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EDITORIAL

Computers are becoming an increasingly important tool in the management of information so that the relevant data is available at the right place and at the right time. All too often, however, individual computer applications have been developed in isolation, many of them making use of the same basic data but lacking the ability to integrate with each other thus duplicating resources. One way in which British Telecom is improving its service to customers is the introduction of the Front Office concept whereby most enquiries from customers are dealt with at the first point of contact without the need to transfer them from department to department. This implies that a wide range of vital information must be readily available at the initial contact point and at various support groups throughout the District. To achieve this level of response, one of the most ambitious and complex computerisation exercises, the Customer Service Systems project, is currently being carried out. An article on p. 18 of this issue of the *Journal* outlines the philosophy behind the project and describes the magnitude of the tasks involved.

Customer Signalling in the ISDN

A. D. BIMPSON†, D. C. RUMSEY*, and A. E. HIETT‡

UDC 621.395.34 : 621.394.4

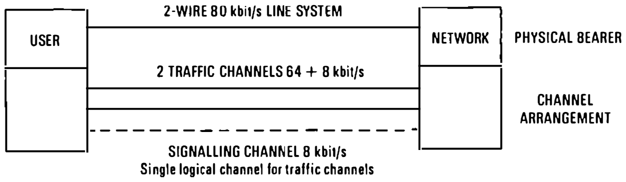
This article reviews the signalling system used in the integrated services digital network (ISDN) pilot service between the customer and the network. The system is based on the high-level data link control procedures described by the International Standards Organisation[1]*. A brief description of the principles and operation of the message transfer and call-control procedures is given. Evolution to a UK national standard system and its relationship to the private network signalling system is also outlined.*

INTRODUCTION

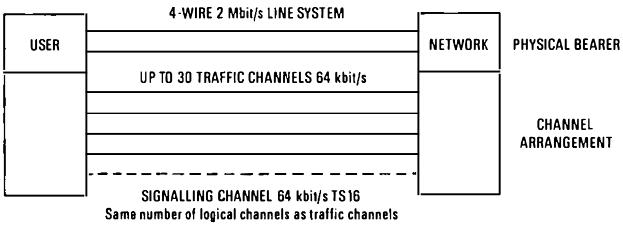
The introduction in the British Telecom (BT) network of an integrated services digital network (ISDN) produced the need for more efficient customer–network signalling methods. Existing methods based on interrupted direct current or in-band tones are not appropriate to the needs of ISDN terminals.

A previous article in this *Journal* has outlined the operation of the pilot service ISDN terminal, called the *network terminating equipment* (NTE)[2]. Further articles have illustrated the use of the ISDN to support various voice and data services[3].

The channel structure of the customer's interface allows the use of common-channel signalling related to the traffic channel in a logical rather than in a physical sense. Such a system needs to support the two interface structures offered to BT's customers. These interfaces are illustrated in Fig. 1. The basic access at 80 kbit/s provides a line with two traffic channels, one at 64 kbit/s and the other at 8 kbit/s, and a signalling channel of 8 kbit/s. The extended or primary rate access is based on a 2 Mbit/s link and provides up to 30 traffic channels and a 64 kbit/s signalling channel (timeslot 16 (TS16)).



(*a*) Basic single-line connection



(*b*) Extended multi-line connection

Fig. 1—Customer interfaces

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SUMMARY OF ABBREVIATIONS USED IN THIS ARTICLE

BTNR	British Telecom Network Requirement	ISO	International Standards Organisation
CAM	*Call accepted* message	ISPBX	Integrated services private branch exchange
CBWF	Call back when free	ISRM	*Initial service request* message
CCM	*Call connected* message	LAN	Local area network
CIM	*Clear indication* message	LAP	Link access protocol
CLC	Calling line category	NAM	*Number acknowledged* message
CLI	Called line identity	NTE	Network terminating equipment
CRM	*Clear request* message	OLI	Originating line identity
CS	*Channel seize* message	PBX	Private branch exchange
CUG	Closed user group	PDR	*Power down request* frame
DA	Destination address	SABMR	*Set asynchronous balance mode (restricted)* frame
DASS	Digital access signalling system	SIC	Service indicator code
DPNSS	Digital private network signalling system	SNU	Signal not understood indication
EEM	*End–end* message	SPC	Stored programme control
FCS	Frame check sequence	UA	*Acknowledgement* frame
HDLC	High-level data link control	UI(C)	*Information (command)* frame
ICI	Incoming call indication	UI(R)	*Information (response)* frame
IG-SNU	Signal ignored indication	UUD	User-to-user data
ISDN	Integrated services digital network		

No ISDN access standards existed when the initial proposals for the service were formulated and therefore BT and the participating firms in the System X development designed the *Digital Access Signalling System No. 1* (DASS 1)[4]. This is a layered signalling method which is independent of the bit rate and offers a secure data-transfer mechanism. It also offers a flexible message set enabling additional services and facilities to be added with minimum change. The system was designed particularly for ease of implementation in order to minimise the cost of terminals.

EVOLUTION OF THE SIGNALLING SYSTEM

In order to support access by the integrated services private branch exchange (ISPBX) to the ISDN at 2 Mbit/s, it was necessary to introduce a number of enhancements to DASS 1. Furthermore, additional changes were made to support the application of the signalling system to the control of digital private circuits. The result of this work was the specification of the first draft of the DASS 2 signalling system in October 1983. From this initial draft, two separate signalling systems evolved: namely, the present DASS 2[5] and the Digital Private Network Signalling System (DPNSS)[6]. Both DASS 2 and DPNSS share a common core of procedures, and together offer the ISPBX implementor a single approach towards the control of both public switched and private digital circuits.

BASIC DASS PRINCIPLES

DASS follows the layered architecture model for data transfer systems proposed by the International Standards Organisation (ISO)[7]. In this system, each layer is considered to provide a service to the higher layer, with the higher layer being unaware of the interactions of the lower layers.

Table 1 shows the relationship between DASS terms and the ISO model.

TABLE 1

Relationship Between DASS and the ISO Model

Layer	ISO Term	DASS Term
3	Network	Call control
2	Data-Link	Link access protocol (LAP)
1	Physical	Signalling channel

Communication between the customer and the network is effected by carefully defined message transfers between the elements at the same layer (termed *peer-to-peer protocols*) and interactions between adjacent layers.

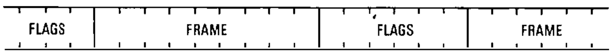
Customer or network action results in a defined sequence of call-control messages at layer 3. Each message is passed to layer 2, the Data-Link layer, known as a *link access protocol* (LAP) which is responsible for safe delivery of the message. The LAP also controls the activation of the Physical layer and the bit sequence applied to the signalling channel.

OPERATION OF DASS LINK ACCESS PROTOCOL

The objective of this layer is to provide a secure method of data transfer to ensure reliable exchange of call-control messages between the user and the network. A single physical connection can support as many LAPs as required. DASS uses a single LAP for the two channels of the basic access and one LAP per traffic channel in a 2 Mbit/s multi-line access link to a PBX.

Framing

There are two parts to the LAP: formatting and control. Messages are formatted by the LAP into high-level data link control (HDLC) type frames, each frame comprising a sequence of a bit fields known as *octets*. Fig. 2 shows the frame format. The frame is delimited by a unique bit sequence, 01111110, which is called a *flag*. When no frame is available for transmission, flags are transmitted continuously. During the transmission of a frame, layer 2 prevents the flag pattern appearing on the link by injecting a ZERO after five consecutive ONEs in the data stream. The receiver removes a ZERO following any group of five consecutive ONEs and thereby restores the original data pattern.



(*a*) Frames separated by continuous flags

(*b*) Frame contents

Fig. 2—Layer 2 frame formats

Within the frame, a number of fields are defined, each field containing one or more octets. The address field identifies the LAP, whether the message is a command or response, and the traffic channel to which the message refers. Two address codings are allowed; a single octet address is used for basic access whereas a two octet address is used for multi-line access. The address field provides the differentiation between public and private network signalling channels. The control field defines the frame type and is used in the peer-to-peer protocol. The information field (when present) contains the layer 3 call-control message. Not all frames carry layer 3 information as some frame types are used only as part of the layer 2 procedures. The frame ends with a frame check sequence (FCS) field. An FCS is formed by a calculation on the data contained in the address, control and information fields. The FCS plays a major part in guaranteeing receipt of messages by detecting errors in transmission.

Frames are retransmitted continuously until an acknowledgement of correct reception is received from the far end; this is referred to as *compelled signalling*. Together with FCS checking, such retransmission of frames gives a system tolerant of line errors even when the error rate approaches 1 in 10^3.

Layer 2 Frame Types and Procedures

Five frame types derived from HDLC are specified in DASS. These are:

SABMR: *Set asynchronous balanced mode (restricted)*
UI(C): *Information (command)*
UI(R): *Information (response)*
PDR: *Power down request*
UA: *Acknowledgement*

All frames contain address, control and FCS fields. Only the *information (command)* frame type carries layer 3 information.

In order to keep track of the flow of messages, each end of the link maintains variables indicating the next expected frame in the sequence. The frames carry a sequence number that can be compared to the variable to ensure a frame is not lost. Modulo 2 sequence numbers are used and are carried in the information frame control field. Separate numbering is maintained for the two directions of transmission. Each end of the link keeps a transmit and a receive variable.

The layer 2 procedures are illustrated in Fig. 3 and are described in the following paragraphs.

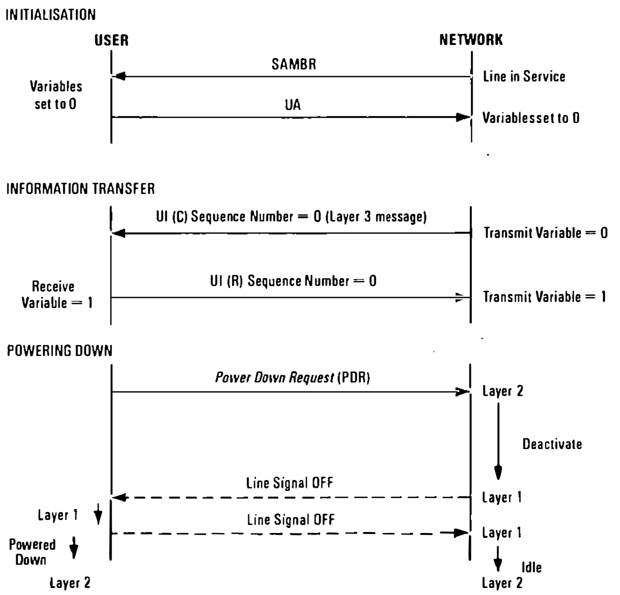


Fig. 3—Basic layer 2 procedures

Layer 2 operations start when the customer's line is brought into service irrespective of whether any call is present. The variables at each end of the link are initialised. After activating layer 1, layer 2 issues an SABMR frame. This acts as a *reset* signal and causes the NTE to set its variables to 0. The NTE responds with an *acknowledgement* (UA) frame to indicate that it has complied with the request. Receipt of the *acknowledgement* frame causes the exchange to set its variables to 0. The two ends of the LAP are now aligned and should stay so unless a fault occurs. The line can be powered down until a call has to be handled.

A layer 3 message (that is, a call-control or maintenance message) is transferred by preparing a layer 2 *information (command)* (UI(C)) frame containing address, control, information and FCS fields. The control field includes the sequence number set to the current value of the transmit variable. This frame is transmitted continuously. The receiving end recalculates the FCS from the incoming address, control and information fields. If the recalculated FCS matches the received FCS, the frame can be accepted. The address and sequence number can now be checked. Provided that all checks are passed, an *information (response)* (UI(R)) frame is returned to the sending end with a sequence number set to the same value as that received in the UI(C). Once the UI(R) is received and validated, the sending end stops further retransmissions of the current frame. During this process the variables at each end are updated ready for the next frame. Any corrupted frame failing the FCS check is discarded, but the next (or a subsequent) retransmission should get through without error and be acknowledged.

If layer 2 receives no acknowledgement after a number of retransmissions (the value depending on whether the line has basic or multi-line access), the link is reset by transmitting an SABMR frame. Any call in progress is cleared. If the link cannot be reset, the line is taken out of service.

When the calls on both channels have been cleared, the NTE requests deactivation of the line transmission system by sending a *power down request* (PDR) frame. Providing it has no further layer 3 messages, the network deactivates the line system. The PDR can be refused by returning a UA frame.

As 2 Mbit/s line systems cannot be powered down during normal operation, PBXs served by such systems do not use the power down procedures and no explicit layer 2 actions occur at the end of calls.

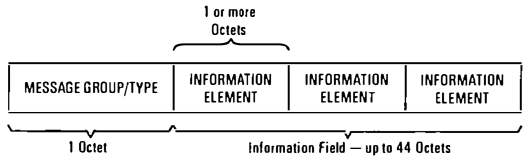
LAYER 3 MESSAGES AND PROCEDURES

The layer 3 message set contains a number of message types which represent the basic building block for call-control procedures. The messages contain information elements which can be extracted by the various network subsystems to enable calls to be processed in the most flexible manner. By this means it should be possible to extend the range of network facilities and services with minimum impact on the layer 3 message set and hence on the customer's terminal.

Signalling Message Structure

The general structure of DASS 2 signalling messages is illustrated in Fig. 4. Each message contains an integral

FORMAT



GROUP

Call control
Maintenance

TYPES

Initial service request	: Service indicator, destination address
Incoming call indication	: Service indicator, caller identity
Call accepted	: None
Clear request	: Clearing cause
Status	: Status details

Fig. 4—Layer 3 format and procedures

number of octets up to a maximum of 45. The first octet contains the message name, in the form of a group/type code, whilst subsequent octets contain a variety of information elements. In some messages, this first octet is all that is needed to identify an event in the call sequence. Message groups are defined for both call-control and for maintenance.

Other messages contain a number of mandatory information elements (for example, the message used to request call establishment always contains a service indicator code (SIC) describing the characteristics of the required call). In addition, some messages contain optional information elements such as network-facility requests. Optional information elements are coded in a flexible manner to allow for future extension. Supplementary service requests are coded as supplementary information strings in the form $\star nn \star$ *information*#, or $\star nn$# where *nn* is a code representing the service requested.

DASS 2 Features

DASS 2 comprises signalling elements for both basic call establishment and the control of supplementary services.

The call-control procedures were specifically designed to accommodate the special requirements of ISPBXs accessing the ISDN. The signalling system is used to effect the control of the 30 communications channels provided by the 2 Mbit/s access arrangement. All DASS 2 signalling messages are conveyed over the 64 kbit/s common signalling channel (time-slot 16), thereby giving potentially fast call establishment on ISDN calls.

A variety of network-provided supplementary services may be requested during call establishment. The following paragraphs give a brief summary of the main features of each service.

Closed User Group

A customer may register with the network as a member of a closed user group (CUG). The network will provide such customers with a level of security which will prevent communication with other network users who are not members of the CUG.

Calling and Called Line Identity

The calling and called line identity facility enables a user to be provided with the network address of the calling user (for incoming calls) or the network address of the called user (for outgoing calls) during call establishment.

Network Address Extension

Network address extension provides a calling user with the possibility of using an extension of up to six alphanumeric characters to the network numbering scheme in order to identify an endpoint (terminal or process) connected to the called network port of a PBX extension (for example, to one of a cluster of terminals connected to a PBX extension or to a particular process in a host computer).

Call Charge Indication

This facility provides an indication of the number of call units and the call charge at the end of each call.

User-to-User Signalling

The user-to-user signalling facility allows signalling information to be conveyed between the calling and called user without it being modified by the network. User-to-user signalling can be transferred during call establishment and after answer. It enables a customer to invoke supplementary services provided by a remote PBX.

The user-to-user signalling service is not confined to circuit-switched calls, but may also be used in association with private circuits routed via the public network. In this way, an ISPBX may route a mixture of public switched and private circuits via the same 2 Mbit/s network access link, signalling for all circuits being conveyed over time-slot 16.

CALL CONTROL PROCEDURES

Call Establishment

Fig. 5 shows the message sequence for basic call establishment (that is, without any requests for supplementary services).

A PBX requests call establishment by sending an *initial service request* message (ISRM). This message contains an SIC and the called address. The SIC contains an indication of whether an end-to-end digital path with common-channel

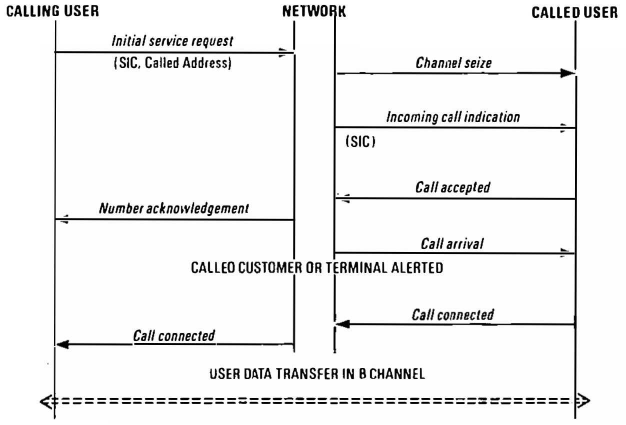


Fig. 5—Typical call sequence

signalling is essential for the call; it also contains a description of the characteristics of the calling terminal (that is, voice or non-voice including data transmission characteristics). This information is eventually passed on to the called customer so that compatibility between the calling and called terminals can be confirmed before the call is accepted.

After the receipt of an *initial service request* message, the network attempts to establish a call path. If the called party is FREE, the network sends a *channel seize* (CS) message as an advance warning of the arrival of an incoming call. Because of the way in which call-related information is passed between originating and terminating local exchanges, the terminating exchange is often informed of the incoming call before all information necessary to complete call establishment (for example, supplementary service information) has been received. Consequently, to discourage the called party from attempting the establishment of an outgoing call before this supplementary information arrives, the terminating local exchange sends the *channel seize* message.

When the terminating local exchange is in a position to indicate the incoming call, it sends an *incoming call indication* message (ICI) to the called PBX. The *incoming call indication* message contains the SIC which the network had previously received from the calling PBX.

The called PBX checks that the called party is FREE, and if the SIC indicates that the calling and called terminals are compatible, the called PBX confirms its acceptance of the call by returning a *call accepted* message (CAM) to the network. At this point, the called extension should be advised of the incoming call (that is, by ringing or by the appropriate non-voice interface procedure).

On receipt of the *call accepted* message, the network informs the calling PBX that the call is being indicated to the called party by returning a *number acknowledged* message (NAM) to the calling PBX. Depending on the type of call being established, the network may also return ringing tone in-band.

When the called extension finally answers the call, the called PBX returns a *call connected* message (CCM) to the network. On receipt of the *call connected* message, the network completes the establishment of the call path and returns a *call connected* message back to the calling PBX to indicate that communication with the called party can begin.

In the case of non-voice communication, completion of the DASS 2 signalling procedures may be followed by in-band procedures to synchronise the entry of both terminals to the data communication phase.

Rejection of Incoming Calls

If after the receipt of an *incoming call indication* message, the called PBX decides that the call cannot be accepted (for example, because the calling and called terminals are not compatible), the call can be rejected by a *clear request* message (CRM) being returned to the network. The *clear request* message contains an information element, known as a *clearing cause*, which describes the reason for call rejection. The network then informs the calling PBX of call rejection by returning a *clear indication* message (CIM).

The network may also reject a request for call establishment by returning a *clear indication* message to the calling PBX.

For voice calls, call rejection by the network or the called customer is indicated to the calling PBX by an in-band tone or announcement supplemented by a *number acknowledged* message. This message contains an information element, known as an *end of call* indication, which conveys the clearing cause generated by the network or the called PBX.

ISDN Call Types

Two types of ISDN call are possible and are referred to as *category 1* and *category 2*. Users indicate the category of call required within the SIC of an *initial service request* message as previously described. Category 1 indicates that a digital routing with common-channel signalling between calling and called PBX is absolutely essential. The service characteristics may be voice or data and in the latter case the terminal rate is included within the SIC. If a digital path cannot be established, a request for a category 1 call will fail.

All of the ISDN supplementary services previously described may be used in a category 1 call.

A category 2 call is one in which a digital path with common-channel signalling between calling and called subscribers is not essential. If a category 2 call is established with an all-digital routing, the supplementary services available are as for category 1 calls. However, if a digital routing is not available, the call is still established, but the only ISDN supplementary service supported is call charge indication. All category 2 calls must commence in the VOICE mode, although mechanisms do exist to enable the mode to be swapped at later stages of the call if an all-digital routing has been established.

Call Termination

An ISDN call may be terminated by either the called or calling parties sending a *clear request* message. Subject to there being no network reasons for holding the call (for example, a 999 call), both categories of call are immediately released following calling-party clear; this is also the case for called-party clear in category 1 calls.

When the called party clears a category 2 (that is, voice) call, the network does not release for three minutes. During this period, the called party is able to answer and continue communication with the calling party simply by sending an *initial service request* message containing no call selection information.

A typical clearing message sequence is shown in Fig. 6.

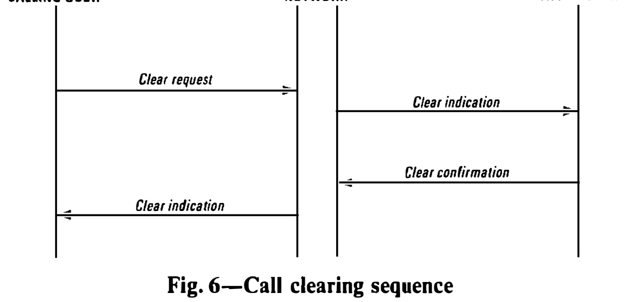


Fig. 6—Call clearing sequence

Procedures for Supplementary Services

A more detailed description of the two most important supplementary services—CUG and user-to-user signalling—is given in this section.

Closed User Group

A CUG member may use the ISDN to communicate with other members of the same CUG group, but communication between other network users who are not members of the CUG is prevented by the network. This basic form of the supplementary service is known as *CUG only*.

All members of a CUG must be registered with the network at the specific request of a user who is designated to be the controlling party of the CUG. Users may be members of more than one CUG. As an extension of the basic facility of CUG only, a user may choose either or both of the following options:

(*a*) *CUG with Incoming Access* allowing both communication with other members of the CUG and incoming calls from users who are not members of a CUG (that is, belonging to the open network).

(*b*) *CUG with Outgoing Access* allowing communication with other members of the CUG and outgoing calls to users who are members of the open network.

Each time a user makes a CUG call, an appropriate facility request must be included within the *initial service request* message. Where a user belongs to more than one CUG, the facility request contains a local identifier to inform the network of the actual CUG to be associated with this call. Following analysis of the CUG facility request, the network associates the appropriate CUG identification code (interlock code) to be used within the network during call establishment.

Before the call is delivered, the network will check that the called subscriber is a member of this CUG by comparing the interlock codes registered against the called user with the interlock code received from the exchange local to the calling user. If the interlock codes match, the network indicates the incoming call to the called user by sending an *incoming call indication* message as previously described. The *incoming call indication* message contains a CUG facility indication with a local identifier giving the CUG to be associated with this call. Call establishment then proceeds as described previously.

If the majority of a user's calls are to members of the same CUG, a preferential CUG may be registered with the network. In such circumstances, the network associates all outgoing calls with the preferred CUG unless the user specifies an alternative CUG by including a specific facility request within the *initial service request* message.

User-to-User Signalling for Circuit-Switched Connections

The message sequences associated with this supplementary service, when used before the call is answered are shown in Fig. 7

A PBX wishing to use the user-to-user signalling service must register this capability with the network. Furthermore, whenever an outgoing call is made, user-to-user signalling may be used only if an appropriate facility request has been included in the *initial service request* message sent to the network to request call establishment.

When the network receives an *initial service request* message containing a request for user-to-user signalling, it verifies that both the calling and called users are registered for this service and then delivers the incoming call to the called PBX. The *incoming call indication* message contains a user-to-user signalling facility information element indicating whether the calling party has any user-to-user infor-

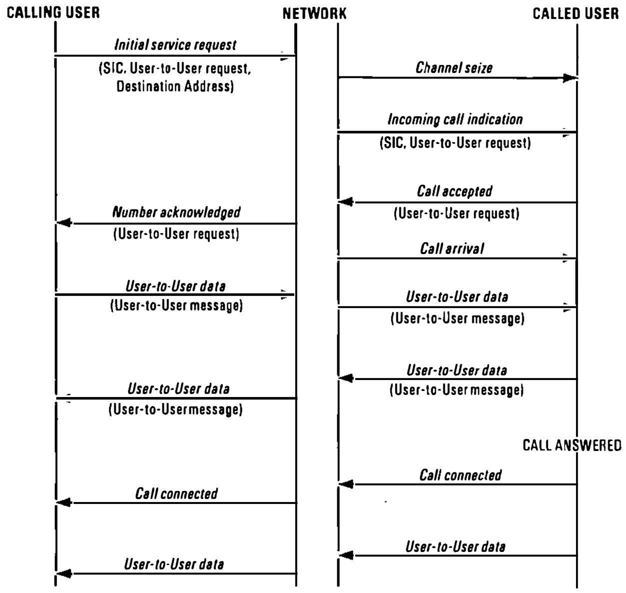


Fig. 7—User-to-user signalling: before and after answer

mation to send or is simply stating a wish to use the service at a later point in the call.

The called PBX can accept or reject the use of the user-to-user service by sending back an appropriate facility indication in the *call accepted* message.

If the called PBX agrees to use the supplementary service, both users can send up to three *user-to-user data* messages (UUDs) before the call is answered (that is, before a *call connected* message is returned by the called PBX). Each *user-to-user data* message may contain up to 32 octets of user data, this data being conveyed transparently between the two parties of the call.

After the call has been answered, *user-to-user data* messages can also be sent in both directions of the call, subject to network flow control.

If the facility negotiation during call establishment has failed because either user was not registered for the service or the called user refused to accept the service, the network still allows the call to proceed although the use of the user-to-user signalling service is prohibited.

User-to-User Signalling for Tie-Lines

The features available for circuit-switched calls after a call is answered are also provided for 64 kbit/s digital private circuits which are routed via the public ISDN (tie-lines). In this case, units of user-to-user data of up to 45 octets may be transferred via the network between two users of a tie-line. The network places no restrictions on the coding of this information, but applies flow control in a similar manner to the circuit-switched service.

IMPLEMENTATION

A typical implementation of the signalling system involves a mixture of hardware and software. The basic functions of layer 2 are performed by using standard HDLC controller chips or dedicated ULAs. A microprocessor runs software to perform the more complex LAP functions. In the terminal, this microprocessor also provides the call-control and human interface supervision procedures. In the exchange, the processor dealing with the layer 2 functions is shared by a number of customers.

DIGITAL PRIVATE NETWORK SIGNALLING SYSTEM

The principles of common-channel signalling described in the previous parts of this article are also appropriate for use in a private network between PABXs.

In fact, modern stored-program control (SPC) PABXs with their wide range of supplementary services are ideally suited to exploit this type of signalling system.

BT, in collaboration with a number of PABX manufacturers, has defined a common-channel signalling system known as the *Digital Private Network Signalling System No. 1* (DPNSS 1) for private network application.

DPNSS 1, like DASS 2, is derived from the earlier DASS 1 signalling system. The development of two systems has reflected the differing requirements of the public and private networks and, although the two systems are similar in principle, they differ in detail.

At layer 1, the two systems are identical when used on a 2 Mbit/s transmission system. However, DPNSS 1 is also defined at 1200–9600 bit/s for use on either KiloStream or via modems on an analogue line.

At layer 2, the two systems are identical, except that DPNSS 1 has the ability to send messages that are not related to traffic channels (virtual calls). This feature is used on some supplementary services.

At layer 3, both systems use similar message and coding structures, but DPNSS 1 has additional features to support the particular needs of private networks.

PRIVATE NETWORKS

In a private network, the PBXs perform similar roles to that of the local and trunk exchanges of the public network (see Fig. 8). The role of DPNSS 1 in a private network can therefore be compared to that of the inter-exchange common-channel signalling system (CCITT† No. 7) in public networks.

In the context of DPNSS 1, a PBX is considered to be an *End PBX*, a *Transit PBX* or *Branching PBX* as follows:

† CCITT—International Telegraph and Telephone Consultative Committee

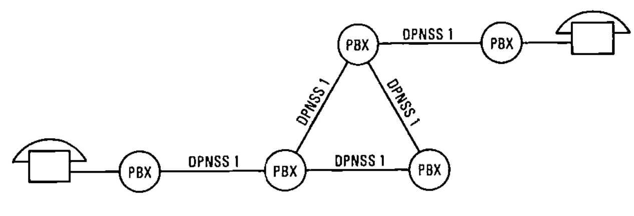


Fig. 8—Interconnection of PBXs by DPNSS 1 to form private network

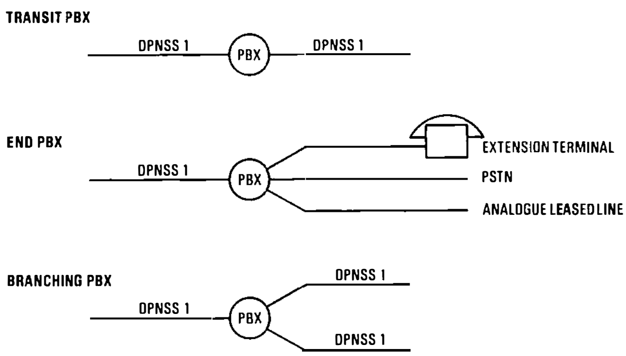


Fig. 9—Types of private network exchanges

Transit PBX A Transit PBX interconnects a call between two DPNSS 1 channels.

End PBX An End PBX interconnects a DPNSS 1 channel to an extension telephone, a data terminal or a route to another signalling system.

Branching PBX Some supplementary services result in a new call (for example, an enquiry call) sharing some of its path from the originating PBX with an existing call. The point where the two calls diverge is the Branching PBX.

Fig. 9 shows typical connections to each PBX type.

DPNSS 1 MESSAGE SET

DPNSS 1 uses a subset of the DASS 2 message set plus a number of additional messages. A major difference is the inclusion of link-by-link and end-to-end message types for the control of Transit and End PBXs.

Coding of Information Within DPNSS 1 Messages

As with DASS 2, the information within DPNSS 1 messages is carried in the form of supplementary information strings. Their structure is the same as for DASS 2 except for the addition of a suffix letter in the string identifier.

The suffix letter is used to indicate how the string should be handled if the receiving PBX does not recognise the numerical part of the string identifier or the contents of the string parameters.

Three levels of string status are defined:

(*a*) The string is MANDATORY and, if not recognised, the call is aborted and a *signal not understood* (SNU) indication containing the identity of the unrecognised string returned to the sending PBX.

(*b*) The string is OPTIONAL and, if not recognised, may be ignored and the call allowed to proceed. A *signal ignored* (IG-SNU) indication containing the identification of the ignored string is returned to the sending PBX.

(*c*) The string is INFORMATIVE and, if not recognised, may be ignored and the call allowed to proceed. No indication is returned to the sending PBX.

A string may have a different status depending upon the function being performed by the PBX that is unable to recognise it. For example, the string *call back when free–request* (CBWF–R) is INFORMATIVE to Transit and Branching PBXs, but MANDATORY to an End PBX.

This procedure enables new services and supplementary information strings to be added to DPNSS 1 networks without necessarily having to update all of the PBXs in the network. It also allows PBXs of different capability to interwork, albeit to the level of the lowest common denominator.

SERVICES AVAILABLE WITH DPNSS 1

DPNSS 1 is published in *British Telecom Network Requirement* (BTNR) 188 which currently (issue 3) specifies a 'simple telephony call' plus the following supplementary services.

Circuit switched data call	Route optimisation
Swap voice/data	Extension status
Call back when free	Controlled diversion
Executive intrusion	Redirection
Diversion	Series call
Hold	Three-party takeover
Three party	Night service
Call offer	Centralised operator
Call waiting	Non-specified Information
Bearer service selection	

The simple telephone call is a mandatory requirement of a PBX which supports DPNSS 1; the supplementary services are optional, however, and the range provided is subject to agreement between a customer and the PBX supplier.

PBX facilities are constantly evolving and DPNSS 1 has been designed for future growth. As the range of facilities offered by PBXs continues to grow, so too will the list of DPNSS 1 supplementary services. The following services are currently under study for inclusion in later issues of BTNR 188:

Conference	Maintenance
Priority breakdown	End-to-end signalling via DASS 2
Call back when next used	PBX–LAN interworking
Do not disturb	PBX–Computer interworking

INFORMATION FLOWS

Simple calls and supplementary services are established and controlled within a DPNSS 1 network by passing messages containing supplementary information strings between the PBXs involved. This interchange of messages is termed *information flow* and is the means by which individual DPNSS 1 services are specified in BTNR 188. The information flows for a simple call and the supplementary service call-back-when-free facility are described below.

Simple Telephone Call Using DPNSS 1

The call set-up sequence for a simple telephony call across two PBXs linked by DPNSS is shown in Fig. 10.

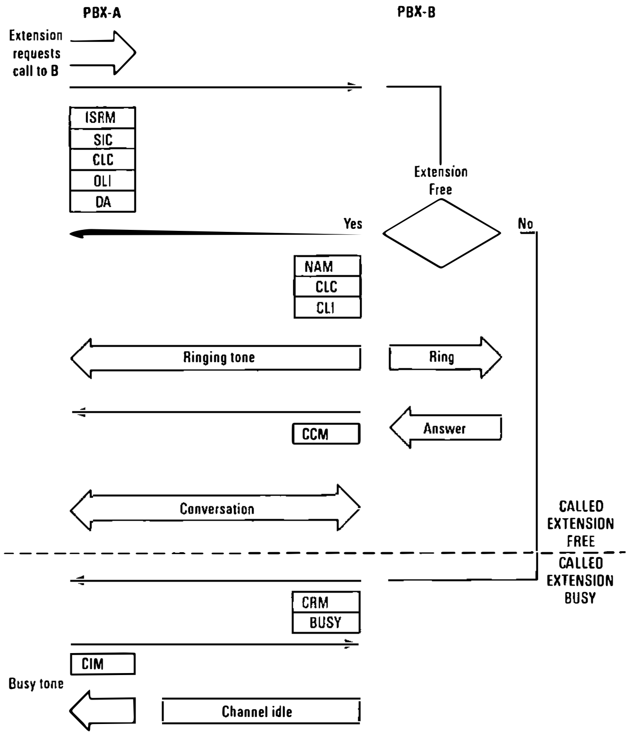


Fig. 10—Call sequence for simple telephony call

When an extension on PBX-A requests a call to an extension on PBX-B, an *initial service request* message (ISRM) is sent. It contains:

Service indicator code (SIC):	telephony
Calling line category (CLC):	ordinary extension
Originating line identity (OLI):	number of extension-A
Destination address (DA):	number of extension-B

Any intermediate Transit PBXs route the call in accordance with the destination address in the *initial service request* message.

On receipt of the *initial service request* message, PBX-B connects the call to the required extension and applies ringing. A *number acknowledge* message (NAM) containing the called line category (CLC) and the called line identity (CLI) is returned to PBX-A. When the called extension answers, a *call connect* message (CCM) is sent by PBX-B. If the required extension is busy when an *initial service request* message is received, PBX-B immediately releases the call attempt by sending a *clear request* message (CRM) containing a clearing cause—BUSY; on receipt of this message, PBX-A applies local busy tone to the caller and restores the outgoing channel to the FREE state.

Call-Back-When-Free Service

The call-back-when-free service comprises three separate but related information flows:

(*a*) request call back when free,
(*b*) notification that the required extension has become free, and
(*c*) the establishment of the call back call.

Call Back When Free—Request

Extension-A, having called extension-B and received a *clear request* message indicating BUSY, requests the call-back-when-free facility (see Fig. 11). PBX-A, having stored the

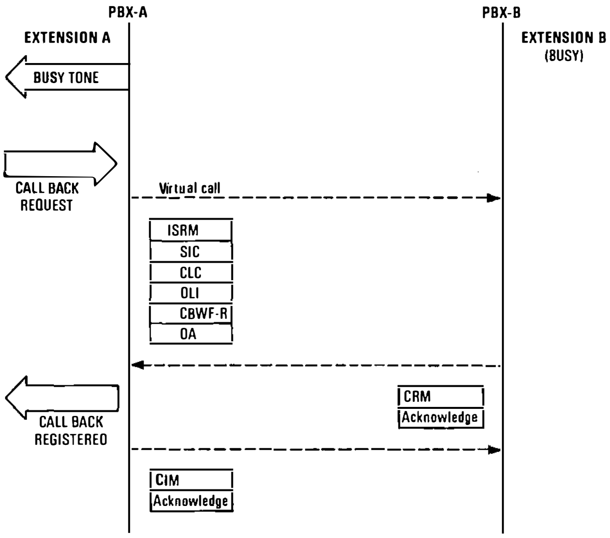


Fig. 11—Call back when free—request

extension number of extension-B from the previous call request, makes a virtual call to PBX-B. The *initial service request* message which establishes the virtual call contains the normal SIC, CLC, OLI and DA plus supplementary information string ⋆10B# (CBWF–R). This indicates to PBX-B that the extension identified by the OLI wishes the extension identified by the DA to call back when it becomes free.

PBX-B accepts or rejects the request by returning a *clear request* message containing either an acknowledgement or a rejection. The virtual call is released and PBX-B monitors extension-B.

Call Back When Free—Notification

When extension-B becomes FREE (Fig. 12), PBX-B makes a virtual call to PBX-A. The *initial service request* message which establishes the virtual call contains the SIC, CLC, and OLI of extension-B, the DA of extension-A and a supplementary information string ⋆11B# which indicates to PBX-A that the extension identified by the OLI is now free.

PBX-A acknowledges the notification by returning a *clear request* message to release the virtual call. This message also contains a supplementary information string to indicate the state of extension-A: ⋆55# if it is FREE or ⋆65# if it is BUSY. PBX-B uses this information to decide whether to block extension-B against other calls.

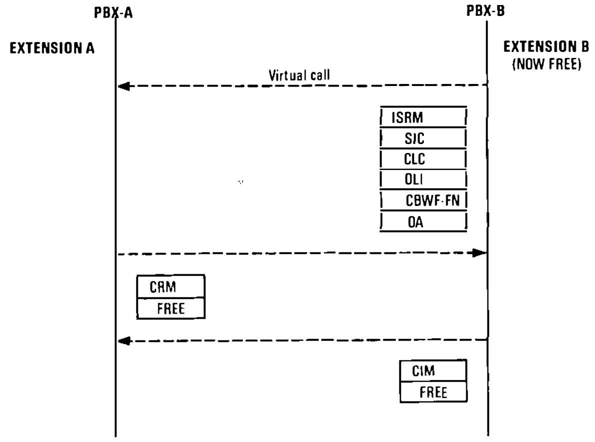


Fig. 12—Call back when free—free notification

Call Back When Free—Call Back Call

On receipt of the free notification (Fig. 13), if extension-A is FREE or becomes FREE, PBX-A makes a channel-related call back to PBX-B. The *initial service request* message which establishes the call back contains the normal SIC, CLC, OLI and DA plus a supplementary information string ⋆12B# (CBWF–CSU) to indicate to PBX-B that the call is a returned call back and that the extension identified by

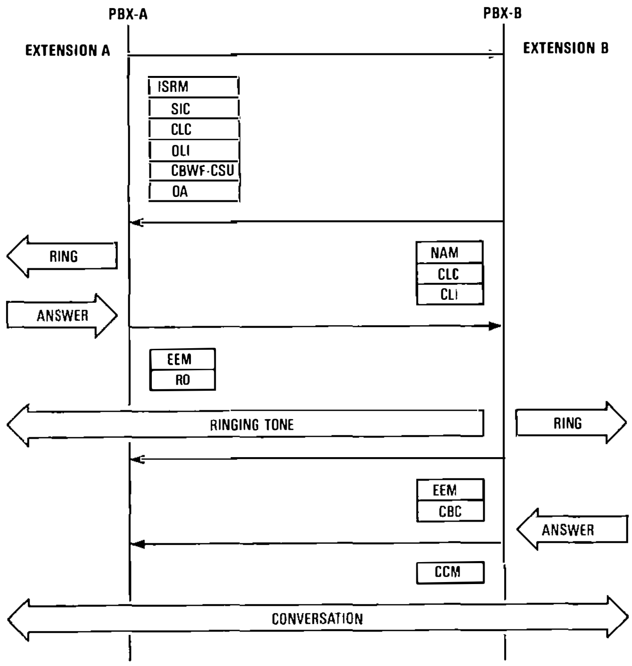


Fig. 13—Call back when free—call back call

the DA should not be rung at this time.

