex terminal, operating to three different networks, are currently envisaged as using the Teletex service: PSTN-based terminals, PSS-based terminals and ISDN-based terminals. It is also a requirement of the Teletex service to interwork with the Telex network.

ISDN Teletex terminals will be supported on IDA via the X21/X21*bis* ports of an NTE, and can use either channel. Two types of terminals are supported by this interface arrangement (see Fig. 3).

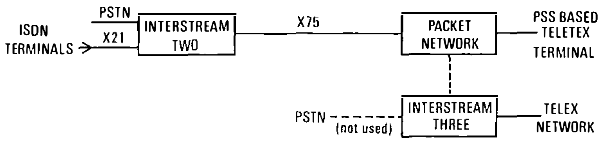


FIG. 3—Teletex interworking

(*a*) ISDN (X21/X25) Teletex terminals are connected to the customer's NTE via the X21 port. X21 procedures are used for initial call set-up, followed by X25 for the DATA TRANSFER mode.

(*b*) PSS-type Teletex terminals use the X21*bis* port on the NTE.

Connection between either terminal across the ISDN will be possible by using normal ISDN digital call procedures. Interworking with other terminals, including analogue-based Teletex terminals connected to the ISDN, requires the use of InterStream Two. If interworking is required with the Telex network, the use of InterStream Three (the Teletex conversion facility (CF)) in tandem with InterStream Two will be necessary.

INTERSTREAM TWO

InterStream Two is one of two existing interworking units connected to the ISDN (see Fig. 2) and one of three InterStreams connected to the PSS network. It is a good example of the interworking-unit approach adopted by BT for the ISDN pilot service. It is a specialised piece of equipment that provides most of the capabilities required, including:

(*a*) signalling conversion,
(*b*) call validation,
(*c*) speed, code and format conversions,
(*d*) optimum routeing, and
(*e*) management procedures.

The basic structure of InterStream Two is shown in Fig. 4. The interface to the PSS network at the X75 level utilises the sophisticated capabilities available on this interface from the existing PSS network. InterStream Two, as seen by the

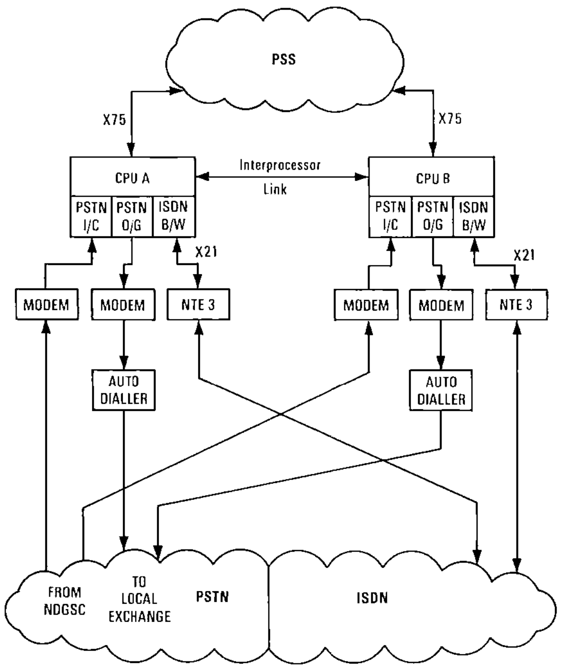
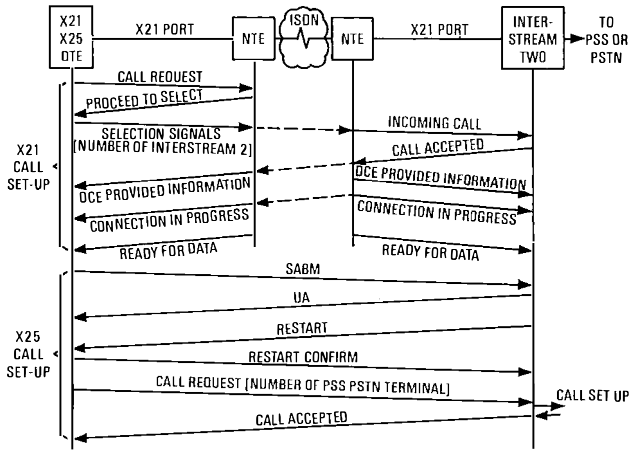
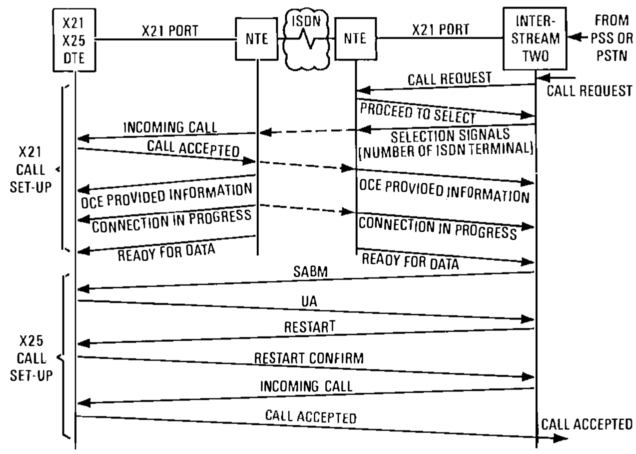


FIG. 4—InterStream Two



(*a*) Incoming call



(*b*) Outgoing call

FIG. 5—InterStream Two two-stage call set-up

PSS network, has similar facilities and characteristics to a packet-switching exchange.

An overview of the general method of interworking via InterStream Two has been given in a previous section of this article. The following explains in more detail the relationship between that method and each of the above capabilities.

Signalling Conversion

By their very nature, the PSS network and the ISDN are very different in their signalling philosophies. PSS uses 'in-band' signalling where control and user data information are conveyed on the same channel, whereas the ISDN separates signalling and data into separate channels (D-channel for signalling and B- and B′-channels for data). A 'half-way' point between the two extremes is, however, offered by the X21 interface where the bulk of call control, the call set-up, is performed on the same channel as the data transfer. No call control is transmitted on the data channel during data transfer and clear down is achieved by very simple signal states on the interface leads.

The main customer data interface offered by the pilot ISDN is X21, and this protocol forms the basis of the interface between the two networks.

Call Set-Up

InterStream Two uses a two-stage call set-up procedure (see Figs. 5(*a*) and 5(*b*)) to establish:

(*a*) a connection between itself and the user's terminal on the ISDN. X21 procedures are used during this stage of the call set-up. Once the X21 connection is fully established and the DATA TRANSFER state achieved, the second stage of the set-up is performed.

(*b*) an X25 connection between InterStream Two and the user terminal on the ISDN. To each end user, the nature of the connection across the ISDN is transparent; it is simply a synchronous data path between the two ends of the connection, in exactly the same way as a more traditional modem link.

Call Clear Down

Normal orderly call-clearing procedures are initiated by an X25 clear down followed, if appropriate, by an X21 clear down. The actual clear-down procedure adopted depends upon the direction of the initial call set-up across the ISDN.

(*a*) *ISDN terminal originated call set-up* If either the ISDN terminal or the PSS terminal clears the call with a satisfactory X25 clear procedure, then that call clears across the PSS network. The connection across the ISDN, however, does not clear until either a time-out of 60 s expires or any other call in progress on that same physical channel has also cleared. A single physical connection across the ISDN can therefore be used for successive calls (in either direction) and for more than one call simultaneously (currently InterStream Two profiles limit the number of simultaneous calls for each ISDN connection to ten).

(*b*) *InterStream Two originated call set-up* An X25 clear procedure from either terminal causes the ISDN connection to be cleared by InterStream Two (assuming no other call is in progress on that connection).

Call Validation

Call validation is performed on all ISDN calls handled by InterStream Two. This validation ensures that

(*a*) InterStream Two adopts the correct X25 profile for a Teletex or non-Teletex call, and

(*b*) only registered customer terminals can use InterStream Two.

For Teletex calls, the validation ensures that the Teletex profile is adopted by InterStream Two. Calls received across the interface with the PSS network, destined for an ISDN Teletex terminal, have the first octet of the call-user data field of the *call request* packet coded with the Teletex protocol identifier (TPI); that is, binary 00000010. Calls from ISDN Teletex terminals for Teletex terminals on either the PSTN or PSS are validated by a similar check for the TPI, taken together with the address of the calling terminal.

For non-Teletex interworking calls, the validation is performed in order to adopt the correct X25 profile for that terminal and to bar access to non-registered terminals. The called-address field of *incoming call* packets received across the PSS interface is examined (if the TPI is not present) and a look-up performed on a table of registered users. An entry in this table indicates the profile to be adopted. If a match is not found, the call will be cleared with *access barred* given as the cause of clearing. Calls from ISDN non-Teletex terminals do not insert their address in the calling-address field of a *call request* packet, but insert instead a user validation code (UVC), which will have been allocated by BT. A table look-up on this UVC gives both a profile and a network user address (NUA), which is substituted for the UVC in the *call request* packet forwarded to PSS. Non-matching UVCs cause the call to be cleared with the same cause as above.

Speed, Code and Format Conversion

Once the connection across the ISDN has been established, the only functions that InterStream Two is required to perform is speed conversion. Code or format conversion is not necessary since the ISDN terminals at this stage of the call are obeying the X25 protocol. Speed conversion is an inherent feature of packet-switched networks and exchanges because of their store-and-forward nature of operation. The management of the speed conversion is achieved by the flow-control properties of the X25 interface protocol.

It may be thought that numbering translation is necessary within InterStream Two: the ISDN forms part of the UK PSTN telephony numbering scheme (essentially conforming to CCITT Recommendation E163), whereas the PSS network conforms to its own numbering scheme defined by CCITT Recommendation X121. An example of each numbering scheme is given in Fig. 6(*a*). However, the use of the network digit in the X121 scheme means that translation is not, in fact, necessary. Fig. 6(*b*) shows examples of the called-address field in *call request* packets for each type of interworking call supported by InterStream Two.

Optimum Routeing

The routeing function of InterStream Two is used to prevent any billing and tariffing problems that could arise through possible asymmetrical call routeing. This can occur when interworking between networks that have differing tariffing and charging policies and methods.

Management Procedures

A range of management functions is supported by InterStream Two. These management functions are controlled from BT's sophisticated PSS network management centre (NMC) rather than from the ISDN (System X) operations and maintenance centre (OMC). Until a truly integrated network exists, the decision must be made as to which network will control any item of interworking equipment. That decision is based on where the network 'ends' in relation to the interworking equipment. For InterStream Two, the decision is clear cut: its interface to the ISDN is as a user terminal; its interface to PSS is as a packet-switching gateway.

The on-line management functions supported by InterStream Two may be accessed remotely from the PSS NMC. Facilities provided include

(*a*) control and read of statistics,
(*b*) change and read the status of any link,
(*c*) perform loop-back tests on out-of-service links, and
(*d*) add, delete and list entries in the UVC/NUA/profile tables and the routeing tables.

Off-line management functions are used to re-configure basic parameters required by InterStream Two; for example, timers, the maximum number of logical channels etc.

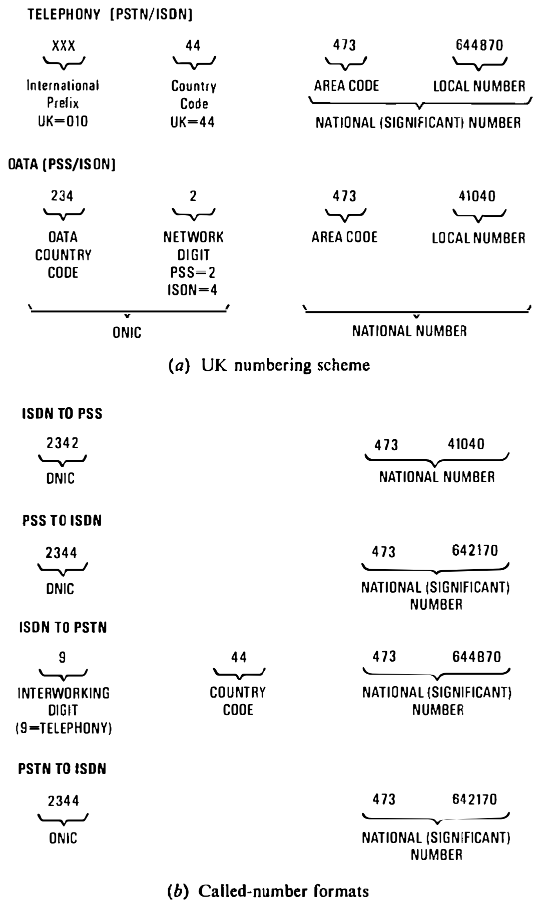


FIG. 6—Numbering of interworking calls supported by InterStream Two

ISDN PACKET ACCESS IN THE FUTURE

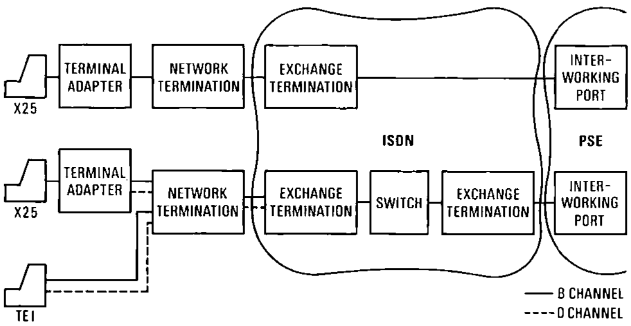
Future ISDN packet access is centred on the 1984 CCITT Recommendation (X31/I462) for *Support of Packet Mode Terminal Equipment by an ISDN.* The Recommendation recognises that the two networks may not, in fact, merge to become a true ISDN, but may remain complementary networks, each suited to different services and facilities. It does, however, address the problems of integrated access procedures between the two networks.

The Recommendation assumes an ISDN structure based on 144 kbit/s access with 2 × 64 kbit/s B-channels and a 16 kbit/s D-channel. The 16 kbit/s D-channel operates the link-access procedure (LAP)D protocol, allowing both signalling and data packets to be statistically multiplexed between the ISDN local exchange and customer terminal(s). High-speed packet access is provided on the two B-channels; low-speed access via the D-channel.

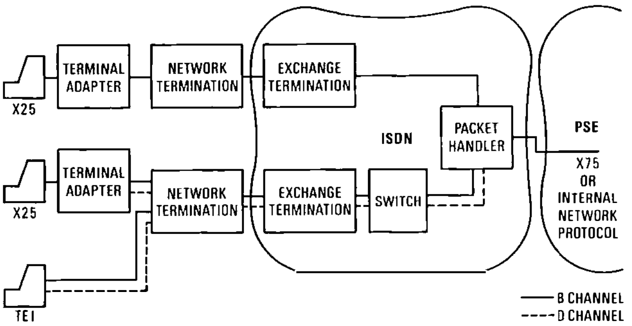
Two scenarios are envisaged:

Minimum Integration

The minimum-integration scenario (Fig. 7(*a*)) closely matches the methods of interworking adopted for the pilot



(*a*) Minimum-integration scenario



(*b*) Maximum-integration scenario

TEI: Terminal equipment 1

FIG. 7—ISDN packet access in the future

service. This scenario refers to a transparent handling of packet calls through the ISDN. Only access via the B-channel is possible. Support is given, as in the pilot service, to packet calls on a physical 64 kbit/s semi-permanent or switched B-channel. Two stage set-up procedures are still required to set-up calls both to and from the PSS network.

Maximum Integration

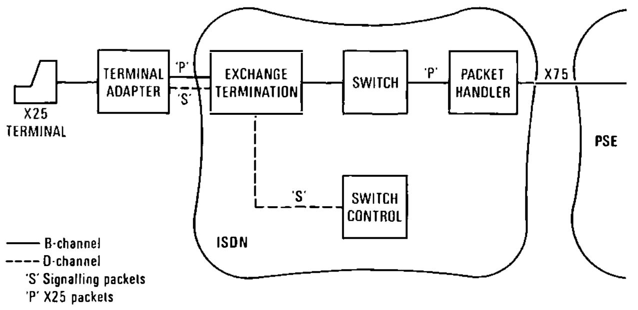
The maximum-integration scenario (Fig. 7(*b*))is the subject of active study and development within BT, UK industry and internationally. It refers to the provision of a packet handling function within the ISDN. Both B- and D-channel access is supported, with the packet handler (PH) performing the necessary processing for packet calls, standard X25 functions for X25, as well as path setting functions and possibly rate adaption.

Generally, the B-channel will support a single link-access procedure (LAPB or D) with multiple packet calls (virtual circuits) achieved by layer 3 multiplex procedures. The D-channel will support multiple links (from separate terminals), which may in themselves have multiple virtual circuits, via the layer 2 multiplex procedures inherent in LAPD.

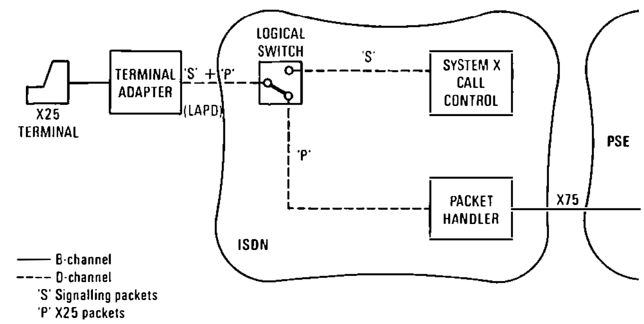
The procedures for B-channel access (Fig. 8(*a*)) are still separated into a similar two-stage set-up procedure as that described above. That is, the establishment of the ISDN access circuit by using LAPD signalling procedures on the D-channel, and the control phase of the virtual circuit(s) by using X25 procedures on the B-channel.

D-channel access (Fig. 8(*b*)) is on a 'permanent' access basis with no establishment phase being required across the ISDN. Although the link establishment between the terminal and the exchange may require an exchange of link information concerned with identification assignment and verification, packet access is always available on the D-channel and requires only X25 procedures to establish a call into and across the PSS network.

The exact nature and 'position' of the PH has yet to be determined; the CCITT Recommendation allows a number of possible options and configurations. The options range



(*a*) B-channel call set-up



(*b*) D-channel call set-up

FIG. 8—Call set-up

from using existing interfaces between the PH and the packet network to new and complex interfacing arrangements that more fully integrate the ISDN and PSS network. The latter may require major changes to the packet network, in both its structure and interfaces. All options are being closely studied within BT to evaluate their impact on existing and future networks and services.

CONCLUSION

This article has described the arrangements for interworking between the pilot ISDN and existing BT networks and services. One of the interworking equipments has been presented in some detail as an example of the requirements and solutions that need to be adopted in order to offer interworking, at least for the initial stages of an ISDN. This example has shown that to interwork networks of radically different type, without major changes to the existing network, requires specialised, complex equipment.

As international agreements are reached on the structure of both the ISDN and the interfaces and services it offers, the pilot service ISDN will be enhanced. Major changes to existing networks may need to be adopted to fully implement a complete ISDN. It remains to be seen whether a truly integrated network evolves that does not require any interworking between networks, at least at the national level.

Biography

Keith Gleen is Head of the Packet Communications Development Group in the System Evolution and Standards Department (SESD) of Technology Executive. He has been with BT for 23 years, starting his career as a Youth-in-Training in the LTR. After he moved to Research Department in 1970, he worked on local digital access (an early forerunner of integrated digital access, then prophetically called *Communications in the 1990s*!). During the major part of the 1970s, he was involved with the System X Local Exchange development, but in 1980 he joined the newly formed SESD to work on low-cost access methods to the PSS network and advanced PSE architectures and techniques. This work has led, over the past two years, to the development of several products, which include low-cost packet assemblers/disassemblers, X25 servers for local area networks and X21 testers and adapters. His group is responsible for the connection of the ISDN to InterStream Two.

ASPRO—On-Line Access to the ASCE

R. W. BUTLER, B.A., T.ENG., M.I.ELEC.I.E., and M. CLEMITSON†

UDC 621.395.74 : 681.3.06

This article describes a local enhancement to British Telecom's national annual schedule of circuit estimates (ASCE) computer system that makes access to the system easier. The enhancement illustrates the use of proprietary software packages to access large databases.

