

ARE 13- SPC transit exchange system

LM Ericsson SPC telephone switching systems.

The ARE 13 transit exchange has been designed to fit easily into any telephone network and to be an efficient tool for all telephone administrations.

It uses a recently developed data processing control system optimized for telephone switching applications.

Its complexity is only a fraction of that of contemporary systems and its capacity is outstanding.

The data processing system is easy for switching engineers to understand and maintain — even without thorough training in SPC techniques.

ARE 13 has a local exchange counterpart — ARE 11. The flexibility and wide range of applications of these two systems make it possible to introduce SPC facilities everywhere in a nationwide network.

Main advantages

Extraordinary flexibility and range to improve the long distance network at all levels

Thanks to its extraordinary flexibility, ARE 13 may be used to improve the quality and economy of the long distance network at all levels, from small and medium-sized primary centres to very large national or international switching centres.

The switching network is built up from a number of identical group selector units with 200 inlets. Forty group selector units form one exchange unit with 4,000 incoming and 4,000 outgoing multiple positions. Three exchange units may be interconnected for a final capacity of 12,000 incoming and 12,000 outgoing multiple positions and a traffic capacity of 9,000 erlangs.

The flexibility of the data processing system matches that of the switching network. Each exchange unit is controlled by a processor group with two to twelve traffic control processors. An ARE 13 exchange with 3 exchange units handles about 300,000 calls per hour.

Thus ARE 13 matches traffic and call handling requirements within a very wide range. Undue investments are avoided and extensions are made in small and economic steps.

A stored program control system that is adapted to switching systems and switching engineers

Distributed call processing, efficient software and a powerful multiprocessor system provide the flexibility, wide range and large ultimate capacity necessary for a universal transit switching system.

A number of novel SPC design features make the data processing system of ARE 13 easy to understand, operate and maintain.

Maximum trunk utilization for network economy

Maximum trunk utilization provides network economy and is a major design goal for transit exchanges. ARE 13 achieves this goal by

- high traffic handling capacity
- high inlet load
- low internal congestion
- full availability for all route sizes up to 1920 trunks
- alternative routing and rerouting

Traffic handling functions to cover all practical situations

The data processing control system provides traffic handling functions that cover all practical situations.

ARE 13 handles any specified signalling system, including common channel signalling. Eight different register signalling systems may be used in one exchange, while the number of line signalling systems is unlimited.

The digit analysis meets the requirements of any routing or charging plan - multimetering or toll ticketing as desired.

Four-wire switching plus switchable pads and echo suppressors contribute to the excellent transmission characteristics of ARE 13.

Cordless switchboards with digit display units facilitate the work of the operators and offer a large number of traffic and charging alternatives for operator-assisted traffic.

A powerful operation and maintenance system plus remote control

Operation and maintenance functions are concentrated to a separate operation and maintenance processor OMP so as not to interfere with the traffic handling. All software for supervision, testing, traffic measurements, traffic statistics, alarms, modification of exchange data and input/output functions are located in OMP.

The operation and maintenance processor handles man-machine communication via input/output devices located at the exchange or at a remote operation and maintenance centre OMC.

System principles

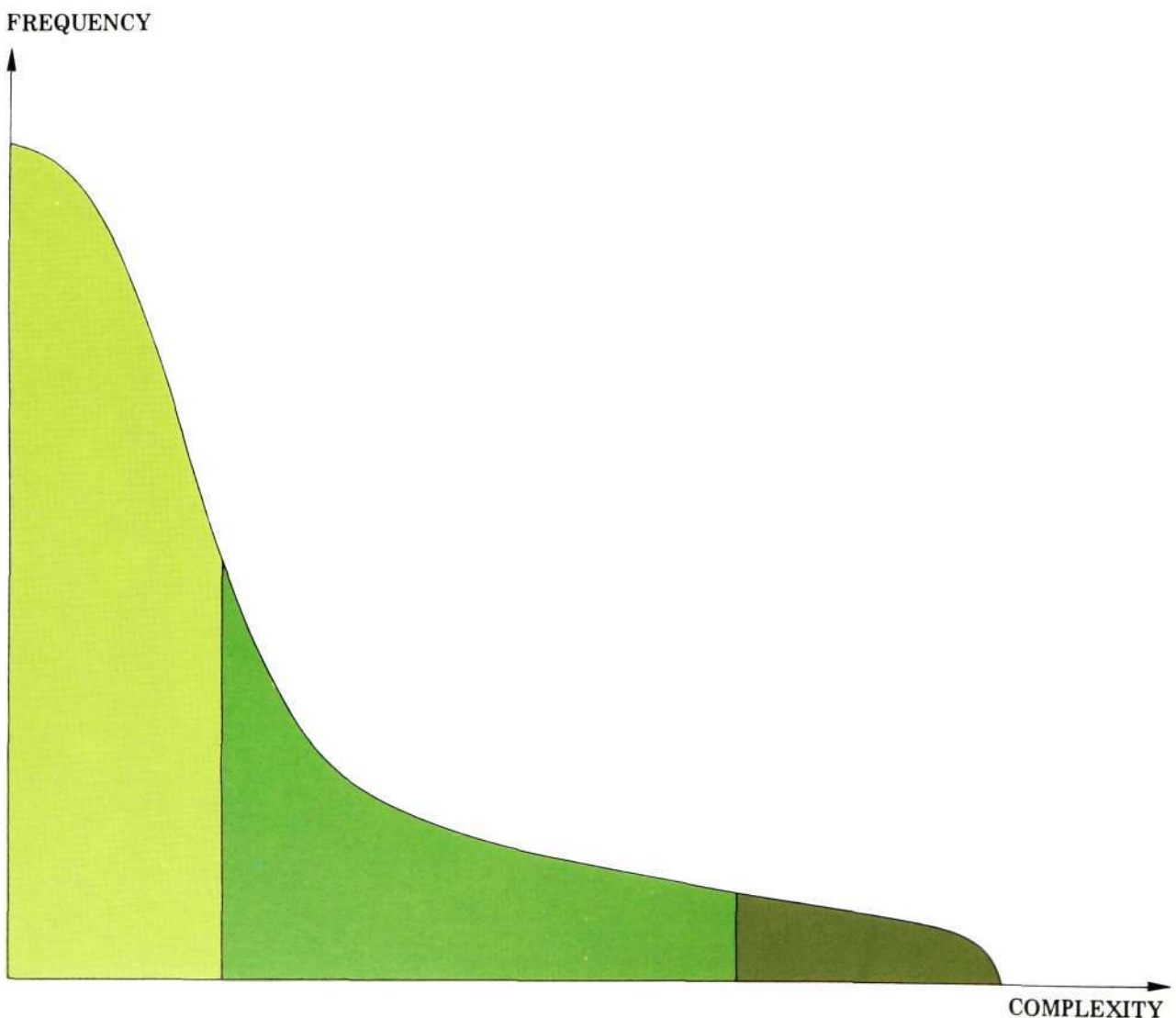
Frequency versus complexity for telephone exchange function

Telephone exchanges perform many different functions. Some of these are simple routine functions unlikely to change during the life of the exchange but, as they occur frequently, they represent a considerable part of the control system load.

Other functions are complex and likely to be modified quite often. Fortunately they occur less frequently, perhaps only once per call.

Fault localization and other maintenance functions are generally the least frequent but also the most complex tasks in a telephone exchange.