PBX-B checks if the required extension is still free and, if so, returns a *number acknowledged* message in the normal way. (If the extension has become BUSY, the call back call is cleared and the sequence returns to awaiting free notification.)

On receipt of the *number acknowledged* message, PBX-A applies ringing to extension-A.

When extension-A answers, PBX-A sends an *end–end* message (EEM) containing the supplementary information string ⁎14B# (R0) which indicates to PBX-B that extension-B should be rung. The call now proceeds as a normal call with extension-A awaiting answer.

CONCLUSION

DASS 2 and DPNSS 1 provide PBX users with the means of satisfying both their private and public network communications requirements.

Both signalling systems offer a comprehensive range of supplementary services and their respective specifications are in an advanced state compared to the ISDN standards currently being developed by the CCITT.

A complete specification of each signalling system is published in the documentation series known as *British Telecom Network Requirements*.

Implementation of systems using these standards is currently in progress. Both System X and System Y exchanges are to provide access to DASS2 circuits by the end of 1987. An extensive private network, based on DPNSS signalling, is being provided for a Government department. The first exchanges and links are in service and the network will be extended during 1986.

The use of DASS in the network provides the UK with a sound base on which to commence ISDN operations. The signalling system offers a secure mechanism for data transfer between the user and network, along with well defined access protocols for basic calls and supplementary services. As a result, early experience can be gained in the use and application of the ISDN prior to the introduction of CCITT standard interfaces towards the end of this decade.

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Biographies

Alan Bimpson is an Executive Engineer in the Digital Networks Division of BT's Applied Technology Department. He joined BT as a Youth-in-Training in the Liverpool Telephone Area in 1962. After a period on external planning, he moved to the Training College at Stone to teach on radio systems, TXE2 and System X. In 1979, he transferred to the System X Development Division in Ipswich where he assisted in the design of the hardware for the IDA pilot service. Since 1982, he has been engaged in system level studies relating to network services and customer interfaces to the ISDN.

Derek Rumsey joined the Post Office as an Assistant Executive Engineer in 1965. After eighteen months Area training, he joined the Network Planning Department and spent three years working on the development of microwave radio links. In 1970, on promotion, he joined the New Data Networks Development Co-ordination Department, where he helped to specify interface protocols for packet-mode communication. He participated in the development of international standards for data communication equipment and became involved in the specification of message-based signalling protocols for customer access to the ISDN. He currently heads a group reponsible for the production of specifications for customer interfaces for ISDN services provided by BT Local Communications Services.

Arthur Hiett joined the Post Office in 1955 as a Youth-in-Training in the London City Telephone Area, where he subsequently worked on PBX maintenance and exchange construction. He joined Telecommunications Headquarters in 1964 and has been involved in component design, exchange development and network strategy. Since 1980, he has been head of a group responsible for private network signalling strategy.

British Telecom's Large PABXs

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UDC 621.395.2 : 621.395.34 : 621.374

This article reviews some of the new facilities becoming available on the large (over 120 lines) PABXs included in British Telecom Business Systems' 1986/87 portfolio of products. Particular attention is drawn to the features offered by developments in networking, which allow closer interaction between remotely-sited PABXs, possibly of different manufacturers' designs. The article then discusses the future role of the PABX in the light of advances being made in the information-technology field.

INTRODUCTION

Dramatic changes have taken place in the UK PABX market over the past few years, many of them brought about by the liberalisation of the customer premises equipment (CPE) business. In a relatively short space of time, there has been a transition from Strowger electromechanical PABXs, through crossbar, to full stored-program controlled (SPC) digital systems, and the market is being rapidly converted from the older products to digital SPC. British Telecom (BT) has played a significant role in this process since entering the large (over 120 lines) PABX switch market some two years ago. BT's success in establishing itself as a leading supplier of large PABXs in such a short period is primarily due to its choice of products for its portfolio, based on its interpretation of customer requirements, and to the high level of support and service BT is able to offer throughout the UK.

CUSTOMER REQUIREMENTS

There is little evidence as yet to indicate that customers are ready for yet another round of PABX replacements, particularly in the large PABX field. Having, in many cases, just invested in new digital SPC systems, customers are expecting their PABX to last for at least the five-year depreciation period which many will have used in their financial appraisal justifying their initial purchases. Also, many of these customers are far from convinced that the new emerging so-called *4th generation* products offer sufficient benefits to justify an early write off or even a massive investment where the write-off period has already expired. A few find that their existing digital PABX has so far failed to live up to all of the promises which were made about its performance before purchase. However, this situation is now changing, and in the latest systems some genuine exploitation of those digital capabilities which give tangible benefits to the customer is beginning to be made.

What are the dominant criteria involved in the purchase decision-making process? Apart from obvious situations where a business moves into new premises or outgrows the capacity of its existing PABXs, market research indicates that there are two dominant factors: value for money and reliability. These two factors alone are normally sufficient justification for a customer to replace an old and antiquated switching system with a more efficient product which is less costly to maintain. Communications equipment buyers in corporate businesses are no longer impressed merely by new and innovative technology. Indeed, the situation has reversed somewhat. Instead of the user being expected to adapt to new technology, technology itself is now having to adapt itself to the needs of the user. Products now have to be tailored to suit individual business needs. This means that a much greater understanding of the way a particular business operates, its structure and its methods is an essential prerequisite to identifying problems and providing solutions. Good and lasting reputations will not be established by selling the customer a product which does nothing but present him with a new set of problems. It was in order to understand some of the issues specific to particular businesses and to offer appropriate solutions that the BT National Account Sales organisation was conceived. This skilled sales team, together with the expert back-up which is provided from within BT, will continue to play a leading role in future business dealings with larger customers.

NETWORKING

Despite the pragmatic approach to buying demonstrated by major customers, there is, however, a general trend in PABX evolution which has become attractive to many large businesses, and this is the introduction of sophisticated networking features. This has mainly been brought about by the digital private network signalling system (DPNSS)[1] standard which has progressively evolved from the deliberations of a joint working party now comprising 15 members, including the traditional PABX suppliers such as Plessey, GEC and Mitel, as well as representatives from the computing industry, including DEC, IBM/Rolm and ICL.

DPNSS has emanated from within the UK, and PABXs for the UK market therefore tend to be taking the lead in its implementation. However, there is increasing interest internationally in the standard, particularly now that it includes around 20 supplementary services.

One of the major objectives for DPNSS is to ensure a high level of interworking between PABXs from different manufacturers. As major suppliers of such products, BT Business Systems regard this as a fundamental requirement and will closely monitor compatibility between BT products and, where necessary, request improvements.

DPNSS uses the same principles as the emerging CCITT*

† British Telecom Business Systems

* CCITT—International Telegraph and Telephone Consultative Committee

standard for the integrated services digital network (ISDN), and is closely related to the digital access signalling system (DASS 2) signalling standard to be used by BT for the ISDN. This will mean that as access to this service becomes more widely available and the benefits begin to be realised, only minimal development will be required to allow PABXs which offer DPNSS to interconnect with the ISDN.

What benefits does DPNSS bring to the customer? To explain this one has to look at the typical organisation of a multi-site business with locations throughout the UK and with links overseas. Many of these sites are served by PABXs which, as well as accessing the public switched telephone network (PSTN), are all linked via a private network of digital and analogue tie lines. Until recently, apart from the cost benefits and perceived security of a well utilised private network, tie lines have given little advantage over the PSTN except for the ability to dial extensions direct without going via the PABX operator. Even this is less significant now that direct dialling-in (DDI) over the PSTN is more widely available. However, DPNSS has initiated improvements by introducing message-based signalling, allowing much closer interaction between the PABXs at each site. Among the benefits this gives are:

(*a*) centralised attendant service,
(*b*) feature transparency, and
(*c*) centralised network management.

Centralised Attendant Service

With centralised attendant service, a single pool of operators can service calls for the whole network including incoming PSTN calls (where DDI is not provided) and general enquiry calls. In addition to allowing the company to recruit PABX operators in an area where demand can be met and/or labour rates are below the national average (whilst still, for example, retaining a prestigious London number), it enhances the corporate identity by allowing the company to present a unified public-relations style to the outside world. It also improves the corporate image by creating a single national enquiry point where such issues as staff movements, organisational changes and company directories can be accurately tracked and kept up to date. The inherent flexibility of this feature also allows the operator answering points to be rearranged within a network to meet the changing needs of the business.

Feature Transparency

Feature transparency is a benefit apparent to the telephone user, and means that the facilities that were formerly available only within each PABX can be extended to every PABX in the private network. For example, fast call set up becomes network-wide, and when used with a common-numbering scheme means that users perceive no difference in setting-up time between network calls and internal calls within their own PABX. This, together with the improved transmission brought about by digital interworking, has the effect of bringing together physically isolated sites. Couple this with a massive reduction in the incidence of 'telephone tag' (calling people back who are no longer there) through the extension of the call-back-when-free facility network-wide, and the general efficiency of the business improves considerably. This is an important factor because, in nearly all cases, most communications are within a business rather than to the outside world. The 'bureaucracy factor', or ratio of internal transactions to external ones, varies between 20:1 in the good corporations to up to 300:1 in some of the most bureaucratic organisations. An improvement in the efficiency of such internal transactions is bound to benefit any company.

Centralised Network Management

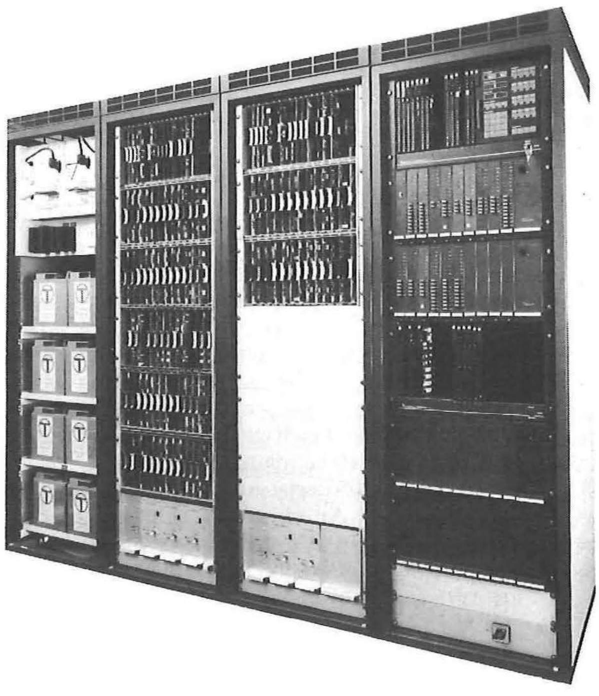
The efficient and cost-effective use of business communications networks depends very much on the degree of feedback given to the company communications manager and in his ability to reconfigure the network as circumstances demand. Highly sophisticated system and network management packages are becoming available, either as separate systems or integrated with the PABX. These extend beyond the provision of call logging into call accounting and cost control, menu-driven customer reconfiguration (for example, adding/deleting extensions, changing call-barring codes, etc), administrative and service reports (emanating from continuous network-wide test sequences) and company databases including corporate directory, network inventory, wiring schemes and spares provisioning. All of these features will, in due course, be offered via DPNSS on a centralised basis serving a complete PABX network giving the customer far greater control than could ever be achieved before.

BT BUSINESS SYSTEMS' LARGE PABXS

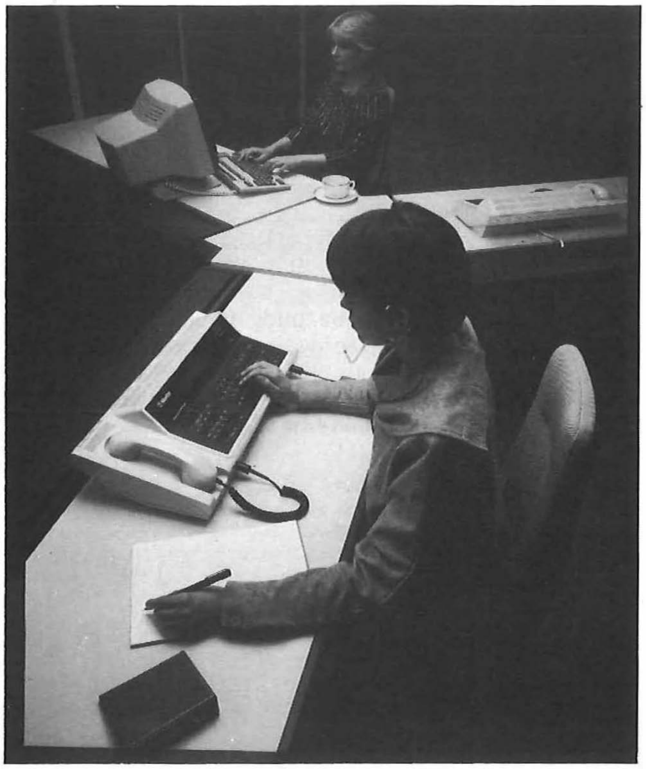
Having outlined some of the benefits of networking, the feature which has recently taken such an important position on the facility-requirements list of many prospective purchasers, the BT Business Systems' large PABX (above 120 lines) portfolio for 1986/87 can now be reviewed.

Monarch

The Monarch[2], with its customer base of around 12 000 systems in the UK and sales worldwide, is already BT's leading system in the 100–250 extension range. In April 1985, a new product was introduced into the Monarch family extending the capacity to over 450 extensions and 60 trunks. This is Monarch IT440 with its highly fault-tolerant design using duplicated control functions and standby power as standard, a comprehensive range of voice features and an



Monarch IT440—full 500-line system with data option



Monarch IT440—console

optional highly featured data switch. Many of the features have been based on BT's small digital public exchange system (UXD)[3] in service in a growing number of locations in the UK and overseas, and itself based on earlier Monarch models. Customers can therefore have a product with the quality and reliability of a proven public exchange system in their own premises.

BT has also recently introduced a further product which will benefit considerably existing customers of Monarch 250. This product, known as *Monarch SE440*, will enable those existing Monarch 250s to be upgraded on site to increase their capacity to around 440 extensions. In addition, the switch will be upgraded to the latest level of software as used on IT440 with all of its feature additions, including enhanced call logging output. All of these products are complemented by a comprehensive range of advanced features[4] and call management systems.

BT Local Communications Services (LCS) has announced plans to introduce end-to-end fast call set up over the public network between 1985 and 1988, linking all major business centres during that period. Development is already under way to exploit this facility on Monarch and to offer it, subject to approval around mid-1986, as an upgrade to the existing Monarch 250 and IT/SE440 products together with other facility enhancements.

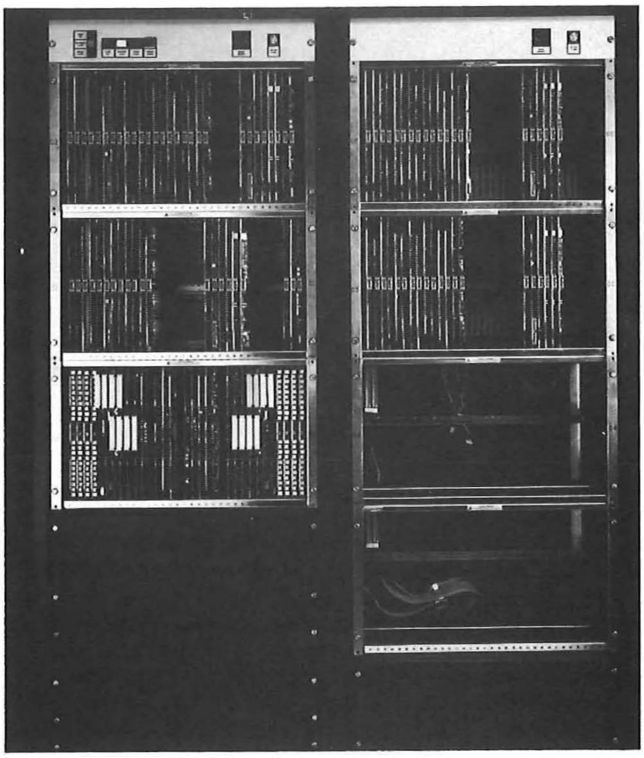
BT has also recently expressed a commitment to develop DPNSS on Monarch so that it can be offered as an upgrade to existing Monarch switches. This will allow customers with Monarch PABXs on large networks to benefit fully from the advanced networking features made available through DPNSS.

The programme for Monarch is therefore comprehensive and long term, showing BT's commitment to this product and its belief that Monarch will retain a dominant position for the foreseeable future.

MDX

The Merlin DX has become an extremely popular switch with the large PABX customer with over 250 000 lines sold already. Manufactured by Plessey Network and Office Systems Ltd, it already offers a comprehensive DPNSS package including centralised attendant service. Recently, Plessey announced a further enhancement to this product by offering a range of ISDN related features and renaming it the *ISDX* (integrated services digital exchange). Included in this package is the integrated services digital terminal (ISDT) and the system management terminal (SMT).

The ISDT, which is expected to become available in mid-1986, provides full featurephone capabilities including loudspeech and manager/secretary facilities, as well as access via V24 and X21 data ports to data terminals, word processors and other office equipment. It is ISDN compatible with access at 144 kbit/s via 2B+D channels (two 64 kbit/s voice/data B-channels and one 16 kbit/s control D-channel) over existing distribution wiring. It therefore allows simultaneous voice and data operation over a single pair via the PABX to the same or different locations.



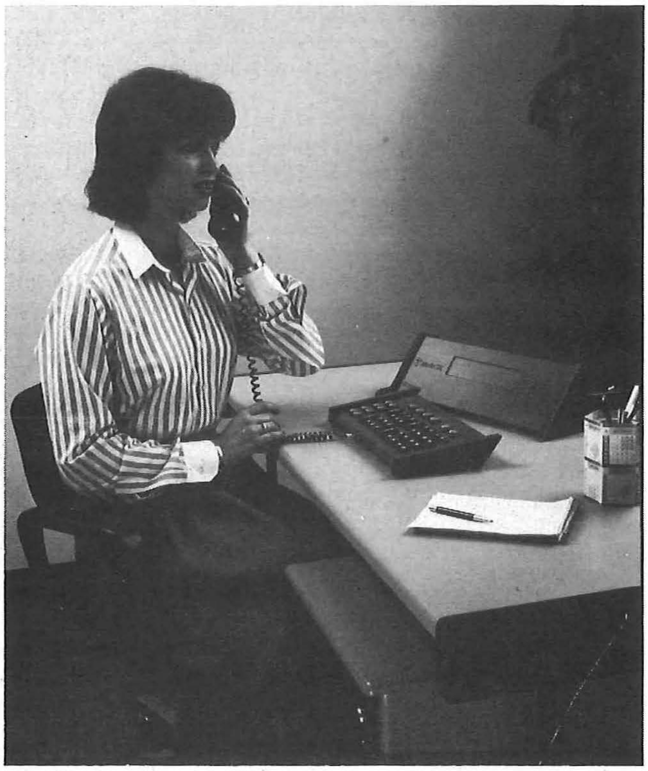
MDX—central unit

The SMT is a microprocessor-based terminal giving customer access to the network for system and network management. Application packages planned or available for the SMT include:

(*a*) *System Interface* This package gives communication management the ability to amend system parameters, for example by re-routing extension numbers and changing classes of service. System interface also gives either graphical or tabular representation of information.

(*b*) *Manuals* Operator and extension user guides and training systems can be stored and updated automatically.

(*c*) *Call Logging* A comprehensive package is available for the analysis of traffic statistics and call information in graphical or tabular formats.



MDX—console

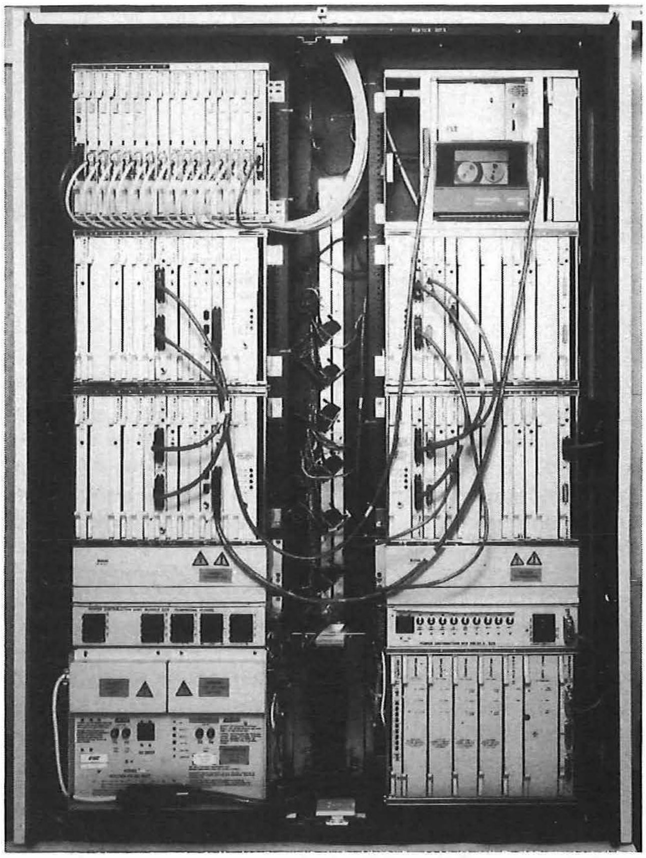
(*d*) *Facility Packages* Applications are available in packages tailored to the needs of systems managers, operators and maintenance engineers.

In addition to these networking features, Plessey will continue with further development of the DPNSS for both voice and data networking. Further enhancements are in hand to increase the capacity of the switch to above 3000 lines. A smaller version, the DX-M, serving up to around 250 lines, is also available, and its development path is closely following that of the larger version.

MDX—integrated digital telephone (IDT)

BTeX

The Merlin BTeX is manufactured for BT by GEC under licence from Northern Telecom. It is based on the Northern Telecom SL-1, one of the most successful large PABXs in the world with over 16 000 installations and over 4·5M lines. It has a reputation for reliability, but, because it has been present in the market place for so long, some people regard it as obsolescent. This is not so, for Northern Telecom recently announced plans to make the SL-1 the hub of their Meridian technology. This will provide high-speed data transport over standard wiring, both circuit and packet switching, protocol conversion, integrated workstations and a vast array of applications software supported via the UNIX operating system. Although this upgrade capability is still some two years off for UK customers, it clearly demonstrates that the product has a sound future.



BTeX—central unit

BTeX is currently available in two versions, the LE handling up to about 600 extensions, and the XL with a capacity of around 2300 extensions. It already offers an impressive set of feature options including DPNSS, featurephones, low-cost networking using remote peripheral equipment (RPE) and the switching of both synchronous and asynchronous data via normal distribution wiring.

GEC has announced a further range of developments for BTeX which includes an increase in the capacity of the switch to about 5000 extensions, which will be available shortly, followed later in 1986 by the provision of advanced DPNSS features including centralised attendant service. Also included is a further range of data modules which typically will provide IBM 3270 protocol conversion and an X21, 64 kbit/s 'pinned up' connection capability.

BTeX—console and featurephone

SX2000

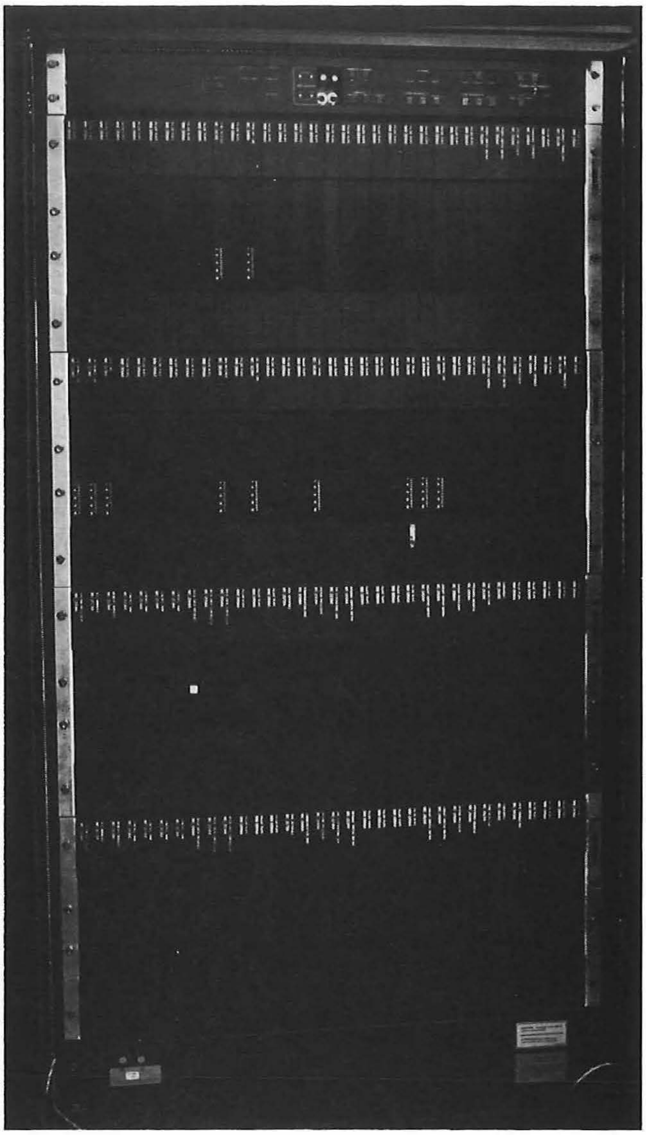
Mitel's SX2000 has established itself as an innovative and popular product with a comprehensive set of features for both customer and service personnel alike. It is a product designed for world markets and is supported by a strong development programme. Currently serving up to around 1400 lines and shortly to be increased to 2500 lines, one of its major strengths lies in its highly featured, user-friendly terminals for both extension users and operators. The TX14 (Mitel Superset 4) is already well known through its use on the BT Regent. Its features include soft keys (whose functions change according to the display), multi-line appearances, hands-free operation, call-by-name and messaging. For the SX2000, Mitel has introduced Superset 7, an operator console, management terminal or visual display unit (VDU) workstation with integral handset. As an operator console it provides all the normal console features plus an electronic directory service and call-by-name. When used as a system administration terminal it can be used for call accounting, making changes in the system configuration and receiving service reports.

In addition, optional data modules are available for the circuit switching of data via normal distribution wiring at speeds of up 19·2 kbit/s. Recent approval of the DPNSS for SX2000, providing fast call set up, marks the first stage of a development programme for DPNSS which will provide enhanced features in the latter half of 1986. Future developments, which include ISDN-compatible digital terminals, will make use of Mitel's expertise in microchip technology.

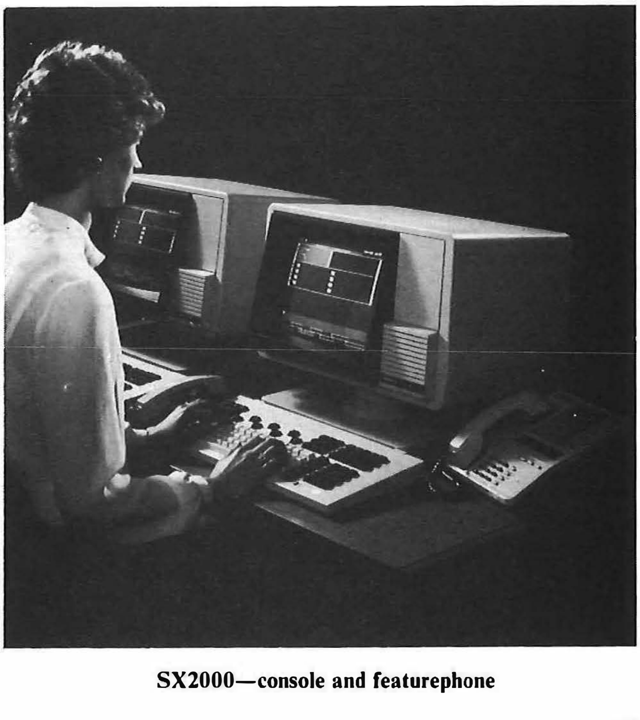
THE FUTURE

Amongst the larger multi-site businesses there is a growing trend towards a more sophisticated view of telecommunications and in their expectation of telecommunication products and services. This arises from a growing awareness of the value of communications in improving business efficiency and of the advances being made in information technology.

However, at present, there is little evidence of significant interest in the current range of non-voice facilities offered. The penetration of data on PABXs remains extremely low and communication services such as Telex, Viewdata and electronic mail are perceived as more closely related to computing than telephony. Customers' buying policies are extremely cost related and it is doubtful if improvements in voice functionality alone on PABXs will be able to command a premium. For example, voice messaging has had little impact on the marketplace so far, usually because its incremental functionality fails to justify the extra cost.



SX2000—central unit



SX2000—console and featurephone

The technologies of communications and computing have been converging for several years to the extent that they are now being integrated. So far, much of the emphasis has been on physical integration, which is analogous to sending different materials down the same pipe and separating them at the distant end. Voice, data and text communications are being merged into a single transmission medium, the integrated services network. This emphasis on the transport of information has clouded what the perceptive customer would regard as a more fundamental issue, functional (or logical) integration. This aspect concentrates on the way information is presented to and handled by the user and deals more with what is commonly known as the user interface. Very little effort has so far been directed towards exploring the symbiosis of voice, data, text and video. The only commercial examples so far include voice annotation of text and combined voice/data conferencing, but these features are really only scratching the surface. However, the combined potential for improved efficiency which future features offer, particularly on a departmental basis within a business, is far greater than the sum of the individual parts. It is extremely likely that the large networked PABX will become the initial focus of activity in this field for the following reasons:

(*a*) The PABX network is a common user group and is ubiquitous with terminals in every office.

(*b*) This common user group has access to terminals throughout the world.

(*c*) Access to a wide range of services and protocols requires a switching engine—the PABX.

(*d*) The networking features defined to a high level of detail for voice are now becoming relevant to data.

(*e*) The information capacity of twisted-pair distribution wiring is vast and largely unused.

(*f*) There is a growing convergence between the information processing industry, the communications industry and the information providers, and nowhere is this more manifest than in the PABX and computing industry (for example, IBM/Rolm).

Interestingly enough, many of these improvements in functional integration can be provided by coupling additional processing power and services into existing PABXs and offer an open-ended evolution for products such as Monarch. This has the dual advantage of extending the life of existing PABXs whilst allowing the customer to track these improvements on an economical incremental cost basis.

BT Business Systems is currently investigating this business opportunity, and the methods necessary to market such complex products and services.

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Biography

David Griffiths joined the Post Office in 1965 as a Post Office Student. After graduating with a first class honours degree in Electrical and Electronic Engineering in 1969, he joined the Exchange Systems Division where he worked on the introduction and type approval of the TXE2 electronic exchange. In 1971, he first became involved with PABX activities when he took on design responsibility for rental PABXs below 100 lines. He was also involved in the introduction of modern large PABXs when he assisted in establishing the standards for proprietary PABX approval. In 1976, he became head of Monarch development and led the joint BT/Industry development programme. More recently, as head of the Monarch systems engineering section, he was responsible for the development and introduction of the Monarch 250 and IT440 variants. He is now Business Manager for PABXs above 120 lines in British Telecom Business Systems.

Product News

Merlin Septara

British Telecom Business Systems has announced a new keysystem, the *Merlin Septara*. The new system can serve up to 48 extensions and 16 exchange lines, and has a wide range of user features available through easy-to-use featurephones. Merlin Septara is aimed at the small-to-medium-size business that needs a modern, efficient telephone system.

Merlin Septara is flexible in its operation because it allows normal keysystem operation, where incoming calls can be answered by any extension, or operator control from a dedicated extension. It is particularly suited to the replacement of older key-and-lamp systems, since it provides that capability plus much more. The system allows shared operation so that businesses operating independently within the same building can use a single system. Each business has its own closed group of lines, with no direct access between sharing parties, even to the extent of separate operator positions if required.

Merlin Septara has all the usual features of abbreviated dialling, with a 50-number system library plus 16-number individual extension library, three-party conference, call diversion, ring when free and hands-free dialling, which all add up to give a more efficient telephone service to the user. Another feature that is much sought after, but not widely available on many keysystems, is the manager/secretary facility with full intercom working plus indication of line status. This facility provides all the features of the old Plan 107 telephone on a modern system.

For improved business-management features, Merlin Septara can also provide call-logging information, including detailed account-code analysis. This facility is particularly valuable to service companies dealing with several clients, and enables cost allocations to be readily made.

Merlin Septara terminals

Two versions of featurephone, the TX28 and TX29, are available on Merlin Septara. Both featurephones have a full set of buttons for feature selection, and provide full-hands-free working, but the TX29 incorporates a light-emitting diode (LED) display giving a range of messages including called number, date and time, or feature selected.

New Features for Merlin Pentara

British Telecom's Merlin Pentara 100 telephone system, introduced in April 1985, now has several added facilities. The system, designated *Merlin Pentara 100E*, provides even simpler operation for featurephone users and more facilities to extensions with ordinary telephones.

Pentara has already proved to be popular with customers. In particular, the modern low-profile terminals and the flexibility of the system have great appeal. Pentara 100E builds on these elements to give a system with single-key operation for many features, a broadcast paging facility, internal or external music on hold and transfer of calls. The system is suited to a wide range of building environments including open-plan and conventional office accommodation.

One of the advantages of Pentara and its predecessor Herald is that ordinary telephones can be used for those extensions where featurephones are not required. Pentara 100E adds a further benefit for the simpler telephones by allowing diversion of calls to an operator/master terminal, ring back when free, repeat last number and parent system recall when the Pentara 100E acts as a satellite on a larger system such as Merlin Monarch. These features are in addition to access to the 100-number system library for abbreviated dialling.

Call-logging information can now be processed remotely by using the modem card option, which allows the existing logging port to be connected to a private circuit or an exchange line. This enables the data to be sent to a centralised call management system—a benefit to multi-site organisations.

Existing users of Pentara 100 and Herald systems will be able to take advantage of the new features with software upgrade packages.

Datel Control 1000

British Telecom's (BT's) wide range of data communications products has been increased by the addition of the Datel Control 1000, which provides central site control over a data network. Datel Control is a modular system of technical control facilities, such as, patching, switching, testing and monitoring, and is compatible with all equipment operating over the CCITT V24 interface; later versions will provide V35 interfaces.

The design of Datel Control 1000 enables it to be installed between computers and data communications equipment. In normal operation the system is transparent to data flow. When problems arise, the network manager can rapidly overcome them by patching or switching to alternative channels or equipment. Control and access are achieved via the front of the system's equipment, which provides flexibility in the features offered, so that users can choose a suitable combination to meet their specific needs. Each basic module can handle up to 16 data channels and options that include patching, test and monitor access, alarms, manual switching and block switching.

Datel Control provides cost-effective and competitively-priced control over data networks; for example, the basic patching option costs less than £80 per channel. This product, which complements the highly successful range of modems and multiplexers, indicates BT's commitment to expanding its range of network management products.

Customer Service Systems

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UDC 621.39 : 681.31 : 659.28

Customer Service Systems (CSS), a set of fully integrated computer systems to be introduced into British Telecom (BT) Local Communications Services Districts, will replace a number of discrete and diverse computer systems to control all aspects of customer service operation, as well as providing management control and financial and accounting systems. This article, which is based on lectures given at Institution of British Telecommunications Engineers Local Centres, describes the background behind the development of CSS, the management structure that was set up, and BT's plans for implementing it. The article discusses the concept of BT's Front Office, which CSS will make possible.

INTRODUCTION

The Customer Service Systems (CSS) project is a large-scale computerisation exercise currently being carried out by British Telecom (BT) Local Communications Services (LCS). Over the next three years or so, each of BT's devolved Districts will install a new mainframe computer which will enable it to modernise its infrastructure by controlling all aspects of its customer service operation, as well as providing management control and finance and accounting systems. In this way, efficiency will be improved and costs reduced.

CSS needs to be seen in the context of a more general reorientation of LCS in order to meet, and beat, the competition. The objective is to be a market-led organisation which is able to offer customers first-rate modern goods and services at the right price. Weaknesses within the organisation need to be eliminated (for example, too much old technology, too great a reliance on Headquarters (HQ) at the expense of local initiatives, the failure to make the most efficient use of manpower and the failure to identify and meet customers' needs) because of the urgent implications of liberalisation; that is, competition in the area of sales, the installation and maintenance of apparatus, telephony and data transmission networks. The primary purpose of CSS is to support this change in emphasis, to bring the organisation closer to customers and make it more responsive to their needs and to ensure that District management can effectively exploit its new autonomy and capitalise on the condition of local markets. CSS will do this by providing support for all District activities in which the benefits of an integrated database and an extensive on-line network can be reaped.

Although sometimes referred to as a 'total' information system, CSS is intended neither to support the real-time telephony service nor to cover such applications as word processing which can be supplied by dedicated micro- and minicomputers without the need for the CSS database and network.

BACKGROUND TO THE DEVELOPMENT OF CSS

Such a radical rebuilding of BT's computing activities was a necessity given the relatively poor customer perception of BT as a service industry, and the condition of its existing computing activities. In the past, all computing was the responsibility of functional HQ departments which, because of their remoteness from end users, could be only relatively responsive to local needs. Computing was a discrete and special activity rather than an integral part of the normal business process. Few of the old Telephone Areas operated their own mainframe-computer environment, tending instead to restrict initiatives to the micro- and minicomputer level. This was a method of operation which had little credibility. In the 1980s and 1990s, any organisation the size of a BT District (where turnover might be £350M) would have its own computing as a matter of course.

To make matters worse, a piecemeal approach to the design and development of systems and to the purchasing of computer hardware had resulted in a large number of disparate systems which duplicated one another in various ways or were incompatible. For example, among the systems and subsystems to be replaced by CSS, six are devoted to billing and customer details, nine relate to accounting, seven are concerned with marketing and sales, and five support line plant and planning. The subtly different ways in which apparently similar information is held can give rise to problems. It is this lack of an integrated approach to design that has resulted in systems being comparatively inefficient and unresponsive to customers' needs. (See Fig. 1.)

From the earliest conceptual stages, it was clear that if CSS was to do everything required of it, all aspects of the project would have to be informed by a 'philosophy' that underpinned the investment in hardware, software and database design. The CSS philosophy insists that design parameters should relate to the current needs of the Business (not existing procedures), and that the facilities should be specified and tested by the users who will operate them as part of their day-to-day work. Consequently, CSS is being defined from the bottom up; end-user requirements are fundamental for determining performance. Management control, analysis and accounting needs are similarly determined with reference to information flowing from front-line activity. In these, as in a number of other respects, CSS is unique in BT's history of developing major systems.