INTRODUCTION

There are 6288 telephone exchanges in the UK and these vary in size from small rural exchanges with less than 50 customers to large multi-unit installations serving over 30 000 exchange lines. Their interconnecting network, which together with these exchanges forms the public switched telephone network (PSTN), consists of more than 80 000 discrete routes and represents a sizeable piece of BT's asset base, attracting, for example in 1983/84, £559M out of a total capital expenditure of £1454M.

The *annual schedule of circuit estimates* (ASCE) is a key document in the planning and implementing of changes to the PSTN. The ASCE consists of forecasts in circuits and traffic (erlangs) for each route in the PSTN for the current and the coming nine financial years (for example, an ASCE forecast published in autumn 1985 would contain forecasts for the financial years 85/86 to 94/95). Different planning groups make use of different forecast years; for example, the forecast for the current year is the authority to install PSTN circuits, the forecast for year 3 is used as the basis for ordering pulse-code modulation (PCM) equipment, and the forecasts for years 8 and 9 determine the appropriate interface hardware on exchange equipment orders. Although the concept of the ASCE dates from the early days of automatic telephony, the present system[1] stems from its computerisation in 1979/80. The main output of the system for users is on microfiche, and this is produced quarterly.

In the relatively stable planning environment that existed when the ASCE was computerised, user output on microfiche was a reasonable compromise between ease of access and the cost of on-line computer access. However, the plans for the introduction of System X equipment, and the attendant refinements and optimisations involved in the planning process, have led to an increase in the quantity of data (new and amended route forecasts) being input to the ASCE, and with it the need for an improvement in the 'visibility' of the forecast data. During 1982/83, the junction network system (JNS) gave cable planning groups on-line computer access to a copy of the ASCE data[2], and it was decided in the Wales and Marches Board Headquarters to investigate what could be done, as a local initiative, to give non-JNS ASCE users, such as trunking and grading, exchange design and traffic planning groups (who relied on the quarterly microfiche), similar on-line screen access.

SYSTEM DEVELOPMENT

A copy of the national ASCE computer file was loaded onto the Cardiff Telephone Area Information Systems Unit's IBM 4300 series computer and a local interrogation program was constructed to access this. Arguably, the conventional approach to this would be to have written a (lengthy) program in COBOL, but instead the User Files On-line (UFO) applications generator package produced by Oxford Software Corporation was used. This package, which provides a high-level procedural language containing a number of COBOL-like statements, is an on-line system for creating, executing and maintaining complete on-line applications in an IBM CICS (Customer Information Control System) environment, and was chosen because of its ease of use and consequent saving in programming time. Some COBOL processing was however necessary, as indicated later. As the intention was to put a copy of the *AS*CE on a local *PRO*-cessor, the project was given the name *ASPRO*.

The national ASCE file, which resides on an IBM 3084 computer, consists of an entry-sequenced dataset with the records stored in order of the ASCE entry number (AEN) of each route. A tape copy of the national file was obtained and run through a preliminary COBOL program to extract entries proper to the Telephone Areas in the Wales and Marches Region (ASCE area codes 681, 682, 683 and 684). Of the various subcomponents in the national file, only the items relating to current data (records 17, 18 and 19) were copied over, and those relating to deleted or historic data (records 20 and 21) ignored. This data was further processed into four separate entry-sequenced datasets, and then converted by a SORT routine into four key-sequenced datasets entitled *ASCE001* to *ASCE004*.

The ASCE001 and ASCE002 files, which use the AEN as a key, hold the route and forecast data, and largely mirror the structure of the national file. The third file, ASCE003, is a linked list, constructed from the essential details in ASCE001 and ASCE002, and contains the THQ1141 code (a unique alphanumeric identifier) and termination code of the exchange at each end of the route, its outgoing selector level, and lastly the AEN. The structure of the ASCE003 file is illustrated in Fig. 1. Each item is labelled as a key in order to facilitate file access by THQ1141 code, as described later. (With this feature in mind it was in fact originally intended to use a copy of the national RAMASCE file (a copy of the ASCE file produced for use by the RAMIS database interrogation package) as this is 'double-ended', every route being listed not solely by AEN as in the national ASCE file, but twice; that is, against each of the two THQ1141 codes on each route (for example, Cardiff–London would also be listed as London–Cardiff). Unfortunately, the RAMASCE file does not contain some of the supplementary information, for example, route notes contained in the main ASCE file, and was thus not suitable. To overcome this setback the ASCE003 file was itself constructed as a double-ended file). Finally the fourth file,

KEY ←→ (A1141 to AEN); ← DATA → (AEN)

A1141	ATERM	B1141	BTERM	LEVEL	AEN
AA	STND	BB	E2ND	1	751234
AA	STND	BB	E2ND	2	752345
AA	STND	BB	K1ND	-	753456
AA	STND	CC	E2ND	-	754567

Note: A1141 = THQ1141 code for the exchange at the A-end of the route, BTERM = termination code for the exchange at the B-end of the route, etc.

FIG. 1—Structure of the ASCE003 file to illustrate sequencing arrangement

† British Telecom South Wales

ASCE004, using the THQ1141 code as a key, contains a list of the termination codes on file for each THQ1141 code.

SYSTEM OPERATION

In the working system, a tape copy of the national ASCE file is forwarded weekly to the South Wales District Information Systems Unit (DISU) at Cardiff, where it is loaded onto an IBM 4361 machine running the SSX (Small System Executive) operating system under the VM (Virtual Machine) hypervisor program, and the local ASCE001–ASCE004 datasets are then updated from this tape. Although a range of terminals can be used, the program runs especially well (as explained later) on the colour IBM 3179 terminal/3274 controller arrangement, which is to be the standard equipment for the customer service systems (CSS) project.

The program offers two separate means of access to the ASCE data: AEN mode, and THQ1141 mode. In the AEN mode, the AEN is entered and, by using the AEN as the key in the ASCE001 and ASCE002 files, the full details of the route are displayed. Two screens are provided, a main screen containing most of the data (illustrated in Fig. 2), and a second screen containing intermediate maximum conditions (where appropriate), and some other details, such as the traffic table used. The facility to 'browse' forwards (or backwards) to higher (or lower) numbered AENs is provided.

In the THQ1141 mode, the outgoing-end THQ1141 code and termination code and the incoming-end THQ1141 code and termination code are entered. The program then searches the ASCE003 file for as complete a match as possible, and uses the AEN from the first record meeting the selected criteria as the key for the ASCE001 and ASCE002 files to display the route details corresponding to the selected AEN. Browsing is again available, but, in this mode, to other AENs with the same THQ1141/termination code combination. To minimise the need for extensive browsing, the number of potential records can be reduced by also stipulating the selector level and/or the ASCE section number (for example, Section 2—External Junction Network, Section 5—Miscellaneous, etc.). Also in the THQ1141 mode, if the exact termination is not known, the program uses the ASCE004 file to give a 'help' screen displaying all the available termination codes against the stipulated THQ1141 code.

In practice, the combination of the termination help screen and the multi-key indexing of the ASCE003 file, together with the browse facility, means that generally the first three named parameters are sufficient to allow the user to reach the required route fairly quickly where the AEN is not known.

Lastly, in addition to browsing, further routes can be selected from the display screen, that is, without recourse to the preliminary menu, by overtyping either the AEN field in AEN mode, or the THQ1141 and termination fields in the THQ1141 mode. Where colour terminals are in use the appropriate field(s), depending on mode, are displayed in a different colour for ease of use.

```
YEAR END BROWSE     SOUTH WALES DISTRICT ONLINE ASCE    YEAR END BROWSE
                    ================================
CRS      TERM (O) STND   MTG H B     NE/TK    TERM (I)   K1GS   MTG CB
         TERM (I) STND   MTG CB               TERM (O)   K1GS   MTG H B
O/G LEVEL 9       AEN 752382         SECTION 2      O/G LEVEL 3

ROUTE NOTES

                YEAR ENDING                                    LENGTH    7
YEAR      ERLANGS              CIRCUITS              N/C

        O/G       I/C      O/G       I/C       B/W       OIB       YEAR NOTES

85/86   71.4     127.8     108       183       0
86/87   75.0     133.1     113       190       0               PRIOR CRS RCU
87/88   52.2      92.8      81       133       0
88/89   55.0      98.0      84       140       0
89/90   57.8     103.5      88       148       0
90/91    0.0       0.0       0         0       0         CC    PRIOR CRS MLE
91/92    0.0       0.0       0         0       0
92/93    0.0       0.0       0         0       0
93/94    0.0       0.0       0         0       0
94/95    0.0       0.0       0         0       0

(F)WD (B)ACK (I)NTERMAX (Q)UIT--->                       AEN BROWSE MODE
```

FIG. 2—Main display screen

As indicated earlier, RAMIS access is available to the national ASCE file for database interrogation. An equivalent system is available on ASPRO using the UFO Executive Inquiry package, and is relatively straightforward to use; for example, an enquiry to list all the routes terminating at TXE2 electronic exchanges (termination code E2ND) would be:

UFO DISPLAY FROM ASCE002

A1141 B1141 WHERE ATERM EQ 'E2ND' OR BTERM EQ 'E2ND'

FURTHER DEVELOPMENTS

The program could be developed further. New data (for example, revised route forecasts) is input to the present national ASCE system by means of on-line data capture (OLDC). This involves ASCE forecasting staff having to learn and retain a considerable amount of computing expertise; for example, knowledge of the CP/M microcomputer operating system, the details of the OLDC program and its related communications package, and the rudiments of the IBM TSO (Time Sharing Option) command language. A more simplified inputting system could be constructed by using full-screen editing of the display for any given AEN. It is felt that this UFO-based package has the inherent potential to cope with such a development.

CONCLUSION

The ASPRO project has proved successful not only in its own right as a means of increasing the local visibility of the national ASCE, but also as an example of what is possible in giving ready access to centrally-run national databases by using commercially-available packages and only a moderate amount of program writing.

ACKNOWLEDGEMENT

The authors would like to thank their several colleagues throughout British Telecom (BT) who readily gave their assistance to the development of this project.

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Biographies

Roy Butler is an Assistant Executive Engineer with BT South Wales. He joined the then Post Office in 1968 in the Shrewsbury Telephone Area and, as a Technical Officer, worked on radio and television interference investigation. On promotion to Assistant Executive Engineer in 1979 in the Cardiff Telephone Area, he was responsible for the Area's circuit provision planning function, and transferred in 1984 to the newly set up Information Systems Unit. He is currently a member of the District's CSS implementation team.

Michael Clemitson is a Senior Telecommunications Superintendent with BT South Wales. He joined the then Post Office in 1968 as a Telecommunications Traffic Superintendent in the Preston Telephone Area, where he was employed on traffic design and, later, customer service duties. On promotion to Senior Telecommunications Superintendent in 1980, he was responsible for the setting up and running of the operational arm of the Wales and Marches Regional Prestel Centre. He is currently responsible for the District's traffic design and ASCE forecasting function.

Telecom Technology Showcase Resources Centre

In Search of The Past, Present and Future

N. JOHANNESSEN†

When British Telecom's Technology Showcase opened some three years ago, it set out to display not only the historical artefacts of telecommunications, but also current technology and, where possible, to glimpse the future. In addition, over the years, a large amount of historical information has been collected and this is housed in the Resources Centre.

INTRODUCTION

Whichever way you look at it, telecommunications is a subject of great interest. Be it the enthusiastic engineer who finds it fascinating, the layman, the teacher or the school child who is better off for an understanding of it, each and everyone has a good reason for wanting to know more about telecommunications. Whether as historical information, current fact or future forecasts, there is a widespread and, it would seem, growing demand to know more about the subject.

SOURCES OF INFORMATION

Finding out information about the history of telecommunications has never been easy. This is not to say that the information does not exist, but merely that it can be difficult to find and, more important, very hard to digest. Quite often, what is available is very narrow in interest, such as technical books and, to a certain extent, journals such as this.

Archival material, however, is something that usually appeals only to the determined enthusiast. Specific and hitherto undiscovered facts abound in the reams and reams of papers that can be found in 'archives' throughout British Telecom. For national archives prior to 1969, one needs to look at the Post Office Archives. Welcoming though the staff of such repositories are, serious study of archival material is not for the faint hearted.

Reference libraries are a much more forthcoming way of learning and discovering. Until recently, most Telephone Areas had libraries, many probably still exist and in these a useful cross-section of readable material could be found. The Institution of British Telecommunications Engineers (IBTE), formerly The Institution of Post Office Electrical Engineers (IPOEE), runs a national library and some local libraries. Sets of various journals, exchange lists, Circulars and Gazettes, Reports and Accounts, published books and often material of local interest are typical of the range of material that may be held. Many of these also have the two most useful study aids: indexes and tables and chairs.

The journals to look out for include, of course, the IPOEE/IBTE Journal, *British Telecommunications Engineering*, which runs from 1908 to the present day and deals with most engineering and technical subjects. In the same way, the Journal of the Institution of Electrical Engineers (IEE), *Electronics and Power*, can be useful, as can the IPOEE Red Papers that are published versions of talks on a wide range of subjects. Going even further back there is the *Telegraphic Journal & Electrical Review*, the forerunner of the IEE Journal.

† Manager, Telecom Technology Showcase

GENERAL INFORMATION

On a less technical and more general, in some ways social, level there are *The National Telephone Journal* (1906–1912), the *St. Martin's Le Grand Magazine* (1890–1933), *The Telegraph and Telephone Journal* (1914–1933), the *Post Office Magazine* (1934–1966), *Courier* (1966–1979) and *Telecom Today* (1980 to date). These are usually well illustrated and, for the most part, well indexed. There are also innumerable other in-house magazines ranging from *Green Papers* to *Traffic*, and all of these are useful in their own way.

Published books are another useful source of information and, although the number of these is not large, they also have the advantage of being available in public libraries. They are unlikely to be stocked by them, but can be obtained through the inter-library loan system. The standard works, such as *Telephony* by Herbert & Proctor and *Telephony* by Atkinson, spring to mind as sources of information—but for the historian, a more general overview is to be found elsewhere.

There is of course the quite recently published *The Telephone & The Exchange* by Povey, a brief but clear introduction for all ages. Older titles, all long out of print, include *The History of the Telephone in the UK* by Baldwin (1925); *The Telephone & Telephone Exchanges* by Kingsbury (1915); *The Story of the Telephone* by Robertson (1947); *The Electric Telegraph* by Lardner (1855); *Submarine Telegraphs* by Bright (1898) as well as many other books with useful chapters depending on the reader's interest. Recently, the BT Education service has produced useful material on payphones and kiosks, pioneers in telecommunications, and a list of names and dates. These are distributed for sale through local contacts, often the public relations departments.

Reprint of the IPOEE 50th Anniversary Edition of the *Post Office Electrical Engineers' Journal* available from Telecom Technology Showcase

TELECOM TECHNOLOGY SHOWCASE

Of all repositories, the Telecom Technology Showcase Resources Centre is probably the best stocked providing, for the non-archival reader, the most comprehensive range of material; it is, however, located in London and can be used only by appointment. The Showcase itself is open Mondays to Fridays, 10.00 am to 5.00 pm and its displays are often comprehensive enough to answer most questions. The Science Museum in London is similarly worthy of a visit, and throughout the country there are collections of varying sizes cared for by local enthusiasts, often in their own time and often associated with the IBTE.

Telecom Technology Showcase also houses a souvenir and book shop. Here can be found for sale many of the titles that are available, ranging from semaphores to satellites, and including material on some local Areas.

The most recent title to be added to the list is a reprint of the IPOEE 50th Anniversary Journal*. As perhaps the single most useful record of Britain's telecommunications over the first half of the century, this reissue has already been welcomed by those aware of its value. If successful, it is hoped that further, and hitherto 'lost' material will follow. Given the growth of interest in the subject, this seems likely to be the case.

* IPOEE 50th Anniversary Issue. *Post Off. Electr. Engs. J.*, Oct. 1956, **49**(3).

Available from Telecom Technology Showcase, 135 Queen Victoria Street, LONDON, EC4V 4AT. Price £2.75, post and packing free. Other Showcase Shop items also available by post—details on request.

Telephone Poles in the British Telecom Network—A Review

Part 1—Wood Poles

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This article, which is to be published in three parts, generally reviews the subject of the telephone pole, both the conventional wood type and the newer hollow pole. In the case of the wood pole, the cycle from the growing tree to the final demise of the decayed pole is covered. Particular stress is put on the explanation of why various materials and techniques have been adopted.

This part begins by examining the present use of telephone poles in the British Telecom network and goes on to describe general aspects of wood poles. Part 2 will describe engineering aspects of the use of wood poles, with particular attention to pole testing, and Part 3 will review the use of alternative materials for poles.

INTRODUCTION

Overhead distribution has been a feature of telecommunications since its earliest days and the pole still continues to play a major role in the network. Although the number of overhead routes in existence is much reduced, the number of poles being issued annually has remained high because of the major growth in distribution points (DPs) in residential areas. About 4·5 million poles are in use and about 100 000 new poles are issued each year, either for new work or the replacement of old poles.

The technology has been remarkably stable; the *Pinus sylvestris* tree still provides the main source of supply, with creosote as the standard preservative. The major changes over the past quarter of a century can be summarised as follows:

(*a*) The virtual disappearance of overhead open-wire trunk and junction routes has brought about the demise of the *stout* pole and the very tall poles, present-day requirements being almost entirely satisfied by *light* or *medium* poles of 15 m or less in height. The *extra light* pole is also obsolescent.

(*b*) A substantial proportion of pole erection work is now mechanised; the pole erection unit (PEU) with a two-man team suffices for about 60% of poling work.

(*c*) The introduction of the hollow pole has provided a means of complete avoidance of climbing of overhead distribution (DP) poles with the consequent improvement in safety, particularly as DP poles are those climbed most frequently.

The wood pole is unique among telecommunications equipment because it is a product used in its natural form with a very limited amount of processing. Being a natural product, its properties are also potentially very variable and the production of a safe, durable product requires a combination of subjective and objective selection and analysis. The widespread introduction of a new species of wood or a new preservation process must be approached with considerable caution, for many years are likely to elapse before a valid assessment can be made of their performance, and it can be costly to recover from an unsuccessful trial. The capital cost of the wood pole is low in comparison to the labour and transportation costs involved in getting it to site, erected and wired or cabled; this encourages a conservative approach to changes in long-established and proven materials. This reservation does not apply to the hollow pole, which, as a manufactured product, can be designed at the outset for a much more predictable performance.

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USES OF POLES IN THE NETWORK

Local Distribution

About 25% of all poles in use provide overhead DPs, commonly called *distribution poles*; about two out of every three customers are supplied with telephone service by this means. An overhead DP can have up to 20 feeds radiating from the pole head (Fig. 1(*a*) and 1(*b*)); formerly, open-wire feeds were used, but most have been replaced by dropwire cables. A single span suffices for 80% of such feeds, but, where more than one span is necessary, light poles are used for intermediate supports. According to the number of dropwires likely to be fitted to a distribution pole, a medium or light wood pole is used; alternatively, a hollow pole may be installed.

Aerial Cables

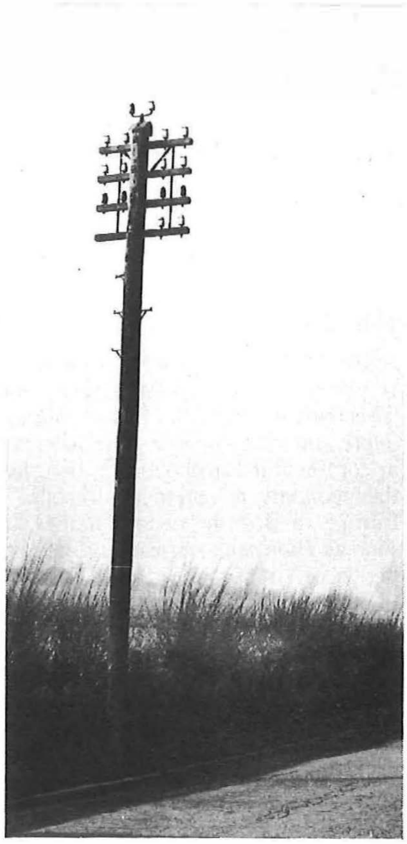
The other major application for poles is to support aerial cables (Fig. 1(*c*)). Such cables are likely to be heavy and the wind forces high, so a pole route for such cables needs to be designed with care. Medium poles are normally used, although many of the former stout type are still in use, often reduced in height compared to their original condition when they would have carried many open-wire circuits. Staying of poles on an aerial cable route is necessary where a change of direction of the route takes place or where a cable suspension wire is terminated.

