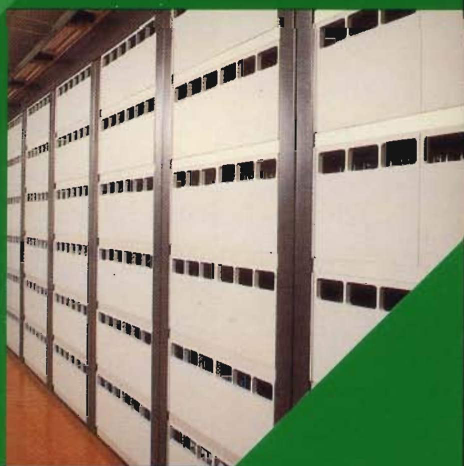
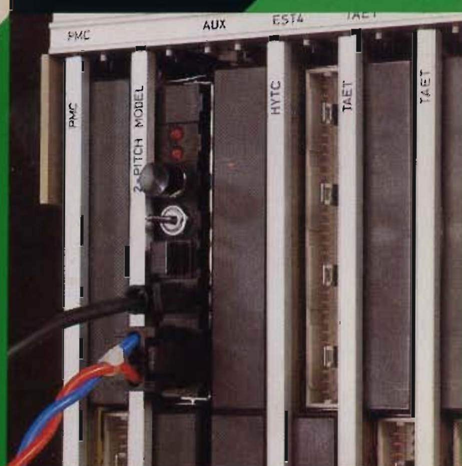
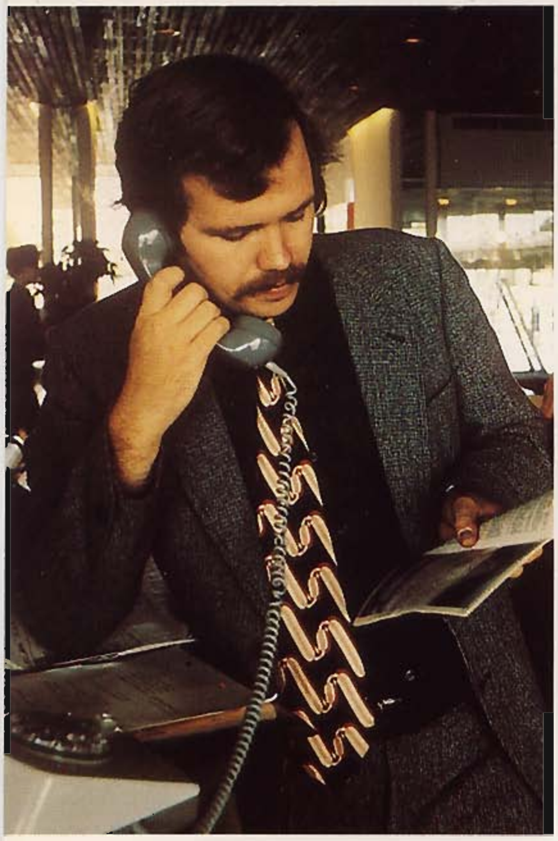
Telecommunications

PHILIPS

PRX D processor-controlled exchange (digital)








Products - Lighting and Batteries
- Consumer Audio and Video
- Household Appliances
- Industrial Supplies
- Total capital
- Own capital
- Turnover
- Result
- Profit after tax
- Dividend per share
Key # for more information

Realising the future-today

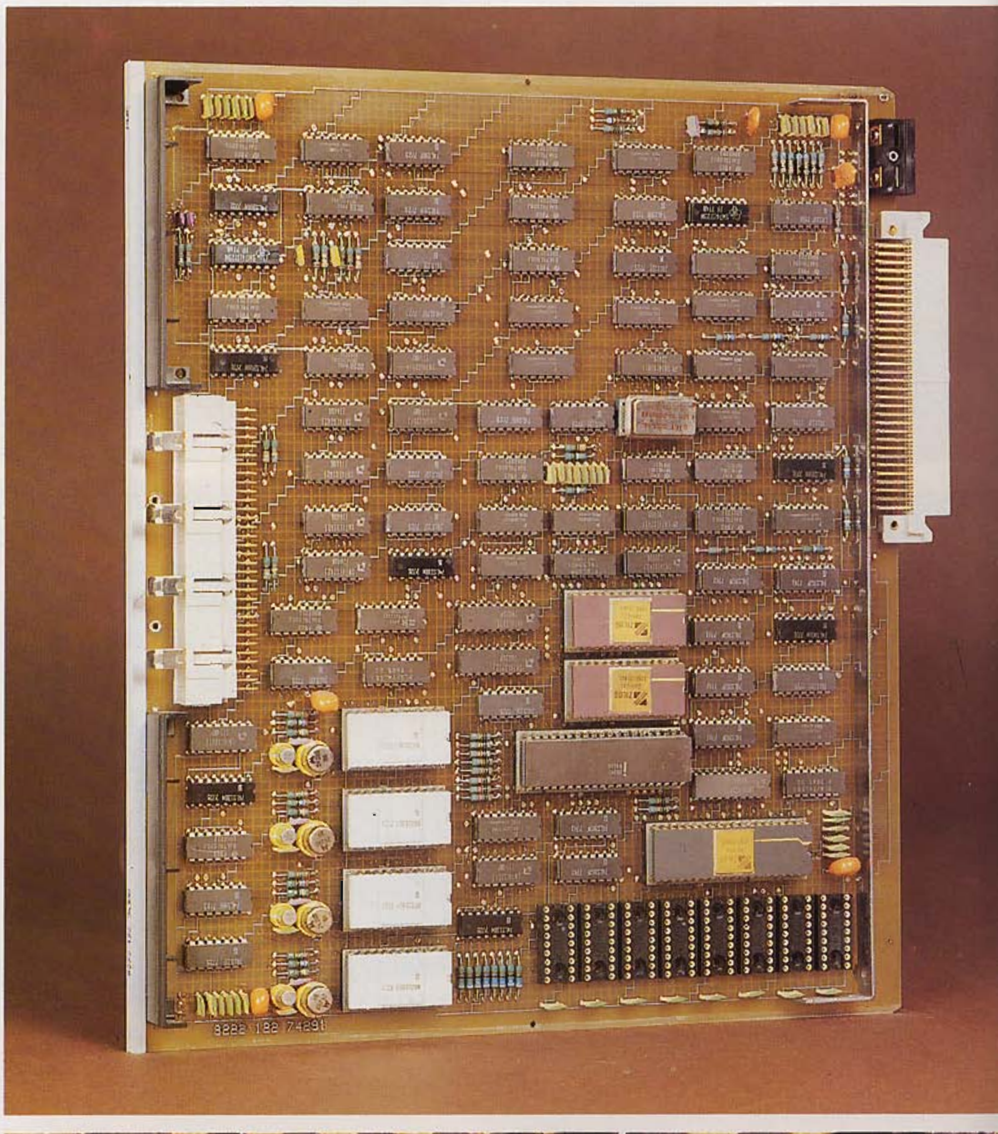
Man's continuing endeavour to respond to the burgeoning demands for more expansive and efficient communications facilities is inexorably leading to the establishment of an integrated digital communications network. Disseminating digital information derived from a variety of media, such a network would provide fast, efficient, and sophisticated communications.