If an SPC control system is to be optimized for switching applications, many different factors must be taken into account. The correlation between the frequency and the complexity of the switching functions is one of the most important of these factors.



Separation of switching functions increases control system capacity

The control system of ARE 13 is designed to take full advantage of the correlation between frequency and complexity for transit exchange functions.

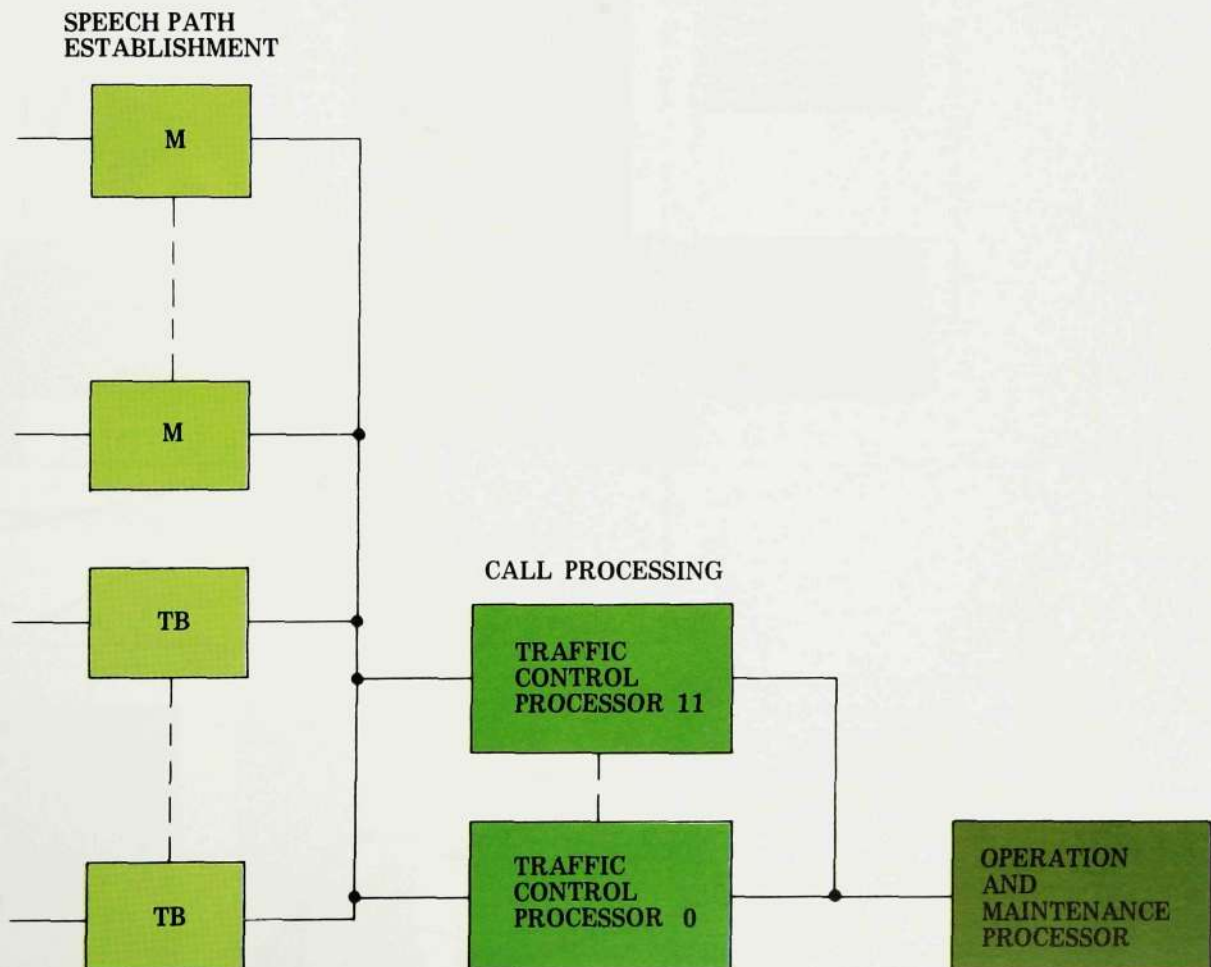
The establishment of speech paths through the switching stages is a permanent, unintelligent routine function. As little can be gained by processor control of this function, it is handled by peripheral, wired logic devices M and TB. TB selects an individual trunk from a set of trunks, preselected by the data processing system, while M selects a path through the switching network and operates the switches in order to establish a connection between the incoming trunk and the outgoing one selected by TB.

Call detection is another permanent routine activity that is handled autonomously to remove the load of trunk scanning from the central processing system.

Intelligent traffic handling functions, on the other hand, are controlled by traffic control processors TCP. Operation and maintenance functions and input/output devices are controlled by an operation and maintenance processor OMP. The two processors are identical but use different software.

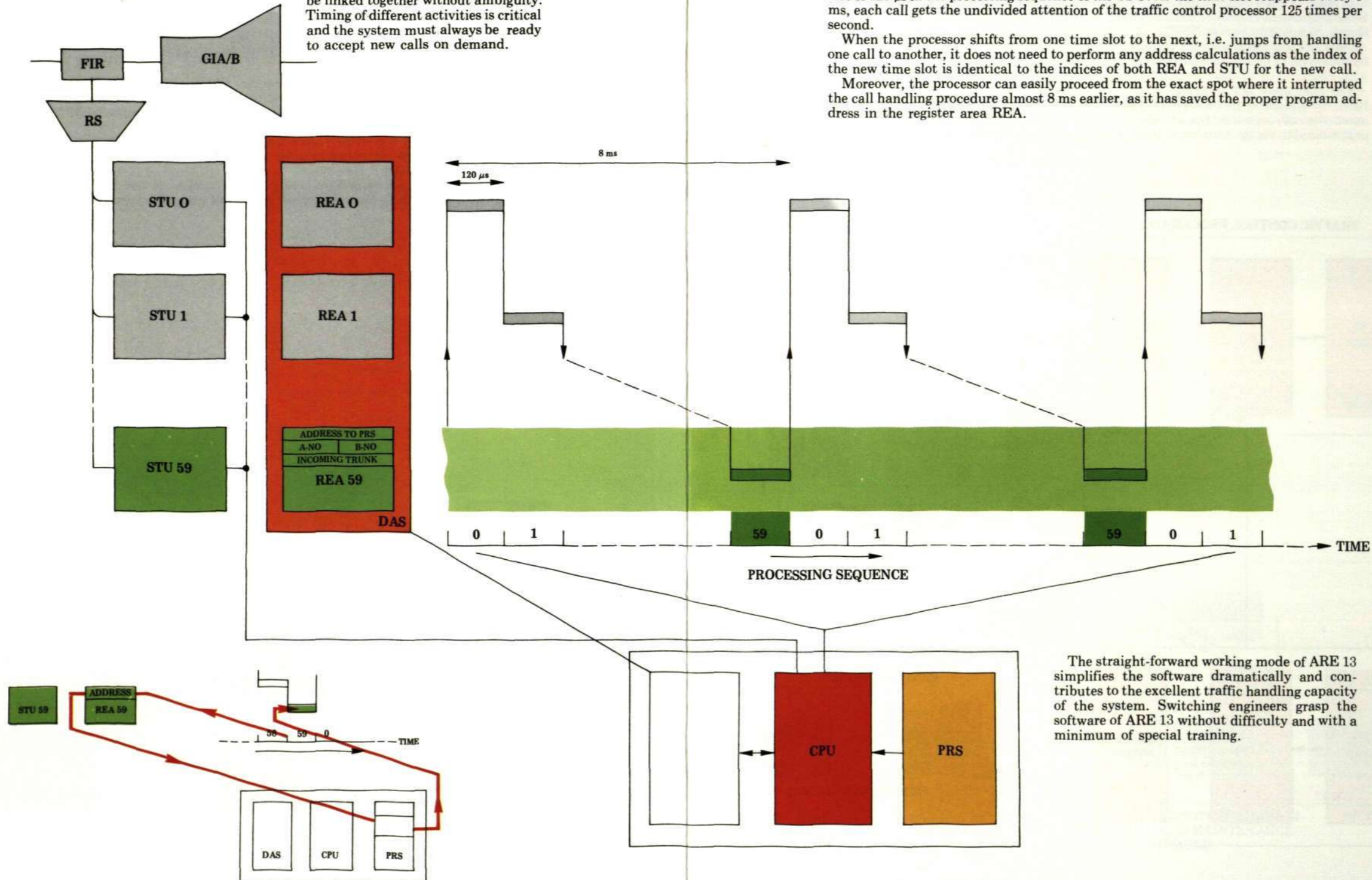
Twelve TCP and one OMP form a processor group. Three such groups may work together in one exchange in order to provide a call handling capacity of 300,000 calls per hour.