Open-Wire Routes

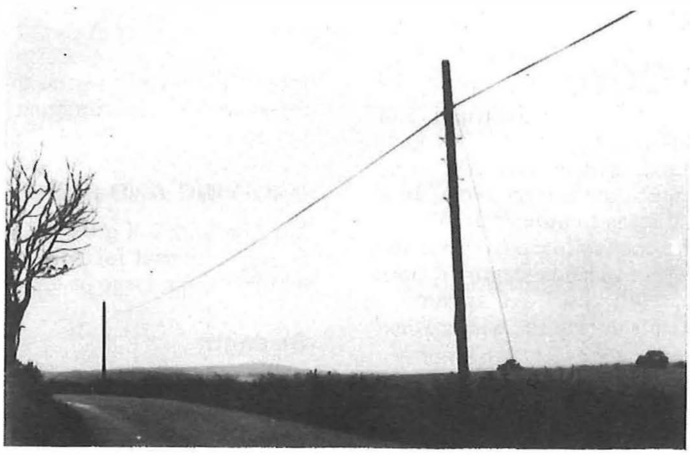
Open-wire systems were formerly the principal means of carrying telephone and telegraph circuits, but few remain, the remainder having been displaced by underground or aerial cables. The routes that still exist are found in the sparsely populated and remote areas (Fig. 1(*d*)). Ice accretion is the major hazard on such routes, and the excess mass of the ice and increased windage as a result can lead to a pole being displaced or broken. Early volumes of the *Journal*[1–3] record a number of events where very extensive damage resulted from 'ice storms'; for example, a blizzard on 27/28 March 1916 caused 6994 poles to be broken or felled, and another 26 551 deflected!

(*a*) A typical wood distribution pole

(*b*) A hollow distribution pole



(*d*) Open-wire route poles



(*c*) Poles supporting aerial cables

FIG. 1—Typical applications for telephone poles

Other Uses

Very tall wood poles were commonly used at Post Office radio stations to support antennae. Heights generally ranged from 15 m to 32 m. The taller examples were made up from two or three selected poles that were spliced together by scarf joints to achieve the desired height. Such poles were used as guyed masts and were only shallowly founded, the desired stability being gained by the use of staying. The use of such poles was discontinued in the 1960s and light steel masts were used instead.

THE WOOD POLE—FUNCTIONAL REQUIREMENTS

The qualities needed for a pole are:

(*a*) *Strength* It must be able to withstand the bending and compressive stresses imposed by wire and cable loading, staying, wind and ice, and staff working aloft.

(*b*) *Stiffness* Excessive deflections should not occur under load. A pole that bends noticeably under static loading is visually unacceptable. A pole that sways excessively in the wind may impose significant fluctuating loads on wires and cables, leading to their premature failure by fatigue.

(*c*) *Long Life* The timber should be naturally resistant to decay or readily impregnated with preservatives. New timber should be free from defects which could reduce its life.

(*d*) *Toughness* The pole should withstand the relatively heavy handling and transportation likely to occur at several stages from felling the tree to erecting the pole.

(*e*) *Appearance* A clean, straight, uniformly-tapering pole is more acceptable to the public, particularly in urban environments.

(*f*) *Reliable Supply* It is most desirable that the sources of supply for the material used are reliable and consistent.

(*g*) *Cost* As large numbers of poles are purchased each year, capital cost is significant; but this must be balanced by the high labour costs involved in the erection, testing and renewal of the pole in the field. The life of a pole is very long compared to most telecommunications plant.

THE TREE

About 85% of all the poles in service are of the species *Pinus sylvestris*. *Pinus sylvestris* is one of the three coniferous trees truly native to the British Isles, and is commonly called *Scots pine* or *Scotch fir*. The species also grows very widely in continental Europe and is the most important timber in the economy of northern Europe. When imported from Europe to Britain, various names are used to describe it, such as *European redwood* or as a *redwood* prefixed by the region or country of origin (for example, *Baltic redwood*). (The terminology can be confusing as *redwoods* in America and Asia are of completely different species and of sequoia or related families.) In addition to *Pinus sylvestris*, other species have been tried for poles, with varying degrees of success. Douglas fir, Corsican pine and larch have been found to be satisfactory and purchased in quantity in recent years.

All the species of tree used for poles by British Telecom (BT) are coniferous and therefore are *softwoods*. Softwoods are not distinguished from *hardwoods* by the degree of hardness of the wood (for balsa is a hardwood!), but by the form of the seed and the cell structure. Softwoods are classed as *gymnosperms* (literally, *naked seeds*) and bear cones containing naked seeds. The hardwoods are one group of the *angiosperms* (literally, *vessel seeds*) and the seed is enclosed in a seed case. Softwood leaves are typically needle-like and hardwoods are broad-leaved. The cell structure of the two classes of tree also differs. The hardwoods have three types of cell—vessels, fibres, and parenchyma—and the softwoods only two—tracheids and parenchyma. In a hardwood, the function of the fibres is to impart strength to the tree and the vessels are the conducting tissues for the flow of sap. In a softwood, the tracheids combine both functions. The parenchyma in both cases act as storage tissue and hold reserves of nutrients during the winter when sap movement is minimal.

The trunk or bole of a tree (as also branches and roots) is covered with a layer of cells called the *cambium*, which is a thin layer between the bark and the wood. In the growing season, the cells in the cambium divide to produce many new cells, those on the inside becoming wood and those on the outside becoming *bast*. The wood cells, as they grow, push the cambium and other outer layers outwards and so increase the diameter of the trunk.

When the cambium cells divide in the spring, large cells are produced on its inner layer and these constitute the *early wood* or *spring wood*. As the growing season progresses, the cells that are produced become smaller, denser and darker (known as the *late wood* or *summer wood*) until the end of the season, when they are very small. In Scots pine/redwood, these annual rings are quite distinctive because of the cell size and colour changes. In any one ring, the late wood typically occupies about one quarter to one third of the thickness of the ring. The succession of annual rings to a depth of 25–75 mm constitutes a distinctive zone called the *sapwood*. This is living tissue and is active in the storage and transport of nutrients and water from the roots to the leaves. As new rings are added, the existing sapwood progressively hardens or lignifies as the cells fill with lignin, a hard durable substance, and changes into the *heartwood*, which is, in effect, dead wood and functions solely to impart strength to the tree. As the sapwood is softer and less dense than the heartwood, it is more prone to decay, but when the tree is converted to a pole this is fortunately counteracted by the sapwood being more permeable and so takes up preservative more readily. The visible distinction between heartwood and sapwood varies between species: it is moderately well marked in Scots pine/redwood and Douglas fir, but indiscernible in others such as larch (Fig. 2). In the leaves, photosynthesis occurs and the substances required for growth of the cambium travel down the tree as sap in the bast.

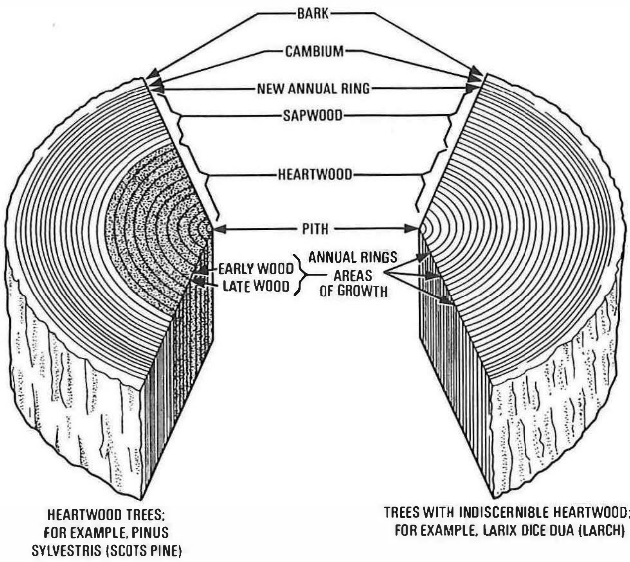


Fig. 2—Tree cross-sections

GROWING AND PROCESSING

The conditions of growth are important for producing satisfactory material for poles, which must be strong, straight, and free from large or dead knots or other defects.

Strength

Climatic changes affect the growth and spacing of the annual rings; the closer together and more evenly spaced they are the greater the inherent strength and resistance to decay of the timber. In general, as the tree gets older, the timber gets denser and stronger, and so a tree grown slowly is more likely to have a greater strength size-for-size than a tree grown at a faster rate. In Britain, owing to the mild winters and long periods of seasonal growth, the annual rings tend to be farther apart. In the colder parts of northern Europe, where summers are short and the long winters severe, the texture of the timber is more solid and the grain closer. Of home-grown trees, those grown in the north of Britain, where climatic conditions are more severe, are more likely to produce timber of the required quality for use as poles. Although a definite correlation between ring spacing and strength cannot be established, it can be stated that trees grown either very rapidly or very slowly produce weaker timber. In the case of Scots pine/redwood, timber with less than 8 rings to each 25 mm of radius is not accepted for use as poles; hardgrown imported redwood commonly exhibits 20 rings or more per 25 mm.

Ring width is only a rough guide to likely pole strength; factors such as the proportion of late to early wood, density and various defects need also to be taken into account when the suitability of timber on grounds of strength is determined.

Straightness

If trees are grown in a forest close together, straight growth is produced as lateral branches are discouraged at lower levels and each tree competes with its neighbours for light and air. Small deviations from straightness are permitted in the specifications for poles. Crooked poles are not necessarily weaker than straight poles but they are unsightly.

Felling and Initial Processing

Trees have customarily been felled for use as poles when there is little or no movement of the sap in the colder months of the year, the argument being that the timber is then dryer. There is, however, no evidence to support this widely-held view concerning dryness. The main advantages of winter felling are firstly, the risk of fungal and insect attack is minimised and, secondly, over-rapid drying is avoided, which could cause splitting especially at the cut ends.

The tree is cut as near to the ground as possible to conserve as much of the natural butt as practical to provide a good foundation. However, with the advent of mechanised pole erection, excessive fluting at the butt is undesirable, and the natural butt may be cut back before processing to give a diameter to suit the hole drilled by an earth auger. All the top branches are lopped off before the tree is drawn out of the forest to a clearing where the outer bark is stripped off. The logs are then transported to the contractor's works, where they are examined by a BT pole inspector and, after selection, are dressed by machine to remove the inner bark, the swellings of wood around the knots and excessive sap-wood on oversize poles.

Seasoning

A tree when felled is 'green', that is, its cells are still full of sap, and the moisture at this stage can be equal to or greater than the dry mass of the woody material. A pole in this condition would be especially prone to decay and could take up little preservative. It therefore has to be seasoned. The poles are stacked so that air can flow freely around each pole for six months to two years, according to pole and weather conditions. Kiln drying to accelerate the seasoning process under controlled conditions is often used for producing construction timber and is being investigated as a means of speeding up the seasoning process for poles. During seasoning, the moisture content is reduced to about 25% of the mass of an oven-dried sample of the wood, and the wood cells harden. In addition, a number of minor longitudinal splits, known as *checks*, appear in the sapwood. These checks assist in penetration of preservative, although large ones, called *shakes*, are undesirable.

Careful seasoning is an important factor in determining pole life. For example, the prevalence to decay of poles creosoted in the period 1914–28 has been noted[4]; the seasoning period was then shortened materially to cope with the demand for poles.

TIMBER DEFECTS

Because trees are very variable in their characteristics, there is a limit to the objective criteria which can be used for selecting suitable material for poles. Several features, such as dimensions, can be specified, but much depends on the experience of specialist pole inspectors employed by BT. The significance of some possibly deleterious features is indicated below. Results[5, 6] from the testing of poles in America and by BT have shown that it is difficult to quantify the effect of specific defects, but general statements can be made.

Knots

Knots are an inevitable feature of timber as they mark where branches existed. The knots may extend to the surface if the branches were present at felling, or they may be overgrown by later growth if, at an earlier stage of the tree's life, the branches had broken off or had been deliberately pruned to produce better quality timber. Trees grown close together tend to yield timber with smaller knots as the main branches develop higher up the tree. Branches on Scots pine/redwood develop in rings or *whorls* around the tree (Fig. 3) and, if a ring of knots is too large, the pole could be weakened; limits are placed on the size of individual knots and on the amount in the circumference occupied by knots. In the case of Douglas fir and larch, the knots are scattered irregularly.

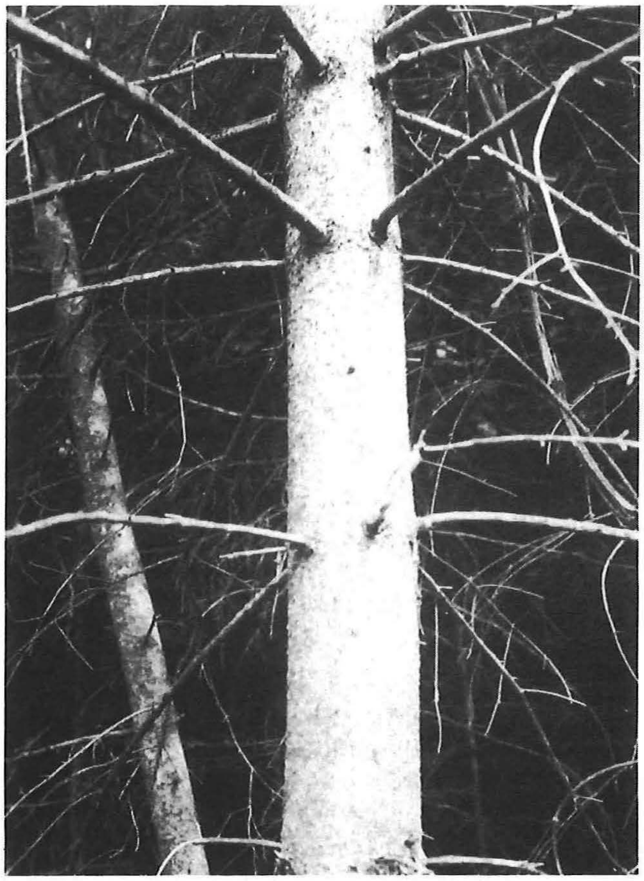


FIG. 3—Branch formation on a European redwood

Dead knots are those not firmly embedded in the rest of the wood. These are usually the result of the presence of a decayed branch. Such knots are likely to have a gap between them and the living wood, and this gap can act as an entry point for decay. They are also likely to weaken the pole.

Checks

Checks are small longitudinal splits of shallow depth resulting from the separation of the fibres along the axis of the pole and occur during seasoning. As stated above, these can be beneficial in facilitating the penetration of preservative during creosoting.

Shakes

Shakes are more severe in extent than checks. Large shakes can penetrate to some considerable depth and, if they open up

FIG. 4—Cross-section showing shakes penetrating to the heartwood, where decay is well advanced

more after creosoting to the extent of exposing unprotected wood, they could act as seats for decay (Fig. 4). No identifiable reduction in the strength of a pole has been noted in bending tests, although shakes must reduce the shear strength of the pole. Another form is the ring shake, where the separation of the wood tissues follows a growth ring and so is not visible unless the pole is sectioned.

Spiral Grain

Sometimes a pole grows as a straight column but the grain of the wood forms in a spiral manner. This is undesirable for trees intended for conversion to sawn timber for the construction industry but, unless severe, probably has little influence when the tree is used as a pole.

Proportions of Sapwood and Heartwood

When timber for poles is selected, a compromise is needed between the ease with which sapwood can be impregnated with preservative and the higher strength of heartwood. In the case of Scots pine/redwood, poles with sapwood extending to about one third of the radial depth are preferred.

Asymmetric Growth

With asymmetric growth the annual rings grow unevenly around the circumference of the tree and an eccentric cross-section results (Fig. 5). A pole made from such material has a varying strength and stiffness according to the direction of loading, and compression wood may also be present (see below).

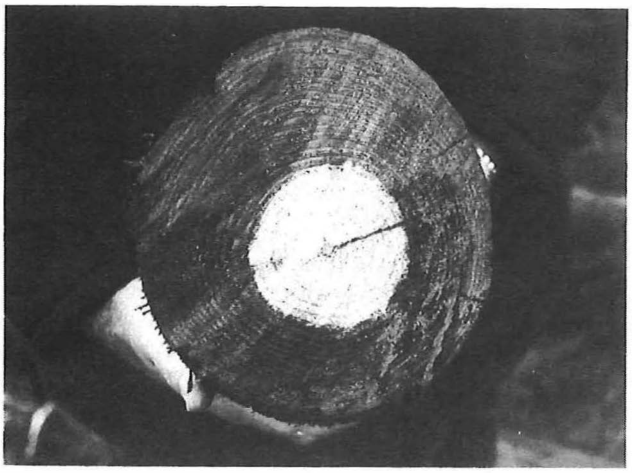


FIG. 5—Asymmetric annual ring growth

Brashness

Brashness is a term used to describe the condition when the natural toughness of the timber is appreciably reduced. Toughness is a measure of the material's resistance to the propagation of cracks during stressing, when large quantities of energy are absorbed. The typical pole fails slowly, with considerable disruption of the wood occurring over a long length (as in Fig. 6). A pole that is brash fails suddenly and breaks off quite cleanly (see Fig. 7). In normal wood, the tensile strength is usually substantially higher than the compressive strength; in brash wood, there is less difference in strengths and this factor contributes to the clean nature of the break.

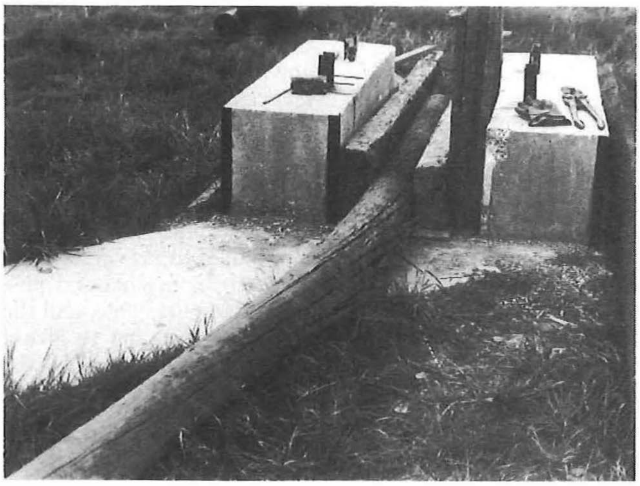


FIG. 6—Typical fracture of pole under test

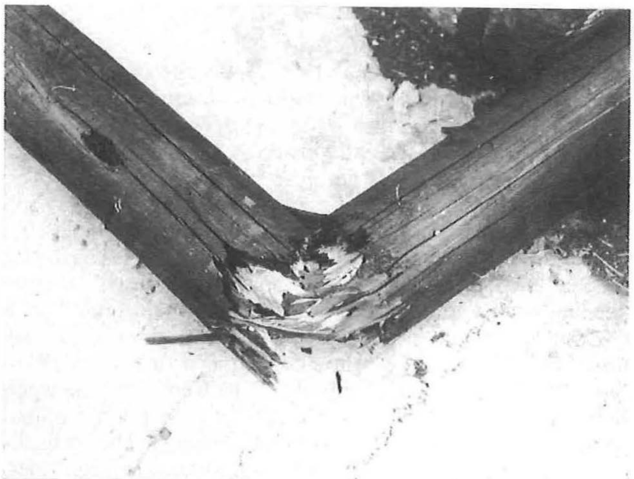


FIG. 7—Failure of brash pole

Several causes have been identified as leading to brashness[7]; the most frequent cause in softwood is the presence of compression wood in the tree. As a tree grows, some wood may have tension or compression 'locked in' and this has abnormal lignin and cellulose contents.

In 1979, a large-scale investigation into the properties of a batch of poles, all of which exhibited brash fractures during test, showed that such poles were only marginally weaker than non-brash poles.