In recognizing the potential of so versatile a communications infrastructure, Philips' Telecommunicatie Industrie has developed the PRX/D digital switching system.

Born of the vast experience the Philips company has acquired since its establishment in 1891, the PRX/D has been designed to provide the switching centres of the integrated digital networks of tomorrow, and yet be compatible with, and economically viable in, any of todays networks.

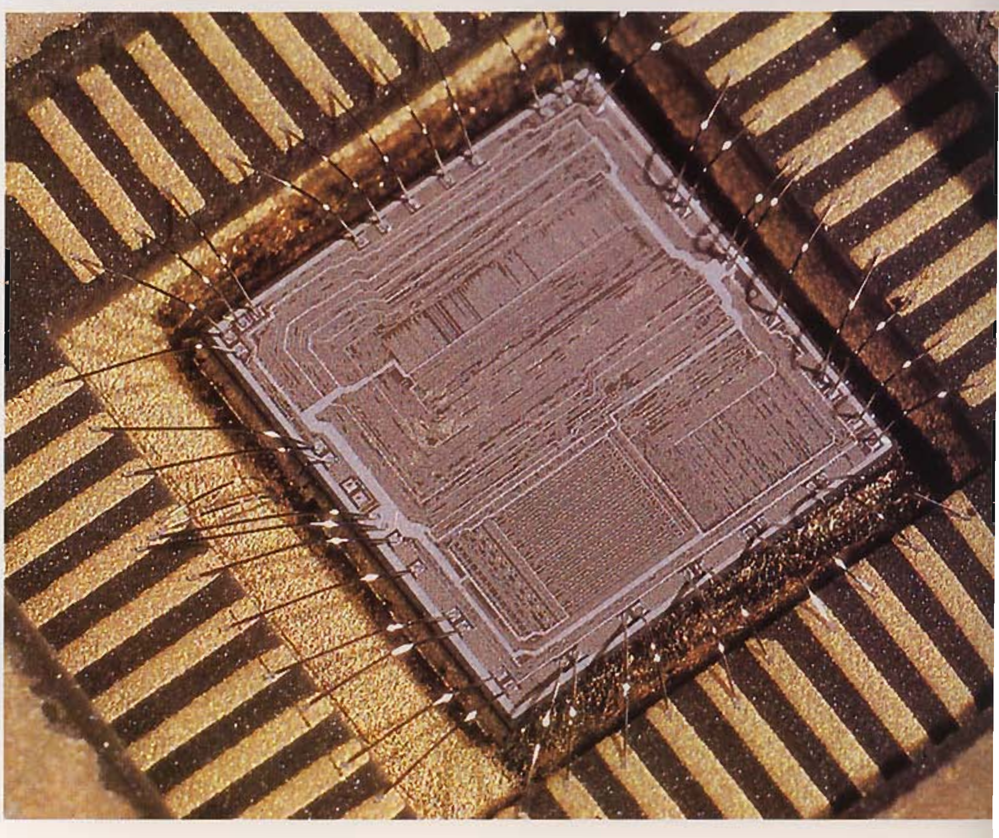
This advanced switching system, with its inherent provisions for system evolution, truly enables the administration to realize the future today.

The definitive digital switching system



The rapid development in the technology of micro-electronics, the increasing adoption of PCM transmission systems, and the synergism between digital transmission (PCM) and digital switching, have been the principal catalysts in the development of digital switching systems. The benefits of using digital technology in telephony applications have been well known for many years; it is however the advent of LSI and VLSI (Large and Very Large Scale Integration) technology that is allowing digital techniques to be employed in a cost-effective manner.

The PRX/D, the state-of-the-art digital switching system from Philips, fully exploits the availability of LSI/VLSI technology to produce a dispersed control switching system of unparalleled flexibility and manageability. System elements can be configured to satisfy any switching requirement; from remote concentrators to large transit exchanges, in the most economical way. Furthermore the advanced system and equipment practice facilitates system evolution in accordance with advances in hardware technology without necessitating major software changes – a truly evolutionary concept.



The superior digital switching system

The adoption of a dispersed control configuration, with its implications in software implementation, and the general equipment practice employed in the PRX/D, results in a host of superior system features. Among the advanced system features of the PRX/D are the following:

- Considerably reduced floor space requirements due to the compactness of the hardware.
- Modular system which can be configured to function at any level in the network.
- Capability of expansion in rational increments simply by the addition of switching stages, peripheral control domains and processor modules.
- The central processing system and the dispersed microprocessors interface on a software-to-software basis.
- The high level of system abstraction renders in the software of the central processing system independent of hardware.
- The peripheral control domain hardware can be kept simple since the accociated microprocessor performs all the logical and diagnostic functions.
- Hardware modules can be tested prior to delivery to the exchange site, significantly shortening installation time.
- Modules representing telephony functions can be added or changed in accordance with traffic requirements or new service needs at any time, without interruption of service.
- Hardware modules are all fully front-connectorised.
- The software modularity ensures that software faults will be confined and not corrupt the system.
- Central processor system programmed in the CCITT high level language CHILL.
- Remote supervision of exchange from a centralized operations and maintenance centre.
- Capability for working in either 24 or 30 channel digital transmission networks.
- New technological developments can be introduced without necessitating major software changes.
- An innovative cooling regime allows each cabinet shelf to be separately cooled by natural convection.
- Provision for direct message communication between peripheral control domains; facilitating end-to-end signalling.
- Built-in hardware and software fault-detection mechanisms with automatic system reconfiguration facilities.