The minimum control system configuration consists of two TCP and one OMP, which is suitable for small transit exchanges with a few hundred incoming trunks.



The working mode of ARE 13 saves processing power and simplifies internal job administration

A fundamental problem for the SPC exchange designer is how to organize the internal work of the data processing system to cope with the traffic load. Many hundred calls in different stages of completion must be handled simultaneously. Each one of these involves components and devices in different parts of the exchange, which must be linked together without ambiguity. Timing of different activities is critical and the system must always be ready to accept new calls on demand.



This means that the data processing system must jump from one call to another and from one activity to another, keeping track of all devices belonging to every call and determining the exact time between all activities. The data processing system must use a considerable part of its processing power to arrange all jobs in a suitable sequence. This is one of the major reasons for the complexity and low traffic handling capacity of many SPC exchange systems.

ARE 13 solves this problem by a simple and elegant method. For every new call, peripheral devices connect the speech wires to an idle signalling transfer unit STU, where they can be accessed by the central processing unit CPU whenever needed.

Each STU has its own register area REA in the data store and its own recurring time slot of 120 μs in the processing sequence of the CPU. As the time slot reappears every 8 ms, each call gets the undivided attention of the traffic control processor 125 times per second.

When the processor shifts from one time slot to the next, i.e. jumps from handling one call to another, it does not need to perform any address calculations as the index of the new time slot is identical to the indices of both REA and STU for the new call.

Moreover, the processor can easily proceed from the exact spot where it interrupted the call handling procedure almost 8 ms earlier, as it has saved the proper program address in the register area REA.

The straight-forward working mode of ARE 13 simplifies the software dramatically and contributes to the excellent traffic handling capacity of the system. Switching engineers grasp the software of ARE 13 without difficulty and with a minimum of special training.

An optimized store organization provides economy, reliability and remote control

The hardware structure of the multiprocessor data processing system of ARE 13 matches the simplicity and elegance of the software structure. The organization of program and data stores is carefully designed to suit telephone switching requirements.

Three types of information must be available in a true SPC system: 1) programs that control the traffic handling functions, 2) variable data that describes the progress of every call, and 3) semi-permanent reference data for analyses, translations etc.

In ARE 13 each traffic control processor TCP has its own program and data stores. Semi-permanent reference data is rarely accessed and is therefore stored in central stores, common to twelve TCP.

Only one central store, the translation store, is used for normal transit exchange applications. Two additional central stores provide registerless terminal exchanges with abbreviated dialling and category facilities.

The data store is a dynamic MOS memory that is divided into 60 register areas REA. Each register area serves one call at a time and stores all temporary information about the call, including the address to the program that is to be executed during the next time slot. As the number of time slots is limited, the traffic control processor can

never be overloaded. Momentary loss of all information in the data store affects only those calls that are being handled at that moment.

The program store is a programmable read only memory - PROM - and the contents of this can never be lost or mutilated.

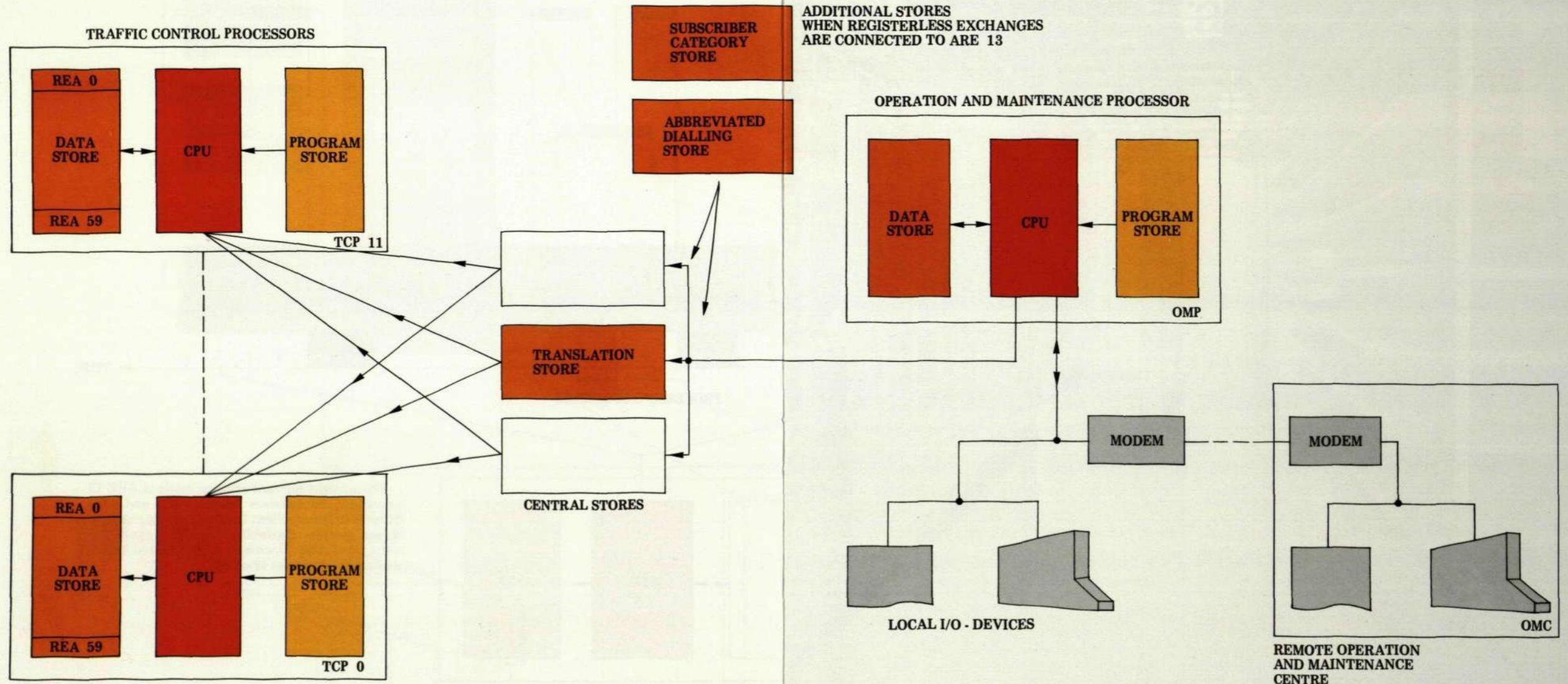
The programs define general functions, which are rarely changed, while the contents of the central stores give these functions the special significance that separates one exchange from another.