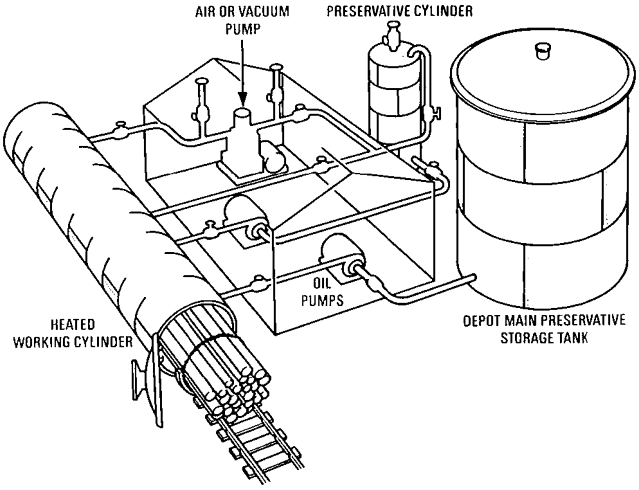


FIG. 8—Layout of creosoting plant

Decay

Wood decay is caused by the growth of fungi, the spores of which feed on the wood and cause it to disintegrate. Fungal growth generally needs warm, damp and oxygenated conditions to sustain it, and so exterior timbers are especially vulnerable, particularly when in contact with the ground. Softwood has only moderate resistance to decay, and a Scots pine pole could be expected to last only about five years, unless treated with preservative. Fungal decay can attack the timber in the growing tree, after felling, during seasoning, and finally in the standing pole. Several fungi cause rot but one is of especial relevance in the present context for, even when treated with creosote, softwood does not acquire an indefinite life. The fungus which accounts for most of the decay of such wood is *Lentinus lepideus*, and it is remarkably resistant to creosote, albeit in low concentrations[8]. It is economically the most important fungus causing decay of poles, railway sleepers and softwood fencing. *Lentinus lepideus* can attack wood that has up to about 15 kg/m^3 creosote content. Although poles are initially impregnated with about eight times this amount, the concentration declines over a long period of time and the wood becomes vulnerable to decay. As the creosote concentration further reduces, other fungi are able to attack the wood, notably microfungi which lead to soft rot. Deterioration of a pole can be accelerated if fungal spores can gain access to the interior of the pole, as in the case of cracks in the wood opening up after preservation, the heartwood is likely to be attacked, particularly as it does not take up creosote as readily as sapwood. The exterior of the pole may then look sound, yet the interior may be severely decayed.

POLE PRESERVATION

Some form of preservative process is essential to achieve an acceptable life for a pole. A number of different types of preservative have been tried, but creosote has proved to be the most acceptable. Creosote not only inhibits fungal decay, but also deters attacks from boring insects, although insect attack is only a minor problem in the UK.

With the advent of coal-gas production on a large scale and the distillation and use of the by-products, it soon became evident that in coal-tar creosote a most efficient preservative had been found, and it was used extensively as the standard preservative for wood poles used by the Post Office from the early 1900s onwards. Creosote is a complex mixture of distilled tar oils, and its constituency varies according to the nature of the coal tar and control over the distillation process. The creosote used for preserving poles is described in the appropriate British Standard[9] as consisting 'wholly of a blend of distillates of coal tar and shall be free from any admixture of petroleum oils or oil not derived from coal tar'. It is specified in broad terms in the form of the maximum and minimum percentage volumes of distillate at four discrete temperatures, its phenol content and insoluble matter.

With the introduction of North Sea gas and the consequent decline in the production of coal-gas, together with its associated by-products, a new source of supply for creosote had to be found; this resulted in the bulk of the creosote now used originating as a by-product of the carbonisation of coal to produce smokeless fuel.

Creosoting is carried out by the Rüping (often anglicised to *Rueping*) pressure process, which was first used for poles in 1913 (Fig. 8 is a schematic drawing of a creosoting plant). In this process, fully-seasoned poles are loaded on trucks and wheeled into the heated working cylinder, which is then sealed. The sequence of operations for treatment of Scots pine/redwood is as follows:

Stage 1 The air in the cylinder is pressurised to about 3·45 bar to compress the air in the wood cells.

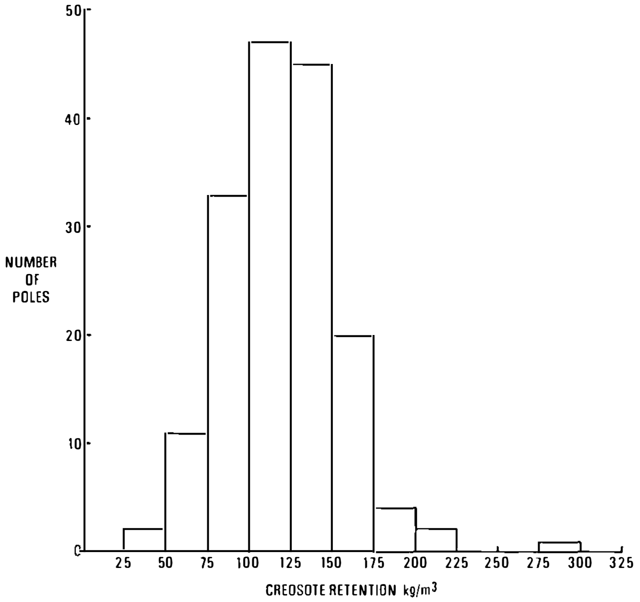
Stage 2 Without the air pressure being released, hot creosote at 80°C is transferred from the preservative tank to the working cylinder until it is full. The pressure is then increased to 12·5 bar and extra creosote is pumped in from the main storage tank until the requisite amount of creosote has been absorbed. This is determined on the basis of an injection of 240 kg of creosote for each cubic metre of timber loaded into the working cylinder.

Stage 3 The pressure is released, the surplus creosote drained off and a vacuum applied for at least one hour. This drives out the surplus creosote within the wood cells while leaving a coating on the cell walls; about 115–128 kg of creosote per cubic metre is retained in the timber.

Stage 4 The vacuum is released and the timber removed from the working cylinder, at which stage the poles appear dry. They are then taken to pole stacks and allowed to weather prior to issue.

The Rüping process is successful in forcing creosote to penetrate the sapwood of Scots pine/redwood; but, in the case of larch and Douglas fir, there is a greater difficulty in impregnating the sapwood and it is necessary to vary the above process. The initial air pressure stage is omitted and the creosote pressurisation and subsequent vacuum processes are modified. This method is known as the *Lowry process*. Timbers that do not take up creosote readily may be incised by making cuts parallel to the fibres to facilitate impregnation.

In the Rüping process, the minimum creosote retention specified up to 1951 was 75 kg/m^3; since 1951, the requirement has been increased to 115 kg/m^3. A statistical survey in the late-1940s indicated that 5% of poles aged 28 years could be expected to be decayed; increasing the creosote retention was designed to substantially extend pole life. It should be noted that the retention values cited represent the minimum uptake per cubic metre of creosote for the batch of poles in the working cylinder. Within the batch, individual poles may retain appreciably more or less than the average for the batch, as illustrated in Fig. 9. However, poles with a low uptake are not necessarily more prone to decay as they are likely to be denser and more resistant.



Size of batch: 165 poles
Average creosote retention per batch: 119 kg/m^3
Standard deviation: ± 32 kg/m^3

FIG. 9—Variation of creosote retention within a batch of poles

The Rüping method is known as the *empty cell* method, as the surplus creosote is removed from the wood cells. Prior to 1913, the Bethel *full cell* process had been used. In this method, the poles were placed in a vessel, initially subjected to a vacuum to remove air from the cells and the vacuum was then replaced by hot creosote under pressure. As the poles were not subjected to a further vacuum, the creosote was left in the cells—hence the name of *full cell*. The minimum absorption of creosote was specified as 192 kg/m^3, although up to 320 kg/m^3 could be taken up. The Rüping method was adopted as it was more economical in the use of creosote, the preserved poles were of lower mass and a cleaner and more socially acceptable pole resulted, with much less creosote bleeding through to the surface. The relative long-term efficiency of the two methods does not appear to have been explored.

After the pole is creosoted, it is most desirable to preserve the creosoted layer over the whole surface of the pole. At one time, poles were slotted to take arms and bored for the arm bolts at the roadside. Such activities exposed less-effectively preserved wood, and it has been shown[10] that decay was almost as prevalent near the top of the pole as it was at the ground-line. In the mid-1930s, a change was made so that the poles were pre-drilled and pre-cut before creosoting to provide a flat surface of sufficient length to accommodate the arms and arm bolts. As few poles are fitted nowadays with arms, poles are no longer pre-cut, although bolt holes are still provided. Where it is necessary to fit an arm, a specially-shaped steel arm-seat is used to enable the arm to sit on a flat surface without the need to cut the pole.

Creosote is not completely stable in the pole and with time a slow reduction of the degree of protection results[11,12]. The more volatile fractions of creosote are gradually lost by evaporation, and changes occur as a result of oxidisation and polymerisation. Perhaps most importantly there is a downward flow of creosote in the pole and some is lost from the buried section into the surrounding soil. This leakage is beneficial and helps to sterilise the surrounding soil. However, if that soil is disturbed or the pole re-used in a new position, this protection is lost. It has been found that otherwise sound poles have decayed rapidly when moved to a new site, and this may have been the cause. It has also been noted that the amount of creosote retained in a pole falls off rapidly above ground level, and so planting a pole in a deeper hole or raising the ground level around an existing pole is likely to lead to an acceleration of decay. Pole testing parties are required to apply creosote liberally around the exposed base of the pole and in the backfill material after checking the condition of the pole below the ground-line to avoid such decay acceleration.

Many other methods of preservation have been examined and some subjected to extensive trials but none has yet superseded creosote. There have been two main classes of alternative preservatives, namely water-borne salts and organic solvents. The general requirements of a preservative for pole applications are that it must

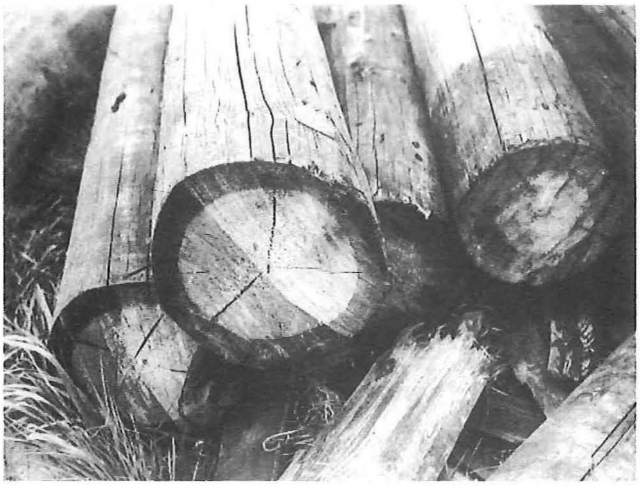
(*a*) provide long-term protection to the pole; that is, it must be chemically stable and not easily leached out of the wood;
(*b*) penetrate the wood readily;
(*c*) be economic, so that any extra costs incurred in improving preservation are balanced by savings accruing from a longer pole life;
(*d*) have high toxicity to fungi and insects but low toxicity in other respects, endangering neither BT staff, the public or animals;
(*e*) not cause accelerated corrosion of pole fittings; and
(*f*) give a clean and pleasing finish to the pole.

LIFE OF A POLE

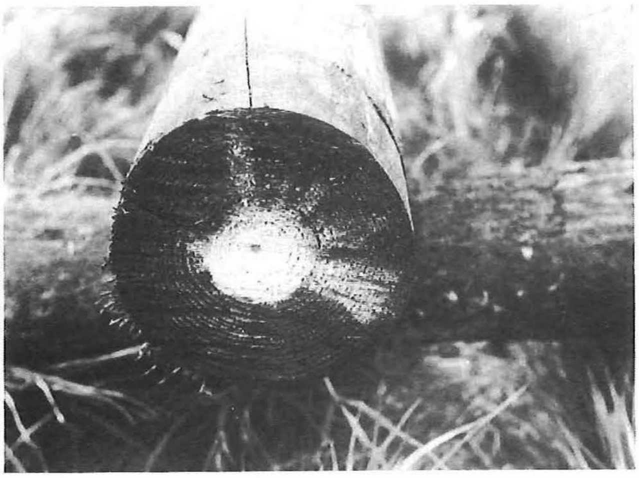
The life of a pole is dependant on factors such as

(*a*) tree species;
(*b*) growing conditions;
(*c*) method and effectiveness of preservation (compare depth of penetration in Figs. 10(*a*) and 10(*b*));
(*d*) environmental conditions at pole location—soil type, air and ground temperature, air humidity, pollutants in atmosphere or ground water, etc;
(*e*) effectiveness of routine maintenance when the pole around ground level is re-cresoted during the pole examination procedures; and
(*f*) physical damage by hedge-cutters, vehicle impact, lightning strokes, woodpecker activity etc.

The environment clearly plays a part in determining pole life; there are indications, for example, that the mild climate of South-West England facilitates more rapid fungal attack than the cooler conditions in Scotland. Another factor which may be significant in northern Britain is the continuous wetting with acidic ground water, common in moorlands, inhibiting decay. The determination of the average physical life of a pole, that is, the life taken to the point where the pole is no longer safe to retain in use, is a difficult task. The main statistical sources for such calculations are the records of pole purchases for the whole of this century, and the returns which result from the monitoring of the routine pole-testing programme. It is necessary to obtain a realistic estimation of pole life to provide data for economic purposes



(*a*) Hardgrown timber with restricted creosote penetration



(*b*) Deep creosote penetration

FIG. 10—Creosote penetration

as well as for design and safety considerations. The calculation is complicated by such factors as the following:

(*a*) The service life may be substantially shorter than the pole's physical life, and the pole may be scrapped although it is still sound.

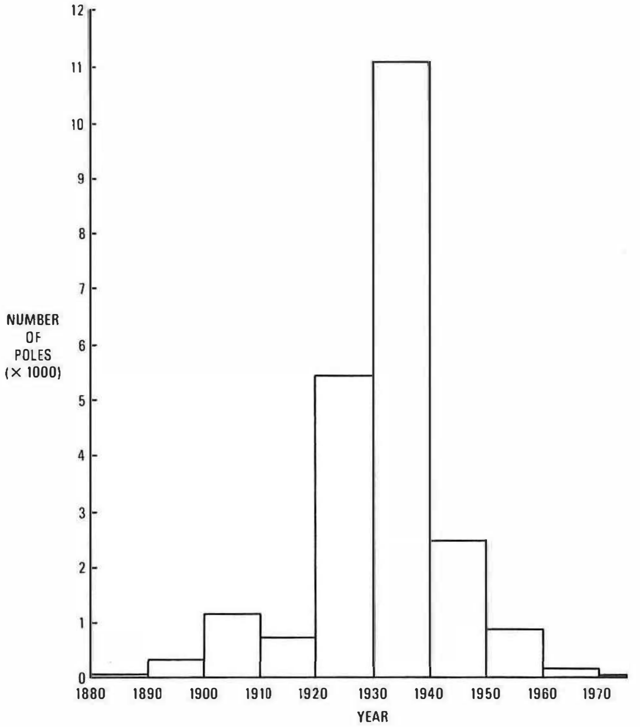
(*b*) Standards for poles and their preservation have changed with time.

(*c*) Many poles are reissued after recovery, and at one time re-creosoting was also adopted.

(*d*) Sample surveys indicate that, because pole testers tend to err on the safe side, some 10% of poles classed as decayed are in fact sound.

(*e*) Poles can be classed as defective for reasons other than decay.

Two recent independent studies have arrived at average lives of 42 years in one case and 44 years in the other. One of these studies also concluded that the average service life was 33 years and the average life in one location 29 years. It is to be expected that, as the post-1950 poles with the higher creosote retention constitute an increasing proportion of the poles in service, the average life of the population of poles will increase substantially.



Results of a nationwide survey of the date marks on all poles made 'D' during the period Sept. 1975–Sept. 1976. 26 437 'D' poles were found, but of these 4224 poles had no date mark and so are omitted from the histogram

FIG. 11—Histogram of the age of poles classified 'D'

Fig. 11 shows the result of a national survey to determine the age of all poles classified as 'D' (defective) for whatever reason over a one-year period. The peak value at year 1936 should not be taken as directly indicating the average life of a pole, as that year also corresponds to the period when pole issues nationally were twice the average (Fig. 12), and

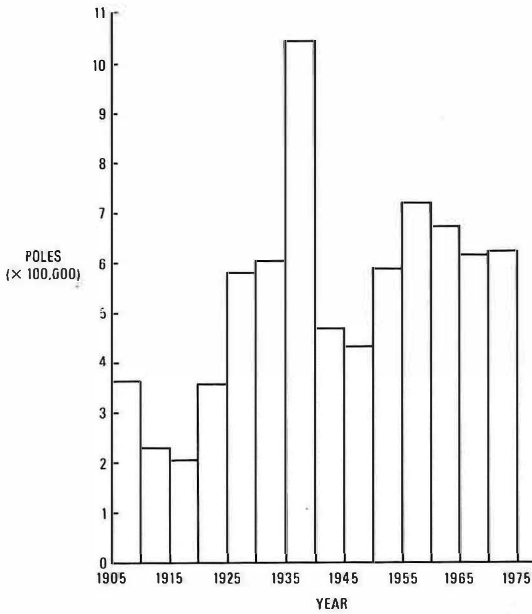
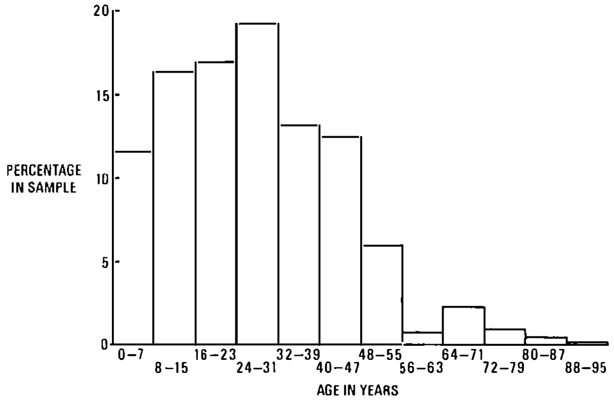


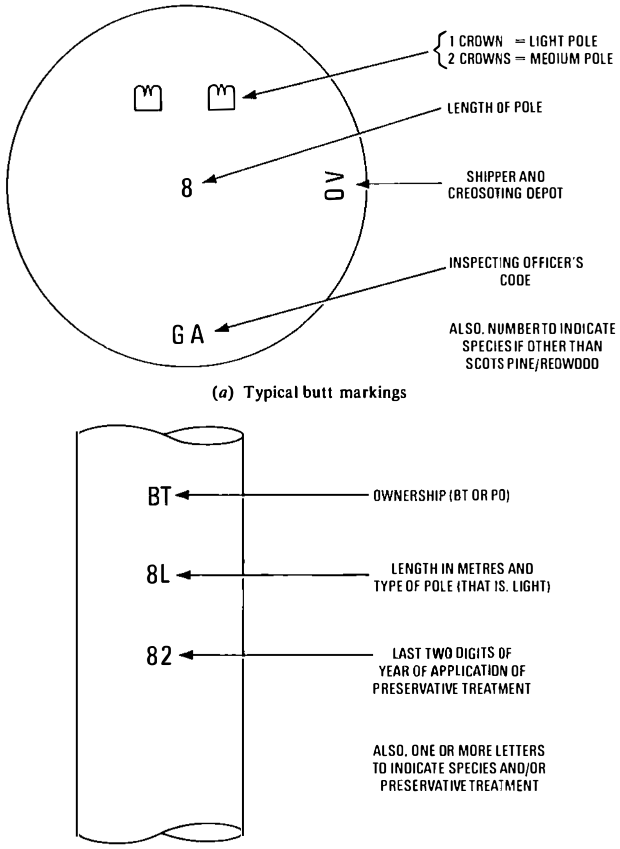
FIG. 12—Histogram of national pole issues during the period 1905–1974

so a 'bulge' in 'D' poles at that age would be expected simply because proportionately there are likely to be more in the field. Applying corrections to account for variations in annual pole issues has the effect of showing an increase in the mean life.