The economic digital switching system

The design criterion applied to the PRX/D was to produce a flexible system structure which would: be optimal, economically, over the entire application range; be cost-effective in any network structure; assure optimal profitability to the administration throughout the lifetime of the equipment.

Likewise, the lowering of operating costs was a paramount consideration in the conceptual and system realization phases of the PRX/D development program. Indeed throughout the program conceptual elegance was constantly moderated by the desire to minimise the expenditure sustained by the administration, both in initial investment and in operating costs. The PRX/D therefore realises substantial savings in the following areas:

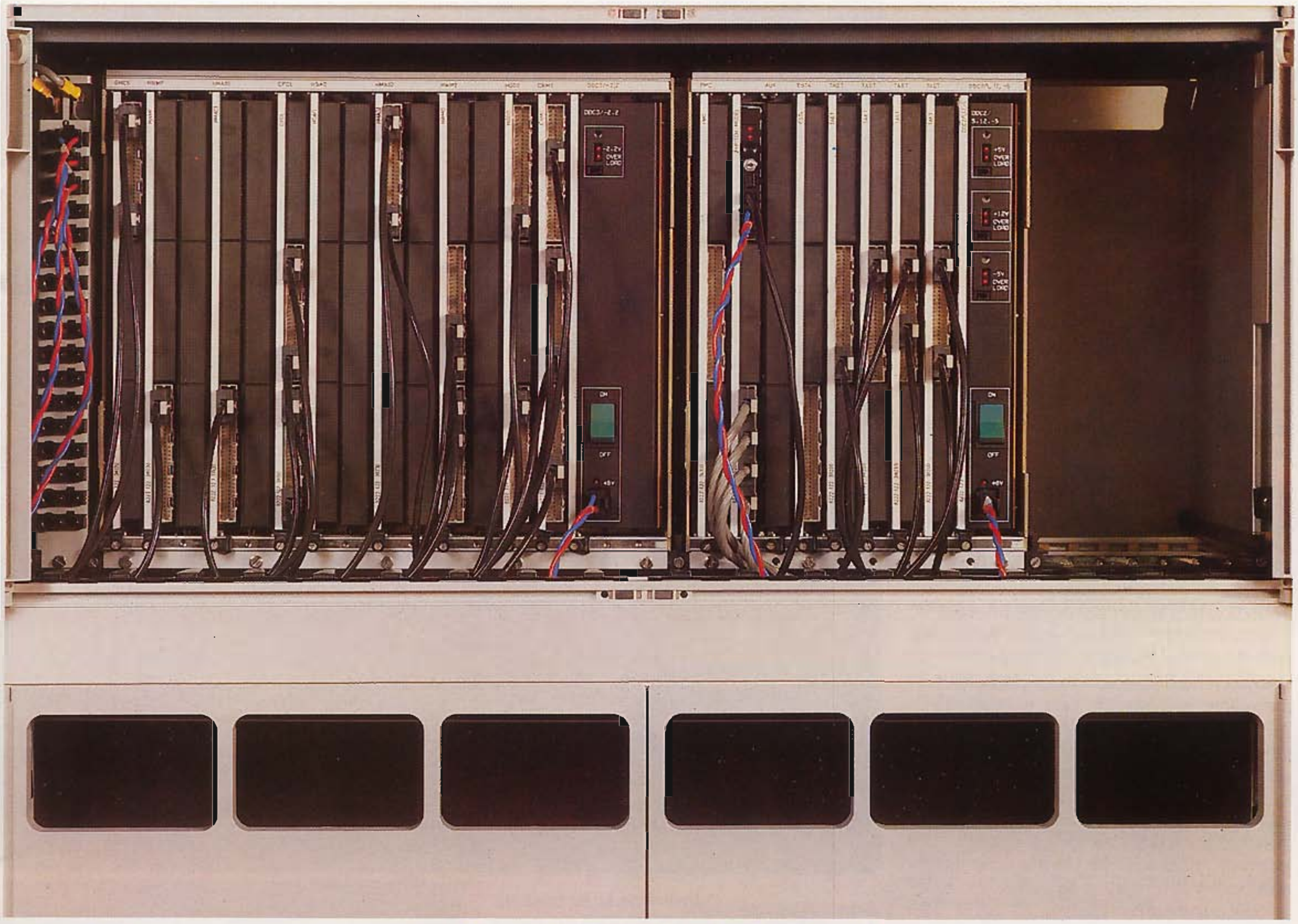
- Building requirements
- Installation time and costs
- Initial training of personnel
- maintenance costs
- administrative costs
- power requirements
- system enhancement
- System availability

Building requirements
The extensive use of LSI and VLSI devices in the PRX/D has resulted in considerable reductions in equipment volume per subscriber/trunk. In addition the elegant equipment practice, in which hardware is realized as fully connectorised modules, ensures optimal usage of cabinet space and facilitates back-to-back cabinet placements. Consequently the floor space requirements of the PRX/D are of the order of 10% of that required by an equivalent capacity crossbar exchanqe.

In addition, although an innovative cooling reqime permits high component packaging densities, the averaqe floor loading for fully installed 6-shelved cabinets ranges from 300 kg/m² for small exchanges, to 360 kg/m² for a large exchange. For 5-shelved cabinets ('office height') this range is 270 kg/m² to 325 kg/m² respectively.

Rapid installation
The PRX/D has been designed to make installation as quick and effortless as possible. The easily managed hardware modules greatly facilitate exchange build-up and considerably simplify exchange projecting. The appropriate aggregation of modules can simply be positioned in the cabinet frame and interconnected by front-connecting preformed cables. Hence all installation procedures, and indeed maintenance operations, are conveniently performed from the front of the equipment.

Furthermore all modules are pre-tested at the factory prior to being dispatched to the exchange site. On-site testing is further reduced by the use of automatic test units and special purpose system-test programs.



Initial training of personnel
To enable the administration to install, operate, and maintain the PRX/D, training courses, conducted either at the Philips factory or on the customers premises, are provided. The unrivalled manageability of the PRX/D, both in terms of hardware and software, is reflected in the well ordered, stratified course structure, enabling experienced instructors, supported by comprehensive documentation, to fully instruct the customers personnel within in a comparatively short period.