Everyday work like temporary disconnection of non-paying subscribers or changes of the routing pattern are readily performed at the exchange or from a remote operation and maintenance centre OMC by modification of the contents of the central stores.

If the functions themselves are to be changed, for example if a new signalling system is to be added, a new program board is simply added to the program store. Standard interfaces provide functional modularity.

Software faults are not easily spread by the CPU, as it normally writes only in the data store where a software fault has little effect and will soon be erased.

The general design of the processor group in ARE 13 is well adapted to switching applications. Economy and flexibility are combined with simplicity and reliability.





Practical design

Call handling in ARE 13

An incoming call is switched from the trunk to an idle signalling transfer unit STU by peripheral wired logic devices. This relieves the traffic control processors TCP of trunk scanning.

The traffic control processors check the call wires of their idle STUs every 8 ms. This is a simple procedure, as the register areas of idle STUs contain the address to the program that checks the call wire.

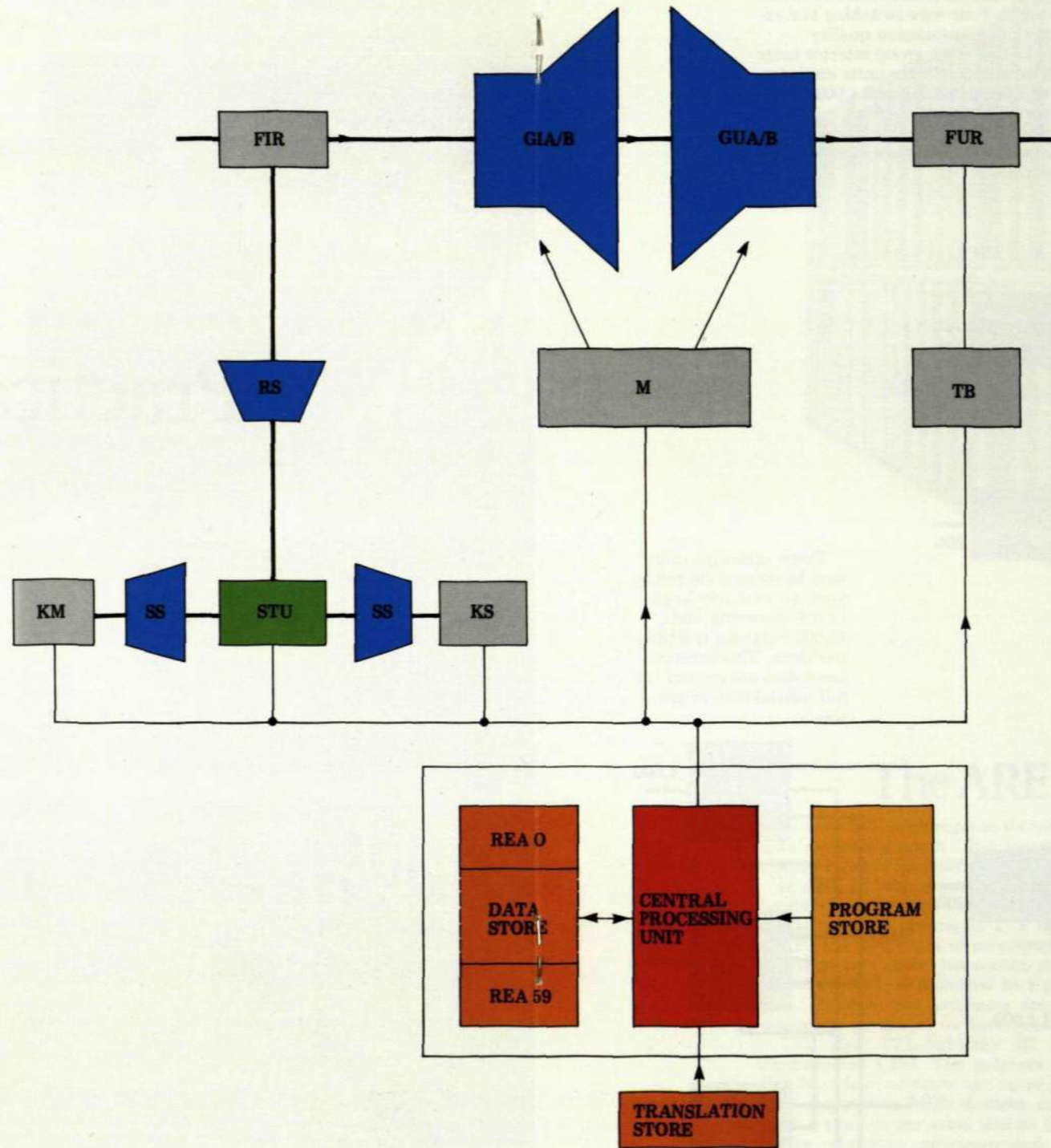
When the TCP detects a new call, it takes full command of the call at once, identifies the incoming trunk and stores this identity in the register area together with a new program address.

During the next few time slots allocated to the STU serving the new call, the traffic control processor finds relevant data for the calling trunk, register signalling system, multiple position etc. and stores this information in the register area. The proper type of code receiver is connected.

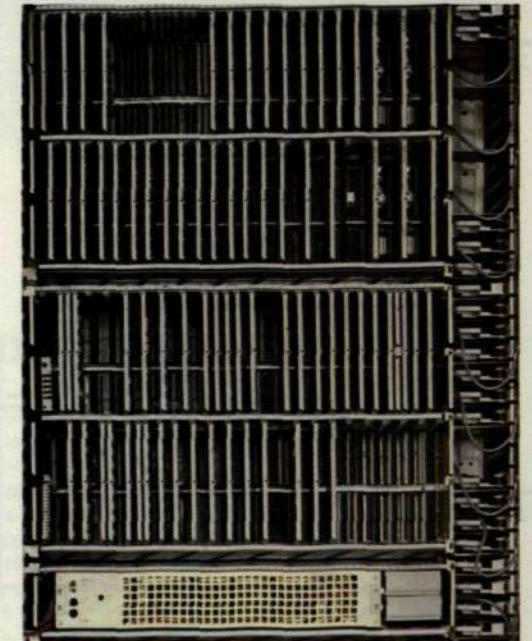
As the establishment of the call proceeds, other programs control digit reception, B-number analysis for routing and charging, and so on.

When the outgoing route has been determined, TCP selects a test block TB which has access to idle trunks in this route. TCP orders the test block to make a random selection of one of the idle trunks. When this has been done, TCP transfers the identities of the incoming and outgoing trunks to a free marker that selects an idle path through the switching network and operates the switches.

This separation of traffic handling functions simplifies software and saves processing power, while all the advantages of stored program control - flexibility, intelligence and remote control - are fully retained.