PROJECT MANAGEMENT

At an organisational level, CSS is also breaking new ground. One of the most important early organisational decisions

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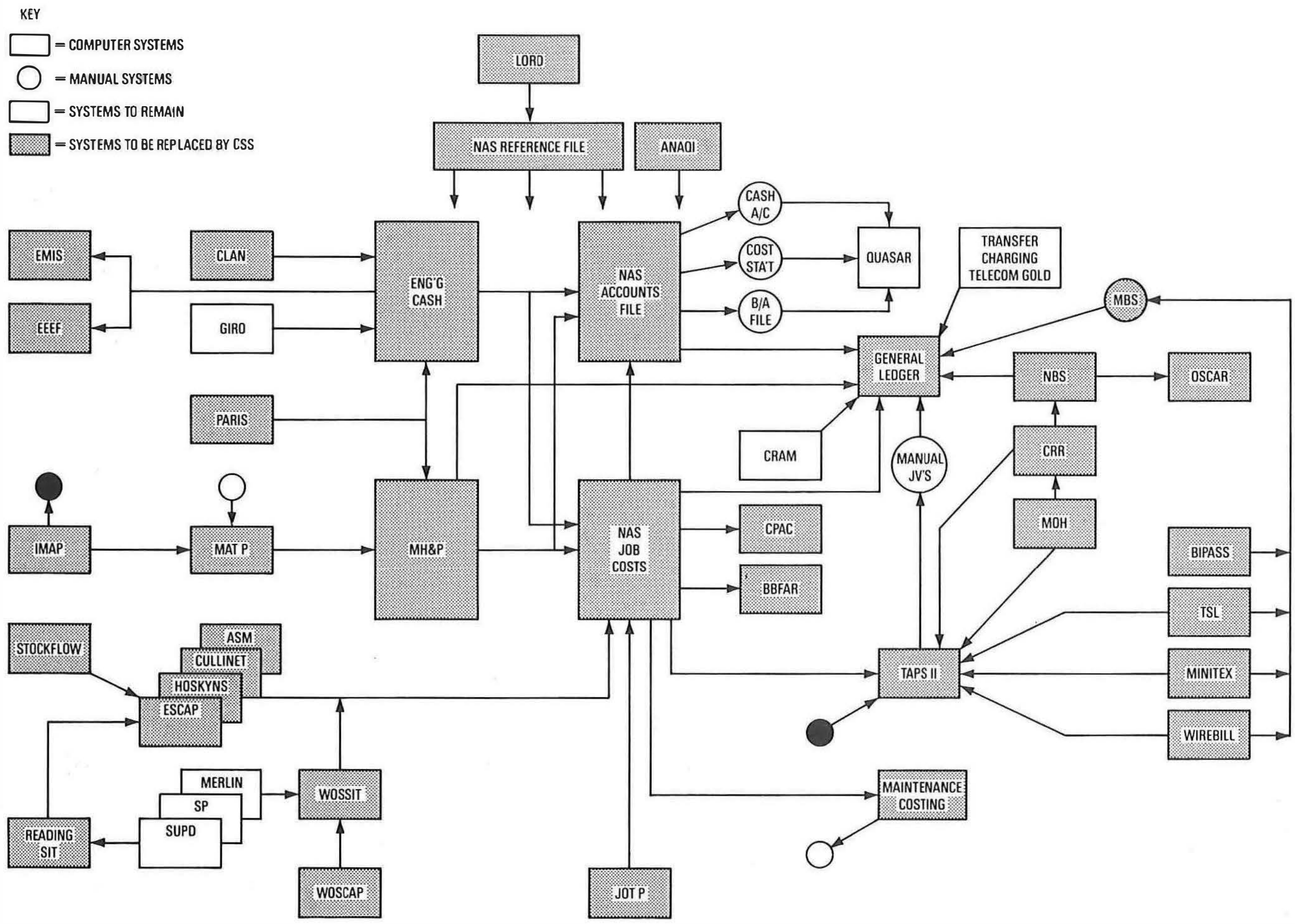


Fig. 1—Pre-CSS accounting systems

was to bring the requisite skills 'in-house'. Not only are systems analysis, programming and financial management done within the CSS Directorate, but so too are applications and customer care training development, communications planning, graphic design services, technical quality assurance, the management of change and so on. Outside consultants—McKinsey and Co. (management consultants) and Logica (software specialists)—were drafted in to plug the gaps in BT's expertise. The Director reports directly to the Managing Director of LCS. The Directorate consists of a number of teams (see Fig. 2):

The *National User Group* (NUG) is staffed by specialists in the relevant applications who have been recruited from the field and seconded to CSS HQ, and is responsible for system specification and testing. The NUG staff bring to the design process years of practical experience unavailable to the conventional, centralised data processing department. Additionally, the NUG is responsible for the production of User Procedure Manuals, and for advising the Districts on aspects of CSS implementation.

The *Systems Development Group* is composed of staff from BT and Logica; Logica provides specialist technical project management and system design skills. The Group's principal responsibility is to translate the users' requirements (as formulated by the NUG) into the software that will support and utilise the new District databases.

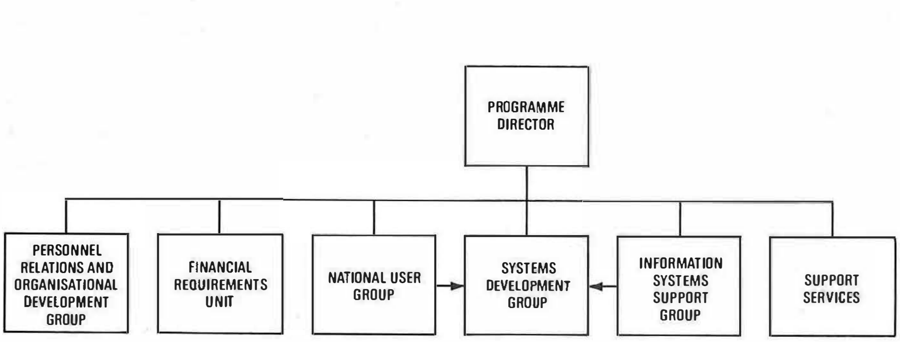


Fig. 2—CSS Directorate organisation

The *Information Systems Support Group* is concerned with the quality assurance of the technical product, the administration of CSS data (setting data standards and exchange protocols), implementation support and support and guidance on all aspects of the building and operation of the new District computer centres, known as *District information system units* (DISUs).

The *Personnel Relations and Organisational Development Group* brings together a team of specialists who have advised on the design of the machine-user-environment interfaces and on the development and administration of training support for the new CSS environment; industrial relations specialists concerned with the negotiation of effective framework agreements within which national issues arising from the implementation of CSS can be resolved; and a communications group which consists of writers, graphic designers and communications planners who offer a variety of services to the rest of the Directorate and to the Districts, and who support the Districts in drawing up their own communications strategies.

The *Finance and Support Services Group* is primarily concerned with the preparation, submission and subsequent monitoring of the Directorate's budgets and financial reviews, the compilation of the total costings for the CSS project and the monitoring of outturn nationally and the provision of office and support services to all CSS groups.

The *Financial Requirements Unit* (FRU) is responsible for accounting development in BT, and the unit's head has dual reporting responsibility to the Director of CSS and to the Director of LCS Finance. In the CSS context, the FRU is responsible for specifying the content and shape of the accounting systems, whilst maintaining existing systems to ensure that they provide the necessary information without inhibiting CSS development.

FRONT OFFICE WORKING

Perhaps the most important contribution that CSS will make to LCS's commercial future is that it is a necessary precondition for Front Office working. CSS will radically enhance customer service, and thus improve customers' perception of BT, because it will enable staff in the Front Office to meet the majority of customer requirements—for example, a billing query, an order, a complaint—at a single point, either over the telephone or in person in a walk-in office. This will be possible because of the development of an integrated database of customers' information which will give staff on-line access to information that can be immediately updated when it changes rather than, as now, changed in the course of periodic batch processing. A Front Office of this level of technological sophistication has only recently become technically feasible. Although other telecommunications authorities in the USA, Australia and Scandinavia and elsewhere are experimenting with a variety of Front Office configurations, BT leads the world in this respect. The scope and possibilities of Front Office working are currently being tested in three Districts.

Investment in CSS is immediately justified by reference to the ways in which customers' contacts are currently dealt with (see Fig. 3). In a typical District, 10% of customer-initiated calls concerning sales, accounting or customer relations are routed to the wrong department and, of those that do go to the correct department, 10% cannot be handled by the first person contacted. Such statistics indicate high and damaging levels of customer dissatisfaction.

The problem is that staff are required to do an important and demanding job with the wrong tools, and have to rely either on manual procedures or on cumbersome automated systems that do not really meet their needs. For example, a member of staff dealing with a billing enquiry may need to access a range of information from customer rental records, advice notes and fault cards to meter reading files, routine test forms and customer case papers. Or again, taking an order for a single exchange line can involve reference to post-code books, gazetteers, printed number lists, line-plant records, printed product information, price lists and diaries, as well as requiring a certain amount of local knowledge and, possibly, calls to the customer. The maintenance of these disparate information sources is clearly a major task and it is scarcely surprising that discrepancies and duplications occur.

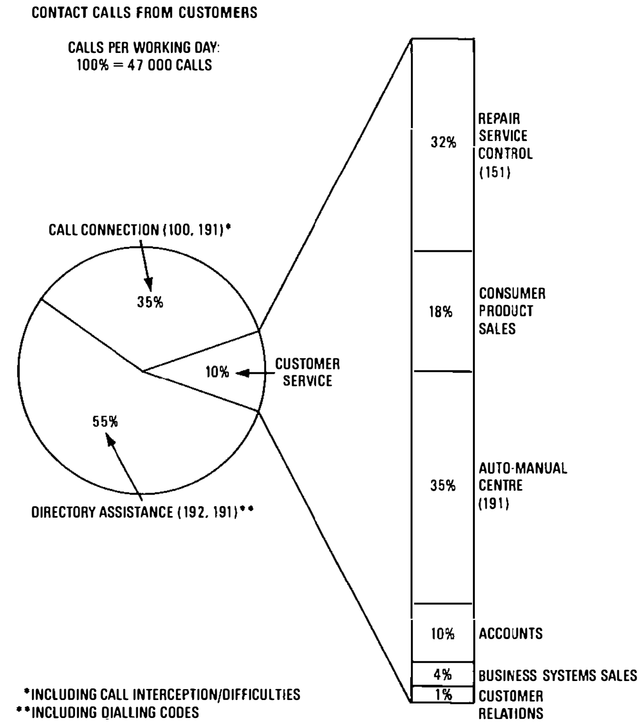


Fig. 3—Distribution of customer enquiry calls to a typical area

CSS-supported Front-Office working will solve these problems precisely because it will involve reference to a single source of information. This information will be reliable and up-to-date, will minimise the need to contact other departments when a job is being processed and should do away with much routine and time-consuming paperwork. Staff facing customers will spend less time on repetitive clerical tasks and will be able to devote more to the customer to achieve those levels of responsiveness which are so urgently needed.

The actual conditions of Front Office working and the precise nature of the work involved are still subject to negotiation between management and unions. However, it is clear that the Front Office will be a two-part structure (see Fig. 4): Tier 1 will deal with about 90% of routine fault reports, billing enquiries, orders and general queries; Tier 2, which will be staffed by specialists, will deal with anything up to 10% of queries, generally, the more complex or time-consuming ones or those from larger business customers. Of the existing operator services, call connect (100) and directory enquiries (192) will remain unchanged, although a part of the current 191 enquiry service will be moved to Tier 1 of the Front Office.

Although originally envisaged as a system that would support customer service activities such as order processing and billing, CSS has grown and now covers a far wider

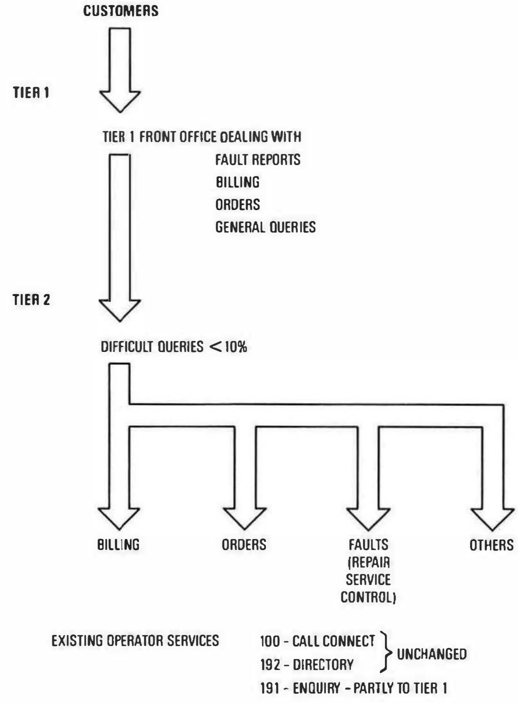


Fig. 4—Front Office concept

range of applications, including those facilitating resource management (for example, manpower, line plant, stores and transport) and those necessary to run the Business on a sound financial footing (for example, cost accounting and general ledger). Additionally, CSS is a tool for controlling directory compilation, market analysis, sales statistics, debt management, remote line testing, network allocation, payroll and expenses. A detailed list of CSS applications is given in Table 1.

CSS IMPLEMENTATION STRATEGY

The implementation of a large number of new subsystems will pose enormous logistical problems of training and accommodation as well as requiring the diversion of considerable effort and resources into acceptance testing and evaluation of the hardware and software. Consequently, software will be introduced into the Districts as part of a 'rolling schedule'. Full implementation within any District will take about two years and the plan is for completion in all Districts by late-1989/early-1990. The key elements of the first software delivery will be order entry, order handling, customer account management (billing) and directory compilation. The timescales are tight but everyone is responding well to the challenge. The development from scratch of new order processing and billing systems has taken about 18 months, which is remarkably fast when seen in the context of the five years that were required to get the new billing system (NBS) introduced.

CSS is being piloted in the Thameswey District (see Fig. 5), which is based on Reading, Guildford and Slough. Live running of the first phase of the software in the Guildford Customer Service Area (CSA) began on 10 March 1986; this will affect 300 000 customers. The purpose of the pilot implementation is to prove that the CSS applications have been debugged and that they meet their design requirements, that the DISU configuration and networking arrangements are appropriate, that the system is fine-tuned so that it is capable of handling volumes of traffic without

TABLE 1
CSS Applications

Order handling	Market analysis
Repair service handling	Accounting (Phase A)
Customer account management	Operator services support
Customer contact register	Directory support—district
Premises locator	Directory/directory assistance system (DAS) support—central
Billing—charge inputs	Line test systems support
Bill production	Products/services register
Billing—receipts posting	Staff roster management
Billing—follow-up	Sales activity support
Billing—statistics	Manpower resources
Customer debt management	Transport and mechanical aids
BT credit card management	Stores and inventory management
Accounting—nominal ledger	Materials forecasting
Accounting—common account processing	Purchasing
Accounting—subsidiary ledgers	Estates management
Budget preparation and management	Network management
Miscellaneous accounting	Pair allocation
Receipts	Exchange records
Cashier support	Plant management
Bank reconciliation	Operations and Maintenance Centre interface support
Payments/disbursements	Fault analysis
Time recording	Traffic analysis
Payroll	Plant forecasting
Expenses and allowances	Maintenance programme management
Fixed assets register	Projects planning and management
Revenue analysis	Resource estimation
Revenue forecasting	Works order management
Tariff planning	Job management
Management control	

Fig. 5—Thameswey DISU

response times suffering and that the user training and new job procedures are efficient. Once these matters have been resolved (and this will take a minimum of 12 weeks), implementation will begin in two trial sites, at the Liverpool and the South Wales Districts. The purpose of the trials is to demonstrate the transportability of CSS from one District to another, to confirm the efficiency of inter-District networking, to test user training and documentation and to check the volume handling capacity of the link between the Districts and the HQ system centre and the national 'fallback' machine. Subsequently, other Districts will be brought on stream at a rate of two or three a month.

CSS computing and much of a District's other computing will be carried out at the District computer centre or DISU. These comprise a mixture of converted computer and other accommodation and green-field sites; DISU specifications relating to staffing levels, kit, accommodation details and so on have been defined by the Information Systems Support Group. DISU hardware is being purchased in accordance with BT's policy of dual sourcing. CSS will eventually be run on the IBM 3081 series of mainframes (using the MVS operating system) or an IBM plug-compatible mainframe and ICL's new Series 39 Level 80 machine (using the VME operating system). Under the terms of a recent equipment allocation, the North of Scotland, East of Scotland, North Wales, Solent, Mid-Anglia and North Downs and Weald Districts will get the ICL machine and all other Districts will get IBM or IBM plug-compatible (see Fig. 6). The IBM 3081 is a 32 Mbyte twin processor with a total disc capacity of 20 Gbyte. The ICL 3980 is available in one-, two-, three- or four-node configurations; CSS has opted for the dual-node configuration, which, in throughput terms, is equivalent to an IBM 3081KX, although more nodes can be added if subsequently necessary.

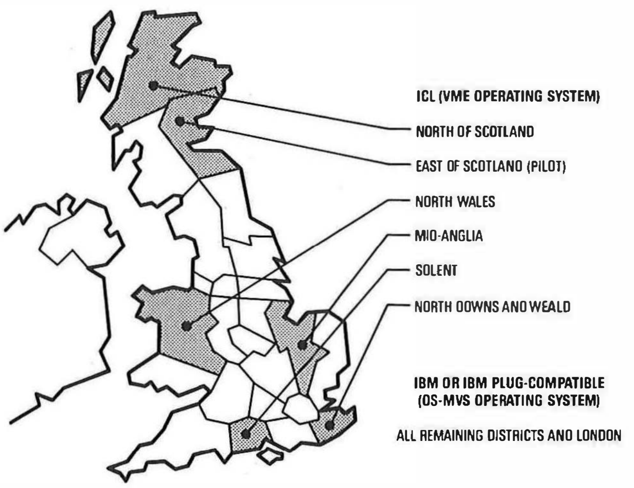


Fig. 6—CSS Computer allocation

Because CSS requires considerable capital investment in computer equipment, it is essential that the most efficient use is made of the hardware and that it should not require unusual and expensive configurations in order to meet other objectives. In the longer term, it must be capable of expansion and cope with predicted growth in activity.

Just as Thameswey is the pilot site for IBM CSS, so the East of Scotland District (based on Edinburgh and Dundee) will act as the pilot site for the ICL CSS. The intention is that the ICL implementation will provide exactly the same facilities as the IBM and will be indistinguishable from it from the user's point of view. The bulk of the applications code for ICL CSS will be compiled from the original IBM COBOL (using a specially developed code converter), although some elements, such as those coded in assembler or those requiring a different style of implementation, will be re-coded by a project team composed of BT and ICL staff. Some of the 'middleware' (dialogue manager and ancillary software) will need to be written from scratch.

CSS has a team of networking specialists which is responsible for assisting DISUs in the design of the specific network configurations for CSS systems and related interfaces, for support of the network both pre- and post-implementation, and for evaluating such new communications hardware as may be suitable for DISU networks. Given that there might be more than 1000 terminals within a District, the use of modems and private wires would have proved expensive and inflexible. Instead, CSS is recommending a MegaStream link between the DISU and the Customer Service Areas which makes use of National Networks' NetMux Manager—the latest MegaStream multiplexor—to control the MegaStream circuit. Fully software controlled, the NetMux Manager can automatically divert traffic down alternative routes if a circuit fails. Packet SwitchStream (PSS) will be another integral part of the CSS network.

The DISU will also be connected to the LCS HQ Information Centre and will process inter-District business or business between a District and other BT divisions or the bank clearing system. It will also provide LCS HQ with access to vital information which will help to determine LCS policy.

If a DISU fails, the District network can be connected, via the fallback network, to the fallback centre which will function as the DISU for that District. All DISUs will hold regularly updated fallback tapes of their database which can be loaded onto the fallback machine should a major disaster occur.

As with any computer system, the question of security will be vital. Quite apart from the financial loss to the Business as a result of equipment theft, there is the potentially much more serious damage that might be done if unauthorised users were to gain access to the database. The first line of defence is the physical security of the terminals, preventing unauthorised access in the first place. Additionally, each terminal will have a security key which must be in the lock and turned before it can be used; removal of the key isolates the terminal from the rest of the system. Furthermore, security measures have been incorporated into the system software. Every terminal user will have a unique password that will allow the user access only to the parts of the database that are essential to the carrying out of their duties. Also, individual terminals can be set up by the District which can access only specific parts of the database.

PREPARING FOR CSS

In a project as large and ambitious as CSS, the complexities of hardware, software and networking development are compounded by the logistical problems of implementation: organising training, designing the environment, ensuring the availability of overlay staff, providing sufficient accommodation and so on.

If CSS is to be implemented successfully, the staff that will be using the system will need to learn a wide range of new skills. In some Districts, in excess of 1200 staff and managers will receive CSS-related training of some kind (see Fig. 7). Consequently, a wide range of applications and customer handling packages has been developed. Applications training has been developed along modular lines. There are more than 200 modules relating to Phase A applications alone; there are modules on order entry, order processing, operator services, repair service handling, product services duties, market analysis and sales support, directories, exchange jumpering, billing, number allocation, routing and records, accounting and financial administration and order closing. A 'customer care' programme has been developed jointly by members of the CSS Organisational Development Group (ODG) and their colleagues from the BT Management College. This consists of a number of videos and a range of printed materials for managers and basic grade

Fig. 7—CSS training session

staff. The training materials were designed to give a feel for real day-to-day dealings with customers and the emphasis is on building practical skills such as how to deal with irate customers, how to listen with understanding and how to explain BT's position effectively.

This emphasis on *professional* customer-handling is indicative of the fact that CSS itself acts as a catalyst within BT and has the potential to revolutionise organisational precedents and procedural constraints. In a sense, it offers Districts infinite possibilities for doing new things in new ways, provided only that Districts recognise that the majority of initiatives must emanate locally and cannot be dictated from the centre. Change will not happen automatically; a strategy is needed and it must be managed. District management must take the lead and must itself acquire new skills. Technology cannot, in itself, guarantee the commitment and responsiveness that customers demand. The Directorate itself has been organised and managed in new ways: short lines of reporting make for rapid decision making; the insistence on short timescales promotes initiative; the devolution of authority makes for more demanding and satisfying jobs.

The frequently invoked 'cultural change' which BT is currently experiencing means shaking off a residual civil service culture which put a premium on standardisation and central control. Such an orientation is at odds with the business of staking entrepreneurial claims in an increasingly competitive market-place. CSS will be an invaluable tool in the drive for quality and flexibility of service. The organisation must learn to look outward to the customer and get the best from staff and management at all levels.

The process is two-way: on the one hand, a great deal is being asked of staff; on the other, they are being given the tools with which to do the job. The ODG is also organising a drive to create an effective environment in which staff can be comfortable and in which the necessary improvements in efficiency and customer care can be achieved. Among the areas that have been investigated are desk and workstation ergonomics, temperature control, lighting and office layout. The fact that CSS is a colour system also indicates a concern for the comfort of staff and user-acceptability.

SCALE OF IMPLEMENTATION

Some idea of the scale of the exercise of implementing CSS can be found from looking at the work that needed to be done to provide some 300 000 customers in the Guildford CSA with access to the live system. A usable database of customer information had to be built using six conversion sources: customer rental records (CRR), new billing system (NBS), mechanised order handling (MOH), administration of repair service control by computer (ARSCC), automatic market intelligence system for Telecom (AMIST), directory delivery system (ADDS) and number information service (NIS). To take a single example, the task of computerising all the manually-held distribution point (DP) records for the District involved the entry of 96 000 DPs each with a minimum of ten associated pairs.

The programming and system analysis effort has been directed towards the production of 1·3 million code statements, which make possible 600 on-line transactions and more than 1600 screen options. The database consists of 100 million records organised as almost 500 record types. A District accommodation programme was needed to site something in the order of 1100 terminals which will cater for full implementation. These are distributed amongst more than 50 locations, connected to the DISU by 68 circuits. Front Office sites at Aldershot, Newbury and Reading have been fitted with automatic call distribution (ACD) equipment. Upgrading the accommodation at the General Manager's Office in Aldershot alone entailed the installation of chilled air handling, new power equipment, cluster controllers and lighting in accordance with the ODG's standards (3000 light fittings were changed and 600 new ones installed). More than 60 training courses, varying in length from three to ten days, have been run involving eight members of staff at a time. To cover for them when they leave their jobs for training, there has been a steady build-up of overlay staff from other Districts to the present level of about 130.

CONCLUSION

In conclusion, CSS is not just a computer system: it embodies new attitudes and new ways of doing things. It underlines BT's new consumer orientation. It is so vital because it will help BT better to deploy its resources and to transform its relationship with its customers. More than this, it will help to cement the organisational structures of the new-look BT; it will provide ready access to the marketing and financial information essential to a full understanding of the nature and economics of the services on offer; and it will epitomise the new balance of power between HQ and the field.

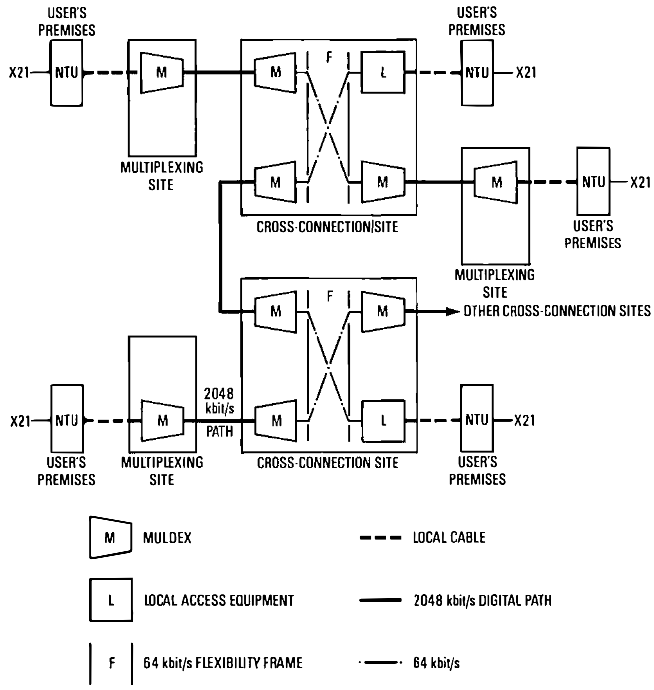
Biography

Keith Gorton joined the then General Post Office in 1947 as a Y2YC apprentice. After completing his apprenticeship and two years national service in the RAF, he spent some seven years as a T2A and Technical Officer working on auto-exchange and transmission maintenance. He was promoted to Assistant Executive Engineer by competition in 1959 and spent six years on transmission, auto-exchange maintenance and local line planning. After his promotion to Executive Engineer by competition in 1966, he spent two-and-a-half years working in Sarawak with the Malaysian telecommunications authority. On his return, he was employed on exchange contract specifications in the North West Regional office and later, on promotion to Senior Executive Engineer, moved onto long-term planning. In 1974, he joined the Hong Kong Telephone Company for a two-year spell as Assistant Chief Engineer (Internal); on his return he became Deputy General Manager of Shrewsbury Telephone Area and, in 1980, General Manager in Liverpool. He was promoted Chairman Wales and the Marches (Regional Director) in 1982. In December 1983, he became Director of the CSS project, but retained his Regional Director responsibilities until the post was abolished in November 1984.

Private Circuit Services at Communications 86

INTRODUCTION

The theme for Private Circuit Services reflects BT's capability to offer total networks to business. The emphasis is placed on the quality of service offered in terms of range, speed of delivery and comprehensive maintenance and support services, and underlines BT's commitment to support the existing analogue circuits whilst offering digital circuits for the developing digital communications environment (see Fig. 1).



NTU: Network terminating unit

Fig. 1—KiloStream: network outline

The display features speech, facsimile and data being transmitted over a KiloStream circuit between the stand at the National Exhibition Centre and Seal House, London (see Fig. 2). Other items being shown include a KiloStream Plus cabinet and line terminating equipment (LTE) for 2 and 8 Mbit/s circuits. A new range of audio line terminating units, LTU 13A, 15A and 16A are also on show.

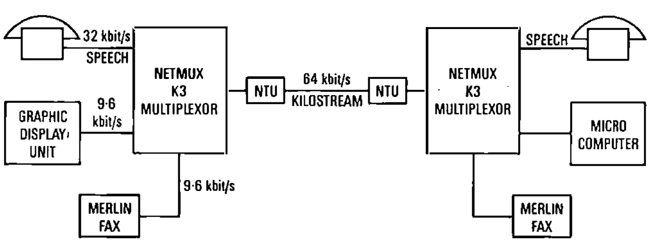


Fig. 2—NetMux K3 demonstration network

NETMUX K3

A NetMux K3 is connected to each end of the 64 kbit/s KiloStream circuit. The K3 can accept up to two data channels at 9·6 kbit/s or one channel at 19·2 kbit/s together with one 32 kbit/s speech channel (see Table 1). The speech channel is connected to normal HMTs to give a direct connection. The voice channel is encoded by using continuously variable slope delta modulation (CVSD) and uses E&M signalling. CVSD is a system of encoding developed in the USA originally for use by the military. It does not have a CCITT† standard and as such has restrictions on its usage within the BT network. The main limits are no access to the public switched telephone network (PSTN) and no tandem connections on private circuit networks. It does, however, give totally acceptable speech at 32 kbit/s on point-to-point private circuits.

TABLE 1

K3 Multiplexor Technical Information

Multiplexor technique	Time division
Channel Characteristics	
Capacity	3 Channels
Data channel speeds	Two at 9·6 kbit/s synchronous, or One at 19·2 kbit/s synchronous
Voice channel	One at 32 kbit/s CVSD
Voice channel signalling	E&M provided by the unit
Voice channel presentation	2-wire or 4-wire
Data channel interface	CCITT X21*bis*/V24
Aggregate interface	CCITT X21/V11 at 64 kbit/s
Power	240 V AC 50 Hz nominal
Terminations	
KiloStream NTU	15-pin D-type socket
Speech	9-pin D-type socket
Terminal	25-pin D-type socket per channel (channel 1 socket used at 19·6 kbit/s)

The system on display at Communications 86 has a MerlinFax machine connected to the first 9·6 kbit/s data channel. This machine has been specially adapted for use with a V24 circuit. On the second data channel, a Gresham 8000 Graphics display unit on the exhibition stand is connected to a Rair microcomputer located in Seal House.

MERLINFAX

MerlinFax is a very easy to use facsimile machine that can transfer an A4 page in about 20 s. It has a range of features that provides the user with a variation in resolution standards to ensure good reproduction of poor quality originals and a choice of contrast settings for documents with varying or coloured backgrounds.

Normally, MerlinFax transmits at 9·6 kbit/s, the fastest modem speed possible over the PSTN. However, if a poor connection results in errors, the automatic fallback function takes over and lowers the speed of the modem until clear

† CCITT—International Telegraph and Telephone Consultative Committee

transmission is achieved. The machine operates to the CCITT Group 3 standard, but, as many businesses still use the slower Group 2 machines, it also includes Group 2 capability.

Other features of the MerlinFax include a journal print with a log of all transactions; a header print with the date, time, transmitter identification code and page number printed on the top of each page received; a transmission verification stamp that is automatically applied to all originals sucessfully sent; and the ability to function as a quick, economical copier.

The main technical details are summarised in Table 2.

TABLE 2
MerlinFax Technical Specification

Main scanning system	Transmitter: flat bed scanning with CCD Receiver: solid-state thermal recording head
Effective scanning width	G3: 208 mm (252 mm reduction) G2: 205 mm
Scanning line density	Main scan. G3: 8 pel/mm; G2: 3·85 pel/mm Sub scan. G3: 15·4 line/mm (Superfine), 7·7 line/mm (Fine), 3·8 line/mm (Standard); G2: 3·85 line/mm
Compatibility	CCITT G3 (MH), G2
Recording method	Thermal
Recording paper size	210 mm × 100 m (paper roll)
Automatic document feeder	Maximum 30 sheets
Modem speed	9·6/7·2/4·8/2·4 kbit/s with automatic fallback
Power consumption	Stand-by: 8 W, Transmit: 70 W, Receive: 90 W, Copy: 120 W
Power requirement	110–120 or 200–240 V AC 50 or 60 Hz

LINE TERMINATING UNIT 13A

The LTU 13A (Fig. 3) is equipped with a pair of line transformers which can match local lineplant at 600, 900 and 1200 Ω: low frequency (LF) equalisation components are also fitted. All such select options are achieved by using mini U-links on the printed wiring board. The office side of the transformers are wired via standard test links on the front panel to give test access and line looping facilities. These links also provide a secure means of flexibility cross-patching between cards on a shelf or rack. A further looping facility is provided in the form of a single latching loop button, which allows the customer easily to co-operate with BT engineers in line testing.

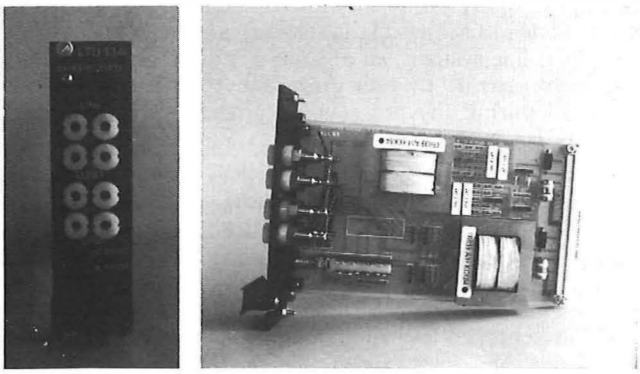


Fig. 3—LTU 13A

Up to 12 cards can be fitted into an Equipment Audio No. 1021A, which is fully wired and designed to fit into a wide variety of racks and housings. Each card is connected via a Strip Connection 237 mounted on the rear of the shelf. This provides a convenient connection position for both customer and incoming wiring and a break test access point on the line side of the network terminating transformer.

LINE TERMINATING UNITS 15A AND 16A

These two items supersede the Case 200A for their particular application.The LTU 15A (Fig. 4) is pre-assembled to give a 4-wire presentation to the customer of the 4-wire private circuit. The LTU 16A (visually identical to the LTU 15A) gives a 2-wire presentation to the customer of a 4-wire routed private circuit.

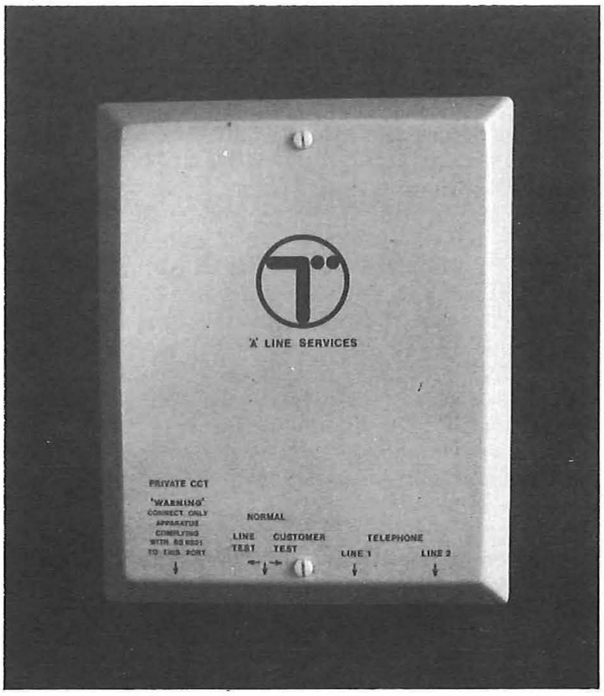


Fig. 4—LTU 15A

The incoming line is terminated on Krone strips and customer connection is via a standard line jack provided on the outside of the LTU case. All configuration options: LF equalisation, line impedance and the option to extract DC signalling wires, are carried out by moving miniature links. This allows for ease of installation and setting up of the private circuit.

A manual line looping facility is provided by a keyswitch to facilitate co-operation when circuits are tested.

Incorporated in the LTU 15A/16A are facilities to provide two exchange lines. These provide a convenient way of terminating one or two exchange lines at the same location as the private circuit, should the customer require them.

Towards The Paperless International Telecommunications Services Centre—The Keybridge Engineering Records System

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UDC 621.395.12 : 621.395.345 : 681.3

A computer system has been installed to store all the engineering records for the provision and maintenance of circuits in Keybridge International Switching Centre. The activities involved in the provision and maintenance of circuits are outlined. Technical details are given for both the proprietary fault-tolerant computer system upon which the development was based and the applications software developed by British Telecommunications International. The experience gained from the system in service is examined, and future developments are discussed. It is concluded that the system has performed well and that engineering records systems will be installed in future international switching centres.

INTRODUCTION

Keybridge House is a major international telecommunications services centre (ITSC) containing switching and transmission equipment to provide a range of international telecommunications services. This article describes the computer system which has been developed by the International Telephones executive of British Telecommunications International (BTI/IT) and installed in Keybridge House to provide and maintain engineering records for the ITSC.

A computer-based record system was first considered in 1977, when the ITSC was opened with equipment for business services. These units were comparatively small and, for these, paper record systems performed well. It was known, however, that the ultimate requirement for records within the ITSC was considerable and would require a large computer system, but this was not cost justified until its own load was substantial.

Keybridge International Switching Centre (ISC), a large stored-program control (SPC) switching centre for the international telephone service, was due to be opened in 1984 and its volume of equipment records both demanded and cost justified a computer system to handle them. The Keybridge engineering records system (ERS) was developed in parallel with the procurement of the ISC and was fully operational when the ISC opened. At the time of writing, the ERS holds many thousands of records for the ISC and is being extended to support the international business services.

SCOPE AND OBJECTIVES

When the record system was first considered, a study was made into the feasibility of holding on a computer the records required for the maintenance of the telecommunications equipment. The benefits would be better legibility of records, faster access to them, simultaneous access by more than one person and more easily produced fault statistics. It was recognised that the major problems with holding maintenance information on a computer were how the information would be input and how the accuracy of that information would be guaranteed. The information required for maintenance of, for example, a circuit, comprises everything about that circuit—in broad terms, its identity, its controlling point, its type, the exact identity and location of each cable pair, each appearance on a distribution frame and each item of equipment used by it. Clearly, manual input of all this information would be a tedious and error prone process. It was therefore apparent that the computer system should also encompass the activities involved in the generation of this information. These activities are collectively referred to as *circuit provision*. The scope of the Keybridge ERS was therefore defined to encompass all engineering records used for circuit provision and maintenance within the ITSC. The objectives were to store all engineering records on the computer system, and thereby eliminate the need for permanent paper records; to provide all users of the records with appropriate facilities for their access; to provide users with facilities to enter information and to permit the transfer of information between users in order to generate the records; and to produce the required statistics.

† International Telephones, British Telecom International

USERS' REQUIREMENTS

Potential users of an ERS can be divided into two broad groups: staff responsible for provision and staff responsible for maintenance.

Provision

Different staff may be responsible for provision of audio circuits, frequency-division multiplexed systems (groups, supergroups, hypergroups), time-division multiplexed blocks (2, 8, 34 or 140 Mbit/s digital blocks), analogue line systems or digital line systems; all of these are referred to below by the term *circuit*. In each case, the traditional sequence followed during the provisioning process, by using paper records, is similar:

(*a*) A document, normally called an *advice*, is issued, giving authority for the provision of the circuit to take place.

(*b*) This advice is checked to ensure that it is logical and consistent with other information known locally. If it is not, it is returned to the issuing authority.

(*c*) The records of the exchange and transmission equipment are checked to find spare equipment that can be used to provide the circuit. The equipment selected is marked as belonging to the circuit, and a circuit card containing this information is generated for eventual handing over to the maintenance staff.

(*d*) A list is drawn up of all the jumpering required to connect the selected equipment together to form a permanent circuit, and the jumpers are wired in.

(*e*) The circuit is tested in co-operation with the staff at its distant end, and any necessary adjustments to equalisers and attenuators are made. The test results are recorded on the circuit card.

(*f*) The circuit is handed over to the maintenance staff with the circuit card and the advice.

The above sequence has been simplified, since, as well as being provided, circuits must also be removed from service (known as *recovery*), and altered (known as *rearrangement*). In addition, procedures exist for handling anomalies that occur at any stage; for example, there may not be any equipment available for the circuit.

When the ERS was being created, all these procedures, or their equivalents, had to be built into the system.

Maintenance

The sequence of maintenance procedures, common to all types of circuit, as it exists in a traditional paper records system, is as follows:

(*a*) When a fault on a circuit is reported, it is recorded and a code, known as the *slip number*, is given to the reporter of the fault. This slip number is used whenever this particular fault has to be identified. The fault is added to the list of outstanding faults, and is recorded on the circuit card.

(*b*) The circuit is checked, to confirm that the fault is still present; if not, the fault is removed from the list and the circuit card marked to show that the fault was not found.

(*c*) If the fault is confirmed, it is passed to a member of the maintenance staff to find and clear. The circuit card, containing all the information about the circuit, is required and all the details of the fault are recorded on it.

(*d*) When the fault is cleared, it is removed from the list of outstanding faults, and the updated circuit card is returned to its place in the file.

In addition to the provisioning procedures, the ERS had to support all of these maintenance procedures, or their equivalents, and, in particular, had to permit rapid entry of information and access to it.