Maintenance

Among the advanced system concepts embodied in the PRX/D is a multifunction software package which attends to the maintenance of the PRX/D with a minimum of human intervention. Coupled with hardware fault-detection provisions the package bestows the PRX/D with a high degree of "inherent maintainability", making it self-detecting, self-reporting and self-diagnosing. Should a fault condition develop alarm messages are passed automatically to designated operator stations, either remote or local. The exact nature of the alarm indication is dependent upon a number of factors, such as the time of day, and the presence or absence of maintenance staff. Among the more sophisticated solutions is the automatic setting-up of a telephone call to a predetermined number.
For a particular class of system faults, particularly those occuring in the switching network, the system is automatically reconfigured and the fault isolated from the remaining system parts.

To facilitate the tracing of faulty or suspect circuits Keyboard Display Units (KDU's) are provided. Maintenance instructions are simply keyed-in and actioned by the maintenance software package. In this way fault location is generally traceable down to circuit board level.

Administrative costs

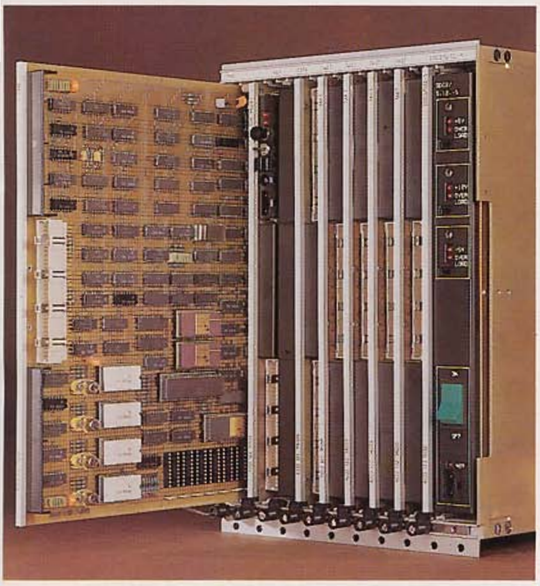
Administrative functions, such as tariff billing, subscriber number changes, routing changes and traffic control, are realized in software and implemented by keyboard action. Keyboard instructions can be entered in two dialog modes: a concise form for experienced operators; and a 'guided' form in which explanatory text is displayed to assist the machine operator.

Administrative functions may be actioned locally at the exchange site, or remotely in a centralised management centre to which a number of PRX/D exchanges can be connected. The installation of an accounting system in such a centre enables detailed billing information to be transferred, via data lines, from each exchange and dumped on magnetic tape for subsequent processing.

Power requirements

Power consumption of the PRX/D is remarkably low, primarily through the use of fast low-power Schottky TTL devices. Furthermore, the PRX/D only requires a small low-cost exchange battery since the voltage converters are designed to operate with wide fluctuations in the primary voltage supply. Because the PRX/D has been designed to operate without airconditioning equipment, the administration is only required to install inexpensive airconditioning equipment for the comfort of its personnel.

PRX/D undergoing testing for the German Bundespost



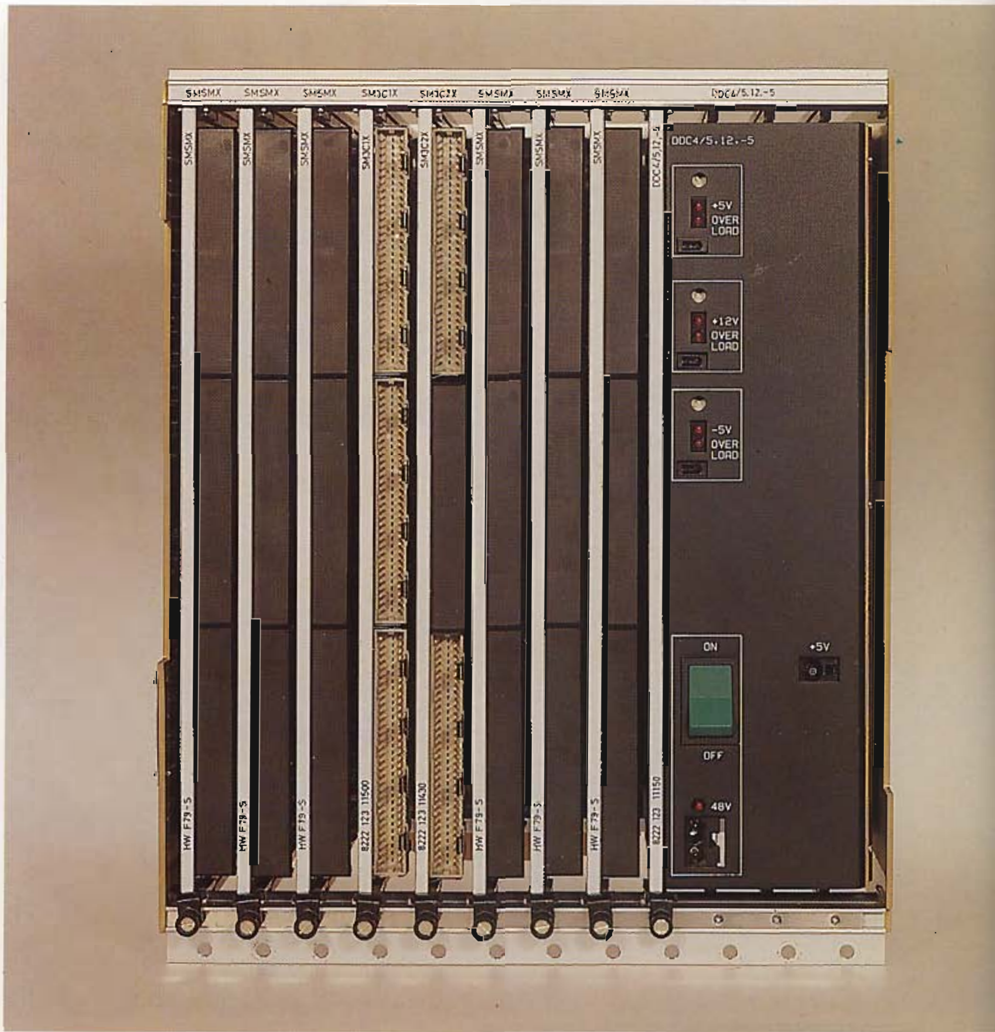
System enhancement
Although a newly introduced digital switching system can be claimed to exemplify the 'state-of-the-art', rapid developments in microcircuitry and memory concepts can soon result in its eclipse by a later generation of digital switching systems. With the PRX/D the 'state-of-the-art' provision can be perpetuated through the ability of the system to assimilate new technological developments. This important concept, enabling the administration to sustain maximal profitability, is realized by rendering the software virtually independent of hardware. This is achieved by producing virtual machine software structures and programming the Central Control in the CCITT high level language CHILL.