SWITCHING STAGES



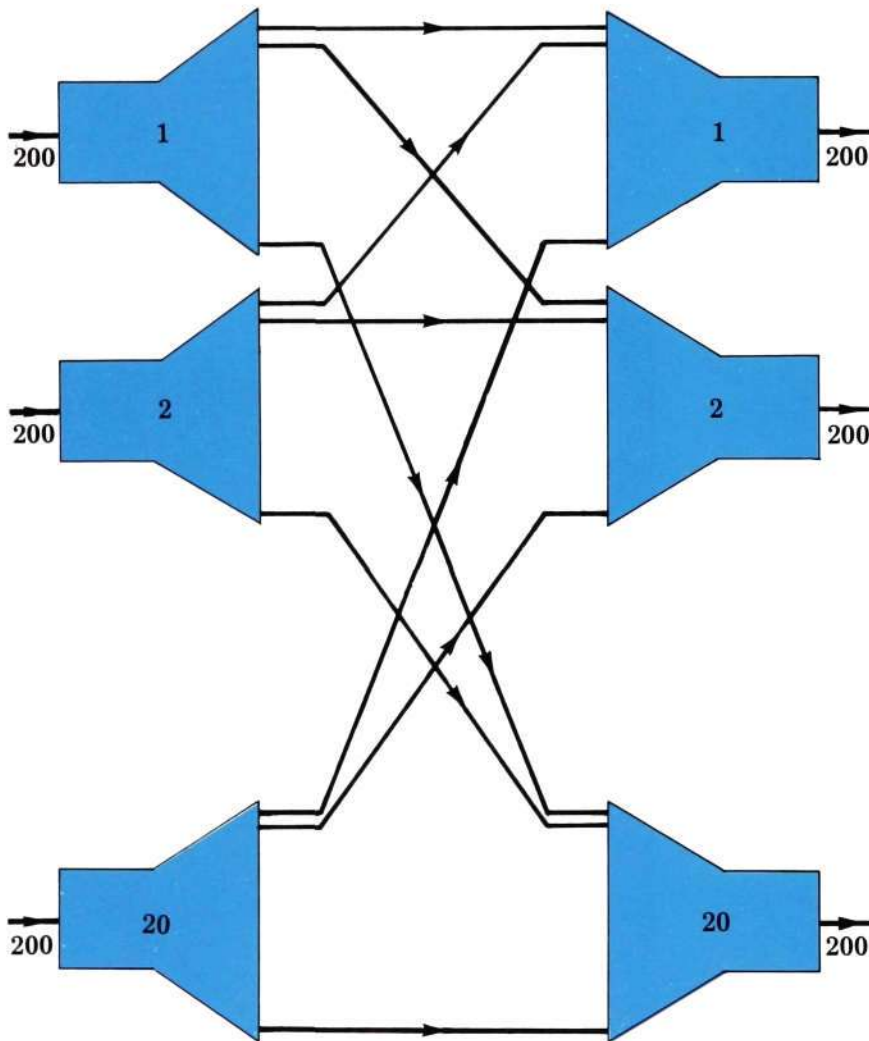
TRAFFIC CONTROL PROCESSORS TCP

Switching network

The switching element in ARE 13 is the rugged, reliable LME Crossbar switch proven under difficult conditions all over the world. Four-wire switching and excellent contact properties contribute to the perfect transmission quality.

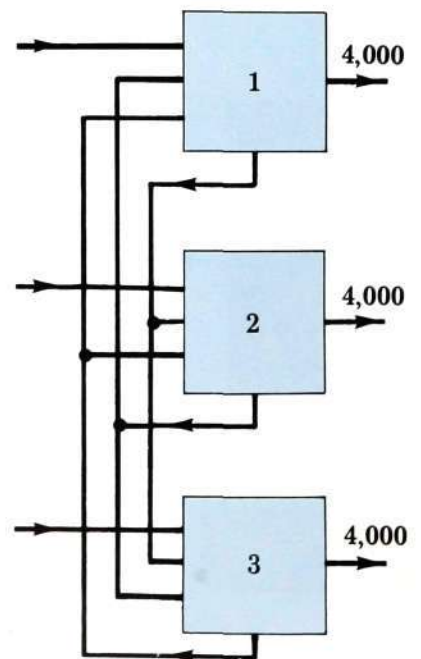
The switching network consists of a number of two-stage group selector units with 200 inlets, 200 links and 500 outlets. These group selector units are interconnected to form an exchange unit with up to 4,000 incoming and 4,000 outgoing multiple positions.

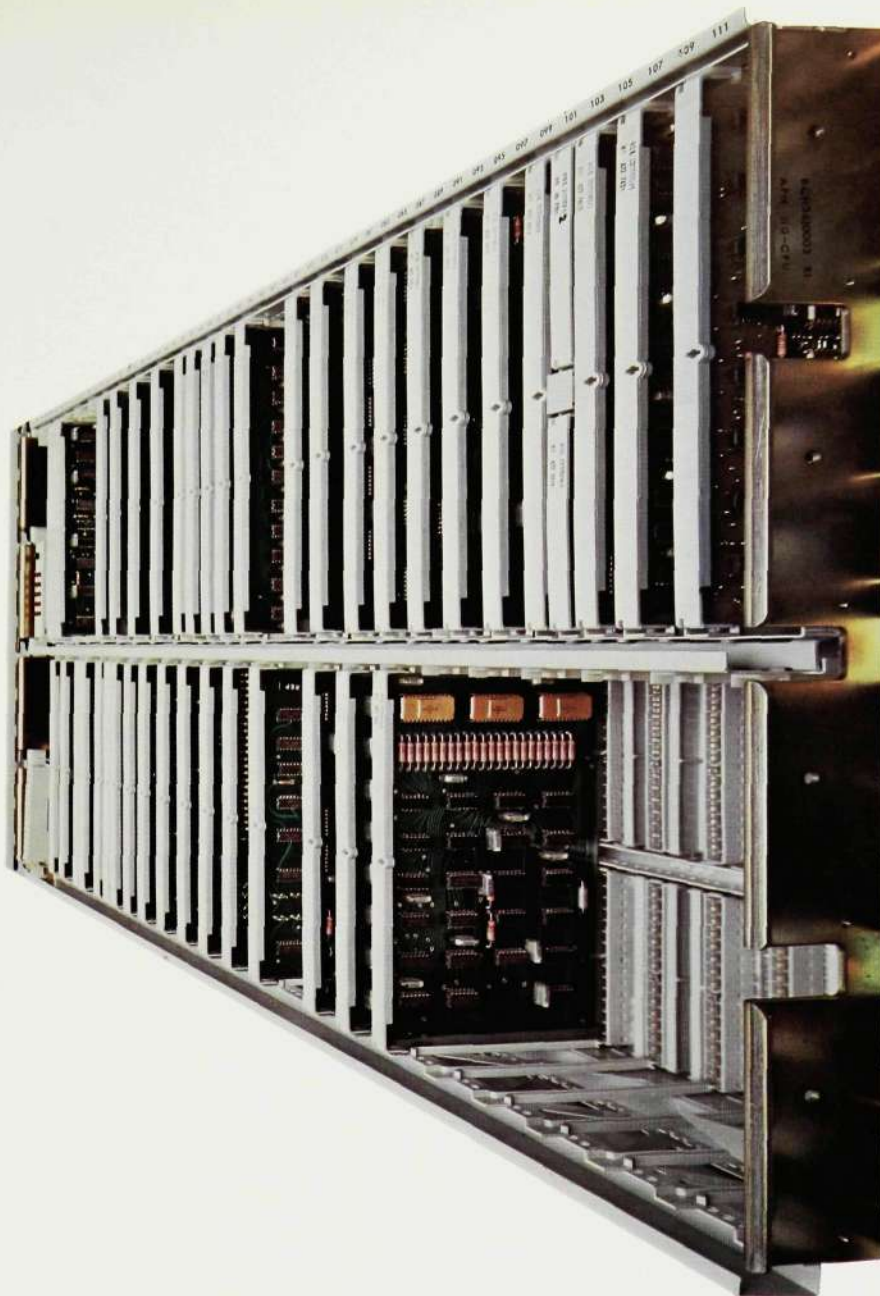
The switching network of the exchange unit is very flexible and may be arranged as a one-way, both-way or mixed network. It tolerates a load of 0.75 - 0.85 erlangs per inlet at 0.2 % internal congestion.