Availability and Data Security

Although circuit provision normally takes place during office hours, the maintenance of international circuits is required 24 hours a day every day of the year. Circuit information must be available to the provision and maintenance staff. The availability requirement for maintenance is the more onerous, and maintenance staff can tolerate non-availability of the information for only very short periods.

If all the data were lost, it could not readily be recreated since it is dependent upon choices made during provision. The loss of an individual item of data may not always be readily apparent but can result in the effective loss of the equipment or circuit, since it may preclude the allocation of the equipment or access to the circuit. The only effective method of recreating lost data would be from physical inspection of the equipment and circuit wiring. This would be an extremely time-consuming and expensive process. It is therefore essential that the probability of data loss is extremely low.

The above requirements clearly elevated both system availability and data security to positions of high priority in the design of the ERS.

THE ENGINEERING RECORDS SYSTEM

The system that was developed had to meet the following user requirements:

(*a*) it had to store the large amount of data required for the ITSC,

(*b*) it had to provide facilities for reading and manipulating the data for both the circuit provision and maintenance functions, and

(*c*) it had to meet the onerous availability and data security requirements.

The data storage requirements dictated the use of a hardware system capable of supporting a large number of magnetic disc drives. In order to minimise the physical data storage requirement and to maximise the ease and efficiency of its access, the data to be stored was organised into a database. A database is an organised structure for data storage where unnecessary duplication of information is avoided. The data is grouped into records, each containing closely related data. In the ERS, a single database was used to exploit the commonality between provision and maintenance data.

The requirements for accessing and manipulating the data in the ERS were not particularly unusual and many standard computer systems offered facilities which enabled suitable applications software to be written. Nevertheless, the amount of effort involved in generating the application software would depend upon the facilities available on a particular computer system; for example, savings would result from the use of a transaction-processing system that provided a simple method of generating screen formats.

The requirements for high availability and a high level of data security, however, did place severe restrictions on the system to be developed. To obtain a high degree of availability, the computer system had to be tolerant to single faults. This implied, at its simplest, duplication of the various hardware modules of the system, with a failure of one module leading to its duplicate automatically taking over. To obtain a high degree of security for the information, there had to be a number of copies of the database; typically, two up-to-date copies on the system, and further copies taken at regular intervals for remote storage. This required the computer system to offer an easy method of archiving (that is, taking copies of the database).

The ways in which these requirements were met are described below; the following are dealt with in turn: the database structure, the applications software and the way that the chosen computer system, an Information Technology Limited (ITL) Momentum 9000 system, provides the required availability and data security.

DATABASE STRUCTURE

The design of the database is a direct mapping of the equipment in Keybridge House, the circuits or multiplexed analogue or digital systems that pass through or terminate there, and the work that takes place on this equipment and circuits. Fig. 1 is a schematic diagram of the database records and the relationships between them. The meaning of a one-to-many relationship can be readily understood by considering 'equipment items' and 'equipment type': there are many items of equipment of each particular type.

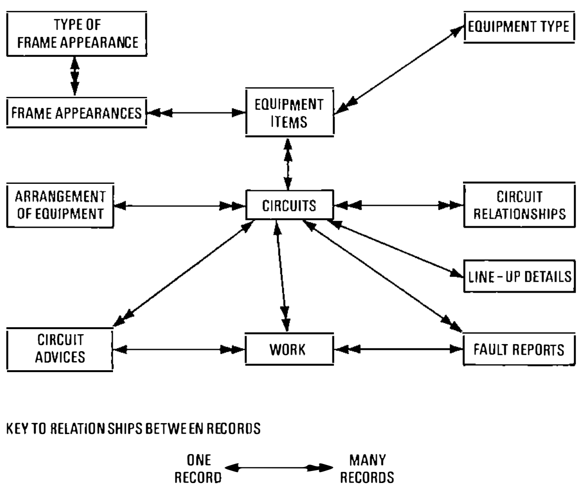


Fig. 1—Logical structure of database

Equipment

Each equipment item has a record which contains data on its type, its location and its status (that is, FREE or ALLOCATED TO A CIRCUIT). For each equipment type, a record stores both the total number of items installed and the number still available to be allocated. For each equipment item, there may be several appearances on a distribution frame and, for each appearance, there is a 'frame appearance' record which stores the terminating position of each set of wires (for example, a transmit pair). Each type of frame appearance has a record identifying each wire in the set and its position relative to the others. This approach gives a significant saving in the overall amount of data stored when compared to recording the position of each wire individually.

Circuits

Each circuit advice generates a 'circuit advice' record (see Fig. 1) to store the same information as a paper circuit advice; that is, the information specifying the requirements of the circuit. Each circuit has a record containing its type (for example, audio), its designation (that is, a code used to identify it) and its status (for example, BEING PROVIDED, IN SERVICE). Multiplexed analogue and digital systems are treated in exactly the same way as audio circuits. To show how circuits are connected or multiplexed together, each pair of circuits that are connected in any way has a 'circuit relationships' record showing the type of connection. There is a record for each circuit type, showing the normal arrangement of equipment. Each circuit has a line-up record, which contains the result of the most recent measurement of transmission parameters taken and its date. A fault report record is generated for each reported fault on any circuit and in this is stored a description of the fault, the time the fault was reported and the time and details of the clear.

Work

Each item of work to be done (usually dealing with a circuit advice or a fault report), has a work record (see Fig. 1), giving a description and history of the work. If the work being dealt with is a circuit advice, then the history of the work includes a jobcard—a check sheet used by the provisioning staff for recording the progress in providing the circuit. The work records are organised into queues, and a particular member of staff is responsible for dealing with the work in each queue. The identity of the queue in which the work is currently waiting is held in the work record, together with the date and time the record entered the queue, and a priority designation. The work records in the queues are presented in order of priority and then by received date and time.

APPLICATIONS SOFTWARE

The applications software is divided up into packages, as shown in Fig. 2. The two main packages are the provision package, dealing with the provision of circuits, and the maintenance package, dealing with the maintenance of both circuits and the ISC circuit terminating equipment. Both these packages are further divided into modules. The database administrator package is dedicated to the use of the person, the database administrator, who has overall responsibility for the information in the database. This package allows the database administrator to access the database, to initialise it and to correct errors in the data. The needs of the various users who need to view the circuit information are catered for by the general enquiries package, which allows circuit information to be displayed but not altered.

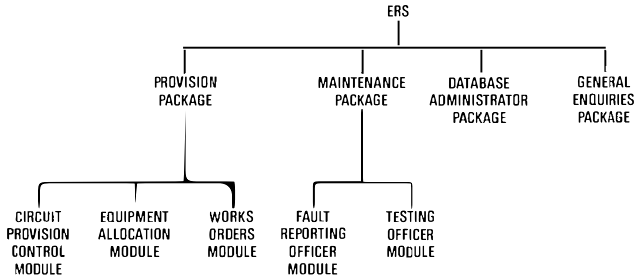


Fig. 2—Organisation of the applications software

Every user has a visual display terminal (VDT), and has access to a printer. Enquiries to the system are made via a keyboard and the results are displayed on the screen of the VDT. A copy of the screen display can also be printed. In most cases, the selection of data to be entered and action to be taken are made via a menu. The possible choices are presented on the screen in the form of numbered lists, and the user enters the appropriate number. Where the data to be entered cannot be presented as a menu, the user has to type it in on the VDT keyboard. Data entered from the keyboard is checked where possible for validity; for example, the name of an item of equipment is checked to ensure that there is equipment in the database with that name. If the entry is invalid, the user is asked to re-enter the data.

The tasks that the users can carry out by using the two main packages, for provision and maintenance, are described below.

Provision

The movement of advices between the queues in the Keybridge ERS is shown in Fig. 3. The sequence of actions taken is as follows:

(*a*) Advices for audio circuits and higher-order systems are prepared on the international circuit allocation record update system (ICARUS). The ICARUS creates paper copies of advices for the distant ends of circuits and for intermediate stations on the national network which cannot yet accept 'electronic' advices.

(*b*) All advices for Keybridge are transferred as data over a CCITT† X25 link from the ICARUS to the Keybridge ERS. These are placed into a circuit provision control (CPC) 'incoming advices' queue. The CPC staff display the advices that arrive in this queue, and, if the advices are in error, or if they reject them for some other reason, they inform the issuing staff and place the advices in their 'awaiting reissue' queue. When a reissued advice is received, the original advice is automatically deleted from this queue. If the CPC staff accept the advices, they decide on and enter target dates for the next stage in providing the circuit, and they then transfer the advices to the 'equipment allocation' queue.

(*c*) The equipment allocation staff inspect the advices in their queue and select equipment marked as FREE in the database from which to build the circuit. They work out and enter a jumper schedule by using the equipment details from the database, detailing how the equipment shall be connected together.

(*d*) The advice and its jumper schedule are then transferred to the CPC 'arrange co-operation' queue. The CPC staff check the progress of the advices against the target dates, and arrange a date with the distant end for the circuit to be tested and lined-up. This date is known as the *co-operation date*, and is entered as the target date for the next stage.

(*e*) The advice and its jumper schedule are then transferred to the 'works orders' queue. The works orders staff print out the jumper schedules of the advices in this

† CCITT—International Telegraph and Telephone Consultative Committee

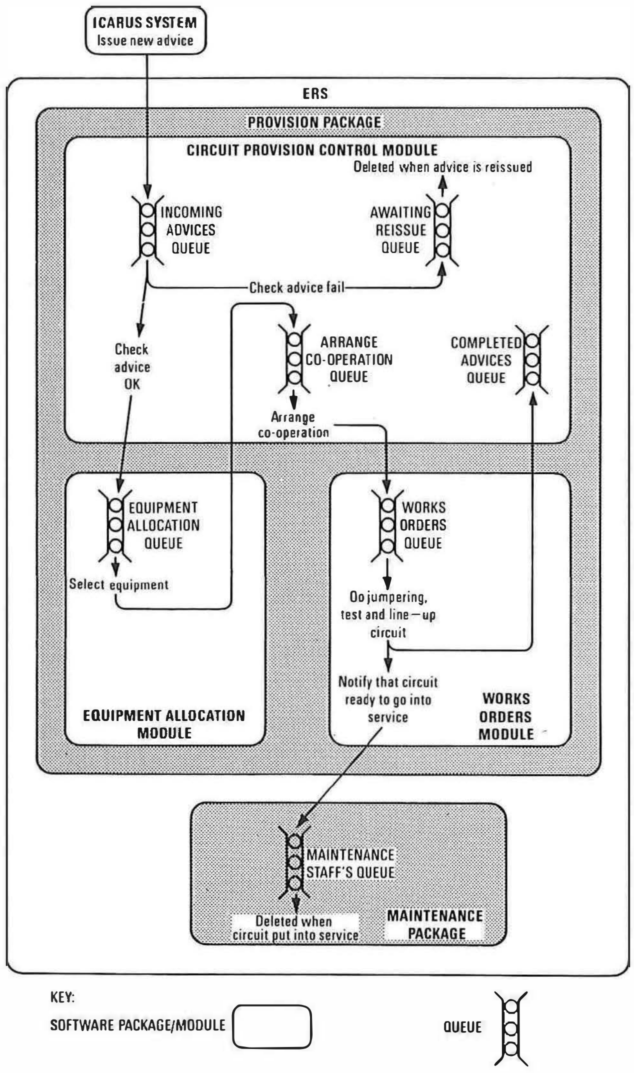


Fig. 3—Circuit provision process on the ERS

queue and connect the jumpers on the distribution frames.

(*f*) On the co-operation date, the works-orders staff test and line-up the circuit with the distant end and enter the line-up test result figures. They place a message in the appropriate maintenance staff's queue, informing them that the circuit is ready to be put into service and that all the circuit details are available in the database. At the same time, the advice is transferred to the CPC 'completed advices' queue.

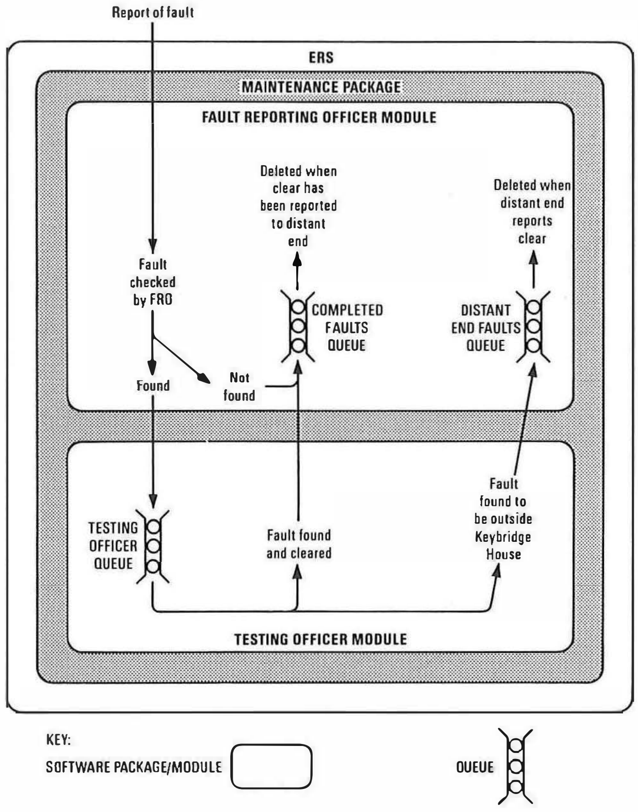
(*g*) The maintenance staff put the circuits into service and delete the entries from their queue.

(*h*) The CPC staff check the advices in the CPC completed advices queue, record the completion of the work on the advice, and delete it from this queue. When the queue entry is deleted, the advice itself remains in the database and can still be inspected as part of the circuit details.

Maintenance

The movement of fault reports between the queues in the Keybridge ERS is shown in Fig. 4. The sequence is as follows:

(*a*) Reports of faults on audio circuits are received at the Keybridge international maintenance centre by a fault reporting officer (FRO), who checks the circuit details to ensure that the fault has not already been reported, and



FRO: Fault recording officer

Fig. 4—Maintenance process on the ERS

then enters the fault details, giving the person reporting the fault a slip number by which to identify it. The FRO tests the circuit to check that the fault is still present. If it is no longer present, this is noted with the fault details and the fault is transferred into the 'completed faults' queue. If the fault is found, the FRO transfers the fault report into the testing officer queue.

(*b*) The testing officer selects a fault report from the testing officer queue. The testing officer, who can display all the details of the circuit, uses the test and maintenance equipment to locate and clear the fault, and enters details of the clear and transfers the fault report into the FRO's completed faults queue. If the fault is outside of Keybridge House, the testing officer reports it to the relevant fault reporting point, and places the fault report in the FRO's distant-end faults queue.

(*c*) Faults in the completed faults queue are reported as cleared to the distant end by the FRO and deleted from all the queues. Those in the distant-end faults queue are deleted when the distant end reports them as cleared. When the queue entries are deleted, the fault details remain in fault report records within the database, and can be displayed whenever the circuit details are inspected.

Faults on multiplexed analogue and digital systems are dealt with in a similar manner by the Keybridge international repeater station.

SYSTEM CONFIGURATION

The computer system purchased comprised hardware and system software. These two aspects are described separately in the following paragraphs and in particular the contribution of each to overall system availability and data security

Fig. 5—General view of the computer room

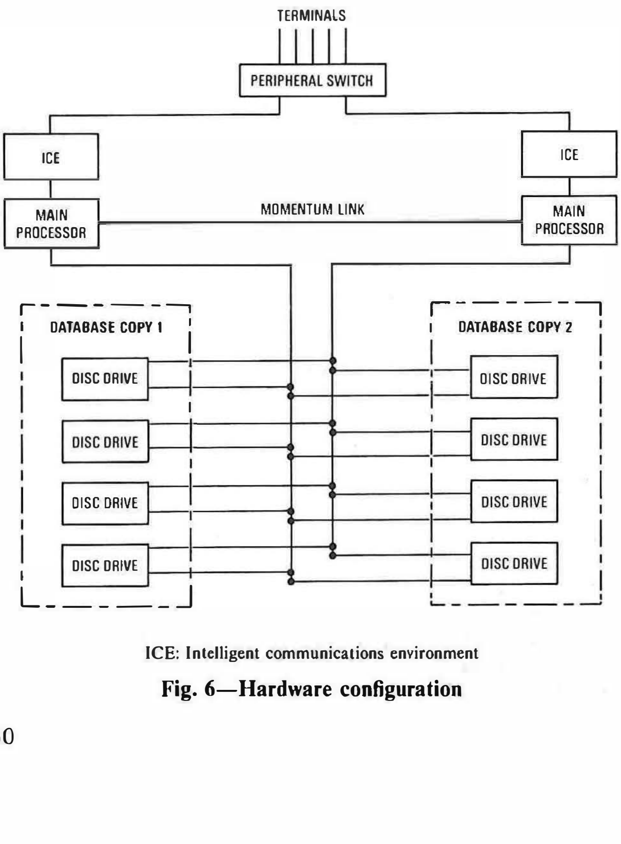
is described. A general view of the computer room is shown in Fig. 5.

Hardware

The configuration of the hardware is shown in Fig. 6. There are two loosely coupled main processors, two input/output processors, called *intelligent communications environments* (ICEs), two sets of disc drives, each containing a complete copy of the database. The main processors communicate with each other over the Momentum link. The terminals can be switched between the two ICEs by using the peripheral switch.

The ICE relieves the main processors of the mundane tasks associated with running the terminals. The work from the terminals is normally shared between the two main processors; however, should one main processor fail, the other is capable of handling it all.

The disc drives are dual access, each drive having a separate connection to a disc controller in each processor. Access to the disc drives is co-ordinated between the processors by communications across the Momentum link, and by arbitration logic within the drives themselves. The two sets of disc drives each contain, on removable disc packs, an up-to-date copy of the database. If a disc drive becomes faulty, it is automatically taken out of service, an error report is given at a terminal and the system continues by using the other copy of its data. When the ERS maintenance staff have cleared the fault and put the disc drive back into service, the system automatically copies the up-to-date data on to it.



ICE: Intelligent communications environment

Fig. 6—Hardware configuration

Compared with an unduplicated system, this configuration gives a faster response to users, but not twice as fast, since any update of the database must be carried out on both copies, and effort is required for the two main processors to co-ordinate their activities across the Momentum link. Nevertheless, duplication does give the system tolerance to a single hardware fault.

It is important that, if a main processor stops or there is a software fault, any updates to the database that are only partially complete are removed entirely, leaving the database in a known, and so usable, state. Each main processor has a section of non-volatile memory (that is, memory that does not lose its contents when the power is removed from the system), where copies of database records are stored by the system software when they are about to be altered. The non-volatile memories in both main processors are kept identical by messages sent across the Momentum link. If a main processor or the software fails, these copies are used to restore the records to what they were before the update started. The system software later repeats and completes these updates.

The applications programs also make use of the records held in non-volatile memory. The application program which writes to the database notifies the system software whenever a task is successful (called *check-pointing* by ITL). At this point, all the copies of records written into the non-volatile memory since the last check-point are deleted. If a task fails, it calls an error routine in the system software that restores all the changed records to the originals held in non-volatile memory.

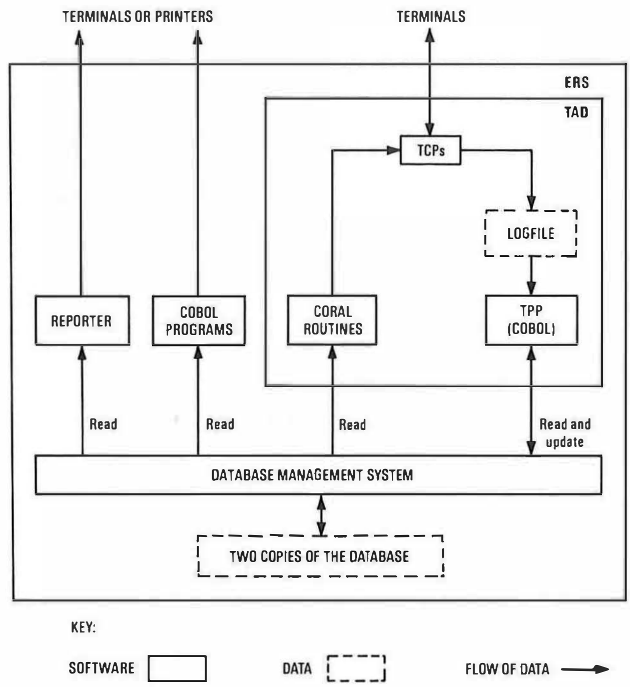
To cater for total system software or hardware failures, after the system is restarted and before any package accesses the database, the system software automatically uses the copies of records in the non-volatile memory to restore the database to the status at the last check-point. Thus check-pointing and restoration give protection against many software or hardware failures.

The method of archiving the database makes use of the duplication of the data. When an archive is to be taken, a command entered by the ERS maintenance staff stops the updating of the database, to ensure that it includes only complete information. They turn off one set of disc drives, containing a complete copy of the database, and then enter a command to allow updating of the database to recommence. The disc packs on the disc drives that are turned off are removed to form the archive, and replaced with blank disc packs. When the ERS maintenance staff restart the disc drives, the system copies the database on to the blank discs.

Software

The applications software uses ITL's transaction-processing system *TAD* (transaction applications driver). The structure of TAD with the associated modules of the system software is shown in Fig. 7.

The man–machine interface is provided by transaction control programs (TCPs) within the TAD. To extend the facilities available in the TCP screen control language, routines, written in CORAL 66, to read data from the database were used.



TAD: Transaction applications driver
TCP: Transaction control program
TPP: Tranaction processing program

Fig. 7—Transaction processing software

To update the database, the TCPs pass information to a disc file, called the *logfile*. The information in the logfile is read by a COBOL program called the *transaction processing program* (TPP), written by the BTI/IT development team around a skeleton program provided by ITL. A record of completed updates is kept in the logfile. If the system fails during an update, the partially complete update is removed when the system is restarted, as described above, and all the updates on the logfile that have not been marked as complete are reprocessed. The logfile can also be used to bring an archived copy of the database up-to-date by making the TPP reprocess all the information in the logfile written since the archive was taken.

The database can also be read, but not updated, by other programs written in either COBOL or ITL's report-generation language *REPORTER*. These programs are used for the generation of reports and statistics at the request of terminal users.

Reading from and writing to the database is via the system software, the database management system.

TESTING THE PROPRIETARY SYSTEM

As well as the development of the applications software, it has also been necessary to carry out a considerable amount of testing of the proprietary system. No operating system is ever truly fault free, although the operating system provided by ITL was a relatively mature product when configured to run on a single processor with a single set of discs. With its extension to dual main processors and dual disc drives, a number of faults were introduced. To ensure that the system software was reliable enough to be used for the ERS application, it had to be tested in a number of different hardware configurations and with a number of different types and levels of load. The errors found were passed to ITL for correction.

PRACTICAL EXPERIENCE

The Engineering Records System in Service

The major benefits of the system in service have proved to be as anticipated:

(*a*) The process of providing circuits has been speeded up; this has been achieved by removing postal delays, and by permitting several individuals to look simultaneously at the records.

(*b*) The accuracy of the records generated for use by maintenance staff has been improved; this has been achieved by computer validation of input data.

ERS terminals are located throughout the ITSC for the convenience of users; a typical siting is shown in Fig. 8. The system has been in continuous use by both circuit provision and maintenance staff, and no permanent paper records are used. It is the first comprehensive engineering records system to be installed within BTI, and is believed to be as advanced as any in the world.

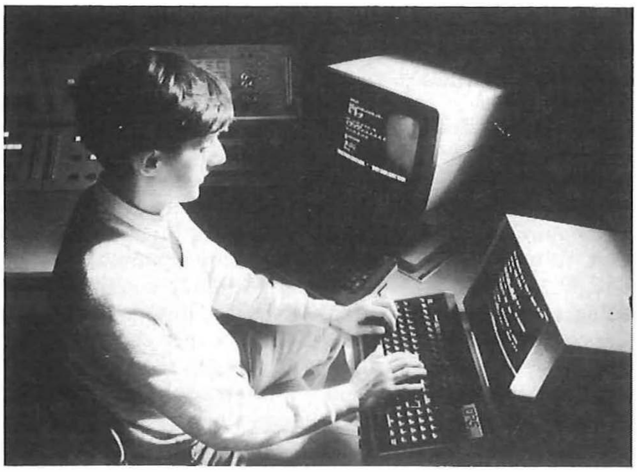


Fig. 8—Typical ERS terminal in use

The ERS has achieved its goals both in performing its functions and in providing the high level of security required of it. However, at first it suffered from two problems: poor response times and reduced availability. Because these were related, solutions to either were likely to exacerbate the other. The poor response time was due in part to the departure of the files from optimal organisation as large numbers of records were added. The reduced availability was due to having to shut down the system in order to reorganise the files and to archive the database. The ability to archive on a live system has now been provided by a program written by BTI/IT. The need to reorganise the files has been greatly reduced, and the response times have been greatly improved, by a new version of the system software and by improvements in the efficiency of the applications software.

The Engineering Records System Development

Experience gained from the development of the ERS has confirmed the value of accredited standards in software development and documentation.

Firstly, the value of some general features of computer application development has been observed:

(*a*) The choice of a proprietary database system enabled development to proceed quickly.

(*b*) A modular and structured approach to programming and documentation has enabled subsequent changes to be incorporated and controlled more easily.

(*c*) Throughout the development of the system and since it has been in service, the users have requested enhancements; a systematic procedure has been used, to great advantage, for the control of such requests.

Secondly, experience specific to the fault-tolerant system has been gained. The ERS, at the time of installation, was the largest configuration of the Momentum system in existence. This meant that careful and thorough testing had to be employed since the system software was being used under conditions not previously experienced. As a result of the thorough testing, very few problems have occurred on the live system; and by having good documentation and a well-planned and well-understood fault procedure, these have been dealt with efficiently.

THE FUTURE

The Keybridge ERS is being expanded to cover all international services and equipment within the ITSC. The outcome will be the replacement of all permanent paper engineering records.

It is anticipated that computer-based systems for engineering records will be installed at all future ISCs. These systems will go further towards the goal of an efficient paperless ITSC by integrating the functions of the present ERS more closely with other engineering functions.

A fully integrated system could, for example, allocate equipment to circuits, make the necessary connections by using an automatic distribution frame, automatically test the circuits via the switching units at either end, and automatically advise the switching units when the circuits were ready for use. For circuits in service, it could automatically generate fault reports from equipment failure alarms, or identify areas for testing when analysis of the alarm information proves to be inconclusive. There is an increasingly well-defined demand for integrated telecommunications operation and maintenance systems, and the ERS has provided BTI with valuable experience from which such future systems will benefit.

CONCLUSION

A computer system has been installed to store all the engineering records for circuit provision and maintenance in Keybridge ITSC. It has been based on a proprietary fault-tolerant computer, and the applications programs have been developed within BTI/IT. The ERS has performed well in practice for the telephone service units and is being expanded to cover records for the business services. An exciting future lies ahead for computer-based records systems as part of an integrated approach, using computers, to assist with all aspects of telecommunications operation and maintenance.

ACKNOWLEDGEMENTS

The authors would like to thank all those people both within and outside British Telecom who have contributed towards the successful implementation of the Keybridge ERS. Particular thanks are due to Felix Redmill for his thorough reviews of the draft versions of this article.

Biographies

Kenneth Boot-Handford is head of a computer systems development group within BTI/IT. He graduated in Physics at the University of Sussex in 1973 and joined the External Telecommunications Executive (ETE) of the Post Office to train Trainee Technicians (Apprentices) in transmission systems, and later to train technicians in the TXK6 international telephone exchange system. In 1982, he obtained an M. Sc. degree in Computer Science and returned to BTI/IT to lead the development of Keybridge ERS.

Ray Griffith is a member of the team which developed Keybridge ERS and now provides engineering support for the system. He joined the External Telecommunications Executive (ETE) in 1966 as an apprentice and worked on the original international leased telegraph message switch systems. This was followed by a period in the telegraph retransmission centre on hardware maintenance. He then went back to working on the international leased telegraph message switch systems and was responsible for software testing. In 1980, he moved to the group responsible for providing the Keybridge ERS and performed much of the original design work for the system. He is now responsible for testing system software and for providing maintenance support.

Robert Kimpton is head of a computer systems development group within BTI/IT. He graduated in Engineering with Operational Research at the University of Sussex in 1970 and joined the Network Planning Department (NPD) of the Post Office to work on data transmission. In 1974, he obtained an M. Sc. degree in Telecommunications Systems and returned to NPD to plan and specify the introduction of stored-program-controlled Telex exchanges. He then moved to the Network Department of BTI where he produced strategies and requirements for international telephone switching centres until taking up his present position in 1982. Since then, he has overseen the development of Keybridge ERS from the original proposal to its implementation.

OFTEL—Its Role and Relationship with British Telecom

Keynote Address to the Institution of British Telecommunications Engineers

PROFESSOR B. V. CARSBERG†

UDC 654.091 : 621.39

This is an abridged version of the address given by Professor Bryan Carsberg, Director General of Telecommunications, Office of Telecommunications (OFTEL), to the London Centre of the Institution of British Telecommunications Engineers on 12 September 1985. In his address, Professor Carsberg described the duties and objectives of the Director General and explained how his activities are governed by the 1984 Telecommunications Act and the terms of the Licences issued under the Act. He concluded by outlining some of the work carried out in the first year of OFTEL and discussed some of the reasons underlying the decisions made.

INTRODUCTION

I am delighted to have the opportunity to present a keynote address to members of the Institution of British Telecommunications Engineers and their guests. British Telecom (BT) is, of course, a most important part of the industry that I regulate and I have many contacts with BT's senior managers on a day-to-day basis. However, these contacts are with a relatively small group of people, often with members of the Government Relations Department, and I welcome the opportunity of talking to a larger group of people who have an important role to play in making a success of the newly liberalised environment in telecommunications.

I plan to use this opportunity to describe to you my duties and my objectives, to tell you about some of the activities of the past year and to explain to you the reasons for some of the decisions I have made. I want to emphasise at the start my belief that the new regime in telecommunications can bring benefits to all participants in the industry. BT will inevitably lose some of its share of the market because it starts from a position in which it had 100% of most of the markets in which it operated. Losing market share may not be to your liking. However, it is possible to lose market share while experiencing a growth of income, and that is what I expect to happen for BT. I believe that the whole industry will get bigger, as a result of the development of competition, and that room therefore exists for all participants to grow. Competition can bring down prices and thereby cause the volume of business to expand and, perhaps more importantly, it can encourage the rapid introduction of new services, building on the possibilities established by new technology. These things can happen in state monopolies, but experience suggests that they are more likely to happen and likely to happen faster with private companies facing competition.

FUNCTIONS OF OFTEL

I shall begin my description of what OFTEL does by explaining my functions. My Office was brought into existence by the 1984 Telecommunications Act which serves, together with Licences issued under the Act, as a sort of rule book setting out what I can do and what I must do. I took up my appointment on 1 July 1984 and business started in earnest on 5 August 1984, the date on which BT's Licence came into effect. BT's Licence is the rule book to which I have to refer most frequently. However, many other Licences form part of the regime that I administer, including those for the City of Hull, which operates local telephone services in Hull; Mercury Communications Ltd., which will become a competitor to BT in many of its activities; Racal-Vodaphone and Cellnet, which operate the mobile cellular radio telephone systems; the cable television companies, currently getting started in business, which need telecommunications licences as well as licences from the Cable Authority for programming purposes; and a general licence for the provision of value-added services. Furthermore, the private systems that are attached to the public network are defined as *branch systems* and these also have to be licensed: a general licence exists to cover them, but in many cases the systems operated by businesses do not fit the concepts of the general licence and these have to be considered for the issue of special licences. As you can see, the licences form an extensive body of rules and their administration accounts for a very great deal of our administrative effort.

Office of Telecommunications

If I wish to take some action, my first step is to study the 1984 Telecommunications Act to establish whether or not I am able to do so. As my lawyer likes to tell me, I am, in my official capacity, a creature of statute and I can take an action only if it is explicitly authorised by the Act. The main functions given to me by the Act are the following. First, the Act gives me the job of enforcing Licences, a job which has two aspects. One is to enforce the rules as they stand, considering any evidence that is provided to me about breaches of the Licence and taking appropriate action to ensure compliance if necessary. The second aspect is in exercising discretion given to me in the Licence to decide exactly how the rules should apply in particular circumstances. The BT Licence makes over 100 references to

† Director General of Telecommunications, Office of Telecommunications

circumstances in which I have to make a decision about the way in which the rules in the Licence are to be applied. For example, the Licence contains rules about the provision of services in public call boxes. If BT wishes to remove a call box, in some circumstances it is permitted to do so on the basis of criteria in the Licence; in other cases, it must obtain my consent. Another example concerns the interconnection of BT's network with that of Mercury. The BT Licence imposes the obligation of connecting the BT system to that of Mercury if BT is requested to do so and I have to determine the permitted terms and conditions governing that interconnection if the parties cannot reach agreement between themselves. I might add that the job of enforcing Licences is made more difficult by the fact that they are very long and complicated documents: I sometimes feel the need to translate them into simpler language to make their messages more readily accessible.

My second main function is that of amending Licences. Very sensibly, those who established the rule book recognised that they would not be able to define all the rules that would be needed because the environment would be changing rapidly. Some of the rules designed for today's environment would become out of date in a few years time. Furthermore, one cannot be sure of foreseeing all the rules that are needed and the precise form of rule that will work best even in the existing environment because of the novelty of the whole situation. Some rules may need relaxing and others may need tightening. If I wish to make a licence amendment, I have to follow a particular procedure laid down in the Act involving either agreement with the licensee or a reference to the Monopolies and Mergers Commission.

My third function is the enforcement of the Competition legislation insofar as it affects telecommunications. The main idea behind this function is to prevent companies from following courses of action that have the effect of restricting competition and any action I take in this area I have to take jointly with the Director General of Fair Trading. Finally, in this list of my functions, I will mention two others which are general in nature, but which turn out to be quite important in practice. One is the publishing of advice. I can publish advice to whomsoever I choose when I feel it is appropriate, and I have a particular role in giving advice to the Secretary of State in certain circumstances. The other of my general functions is to investigate complaints. I have a duty to investigate any complaint that is made to me by people who have a legitimate interest and are not merely being frivolous. Consequently, the fact that I am investigating a complaint does not necessarily imply that I believe something to be wrong; it may mean merely that somebody has made a representation to me and I am undertaking my duty to investigate.

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ADVICE

Submitted by the Director General of Telecommunications to the Secretary of State

WIDE AREA RADIO-PAGING

This document sets out advice which the Director General of the Office of Telecommunications, Professor Bryan Carsberg, has given to the Secretary of State on the expansion and allocation of radio frequencies for radio paging use. This advice has been given in response to a request from the Secretary of State.
In giving advice the Director General has acted under section 51 of the Telecommunications Act 1984 which places on him a duty to advise the Secretary of State on the exercise of his powers under the Wireless Telegraphy Act 1949 in cases where the running of telecommunications systems is involved.

Expansion of wide area paging

1 Radio-paging is a field in which technical advance is particularly rapid. The variety of services on offer is constantly increasing and all the discussions on this subject in which my office has been involved have shown the potential for a rapid expansion of the market. This applies to on-site paging as well as to wide area paging, and to both private systems and "public" networks.
In the case of wide area paging, "public" networks greatly predominate. It is clearly desirable that the maximum choice should be available to users in a manner that reflects the potential variety of services.

2 Paging does not require very large allocations of spectrum. However, there have been spectrum constraints on wide area paging, as there have been on other uses of frequency. This advice is given on the assumption that at least two, and perhaps three, additional channels can be made available at 153MHz, and at least two, and up to four, at 454 MHz. This should suffice to meet users' requirements for some time to come.

British Telecom Monopoly

3 The main problem which arises in connexion with wide area paging is that of monopoly. With some 250,000 paging customers, British Telecom (BT) offers a service throughout the UK on three channels at 153Mhz.

4 The next largest "public" operator can scarcely have more than 20,000 paging customers, although such operators offer analogous services at 153MHz, and at 454MHz with tone and voice. The other "public" operators are smaller still, as are the private operators.

5 BT's competitors have complained to me that some of BT's practices in radio-paging represent unfair competition. The practice of joint billing illustrates the issues. BT bills jointly for radio-paging and basic telephone services. Indeed, the rental of the radio pagers and the telephone exchange line are shown as one line on the bill. BT had agreed to change to separate billing as soon as possible as a result of an investigation by the Office of Fair Trading before I was appointed. Matters then came to a head when BT introduced a new service last January – a new alpha-numeric pager – which improved its competitive position vis-a-vis the independents. The independents asked me to require an immediate move to separate billing to redress the balance.

6 My first thought was to assess whether or not cross-subsidisation was taking place and I commissioned a leading firm of accountants to investigate the situation. They advised me that BT's radio-paging division was not currently paying enough for billing services but that changes already proposed for the 1985/6 financial year would eliminate any cross-subsidisation. They also told me that a date in 1986 was the earliest by which separate billing would be possible and that any attempt to rush the process might threaten the reliability of the whole billing system, which they regarded as rather fragile.

7 Even if cross-subsidisation has been eliminated, I remain concerned about the "intangible benefits" conferred on BT's radio-paging division by the joint billing: such matters as improved credit-control, improved debt collection, and, perhaps most important, the marketing advantage that comes from obscuring costs from customers. I am still collecting evidence about these benefits but if I find them to be significant I shall want to ensure that BT does move to separate billing as quickly as possible. This I cannot do under present licence arrangements because they contain no requirement for separate billing for radio-paging. Consequently, I may have to seek a licence amendment to give me these powers.

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REPORT

REPORT ON INVESTIGATION OF COMPLAINT ABOUT ALLEGED UNFAIR COMPETITION IN RADIOPAGING

by Professor Bryan Carsberg, Director General of Telecommunications

The Complaint

A complaint about unfair competition in wide-area radiopaging was received from Air Call plc in October 1984. (References to "radiopaging" throughout this report are to wide-area radiopaging, as opposed to on-site radiopaging which forms a distinct market with very different characteristics.) The complaint referred to British Telecom's (BT's) practice of billing jointly for telephone services and radiopaging services and also the fact that BT provided direct dialling facilities for its radiopaging customers but did not make the required facilities available for other companies to operate similar services for their customers. I have a duty under Section 49 of the Telecommunications Act 1984 to consider any matter which relates to telecommunication services and is the subject of a representation made to me other than one that appears to me to be frivolous. Consequently I began an investigation of the matters raised by Air Call.

2 Further representations were made to me about the same issues in December by Air Call together with three other competitors to BT, Digital Paging Systems (UK) Limited, Inter-City Paging Limited and Pageboy Services (UK) Limited. The complainants told me that they had heard that BT planned to offer a new alpha-numeric radiopaging service with effect from early January 1985. They each already provided a service of this kind but they feared that BT's entry into the market with a similar service would be facilitated by the practices of which they complained with the result that effective competition would be impossible. They asked me to delay BT's offering of such a service until separate billing had been introduced.

3 BT's competitors explained why they considered the practices complained of to be unfair. They pointed out that BT had a very powerful position with 85% or more of the market for radiopaging. They acknowledged that its established position, as a very large and well known company with the associated opportunity to enjoy economies of scale in its operations, gave it certain advantages which were a fact of life with which they, as competitors, had to live. Certain other advantages might be unfair but could be remedied only over a reasonable period of time. These were the advantages that came from being able to operate radiopaging services as an adjunct to the telephone business. BT had a very large number of customers and a large sales force and advertising budget to match; consequently, radiopaging would get spin off advantages from general advertising, from its ability to share other selling resources, and from other matters, such as the ready availability of capital. Even though a charge was made for the use of shared services as required under the licence rules against cross-subsidisation, the charge would be less than incurred for similar resources in a separate business. In this connection, the complainants noted that control of BT's behaviour was complicated by the fact that BT's licence obligation to produce separate accounts for the radiopaging business gave an ultimate deadline of April 1987, even though the main requirement was that such accounts should be available as soon as practicable.