Correspondingly, the hardware modularity of the PRX/D facilitates the physical introduction of new technologies. Existing modules can simply be replaced by new, technologically advanced, but system-compatible versions.

System availability
Dispersed control, and the duplication and/or sectionalisation of system parts imparts to the PRX/D an extremely high degree of system reliability. System failure is essentially limited to small autonomous groups of lines or trunks, resulting in a graceful degradation of service. Indeed should a subscriber line circuit fail the facility exists to immediately access a spare line circuit located in the Signalling and Services unit.

Software reliability is ensured through the use of 'built-in' software checks which isolate fault conditions and prevent corruption of related software. Reliability is further enhanced by the use of the CCITT high level language CHILL which contributes to the readability and serviceability of programs.

System Outline of the PRX/D



The design philosophy of the PRX/D has been based on the two principal requirements of administrations in todays rapidly changing telephony environment: the need for smooth, economical growth as networks expand and subscriber needs change; and the ability to implement new technologies as they become economically feasible. The PRX/D is hence fully compatible and economically viable in analog, mixed analog/digital, and completely digital telephone networks; ensuring continuity to the administration in the evolutionary development of the network.

Final number of PCD's	Type of DTN	Number of DTN ports	Type of CC	Final traffic capacity	Max. number of subs. lines	Max. number of trunks
1	—	—	Remote control	100 E	250	—
3	—	—	TCP 16	300 E	600	380
15	T	2 048	TCP 16	1 500 E	3 000	1 900
63	TST	8 192	TCP 16 or TCP 36	6 300 E	12 000	8 000
504	TSSST	65 536	TCP 36	50 400 E	100 000	60 000

Table 1 Overview of PRX/D exchange configurations

The complete range of applications (table 1), from small remotely located subscriber line concentrators to large capacity transit exchanges, is configured from three basic building blocks: (fig. 1)

- Peripheral Control Domain (PCD)
- Digital Trunk-Link Network (DTN)
- Central Control (CC)

A Peripheral Control Domain is a compilation of interactive functional units which interface the exchange to the outside plant and offer a high degree of autonomy in dealing with telephony processes.
It represents a uniform building block with a fixed traffic capacity of approximately 100 erlangs. Equipped with the required interface units and a non-blocking switching stage, it can serve 128 high-traffic connections, such as interexchange trunks, or 256 low-traffic lines – subscriber lines – or combinations of both.

The Digital Trunk-link Network is a data-transparent switching network for establishing bit-stream connections between attendant Peripheral Control Domains. The network, depending upon the required capacity, is composed of time switches or combinations of time and space switches.

The Central Control consists of two main parts: the Central Processing System (CPS) and the Central Control Interface (CCI) which includes the Central Clock (CCL). The Central Control controls line