One exchange unit with 4,000 incoming and 4,000 outgoing multiple positions.

Three exchange units may be interconnected to form an exchange with 12,000 incoming and 12,000 outgoing multiple positions. This arrangement does not restrict the full availability in any way.





The ARE 13 Processor

In most SPC exchanges to-day, it is possible to vary the store sizes but not the data processing power. This means that it is possible to vary the size of the exchange but not its traffic handling capacity.

In ARE 13 both stores and data processing power may be varied within wide limits. One exchange unit is controlled by a processor group with two to twelve traffic handling processors TCP and one operation and maintenance processor OMP. The two types of processors are identical but have different software.

The picture shows the central processing unit CPU, which occupies one shelf unit only. This is delivered as a pre-tested unit and is connected by plug and jack. Routine test programs are available for testing the CPU, as well as diagnostic programs for fault localization.

TTL and TTL-Schottky IC circuits are used in the modern, micro-programmed CPU. The program store is a programmable read only memory PROM, whose contents can never be lost or mutilated. The data store uses large scale integration MOS memory components. The program and data stores occupy a shelf of the same size as that of the CPU.

The reliability, efficiency and modularity of the ARE 13 data processing system set new standards for SPC telephone exchanges.

Applications

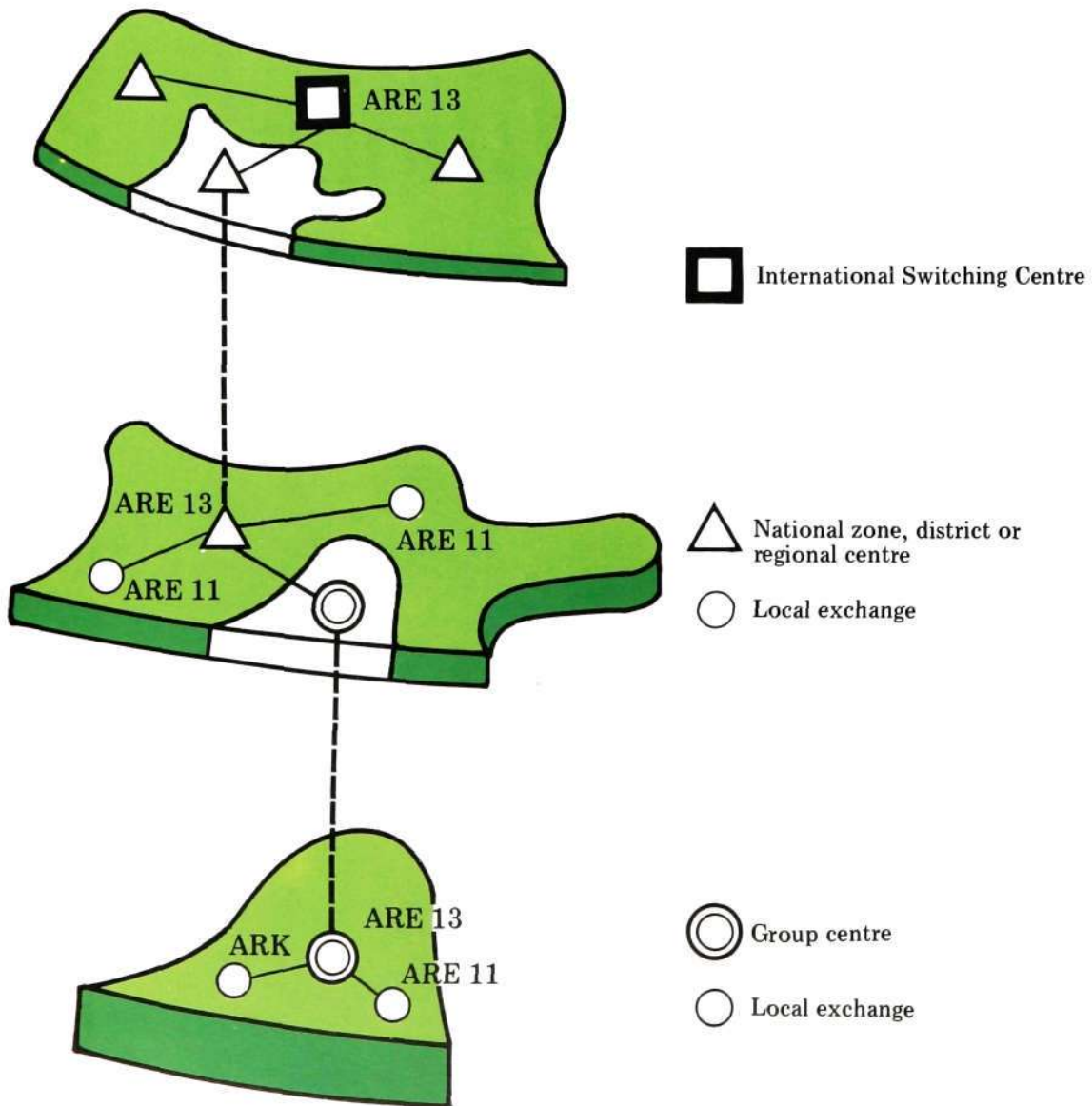
ARE 13 – a standard solution for all levels of the long distance network

The demands on transit exchanges vary considerably with their positions in the long distance network hierarchy.

The most important properties at the lowest level are usually low initial cost, reliability and simple operation and maintenance.

Other factors like large ultimate capacity, contribution to overall network economy, ability to handle complex traffic cases and flexible adaptation to unforeseen developments come in the foreground at higher levels.

With modular design and flexible software, ARE 13 provides a very favourable standard solution for all levels of the long distance network.