4 The complainants explained that they regarded BT's practice of joint billing as objectionable for a number of reasons. The position was that the charge for radiopaging would be included in the telephone bill with the rental of the exchange line and normally no analysis would be provided; only when a new radiopaging service was taken up or when any change was made in the service provided, would BT attach a supplementary sheet to the bill giving details of the changes. The practice of joint-billing raised the question of whether or not the radiopaging business was bearing a proper part of the total billing cost in a manner that would avoid cross-subsidisation. But it would, the complainants claimed, in any case also confer "intangible benefits" on the radiopaging business. It would mean that BT's customers were less aware than the customers of its competitors of the cost of their radiopaging services so that ordinary budgetary control procedures would be less effective in controlling expenditure; in extreme cases, customers might be unaware that they were still paying for pagers that were no longer used. The ability to avoid strict budgetary control would give communications managers an incentive for dealing with BT rather than with one of their competitors who, necessarily, submitted a separate bill. The effect might be that BT could charge more than in a situation that involved full disclosure in the bill and that it might obtain the benefits of added volume of sales. Other benefits alleged to flow to BT from its joint billing included low-cost credit control, debt collection and minimisation of bad debts. These effects might arise because BT's customers were accustomed to the rule that non-payment of the telephone bill would lead to disconnection of the telephone service. Even though BT

DUTIES UNDER THE ACT

Let us now suppose that a situation has arisen in which I see the need to consider amending a Licence or exercising one of my other functions. How should I decide what to do? The answer can be inferred from duties that are set down for me in the Act. They are there to ensure that I do not use my powers in a capricious manner or a manner that is likely to be against the public interest.

My primary duty is to do what I can to ensure that telecommunications services are provided to meet reasonable demands for them and that those who provide them are able to finance them. This primary duty puts a clear emphasis on the need to secure services with the benefit of consumers in mind. Then follows a list of more detailed duties. I must promote the interests of consumers as regards price, quality and variety of service. I have to promote competition because competition is thought to be in the interests of consumers. I have to promote efficiency in the industry, and I have to promote research and development. I have to encourage users of telecommunications services to locate in the UK, and in this connection it is interesting to note that some international companies have already decided to locate their European operations in the UK rather than in other European countries, partly because of the favourable situation in our telecommunications industry. And I have to promote the ability of those who produce goods and services in the UK to compete effectively overseas.

For each decision I make, accordingly, I have to identify the alternative courses of action and evaluate its likely effect in terms of each of the duties I have described. I then have to choose the course of action which seems overall to be best in the context of the duties. Some people have observed that it is difficult to decide how much emphasis to give different duties in relation to a particular decision when an element of conflict exists. For example, the promotion of the ability of producers in the UK to compete effectively overseas is not necessarily going to enhance the position of consumers of telecommunications services at home. However, in many cases I believe the duties all point in the same direction, and in other cases I have to attempt a trade off of different factors to the benefit of the overall public interest.

ADEQUACY OF REGULATORY POWERS

From time to time, I read comments to the effect that OFTEL does not have sufficiently strong powers to achieve the duties set down in the Act and that the powers will need to be strengthened in the near future. I find these arguments rather surprising because I do not myself believe that the powers have yet been shown to have any significant deficiency. I note that those who make this comment generally fail to explain the evils that need to be brought under control by additional powers and exactly what kind of powers are needed to put things right.

However, I want to consider the adequacy of my powers in rather more detail because everyone concerned with telecommunications has a mutual interest in reaching agreement about the best form of regulation. Furthermore, people are interested in learning from experience with telecommunications to help with the design of regulatory systems in Gas and other industries that may be privatised. The comment about the need for strengthening of the regulatory arrangements may perhaps reflect a misunderstanding of the system that we have. It incorporates, in effect, a series of checks and balances which limit very properly the amount of power given to any single institution. Often comparisons are made with the United States where regulatory powers are exercised by a commission typically comprising five or seven people. In the UK, we do not have a commission and the main regulatory authority is exercised by the Director General personally, but that is limited by the involvement of other institutions.

Consider for example the enforcement of licence conditions. In this I have strong powers. If I become aware of a breach of a licence condition, I have a duty to issue an order requiring compliance in the future, unless I am satisfied that the breach is not continuing and is not likely to recur. Any order that I issue in this connection is enforceable in the courts. Anyone who suffers loss from a further breach of the Licence can obtain damages in the courts and I can obtain an injunction with the remedies attached to that course of action. My role in the enforcement of licence conditions is exercised independently of Government and in particular without reference to Ministers. The Secretary of State has no power to take enforcement action directly himself nor do I refer to him before deciding whether or not I should take action. This independence from Government was established in order to protect private investors in BT from the effects of political interference. A check on my own power is provided by the courts. If I exercise my role unreasonably, then my decision can be challenged in the courts though, they would not interfere simply because they differed in opinion over a matter of judgement: unreasonable behaviour is the signal for interference.

If I wish to amend a Licence, I can do so by agreement with the licensee provided that I give notice to the public about my intentions and consider any objections that are made. If the licensee does not agree to my proposal, I can make a reference to the Monopolies and Mergers Commission and I can still proceed if they provide support for the proposal. The Commission has a special telecommunications panel and that provides a check on my ability to change the rules. The Monopolies and Mergers Commission will also be involved if I wish to pursue a case under the Competition legislation though, as I have noted, I also act jointly with the Director General of Fair Trading in such cases.

Some functions with regard to the new telecommunications regime are still administered by the Secretary of State. He retains the function of issuing new Licences so that, for example, if a third general competitor to BT were to be introduced to the market—another Mercury so to speak—it would be on the edict of the Secretary of State. The Secretary of State also has the function of approving apparatus and maintainers, and for designating standards. He also retains most of the direct responsibilities for international matters where negotiations with other Governments are involved. Several of the functions of the Secretary of State can be delegated to me and may well be so before too long. However, where a function remains with the Secretary of State, I am in a position to give advice. The Secretary of State has to consider my advice with regard to licensing and I shall give that advice in public to the extent that it involves general concepts as opposed to an analysis of the merits of individual companies; and I am able to give advice, if I wish, with regard to the other functions of the Secretary of State.

The above analysis of the exercising of functions under the 1984 Act indicates that for each function somebody has a primary responsibility for action subject to a check exercised by some other institution. That seems to me to be an entirely appropriate way of doing things. It allows for the possibility of strong and rapid action for the enforcement of existing rules but it gives Licence holders the reassurance of knowing that things will move a little more slowly with consideration by the Monopolies and Mergers Commission when changes in the rules are being considered. I have every reason to suppose at the moment that these provisions will work satisfactorily. My powers do not extend to the imposition of financial penalties on licensees, in the manner that can be undertaken by commissions in the United States, but financial penalties may nevertheless be imposed by the Courts under the British system if a licensee fails to comply with an order.

Two other issues that have arisen during the past year may be in people's minds when they argue that additional powers of regulation are needed. First was the specific case of my investigation of BT's purchasing activities in public switching: System X versus System Y. In that case, I had received a complaint about BT's decision to purchase part of its public switching requirements from Thorn Ericsson, using basic technology developed in Sweden. After studying the situation, I published a report containing advice to the effect that I believed BT to be entitled to bring commercial pressure to bear on its traditional suppliers by introducing new suppliers but that BT should give some recognition to the transitional problems of the traditional suppliers in moving from a position in which they had a special relationship with BT, and in effect developed products jointly with BT, to a situation in which more open competition would exist. I suggested that the proposed level of orders should be held for three years, before consideration was given to


Office of Telecommunications

BRITISH TELECOM'S PROCUREMENT OF DIGITAL EXCHANGES

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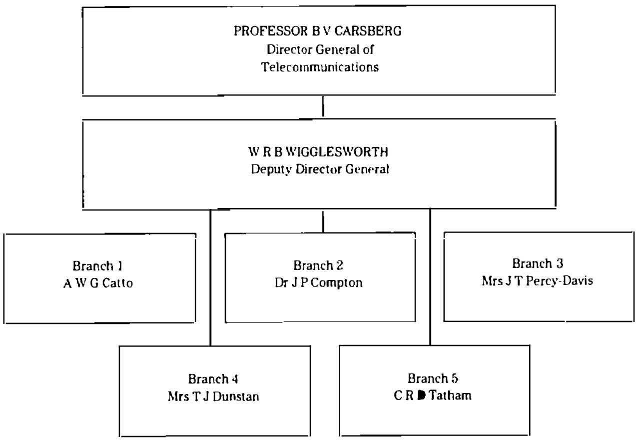
further changes, subject to reasonably satisfactory performance as regards price and delivery on the part of the traditional suppliers. BT's response to this advice created doubts about whether or not it intended to accept it. Consequently, people wondered whether or not I had powers to enforce my point of view. I should say, first, that I do not see a position of crisis as far as this issue of purchasing policy is concerned. I expect BT to exercise its purchasing power responsibly and I shall be keeping the situation under review. If some abuse were to take place, I could consider action to obtain a licence amendment or action under the Competition legislation to deal with the situation. The range of options open to me would, however, be limited in one respect. I could not propose a rule to require BT to purchase a minimum percentage of its supplies from firms using UK technology, even if I wanted to, because such a requirement would conflict with the competition rules of the European Economic Community. Consequently, I do not see the position on procurement policy as indicating any inadequacy of my powers that could have been avoided by different drafting of the Act or the Licence.

The other issue about which questions concerning the extent of my powers may have arisen is in the relationship between my functions and those of the courts. I sometimes receive complaints from people or firms who have a contractual dispute with BT or some other company. When I receive such a complaint I contact BT to make sure it has given it reasonable consideration according to normal procedures and I also investigate to make sure that no breach of a licence condition is involved. However, a complainant would often wish me to go further and order a particular settlement, perhaps order BT to abandon its claim for a debt. That I cannot do because it would involve a usurping of the proper function of the courts.

I will conclude my discussion of OFTEL's powers, by adding a few words about the resources we have to do our job. Our budget comes from licence fees almost entirely. It comes under the Parliamentary vote procedure but we obtain only a nominal sum from general Government revenues. Our current annual budget is between £3M and £3·5M per annum. Our staff numbers about 90. When we started in business, the plan was for staff of about 50, and at that time much criticism centred on the ratio between our staff numbers and the 240 000 or so staff of BT. People doubted that we had the resources needed to exercise effective control.

OFTEL Departmental Structure



Branch 1: PTO Licences
Branch 2: non-PTO Licences, apparatus approval, public registers
Branch 3: consumer affairs, press and publicity, PTO codes of practice, advisory committee liaison, public call office issues, library.
Branch 4: Legal advice
Branch 5: Technical advice

Our actual experience indicates that the administrative arrangements made it possible for us to increase our size significantly beyond 50 once we could show the need to do so. Indeed, the arrangements for licence fees would enable me to increase our size a good deal further if the need arose. However, I like to emphasise that the numbers you need for regulatory purposes do not vary as a direct proportion of the numbers of employees of the licensees. If you have clear rules, good information systems to indicate whether or not the rules are being obeyed, and strong powers to take action if the rules are broken, then a small number of staff can keep the situation satisfactorily under control. If you double the number of carriages on a train, you still need only one speedometer to measure how fast it is going.

As you will see from what I have said, I believe that adequate provision has been made for our resources. Present plans will increase our staff to 110 or so and we may need to increase a little further in the fullness of time. We have been extremely busy in our first year, but that is partly because we have had to do many things as part of the set-up process that will not recur on an annual basis. On the other hand, some of our routine monitoring activities have not yet reached their steady-state level and we are aware that a great deal more detailed work has to be done in certain areas, for example in the development of procedures for the licensing of private systems.

PROMOTION OF COMPETITION

I have already emphasised that one of my functions is to promote competition in telecommunications. It is one of the most important aspects of my job. The main purpose of introducing competition is to promote the interests of consumers. The idea is that competition produces keener prices because a firm facing competition cannot take a relaxed view of its level of costs in the expectation that it can always pump up prices a bit to make sure that costs are recovered. Perhaps more importantly in telecommunications, competition provides extra incentive for technological innovation. In a monopolistic industry, the introduction of technological innovation is often sluggish whereas in competition the incentives for innovation are very strong indeed: a firm that does not innovate risks losing its market to competitors. For people working in an industry, many of these effects of competition are to be welcomed. The probable interest in technology suggests a strong demand for the services provided by telecommunications engineers, even if the results of innovation have to be judged on commercial criteria. Furthermore, the stimulus given to the industry is likely to make the total size of the market for telecommunications bigger than it would have been without competition and this will not only make the industry a more stimulating place in which to work, it will also create a more active market for employment. I will turn next to make some comments about the development of competition in several of the main areas of the industry.

Long-Distance Telephony

The pattern for competition in long-distance telephony is now established for the next few years. Mercury has been licenced to compete with BT and that competition is likely to become a reality next year when Mercury commences to offer a switched service. The Government has indicated that it does not intend to introduce additional competition before 1990. I am often asked whether or not others are likely to be admitted in 1990 and the honest answer is that it is too soon to judge. The decision will depend mainly on how successful competition between BT and Mercury turns out to be. The introduction of additional competition would entail additional large investments for the establishment of a network by any new operators. That would be worthwhile if the benefits of additional competition outweighed the cost of the extra investment. The present framework for the industry suggests a presumption that more competition is better than less. However that presumption could be overcome if the evidence suggested that no more than two general operators could survive as effective economic forces under current conditions.

The pattern of competition will be affected by arrangements made for the resale of capacity on private leased lines. At present, such resale is prohibited and the Government has stated that it does not intend to allow resale before 1989. Value-added services are permitted, under a general licence, and proposals are being considered for amending that general licence to make the arrangements more liberal; in particular, the provision of managed data network services may be permitted, and this could be said to involve complex resale of data as opposed to simple resale. The delay in allowing simple resale is attributable mainly to the need for BT to rebalance its tariffs for leased lines. At present, these tariffs are claimed to be rather low because they have been held down as a result of political pressures in the past; if resale is permitted in that situation, competition will not be stable. Equally, a too rapid rebalancing has a disruptive effect on the market. However, I take the view that the case for allowing resale once the rebalancing of tariffs has been accomplished may well be a very strong one. Simple resale would allow a kind of wholesaling activity into telecommunications which would have the effect of promoting competition over and above what can be achieved by bringing in other network providers; it would also allow the operation of private systems in a way that more fully realised their value because they would be subject to fewer restrictions.

I will say a few words at this stage about the interconnection of British Telecom's system with that of Mercury. BT's Licence gives Mercury the right to require connection of its system to BT's and vice versa. Indeed, the right of interconnection applies to all licenced operators, though those who carry traffic over long lines have more extensive rights than others. The rationale of the right of interconnection is that competition cannot really become effective without it because a competitor to BT cannot develop a viable business unless it can assure its potential customers that they will be able to telephone everyone else regardless of whether they are connected to the system of the competitor, the system of BT or some other system.

Accordingly, the Licence gives long-line operators the right to interconnection to allow any telephone customer to call any other telephone customer and to allow customers the right to choose the route over which long-distance traffic flows. The Licences envisaged that BT and Mercury and others might be able to reach agreement about the detailed terms and conditions governing interconnection but provided that either party can request me to determine the terms and conditions if agreement has not been reached within a reasonable time. Mercury came to me to ask for a determination of the terms and conditions early in 1985 and, after some actions in the courts to determine the status of certain documents that already existed, the way was cleared for me to proceed with my determination. The Licence establishes a detailed framework within which my determination must be made. It lists the general kinds of conditions that are permitted and establishes certain objectives that the detailed conditions should meet. It says, for example, that the costs of providing the services under the interconnection agreement must be covered by the charges that are made. It also says that the company requesting interconnection should not be put in a position to rely unduly on BT's network in meeting its own Licence obligations and that the agreement should promote fair competition. I have not yet finalised my Determination, but my work is at an advanced stage and I am proceeding with an appreciation of the urgency of settling matters in the interests of all concerned†.

Competition in Local Networks

Less opportunity for competition exists in local networks than in long-distance networks. Mercury has the legal ability to establish local competition, but it is unlikely to do so extensively, except perhaps in collaboration with cable television companies, because the cost of duplicating BT's network on a large scale would be uneconomic. Cable television, indeed, seems to be the best prospect for promoting competition at the local level, but a great deal of uncertainty about its potential exists at the present time. The economics of the cable television industry as a provider of entertainment appear to be somewhat uncertain at the present time and, with present technology, substantial additional costs would be involved in the provision of switched voice telephony. The Licences of cable television companies require them to provide any voice telephony services in co-operation with BT or Mercury for the time being. This requirement will be reviewed in 1990 as part of the review of competition in the operation of telecommunications networks.

My position is that I want to keep open the option of competition in local telecommunications services as far as possible. I think it entirely appropriate that BT should have a role in certain cable television operations as it already has in a number of cases. It has substantial expertise which it can appropriately bring to bear in the provision of cable services. I should be concerned if BT were to have a significant role in a high proportion of local cable areas, because

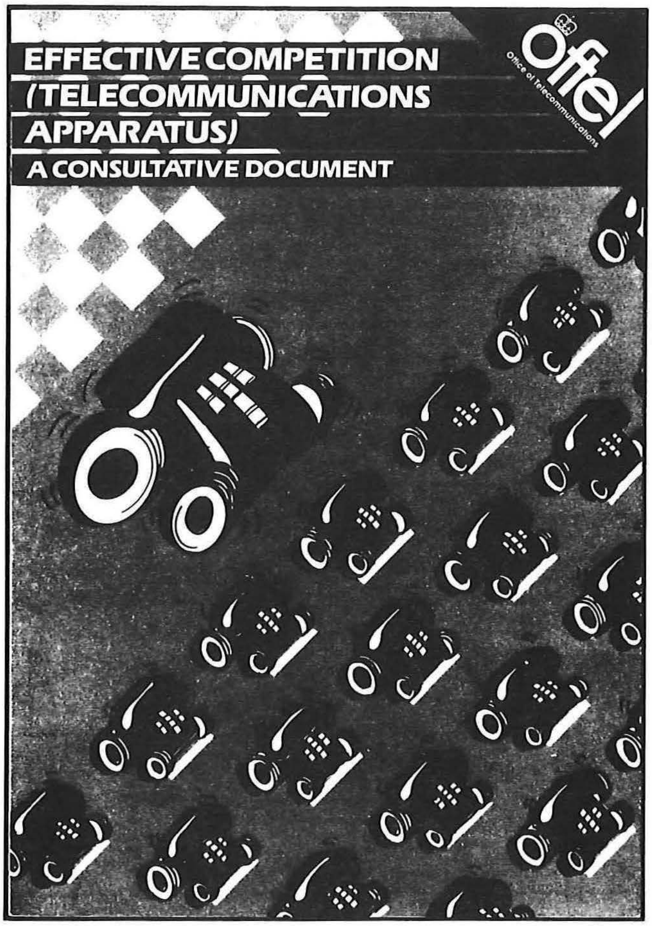
† The Director General's Determination of the terms and conditions which will govern the interconnection of the BT and Mercury telephone networks was published on 14 October 1985, and is available from the OFTEL Library, price £6.00.

that would inhibit the prospects for future competition and for constructive diversity in the industry. Consequently, I am looking for BT to have a role but not an overwhelmingly dominant one.

Competition in Apparatus Supply

Finally, in this short review of the main strands of competition, I want to say a few words about apparatus supply. This has actually been a subject of very great concern and has indeed been one of the most important issues for OFTEL during our first year of operation. When I took up my appointment, several individuals and organisations told me that they were worried about the possibility of fair competition with BT in the area of apparatus supply because of the advantage obtained by BT from being the established main network operator.

Several licence rules exist to promote fair trading in apparatus supply and limit the advantage that BT can give to its apparatus business as a result of its ownership of the network business. However good rules alone are not enough. People will be willing to enter the apparatus market and compete energetically and in the fullest possible sense only if they believe that I will play my part in enforcing the rules vigorously. Consequently, I decided that I must develop and announce a strategy for promoting fair competition in apparatus supply in a manner that would reassure people about my determination. I first explained the rules and published a document inviting people to let me know if they became aware of any breaches of the rules. I indicated that I would not hesitate to issue an order if I became aware of breaches of the rules and I called on BT to play its part by making sure that its employees were well informed about their responsibilities. I undertook to launch a study after the new regime had been in operation for a year or so to seek evidence about compliance with the rules. I would not simply wait for people to come to me with information but I would take an active part and go out looking for breaches. I also said that I would review the rules at a detailed level, after a reasonable interval of time, to make up my mind about whether or not the existing rules were satisfactory for the promotion of effective competition or whether additional rules were needed. I believe that this policy has made most people in the industry aware that I am determined to make competition effective in apparatus supply as indeed in all other areas of the industry.

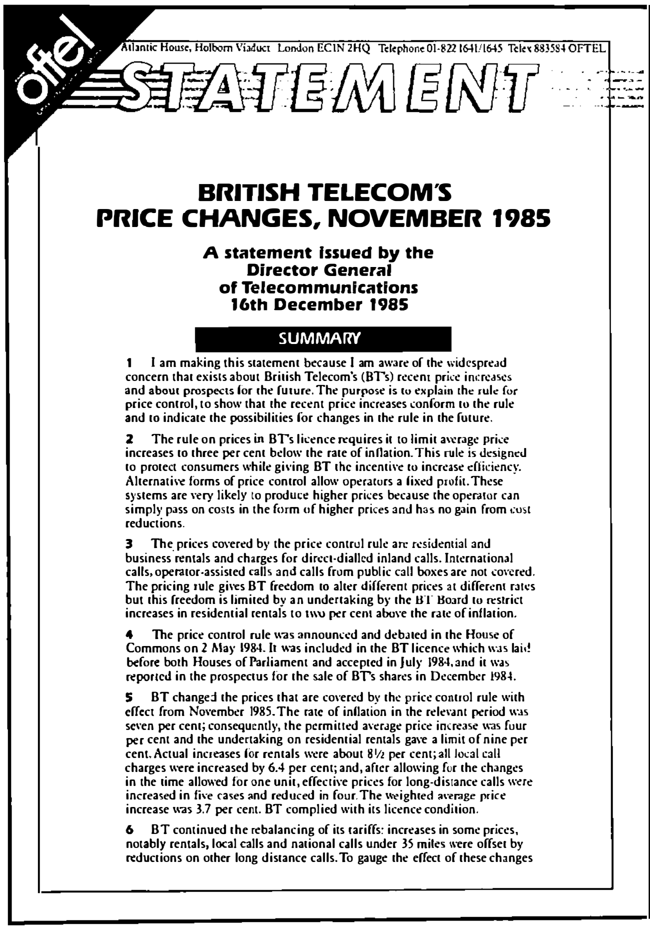


The main rules that exist to promote fair competition are a rule against undue preference and discrimination, a rule against cross subsidisation, and a rule to restrict the passing of information from the main telephone business to other businesses. The principle behind these rules is that BT should not be able to gain an advantage for the purposes of the businesses that are open to competition by using some aspect of its monopoly privilege. The appropriate course of action in any particular situation can often be detected by asking the question whether or not one of BT's general competitors could undertake the action proposed by BT: if the competitor can take the action, BT also should be allowed to do so. Undue preference, for example, would arise if BT were to say to a potential apparatus customer that an exchange line would be provided more quickly if the customer were to buy apparatus from BT than if the customer purchased from a competitor. The competitor is not in a position to match such a proposal. Cross subsidisation occurs if profits made on the monopoly business are used to hold down prices in a competitive business either because the monopoly business provides services for the competitive business without requiring adequate payment or simply because the existence of monopoly profits makes it possible to accept a lower than normal rate of return on the competitive business for a period of time. Evidently, competition cannot be sustained if cross subsidisation is allowed. The passing of information from the basic telephone business to the apparatus supply business may be objectionable because it provides a means of directing marketing effort to maximum effect. For example, a customer who has just ordered a new exchange line is likely to be a better than average prospect for apparatus sales; if the basic telephone business were to keep the apparatus supply business informed of all new orders for exchange lines, it would be conferring an unfair advantage, derived as a result of having the privilege of being network operator. An exception to this prohibition on the passing of information has to be made in cases in which a customer asks explicitly for the network business to pass a message to someone in the apparatus supply business asking for a sales person to call. I want to acknowledge my recognition that BT's own management accepts the principle of the fair trading rules and is determined to do its part to ensure fair trading by BT. Furthermore, I have not yet found a case in which a breach of the fair trading rules has been clearly established although one or two cases have arisen in which the facts have been difficult to establish and one or two other cases are still under investigation. Sometimes difficulty in establishing what has happened arises because BT's customers hesitate to complain, given fears that the making of a complaint will lead to discrimination against them in the future. I was delighted when BT's Chairman agreed recently to help me with this difficulty by writing an open letter assuring me that he would do all in his power to prevent discrimination against customers who complained and agreeing that I could make that letter available to anyone who appeared to be concerned about the possibility. I was also pleased when BT agreed recently to issue marketing guidelines to its staff to explain the licence rules and to emphasise to everyone concerned the importance of adhering to them.

CONCLUSION

I referred earlier to concern as to whether the regulatory regime contains sufficient powers to ensure achievement of the goal of fair competition. Another point of view is to emphasise the value of the concept of the light rein in regulation. A good deal of emphasis was given in some quarters to the desirability of a light rein when the Telecommunications Act was making its way through Parliament and I am aware that BT's management attaches importance to the concept. The concept does not mean of course that breaches of the rules will be disregarded. I take the concept to mean rather that the regulatory process has to meet a criterion of efficiency, that the regulators should focus their main attention on the issues of substantial importance and avoid incurring large costs in investigating matters in great detail when the matters concerned do not pose a serious threat to competition or other aspects of the interests of consumers.

I accept this objective of efficiency in regulation fully and I hope that OFTEL is seen to be playing its part in achieving the aim. The rule on price control is a good example of the concept—the rule that average increases in a basket of prices should be limited to 3% below the rate of inflation—because it provides a protection to the consumer while being relatively inexpensive to administer. And the best example of all perhaps is in the promotion of competition itself. The promotion of competition, in many areas, is a more efficient way of serving the interests of consumers than heavy handed regulation and, as you have heard, it is an objective that I am pursuing with determination.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STATEMENT

BRITISH TELECOM'S PRICE CHANGES, NOVEMBER 1985

A statement issued by the Director General of Telecommunications 16th December 1985

SUMMARY

1 I am making this statement because I am aware of the widespread concern that exists about British Telecom's (BT's) recent price increases and about prospects for the future. The purpose is to explain the rule for price control, to show that the recent price increases conform to the rule and to indicate the possibilities for changes in the rule in the future.

2 The rule on prices in BT's licence requires it to limit average price increases to three per cent below the rate of inflation. This rule is designed to protect consumers while giving BT the incentive to increase efficiency. Alternative forms of price control allow operators a fixed profit. These systems are very likely to produce higher prices because the operator can simply pass on costs in the form of higher prices and has no gain from cost reductions.

3 The prices covered by the price control rule are residential and business rentals and charges for direct-dialled inland calls. International calls, operator-assisted calls and calls from public call boxes are not covered. The pricing rule gives BT freedom to alter different prices at different rates but this freedom is limited by an undertaking by the BT Board to restrict increases in residential rentals to two per cent above the rate of inflation.

4 The price control rule was announced and debated in the House of Commons on 2 May 1984. It was included in the BT licence which was laid before both Houses of Parliament and accepted in July 1984, and it was reported in the prospectus for the sale of BT's shares in December 1984.

5 BT changed the prices that are covered by the price control rule with effect from November 1985. The rate of inflation in the relevant period was seven per cent; consequently, the permitted average price increase was four per cent and the undertaking on residential rentals gave a limit of nine per cent. Actual increases for rentals were about 8½ per cent; all local call charges were increased by 6.4 per cent; and, after allowing for the changes in the time allowed for one unit, effective prices for long-distance calls were increased in five cases and reduced in four. The weighted average price increase was 3.7 per cent. BT complied with its licence condition.

6 BT continued the rebalancing of its tariffs: increases in some prices, notably rentals, local calls and national calls under 35 miles were offset by reductions on other long distance calls. To gauge the effect of these changes

Biography

Professor Bryan Carsberg qualified as a Chartered Accountant in 1960. After four years in private practice, he became a lecturer in accounting at the London School of Economics and Political Science (LSE) and a visiting lecturer at the University of Chicago. He gained an M.Sc.(Econ.) with distinction through part-time study at the LSE in 1967. In 1969, he became Professor of Accounting and Head of the Department of Accounting and Business Finance, University of Manchester, and later Dean of its Faculty of Economic and Social Studies. He was made a Fellow of the Institute of Chartered Accountants in England and Wales (ICA) in 1970. From 1978 to 1981, he was Assistant Director of Research and Technical Activities, and Academic Fellow on the Financial Accounting Standards Board, USA. Since 1981, he has been Arthur Anderson Professor of Accounting at LSE and part-time Director of Research for the ICA. He is a member of the UK Association of University Teachers of Accounting and the American Accounting Association. He has advised the Secretary of State for Trade and Industry on the liberalisation of the UK telecommunications industry and privatisation of BT. He was appointed Director General of Telecommunications, Office of Telecommunications, in July 1984.

Progress in Parcel Sorting

Watford Parcel Concentration Office

D. BOLTON, C.ENG., M.I.MECH.E., F.I.E.D., and R. P. WOOD†

UDC 656.851 : 681.187

This article describes the sorting operation at a parcel concentration office with particular reference to the tilting-tray parcel sorting machine and control system installed at the new Watford parcel concentration office.

INTRODUCTION

Because of overcrowding and lack of space at the former premises in Imperial Way, Watford, consideration was given by the Post Office (PO) Board to the need for the establishment of a combined mechanised letter office (MLO) and parcel concentration office (PCO) on a more suitable site. Such a site became available when the British Printing and Communications Corporation vacated one of its works in Ascot Road. The PO acquired these premises and had the buildings refurbished and extended to meet the requirements for postal mechanisation of letter and parcel sorting functions; this article is concerned with those applicable to the PCO.

Apart from the Redhill/Salfords PCO (tilting-slat installation)[1], almost a decade had passed since the PO had designed, for its own use, a comprehensive system for the receipt, handling, sorting and subsequent despatch of parcel traffic. In addition, a wider range of parcel weights and sizes now had to be processed, much of which was unsuitable for mechanised sorting in the older type of office.

The old limits for parcels were 1·07 m long × 2 m combined length and girth, and a weight of 10 kg; the current limits are 1·5 m long with a maximum combined length and girth of 3 m, and a weight of 25 kg.

The new project would enable the PO to introduce many of the latest design developments and to take advantage of the advances which had become available from the commercial field. However, the shape and size of the building itself dictated the types of different equipment that might actually have to be installed (see Fig. 1).

† Engineering Department, The Post Office

THE PARCEL SORTING PROCESS

Parcel mail mainly arrives at sorting centres in vehicles, and the mail may be loose, bagged or containerised. This latter method covers a range of techniques such as the mail all-purpose trailer equipment (MATE) (see Fig. 2), a wheeled container which is manually handled, and the pallet retention unit (PRU), a collapsible wire cage (see Fig. 3), which is handled by fork-lift trucks. The mail arriving at the PCO is fed into a conveyor system which, during periods when sorting is being carried out, acts as a transfer medium from the input area to the actual sorting operative, or, during a pause in sorting, as a store which provides a head of work.

The sorting operatives perform either of two functions, facing or coding, and are thus known, from their operational employment, as *facers* or *coders*. The facer actually handles each parcel in order to place it on an induction-conveyor system so that its address is easily viewed by the coder as it travels along the conveyors. The address of the parcel is read by the coder, who has been taught to convert each destination into a two-digit code. This is entered into the electronic control system by means of a press-button keyboard. A sequence of conveyors feed the parcel on to its own allocated tray of the tilt-tray parcel sorting machine (TTPSM), which circulates above the destination chutes.

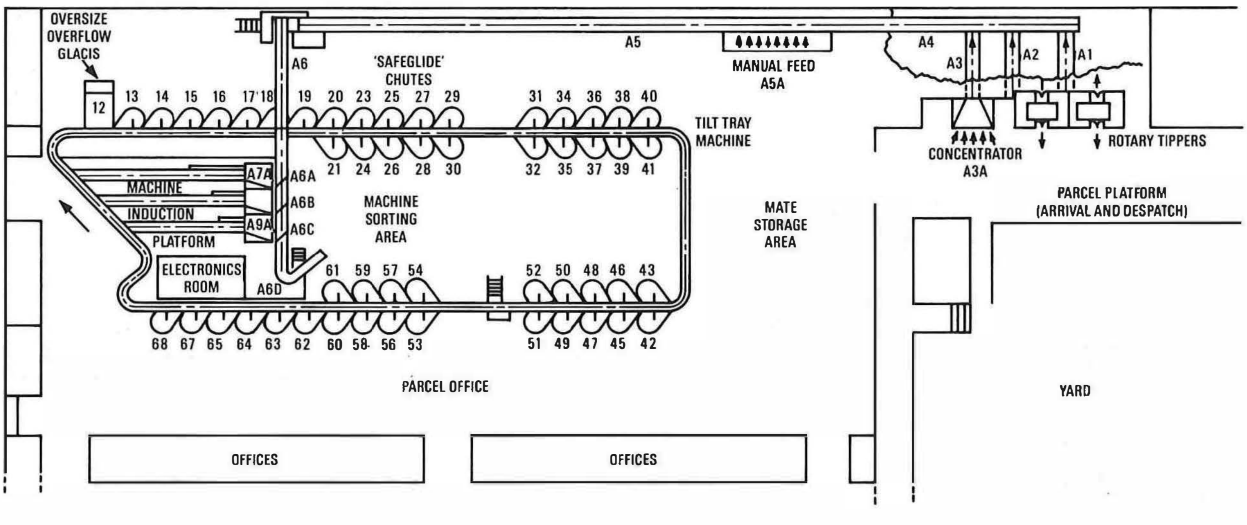


Fig. 1—Watford PCO

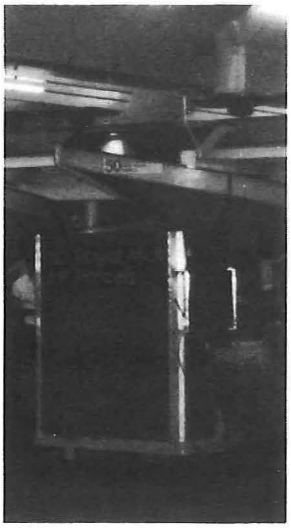


Fig. 2—Mail all-purpose trailer equipment (MATE)

Fig. 3—Pallet retention unit (PRU)

These chutes represent the areas to which parcels are to be despatched; for example, Bristol, Southampton etc. Each chute receives parcels allocated to it by means of a mechanism which causes the appropriate tray to tilt so that the parcel slides into the chute.

A chute can store a quantity of parcels which exceeds the capacity of a MATE before it is considered to be full. Sorting operatives at the chute tables load the parcels into MATEs which are then towed by battery-driven tugs to the despatch area of the parcel platform, see Fig. 1.

The operational instructions for the above processes are directed by a supervisor at the central control, using a hand-held radio to communicate with other supervisors at the arrival and despatch platforms and the hand-loading section inside the office.

SORTING OFFICE EQUIPMENT

Rotary Tippers

Two rotary tippers are installed for emptying the MATEs. The MATE is positioned and locked in a cage which is constructed within, and integral with, a rotating drum (Fig. 4). A lid covers the top of the MATE to control the discharge of the parcels. The tipper is under the control of the loader who, when a MATE is correctly positioned in the cage and safety doors in the surrounding enclosure are locked, operates the TIP button on the local control panel. The cage rotates to the discharge angle (Fig. 5), but the parcels cannot leave the MATE until the lid is opened. The discharge of the parcels is controlled by the condition of the take-away conveyors Al or A2, which, if running, permit the lid to open in three stages. This allows the parcels to enter the system in a controlled stream rather than as a mass, and thereby reduces the probability of damage. When the discharge is completed, the cage returns to its upright position. The enclosure may then be entered so that the empty container can be moved to a MATE storage area so that the next full MATE can take its place.

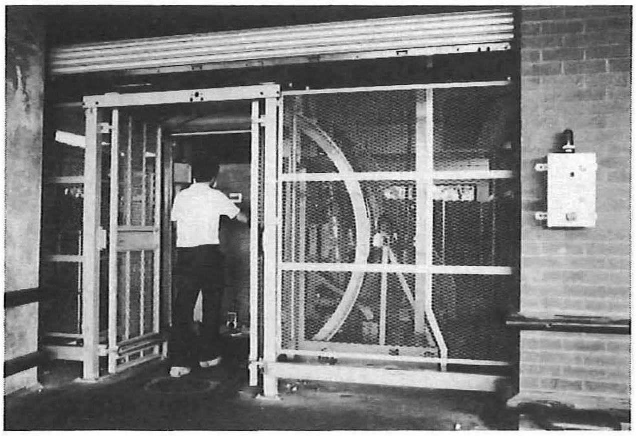


Fig. 4—Loading MATE into rotary tipper

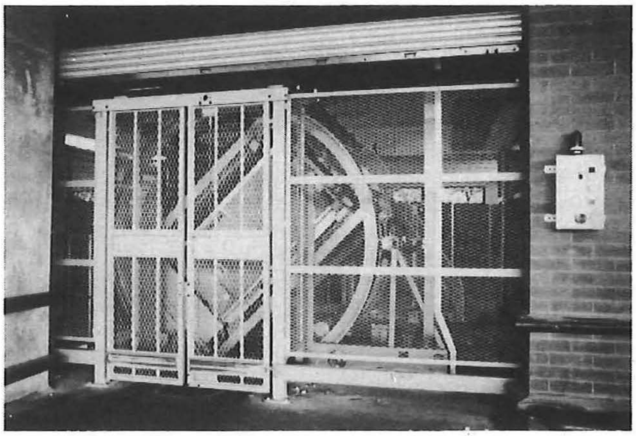


Fig. 5—Rotary tipper in operation

The Hand Fed Sections

A wide glacis, A3A, is provided on the parcel platform for the manual induction of loose parcels into the system via conveyor A3. A separate hand feed position, A5A, inside the office allows parcels from PRUs to be manually loaded on to conveyor A5.

Belt Conveyors, Diverters and Glacis

Three belt-conveyors, A1, A2 and A3, are connections between the feed points on the parcel platform and conveyor A4. Conveyors A4 and A5 are in line, and A5 feeds the tail-end of conveyor A6 at a right-angle junction, see Fig. 1. Conveyor A6 starts with a rising section and returns to the horizontal at a suitable height to feed the three glacis A7A, A8A and A9A. Discharge into these from the conveyor belt is effected by diverters A6A, A6B and A6C, which may be positioned diagonally across the stream of parcels in order to direct these into the glacis; this is illustrated in Fig. 6. Each glacis may be filled to provide a continuous supply of parcels to the sorters.

Presentation Conveyors

The presentation conveyors, A7, A8 and A9, become filled as the glacis fills and are under the control of the facer by means of a foot-operated switch. This arrangement is provided to ensure a steady flow of parcels to the coder.

Parcel Sorting Machine System

This consists of three induction lanes, C1, C2 and C3, which are mechanically and electronically integrated with the TTPSM.

Fig. 6—Diverter A6A in operation

Induction Lanes

Fig. 7 shows the layout of the three separate induction lanes, C1 and C2 each having seven sections, and C3 having five. Seven-section lanes were planned initially for this project, but the physical limitations of the sorters' platform dictated that this was not possible for all three, thus the five-section lane appears. The optimum number of sections is subject to further research and it seems that as few as three is a practical proposition for some installations. Seven-section and five-section lanes are standards adopted by the United States Postal Service.

As stated earlier, parcels are placed on the induction system by the facer so that the coder can easily read the address and key it into the control system. This system then takes charge of the movement of the parcel, and controls its progress along the downstream stages of the induction lane, and subsequently injects it on to its own allocated tray (or two trays for parcels 0·9–1·5 m long). The last section of each induction lane is a driven-roller injection conveyor shaped so that parcels are fed on to the TTPSM with a forward component in their movement which helps to locate each parcel accurately on its tray. These rollers run continuously when the lane is operational, but the preceding belt conveyors run under the control of photo-electric beams as will be explained later in this article. Two of the belt-conveyor sections (for example, C1.2 and C1.5) on the seven-section lane act as buffers. The former (C1.2) helps to ensure that the coder is not starved of parcels when these are available.