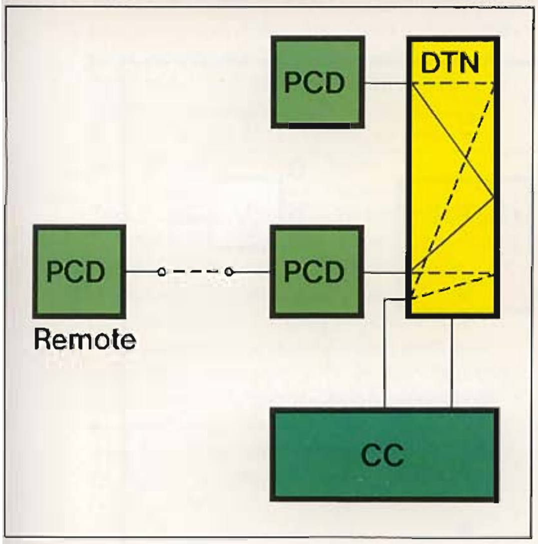


Fig. 1 PRX/D Block diagram

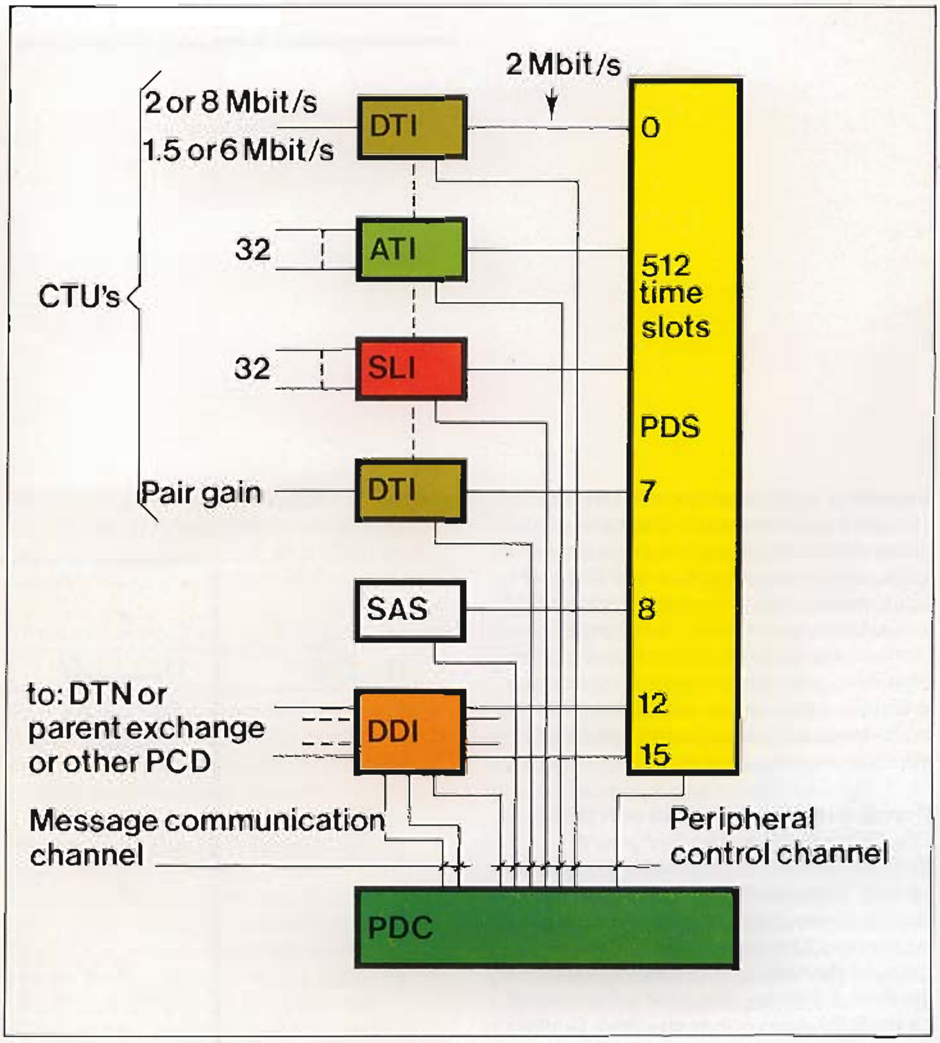


Fig. 2 Peripheral Control Domain PCD

interconnections, routing, charging, and configuration management.

There are two basic types of Central Processing System: the TCP 16 and the TPC 36. Both systems are modular, facilitating the addition of control power in rational increments, and have overlapping processing capacities.

Thus with this basic building block arrangement the PRX/D represents a linearly expansible switching system which covers the range from 250 to 100,000 subscribers and 100 to 50,400 erlangs.

Peripheral Control Domain (PCD)

The main elements of a Peripheral Control Domain are: the Circuit Terminal Units (CTU's), the Peripheral Domain Switch (PDS), the Signaling and Services unit (SAS), the Domain-to-DTN Interface (DDI), and the Peripheral Domain Controller (PDC). A schematic diagram is given in fig. 2.

For terminating digital trunks which utilize Common Channel Signaling and in the case of a local PCD used to connect remote PCD's to the exchange, the PCD is devoid of the Peripheral Domain Switch (PDS) and the Signaling and Services unit (SAS).

Circuit Terminal Units (CTU's)
The Circuit Terminal Units directly interface the PRX/D exchange with the outside plant. A CTU terminates up to 32 lines or trunks, analog or digital, and provides a standard 2Mbit/s interface to the Peripheral Domain Switch (PDS).
There are essentially three types of CTU:

A Subscriber Line Interface unit (SLI) for terminating 32 analog or digital subscriber lines.

An Analog Trunk Interface unit (ATI) for terminating 32 analog trunk lines.

A Digital Trunk Interface unit (DTI) for terminating either a 30-channel or 24-channel PCM transmission system.

Peripheral Domain Switch (PDS)
The Peripheral Domain Switch (PDS) is a non-blocking time switch with 512 independent switchable timeslots to which 16 2048kbit/s bit-streams can be connected. To these 16 2048kbit/s bit-streams can be connected 8 CTU's, one SAS, and one DDI. Thus the PDS establishes time-slot interconnections between these devices in accordance with directives received from the Peripheral Domain Controller.

For all but the smallest exchanges, where a maximum of three peripheral control domains can be interconnected to form an exchange, a digital trunk-link network providing additional switching elements is required.

Signaling And Services unit (SAS)
The SAS contains multi-frequency generators and receivers, tone generators, and subscriber line and SLI test equipment. Line connections to the SAS are established via the Peripheral Domain Switch. The tones required for signalling and telephone user guidance are stored digitally in memories. For multi-frequency tone reception use is made of digital correlation techniques.

Domain-to-DTN Interface unit (DDI)
The DDI interfaces the Peripheral Control Domain to attendant exchange blocks. The precise nature of the interface is dependent upon the functional relationship between the Peripheral Control Domain and the associated exchange blocks. Thus for a Peripheral Control Domain connected to a Digital Trunk-Link Network of the TST or TSSST type the DDI establishes a duplicated 8Mbit/s bit-stream interface. For all other configurations the DDI establishes a 2Mbit/s bit-stream interface.

In all instances the DDI presents a standard internal functional interface to the Peripheral Control Domain.

Peripheral Domain Controller (PDC)
The PDC provides control and administration facilities to the functional units of the Peripheral Control Domain. It is equipped with a microprocessor and associated memory, a crystal oscillator subordinated to the central clock and providing the whole domain with clock and synchronisation pulses, and additional circuitry for providing interrupt and domain integrity provisions.

The principal function of the PDC is to translate telphone information peculiar to the PCD into standardized messages for communication with the Central Control (CC), and vice-versa. It therefore controls the line/trunk circuits, signalling procedures, time supervision and the Peripheral Domain Switch.