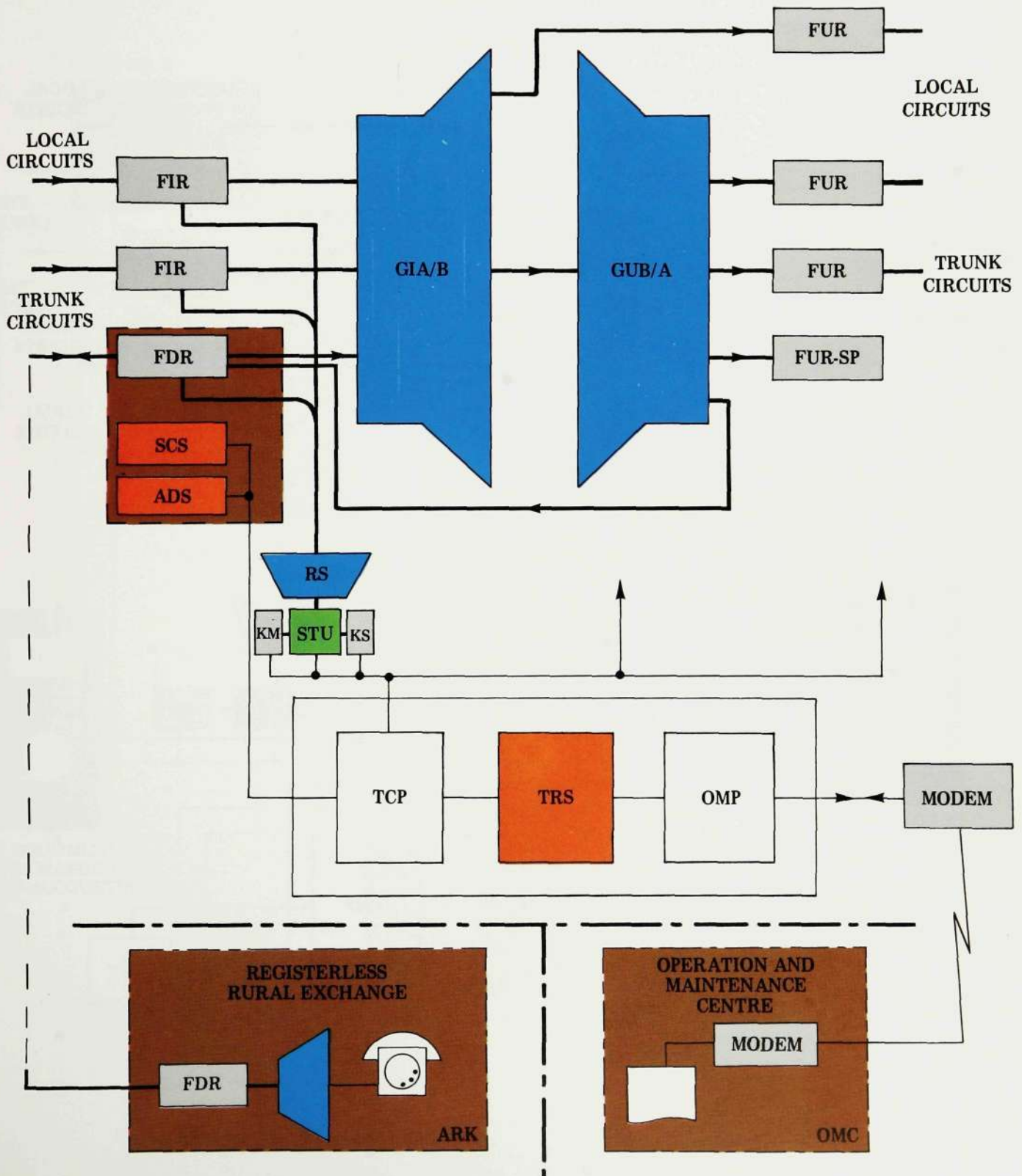


ARE 13 in rural networks

The modular design and the relative simplicity of ARE 13 make this system the ideal choice for the introduction of stored program control at the lowest levels of the long distance network.

A special advantage is that ARE 13 offers new services for subscribers connected to rural terminal exchanges without local registers. Calls originating from such exchanges are handled by the ARE 13 data processing system, which has access to subscriber data in two optional central stores - the abbreviated dialling store ADS and the subscriber category store SCS.

Operation and maintenance activities, including modifications of the contents of the optional stores, may be performed from a remote operation and maintenance centre OMC.

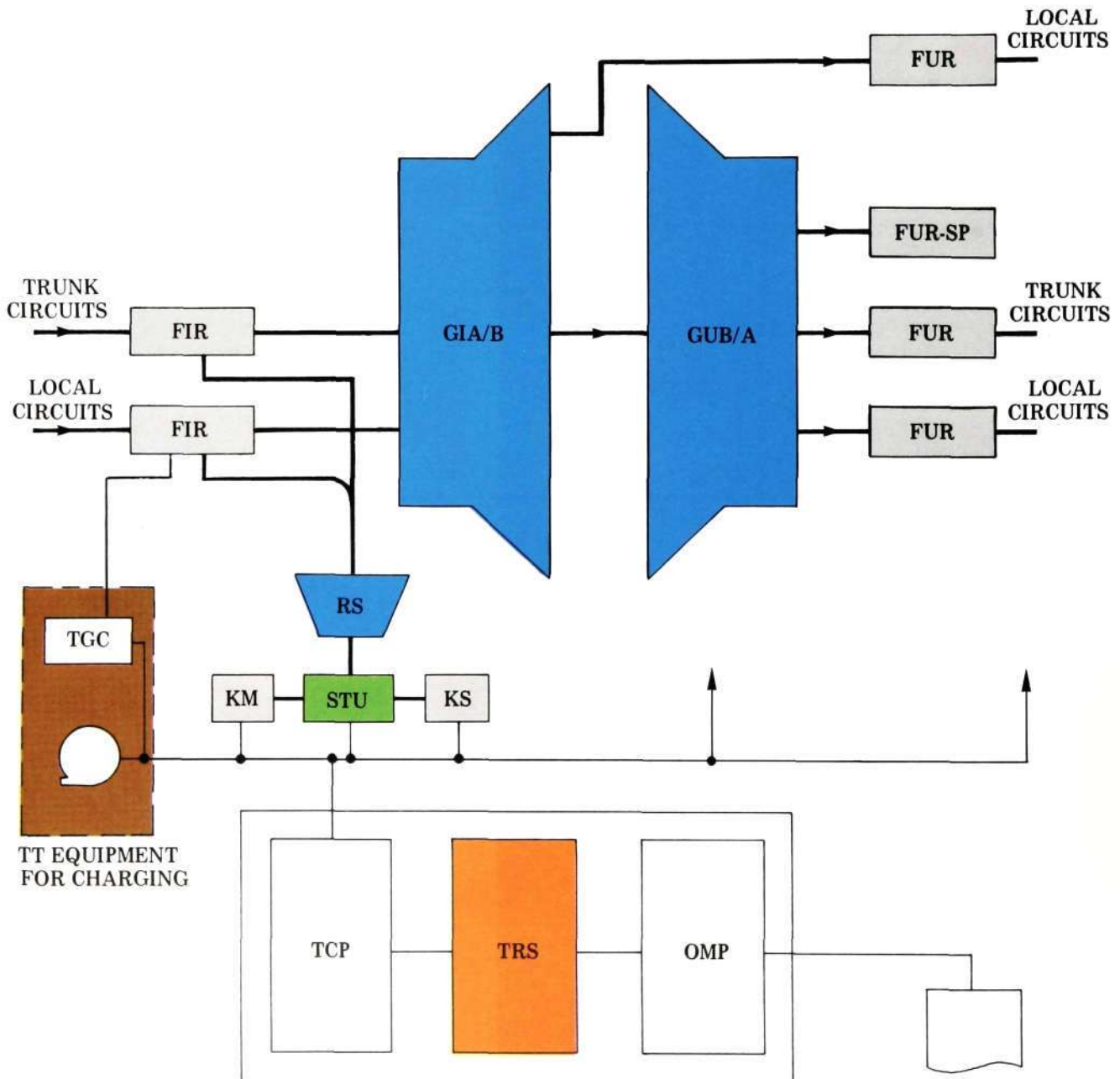


ARE 13 in the national network

ARE 13 offers a combination of flexibility, capability and network economy that is unusually attractive for medium and large transit exchanges.

The switching network is designed to fit any routing plan and the generous inlet load is matched to the high trunk utilization of modern LD networks.