Random sample of 3351 poles, representing all those visited by pole testing parties in the South West Region in one week in March 1976

FIG. 13—Typical age distribution of poles



(*a*) Typical butt markings

(*b*) Typical markings 3 m from butt

FIG. 14—Pole markings

A typical age distribution of poles in service (Fig. 13) shows that many poles survive for over half a century. It is most unusual for any pole to require replacement because of decay in less than 20 years, although replacements are sometimes necessary in less than 20 years as the poles may be regarded as unsafe to climb for a variety of other reasons—unsafe location, physical damage, inadequate depth due to ground level alterations subsequent to erection, or located such that they cannot be examined for decay. Many older poles are scrapped not because of a 'D' classification, but as a result of technical change; for example, a recovered stout pole, even if sound, would not now be reissued.

TYPES AND MARKINGS

Four classes of wood pole exist: medium (M), light (L), extra-light (XL) and stout (S). Classes XL and S are obsolete, but some still remain in service. The stout pole, last issued in 1966, was extensively used on major open-wire routes and is now likely to be found only in a reduced-height form supporting aerial cables. Extra-light poles were purchased from 1935 onwards to assist in reducing the costs of rural work in circumstances where the loading was very light with no more than four wires on the pole. However, issues of XL poles ceased in the early-1970s, although many such poles remain in service. Light poles are available in standard lengths from 6–13 m and medium poles from 9–15 m; Table 1 lists the current metric range of sizes.

TABLE 1
Current Range of Pole Sizes

Length (m)	Minimum Diameter at Top (mm)	Maximum Diameter at Top (mm)	Minimum Diameter 1·5 m from Butt-End (mm)
LIGHT POLES			
6	125	150	150
7	125	150	160
8	125	150	170
8·5	125	150	180
9	125	150	180
10	125	160	185
11	125	160	195
13	130	170	210
MEDIUM POLES			
9	150	180	220
11	150	190	240
12	150	190	250
13	160	200	260
15	165	210	290

Poles are stamped or gouged in two places, as shown in Fig. 14, to enable details of the pole to be determined readily.

In the case of poles dated 1931 or later, if there are no letters indicating species or preservative treatment, the pole can be assumed to be Scots pine/redwood and preserved by the Rüping process. If a pole has been shortened at the tip and re-issued, a fourth line indicating its new length will have beeen added to the 3 m mark. The 3 m markings also function as a simple means of checking the depth of the pole in the ground.

(To be continued)

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Audiovisual Telecommunication Services—A Unified Approach

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Some attractive new services now approaching the marketplace offer the user, on a single telecommunication connection, alternate or simultaneous transmission of two or more types of signal: of particular interest is the combination of speech with visual stimuli such as images or text. This article explores the features common to such services and the problems of harmonising them.

This article is based on a paper which first appeared in British Telecom Technology Journal.*

INTRODUCTION

A wide variety of services can be envisaged in which speech communication between two or more terminals is augmented by other visual forms of communication, such as documents, diagrams or other forms of still image, moving images, control signals and so on. On the classical analogue telephone network such services are difficult to achieve in a convenient and cost-effective way. Although it is possible to insert a data signal of up to 300 baud into the speech band (for example, between 1500–2000 Hz[1]) without seriously degrading the speech quality, for higher rates it is necessary either to set up a second connection in parallel, or to preclude speech communication for the duration of the data transmission.

Digital networks at 64 kbit/s and above offer considerably greater flexibility for time-division multiplexing to allow a single transmission path to be shared between speech and other facilities. In this article, this class of service is referred to simply as *audiovisual services*, on the basis that almost all the auxiliary facilities mentioned reach the recipient in visual form. There is the opportunity, since such services are not yet heavily committed in the marketplace, to define a general-purpose transmission framework to ensure that, whatever mix of facilities a user may select, recognition of those signals by a remote terminal is assured.

By considering the likely attributes of the plausible range of audiovisual services, the scope for harmonisation is deduced and a possible frame structure described. Finally, some network aspects of audiovisual services are discussed.

AUDIOVISUAL SERVICES

Fig. 1 is a representation of a generalised communication terminal, distinguishing various types of facility, which may be defined as an input/output means perceived as distinct by a human user; for example, the 'audio facility' provides a microphone for input and loudspeaker for output, perceived ultimately by the human ear.

There are many possible services represented by the generalised terminal of Fig. 1: examples of plausible services are

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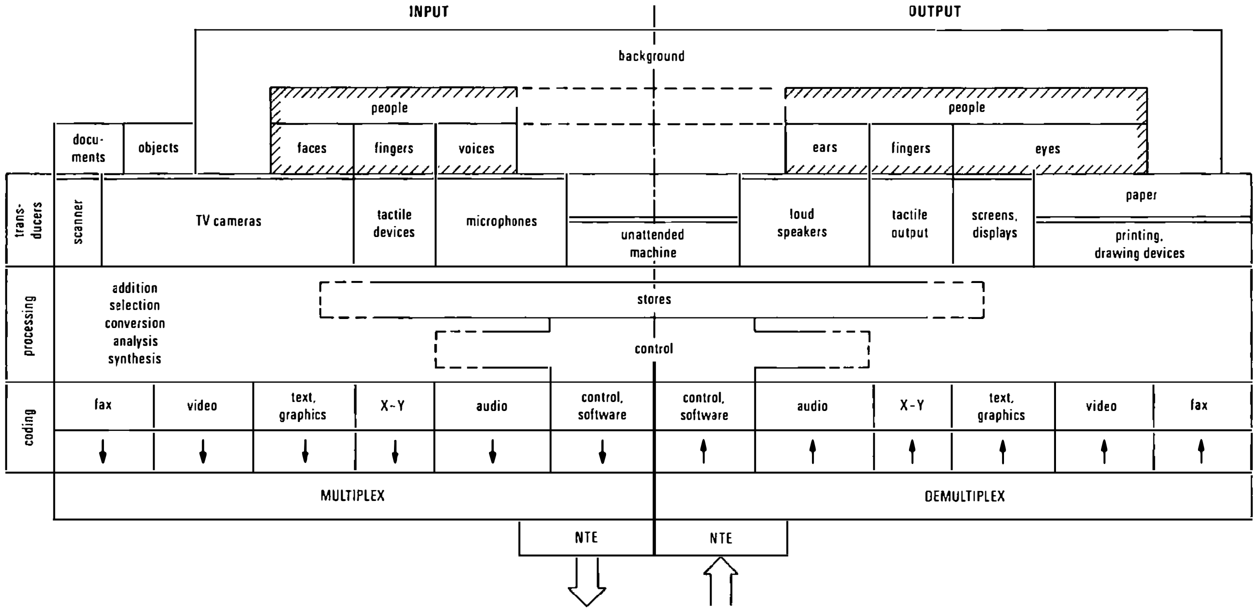


NTE: Network terminating equipment

FIG. 1—General scheme of audiovisual terminals

TABLE 1

Examples of Audiovisual Services, and Associated Facilities

FACILITIES	SERVICE				
	Audio-conferencing	Remote Lecturing	Medical Consultancy	Videophone	Video-conferencing
Loudspeaking telephone			E	E	
Microphone/loudspeaker system	E	E			E
Audio—telephony quality		E	E		
Audio—higher quality	E	E			E
Speaker/location indentification	O				
Text/graphics system	O	O			O
Cursor/telewriter/electronic blackboard	O	E	E		O
Remote control system		O			
Facsimile—hard copy	O				O
Facsimile—soft display	O	O	O		O
Still-picture TV system	O	O	E		O
Moving-picture TV system				E	E
Multipoint service	E	E		O	E
Reservation service (or availability guarantee)	E	E	(E)		E

E: essential O: optional

given in Table 1, with relevant facilities, both essential (E) and optional (O). While audioconferencing and viewphone/videoconferencing may be familiar concepts, there is a middle ground, exemplified by the medical and lecturing applications, a wide variety of possible applications in which speech communication is enhanced by the use of still pictures. Other applications which have come to light include remote witness interrogation for law courts, remote tutoring[2], and communication between design office and workshop.

The important characteristic of the new services listed is that they are *multi-facility* services—in the course of a single call (again, as perceived by the user) two or more facilities can be used. The expression should not be confused with *multi-service*, a term commonly applied to networks to indicate that they are capable of carrying various services at different times.

Although a wide range of input/output devices is represented in Fig. 1, the corresponding communicated signals can, in principle, be reduced to one of a limited set of formats; namely, audio, video, facsimile, text/graphics, X–Y devices, and controls. Since these formats are to be recognised by the distant terminal(s), which may be from a different manufacturer, it is important that they should be carefully defined, and should not proliferate. Moreover, a common method is required for multiplexing the facilities in variable combinations as required, in such a way as to make maximum use of the available transmission capacity.

The facilities listed in Table 1 have some aspects which are common to the various services, as follows.

Audio

In general, only one person speaks at a time, and is heard at all other terminals: this could imply that the outgoing audio channels from the other terminals are not required for the time being, but when the use of that capacity for any other purpose is being considered, it should be borne in mind that

(*a*) in order not to inhibit verbal interruptions by a listener, the return channel should be available for speech at a few milliseconds notice; and that

(*b*) the absence of the background noise from other silent locations may confuse or disturb the speaker.

The quality of transmitted speech is dependent on the available transmission capacity and the complexity of the coding equipment. The possibilities here include 3·4 kHz bandwidth speech into 56 or 64 kbit/s using pulse-code modulation (PCM), into 32 kbit/s using adaptive-differential PCM (ADPCM), and into 16 kbit/s or less using sophisticated techniques. Similarly, 7 kHz bandwidth speech can be put into 48–64 kbit/s[3]. For stereo sound, on the basis that the bandwidth should be kept high, at least 96–128 kbit/s would be required at present.

Video

Here it is essential to distinguish between still-picture television (SPTV) and moving-picture television (MPTV). In the latter case, the picture contents are updated at least ten (preferably 25) times per second to preserve the illusion of motion; SPTV, on the other hand, captures 'frozen' images—even if the system frequently updates a changing scene, each image is presented in its own right with no attempt at continuity of motion.

Fig. 2 shows the time taken to update a full-screen picture of the given resolution, with different degrees of picture compression ranging from simple PCM to complex

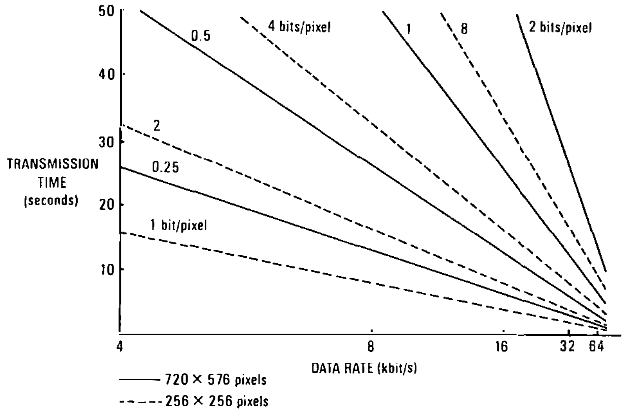


FIG. 2—Transmission time for full-screen pictures

transform algorithms. However, a constant data rate is not essential. Under various circumstances, it may be preferred to send a single high-quality image quickly (requiring a high data rate) and perhaps subsequently to point to this image by using a cursor, or to annotate it by means of a telewriter. At the other extreme, a continuous sequence of medium-quality pictures at half-minute intervals needs only a low data rate. For other purposes, an intermediate rate is appropriate. Where the scene being transmitted is relatively constant, faster updates are possible by transmitting only the changed portions of the picture.

For MPTV, the bit rate should be as high as possible, consistent with transmission economics; fundamentally, the rate of information generated is highly variable, but it is unlikely to be practicable to use part of the transmission capacity for other facilities during periods of low movement. The picture quality achieved at various bit rates is not easy to specify, since it is the movement rendition rather than the static picture clarity which is compromised as the bit rate is reduced. Progress in the field of picture coding algorithms promises, in the not too distant future, videoconference pictures in 320 kbit/s and a lower quality in 64 kbit/s or less.

A third type of video image, little investigated to date, can be referred to as *processed-picture* television. This would include feature-extracted images such as sketches. These will probably, like SPTV, be tolerant to data-rate variations in the range 0–16 kbit/s.

Facsimile

Transmission should be as fast as possible when required, but the facility is not foreseen as being in continuous use during conversational communication. Like SPTV, a constant data rate is not required. There is no experience of use of facsimile in a multipoint audiovisual environment, but discussion of documents is very much an everyday practice in the business world and should be allowed for in future systems (this applies particularly to *soft facsimile*—where the received pages are displayed on a screen instead of printed out on paper).

Other Facilities

Text, graphics, X–Y devices, and control signals typically require only low data rates and, although they are probably used only occasionally with audio (people do not often key or draw things while talking), the incorporation of such signals poses no special problem.

HARMONISATION

Although each of the services listed in Table 1 could be developed independently of the others, this would in the longer term be greatly disadvantageous. Terminals should be developed so that in general they are able to cope with a variety of applications requiring more or less the same facilities. In the absence of harmonisation, such terminals would become unnecessarily complex, and cumbersome to operate.

The following aspects of harmonisation can be identified:

(*a*) *Terminal design* While many aspects of physical design could and should be left to the individual suppliers of the equipment, some parameters must be specified for satisfactory end-to-end service. This applies particularly to audio conditions (level, background) and video conditions (lighting, contrast, etc.)—as for telephony, poor design at one terminal can cause the greater inconvenience to the remote party. It is also desirable for controls and indications to be reasonably consistent from one service to another (icons, key responses, tones, etc).

(*b*) *Protocols and signal formats* These must be standardised for each of the facilities to be transmitted to ensure that different types of terminal can be interconnected.

(*c*) *Multiplexing* The formation of a multi-facility channel on a single transmission path, or on parallel paths set up by a single calling procedure.

(*d*) *Network aspects* Although it is expected that the networks used for these audiovisual services will be general-purpose networks, the network configuration and equipment will have a bearing on the service that can be provided.

At the present time, practical experience with many of the new services is insufficient to be definitive about the terminal design aspects; it is therefore all the more important to standardise the general transmission format and inter-working arrangements, and to ensure that these are flexible to accommodate the changing patterns of utilisation as user experience is gained. The existence of transmission standards will do much to facilitate the introduction of new services on a provisional basis, thus providing the experience upon which further standardisation can be based.

Such a stance is adopted by the International Standards Organisation (ISO), which is in the process of developing protocols for Open Systems Interconnection (OSI). Initially, OSI is intended for computer communication, and little attention has been given to the possibility of extending its principles to include audiovisual services, particularly as regards speech and multipoint working. However, it is clear that similar hierarchical principles should be employed with layer protocols adopted from the OSI set where appropriate.

It is worth noting that the multi-facility service problem is being tackled from two opposite directions: on one hand, audio and videoconference services are being developed to include telematic-type aids; on the other, developers of telematic services are contemplating the addition of speech and close-to-real-time working. Clearly, from either direction, the outcome should be the same, a channel and protocol structure capable of carrying a variety of mixes of facilities.

PROTOCOLS AND FORMATS

This subject is not covered here in detail. The activities of the many international study groups engaged in defining such structures can be summarised as follows:

(*a*) *Audio* CCITT† Study Group SGXVIII has standardised 3·4 kHz bandwidth PCM (56/64 kbit/s) and ADPCM (32 kbit/s); studies are underway for 16 kbit/s, and 48–64 kbit/s (7 kHz bandwidth).

(*b*) *Facsimile* CCITT has adopted Recommendations T5, T6 and T62, for Group 4 facsimile; SGVIII continues to study the requirements under Questions 4, 6 and 22/VIII.

(*c*) *SPTV* CEPT* Recommendation TD 06.1 contains protocol and signal format for photographic videotex; the specification could be extended to include the requirements of other still-picture services. CCITT has adopted Recommendations T100, 101 and will study Questions 8 and 16/VIII.

(*d*) *MPTV* CCITT adopted Recommendation H120 for videoconferencing at 2/1·5 Mbit/s; in practice, the same format can be used down to 768 kbit/s (including 64 kbit/s audio). A new SGXV *ad hoc* video coding experts working party will produce Recommendations for video coding at still lower bit rates.

(*e*) *Text, graphics, X–Y devices* further to CCITT Recommendations T60, 61 and 62, there is intensive study of these facilities in SGVIII and in the ISO.

† CCITT—International Telegraph and Telephone Consultative Committee

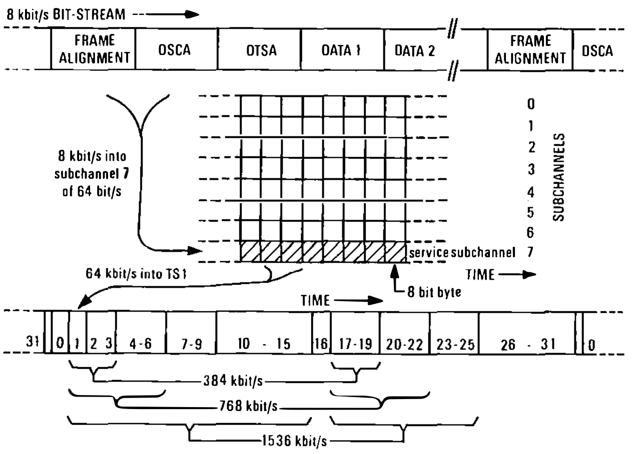
* CEPT—Conference of European Postal and Telecommunications Administrations

FRAME STRUCTURE

It is assumed that, once the connections have been established between the terminals, a fixed transmission capacity is available, to be partitioned in such a way as to present the best possible service to the users in a wide range of circumstances, including multipoint working. Flexibility is essential here: the required mix of facilities will vary from application to application, and perhaps also during each call; and the system must accommodate such variations automatically, preferably without the user being aware of them.

For some applications the simplest solution may be to have parallel connections (for example, two or more standard 64 kbit/s channels) set up between interlocutors at the start of the call. The main objection here must be the higher transmission costs of the call, especially if some facilities are used only occasionally. However, the digest of facilities mentioned earlier suggests that flexible use of a single 64 kbit/s channel may satisfy many applications. For services requiring high visual data rates, further 64 kbit/s channels can be added; for example, a second B-channel as in the integrated services digital network (ISDN), or five such channels giving an aggregate 384 kbit/s (the so-called *H0* channel), or indeed higher multiples of 384 kbit/s.

A proposal along these lines is as follows (see Fig. 3):



TSI: Time-slot I
DSCA: Dynamic subchannel allocation
DTSA: Dynamic time-slot allocation

FIG. 3—Proposed frame structures

(*a*) The first 64 kbit/s channel, which we might call the *audio-plus* channel, is available as 8-bit bytes: seven of these can be treated as individual subchannels of 8 kbit/s, while the eighth is designated the *service subchannel*.

(*b*) An audio channel is formed from a block of subchannels, giving a net bit rate of $n \times 8$ kbit/s, with $n = 1$ to 7; for 32 kbit/s, ADPCM to CCITT Recommendation G721 is to be used; an algorithm capable of working adaptively at 56, 48 kbit/s (also 64 kbit/s), conveying speech at a higher quality than telephony, is being developed[3]; in the future, algorithms at 16 kbit/s and 8 kbit/s may be recommended. A dynamic subchannel allocation (DSCA) code contained in the service subchannel indicates at all times which audio bit rate is in force.

(*c*) Subchannels not in use for audio are available for other facilities, as is also part of the service subchannel, shown as DATA 2 in Fig. 3; one part-time application of Data 2 will be to carry a control message capability which is used, *inter alia*, to organise the communication between the terminals of such facilities (including working in a multipoint environment).

(*d*) Transmission of very low-speed information (for example, telewriter, cursor, videotex, etc) will be within the service subchannel: this is shown as DATA 1 in Fig. 3.

(*e*) A further code (designated *dynamic time-slot allocation* (DTSA)) contained in the service subchannel, specifies at all times what signals are being carried on any additional 64 kbit/s channel also routed to the same destination terminal.