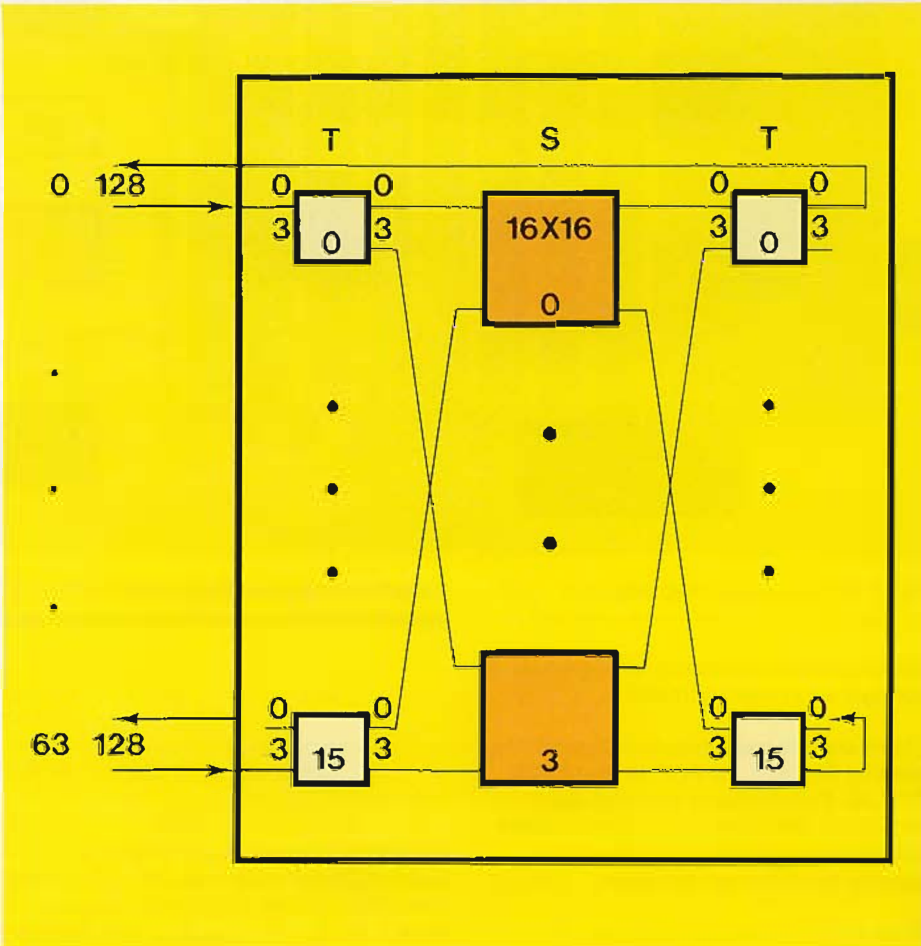


Fig. 3 Digital trunk-link network of the type TST

Depending on the size of the exchange, the DTN consists of time switches, or a combination of time (T) and space (S) switches, configured to provide full availability and facilitate growth simply through the addition of extra switching blocks.

Three basic structures are recognizable in the continuous spectrum of DTN configurations. These have a T, TST, and TSSST configuration respectively. (fig. 3)

Central Control (CC)

The DTN is completely sectionalised, enabling corrupted sections to be completely isolated from the remainder of the network. Full availability is assured either through duplication of the DTN, for TST and TSSST types, or through load sharing for the T type.

The DTN transfers 16-bit words through the network: 8bits representing speech or data, and 8 bits used for control, checking, and establishing a direct signalling path between PCD's. It is completely data transparent and bit-sequence independent. In addition the DTN effects the transfer of messages between the Central Control and the Peripheral Control Domains through the establishment of semi-permanent connections.

The Central Control provides exchange administration facilities. It consists of a Central Processing System (CPS) and a Central Control Interface (CCI).

The Central Processing System provides the data-processing facilities for handling traffic, routing, and charging. With the PRX/D system two basic types of processor are available: the TCP 16, for small to medium exchange configurations and the more powerful TPC 36 for larger exchange configurations. Both the TCP 16 and TCP 36 processors may be internally expanded in modular steps to their maximum memory capacities as the exchange grows. When the control power demands exceed the capacity of a single processor complex, additional processors may be added enabling the PRX/D to handle up to 200 calls per second.

The software for the CPS is written in the CCITT high level language CHILL. The use of this machine independent language results in improved software reliability, understandability, and maintainability, facilitating complete customer involvement in the generation and maintenance of exchange software.

The Central Control Interface (CCI) consists of the Central Clock (CCL) and a compilation of message communication handlers.

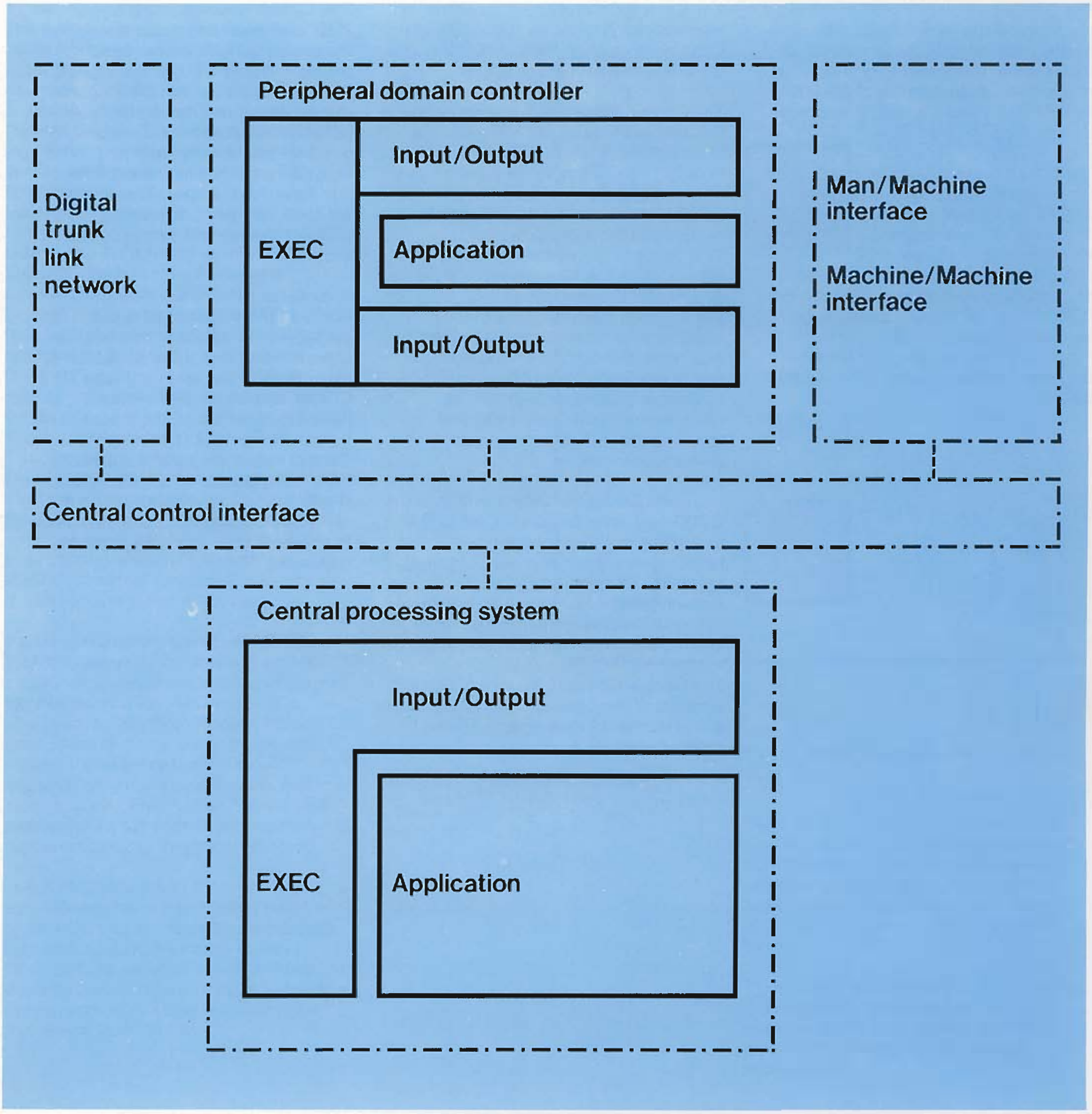
The Central Clock, containing stabilised quartz oscillators provides the exchange with the required timing and frame alignment signals. The oscillators can function autonomously or subordinated to a local primary time standard (caesium oscillator) or to external timing signals derived from one or more connected exchanges. This facility enables the PRX/D to work in plesiochronous and synchron ous networks.