Tilt-Tray Parcel Sorting Machine

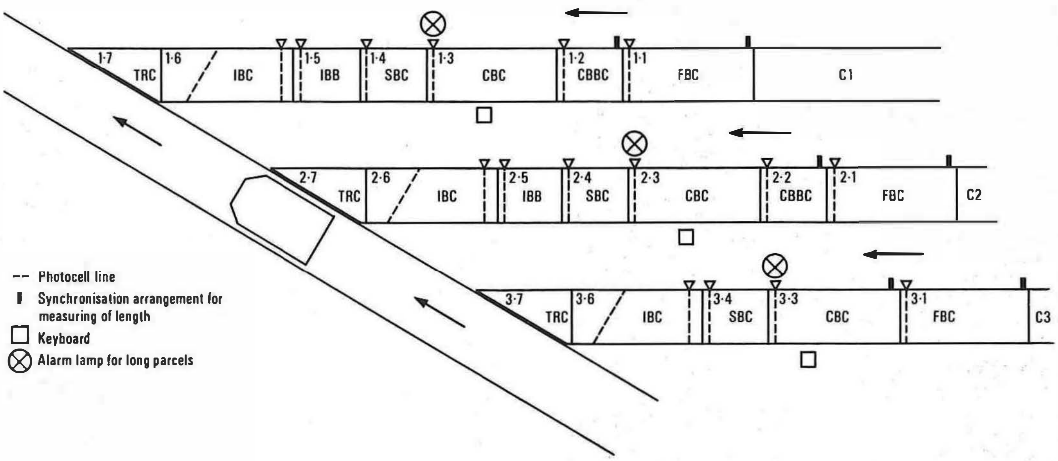
A conventional tilted-belt parcel sorting machine (TBPSM) could not offer the facilities available from a TTPSM. A single TBPSM, or even two or three, would have occupied more space in the building and would have considerably fewer destinations as well as a lower sorting rate. Three or more TBPSMs would also require a space-consuming aggregating-conveyor system. Such a system would need more height than is available. In any event, while TBPSMs continue to give excellent service for parcels within the old size and weight limits, they no longer represent what is available in the state-of-the-art and lack the flexibility of layout permitted by the TTPSM.

The TTPSM is basically a chain conveyor with attachments that support the trays and incorporate the tilting mechanism. The conveyor may take any available path through a building and may incline or decline to change level if required. However, such slopes must not cause any parcel to lose its station on the tray. The dimensions of the destination chutes enable them to be spaced close together and thus permit a large number to be installed in a given area; this reduces or eliminates the second sorting process which was necessary with the lower number of primary selections available from older sorting systems.

The TTPSM circuit installed is 162 m long and carries 0·95 m long plywood trays 0·75 m wide at 1·0 m pitch. Its speed can be accurately controlled up to a rate of 6000 trays per hour. A parcel has its identity and destination chute recorded in the control system electronics and is normally injected onto one tray (see Fig. 8). The tray travels round the system and, when it reaches the appropriate destination chute, it is mechanically tipped at a point which permits the parcel to slide off the tray and make an accurate entry into the chute. The tilting mechanism on the tray is unlatched by an electromagnetically operated ramp. Reset mechanisms which return the tilted, and therefore unladen, trays to the horizontal position are located at two points around the circuit.

Destination Chutes

The destination chutes are single-turn Safeglide chutes manufactured from glass-reinforced plastic (GRP) and coated internally with a compound which, together with the computer-designed profile, limits the speed of descent of items, and thus reduces the risks of damage to parcels or operators. The chute tables are designed to accept a small store of parcels and to allow easy handling from them by the operatives on the floor (see Fig. 9).



CBBC: Coding buffer belt conveyor
CBC: Coding belt conveyor
FBC: Facing belt conveyor
IBB: Injection buffer belt
IBC: Injection belt conveyor
SBC: Singliser belt conveyor
TRC: Transition roller conveyor

Fig. 7—Induction lanes

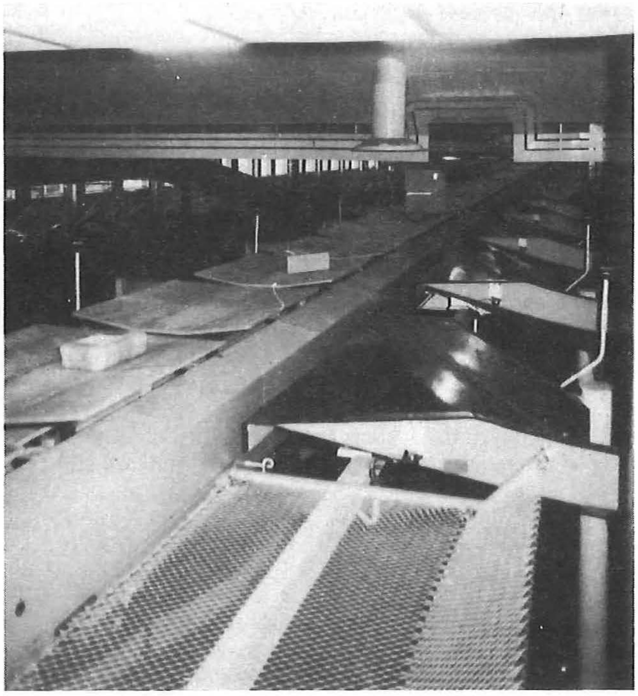


Fig. 8—Tilt-tray parcel sorting machine

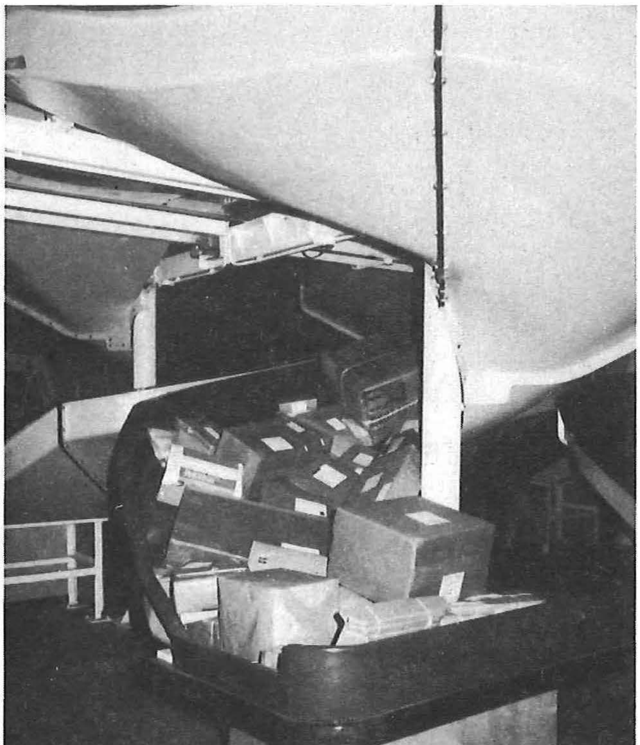


Fig. 9—Destination chute and table

THE CONTROL SYSTEM

Programmable Logic Control

At the planning stage for this project, considerable attention was paid to various developments that had taken place in the control equipment to be used throughout the scheme.

Programmable logic control (PLC) was considered to be an advance on electromechanical control, largely because of its flexibility in permitting changes to be made to the methods of operating the system, should this be thought desirable, together with considerably reduced costs for adjustment and maintenance. Three separate PLC units are used, one for each of the rotary tippers, and one for the conveyor system and the parcel-sorting drives and monitoring equipment.

Main Control Cubicles

The main cubicles (see Fig. 10) incorporate speed control equipment for each induction lane C1, C2 and C3. The TTPSM, which is provided with two drives owing to the length of its circuit, has its speed controls fitted beside these cubicles.

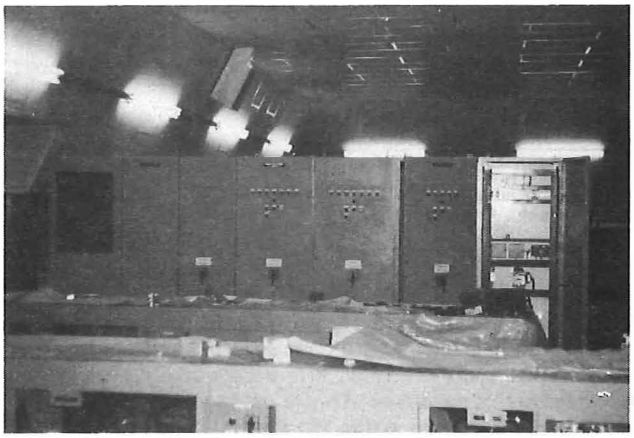


Fig. 10—Main control cubicles

Speed control is provided so that investigations to determine, for example, an optimum speed of operation of the mechanical system in order to establish improved sorting rates can be carried out. Each of the seven separate conveyors in induction lanes C1 and C2, and the five in lane C3, has its own electronically-controlled speed-varying unit mounted on cards in separate cubicles, one cubicle for each lane. Any change of speed of the TTPSM must be matched by a corresponding change of speed in each induction lane. The speed of the TTPSM is the paramount factor, and any change is initiated by typing the desired speed in 'trays per hour' on the control keyboard. Confirmation of the execution of this request is given by the visual display unit (VDU) displaying the required speed. The change is effected by the electronic control which ramps the voltage level required by each control unit in order to adjust the speed of each of the separate conveyors in each lane. It follows that the injection speed from the induction lanes must rise as the TTPSM speed rises. The design range of speeds for the TTPSM is 3000–6000 trays per hour, but the electronic controls allow lower speeds, almost down to zero. The speeds of each induction lane, in order to match the TTPSM speed, are regulated pro-rata; that is, from a minimum rate of induction of 1000 to a maximum of 2000 parcels per hour.

A proficient facer/coder team can achieve a steady throughput of some 1200 parcels per hour, and rates of 1900 items per hour have been reported and are within the machine's capability. Facers and coders alternate duties several times during a shift in order to avoid mental fatigue.

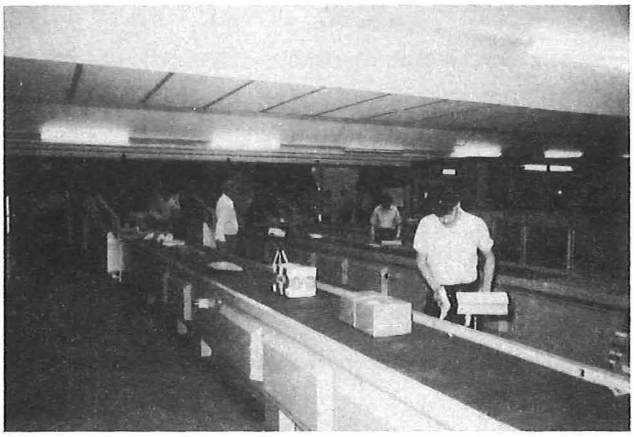


Fig. 11—Facer/coder pair at work

Fig. 11 shows a facer/coder pair at work.

The other cubicles contain main contactors and switchgear for controlling the conveyor system, diverters etc. and the DC rectifiers which supply the power for the signalling systems. The left-hand cubicle contains the PLC equipment.

Supervisor's Control Cubicle

The control panel and mimic diagram shown in Fig. 12 is the heart of the supervisor's operational control and, together with two-way radio, enables the supervisor to direct the complete sorting process. The condition of each item of equipment appears on the mimic diagram. Green lights indicate conveyors RUNNING, blue lamps show glacis or chutes FULL, red is for an EMERGENCY STOP condition, orange for a MAINTENANCE condition, and orange with a black bar shows a BLOCKAGE condition at a conveyor junction. When the diverters on conveyor A6 are extended across the conveyor, green diagonal strips are illuminated. The status of the PSM controller is also indicated on the control panel. START and STOP buttons are provided for the four separate methods of feed, together with MAIL WAITING and LAST PARCEL SENT indications.

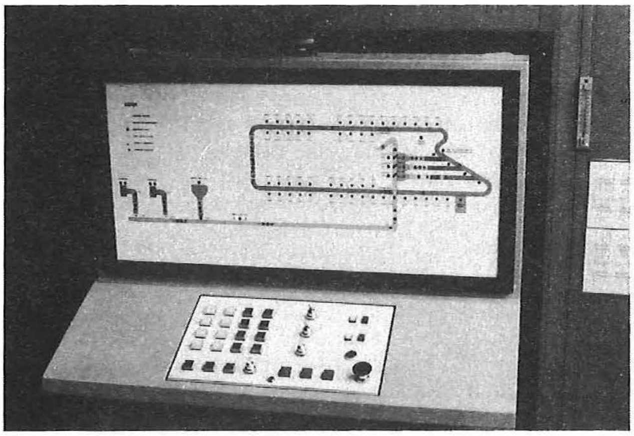


Fig. 12—Central control panel and mimic diagram

Automatic storage of parcels in the uplift and glacis system is achieved by setting the glacis selection switches for A7A and A8A to AUTOMATIC, and setting glacis A9A switch to ON. This latter switch will cause diverter A6C to extend across conveyor A6. Parcels fed into the system, at say hand feed A3A will, on arrival at the base of the glacis, block a photo-electric beam which will cause conveyor A3 to run until the beam is cleared. Subsequent parcels will repeat this process until conveyor A3 is full when it will discharge into conveyor A4 which has its own similar controls, as have conveyors A5 and A6. The completely-full stage occurs when all three glacis are filled up to the discharge ends of the presentation conveyors. Diverters A6A and A6B will be advanced automatically and will retract when the associated glacis becomes full.

A refinement in the method of operating the photo-electric controls for conveyors A2, A3 and A4 causes an interruption in the discharge of parcels from conveyors A2 or A3 onto A4 if the section of conveyor A4 passing them is already carrying parcels.

Full manual control is achieved by switching A7A and A8A controls to MANUAL. With A9A at ON, the use of the three glacis is retained, but when A9A is OFF, the diverters retract and the system feeds through to emergency chute A6D. This gives the system the availability of becoming a complete manual sorting operation in the unlikely event of a PSM failure.

PSM Controller

This is a microcomputer-based control unit which receives its instructions from the sorter's keyboard (see Fig. 13), and the photo-electric controls on each induction lane.

The PSM has 51 selections plus an overflow chute. Each selection is given a two-digit code. Since the sorter's keyboard needs to recognise two separate input signals such numbers as 11, 22, 33 etc cannot be used.

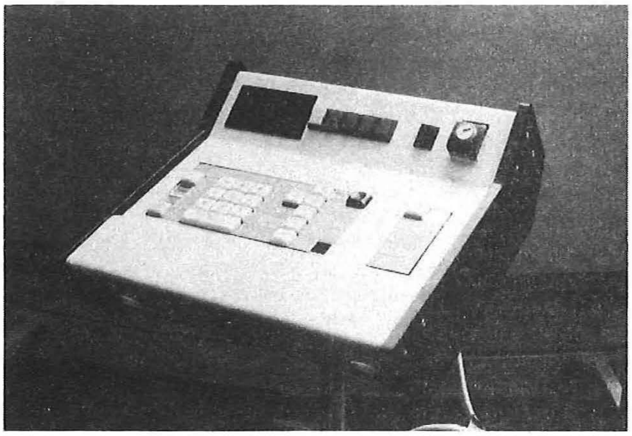


Fig. 13—Sorter's keyboard

When a parcel arrives at the photo-electric unit on the coding belt (section C1.3, C2.3 or C3.3) the breaking of the beam causes the conveyor to stop until the coder enters the selection number. The PSM controller receives this data and sends a signal to the subsequent conveyors in the lane to run or stay still until a search through the sorting-machine control electronics reveals that an empty tray is approaching the induction lane. This tray is allocated for the reception of the parcel under consideration and transports it to its chosen selection chute. The distance from the position at which a parcel is deposited on to a tray until it arrives at the discharge device is measured by a pulse counter fitted to one of the PSM drives. The pulses are fed into the microcomputer, and when the correct number have elapsed, the tip device is activated and the parcel is deposited into its appropriate chute. If, however, many previous parcels have filled the chute before the floor operatives can clear them, a photo-electric unit at high level on the chute will prevent the tip device from operating and cause local and mimic diagram lamps to illuminate to indicate that the chute is full. The parcel will remain on the tray (and in the electronic memory) for three further circuits of the TTPSM, after which, if the chute remains full, it will be discharged into the overflow chute.

This overflow chute also receives all of the parcels which need to travel on two trays.

As stated earlier, coding is done by means of a sorter's keyboard. The controller will also accept other inputs such as bar-codes and voice-recognition. The latter would allow the coder to carry out facing since he would have both hands free. The PSM controller also provides management data which may be presented once a day, or on demand. This data covers numbers of parcels sent to each destination, those to overflow, total numbers encoded at each keyboard and the sum of these, number of parcels sorted per hour, etc. Such data is also fed into the traffic-related information in parcel offices system (TRIPOS)[2], which is briefly described below.

TRIPOS

TRIPOS is a computerised data processing system which provides similar information to that described immediately above. It is planned to connect the Watford TRIPOS with other TRIPOS installed in PCOs throughout the country and link them all to a central processor.

Thus, data provided on a national scale to a central point will enable planners to devise more efficient ways of handling large quantities of mail. For example, *inter alia*, vehicle journeys may be organised in such a way as to show a significant reduction in running costs.

Miscellaneous Control Features

Photo-electric controls, with timers where necessary, are widely used throughout the entire project to initiate or prevent movement of parcels, conveyors or tilting-trays. They are used for controlling the flow of parcels going into storage, and travelling along the induction lanes. In the selection chutes, a photo-electric beam at high level, when interrupted for a period longer than is necessary for a long parcel to pass by, will prevent the discharge mechanism from tilting the tray. This ensures that the chute will not become so full that projecting parcels might be damaged by the moving parts, or conversely, cause damage to the tray-tilting mechanisms. In addition, when a chute or glacis is full, and its high-level photo-electric beam is obscured, a local blue beacon, and a lamp on the mimic diagram are illuminated. Photo-electric devices are also used to indicate a blockage at chute junctions and to make any conveyor feeding into the blockage stop.

Speed switches are fitted to each conveyor A1 to A6 inclusive, and to the driven-roller section of each induction lane, to provide the signal to illuminate the green CONVEYOR-RUNNING lamps on the mimic diagram.

Limit switches are fitted at various points on the rotary tippers and their enclosures to ensure that the MATEs are accurately located and that the enclosures are safely closed. They are also fitted at the diverters to signal whether a diverter is advanced or retracted.

EMERGENCY STOP buttons and pull-wires which 'lock' in the operated position are fitted throughout the system for the use of anybody who discovers that a person, parcel or machinery may be harmed. Operation of such a device will, generally speaking, stop the machinery in its vicinity, for example, at a rotary-tipper, the set of induction lanes and the TTPSM, etc, and allow the mishap to be dealt with. A local red beacon will be illuminated together with its counterpart on the mimic diagram. After the emergency condition has been removed, the switch may be reset. The two separate illuminations and the STOP condition will continue until the RESTORE EMERGENCY STOP button on the control panel is operated. For reasons of safety, no conveyor will restart automatically; the normal start procedure has to be activated.

Local/Remote Control Boxes

Local/remote control boxes are fitted at the drive of each conveyor. When the whole system is in normal use, the switches are in the REMOTE position. However, should it be necessary to carry out maintenance on a conveyor, the switch is set to LOCAL. This action takes the conveyor out of the operational system, and, if it were in a series of conveyors necessary for continuous service, for example, conveyor A5, all upstream conveyors would have to be stopped. However, in the cases of conveyors A1, A2 or A3, these may be taken out of service without the rest of the system being upset. Switching to LOCAL gives the maintenance engineer complete control at the drive since the local/remote box is provided with START and STOP buttons, or, for the diverters, ADVANCE and RETRACT buttons. A local orange beacon and an orange lamp on the mimic diagram are illuminated while local control exists.

TRAINING FOR SORTERS

A large number of competent sorters had to be trained to operate the above system and a number of training aids including keyboards, a control panel and a television representation of the mimic diagram were provided by Postal Headquarters. In addition, the operators had to learn, from a code-book, a large number of two-digit codes representing each of the 51 destinations available on each of two sorting plans, one each for 'Inward' and 'Despatch' mail; 'Inward' being that arriving from other PCOs for local delivery, and 'Despatch' being the mail due to be sent to other PCOs.

ACKNOWLEDGEMENTS

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Biographies

Derek Bolton is Head of the PCO Projects, Standards and Industrial Liaison Group of the Engineering Department of Postal Headquarters. He joined the Post Office in 1961 as a Draughtsman at the Research Department, Dollis Hill, where he worked on satellite communication aerials. He moved to the Postal Mechanisation Department in 1967, and has worked on several PCO mechanisation schemes; latterly, he was the mechanisation consultant for the new Reading PCO. He is also responsible for the procurement of MATEs, PRUs, trollies, and the standardisation of bulk mail handling equipment for postal mechanisation

Reginald Wood joined the Post Office as an Executive Engineer in 1969. Prior to his retirement, he was an Executive Engineer (A), in PHQ Engineering Division specialising in the planning and project control of mechanised sorting systems for parcel mail. Before joining the Post Office, he worked as a designer for the now defunct company, Sovex Ltd., on mechanised handling systems for the printing and brewing industries and on postal mechanisation schemes. During his career with the Post Office, he has worked on several postal mechanisation schemes including Manchester, Bristol, Belfast, Southampton, Redhill and Watford.

TX72—The Monarch Featurephone

S. J. LAMBLEY, B.SC.(ENG.)†

UDC 621.395.6 : 621.395.2 : 621.374

The TX72 Featurephone is a new terminal to complement the Monarch telephone system. It is a low profile terminal of compact modern design and gives users single key access to many of the Monarch's special features. In addition, it has personal short-code dialling facilities for 40 numbers and a 21-digit liquid crystal display to provide information for the user.

INTRODUCTION

Monarch, in common with other modern stored-program controlled (SPC) PABXs, offers a wide range of features to the extension user via a standard multi-frequency MF4 telephone. These features, principally involved with call management, are accessed by codes comprising a combination of earth-loop recall and digits 0–9, ⋆ and #. To access the features, the user needs either to remember these codes, which are specific to the Monarch, or to be able to refer to them in one of the various *aides-mêmoire* provided in the form of booklets, plastic cards and stickers. The features tend to be under-used, principally because of difficulty in remembering the codes when they are required. A terminal which gives access to these features on dedicated buttons is therefore an extremely useful adjunct to the PABX.

It was primarily for this reason that the TX72—the Monarch Featurephone—was developed (Fig. 1). The objectives in the design process were to produce a line-powered analogue terminal which could plug into an extension of any Monarch generic without the need for a special extension line-card. Because the terminal was to be an analogue device (that is, with no backward digital signalling from the Monarch), the end-user price could be kept to a reasonably low level. Additionally, the TX72 was to have certain 'executive' telephony capabilities, including a display and an extensive repertory store. A simple form of manager/secretary system was also to be included.

The development of the TX72 hardware and overall project control was undertaken by the Business Systems Division of British Telecom Enterprises. The software development was contracted to Rathdown Industries Ltd., which also manufactures the instrument.

† British Telecom Business Systems, British Telecom Enterprises

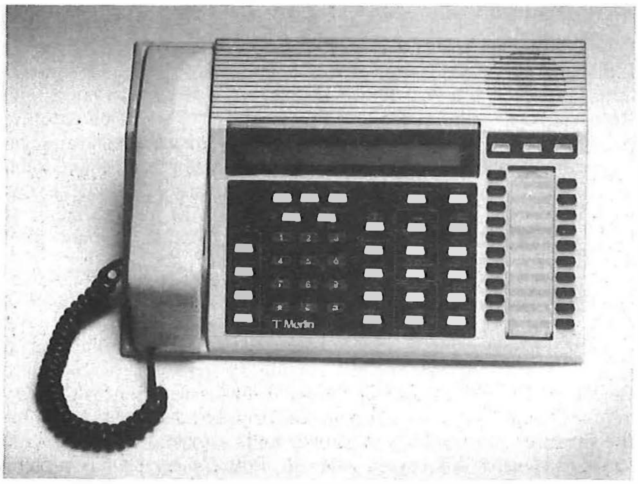


Fig. 1—TX72 Featurephone

TELEPHONE DESCRIPTION

The TX72 measures 300 mm × 220 mm, giving it roughly the same desk footprint as a sheet of A4 paper. The case, designed at the British Telecom Research Laboratories (BTRL), Martlesham Heath, is similar in profile to the Viscount. It incorporates the Sceptre handset, and has a modern and highly attractive appearance. The handset itself is located on the left-hand side of the instrument. To the right of the handset, taking up about two-thirds of the available width, is a 21-digit liquid-crystal display (LCD). Beneath this display is an array of 38 buttons arranged in three separate groups (Fig. 2).

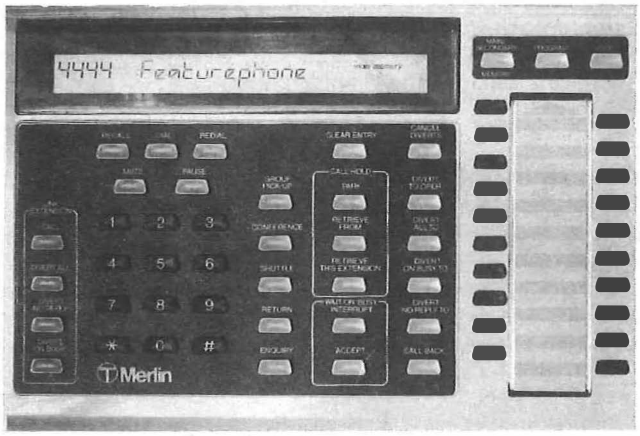


Fig. 2—Button layout

The central group of buttons comprises the standard 12-button MF4 keypad and five additional buttons for call management—including RECALL, DIAL and REDIAL. The standard keypad buttons are two-shot moulded and of a different colour to the remaining keys.

To the left of this are four buttons used for the link extension facilities which are designed to emulate manager/secretary operation. On installation of the terminal, the user has the option of nominating an extension number as the link extension. This can be any extension on the same PABX with which the user operates closely. Once the extension has been chosen, the link extension buttons enable the user to call or invoke diversions to that extension by single key operations.

The right-hand group of 17 buttons is used for the invocation of the features provided by the Monarch. All features which are common to all Monarch generics are available to the user on dedicated buttons. Within the grouping, the buttons are arranged in logical sub-groupings, such as diversions, call management and call parking. Features which are non-transient, such as callback, are cancelled by subsequent key depressions, obviating the need for separate CANCEL keys, although all diversions set can be cancelled by a single keystroke.

On the extreme right-hand side of the instrument are buttons associated with the repertory store. The top three buttons are used for programming and examining stores, and the block of 20 buttons below these are for the dedicated stores themselves. The repertory store can hold a maximum of 40 numbers, in two memory levels of 20 numbers each. The stores are backed up in the event of loss of line power by two internal lithium cells. Between the two columns of buttons is a clear plastic window beneath which is a card for labelling the stores. The operation of the repertory stores is described more fully below.

Beneath the telephone is a pull-out drawer on which is written a brief summary of the instructions for using the TX72, together with space for labelling the second set of 20 repertory stores (Fig. 3).

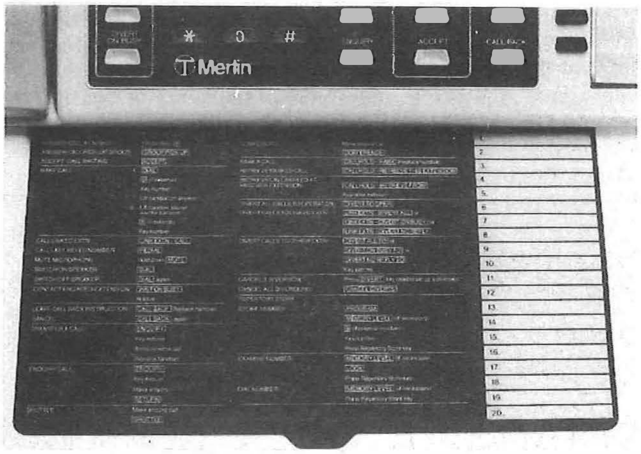


Fig. 3—Pullout instruction plate

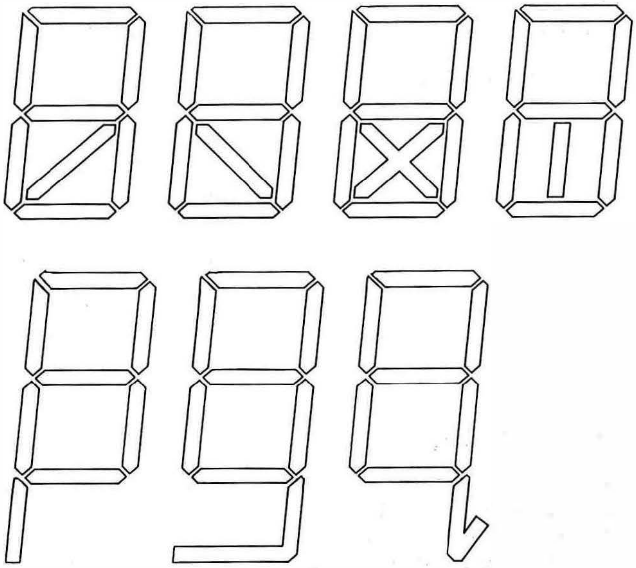
Display

The custom LCD is of an unusual design and a patent application is pending. It is a 21-digit eight-segment display, with seven of the segments in the normal numeric format. The location of the eighth segment, however, varies between digits (see Fig. 4(*a*)). This allows the display to show words as well as numbers.

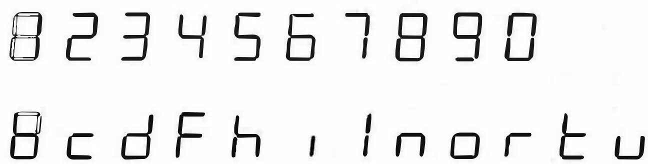
For example, a standard seven-segment digit can display the numbers 0–9 and the lower-case letters b, c, d, f, h, i, l, n, o, r, t, and u (as shown in Fig. 4(*b*)). By adding an eighth segment to the lower half of the digit, the remaining letters can be formed. A diagonal segment '/' gives the letters a, e, v and z, and the reverse diagonal gives the letters k and s (Fig. 4(*c*)). A vertical segment allows m and w (Fig. 4(*d*)), and the letter x is formed by placing a single segment in the form of a cross in the digit (Fig. 4(*e*)). Descenders are used to form the remaining letters g, j, y, p and q (Fig. 4(*f*)).

Therefore, a display made up of a variety of these digits can show a number of different messages, providing there is no conflict in the requirement for letters at one particular digit. (If one particular digit is to be an 'e' for one message, for example, it cannot be an 's' or 'k' for another message, although it can be any of the other letters in Figs. 4(*b*) or 4(*c*)). By judicious spacing of messages, an extensive repertoire can be accommodated by a single display.

The PABX features invoked by the TX72 are displayed in the prescribed manner for as long as the feature is



(*a*) Arrangement of segments



(*b*) Figures and letters formed by standard 7-segment display

(*c*) Letters formed with diagonal segments

(*d*) Use of vertical segment

(*e*) Cross segment

(*f*) Use of descenders

Fig. 4—Display characters

operational. Multiple features, such as DIVERT ALL to one extension and CALLBACK on another, are displayed sequentially, and change every 2 seconds. With no PABX feature invoked, the display shows the extension number of the instrument followed by *Featurephone*. The display also has three annunciators to indicate the memory level selected, as described above, and a *service required* message, chiefly to indicate when the voltage of the internal back-up battery is low.

The main advantages of using such a display are its low cost and legibility. The TX72 display costs approximately the same as an equivalent standard 8-segment display. An alternative would be to use either a 14-segment 'star-burst' or a dot-matrix display, whereby any message could be displayed. At the time of development, however, the cost of

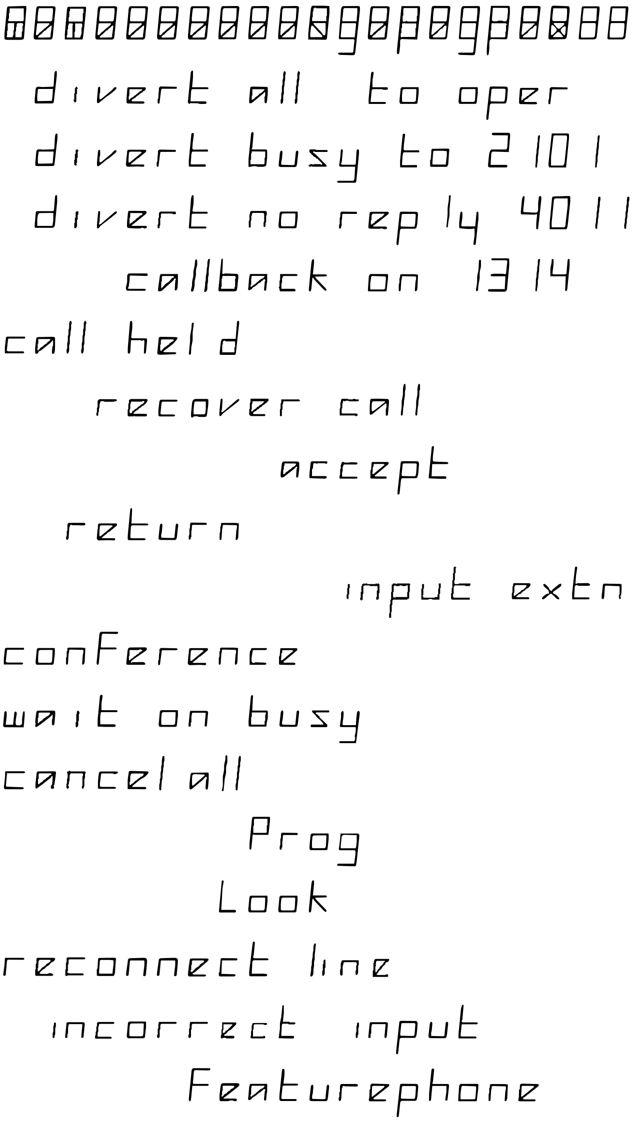


Fig. 5—Message repertoire

a 21-digit dot-matrix display was about six times the cost of the display used. Therefore, in cases where there is a strictly defined set of messages required (see Fig. 5), the TX72 type of display eliminates the need for a full alphanumeric display and the multiplicity of display drivers this requires. Additionally, an 8-segment display can be operated at a high duty ratio, giving an excellent viewing angle compared to a dot-matrix LCD.

FUNCTIONALITY

The functionality of the TX72 differs from a simple telephone in three main areas: the 'executive' telephony facilities, the concept of link-extension working, and its operation as a PABX featurephone.

Telephony

The TX72 has a call-progress monitor based around a loudspeaker located at the top of the case, above the repertory store keys. This provides both ON-HOOK dialling and group-listening. To make a call hands-free, the DIAL button is pressed; this seizes the line and turns on the monitor. The progress of the call can then be followed, until it is either successful, when the handset must be lifted, or fails, when DIAL must be pressed again to release the line. If at any time while the handset is lifted, the DIAL button is pressed, the conversation can also be heard through the loudspeaker. The monitor also allows the user to hear supervisory tones for the activation of Monarch features. When a feature is invoked while the telephone is IDLE, the line is looped and the monitor is turned on. The MF4 code for that function is then transmitted to the PABX and the user hears the Monarch acceptance tone, after which the line is released. The invoked feature is then displayed on the LCD as described previously.

When a TX72 is installed, the user can select one of four separate ringing tones. These vary in both frequency and warble rate and are easily distinguishable. Therefore, if more than one TX72 is located within the same office, the problem of identifying which telephone is ringing is reduced.

As has been mentioned, the TX72 has the capability of storing up to 40 21-digit numbers in addition to the last number redial store. The repertory stores are organised in two levels, selectable by using the MAIN/SECONDARY MEMORY button. To program a number into a repertory store, the appropriate memory level is selected, and the PROGRAM key is pressed followed by the number to be stored. This number may include *, #, RECALL or PAUSE and therefore may be an internal number, an external number with a pause after the access digit(s) if required, or a Monarch feature in addition to the ones for which there are dedicated keys. The required repertory store key is then pressed and the number stored. Contents of the stores may be altered by overwriting. The repertory stores and redial store may be examined by pressing the LOOK button followed by the appropriate store key. Both programming and examination of stores can take place with the telephone ON or OFF HOOK. To dial a number held in store, the appropriate store key is pressed. If the handset has not been lifted, the line is seized, the monitor activated and the stored number dialled.

Link Extension

For users requiring a degree of specific interworking with another extension—for instance a manager/secretary relationship—the TX72 incorporates link-extension working. The link-extension number is programmed as part of the start-up sequence (together with the unit's own extension number and the required ringing tone). This allows single button calling of, and call transfer to that extension either ON or OFF HOOK, and single button invocation of call diversion to that extension by using the group of keys marked LINK EXTN.

Feature Invocation

The principal benefit derived from using the TX72 is the single-button invocation of the Monarch features. Dedicated keys are provided to allow access to the PABX features shown in Table 1.

The call diversion and callback features are cancelled by a second keystroke. The display messages associated with these features are shown until they are cancelled, or in the latter case, until the callback matures.

Wait-on-busy is a means of contacting a busy extension. When engaged tone is received, WAIT ON BUSY INTERRUPT is pressed. This causes a tone to be heard by the busy party, indicating that someone is waiting to speak with them. By pressing the ACCEPT key, the existing call to that extension is held, and a connection made to the waiting extension.

A call may be parked for up to 4 minutes. During this period, it can be retrieved either from the extension at which it was parked, or from a different extension (although if the extension has no TX72, the Monarch code *87*_extension no_# must be entered in full).

Group pick-up allows any ringing telephone within a

TABLE 1

Monarch Facility Schedule

divert all calls to the operator divert all calls to a nominated extension divert on busy to a nominated extension divert on no reply to a nominated extension cancel all diverts
callback when free
wait on busy accept wait on busy
call park retrieve call from another extension retrieve call from own extension
enquiry call to another extension return to original call shuttle between calls conference
group pick-up

nominated group to be answered at any other telephone within that group. Pressing GROUP PICK-UP either ON or OFF HOOK answers the ringing telephone at the TX72. If pressed whilst ON HOOK, the handset must be lifted immediately afterwards.

ELECTRICAL DESIGN

The circuitry of the TX72 can be considered in analogue and digital parts: the analogue telephony circuit, including the transmission, MF4 signalling, monitor and tone caller circuits; and the digital processor circuit, including the LCD, driver and keypad. A block diagram of the TX72 circuitry is given in Fig. 6.

Telephony Circuit

The analogue circuitry is based on proprietary integrated circuits. The TX72 telephony circuit is based on the SGS LS356AB transmission circuit. The circuit has been designed to work specifically on the Monarch PABX in terms of impedance matching and sidetone cancellation. Also, the transmission levels of the TX72 have been tailored to take account of the nature of the Monarch line current supply. As this differs from the public switched telephone network (PSTN), in that it is not a limited voltage source, telephones connected to the Monarch will not regulate at short line lengths. Transmission levels for terminals connected to PABXs therefore need to be specified more tightly than for PSTN applications. Thus, the TX72 circuit exceeds the transmission requirements for approval of a simple telephone in both sidetone performance and send and receive levels.

Associated with the transmission circuit is the call progress monitor, which uses the SGS TDA2822 audio amplifier. Because Monarch provides a current-limited power source, the amplifier is connected in series with the transmission circuit. A signal from the receive output of the speech chip is connected via a decoupling transformer to the amplifier input. The monitor output is controlled by using a simple field-effect transistor (FET) arrangement.

The MF4 signalling is achieved by using the Philips PCD3311P integrated circuit (IC). This was, at the time of development, the only microprocessor-addressable signalling circuit in production. It signals to line through the MF interface of the transmission circuit. During signalling, the microphone input of the speech chip is muted by an FET controlled by the processor. This FET is also selectable in normal transmission mode, and allows privacy during a call by pressing the MUTE button. Earth-loop recall signalling is provided by means of a Darlington pair, again controlled by the processor.

The four user-selectable ringing tones are produced by software. Ringing on the line is detected by the TI 1520 IC which does two things: it signals to the processor that ringing is present, and it provides power from the ringing signal for a buffering circuit which causes a piezo-transducer to warble according to a signal produced by the processor.