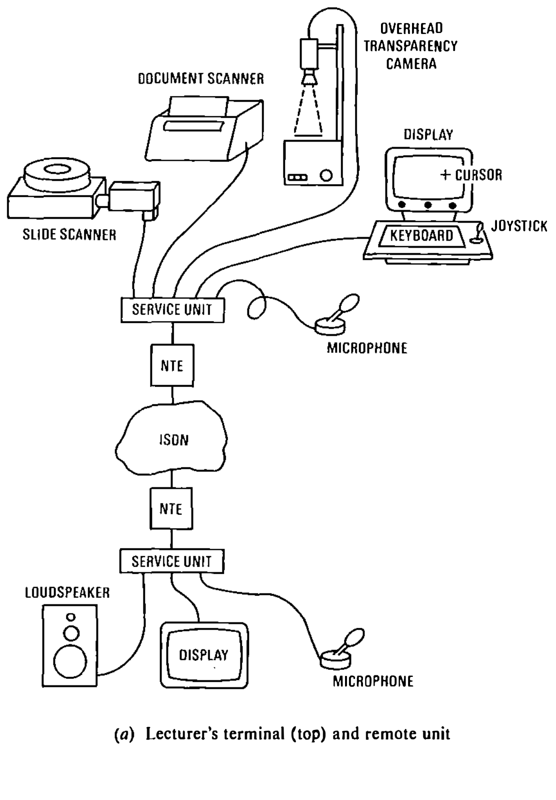
By way of illustration, consider again the applications of Table 1.

Audioconferencing

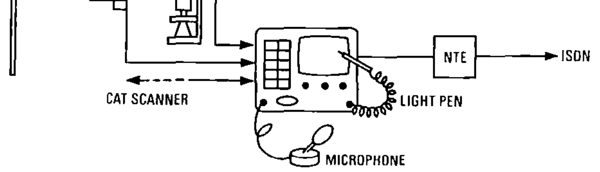
For audioconferencing, high-quality speech will be preferred, using 56 kbit/s. When it is desired to send a still image (facsimile or SPTV) a subchannel is made available by dropping the audio to 48 kbit/s. With 56 kbit/s audio, a continuing sequence of fairly slow still pictures can be conveyed within the spare part of the service subchannel, Data 2.

Remote Lecturing

Here again, for remote lecturing, high-quality speech is preferred. If the high transmission cost of MPTV is not justified, still images may be used as for audioconferencing; an X–Y device is indispensable—a cursor for pointing at the visual display, or perhaps a telewriter for sketching, equations, etc. Fig. 4(*a*) illustrates a lecture terminal incorporating several facilities.



(*a*) Lecturer's terminal (top) and remote unit



(*b*) Medical terminal

FIG. 4—Typical applications

Medical Consultancy

Medical consultancy may be typical of a wide range of specialised applications in which conventional telephone conversations are enhanced by image transmission. Speech is encoded at 32 kbit/s (or less) leaving a fairly high bit rate for simultaneous still-picture transmission. In the medical case, illustrated in Fig. 4(*b*), the image source could be X-ray plates, CAT scanner output, optical microscope with video camera, and so on. Probably a cursor, driven by a joystick or mouse, would also be advantageous.

Videophone

At some time in the future, it may be possible to transmit a suitable quality of speech at 8 or 16 kbit/s, with a moving picture taking up the remainder of the capacity; an alternative solution for the videophone is that of utilising a second 64 kbit/s channel for the moving pictures.

Videoconferencing

For videoconferencing, the total bit rate may be considerably higher: a formula of $n \times 384$ kbit/s is agreed in CCITT SGXV, with $n = 1$ to 5. It may be foreseen that adequate performance may be achieved in 384 kbit/s, but the use of higher rates for better quality (for example, teleseminars) is allowed for. In either case, the audio-plus channel occupies one 64 kbit/s time-slot in a primary access, while MPTV is carried on a further five (or eleven, etc). If it is desired to transmit facsimile at 64 kbit/s, one of the MPTV time-slots is temporarily taken over for the purpose. It should be noted that the first generation of videoconferencing codecs, defined in CCITT Recommendation H120/130, do not quite line up with the above proposal: while the use of an audio-plus channel is not precluded, the function represented by the DTSA is included in time-slot 2 instead.

Non-Audio Applications

The proposed multi-facility frame structure is valid for any combination of signal formats, audio not being obligatory. Thus, the scheme is applicable to other multi-facility services, such as surveillance, in which picture transmission is combined with remote control signals.

NETWORK ASPECTS

It is intended that standard bearer services should be used for transporting the proposed set of audiovisual service signals through the network. However, the network itself has an influence on the overall services.

Access

In the examples given earlier, it is assumed that the bearer service is provided directly by the ISDN as one or two 64 kbit/s paths, or by a primary access to the integrated digital network carrying $n \times 384$ kbit/s. Private circuits at these bit rates can of course be used instead. However, where a broadband or high-speed digital local network is available, there is an opportunity to provide relatively high-quality video transmission within the local network, using compression to low bit rates only for trunk transmission.

In the example shown in Fig. 5, the trunk access is via two switches, one dealing with the audio-plus channel, the other feeding the video signal to a codec operating at 64 kbit/s or 320 kbit/s. This configuration has an interesting consequence: the cost-conscious customer may exercise a choice as to the bit rate and hence quality of picture transmission, with further choice as to whether still or moving pictures are transmitted.

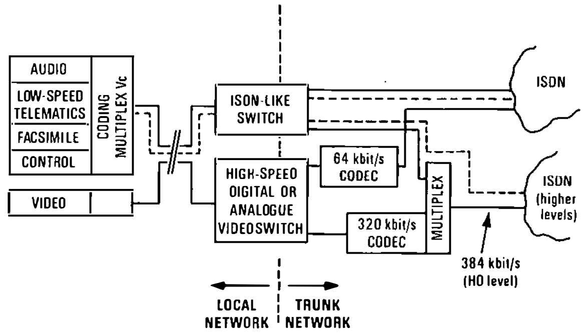


FIG. 5—Example of access via broadband network

Multipoint Calls

It is not impossible to conceive a digital network in which the handling of real-time audiovisual services in multipoint configuration is an integral part of that network in its bearer services aspects, operating on all of the protocols at the relevant layers and routeing all facility signals (audio, video, fax, etc.) according to customers' wishes. On the other hand, not only is such a network a long way off in real terms, but there is as yet virtually no operational experience of audiovisual services, making it impossible to specify even a conference-service multipoint system, let alone a generalised multipoint system.

A more realistic alternative is to treat multipoint calls as a number of bidirectional point-to-point calls to a special bridging unit, called the *multipoint control unit* (MCU). This relieves the general switched network of the burden of continual reconfiguration within the fixed channels, but at the same time places upon the MCU the tasks associated with call initiation and clear-down.

It is assumed that the MCU should transmit to every terminal the mixed audio signals from all other terminals—the mixing is additive and does not involve an increase in bit rate; telematic signals are likewise broadcast from one terminal to all others, but since they are not 'mixed' there has to be contention for the limited transmission capacity available, probably on a one-at-a-time basis. On the other hand, pictures of people (as in videoconference and videophone) may be treated differently: a desirable objective is that a picture from each terminal is available at the MCU, but each participant location may choose which of the other pictures to receive[4].

Service Availability

Some types of service will require a very high probability of connection at the time of customers' wishes—much higher than telephony, where the call can often be deferred a little without loss. Conferencing and seminars/lectures are obvious cases, while some medical applications may also be non-deferable. The requirement could be met by a sufficiently high grade of service in 'on-demand' applications. On the ISDN in particular, a reservation system may be impractical: it follows that there must be a high probability of successful interconnection within at most a minute or two in the busy hour.

A reservation system is likely to be essential for all part-time circuits for services at 384 kbit/s or above, whether national or international, and for international services at 64 kbit/s or 2×64 kbit/s.

It is unlikely that sufficient MCUs will be available to meet on-demand service: therefore, the MCU must be available by advanced reservation. The reservation system need not make a demand upon the network: the MCU itself is programmed to handle only calls initiated by the identified party during the reservation period, and to clear all its lines at the end of that period, or as soon thereafter as the MCU is required for another reservation.

It is essential, for teleconference services, to be sure of a call maturing at the time all parties have agreed to attend their respective terminals, so it is essential to ensure that, if the network fails, service is restored quickly to a sufficient level to continue the meeting. In the case of dialled calls, the simplest restoration consists of redialling (for multipoint calls, the MCU should do this): however, it is advantageous if indications are available at the terminals that action is necessary: possibly, the D-channel can convey this (except for local line plant failure). In the case of higher bit rate services, there may be insufficient transmission channels or route diversity to restore the call quickly at the full bit rate. However, it should be practical to restore 'priority' sub-channels, such as the audio-plus channel referred to earlier.

CONCLUSION

The advent of digital switched bearer services will make possible the provision of a wide range of audio-visual services, as well as other multi-facility services not involving audio. There is an opportunity now, before these services proliferate and their transmission formats diverge, to standardise a set of protocols with a suitable and flexible multiplexing scheme, whereby the various facilities may be carried in any combination on a single call.

This article has presented an example of a possible signal structure to fulfil these aspirations; whatever scheme is finally selected for standardisation, the existence of standards should make it very much easier for new applications to emerge uninhibited by incompatibility with terminals for existing services.

References

[1] CCITT Annex to Question 17/VIII: Draft Recommendation on Telewriting Terminal Equipment. CCITT **COM VIII-1-E**, Part 3, p. 62.

[2] CLARK, W. J. Cyclops—a field evaluation. Proc. Intl. Zurich Symp. on Digital Comms., Paper D4, IEEE(1982).

[3] WESTALL, F. A., and LEE, D. S. K. Simultaneous transmission of 7 kHz bandwidth speech and data in 64 kbit/s. *Br. Telecom Technol. J.*, Apr. 1985, **3**(2), pp. 13–20.

[4] NAGRA, A., TEMIME, J. P., and VIALE, E. Multipoint videoconferencing using conditional replenishment codecs. Proc. Intl. Symp. on Teleconferencing, London, Apr. 1984, pp. 248–255.

Biography

Norman Kenyon studied at St. John's College, Cambridge from 1960–67, obtaining the BA degree in Natural and Electrical Sciences in 1963 and PhD in 1967. For four years until 1971, he worked at Bell Laboratories, Murray Hill, New Jersey, on millimetre-wave oscillators. He returned to the UK in 1972 to join British Telecom Research Laboratories where over the period to 1977 he was responsible for the repeater equipment development for the UK trunk waveguide system. In 1978, he transferred to the Visual Telecommunications Division, in charge of a section responsible for system development and public visual services trials, and in April 1982 became Head of that Division.

Institution of British Telecommunications Engineers

(formerly Institution of Post Office Electrical Engineers)

General Secretary: Mr. J. Bateman, National Networks Strategy Unit (NNSU1.4), Room 304, Williams National House, 11–13 Holborn Viaduct, London EC1A 2AT; Telephone: 01–357 3918.
(Membership and other enquiries should be directed to the appropriate Local-Centre Secretary as listed on p. 177 of this issue.)

IBTE LOCAL-CENTRE PROGRAMMES, 1985/86

Unless otherwise stated, members must obtain prior permission from the Local-Centre Secretary to bring guests.

Aberdeen Centre

Members will be advised individually of locations for meetings. All meetings will commence at 14.00 hours.

19 November 1985:

Electrostatics Seminar by Mr. D. Ray, Materials and Components Centre, British Telecom Development and Procurement.

10 December 1985:

Communications for Weather by Mr. H. Cummings, Aberdeen Meteorology Office.

22 January 1986:

Optical Fibre Cable by Mr. D. Stanley and Mr. J. Macauley, British Telecom National Networks.

18 February 1986:

Cellular Radio by Mr. B. McPhee, Marketing Manager, Cellnet.

11 March 1986:

AXE 10 (System Y) by Mr. D. Colbeck, Thorn Ericsson.

Anglian Coastal Centre

Meetings will be held in Room LTB5, University of Essex, commencing at 14.00 hours, unless otherwise stated.

Wednesday 20 November 1985:

Network Master Plan by Mr. T. C. Haigh, Network Master Planning Office. Meeting to be held in the Conference Room, Southend TAO at 14.00 hours.

Wednesday 12 February 1986:

Network Nine Concept by Mr. D. J. Brunnen, Business Manager, Network Nine. Meeting to be held in the Assembly Rooms, Norwich, at 14.00 hours.

Wednesday 12 March 1986:

Optical Character Recognition by Mr. H. A. J. Bennett, OCR Project Manager, The Post Office.

Wednesday 23 April 1986:

Marketing in British Telecom by Mr. N. J. A. Kane, Director of Marketing, British Telecom. Meeting at Guildhall, Cambridge, commencing at 14.00 hours.

Wednesday 21 May 1986:

The Role of British Telconsult by Mr. R. Marchant, Marketing Manager, Middle and Far East.

Bletchley/South Midlands Centre

All meetings will be held at Bletchley Park and will commence at 14.15 hours, except where stated otherwise.

Wednesday 27 November 1985:

System X—The Experience Gained in the Commissioning of the Early Exchanges.

Wednesday 29 January 1986:

Audiovisual Communications by Dr. N. D. Kenyon, British Telecom Research Laboratories.

Wednesday 26 February 1986:

Submarine Cables by Dr. T. R. Rowbotham, British Telecom Research Laboratories.

Wednesday 23 April 1986:

Marketing in British Telecom by Mr. N. J. A. Kane, Director of Marketing, British Telecom. Meeting at Guildhall, Cambridge, commencing at 14.00 hours.

Central Midlands

Meetings will be held in the Lecture Theatre, Room UG35, British Telecom, Berkley House, commencing at 14.00 hours, except where stated otherwise.

Thursday 14 November 1985:

See Fibres in a New Light by Mr. T. G. Hand, Materials and Components Centre, British Telecom Development and Procurement. Meeting will be held in the Conference Room, 310 Bordesley Green, Birmingham, with laboratory demonstration, and will commence at 14.00 hours. (Numbers are limited.)

Monday 25 November 1985 (Joint IEE/IBTE meeting):

Quality Engineering within British Telecom by Mr. T. Lomas ERD, Deputy Director Professional Services, British Telecom Development and Procurement. Meeting will be held at the Aston University Sumpnar Building, Birmingham, commencing at 18.30 hours (tea served from 18.00 hours).

Thursday 12 December 1985:

Customer Interface to the ISDN by Mr. B. R. Kerswell, British Telecom Research Laboratories.

Thursday 9 January 1986:

Network Modernisation by Dr. C. A. Brown, Head of Network Strategy and Digital Exchange Department, British Telecom Local Communications Services.

Thursday 13 February 1986:

Integrated Circuit Technology and Failure Causes by Mr. R. G. Taylor, Materials and Components Centre, British Telecom Development and Procurement. Meeting will be held in the Conference Room, 310 Bordesley Green, Birmingham, with laboratory demonstration, and will commence at 14.00 hours.

Thursday 13 March 1986:

High Definition Television by Mr. D. P. Laggatt, Chief Engineer, External Relations, British Broadcasting Corporation.

Thursday 10 April 1986:

JET (Joint European Torus) Project by Dr. E. Bertolini, Head of Power Supply Division, JET Joint Undertaking.

East Midlands

All meetings will commence at 14.00 hours.

Wednesday 6 November 1985:

Stores at Last!!! by Mr. R. Edgson, East Midlands District, British Telecom Local Communications Services. Meeting will be held at Nene College, Northampton.

Wednesday 4 December 1985:

East Midlands District is being Digitalised by Mr. A. Harris, Mr. B. J. Hart and Mr. S. J. Windram, East Midlands District, British Telecom Local Communications Services. Meeting will be held at Nottingham University.

Wednesday 8 January 1986:

Holography by Mr. N. Philips, Loughborough University. Meeting will be held at Loughborough University.

Wednesday 5 February 1986:

Making Technology make a Profit by Mr. R. Farrow, British Telecom Local Communications Services. Meeting will be held at Nottingham University.

Wednesday 5 March 1986:

Remote Line Testing by Mr. A. Hart, Northern Telecom (UK) Ltd. Meeting will be held at Leicester University.

Wednesday 9 April 1986:

The Changing Role of the Engineer in British Telecom by Mr. J. W. Young, Territorial Engineer, British Telecom. Meeting will be held at Peterborough Technical College.

London Centre

Meetings will be held at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, commencing at 17.00 hours; tea will be served from 16.30 hours. (Please note times associated with the meeting on Saturday 14 December 1985.) IBTE Members may bring a non-member guest to any evening meeting. Associate Section Members are also welcome to attend.

Thursday 14 November 1985:

A Customer's View of BT by Mr. P. Donnelly, Regional Telecommunications Engineer, Central Electricity Generating Board.

Saturday 14 December 1985:

ANNUAL FAMILY CHRISTMAS LECTURE. *In and out of the News* by John Craven of the BBC Childrens Television Programme 'John Craven's Newsround'. Meeting commences at 15.00 hours (refreshments from 14.00 hours). Admission is by ticket only. This meeting is now fully subscribed.

Tuesday 28 January 1986:

Optical Character Recognition by Mr. H. A. J. Bennett, OCR Project Manager, Postal Headquarters.

Mid Anglia Centre

All meetings will commence at 14.00 hours.

Tuesday 12 November 1985:

Holography by Mr. N. Phillips, Department of Physics, Loughborough University. Meeting will be held in Mumford Theatre, College of Arts and Technology, Cambridge.

Wednesday 11 December 1985:

Information Technology (A New Market-Place for BT) by Mr. D. A. Ingram, Mile Post Business Systems. Meeting will be held in the Exservicemen's Club, Peterborough.

Tuesday 21 January 1986:

Customer Service Systems by Mr. R. K. Gorton, Director of Customer Service Systems, British Telecom Local Communications Services. Meeting will be held in the Mumford Theatre, Cambridge.

Wednesday 12 February 1986:

Electronic Funds Transfer by Mr. B. D. Hingston, British Telecom National Networks. Meeting will be held at the Exservicemen's Club, Peterborough.

Wednesday 12 March 1986:

Managing National Networks by Mr. R. E. G. Back, Corporate Director, Managing Director British Telecom National Networks. Meeting will be held in Rhodes Centre, Bishop's Stortford.

Wednesday 9 April 1986:

The Changing Role of the Engineer in British Telecom by Mr. J. W. Young, Territorial Engineer, British Telecom. Meeting will be held in Peterborough Technical College.

Wednesday 23 April 1986:

Marketing in British Telecom by Mr. N. J. A. Kane, Director of Marketing, British Telecom. Meeting at Guildhall, Cambridge.

Scotland East Centre (Edinburgh)

Members will be advised individually of locations for meetings. All meetings will commence at 14.00 hours.

20 November 1985:

Electrostatics Seminar by Mr. D. Ray, Materials and Components Centre, British Telecom Development and Procurement.

4 December 1986:

Towards Zero Defects by Mr. W. H. Wilson, IBM.

22 January 1986:

AXE 10 (System Y) by Mr. D. Colbeck, Thorn Ericsson.

19 February 1986:

Why Forecast the Weather? by Mr. J. Allardice, Glasgow Weather Centre.

19 March 1986:

Optical Fibre Cable by Mr. D. Stanley and Mr. J. Macauley, British Telecom National Networks.

Scotland East Centre (Dundee Sub-Centre)

Members will be advised individually of locations for meetings. All meetings will commence at 14.00 hours.

20 November 1985:

Electrostatics Seminar by Mr. D. Ray, Materials and Components Centre, British Telecom Development and Procurement.

11 December 1985:

Communications for Weather by Mr. H. Cummings, Aberdeen Meteorology Office.

21 January 1986:

Optical Fibre Cable by Mr. D. Stanley and Mr. J. Macauley, British Telecom National Networks.

12 February 1986:

Lightning and Power Protection by Mr. R. Adcock and Mr. J. Cook, Local Lines Services, British Telecom Local Communications Services.

12 March 1986:

AXE 10 (System Y) by Mr. D. Colbeck, Thorn Ericsson.

Scotland West Centre

Members will be advised individually of locations for meetings. All meetings will commence at 14.00 hours.

19 November 1985:

5ESS—PRX Digital Switch by Mr. S. Piggott, AT & T and Philips.

5 December 1985:

Offshore Communications by Mr. I. Gault, Britoil plc.

23 January 1986:

AXE 10 (System Y) by Mr. D. Colbeck, Thorn Ericsson.

20 February 1986:

Electrostatics Seminar by Mr. D. Ray, Materials and Components Centre, British Telecom Development and Procurement.