The message communication handlers interface the CPS with exchange message communication channels and with various classes of utility equipment, and data lines. The CCI therefore includes protocol handlers for establishing message transport interfaces between the Central Processing System and: the Peripheral Domain Controllers; the Digital Trunk-Link Network; and the utility equipment, including data lines to a remote operations and maintenance centre.

Software

The employment of a dispersed control structure, with microprocessors in the periphery of the exchange directly communicating with a Central Control, produces a physical and functional division within the PRX/D software structure (fig. 4).

Fig. 4 PRX/D Software organisation



The software in the dispersed Peripheral Domain Controllers attend to the time-consuming repetitive telephony functions, while the Central Control software performs the 'high-intelligence' functions such as: call processing, resourse mangement, charging etc.

Both the PDC and the CC software are similar in structure and consist of discrete functional modules which can be compiled according to the exchange requirements. With this modular structure, and attendant software provisions, the PRX/D software offers a number of advantageous features:

Reliability
High software reliability is achieved by the use of advanced technology in the design, implementation and testing of programs and data. The software of the Central Control has been programmed almost entirely in the high-level CCITT programming language CHILL, which yields the following advantages:

- CHILL allows a high degree of static verification of programs enabling the majority of programming errors to be detected and corrected at an early stage, greatly contributing to the ultimate reliability.

- CHILL uses a number of concepts and constructions which greatly support the programming and multi-processing systems, e.g. processes, critical sections, synchronisation, communication primitives, etc.

- CHILL improves the readability and serviceability of programs, easing the maintenance of the initial high quality of the software throughout the life of the system.

Both Central Control and Peripheral Domain Controller software packages comprise carefully defined functional modules, with special attention having been given to the defining and guarding of the interfaces between modules. All software is subject to stringent testing at the module, subsystem and system levels.

Flexibility
The software in both the Peripheral Domain Controllers and the Central Control is divided into three main categories: executive software (EXEC); input/output software; and application software.
EXEC is responsible for machine handling and offers provisions by which the application software can be managed and executed in a simple manner via a virtual machine interface.
The input/output software deals with the channel equipment and utilities surrounding the basic machine and offers provision for message communication between the application software and the utility equipment, external machines and application software of directly connected system parts.

Modularity and flexibility are achieved by a clearly defined separation between the three categories of software and by the introduction of functional modularity within each of the three categories. Software additions or substitutions on existing plant can therefore be effected in a comparatively simple manner, on-line, without affecting normal operation.

Safeguarding
To locate and isolate software faults the system, in its operational phase, incorporates a number of trouble shooting provisions. If a software fault does occur a trace program is automatically activated to save the relevent data and make rectification of the fault easier.

The hardware is also checked by regular periodic tests controlled by the software as well as continual comparison checks between dual equipment; any discrepancy resulting in immediate validity checks. The faulty equipment is isolated by the software configuration control and the operational equipment configured to maintain fully operational status. Internal message communication between application software of Pheripheral Domain Controllers and Central Control follows a special procedure which controls transfer and prevents loss of information. In addition, data transfers to and from the central memory of the system are safeguarded at each end of the transfer action to prevent losses.

Standardisation
The load tape for the Central Processing System of an individual exchange is assembled by selecting a number of precompiled modules suiting the functions which the hardware has to perform. Dimensional data is then added before the system is initialised, after which the installation data is read in.
The Peripheral Domain Controller software comprises a number of standard packages which are read in via the Central Processing System back-up memory under control of a bootstrap program in the PROM of the Peripheral Domain Controller itself. Dimensional data for the Peripheral Domain Controller is generated by the Central Processing System.

PRX/D specification

Application Status	Remote Concentrator Local Exchange Tandem Exchange Transit Exchange
Application Range	
System	256-100,000 lines 128- 60,000 lines
PCD (inlet)	256 lines
(outlet)	128 channels
Traffic Handling Capacity	
System	100-50,400 Erlangs
PCD	100 Erlangs
Call Handling Capacity	upto 200 calls/sec. or 720,000 BHCA.
Signalling	
Subs. line	Rotary dial Push button
Trunk	All signalling systems, including E and M, R1, R2, C5; common channel signalling C6 and SS7 (C7).
Routing Capability	Complete flexibility
Charging	charge free, Fixed rate, Multi-metering Automatic Message Accounting (AMA).
Subscriber Loop Resistance (incl. telephone set)	2,000 ohm
D.C. Trunk Loop Resistance	3,000 ohm
Line Leakage Resistance	15k ohm (subs. lines) 20k ohm (trunks)
Digital Trunk Interface	
Bits per channel	64 kbits/channel
PCM coding	CCITT, A-law and μ-law
Standard Operating Voltage	
range	–44 V to –55 V
nominal	–48 V

Operating Conditions	
temperature	– 5° to 45°C (guaranteed) –15°C to 55°C (for short period)
Humidity	10% to 85% (guaranteed) 5% to 95% (for short period)
Cabinet Dimensions	
Height (including superstructure)	2,760 mm (6 shelves) 2,348 mm (5 shelves)
Width	950 mm
Depth	430 mm
Module Dimensions	
height	300 mm
width	variable
depth	310 mm Standard printed circuit card dimensions: 236 x 279 mm
Floor Load	cabinets with 6 shelves 300-360 kg/m² (average); cabinets with 5 shelves 270-325 kg/m² (average)
Equipment Cooling (including processor)	Separate natural convection cooling for each shelf. No forced cooling.

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Printed in the Netherlands
Data subject to alterations without notice

3256-5-80E