The traffic handling software is designed to cope with many different register signalling systems, complex numbering and routing situations, and charging by multimetering or toll ticketing.

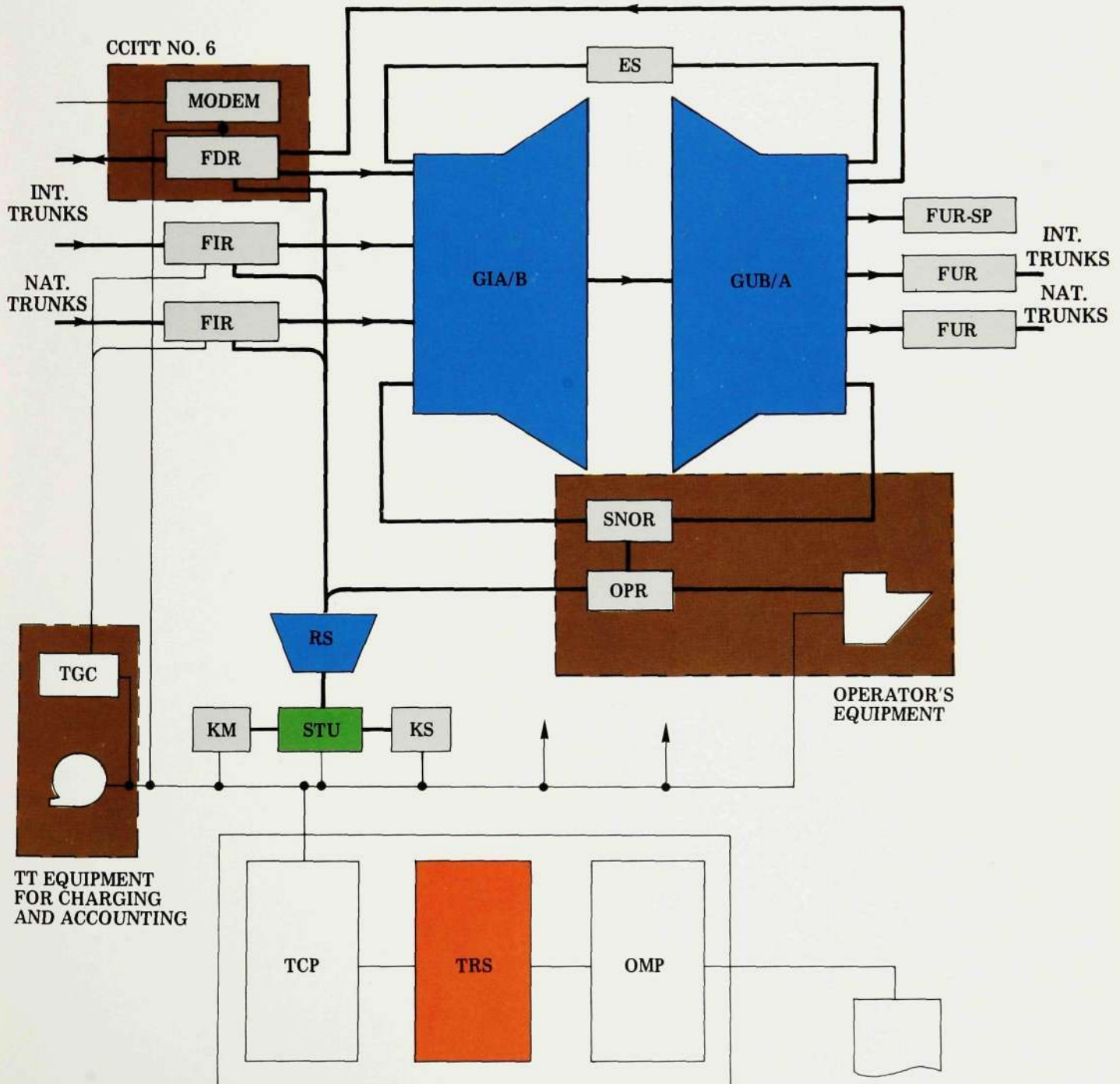


ARE 13 in the international network

International telephone exchanges work in a highly standardized environment and expensive international trunks put a premium on network utilization.

ARE 13 is well adapted to such demands. It interworks with any signalling system specified by CCITT, including No. 6, it handles all kinds of international operator-assisted calls, and toll ticketing equipment provides information for charging of subscribers as well as for the settlement of interadministrative accounts.

ARE 13 is designed to interwork with an International Trunk Maintenance Centre ITMC and with Automatic Transmission Measurement Equipment ATME.



Technical data

Technical data for ARE 13

Traffic handling properties

Max. no. of multiple positions	12,000 inc. + 12,000 outg.
Extension module	200 multiple pos.
Traffic capacity at 0.2% internal congestion	9,000 erlangs
Call handling capacity	300,000 calls/hour
Max. route size	1920 trunks
Max. no. of routes	250 inc. + 250 outg.
Full availability for all routes	
Alternative routing	1 + 7 alternatives
Max. no. of simultaneous register signalling systems	8
Max. no. of line signalling systems	Unlimited
Common channel signalling system	CCITT No. 6
Digit analysis	
No. of destinations	1024
B-number store capacity	16 digits
A-number store capacity	10 digits
Priority	
U-turn control	
Traffic discrimination	
Subscriber facilities such as hot line and abbreviated dialling can be handled by ARE 13 for terminal exchanges without local registers	
Charging	
Conventional multimetering pulse sending equipment	
Max. no. of tariffs	40
Charge pulse intervals	0.5 – 1,000 s
Electronic charging equipment	
Multimetering or Toll Ticketing	
Max. no. of tariffs	127
Max. no. of tariff classes	127
Charge pulse intervals	0.5 – 1,000 s
Interadministrative settlement of accounts	
Pad switching	
Automatic disconnection of echo suppressors	
Cordless switchboards with digit display panels for all types of operator-assisted traffic	
National and international CLR traffic	
National and international delay traffic	
Code 11 and code 12 traffic	
Many additional traffic cases and charging alternatives	

Operation and maintenance properties

Supervision of blocking, seizure and fault ratio for individual devices and device groups, processors, central devices, switching stage operation, transmission, etc.

Remote control from Operation and Maintenance Centre (OMC) for

- modification of traffic routing data
- modification of rates
- supervision
- fault indication
- statistics
- disturbance recording of live traffic
- traffic recording of device groups and routes

Transmission measurements and signalling control
National and international ATME as specified by CCITT
Generated test traffic
Code answer

International Maintenance Centre (IMC) for supervision of international trunks as specified by CCITT.

Data processing system

Primary interval	8 ms
Max. program store volume	32 K 16
Max. data store volume	32 K 8
Number of instructions	63
Average instruction time	2 μ s
Micro-instruction time	250 ns
Multi-processor system with roving spare equipment	
Max. no. of Traffic Control Processors	3 \times 12
Max. no. of Operation and Maintenance Processors	3 \times 1
Working mode	Time division with fixed time slots

The Ericsson Group

The Ericsson Group comprises the Parent Company, Telefonaktiebolaget LM Ericsson, founded in 1876, with headquarters in Stockholm Sweden, and more than 80 subsidiaries and associated companies around the world.

One of the main divisions of the Parent Company is the Telephone Exchange Division. This division designs, markets, installs and services switching systems for use in public networks. Its product program ranges from small exchanges for rural locations to large computer-controlled exchanges for national, international and intercontinental traffic.



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