20 March 1986:

Optical Fibre Cable by Mr. D. Stanley and Mr. J. Macauley, British Telecom National Networks.

Severnside Centre

Meetings will be held in Nova House, Bristol, commencing at 14.15 hours, except where stated otherwise. Members must obtain prior permission from the Local-Centre Secretary to bring guests.

Wednesday 6 November 1985:

Customer Service Systems by Ms. A. Orr, Customer Services Systems, British Telecom Local Communications Services

Wednesday 4 December 1985:

AXE 10 Exchange Equipment by Mr. D. Colbeck, Engineering Manager, Public Systems, Thorn Ericsson.

Wednesday 8 January 1985:

Plans for the Integrated Services Digital Network by Mr. J. R. W. Newman, Network Strategy and Digital Exchange Department, British Telecom Local Communications Services.

Wednesday 5 February 1986:

Quality in a Service Industry by Mr. P. Gillam, Major Systems Procurement, British Telecom Development and Procurement. Details of venue not yet available.

Wednesday 2 April 1986:

LCS in the New Environment by Mr. I. D. T. Vallance, Corporate Director, Chief of Operations, British Telecom. Meeting will be held at Queens Buildings, University of Bristol.

LOCAL-CENTRE SECRETARIES

The following is a list of Local-Centre Secretaries, to whom enquiries about the Institution should be addressed.

Centre	*Local Secretary*	*Address and Telephone Number*
Aberdeen	Mr. A. T. Mutch	British Telecom, A4.1.2, 2 Golden Square, Aberdeen AB1 1RD. Tel: (0224) 752901.
Anglian Coastal	Mr. T. W. Birdseye	Anglian Coastal District, Telephone House, PD2.1.5, 45 Victoria Avenue, Southend-on-Sea, Essex SS2 6BA. Tel: (0702) 373723.
Bletchley/South Midlands	Mr. D. R. Norman	British Telcom, ES2.3.4, Telephone House, 25–27 St. Johns Street, Bedford MK42 0BA. Tel: (0234) 57829.
Central Midlands	Mr. G. R. Chattaway	British Telecom/BES5.5, Little Park Street, Coventry CV1 2JY. Tel: (0203) 28396.
East Midlands	Mr. D. W. Sharman	British Telecom East District Training Office/PS1.7, 200 Charles Street, Leicester LE1 1BA. Tel: (0533) 534409.
London	Mr. L. J. Hobson	British Telecom LCS/OPS/CM2.1, Room 141, Procter House, 100–110 High Holborn, London WC1V 6LD. Tel: 01–432 2119.
Liverpool	Mr. B. Stewart	6th Floor, Liver Buildings, Liverpool L3 1NP. Tel: 051–229 4312.
Manchester	Mr. C. W. Jackson	Manchester District/BS14, Room 603, Telecommunications House, 91 London Road, Manchester M60 1HQ. Tel: 061–600 3333.
Martlesham Heath	Mr. G. Popple	British Telecom Research Laboratories, R9.2.4, Martlesham Heath, Ipswich IP5 7RE. Tel: (0473) 643341.
Mid Anglia	Mr. W. G. Castle	British Telecom, BP35, Telephone Engineering Centre, Station Approach, Boston, Lincolnshire PE21 8RN. Tel: (0205) 67233.
North and West Midland	Mr. R. J. Piper	Kimberley, Bury Bank, Stone, Staffordshire ST15 0QA. Tel: (0785) 813483.
North East	Mr. L. G. P. Farmer	British Telecom North East/EC1.4, Swan House, 157 Pilgrim Street, Newcastle-Upon-Tyne NE1 1BA. Tel: (0632) 613657.
North Downs and Weald	Mr. K. T. Bartlett	British Telecom, ES3, Best Street, Chatham, Kent ME4 4AB. Tel: (0634) 43372.
North Wales and the Marches	Mr. P. D. Jones	E3, Telephone House, Smithfield Road, Shrewsbury SY1 1BA. Tel: (0743) 69807.
Northern Ireland	Mr. W. H. Tolerton	BS1, 5th Floor, Dial House, 3 Upper Queen Street, Belfast BT1 6LS. Tel: (0232) 42444.
Preston	Mr. A. J. Oxley	British Telecom National Networks/TSP3/NW1.2.6., 10th Floor, Guild Centre, Lords Walk, Preston PR1 1RA. Tel: (0772) 22599.
Scotland East	Mr. T. L. McMillan	British Telecom Scotland/T432/3, Canning House, 19 Canning Street, Edinburgh EH3 8TH. Tel: 031–229 3296.
Scotland West	Mr. L. M. Shand	British Telecom National Networks/TSO/S2.1.6, Dial House, Bishop Street, Glasgow G3 8UE. Tel: 041–220 2576.
Severnside	Mr. P. James	Mercury House, Bond Street, Bristol BS1 3TD. Tel: (0272) 296281.
Solent	Mr. I. Ferguson	LCS/QE6, Telephone House, 70–75 High Street, Southampton SO9 1BB. Tel: (0703) 823635.
South Downs	Mr. C. J. Mayhew	British Telecom South Downs District Office, ED7.1, Grenville House, 52 Churchill Square, Brighton, BN1 2ER. Tel: (0273) 201598.
South Wales	Mr. D. A. Randles	British Telecom South Wales District/EP1.6, Roath ATE, Adam Street, Cardiff CF1 2XF. Tel: (0222) 464262.
Thameswey	Mr. R. D. Hooker	Thameswey District Head Office, DE1.4.5, Telecom House, 49 Friar Street, Reading Berks RG1 1BA. Tel: (0734) 501504.
Westward	Mr. C. S. Gould	British Telecom, NP37, Exbridge House, Commercial Road, Exeter EX2 4BB. Tel: (0392) 212516.
Yorkshire and Lincolnshire	Mr. R. S. Kirby	British Telecom North/TEM1.2.1, Netel House, 6 Grace Street, Leeds LS1 1EA. Tel: (0532) 466366.

ASSOCIATE SECTION REGIONAL CONTACT POINTS

The following is a list of Associate Section regional secretaries to whom enquiries about the Associate Section should be addressed.

Region	*Local Secretary*	*Telephone Number*
East	Mr. T. Turner	(0582) 573301 (evenings only).
London	Mr. P. Lendon	01–829 3180.
Midlands	Mr. R. E. Teasdale	(0203) 27824.
North East	Mr. K. Whalley	(0642) 242567.
North West	Mr. R. Craig	(0772) 267236.
Northern Ireland	Mr. S. Heraghty	(0504) 262222.
Scotland	Mr. A. Johnstone	031–447 8490 Extn. 61.
South East	Mr. R. P. Coveney	(0634) 45500.
South West	Mr. J. R. Dymott	(0202) 26789.
Wales	Mr. M. L. Thomas	(0492) 632411.

A New Method of Letting Underground Duct Contracts

P. RENHARD, T.ENG., M.I.ELEC.I.E.†, and K. LISTER*

INTRODUCTION

During 1979–80, Sheffield Telephone Area tested the concept of letting contracts for underground works by a lump-sum method rather than the traditional measured-rate method. Under a lump-sum contract, a single price is quoted by the contractor for laying duct and executing other associated works in accordance with plans and diagrams prepared by the Area's external planning groups. A measured-rate contract requests a tendered rate to be quoted by the contractor for each type of surface, footway or carriageway, encountered. A price is also quoted for the various types of jointing chambers constructed, cabinets erected, etc. Significant savings were claimed on Sheffield Area's contract rates when the lump-sum method was used. These savings were felt to be sufficiently encouraging to warrant further investigation within the Experimental Changes of Practice Committee (ECOPC) procedure, and so a field trial (Field Trial No. 633—Lump-Sum Underground Contract Letting) was instigated.

The field trial was sponsored by the Underground Construction Practices Group, British Telecom (BT) Local Communications Services (LCS), supported by the Procurement Co-ordination Division, BT Development and Procurement, and commenced in September 1982 in the Peterborough and Sheffield Telephone Areas. BT Midlands and BT North East Headquarters were responsible for monitoring the trial. The Areas provided local project supervisors.

In the lump-sum method, the contractor includes in his price all the planned work, any deviations or miscellaneous work required as a result of ground conditions found during execution of the work and extras for foundations and excavation in rock etc. (Diversions of other undertakers' plant, as for measured-rate contracts, are paid for by BT.) As with any other underground-duct contract, all work executed by the contractor is to BT Specification LN139 (Underground Duct Laying and Associated Works) and supervised by a BT works supervisor.

Approximately half of the duct contract works in Peterborough and Sheffield were considered for issuing as lump-sum contracts. For the duration of the trial in BT Midlands, the southern part of the Peterborough Telephone Area was chosen because this Area works to an agreement made with the Cambridgeshire County Council that requires BT contractors to carry out all reinstatements except for hot-rolled-asphalt carriageways.

The lump-sum contracts suitable for letting during the trial were subject to the following constraints:

(*a*) an upper let value limit of £25 000;
(*b*) a maximum of two duct ways to be laid;
(*c*) no manhole construction, tunnels, auger boring or pipe jacking;
(*d*) no housing estate work;
(*e*) no repayment works; and
(*f*) no element of measured rate in the contract.

Since adoption of this method of letting contracts, (*a*) and (*b*) are now recommendations only.

† Central Midlands District, British Telecom Local Communications Services
* Mid-Anglia District, British Telecom Local Communications Services

PLANNING ASPECTS

Any job which met the constraints set was considered suitable as a lump-sum contract. Although no procedural change was made to the planning of a lump-sum contract as against a measured-rate contract, the planner was asked to bear in mind that any information he had available about possible conditions along the route, for example, concrete, rock, presence of services etc., should be made known to the contractor at the invitation-to-tender stage. This information was entered on the Paving Schedule.

TENDER PROCEDURE

The tender document itself presents a change from the measured-rate system as the contractor is requested to give a price (net) for the complete work rather than for each individual item. With lump-sum tenders, the price adjudication is based on that quoted by the contractor, which is much simpler than for measured-rate contracts, where the contracts group calculates an estimated price from the tenders submitted from each competing contractor. This involves selecting the appropriate rate from each tender in accordance with the planner's schedule, and extending rates to give the total price for the job as planned. The amount of time this operation requires depends on the number of items on the schedule.

The bill checking procedure is simplified in the case of lump-sum contracts: the contractor presents his bill and this is paid on his 'fixed price' quote. With measured-rate, each item of the bill is checked against the Diary Page entry. The Diary Page, which is completed by the contractor, gives a record of the number and grades of men employed on the work each day, measurements of all work executed and details of any deviations and/or extra work.

SUPERVISION

Field supervision of both lump-sum and measured-rate types of contract is similar. In both, BT Specification LN139 is used and the works-supervisor's track book and works diagrams are completed as normal.

For monitoring purposes and during the field trial only, the works supervisor completed the Diary Page. The responsibility for completing the Diary Page, now that this type of contract letting has been adopted, has reverted to the contractor, although a simpler method of recording the Diary Page entries is recommended.

Although some works supervisors felt at the beginning of the field trial that their power would be eroded, this did not transpire during the trial. A high degree of supervision had to be maintained to ensure that contractors took no short cuts. It must be borne in mind that the financial incentives for extra depth, encountering rock, change of duct line, etc. that are payable for measured-rate contracts do not exist under lump-sum arrangements.

FINANCIAL SAVINGS

During the field trial, Peterborough Area let 26 lump-sum contracts, with a total value of £228 000, and Sheffield Area let 60, with a total value of £463 000. The monitoring of the field trial indicated that prices for lump-sum contracts were, on average, significantly below the estimated measured-rate values in both Areas. The field trial indicated a saving upwards of 78% on the bill processing time and a 1·1 hour saving on tender processing.

CONCLUSION

Based on the evaluation of the field trial, it was found that lump-sum tendering and contract letting offers the following advantages over measured-rate for straightforward duct-work contracts of the type let during the field trial:

(*a*) the final contract payment is less,
(*b*) tender processing time is reduced, and
(*c*) bill processing time is reduced.

It would be unfair to say there were no disadvantages evident from the field trial; the main ones were as follows:

(*a*) Works supervisors felt limited over their engineering ability to rearrange existing plant; for example, changing the position of existing duct entries into existing jointing chambers to enable new plant provision.

(*b*) The contractors have to be paid the whole lump-sum quote, even if some of the work cannot be completed because of changes beyond BT's control; for example, if a change of duct route is requested by a surveyor after a contract has been let.

BT Headquarters has now implemented the use of lump-sum contracts nationally, recommending some of the field-trial constraints. The availability of the lump-sum contract together with the traditional measured-rate contract in its various form (area and disconnected contracts) means that BT is now well provided with contract-letting procedures. Districts are now in a better position to select the right type of contract to fit the job in hand, which hopefully will mean a better and speedier service to BT's customers.

ACKNOWLEDGEMENTS

Acknowledgments are given to Sheffield Telephone Area, Management Services, Harrogate, and Materials Department, BT Procurement and Development.

Biographies

Peter Renhard is employed in the Central Midlands District, LCS, on engineering support management work. He joined BT in 1963 as an apprentice. From 1965–77, he has worked on external planning duties in Birmingham Telephone Area before being promoted to an Assistant Executive Engineer in BT Midlands Headquarters. For the past 8 years, he has been involved in underground projects, which encompasses a knowledge of BT contract procedures.

Ken Lister is a Contract Supervision Officer in the Peterborough Customer Service Area of Mid-Anglia District, LCS. He started his career as a Boy Messenger in 1939 in Grantham; he has spent most of his career on the external side of the business including 17 years on his present duties.

Faraday Lectures 1985–86

British Telecom (BT) is presenting the 1985–86 series of Faraday Lectures on behalf of the Institution of Electrical Engineers (IEE). The lecture, entitled *Beyond the Telephone: the Intelligent Network* is touring 16 towns and cities, playing to an estimated audience of more than 70 000 people. The lecture explains to the layman how microchip technology is changing telecommunications, and how engineers are bringing its benefit direct to the user. Many of those attending will be students from schools and colleges, and BT's lecture aims to give them a greater understanding of how modern telecommunications operate.

Mr. Bill Jones, BT's Chief Executive of Technology and the senior Faraday lecturer, said: 'As we move into the information age it is becoming increasingly important that people understand the technology that is changing our lives. Young people, who may be about to choose a career, will be a particularly important part of the audience. Our presentation is planned to stimulate a lasting interest in electronics and telecommunications. That is why BT and the IEE are spending a very substantial sum of money on it. There will not be much change for BT out of our budget of around £750 000 for the cost of the presentation and the tour.'

How is speech converted into a digital signal? How does the network send thousands of such signals simultaneously down a single link, ensuring that each gets to its proper destination? How can computer data or a facsimile of a document be sent half way round the world and back again in seconds? How might the network develop in the future? These are some of the questions that the lecture answers. Supported by live demonstrations, high-quality audio-visual material, film, sound and other special effects, BT's lecture explains how telecommunications is making increasing use of computer technology.

The Faraday Lecture was inaugurated by the IEE in 1924 to promote public interest in electrical science and technology. It pays tribute to Michael Faraday, the nineteenth-century scientist, whose discovery of electromagnetic induction greatly influenced the development and practice of electrical engineering. Every year, the IEE invites a major organisation to show a different aspect of the work of electrical engineers.

The presentation lasts for 55 minutes; admission is free, but by ticket. Usually, three performances are given at each venue: morning and afternoon performances are attended by local schools, and the evening performance by the general public, members of the IEE and their families. Applications for tickets should be made to:

The Faraday Officer
The Institution of Electrical Engineers
Station House
Nightingale Road
Hitchin
Hertfordshire SG5 1RJ
Telephone: Hitchin (0462) 53331

Venues

2 October 1985	Gaumont Theatre, Ipswich
16 October 1985	Town Hall, Middlesbrough
30 October 1985	Usher Hall, Edinburgh
6 November 1985	St. David's Hall, Cardiff
13 November 1985	City Hall, Sheffield
17 November 1985	Free Trade Hall, Manchester
4 December 1985	Dome, Brighton
11 December 1985	Conference Centre, Harrogate
22 January 1986	Guildhall, Portsmouth
30 January 1986	Philharmonic Hall, Liverpool
4–6 February 1986	Logan Hall, London
12 February 1986	Town Hall, Birmingham
26 February 1986	Sir William Whitla Hall, Belfast
5 March 1986	University Great Hall, Exeter
12 March 1986	Colston Hall, Bristol
19 March 1986	Assembly Rooms, Derby

British Telecom Press Notices

100 000-Line Milestone for British Telecom Telex

British Telecom's (BT's) Telex service has reached the 100 000-line milestone and is on course to complete its £70M modernisation programme by 1987. This was achieved when United International Finance Ltd of London was connected to BT's Telex network.

To mark the event, which brings the UK's Telex network to 100 000 lines, Dr. Sydney O'Hara, Chief Executive of Specialised Services in BT National Networks, presented Mr. Peter Atkin, Managing Director of United International Finance, with a free Telex line installation and a year's free line rental. In addition, a Merlin Cheetah 85 Telex terminal has been provided by BT Business Systems.

At the presentation, Dr. O'Hara said: 'We have reached this important landmark at a time when the Telex service is successfully undergoing the biggest transformation in its history. We are bringing customers faster service and new facilities thanks to a three-year programme to upgrade British Telecom's main Telex exchanges with stored-program control equipment (SPC) and provide digital trunk transmission links.

'National private networks have become an important part of business operations for the larger company, but public networks, such as Telex, remain the most cost-effective means of national and international text messaging for many, more centralised, businesses.

'Telex is rapidly becoming the foundation stone for more advanced message services. The network is changing. The switches and transmission paths, the customer access lines, and a growing number of gateways to other networks and services are all being developed to meet the growth in demand for text communications. Telex is the largest public messaging network in the UK and one of the main focal points for change.'

The domestic network is also connected to the international Telex network, which has almost two million users in nearly 200 countries. Many large international message carriers also have access to the Telex network. Each year, more than 215 million calls, over half of them to or from international destinations, are carried by UK Telex and the number of messages is growing every year. Almost half the UK Telex lines are in London.

Over the past few years, advances in the design and versatility of BT's Telex terminals such as the Merlin Sable, Puma and Cheetah have done much to enhance the importance and usefulness of the Telex service. Recent developments include:

(*a*) a programme for replacing 16 Strowger exchanges with ten new SPC exchanges, the benefits of which include faster call set-up times and improved network operations;

(*b*) InterStream Gateways 1, 2 and 3, which allow communication between the public telephone, data and Telex networks for text and data interchange (Teletex is one service which will span all three networks.);

(*c*) the enhancement of value-added services such as Prestel and the Telecom Gold electronic mail service to provide a Telex handling capability to all Telex users;

(*d*) the linking of Telemessage and Radiopaging to the Telex network to offer even wider forms of message delivery;

(*e*) the introduction of low-voltage links to customers' premises, known as *single-channel voice frequency* (SCVF), which are designed to conform to modern equipment practice; and

(*f*) the installation of 60-channel time-division multiplex digital links on the Telex trunk network to replace ageing analogue multi-channel voice-frequency systems.

Investment in the Telex network demonstrates BT's commitment to this service, so vital to the business community. It is the universal text messaging service which remains an essential aid to business efficiency. No other public message service can offer access to so many potential contacts, not only here in Britain but, more importantly, overseas.

First Public International Videoconferencing Service

Europe's first public international videoconferencing service, enabling groups of people to see and speak to each other face-to-face by television, was launched in August of this year between the UK and the Federal Republic of Germany (FRG). The new digital service was inaugurated in a videoconference between the two countries, with Mr. Geoffrey Pattie MP, Minister of State for Industry and Information Technology, and Sir George Jefferson, Chairman of British Telecom (BT), in London. Dr. Christian Schwarz Schilling, Minister of Posts and Telecommmunications in the West German Government, officiated in Cologne, with Herr Waltemar Haist, Director General of the Deutsche Bundespost (German Post Office).

This advanced form of communications is currently available from BT's public videoconferencing rooms in London, Bristol, Birmingham, Glasgow and Martlesham. Further studios are also to be brought into use. The British rooms can be linked to similar studios in Berlin, Cologne, Dortmund, Dusseldorf, Frankfurt, Hamburg, Hannover, Munich and Stuttgart. Links to Bonn, Bremen and Numemberg will follow later this year.