An FET serves to loop the line, and is operated when the handset is lifted (signalled to the processor from one of the hookswitch contacts) or the DIAL button is pressed, or a PABX facility (such as a diversion) is selected. A second contact in the hookswitch mutes the microphone during ON-HOOK dialling to prevent howling.

Processor Circuit

The microprocessor used in the TX72 is the Hitachi 4-bit CMOS HMCS47C with 4 kbyte of 10-bit read-only memory

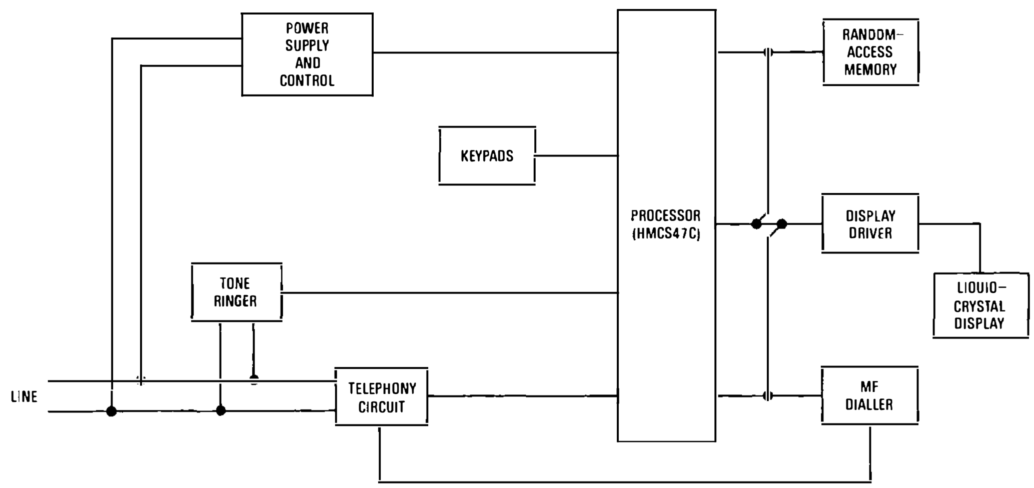


Fig. 6—Functional layout

(ROM). This principally performs the following functions:

(*a*) decodes keypad inputs,
(*b*) operates the display driver,
(*c*) detects power-fail conditions,
(*d*) controls the MF dialler, and
(*e*) performs telephony functions:
  (*i*) line loop,
  (*ii*) earth-loop recall,
  (*iii*) frequency generation for ringer, and
  (*iv*) call progress monitor operation.

In addition to the 256 bytes of internal random-access memory (RAM), there is also an external 2 kbyte of 8-bit RAM. Together these allow storage of the repertory store numbers, PABX features currently invoked, own and link-extension numbers, ringing tone required and numerous flags to monitor the use of the TX72.

The powering arrangement for the processor essentially consists of two regulated supplies: one at 8 V and one at 5 V. The current-limited 8 V supply is situated across the line and feeds a storage capacitor which in turn feeds the 5 V processor supply. The processor circuitry draws about 3 mA continually from the line. The Monarch PABX will allow up to 6 mA to be drawn from the line without indicating an OFF-HOOK condition, except during ringing when the line polarity is reversed. For this reason, the TX72 has a RESET button at the rear of the case which makes it polarity sensitive. In normal conditions, the TX72 draws current to power the processor as described. During ringing, however, the reversal effectively disconnects it from the line, and power for the processor is provided by a storage capacitor.

If the 5 V supply drops below a certain voltage, the back-up lithium cells take over and the processor is put into HALT mode until such time as power is restored. While in this mode, the display shows *reconnect line*, and the processor will not respond to any keypad inputs. The RAM (and therefore the repertory stores) are held up for as long as the cells are operative. If the TX72 is to be disconnected for any significant length of time, the batteries should be turned off, as the lithium cells are required to operate only in power-fail conditions and are not user-replaceable.

The LCD is supplied complete with on-board driver and connector and contains 52 bytes of RAM. The module is capable of driving a total of 204 segments, although for the TX72 application only 169 segments are required.

MECHANICAL DESIGN

Case

As has been mentioned, the TX72 case is a new design and has been developed by BTRL. The component piece-parts of the case are shown in Fig. 7.

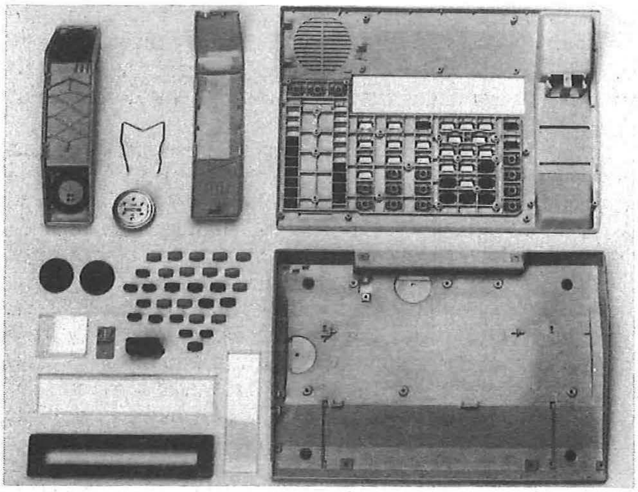


Fig. 7—TX72 case

The case top is made from acrilonitrile/butadiene/styrene (ABS). In addition to the 12 standard MF keypad buttons and the 23 repertory store buttons, it has the capacity for providing up to 29 further buttons (of which 26 are used on the TX72). Button positions which are unused are blanked off by the polycarbonate graphics overlay. The case can therefore be used for a number of developments where the button count and layout are different, giving each different terminal a distinctive appearance, but using the same basic case; this provides coherence within a product portfolio.

The buttons themselves are made from Kematal Acetal, and come in two sizes. The 20 repertory store buttons measure 12 × 5 mm, and the remainder, including the 12 MF4 keypad buttons, 13 × 6 mm.

The LCD is housed behind an escutcheon, also made from ABS. In addition to the display and keypad assemblies, the case-top assembly also includes the hookswitch actuator, the loudspeaker and three transparent polycarbonate windows for the repertory store label, the display, and the exchange label located beneath the handset.

The case bottom is also made from ABS. The mould tool has an insert at the rear of the case which allows different interface connections to be produced for different case applications. On the TX72, there is a grille for the output of the tone ringer and two switches: one is a 3-pole subminiature 60° rotary switch to turn the battery on, and the other is a press-button latching RESET switch used on installation. Therefore, if a future application of the case should require a digital interface or a socket for a mains derived supply, these could be easily implemented by using a different insert, without the need for a major tool modification. The case-bottom assembly includes two acetal thumbwheels to control the volume of the tone ringer and the call progress monitor.

The TX72 sits on four standard rubber feet, which are the same as those used on many BT products, including the Statesman telephone.

Keypad

The keypad mechanism is the result of considerable engineering effort. The underside of the case top reveals the complexity of the moulding in respect of the keypad operation. The long, flat nature of the case requires significant strengthening in the form of ribbing along the length of the case. The single-sided resin-bonded paper keypad printed-wiring board (PWB), measuring 237 × 146 mm, is secured to the case with self-tapping screws at 19 points.

The keys themselves operate directly on a standard rubber mat with conductive carbon nipples which act on gold-plated contacts on the PWB. There are two of these mats—one for the main keypad area and one for the repertory keys. Sandwiched between the case top and the main keypad mat is a thin polycarbonate stop plate to limit the travel of the keys and so prevent them sticking beneath the graphic overlay. The force/displacement characteristic of the key travel is governed by the shape of the keypad mats. In practice, the TX72 keys have a very positive and reliable collapse action.

Main PWB

In the lower case assembly is the main PWB, containing all the TX72 electrical components except those associated with the display module. The main PWB is a double-sided plated-through-hole glass-fibre board measuring 210 × 120 mm. The keypad PWB and display module are connected to the main board via a 34-way connector. There is also a two-way connector to the loudspeaker on the case top.

The microswitch assembly, which acts as the hookswitch, is situated on the left-hand side of the main PWB. This consists of two separate single-pole change-over micro-switches with a single switch plate on which the hookswitch actuator operates. One of the contacts signals to the microprocessor that the handset has been lifted, the other short circuits the microphone during ON-HOOK dialling.

During manufacture, most of the components can be placed on the PWB by using automatic-insertion techniques, although there are a number of components (such as the lithium cells, the decoupling transformer and the piezoelectric tone ringer) which need to be inserted by hand.

CONCLUSIONS

The TX72 development has produced a unique product—it is the only analogue Featurephone currently available—which is both technically and aesthetically of a high standard. Customers nationally have shown satisfaction with the product and consideration is now being given to a new PABX terminal which will give full hands-free operation, a cross-range capability, and dedicated manager/secretary functions.

ACKNOWLEDGEMENTS

Grateful thanks are due to colleagues within BT Business Systems involved with the development and launch of the TX72, and to the team at Rathdown Industries Ltd. for their hard work and support. The work of staff within BTRL in the design of the case used for TX72 is also greatly appreciated.

Biography

Steve Lambley joined BT as a student in 1978 and gained a B.Sc. in Electrical/Electronic Engineering at Nottingham University in 1982. He then joined BT Business Systems at Felixstowe as a Level 1 engineer responsible for the development and support of the TX72, Genie and Statesman telephones. He was then involved in the initial development stages of Tonto and other terminal equipment developments.

TALLIS Consultancy at Communications 86

INTRODUCTION

TALLIS Consultancy is an independent communications consultancy operating autonomously with the British Telecom (BT) organisation. TALLIS is able to draw on personnel from the top levels of a wide range of disciplines within BT to assemble flexible and powerful teams of experts, and can thus provide one of the best and the most comprehensive consultancy service in the UK to major users of communications facilities.

TALLIS Consultancy is able to take on and solve a whole range of communications problems from telephone exchange design to network appraisal and management, from message switching to electronic mail, from data transmission to facsimile, and from packet switching to office and factory automation. In addition to the consultancy service, TALLIS Consultancy also provides a call information logging service.

NEED FOR CONSULTANCY

Any organisation planning its future must consider the implications of those plans upon its total communications requirements. Not only must someone have vision of the future, but they must also be aware of precisely what they have today, and how it is practicable to get from one to the other.

It is unusual for a business to have this expertise readily available and be sure that it is sufficiently well informed and kept in touch with the changing technology in the market place. Because the consultancy service is dealing with such projects on an ongoing daily basis, they are able to provide this expertise.

NETWORK ANALYSIS PACKAGE

At Communications 86, TALLIS Consultancy is showing the Network Analysis Package. This service makes use of the micro-NAP† Network Analysis Package which is based on extensive experience of using computer techniques in the design and analysis of private telecommunications networks. It provides both a means of reducing the effort in performing the many necessary calculations, together with insights into the characteristics of the network itself. It includes many easy-to-use features that make it a powerful and sophisticated system for exploring the options, costs and benefits of network alternatives.

The package helps in the design, analysis, development and management of telecommunications networks from the input of call-logging data or traffic parameters through to the preparation of maps, tables, and management reports. The system handles the calculations associated with optimising network design including network costs, capacity, traffic and tariffs. It has built in traffic and tariff tables with an updating service. It can calculate traffic data from network parameters or data transferred directly from call-logging equipment. It provides an organised structure for exploring network options as well as handling multiple versions of networks.

† **micro-NAP** is licensed from Telecommunications Management Ltd., Leeds.

ARSCC/E—Administration of Repair Service Controls by Computer

Part 2—System Operation and Management

C. A. F. GILL†

UDC 621.395 : 681.31

Part 1 of this article examined the background to the development of a computerised system used for the administration of British Telecom's repair service controls, and described how the system is configured to meet particular local requirements. Part 2 describes the operation of the system in more detail; in particular, the subsystems that handle the fault reports and provide management information. It goes on to describe the hardware configuration of the system and closes by discussing future developments.*

INTRODUCTION

This article continues the description of the major features of ARSCC/E, British Telecom's fully-interactive computerised administration system for repair service controls (RCSs). Part 1 traced the historical background to the development of ARSCC/E and described the design philosophy. In Part 2, the major features of the subsystems in the operation of the system are described; in particular, those that handle the 'electronic' fault report records, provide network information, deal with special services customers and provide management statistics. The article also briefly describes the hardware structure and the operation of the system. It concludes by discussing the implementation of the system and the features that will be considered in the future development programme.

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* GILL, C. A. F. ARSCC/E—Administration of Repair Service Controls by Computer. Part 1—Background to Computerisation and System Design Philosophy. *Br. Telecommun. Eng.*, Jan. 1986, **4**, p. 207.

REPORT HANDLING SUBSYSTEM (RHSS)

The report handling subsystem (RHSS) manages the creation, amendment, movement and eventual clearance of fault report records (FRRs) (Fig. 5).

Choice Of Dialogue Method

The user/system dialogue in all areas other than the records maintenance subsystem comprises command line entries: This approach was chosen because of the many alternative routes that can be taken from any current transaction when FRRs are being processed; this makes menu selection both impractical and tiresome for the experienced user. A further advantage of command line entry is that it allows the user

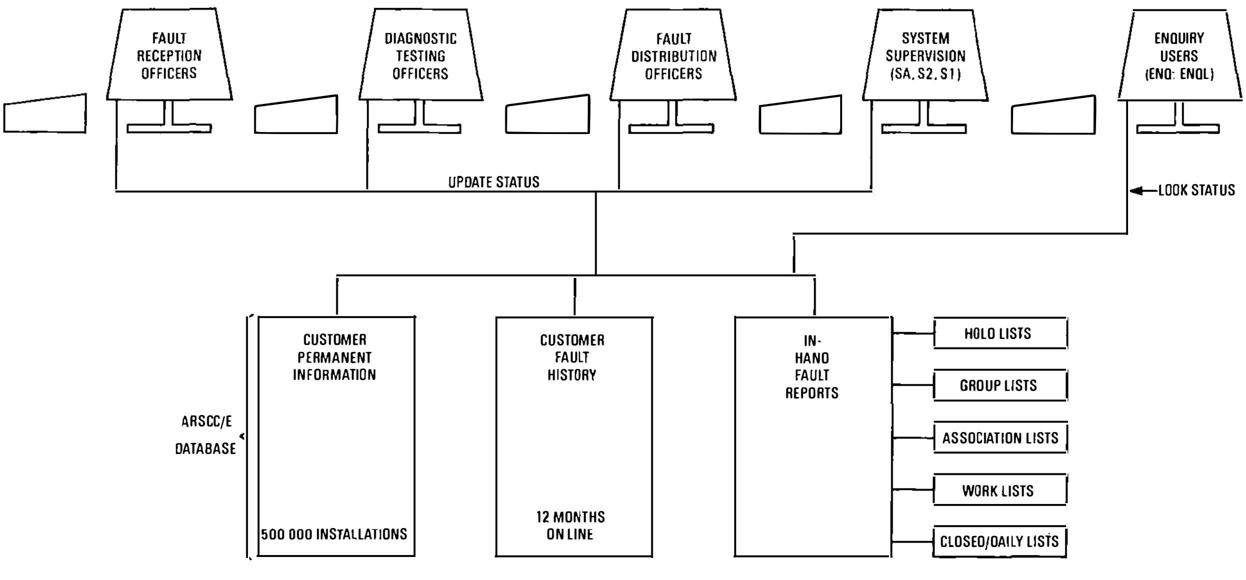

Fig. 5—Report handling subsystem

complete freedom to enter updates in whatever order is dictated by the dialogue between the user and the customer or field engineer, thus improving overall transaction times. Command line entry does not, however, exclude the possibility of a more disciplined approach in the future, should more emphasis be required on structured questioning techniques. The general format for command line entries on ARSCC/E is:

<command> <space> <parameter 1> <space> . .
. . <parameter 2> <space> . . . . <parameter n> <send>

In some cases, parameters are not required, or have default values if omitted. In other cases, parameters are mandatory, and error prompts are given if they are absent from the command line.

Accessing Customer Permanent Information

The means by which customer permanent information (CPI) is retrieved from the database is by use of the command I followed by an installation number.

The installation number may be qualified with either an auxiliary line number or an extension number, known as the *circuit number qualifier,* and its nature and value cause different aspects of the overall customer record to be displayed.

In all cases, the installation header record is displayed. If the installation is a direct exchange line, then, additionally, the exchange line information is displayed, together with any exchange line notes. If the installation is complex, such as a PBX, and no qualifier is entered, the header record is displayed in isolation; however, if the installation is complex and the qualifier is an auxiliary line number, the header together with the identified auxiliary line record is displayed.

Similarly, if the qualifier is an extension number, the extension record is displayed with the header. If the extension is external, the external extension routing information is also displayed.

CPI Notes

ARSCC/E can retain multiple-page freefield-notes text relating to CPI. This is highlighted in the header and/or the qualifier record by means of indicator fields relating to the type of notes present. The notes are accessed by using a dedicated NOTES function key. The original CPI display can be retrieved by depressing another dedicated function key, EXIT.

Retention of the Entered Circuit Number

Once a circuit number has been entered as a parameter of the I, H or F commands (described below), it becomes part of the session continuity data and is retained for that user session until another circuit number is entered. By this means, repeated entry of the circuit number for all transactions related to it is eliminated.

Accessing Customer Fault History

The customer fault history (CFH) is retained in both detailed and summarised formats. Detailed history records are retained for three months, summarised records for 12 months. If no history record less than 12 months old exists, the last known incident is retained as a summary record.

To display a CFH, the user enters the command H followed by the circuit number. The circuit number is taken from the session continuity data if it is omitted from the command line. The display returned comprises one or more pages of summarised records, ordered chronologically. An individual detail record can be displayed by selection from the summarised list. This selection requires entry, on the command line, of the index number displayed alongside the summary record. Having accessed a detail record, the user can 'page' chronologically back or forward through the detail records by using dedicated paging function keys. The EXIT key causes the summary list to be redisplayed.

FRR Handling

The system provides the means to create, update and delete an FRR by entry of the command F followed by a circuit number. This causes any current FRR with that number (or a summary list if more than one FRR exists) to be displayed, or, if no current FRR exists, causes the CPI record for the entered number to be displayed. The circuit number is taken from the session continuity data if it is omitted from the command line.

If no current FRR exists, the system assumes by implication that it is intended that one should be created, and, if the user enters an update command related to FRR processing as the next entry, a new FRR is created in the in-hand file and the CPI display is replaced by an FRR display.

The FRR display contains an abbreviated version of the CPI header and qualifier records plus the necessary FRR handling fields, which are described below.

Report Update

If the FRR is new, the only handling fields completed are the report code, the time that the FRR was created and the initials of the creating officer, assumed to be a fault reception officer (FRO). As is the case with all FRR updates, the time and date, and updating officer's identity are supplied by the system. The customer-report update is achieved by entering, on the command line, the command R followed by one of 34 report codes. These include, for example, NDT (no dial tone), BNR (bell not ringing) and NSY (noisy). The report code is vetted and is rejected with a suitable error prompt if it is incorrect. The user cannot progress until a correct report code is entered, except by using the ABANDON FRR function key, which immediately reallocates the FRR to the supervisor group list with the erroneous code included, together with the identity of the user experiencing the difficulty. This ensures that no reports are lost, that the user can continue to operate effectively as a receptionist and that subsequent corrective advice can be given by the repair service control (RSC) manager or his Technical Officer with Allowance (TOA).

After the system has accepted a valid report code, it accesses and includes on the display the 'test by' target time, which is derived from a control parameter amendable locally. This is part of the jeopardy reporting software and will be described under the heading 'Management Statistics Subsystem'.

Test-Result Update

The command T followed by one of 21 valid test result codes, to record either the initial functional test result or the full diagnostic test result at a later stage, results in an immediate prompt for a fault localisation code, on the basis that the testing officer should have a good idea of where the trouble is to be found. The default value for the localisation code is UTT, meaning that the fault cannot or has not been localised. Other localisation codes include, for example, EXCH (an exchange equipment fault), CA (customers' apparatus), PABX (fault on PABX switching equipment), UG (fault localised to underground plant), OH (fault localised to overhead plant) and SMPL (parts-replacement faults requiring no on-site diagnosis).

When the test result is entered, the system consults the supervision and management subsystem (SMSS) for the lead-time-to-clearance for the localisation entered and displays the projected clearance time as a 'clear by' time on the FRR. This is targetted within the jeopardy reporting software, which is discussed under 'Local Management Statistics Subsystem'.

Appointment Update

When APT followed by the time and date of the appointment is entered, the clear-by commitment time is overwritten with the appointment time; this prompts the system to revise the clear-by time on the basis of the appointment time.

Other FRR Updates

Other FRR updates include the slip-number update, to facilitate the recording of issued slip numbers when requested; the incoming-slip-number update, to record a quoted slip number; the referred-to-other-maintenance-duty update, to record the identity of a maintenance duty that is external to the RSC that may be dealing with the report; and the notes update, up to 66 characters of freefield text, used to amplify or clarify the encoded updates already entered. In order to monitor service code 2 and 3 maintenance commitments, the system also accepts response-time and response-action updates.

Reallocate Update

If A followed by a valid allocation code is entered, the FRR is reallocated to the list identified by that code. It is this update which 'moves' the FRR between the various functions within the RSC for further processing.

When a new FRR is created, it is automatically allocated to either the hold list of the creator or, if the FRR is proper to an operational unit (OU) on the system other than the one in which it has been created, it is automatically allocated to the reception-group list of the parent OU. This feature allows global reception of customers' complaints, but ensures that the progression of the FRR is within the OU that services the customer.

FRR Progression

All the above updates are available to any user in the reception, test, distribution or supervision functions. If the FRR is new, the FRO can use these updates to record the customer's complaint and the result of a basic functional test. The FRO can also negotiate access to the customers' premises if necessary, and record this, either as a firm appointment or as a note. When the reception transaction is complete, the FRO has the choice of leaving the FRR in the hold list, until reception pressures ease, or immediately reallocating the FRR to the next function. This can be diagnostic test, if required, or directly to the fault distribution officer (FDO). Other reallocations could be to an association list, if the report was found to be one of a common group; for example, a cable breakdown or exchange fault. The FRO also has the means to clear the report at reception if it proves to be right-when-tested (RWT). The clear update is discussed later. The most common course of action is to reallocate the FRR to the appropriate distribution-group list, where it awaits the attention of the FDO.

List Displays

The FDO regularly examines the contents of the distribution-group list to determine the nature and quantity of the outstanding work load. In order to do this, the list-handling software provides several commands, including the display-list command, L, followed by a valid list identity, which causes the first page of the identified list to be displayed. Each page comprises a maximum of 10 two-line entries. Each entry is an abbreviated version of the FRR that it represents and includes an index number from 1–10. A list header is also displayed, including the list identity, the total number of entries and pages, and, if it is a work list, details relating to the skills and field maintenance group of the field engineer. Paging facilities, to display the second and subsequent pages of the list, are provided via the paging function keys.

If the list command is not qualified with a valid list-allocation code and the user is affiliated with a test, distribution or supervision group, the group list is displayed by default.

If the command line includes not only the group list identity but also a valid sublist identity, the resulting display is restricted to those entries qualifying for that sublist.

The user can, at any time, display the FRR represented by an entry in the list by entering the index number of that FRR in the command line. When an FRR is displayed in this manner, it is available for update unless it is currently being displayed by another user, in which case the second user is advised that update status is not available, thus avoiding simultaneous updates of the same record.

The user can reallocate any FRR from the displayed list to another list by means of the A command followed by the target-list identity and the index number of the entry to be reallocated. Up to 10 FRRs can be reallocated as a single transaction if required.

The user can clear up to 10 FRRs from the list display by using the clear command followed by the index numbers of the FRRs to be cleared and a valid clear code. The clear command is discussed later.

FRR Issue and Clearance

By using the above facilities, the FDO can sort outstanding work so that many FRRs can be 'preallocated' to field engineers' work lists prior to their next contact with the FDO. This is achieved by using the A command already described.

When a field engineer contacts the FDO, the work list is displayed by using the L command, together with the engineer's identity. Inspection of the list contents will reveal both the FRRs preallocated prior to the call and those already issued to the field engineer (with the index numbers shown highlighted). The usual procedure is that the field engineer reports clears first and then takes further work.

Clear Command

The clear command can be invoked when either a list or an FRR is displayed. When the command is entered whilst a list is displayed, the system requires a parameter, the index number of the FRR to be cleared. Up to 10 FRRs can be simultaneously cleared from a list display by entering up to 10 index numbers as command parameters. Upon entry of the clear command, the system displays a clear-code entry grid, comprising fields to accept an A29 analysis number; a low-level code subdividing the A29 line by 10, for further detail; and an action code, describing the action that was taken to clear the fault. Additional fields exist into which further subdivisions of the clear code can be entered for high-level analysis, and product and man-hours information for later product reliability and maintenance cost analyses. The completed grid is transmitted to the system, and the FRR is updated with the clear information.

The FRR remains available for further updates until the session continuity data is updated, at which time it becomes a closed FRR and is allocated by the system to the closed list, whereupon it can no longer be displayed as a current FRR. Any further fault reporting activity on the entered circuit number results in a new FRR being created. If fault history is requested, the closed FRR is included in any history display.

The system processes the entries in the closed list as an overnight batch job, deleting the FRRs from the in-hand file and creating fault history entries in the history file. By this means performance is improved during the day.

Issue Command

After registering the clears called over by the field engineer, the FDO proceeds with the issue of new work. This is achieved by using the ISS command. If the command is invoked when an FRR is displayed and that FRR is already preallocated, the only change is to the work list, where the issued FRR is highlighted. If the FRR is in some other list, the command requires an allocation code as a parameter. In this case, the issue results in a reallocation from the current list to the work list identified within the parameter. The dialogue when a list is the current display is similar, except that the system additionally requires the index number of the FRR to be issued.

Recording Multiple Handlings

The above description of the processing of an FRR from report to clearance is simplified for the sake of example. In reality, many FRRs are reallocated several times between association lists, group lists and work lists until eventually cleared. During this process, the FRR may be handled by several functions and perhaps more than one field engineer, and, therefore, facilities are provided to record this handling information on the FRR. This is achieved by means of the ACN command followed by a parameter which is the action code, describing the action taken by the field engineer to progress the fault. Up to seven handlings can be recorded on the FRR in this manner and these details are transferred to the fault history record on clearance.

Availability of In-Hand Information

As these multiple handlings proceed, it is often the case that the customer will re-call 151 to enquire when the fault is to be cleared. Under these circumstances, the FRO proceeds with the transaction as if it were a new fault report, except that when the F command followed by the circuit number is entered, the resulting display is the current FRR. Inspection of the display reveals the current handling situation, the current allocation code and any other detail relating to the progress of the report. It is from this display that the FRO can advise the customer of progress and, if necessary, transfer the call to the user currently holding the FRR. Thus, the major objective of making in-hand information available at reception is realised.

ADDITIONAL INFORMATION SUBSYSTEM (AISS)

Nature Of Information Required

In all RSCs, it is necessary to maintain a reference library of supplementary information. This library consists of, for example, records of distribution points (DPs), addresses of public call offices, lists of useful telephone numbers and many more similar collections of material. In the non-computerised RSC, this material is regularly referenced, requires continuous maintenance and is generally inconveniently located for the majority of users.

Most RSCs also have a general announcement system, usually in the form of a wallboard and markers, which carries the more transient information such as details of current cable breakdowns or major switching faults.

Within ARSCC/E, both these types of information are known collectively as *additional information*, and facilities exist within the supervision function to create and maintain such a library, which is then made available to all users via the INF command at the workstation.

Method Of Access

Access to the information is gained either directly or via a process of selection, illustrated in Fig. 6. The library has an index of divisions and each division has its own index of items. An item of additional information contains one or more pages of text, each page containing 20 lines. If the user knows the division and item keys, they can be included as parameters of the INF command, causing the first page of the required item to be displayed immediately. If, however, the user is unsure of either the division or item keys, they can be omitted and the system then displays first the

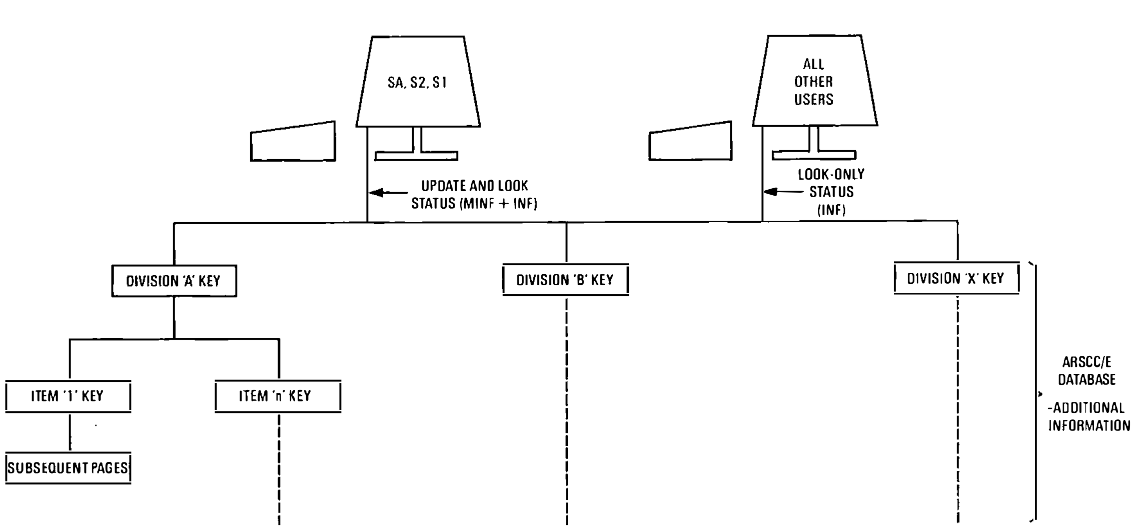

Fig. 6—Additional information subsystem

index of divisions, from which the user chooses a key and enters it on the command line. This results in an index of items within that division from which the user can select the item required. Once the first page of the required item has been displayed, the paging function keys can be used to peruse the item as required. The EXIT function key takes the user back, via the item and division indexes, to the transaction being performed prior to the enquiry.

Maintenance Facilities

The supervision-function users have access to a maintenance facility via the MINF (modify-information) command. This command invokes a menu of options from which the user can choose to create a new item, edit an existing item, change the division and item keys for an item and broadcast to all users the existence of a new item.

SPECIAL SERVICES SUBSYSTEM (SSSS)

Because special services (SS) customers still use the RSC as a fault-reporting point, it is necessary to provide facilities within the ARSCC/E system to support SS report handling, which enables the RSC to maintain a comprehensive record of the SS circuit and to raise reports, process and clear them. Although the SS information held differs greatly from that required for installations on the public switched telephone network (PSTN), the clearance process is essentially similar, except that much of the work required to clear the fault may well lie outside the scope of the RSC, especially on long-distance circuits. Nevertheless, the RSC must still register the report and, in many cases, must provide a field engineer to tackle problems with local-end customer apparatus and/or line plant.

To facilitate this, the SS CPI can be created and maintained by the same principles and procedures as the PSTN CPI. Additionally, the SS FRR can be created, updated and reallocated together with the PSTN FRRs, and appears together with other FRRs in lists, although they may be subject to separate ordering parameters if required. By this means, the FDO can allocate SS work to his regular field engineers without using any special or unfamiliar procedures.

In addition to the regular performance indicators provided within the local management statistics subsystem, ARSCC/E provides information to support the SS escalation procedures and a magnetic-tape output of SS fault clearance information suitable for re-input to the national SS statistics suite, as an alternative to the more familiar SS fault docket.

SS fault histories are retained on-line within the ARSCC/E database for six months, after which they are transferred to hard copy.

LOCAL MANAGEMENT STATISTICS SUBSYSTEM (LMSS)

Any computerised administration system for RSCs must fulfil multiple roles. It must, primarily, provide full and accurate information to the workstation users on any aspect of the report handling function, so that the users will be confident in their approach to the customer and the business of fault clearance. It must, additionally, provide local management with high-quality information regarding the performance of the repair service function as a whole. The design philosophy of ARSCC/E is such that every stage in the progression of a fault report to clearance is interactive. Thus, information can be gathered and monitored at all stages to provide comprehensive performance indicators. The local management statistics subsystem (LMSS) provides such information in a variety of ways, which are described in the following paragraphs and are illustrated in Fig. 7.

Immediate Reports

Immediate reports are defined as those which are immediately available to the user on the workstation visual display unit (VDU), and include jeopardy reporting and status displays. Each current FRR is the subject of jeopardy reports. A jeopardy report is issued on an FRR when a predefined critical process has not been carried out by a target time. These reports are currently applied to two separate targets, the objective clear time (carried-forward statistics) and the clearance commitment time.

Carried-Forward Jeopardy Reports

BT's quality-of-service targets for the repair service include

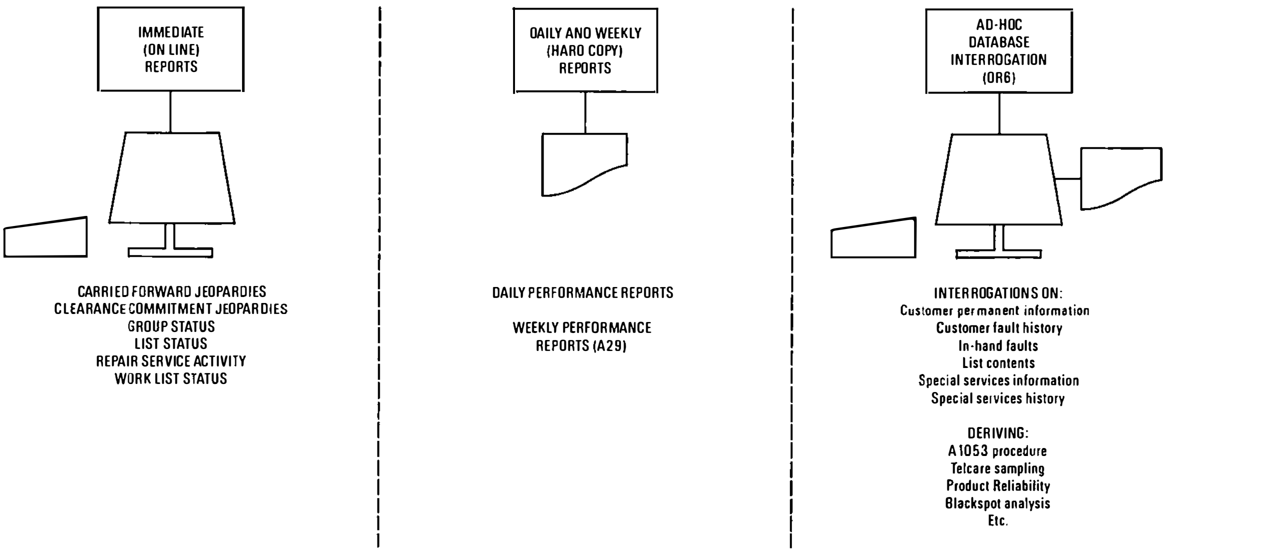

Fig. 7—Management statistics subsystem

the objective of clearing all faults by the end of the second working day after the report, for those customers with a standard maintenance contract condition. This is rarely achieved in practice and the measure of success is therefore expressed in terms of the percentage of reports cleared by the end of the second working day. Those that are not so cleared are termed *carried-forward* reports. To ensure that the optimum is achieved, it becomes necessary to monitor every report and attempt to clear it before it becomes carried forward. As it requires field engineers to clear many reports, the critical process becomes the issue of the report, because, until the field engineer has the work in hand, it cannot be cleared. Put another way, the report can be said to be *in jeopardy* of becoming a carried-forward report if it is not issued by some reasonable time before it needs to be cleared. ARSCC/E sets this issue target exactly 24 hours before the objective clear time. Any FRR which has not been issued by this time is considered in jeopardy of becoming carried forward and, when displayed, either in its entirety or as part of a list, has its circuit number underlined. If the report is not cleared by the objective clear time, the system changes this highlighting to inverse video, indicating that the report is now carried forward.

Clearance Commitment Scheme and Commitment Jeopardy Reports

Much of the 151 traffic from customers comprises enquiries of the progress of previously reported problems. The customer generally calls back because the initial dialogue with the receptionist gives little indication of the likelihood of clearance and, if the fault is not then cleared by some time considered reasonable by the customer, a follow-on call results. The ratio of first-time calls to repeat calls varies, but is typically 1:1·4, and this additional 40% of traffic on 151 circuits degrades the reception service by occupying 151 circuits and those staffing them. Therefore, if some firm commitment could be given to the customer on the initial call, many, if not all, follow-on calls could be avoided and, assuming that these commitments were met, the customer's perception of the quality of service given by the RSC would improve.

The clearance jeopardy reports issued by ARSCC/E are an initial step in this direction because they are applied to individual FRRs when critical intermediate processes required to clear the report are time-expired. The primary target is the clear-by time, which is assessed as soon as a localisation code is entered, after a functional test, at reception. When a new report is tested and localised, the system extracts the lead time from the SMSS and calculates an absolute time in the future by which the report should be cleared. This time is then published on the FRR while the customer is still on the line, and may be offered to the customer as a *clearance commitment*.

To meet this commitment, the intermediate targets which must be achieved are a line test and issue to a field engineer (where appropriate). The FRR is therefore considered 'in jeopardy' of exceeding its clear-by commitment if it is not tested by a locally variable time after report and if it is not issued by a locally variable time before it is due to be cleared.

Such FRRs are highlighted, both in their entirety and in the list displays, by underlining the clearance commitment time. If this time is exceeded before a clear is registered, the clear-by time is highlighted in inverse video. Appointments can be considered to be commitments and are therefore subject to the same jeopardy reports as commitments.

List Status

Each list on the system carries within its header numeric data relating to activity on that list. This includes the current number of entries and how many FRRs have been cleared from the list, both for the current working day and the previous day. The command S followed by the list identity causes these figures to be displayed instantaneously for the list identified, which saves the time and machine resources required to extract the same information from visual inspection of the lists themselves.

Group Status

So that the FDO can rapidly assimilate the state of the distribution group without the need to display each list in turn, the system provides the *group status* display, which gives a breakdown, by list, of the total FRRs in each list and of these the totals in jeopardy and jeopardy exceeded. Lists included are the group list, the hold lists of all users associated with the group and the work lists of all field engineers associated with the group.

Repair Service Activity

A supervision-function command is provided which causes the current log-in status of all users of the system to be displayed. The display differentiates between those logged on and those not. For those logged on, it shows the function they are currently performing and how many FRRs are currently in each of their hold lists. For those logged off, it shows the function they were performing during their last session on the system. This information can be used together with data on call answering performance to ensure adequate staffing on reception and distribution positions to meet peak loads during the day.

Work-List Status

This display, available to the supervision function, shows each distribution group and work list within each group, together with the number of FRRs currently allocated to each work list. The manager can use this information to balance loads between distribution groups as required.

Daily Reports

The primary function of the daily reports is to provide local management with day-to-day performance information for the repair service. The ARSCC/E daily reports cover all aspects of the activity in the RSC in relation to in-hand and recently-cleared FRRs. They are produced at 09.00 hours each working day as a clock-controlled batch process and are published on hard copy. If the ARSCC/E system supports more than one RSC (multiple implementation), one set of reports is produced at each location. They include a current status report, showing for each class of fault the total in hand, carried forward and cleared yesterday across each RSC. Subsequent pages break down the contents of each list in each RSC into FRR age groups, to provide an effective escalation and fault duration monitor. Further pages list each carried-forward FRR in hand in each RSC, and give an indication of which FRRs are not currently with their parent OU.

Ad Hoc Database Interrogations

As well as providing the standard statistical packages described above, ARSCC/E provides a means of *ad hoc* interrogation of the database files, to produce on-demand data in a flexible manner. This has been implemented by the use of a proprietary program product from Honeywell, known as *QR6*, which allows non-programming systems managers to interrogate their databases and thus extract and collate valuable business information in a quick and easy manner, without involving data processing expertise. QR6 achieves this by presenting the data in each file as a two-dimensional table, where the rows of the table represent the records in the file and the columns in the table represent the data fields within the records. By using this graphic representation of the file contents, QR6 then provides facilites to generate masks for the extraction and collation of data.

The most significant advantage of this method of *ad hoc* interrogations is that the investigator can modify the approach used as information is revealed, so that the end result is what is really wanted.