In addition, BT can supply videoconferencing equipment and offer consultancy, to enable users to set up videoconferences from rooms in their own premises without any special alterations to the rooms being required.

At the inauguration, Sir George Jefferson, said: 'This new BT International service is a great achievement. It is digital technology in action, serving the international business community, contributing to increased productivity and stimulating world trade. And for Britain it augments similar services already available to Canada and the USA.

'International videoconferencing allows groups of people at different locations to hold meetings as if they were in the same room. Those taking part see and hear their colleagues face-to-face, in colour. This offers many benefits:

speed and ease in setting up meetings;
additional staff can attend at short notice and at no extra cost;
savings in executive time otherwise spent on travel, avoiding its accompanying stress and benefitting family and social life;
savings on travel, hotel and related costs; and
better understanding from improved communication.

'Moreover, the technology which makes it possible is the product of European technical co-operation and innovation. I am happy to say that BT has made a distinctive contribution to this development in standards conversion, which provides equipment compatible with both European and North American networks.'

The international videoconferencing service uses a high-speed digital transmission link between the UK and the FRG. A special codec compresses the original picture signal while encoding it to reduce the transmission capacity required. Compression gives a good quality moving colour picture that is ideal for conference purposes. The technique reduces the digital transmission capacity required to 2 Mbit/s or less.

The digital-compression codec was developed by BT in collaboration with the telecommunication authorities of six other European countries, which included the FRG, and is made in Britain by GEC-McMichael. The codec is also available in a variant which will work at the North American digital transmission standard of 1·5 Mbit/s. Recent designs can also cater for operation at lower rates down to 768 kbit/s to offer further transmission savings.

Imtran

Imtran, British Telecom's (BT's) life-saving service for sending X-ray and body-scan pictures hundreds of miles by telephone in seconds, was inaugurated in July of this year. This followed a trial in the south-west of England, where the service successfully demonstrated its potential for safeguarding patients' lives and saving the National Nealth Service time and money.

Imtran, which is short for *image transfer*, enables surgeons away from their hospitals to examine patients' medical pictures or records as soon as they become available. The service avoids the wasted hours, and the increased risk to patients' lives that are incurred when information has to be brought by courier from a distant hospital.

Imtran was developed by the BT Research Laboratories at Martlesham Heath. It consists of a portable receiver-transmitter unit that is plugged into a standard telephone socket; it is mains powered. At the transmitting end, the Imtran unit can be connected directly to a body scanner or to a television camera focussed on X-ray pictures or medical records. The images are recreated at the receiver as high-resolution pictures on a television-monitor screen.

Mr. John Ling, the Imtran marketing manager, said 'Imtran will be of great value to National Health Service staff and patients, eliminating a great deal of staff and patient movement, especially in emergencies. Many small hospitals, although equipped with their own X-ray machines, turn to their district hospital for expert interpretation of the pictures or have to wait for the consultant's next visit. In urgent cases, the pictures, or patient's notes, would normally be sent by messenger, or the patient would be transferred by ambulance.

'Imtran can help avoid all this because it enables the specialist to talk directly with the doctor on the spot and, if necessary, begin treatment immediately. In an emergency this could be vital to the patient's survival or recovery.'

Mr. Ling added: 'A basic system of two transceivers costs less than £10 000. This cost can be recovered within a short time by reducing movements of patients and consulting teams.'

Imtran works by converting pictures into audio tones for transmission over the public switched telephone network and then turning them back into high-resolution images at the distant end. Each picture takes 32 s to build up and the effects of disturbance on the line are minimal. Normal conversation is also possible before and after picture transfer. Because Imtran uses normal dial-up telephone lines, it can communicate with similar units anywhere in the world.

Imtran is manufactured in BT's Birmingham factory. Nine pre-production units are already in service with the Wessex and South West regional health authorities. Units have also been exported to the USA.

Touchdown and British Rail

Touchdown, British Telecom's (BT's) unique touch-screen computer and telephone system, has been chosen to help run British Rail's (BR's) Southern Region. The installation at Waterloo Station is part of a £350 000 contract to speed up BR's communications and ensure information to passengers is fully up-to-date.

The first stage, which has already been officially opened, is a suite of Touchdown terminals that enable train operations controllers to direct train movements at the touch of their fingertips. Touch-sensitive screens give them immediate access to telephone lines and computer data. The complex installation comprises 28 terminals that combine telephone, data and Telex facilities; they have been installed at Waterloo regional headquarters to help keep track of some 6000 train movements a day on the Southern Region.

Each controller has direct telephone links to signalling centres, stations and depots, as well as the railway police, from a single desk-top terminal. Calls are connected automatically by the appropriate names on the screen being touched. Action to be taken, in special circumstances, can also be displayed on the screens, and controllers can log incidents directly from the Touchdown keyboard. The Touchdown system is also linked to BR's TOPS computer to enable controllers to check the movements of locomotives and freight trains.

Passenger information will be further improved in the second stage of the project, when the new telephone system for Waterloo's enquiry bureau is completed next year. Waiting time will be reduced because the calls, some two million every year, will be distributed in the order in which they are received. Information on the number of calls answered and waiting will be available at a glance, and printed records will enable the management to monitor performance targets closely.

The Touchdown system has been developed from BT's City Business System, first introduced three years ago. The product is unique and 150 screens have been installed worldwide. A Touchdown system has been installed in BR's London Midland Region control centre at Crewe, and others are in use at Gatwick Airport, in Hong Kong and the Middle East.

New Credit and Charge Card Electronic Transfer Service

A new service for retailers to speed up the processing of credit- and charge-card transactions has been introduced by British Telecom (BT) and Cresta Communications Ltd. The system uses Cresta's newly developed terminal, Teletran, which enables businesses and retailers to validate most major cards while simultaneously recording the sale, simply by wiping the card through the terminal. Information is then transmitted down telephone lines to computers in BT and then on to the card companies.

The service is aimed especially at retail outlets with a high volume of card sales, such as petrol stations, hotels, do-it-yourself and department stores. Cresta Communications is marketing and supplying the Teletran terminal on a rental and transaction-fee basis; it is also undertaking its maintenance. British Telecom Enterprises Value Added Systems and Services(BTE/VASS) is responsible for the provision, under a formal supply agreement, of the computer and database services, and the communicating networks, to Cresta.

The Teletran terminal, acting as an electronic till, eliminates the need for sales staff to write out each card transaction. Within seconds of wiping the card through the terminal, the system validates the card from information held on BT's computers, and then triggers the terminal to print out a sales receipt. Details of the transaction are then passed automatically to BT's computers and subsequently forwarded to the relevant card company. Customers are then billed by their card company in the normal way.

As well as handling sales, Teletran's electronic mail facility can be used to receive information of direct and immediate value to the retailer.

Teletran also offers a linked management control system which enables the retailer's management to monitor the performance of individual outlets to help make more effective business decisions.

Product News

Merlin Octara 32

British Telecom (BT) Business Systems has launched the first of a new generation of fully digital telephone systems. The *Merlin Octara 32*, which offers up to 32 extensions and 10 exchange lines, brings an extensive range of easy-to-use features to the smaller end of the business telephone-system market. Designed and built in Britain, it is the first fully digital key system of its size range and has the potential for future data switching and compatibility with the planned digital public network.

Merlin Octara 32

Octara 32 has been designed to be highly flexible so that it meets users' specific requirements. Its modular design allows for growth in four steps from the smallest size of six extensions, two exchange lines, up to the maximum capacity. The system is ideal for small/medium-sized companies, branches of larger businesses and discrete departments operating as a satellite on larger telephone systems such as the Monarch or Merlin DX. It is an ideal replacement for key-and-lamp and manager/secretary units.

The equipment is supplied in a wall-mounted control unit with a choice of three attractively styled desk terminals. The executive TX25 and TX23 versions are full key terminals with a BUSY lamp field indicating whether exchange lines and extensions are engaged or free. Both allow hands-free calling, while the TX25 offers full loud speech and automatic answering of internal calls. The third terminal, the TX21, is a simple digital telephone providing basic facilities. All three terminals can be mixed in any combination and operate over a digital interface to the control unit.

Octara 32 is designed for ease of use, particularly of the wide range of more than 20 features offered by the system. These include abbreviated dialling, call diversion, enquiry call, transfer, conferencing, on-hook dialling and camp-on-busy. Each facility is simply accessed by its individual clearly-labelled key, which eliminates the need for complex codes and operating procedures to be remembered. On the TX23 and TX25 terminals, status indicator lights are provided to show which facilities are in use. The programming and modification of features available for each extension can be carried out on site by the user.

In addition to the extensive range of standard facilities, system options allow for external music-on-hold, call-logging output to call management systems and output to an external paging amplifier.

For users who require calls to be handled by an operator or receptionist, the individual Octara 32 terminal can be programmed to provide this type of service.

New British Telecom Inphones—Rondo and Slimtel 10

British Telecom (BT) has introduced *Rondo*, a decorative new Inphone. A unique blend of traditional styling with modern time-saving features, Rondo is a press-button telephone having a circular mahogany-look base and real brass trim. It also offers last-number redial, MUTE button and a bell rather than a tone caller.

Rondo is a brand new design, exclusive to BT. The addition of Rondo to BT's decorator range will reinforce BT's already strong position within this market sector. Research highlighted Rondo's unusual styling as its main appeal, and men in particular were impressed by the craftsmanship and quality finish of this telephone.

Rondo is primarily aimed at the residential market as a decorative extension telephone. However, since it can be connected to some switchboards, it also has a role to play in business sectors where decor is important.

A 10-number version of the popular Slimtel one-piece telephone has now been made available. The new *Slimtel 10*, which is attractively sleek and compact, is a modern press-button telephone with last-number redial as well as a memory that can store 10 numbers of up to 16 digits each.

Rondo

Slimtel 10

MerlinFax

British Telecom (BT) Business Systems has concluded an agreement with Panasonic Industrial UK for up to 3000 facsimile terminals a year to be marketed through BT's telephone sales offices under the brand name *MerlinFax*. The model, which is to be supplied by the world's leading facsimile manufacturer, Matsushita Graphic Communications Systems (MGCS), is a compact machine with high-volume capabilities that are superior to other terminals in its class.

Since the advent of international standards, markedly more businesses are actively considering facsimile as an additional practical office facility, often including routine correspondence. The MerlinFax is very easy to use, and transmits an A4 page in about 20 s. Operating to the CCITT Group 3 standard, it can communicate not only with other Group 3 machines but also with the substantial number of Group 2 terminals already in use. It simply adjusts its own operating speed to that of the terminal with which it is communicating. The MerlinFax terminal requires little office space and, because it weighs only 11 kg, is easy to transport between locations.

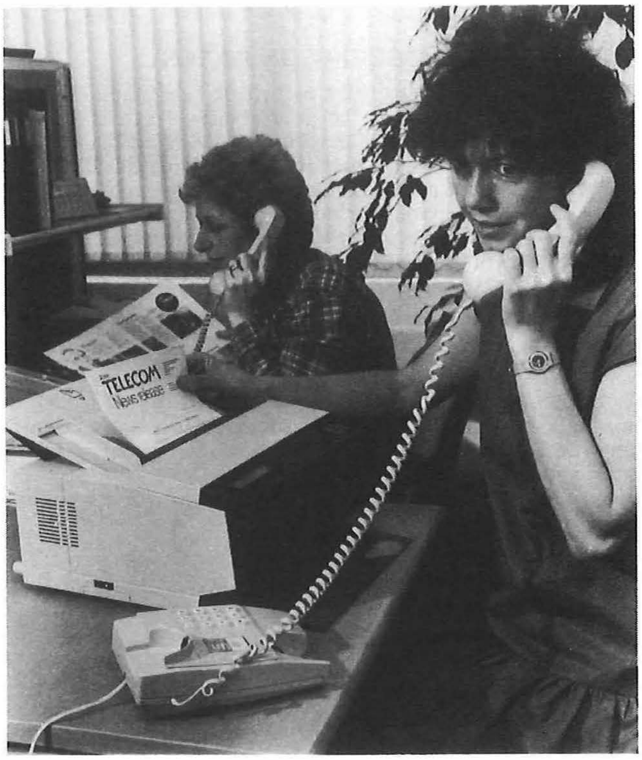
The range of features on MerlinFax provides the user with a variation in resolution standards that ensures good reproduction of poor quality originals and a choice of contrast settings for documents with varying or coloured backgrounds. It provides automatic verification of originals that have been sent successfully and prints the date, time, identification data and page number on received documents. The controls are easy to use and selected features are clearly indicated.

Speaking at the signing of the agreement, BT Business Systems' Chief Executive, Martin Glazebrook, said: 'The move into fax is a logical extension of our existing interests in advanced communicating terminals. BT's Merlin brand only comprises products which satisfy very high standards and offer perceptible value for money. We're certain that the Panasonic hardware will provide customer satisfaction, and is complementary to our existing text communicating terminals, including Telex, Teletex and other electronic messaging solutions.'

Speaking on behalf of Panasonic Industrial and MGCS, Ken Sakakibara, Managing Director of Panasonic, said: 'Contracts such as this are never easy to win and BT's decision to market our facsimile machine is, we believe, a tribute to the quality of the machine that we were able to offer. We successfully demonstrated to BT that the machine fulfils all the requirements that they were looking for. We now look forward to a continuing and mutually successful association.'

MerlinFax operates normally at 9600 bit/s over public telephone lines. This speed is automatically reduced if the quality of the connection is inadequate for this fastest rate. The equipment adopts the maximum speed commensurate with good copy quality for any given transmission link.

Resolution settings for Group 3 are: Standard, 3·85 line/mm; Fine, 7·7 line/mm; Superfine, 15·4 line/mm. Resolution for Group 2 is 3·85 line/mm. Merlinfax uses thermal recording on 210 mm wide paper. The standard paper roll holds 100 m of recording paper. For sending documents, an automatic document-feed feature allows up to 30 sheets of A4-size paper to be inserted for transmission. The maximum size of document for manual insertion is 280 mm × 1000 mm.



MerlinFax facsimile transceiver

MerlinFax provides polling and reverse polling features. Polling enables initiation of document transmission from remote locations. Reverse polling enables MerlinFax to poll automatically after transmitting. Use of easily programmable passwords bars unauthorised polling.

A journal print-out is provided for all transmissions and reception; this is automatically produced after 32 transactions or printed-out on demand.

Mainframe Access for Merlin Tonto

British Telecom's (BT's) Merlin Tonto now has a new feature: a data communications adapter. This is a simple plug-in option which can be specified for new equipment or added to Merlin Tontos already in service.

The data communications adapter provides a standard RS423 interface, which enables direct connection into a local mainframe computer, to a local area network or to a company's data communication network. The adapter allows Tonto to operate as a VT100 terminal, an industry standard for mainframe access.

BT is also offering *VT Link*, which provides VT52 or VT100 emulation for mainframe access over dial-up circuits. This gives an alternative where direct connection to a company's computer is not available.

The data communications adapter and the VT Link module extend the already powerful communications features of Tonto, which include telephony with its featurephone facilities, text messaging directly to other Tontos via the telephone network, and access to electronic mail services such as Telecom Gold. These new items add significant features to the system and should further enhance Tonto's rapidly growing popularity.

Notes and Comments

INCREASE IN SUBSCRIPTION RATES

The Council of the Institution of British Telecommunications Engineers announces that, because of heavy increases in the price of paper, the price of the *Journal* will be increased from the January 1986 issue. The new price will be £1·25 (£1·75 including postage and packaging); annual subscriptions: £7·00 (including postage and packaging) (Canada and the USA: $12·00). The special price to British Telecom and British Post Office Staff will be increased to 75p per copy.

CONTRIBUTIONS TO THE JOURNAL

Contributions of articles to *British Telecommunications Engineering* are always welcome. Anyone who feels that he or she could contribute an article (either short or long) of technical, managerial or general interest to engineers in British Telecom and the Post Office is invited to contact the Managing Editor at the address given below. The editors will always be pleased to give advice and try to arrange for help with the preparation of an article if needed.

Educational Papers

The Editors would like to hear from anyone who feels that they could contribute further papers in the series of educational papers that is to be published in the *Supplement* (for example, *Microcomputer Systems Parts 1 and 2*, October 1984 and January 1985 issues). Papers could be revisions of British Telecom's series of *Educational Pamphlets* or, indeed, they could be completely new papers. It is intended that they would deal with telecommunications-related topics at a more basic level than would normally be covered by articles in the *Journal*. They would deal with, for example, established systems and technologies, and would therefore be of particular interest to those who are new to the telecommunications field, and would be useful for revision and reference and for finding out about new topics.

In the first instance, intending authors should write to the Deputy Managing Editor, at the address given below, giving a brief synopsis of the material that they would like to prepare. An honorarium will be paid for suitable papers.

Guidance for Authors

Some guiding notes are available to authors to help them prepare manuscripts of *Journal* articles in a way that will assist in the uniformity of presentation, simplify the work of the *Journal's* editors, printers and illustrators, and help ensure that authors' wishes are easily interpreted. Any author preparing an article is invited to write to the Managing Editor, at the address given below, to obtain a copy.

All contributions to the *Journal* must be typed, with double spacing between lines, on one side only of each sheet of paper.

As a guide, there are about 750 words to a page, allowing for illustrations, and the average length of an article is about six pages, although shorter articles are welcome. Contributions should preferably be illustrated with photographs, diagrams or sketches. Each circuit diagram or sketch should be drawn on a separate sheet of paper; neat sketches are all that is required. Photographs should be clear and sharply focused. Prints should preferably be glossy and should be unmounted, any notes or captions being written on a separate sheet of paper. Good colour slides can be accepted for black-and-white reproduction. Negatives are not required.

It is important that approval for publication is given at organisational level 5, and authors should seek approval, through supervising officers if appropriate, before submitting manuscripts.

EDITORIAL OFFICE

All correspondence relating to editorial matters ('letters to the editor', submissions of articles and educational papers, requests for authors' notes etc.) should be sent to the Managing Editor or Deputy Managing Editor, as appropriate, at the following address: *British Telecommunications Engineering*, NN/CMkt2.2, Room 107, Intel House, 24 Southwark Bridge Road, London SE1 9HJ. (Telephone: 01−928 8686 Extn. 2233.)

Forthcoming Conferences

Further details can be obtained from the conferences department of the organising body.

Institution of Electrical Engineers, Savoy Place, London WC2R 0BL.
Telephone: 01–240 1871.

Measurements for Telecommunication Transmission Systems
27–28 November 1985
Institution of Electrical Engineers

Computerised Quality Assurance
23–26 March 1986
University of Sussex, Brighton

Speech Input/Output: Techniques and Applications
24–26 March 1986
Institute of Education, London

Software Engineering for Telecommunication Switching Systems
14–18 April 1986
Eindhoven, The Netherlands

Communications—An Industry on the Move (COMMUNICATIONS 86)
13–15 May 1986
Birmingham Metropole Hotel, Birmingham

Online Conferences Ltd., Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE.
Telephone: 01–868 4466.

Cellular and Mobile Communications International, Business Strategy Conference
5–7 November 1985
Wembley Conference Centre, London

NETWORKS 86
10–12 June 1986
Wembley Conference Centre, London

British Telecommunications Engineering

If you wish to subscribe to *British Telecommunications Engineering*, please complete the relevant section of the order form below and send it to the address given. British Telecom (BT) and British Post Office (BPO) staff should complete the upper section and other subscribers the lower section. A photocopy of this form is acceptable.

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Rank .... Pay No. (Note 2) ....

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3 Indicate whether you are a member of the Associate Section of the Institution of British Telecommunication Engineers (IBTE). Full Members of the IBTE receive the *Journal* as part of their IBTE subscription.

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Please supply 4 quarterly issues of *British Telecommunications Engineering.* I enclose a cheque/postal order for the sum of £7·00 (Canada and the USA: $12) to cover the yearly subscription.

(Cheques and postal orders, payable to **'BTE Journal'**, should be crossed '& Co.' and enclosed with the order. Cash should not be sent through the post.)

Name ....

Address ....

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Please state with which issue you wish your subscription to commence (April, July, October or January) ....

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