QR6 has been successfully applied across all major data files in the ARSCC/E database and is being used to good effect both to answer queries from senior management and to conduct longer-term exercises in plant reliability and performance, resulting in significant savings and improvements.

TECHNICAL CONSIDERATIONS

System Sizing

The complete ARSCC/E database comprises 46 files, many of which are for control and statistical purposes. However, the major files in terms of record size are the installation file (520 bytes), the auxiliary lines file (199 bytes), the extensions file (125 bytes), the external extension routing file (400 bytes), the in-hand file (904 bytes) and the fault history file (620 bytes).

These figures resolve into two sizes of database (Fig. 8). The larger size can accommodate the necessary data for up to 500 000 exchange connections and can be accommodated on 825 Mbytes of formatted hard disc. The smaller size can accommodate up to 350 000 exchange connections and reduces to 569 Mbytes, a saving of one complete 256 Mbyte mass storage module.

All mass storage modules are demountable pack drives. The standard configuration comprises one dual 67 Mbyte drive, supporting the system software on one disc pack, and the in-hand file and QR6 library and control files on the other; and four 256 Mbyte disc packs, each on a dedicated drive, two containing the remaining database files, one containing the session recovery log files and a further warm stand-by module in case of failure of one of the others. The larger database configuration duplicates the above but has a further 256 Mbyte pack and drive, to support the additional data.

System Performance

The target response time for the system is less than 2 s for any transaction under normal load conditions. This varies in practice, and can deteriorate under adverse loading to 8 or 10 s. Exceptional response delays of as much as 45 s have been observed, but these are rare and usually due to operating system overheads and file disorders caused by transient congestive peaks. To achieve this stringent response requirement, much attention has been paid to the efficiency of the software and the tuning of the transaction-processing environment. As a further step towards improved performance, to ensure that the FRO can register fault report information rapidly, the reception function is given interrupt priority over other functions and batch processes. Nevertheless, it has been found that, as the complexity of the system has grown, combined with the processing requirements of QR6 and the expected additional load that will be imposed by line test systems, the capacity of the 16 bit trial machines has become inadequate, and therefore a more powerful machine in the family has been found to be required.

The current machine is the DPS6/96, a 32 bit machine capable of one million instructions per second and able to support 16 Mbyte of memory and up to 15 mass storage modules and 115 communications devices. The ARSCC/E application currently requires 2 Mbytes of memory.

The maximum system configuration illustrated in Fig. 9 is capable of supporting up to 9 RSCs under multiple implementation, servicing as many as 85 VDUs, 27 printers (3 per RSC) and a magnetic-tape handler, as well as the mass storage modules previously described.

Environmental Requirements

The system demands a 3-phase 20 kW supply, much of

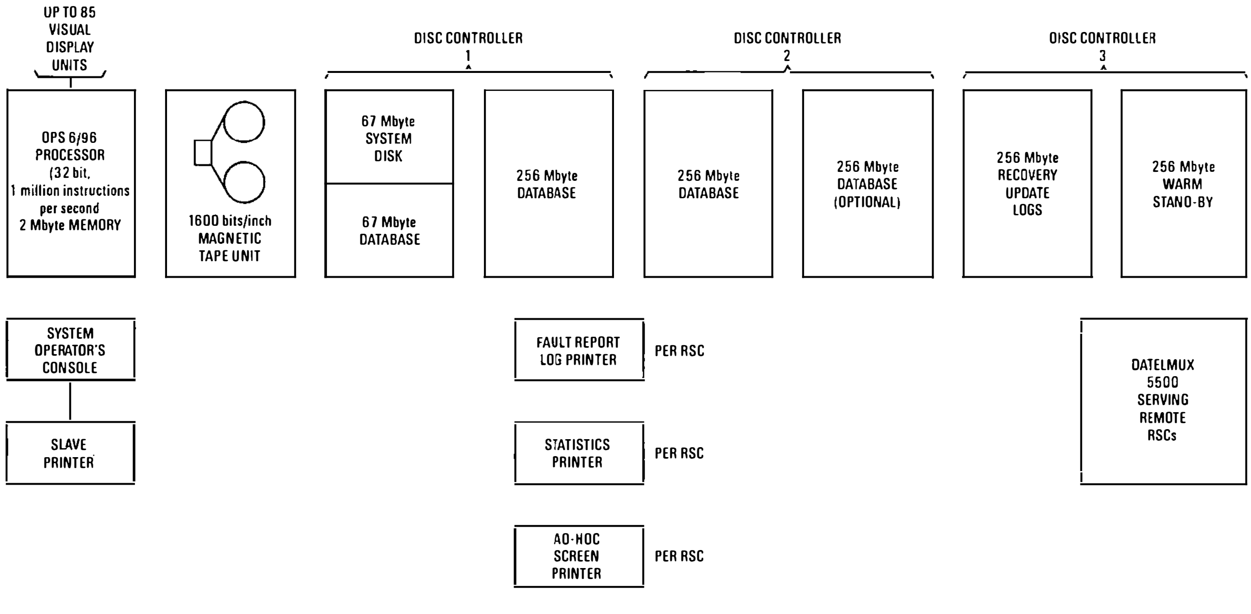

Fig. 8—Hardware configuration

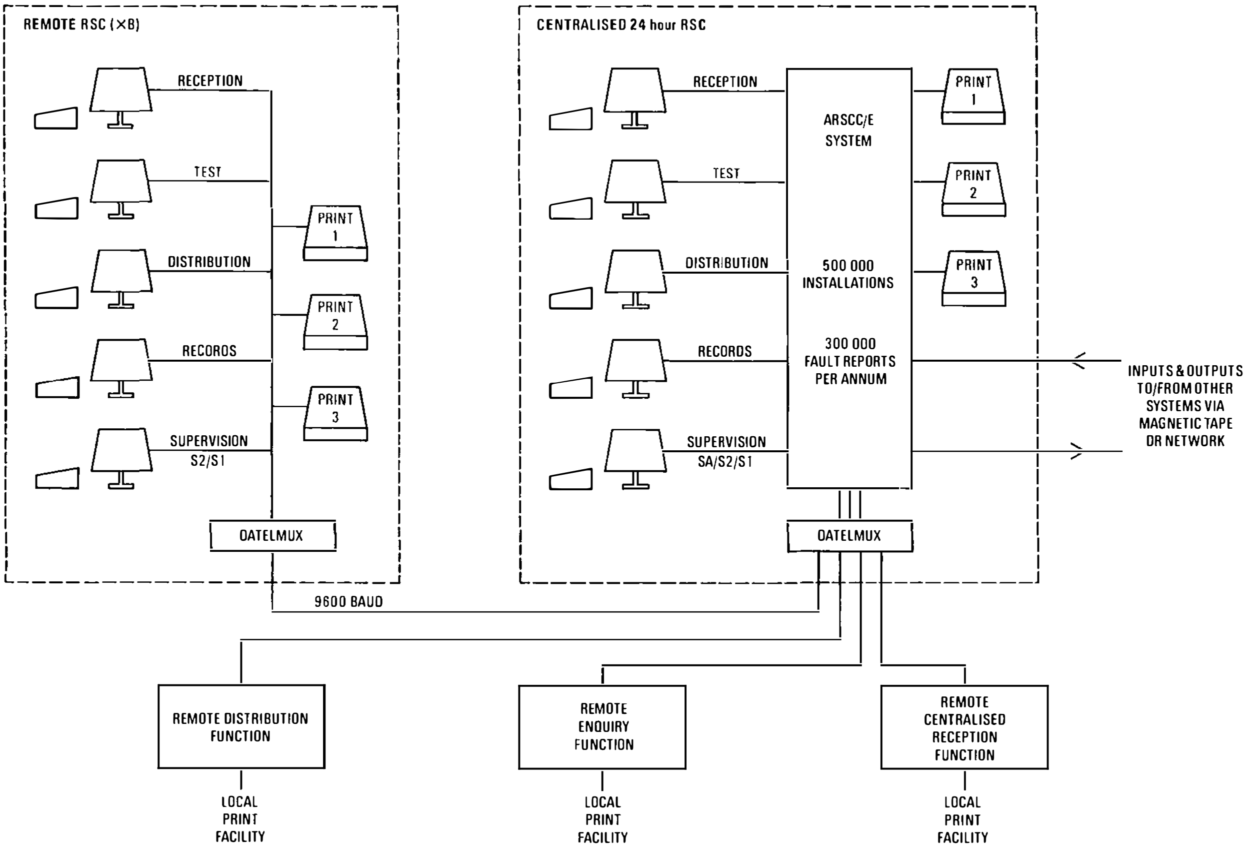

Fig. 9—ARSCC/E multiple implementation configuration

which is converted into heat, and therefore temperature and humidity control equipment is required. In view of the mass storage modules, a degree of cleanliness is also required, although clinically clean conditions are not imposed.

System Operation

Although the system is complex, it has been an objective from the outset that it should be capable of stand-alone operation for the majority of the time, with simple procedures to cover the normal housekeeping requirements. To further this aim, much work has been done in the area of job control language, to minimise the requirements for detailed knowledge of the operating system. All machine-room procedures are fully documented and supported by software job control files. In practice, a full-time operator is not required, although a job-experienced system operator available for occasional consultation at each site helps to keep the system running smoothly. Remote support facilities are available to all sites when required.

Archiving and System Security

The transaction processing system is run with a recovery option, so that all significant transactions affecting the database are duplicated on a session recovery log. Complete security copies of the database are taken at least three times per week, more often if the transaction rate demands it. Additional disaster copies are taken weekly and retained off-site. Should the system collapse, the procedure for recovery is to restore the last clean archive copy of the database and run the session recovery log against it to bring it back to currency. This process can take as long as 2 or 3 hours depending upon the size of the recovery log. During this time, the RSC reverts to manual operation. To assist this process, the system, under normal running conditions, maintains a hard copy log of all FRRs raised and cleared, together with a compressed version of the essential items of customer permanent information, which can be used to process in-hand faults. New reports are recorded on dockets and are reinput to the system when it is once again operational. Should the failure result in a long out-of-service time, the RSC must revert to full manual operation. Facilities provided by QR6 allow hard copy prints to be taken of essential customer information while the system is operational, for use during extended down times.

To minimise the disruptive effects of down time on large configurations, a dual-machine resilient option is available. This is a continuous operation environment, requiring full duplication of all computer room hardware, in which no single component failure will cause the application to be suspended.

Communications for Remote RSCs

Up to nine RSCs can be supported by a single-machine configuration. In some cases, all RSCs are co-located with the machine; the terminals and printers serving them are then directly connected on individual cables. However, in the majority of cases, the RSCs will be spread over a wide geographical area and therefore data communications facilities are required.

The method adopted utilises statistical multiplexers, which interleave data passing between the machine and the remote sites so that it can be economically concentrated for transmission. The data is demultiplexed at the remote site and then routed via individual cables to the target terminals. The data circuits can be either analogue, baseband or KiloStream, depending upon the services and line plant availability. Analogue circuits can handle up to five 9600 bit/s devices, by using statistical multiplexer techniques, whereas a 48 kbit/s KiloStream circuit can handle 24 or more, because of better averaging and a more efficient multiplexer. In the majority of cases, where more than seven or eight devices need to be served, significant financial and service advantages can be gained by using KiloStream.

The recommended multiplexers are in the Datelmux 5500 family, marketed by Merlin, comprising three major models of between four and 240 channel capacity. The larger versions are fully modularised and offer comprehensive networking facilities including multiple outputs to different sites, software route mapping, alternative routing on circuit failure, network surveillance and network management via remote access.

These networking arrangements enable terminals and printers for up to nine separate sites to operate from a single ARSCC/E machine, with no perceived degradation in facilities or response times.

IMPLEMENTATION PROGRAMME AND FUTURE DEVELOPMENT STRATEGY

By the publication date of this article, ARSCC/E will have penetrated 22 Districts and will be supporting 137 of the 361 RSCs in the UK, serving 44% of UK exchange connections. Current and future enhancements of the system are dictated by rapidly changing business requirements which could not have been foreseen during the preparation of the Statement of Requirements, and it is these which will occupy much of the effort in the near future. Future enhancements will include automatic allocation of FRRs, based upon update data and customer information data contained within them; universal mailbox facilities; improved sublist selection criteria; enhanced QR6 facilities and inter-system networking, to provide District-wide integration.

The most significant enhancement to ARSCC/E, currently being implemented in the field, is the integrated line test system (LTS) facility, which will further improve the perceived quality of the repair service and lead to significant plant reliability improvements, as well as the early detection of fault-prone plant. With the LTS, the workstation user can test all lines automatically, irrespective of distance, coupled with the benefits of immediate retrieval of full customer details and fault history, on a single VDU. The LTS also provides local network overnight surveillance facilites, aimed at the early detection of fault-prone plant, thus minimising the need for customers to report trouble; and programmed repeat testing, enabling suspect lines to be tested as a background task while the workstation user continues with more urgent work. The combination of this powerful testing and analysis tool and the comprehensive database facilities of ARSCC/E will ensure that the repair service is fully prepared to meet the challenge of the competitive future.

Biography

Charles Gill is currently Head of the Repair Service Organisation and Administration Group in BT Local Communications Service Headquarters. He joined BT as an apprentice in London City Area in 1963 and moved into Telecommunications Headquarters in 1969. He has since been closely involved with all aspects of the repair service, particularly the design and implementation of computer systems to support the modernisation of the repair service. He has been associated with the ARSCC/E project since its inception in 1977 and continues to have responsibility for the implementation and support of the system.

THE INSTITUTION OF BRITISH TELECOMMUNICATIONS ENGINEERS

(Founded as the Institution of Post Office Electrical Engineers in 1906)

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(Membership and other enquiries should be directed to the appropriate Local-Centre Secretary as listed on p. 177 of the October 1985 issue.)

REVISED RULES

The Rules of the Institution, incorporating all the revisions up to 1 April 1986, have been reprinted and distributed with this issue of the *Journal* to all Members registered on the central membership database. Members who do not receive a copy may obtain one from Local-Centre Secretaries or the IBTE Administration Manager, Room 107, Intel House, 24 Southwark Bridge Road, London SE1 9HJ.

IBTE CHRISTMAS FAMILY LECTURE 1985

The London Centre of the Institution of British Telecommunications Engineers held its fourth annual Family Christmas Lecture at the Institution of Electrical Engineers, Savoy Place, London, on 14 December 1985. John Craven, presenter of BBC Television's Newsround programme, gave the lecture, called *In and Out of the News*, to an audience of some 600 people, about half of whom were children. John explained how his award-winning children's news programme is compiled; he included a video of his recent visit to India to examine conservation work, and emphasised the important part played by British Telecom in passing on news through outside broadcast units, landlines and satellite links.

An exhibition held in conjunction with the lecture featured videos from EMI's Music Box video channel relayed by satellite from Liverpool to a dish aerial outside Savoy Place; the videos could be seen on monitors inside the building. A display of the history of news transmission through the ages was also included in the exhibition, together with demonstrations of optical-fibre cable jointing and a display of payphones. A demonstration of portable electronic news-gathering equipment, which has revolutionised recording outside the studio, was a particular attraction with the children.

The IBTE's annual Family Lecture is always popular with members—all the tickets were taken up within a month. It is hoped that another lecture will be arranged next Christmas.

John Craven at the 1985 IBTE Christmas Lecture

IBTE CENTRAL LIBRARY

The books listed below have been added to the IBTE library. Copies of the 1982 edition of the library catalogue are available, on loan, from The Librarian, IBTE, 2–12 Gresham Street, London EC2V 7AG. An abbreviated catalogue was bound in with the *Supplement* included with the July 1985 issue of the *Journal*. Library requisition forms are available from the Librarian, from Local-Centre and Associate Section Centre Secretaries and representatives. The form should be sent to the Librarian. A self-addressed label must be enclosed.

5424 *The Information Technology Revolution.* Edited by Tom Forester.

This book comprises a series of non-technical articles on information technology (IT). A wide range of papers have been included and many of them have been written by British and American computer engineers. Subjects dealt with include artificial intelligence, fifth-generation computers, the impact on telecommunications, factory automation, the office of the future, the impact on work, the implications for society and the use of IT in schools, factories, offices, banks, shops and hospitals. The book is a useful beginners guide to IT.

5425 *Alan Turing—The Enigma of Intelligence.* Andrew Hodges.

Alan Turing was by any reckoning one of the most remarkable Englishmen of the century. In the 1930s, he was a brilliant mathematician at Cambridge, and in 1936 laid the foundation of the modern computer in his papers 'Computable Numbers'. During the war, he became the presiding mathematical genius of Bletchley Park and made possible the breaking of the German Enigma code. This work culminated in the construction of the speech encipherment equipment codenamed *Delilah*. After the war, Turing joined the National Physical Laboratory and designed the structure of the ACE digital computing machine. In 1948, he joined Newman and Williams at Manchester University, where he made contributions to the software of the Ferranti Mark 1 computer and to the development of high-level computer languages. Because of mistrust and bureaucracy, he became disenchanted with computers and took an interest in morphogenetics. A homosexual, Turing found his morality and scientific ideas increasingly at odds with the values of the state which he served. Eventually, he committed suicide. This book is a very readable biography and a must for any serious student of computer science.

5426 *Interfacing the BBC Microcomputer.* Bannister and Whitehead.

This book explains how external devices, that is, switches, relays, indicator lights, stepper motors etc., can be connected to a BBC microcomputer to build up a system. The book does not assume a high level of technical ability, and hobbyists, students and science teachers should have no difficulties. A few applications are described including an oven controller, stepper-motor drive arrangements and a sound display on the computer screen from the input of a microphone.

5427 *Advanced Digital Information Systems.* Edited by Igor Aleksander.

This is an advanced text on the principles of the digital systems used in sophisticated information-processing tasks. The contents include research in digital systems, automata theory, programming languages, artificial intelligence, pattern recognition, computer automated design and associative processing. This is a useful learning book for electronic engineers and computer scientists who need to keep abreast of major developments in information technology.

5428 *The Universe.* Iain Nicolson and Patrick Moore.

This book gives a comprehensive up-to-the-minute survey not only of our own galaxy, its stars and planets, but of other galaxies only now being explored. The book is illustrated throughout with superb photographs and paintings. It is an invaluable source book for students of astonomy and the ideal introduction for anyone intrigued by the mysteries of the night sky.

5429 *Design and Analysis of Computer Communication Networks.* Vijay Ahuja.

This book provides an introduction to the fundamentals of communication networks and their analysis. The emphasis is on components of networks, such as transmission links and network nodes, and on network analysis problems, such as routing and control. It is intended as a textbook for a first course in computer communications and is suitable for students and professionals who have a background in computer software or computer hardware.

5430 *Electronic Mail and Message Handling.* Peter Vervest.

This book provides an excellent introduction and review of the numerous electronic mail systems that are now being introduced. The concepts behind message switching, facsimile and Telex were developed long before the introduction of computers. Advanced technology has, however, enabled the introduction of newer systems and services such as Teletex, digital facsimile, Intelpost and computer-based message systems (the electronic mailbox) as well as voice mail.

The development of this vast range of electronic mail and message handling systems is described against the background of conventional mail, telegraph and telephone systems. Detailed information is also provided on telecommunication networks, protocols, interfaces and terminal equipment. The intended readership includes telecommunication and EDP managers, PTT and other telecommunication service organisations, computer engineers and students.

5431 *16-bit Microprocessor Systems.* Flik and Liebig.

This book is organised as a textbook and is intended as a self-teaching course on 16-bit microprocessor systems and describes their structure, their behaviour and their programming. The material is based on currently available 16-bit microprocessors; that is, Motorola MC68000, Zilog Z 8000, Intel 8086 and their successors.

5432 *The Encyclopedia of Electronic Circuits.* Rudolf F. Graf.

To compile this encyclodedia, the author consulted 100 highly respected electronics sources to find the very best circuits for virtually every electronic purpose. Details of nearly 1300 circuit schematics are presented for just about any type of electronic project imaginable. This book is a must for the electronics hobbyist and provides a quick reference for the professionals who need fast reliable answers to specific design problems.

5433 *The Hitch-Hiker's Guide to Artificial Intelligence.* Richard Forsyth and Chris Naylor.

This book is a practical do-it-yourself introduction and guide for the personal-computer user, and student of artificial intelligence. All the programs are in BBC Basic and are aimed at the home-computer user who can learn and profit from artificial-intelligence techniques. Topics covered include expert systems, computer vision, machine learning, problem solving, game-playing strategies, creativity and future trends.

RETIRED MEMBERS

The following Members have retained their membership of the Institution under Rules 10(*a*) and 13(*a*).

W. T. Addy	14 Cresttor Road, Liverpool L25 6DW
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G. Bishop	151 Vale Avenue, Brighton BN1 8YF
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R. H. Harper	36 Lockwood Crescent, Woodingdean, Brighton BN2 6VG
D. Hemmingway	8 Longmead, Woolton Hill, Newbury, Berkshire RG15 9XY
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R. G. Heslop	27 Greenhill Drive, Leeds LS13 4JZ
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J. Y. Lilley	3 Harris Road, Inverness IV2 3LS
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D. McGregor	26 Fifehill Park, Dyce, Aberdeen AB2 0NS
M. P. Morrisey	1 Hamilton Road, Church Crookham, Hampshire GU13 0AS
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W. T. G. Murray	69 Craigleith Hill Gardens, Edinburgh EH4 2JB
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Members about to retire can secure life membership of the Institution at a once-and-for-all cost of £10·00 and so continue to enjoy the facilities provided, including a free copy of this *Journal*. Enquiries should be directed to the appropriate Local-Centre Secretary.

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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.

Switching and Signalling in Telecommunications Networks. IEE vacation school. 6–11 July 1986. University of Aston, Birmingham.

Satellite Communication Systems. IEE vacation school. 20–25 July 1986. University of Surrey.

Optical Fibre Telecommunications. IEE vacation school. 31 August–5 September 1986. University College of North Wales, Bangor.

The Evolving Local Telecommunications Network. IEE vacation school. 7–12 September 1986. University of Aston.

Electrical Measurements DC to VHF. IEE vacation school. 7–12 September 1986. London.

Semi-Custom IC Design and VLSI. IEE vacation school. 14–19 September 1986. University of York.

Radiowave Propagation. IEE vacation school. 14–19 September 1986. University of Surrey.

Software Engineering for Microprocessor Systems. IEE vacation school. 21–26 September 1986. London.

ISSLS 86. Seventh International Symposium on Subscriber Loops and Services. 29 September–3 October 1986. Tokyo, Japan.

Secure Communication Systems. 28–29 October 1986. London.

UK Telecommunications Networks—Present and Future. First IEE National Conference. 2–4 June 1987. London. Call for papers: synopses 14 July 1986. Scope: to review recent developments in the technical and regulatory framework of the UK telecommunications network, particularly in the following main areas: network evolution—to present day; the regulatory framework; the standardisation processes; value-added services and future evolution.

Institution of Electronic and Radio Engineers, 99 Gower Street, London WC1E 6AZ. Telephone: 01–388 3071.

Radio Receivers and Associated Systems. 1–4 July 1986. University College of North Wales, Bangor.

Electronic Publication of Data and Software. 16–18 September 1986. Cavendish Conference Centre.

Electromagnetic Compatibility. 28 September–2 October 1986. University of York.

International Conference on Communications '86. 'Integrating the World through Communications'. 22–25 June 1986. Toronto, Canada. Details from: IEEE International Conference on Communications '86, 1450 Don Mills Road, Don Mills, Ontario, Canada M3B 2X7.

Information Communications and Technology Transfer. 43rd Conference and Congress of the International Federation for Documentation. 14–18 September 1986. Montréal (Québec), Canada. Details from: Local Organising Committee, 43rd FID Congress, cp 1144, Succursale Place Desjardins, Montréal (Québec), Canada H5B 1B3.

Plastics in Telecommunications. Fourth international conference. 17–19 September 1986. Institution of Electrical Engineers, London. Details from the Conference Office, The Plastics and Rubber Institute, 11 Hobart Place, London SW1W 0HL. Tel: 01–245 9555.

Forum 87. Fifth World Telecommunication Forum, Part 2, Technical Forum. 22–27 October 1987. Geneva. Call for papers: summaries by 1 September 1986. Theme: 'Telecommunication Services for a World of Nations'. Technical areas: the user in focus; new telecommunications services; network evolution; systems for the mobile user; broadcasting services; trends in technology. Details from: Forum 87 Secretariat, International Telecommunication Union, CH-1211 Geneva 20. Tel: +41 22 995190.

New Systems and Services in Telecommunication. Networks, Cables, Satellites.. the What, the How and the Why. 12–14 November 1986, Liège, Belgium. Details from: Mrs. Ch. Lacrosse, A. I. M., rue Saint-Gilles, 31, B-4000 Liège, Belgium.

Statistical Workshops for Engineers. Statistics for Industry (UK) Ltd. is running a series of practical statistics courses for engineers throughout 1986. Courses include 'Introduction and Statistics for Engineers', 'Introduction to Reliability Analysis', 'Statistical Process Control', 'Statistics in Quality Assurance', 'Statistics in Research and Development', and 'Design of Experiments'. Details of these courses can be obtained from Miss Angela Boddy, Statistics for Industry (UK) Ltd., 14 Kirkgate, Knaresborough, North Yorkshire HG5 8AD. Tel: 0423–865955.

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

Networks '86. 10–12 June 1986. Wembley Conference Centre, London.

Integrated Services Digital Network. 10–12 June 1986. Wembley Conference Centre, London.

Data Networks. 10–12 June 1986. Wembley Conference Centre, London.

Advanced Materials. 24–26 June 1986. Wembley Conference Centre, London.

Knowledge-Based Systems. 1–3 July 1986. Wembley Conference Centre, London.

Voice Processing. 1–3 July 1986. Wembley Conference Centre, London.

Cable '86. 8–10 July 1986. Metropole Hotel, Brighton.

System Security. 30 September–2 October 1986. Tara Hotel, London.

Wideband Communications. 1–2 October 1986. Tara Hotel, London.

Electronic Messaging Systems. 22–24 October 1986. Tara Hotel, London.

Cellular Communications '86. 11–13 November 1986. Hyatt, San Francisco.

British Telecom Press Notices

MOVIT—Aid to Transport Fleet Management

A £3M nationwide computer network, called *MOVIT*, has been brought into service by British Telecom (BT) to help run its fleet of nearly 60 000 motor vehicles more efficiently.

MOVIT (Management Of Vehicles In Telecom) logs the service record and costs for every vehicle. This will help BT to identify vehicles that are giving good service and economic costs, as a guide to future ordering, and to pinpoint particular service problems and make more efficient use of its workshops and stock of spares.

The computer system was supplied to BT by ICL (UK) Ltd. MOVIT keeps a service history of every vehicle in BT's fleet. It plans routine maintenance work at the appropriate time, and logs this as well as any repair work. It also records and performs statistical calculations on the costs incurred and provides management reports. Links with the finance systems within BT for internal transfer charging and asset-base control are also an integral part of the system. MOVIT also gives closer control of costs by recording parts usage and providing stock control.

MOVIT enables BT to get the best possible use from its fleet and maximises workshop resources, while helping BT to keep a closer watch on costs. Importantly, it has streamlined the ordering and delivery of new vehicles and can guide the choice of replacement vehicles and components, as well as recording disposal data. Before any job is performed, history files are accessed and estimates produced to control maintenance before action is taken.

MOVIT uses a distributed database philosophy, file transfer facilities and automatic dialling between sites for the information flow. It uses more than 60 ICL System 25 minicomputers interlinked by telephone lines to serve 48 service control centres, 10 regional offices and the headquarters of BT's Motor Transport Division in London. Staff at remote workshops also have dial-up on-line access to the computers, which form the largest System 25 network in the UK.

Airborne Telephones for Air Travellers

Trials for a satellite telephone service for air travellers, conducted by British Telecom International (BTI), British Airways and Racal-Decca Advanced Development, are expected to begin in 1987. Initially, these trials will be carried out from Racal's Jetstream aircraft but, later, they will be extended to scheduled British Airways flights. Passengers will make calls by inserting a credit card into a specially adapted payphone. This will unlock the handset and connect the caller with a ground-based operator in the UK who will connect the call.

Racal-Decca Advanced Development, in consultation with British Airways, will apply its expertise in satellite technology to produce airborne transmitter/receiver equipment and develop specialised aircraft antennas. The company has already demonstrated an air-to-ground Telex-type link.

On the ground, BTI will dedicate one of the antennas at its Goonhilly satellite earth station to aeronautical services. Initially, passengers will be able to make but not receive calls, although BTI believes that it will be able to offer all normal telecommunications facilities if there is sufficient customer demand.

The decision to conduct the trials follows the earlier announcement by Inmarsat—the International Maritime Satellite Organisation—to allow use of its spare satellite capacity for aeronautical telecommunications.

New Electronic Message Service

Later this year, British Telecom (BT) National Networks is to start a public message handling service. This new managed-network service will help to make electronic transfer of messages as commonplace as the post.

The service will offer a 'conversion' facility enabling users to exchange messages electronically between dissimilar equipment such as office workstations, personal computers, word processors, Teletex and Telex terminals or facsimile. It will also be capable of interconnecting different electronic mail systems. The message handling service will adopt the principles of Open Systems Interconnection (OSI). In general, OSI enables users to mix equipment from different suppliers.

In particular, BT's service will comply with international and European standards for public message handling services, such as the X400 recommendations of the CCITT†.

ITT World Communications Inc. will supply the X400 software for the service. This will provide the basic facilities associated with a generic message handling service: store and forwarding, recorded delivery, access units, addressing and user directory services. This software is an evolution from previous electronic messaging products from ITT and will conform to the European functional standards proposed by CEN/CENELEC* and CEPT‡. These standards are supported in the UK by the Department of Trade and Industry.

Furthermore, International Computers Ltd. (ICL) will work with BT to define and supply document conversion and gateway facilities that will enable the service to address the needs of a wide-ranging community of potential users. These facilities will be based on Office Document Architecture (ODA), the emerging international standard.

The ITT software will be run on Digital Equipment Company's (DEC's) VAX computers, purchased from DEC UK and to be supplied from its Scottish plant.

The new service will be one of the first public electronic messaging services anywhere in the world. It will also be the first network service in Britain to implement OSI in a full and practical manner. It will broaden the market for information technology equipment and services, and offer new opportunities for UK office automation suppliers, both in national and international markets.

† CCITT—International Telegraph and Telephone Consultative Committee

*CEN/CENELEC—*Centre Europêen de Normalisation/Centre Europêen de Normalisation Electrique* (European Centre for Electrical Standardisation, part of the European Centre for Standardisation)

‡CEPT—European Conference of Postal and Telecommunications Administrations

First Digital Link Between Two Continents

In February, the setting up of the world's first all-digital public telephone link spanning the world's oceans was announced. The new satellite link, set up by British Telecom International (BTI) and its Japanese counterpart KDD, interconnects modern digital exchanges in London and Tokyo to benefit customers by giving faster call connection and clearer speech transmission.

The London end of the link is BT's digital international exchange at Keybridge House. Since the exchange was brought into service in April 1984, it has had to operate over non-digital international transmission systems, most of which used either satellites or submarine cables. The Japanese end of the new link uses a similar digital exchange in Oyama.

The factor permitting a total digital path between the two was the commissioning of a new satellite transmission technique know as *time-division multiple access* (TDMA) via an INTELSAT satellite over the Indian Ocean and BT's earth station at Madley in Herefordshire. TDMA had also been in use on the UK–USA route for several months, but it had not been practical to make that route digital all the way.

BT enjoyed the full co-operation of its Japanese correspondent KDD in bringing the new facilities smoothly into service. Several other countries using the satellite are also to start using the TDMA system.

In a TDMA system, transmissions from different satellite earth stations are separated by time rather than by frequency. Calls are transmitted in short 'bursts', which are carefully timed so that they reach the satellite in a pre-assigned sequence every 2 ms. The satellite's amplifer boosts the power of only one burst at a time before it is retransmitted back to earth. This means that the amplifier can be used at higher power, without causing unacceptable distortion. This, in turn, allows more telephone channels to be carried by the same satellite.

Efficiency is further improved by the use of digital speech interpolation (DSI). This technique exploits the fact that, during a telephone conversation, each speaker is silent for about 60% of the time. With DSI, a satellite channel is only assigned when one of the speakers is actually speaking. For the rest of the time, the channel is free to carry speech from other conversations. In this way, a satellite's capacity is shared between a larger number of callers. The use of TDMA and DSI transmission techniques means that the number of circuits that can be carried via satellite can be more than doubled.

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565 Mbit/s Optical-Fibre Link

Britain's most advanced optical-fibre communications link, four times the capacity of existing systems, has been successfully installed for British Telecom (BT). It is a 565 Mbit/s digital link—equivalent to nearly 8000 simultaneous telephone calls—plus associated 140–565 Mbit/s multiplexors, spanning 72 km (45 miles) between Sheffield and Nottingham, and was supplied by Plessey Network and Office Systems Ltd. The optical system is single-mode with a wavelength of 1·3 μm. The link has two regenerators, installed at Mansfield and Chesterfield, giving span lengths of between 22 km and 26 km. It will serve as a new high-capacity long-distance 'highway' in BT's national digital network, and will carry telephone calls, computer data, high-speed facsimile, graphics and pictures.

A second trial system of the same capacity and basic characteristics, with equipment designed by BT Research Laboratories and made by Fulcrum, BT's manufacturing subsidiary, has been installed between Birmingham and Derby for evaluation. It uses ultra-reliable microchip and opto-electronic technology developed for use with the transatlantic optical-fibre cable TAT 8, planned for 1988 and capable of operating for 15 years without breakdown. This second link makes telecommunications history because it uses only one regenerator in its 77 km (45 mile) route. This regenerator is at Tamworth; the span between Tamworth and Derby is 45 km, and is the world's longest for an installed system.

BT already has more than 65 000 km of long-distance optical fibre in place in its national digital network, installed under BT's £1000M-a-year modernisation programme. Most of these existing fibres will be equipped initially with systems operating at 140 Mbit/s, equivalent in capacity to nearly 2000 simultaneous telephone calls. Since 1984, these have been 1·3 μm single-mode systems, designed to the standard developed in Britain by BT and its suppliers.

One significance of the 565 bit/s development is that existing 140 Mbit/s systems can be upgraded to 565 Mbit/s simply by replacing the opto-electronic equipment. The actual cable and its optical fibre is not disturbed. Being 1·3 μm single-mode, the system is able to accommodate the four-fold increase in throughput without introducing significant propagation problems.

By 1990, about half of BT's national digital network will be optical fibre. It will provide a long-life asset, and BT will be able to enhance its earning capacity as opto-electronic technology advances to meet growth or to cater for new services. This will help BT to help its customers by absorbing a large part of the cost of inflation.

Britain's Largest Private Telephone System for British Rail

British Telecom (BT) has successfully installed the first stage of Britain's largest private telephone exchange for British Rail. Customers calling Southern Region stations and offices in London can now save time and money by dialling direct to the required extension. In addition, press-button calling and other new facilities give internal users more efficient communication.

The system, which went live on 15 February 1986, is part of a multi-million pound scheme to give British Rail a single telephone network for the whole of London, with direct dialling both to and from the public network and over British Rail's own national trunk network.

Five all-digital Merlin DX exchanges have been installed at Waterloo and Victoria stations and form the first stage of British Rail's installation, known as *ONLE* (One Number London Exchange), which will eventually serve more than 5500 extensions. It will have one single switchboard number and a common code for dialling all extensions.

Benefits for extension users include press-button dialling and almost instant connection, better speech quality, last-number redial, call redirection, short-code dialling for frequently-called numbers, and automatic ring-back when an engaged number becomes free. These facilities can be used not only at the user's own location but across the whole ONLE system, by the use of the digital private network signalling system (DPNSS). British Rail is the first large-scale user of DPNSS.

Notes and Comments

DISTRIBUTION OF THE JOURNAL

Many IBTE Members and other employees of British Telecom and the Post Office who subscribe to the Journal by deductions from pay have still not yet supplied their home addresses to the IBTE Administration Office so that copies of the *Journal* can be sent direct to their homes. Back issues of the *Journal* since October 1985, when this new method of distribution was started, are being held in store for these Members and readers until this information is received. Members and readers are asked to remind their colleagues to supply this information as soon as possible if they have not already done so; a form for this purpose was included with the April 1985 issue of the *Journal*. These Members and readers will then be sent the back issues and all future issues to their home address. Any enquires about this notice should be directed to The IBTE Administration Manager, Room 107 Intel House, 24 Southwark Bridge Road, London SE1 9HJ. (Telephone: 01–928 8686 Extn. 2233.)

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 published in the *Supplement* (for example, see the paper entitled *Digital Multiplexing*, bound as the centre pages of the *Supplement* included with this issue). 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 would be offered 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.

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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.)

International Switching Symposium, 1987

The International Switching Symposium (ISS) is held once every three years at various locations throughout the world. It is a major switching event that brings together both leading experts in this field of study and representatives from various operating companies.

The Symposium embraces all aspects concerned with switching systems from their conception, through design to field experience. Considerable attention has been focused recently on computer-controlled switching systems, but ISS 87 will look ahead to the twenty-first century and will concentrate on the technologies that appear to be keys to the future.

ISS 87 will be held from 15–21 March 1987 in Phoenix, Arizona, USA. Papers in the following broad areas of interest are invited for consideration by the ISS Technical Committee:

Advanced switching concepts
Network architecture innovations
Operating eperiences
Computerised operations systems
Forward-looking principles and architecture
Impact of new service needs on switching
Reliability and quality
Novel hardware technology
Advances in software development

Complete papers, together with a 500-word abstract, must be received by the Secretariat by 1 July 1986. Further information can be obtained from the UK co-ordinator for ISS 87—Mr. S. R. Loome, Head of Research and Development Strategy Division, British Telecom Research Laboratories, Martlesham Heath, Ipswich IP5 7RE. Telephone: 0473 644720.

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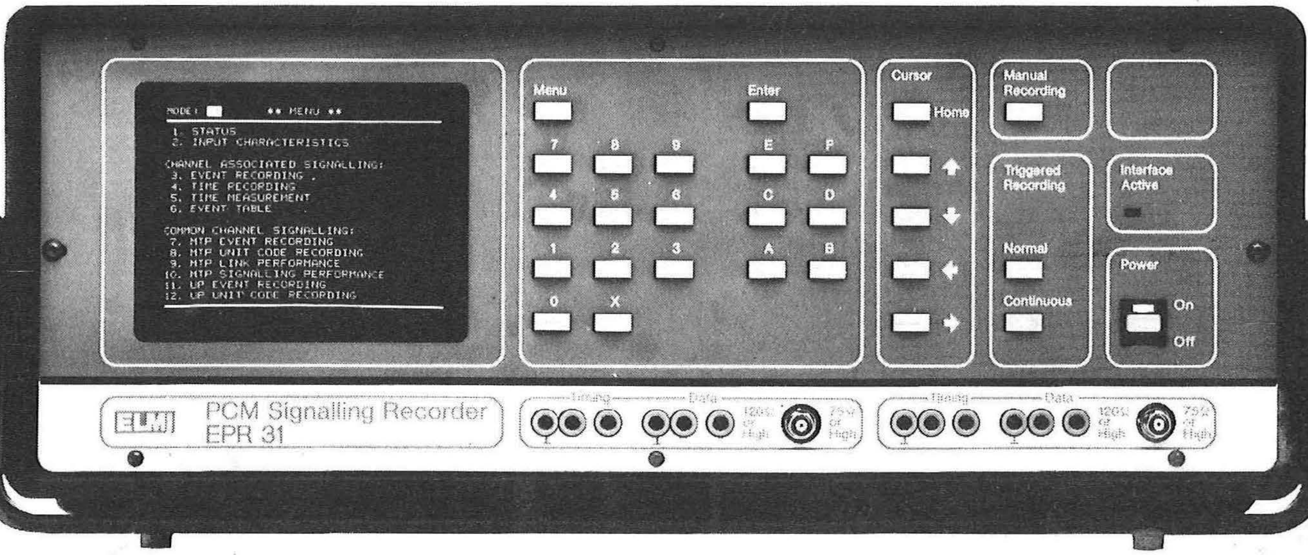

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