AKE 13 – SPC transit exchange system

LM Ericsson SPC telephone switching systems.

In most telephone administrations, the need arises for at least a few exceptionally large transit switching centres.

The extraordinary size, cost and complexity of the networks served by these centres demand something extraordinary in size and capability in switching machines.

AKE 13 is a unique no-compromise switching machine designed for such exacting applications.

AKE 13 is a mature system. Since its introduction in 1971 it has become the most successful SPC transit exchange in the market by far.

At the same time AKE 13 is a very modern system. A new micro-programmed data processing system introduced during 1976 has further improved the economy, call handling capacity and reliability.

Main advantages

AKE 13 reduces the cost of the long distance network

The cost of long distance trunks for national and international networks is generally high and for some international and intercontinental routes extremely high. AKE 13 employs an exceptional switching network and stored program control to increase trunk utilization to the practical limit. AKE 13 features

- large ultimate size to handle large routes with high utilization
- full availability for all routes irrespective of route size
- alternative routing with 1 direct route and 31 alternative routes
- high average inlet load
- low internal congestion
- extensive automatic traffic supervision of routes for check of trunk utilization
- maintenance software checks that each trunk is occupied at least once per day

Superior transmission quality

The continuous expansion of long distance national and international traffic calls for a growing number of switching and transmission links. As normally no operator is present to supervise the transmission quality, the properties of the switching equipment tend to become more and more critical. AKE 13 has been designed to provide the best possible transmission quality. In order to reach this goal, a number of different measures have been combined, such as

- 4-wire through-connection
- code switches with reliable, self-cleaning, high-pressure twin contacts, insensitive to environmental conditions
- direct cabling between group selector units for minimum crosstalk
- transposition in group selector units for minimum crosstalk
- pad switching
- echo suppressors
- automatic check of the speech paths of the switching network during low traffic hours (all 4 speech wires are checked for continuity, connection to earth or cross-connection)
- maintenance software performs automatic transmission measurements for the trunk network

Traffic handling functions without limits

All traffic handling functions are defined in software and no effort has been spared to make the programs as universally applicable as possible.

AKE 13 handles all known signalling systems, including common channel signalling, and contains analysis functions to cope with any routing or charging plan, multimetering or toll ticketing as desired.

A modern operator's system

An integrated operator's system features universal operators' positions equipped with video displays. And cord devices are arranged in a common pool for maximum economy and versatility. The system permits remote connection of operators.

A number of service and charging options are available, such as

- call priority,
- collect call,
- third party pays the call,
- credit card charging,
- charging cancelled temporarily,
- immediate notification of charge.

Powerful operation and maintenance facilities

Experience has shown that manual supervision and maintenance of very large switching centres is expensive, meets with a number of practical obstacles and yields unreliable results. In AKE 13 therefore, very powerful software maintenance routines are interwoven with the traffic handling work.

AKE 13 supervises and logs all telephony devices to make certain that equipment is out of service for minimum periods. By means of signalling analysis, AKE 13 finds faults not only in its own equipment but also in other parts of the network.

Signal durations are checked by software, and equipment with marginal performance are localized before traffic disturbances appear.

Tone signal levels and frequencies, which cannot be evaluated directly by software, are checked with hardware testers controlled by maintenance programs, which produce printouts of test results quickly and automatically.

System principles

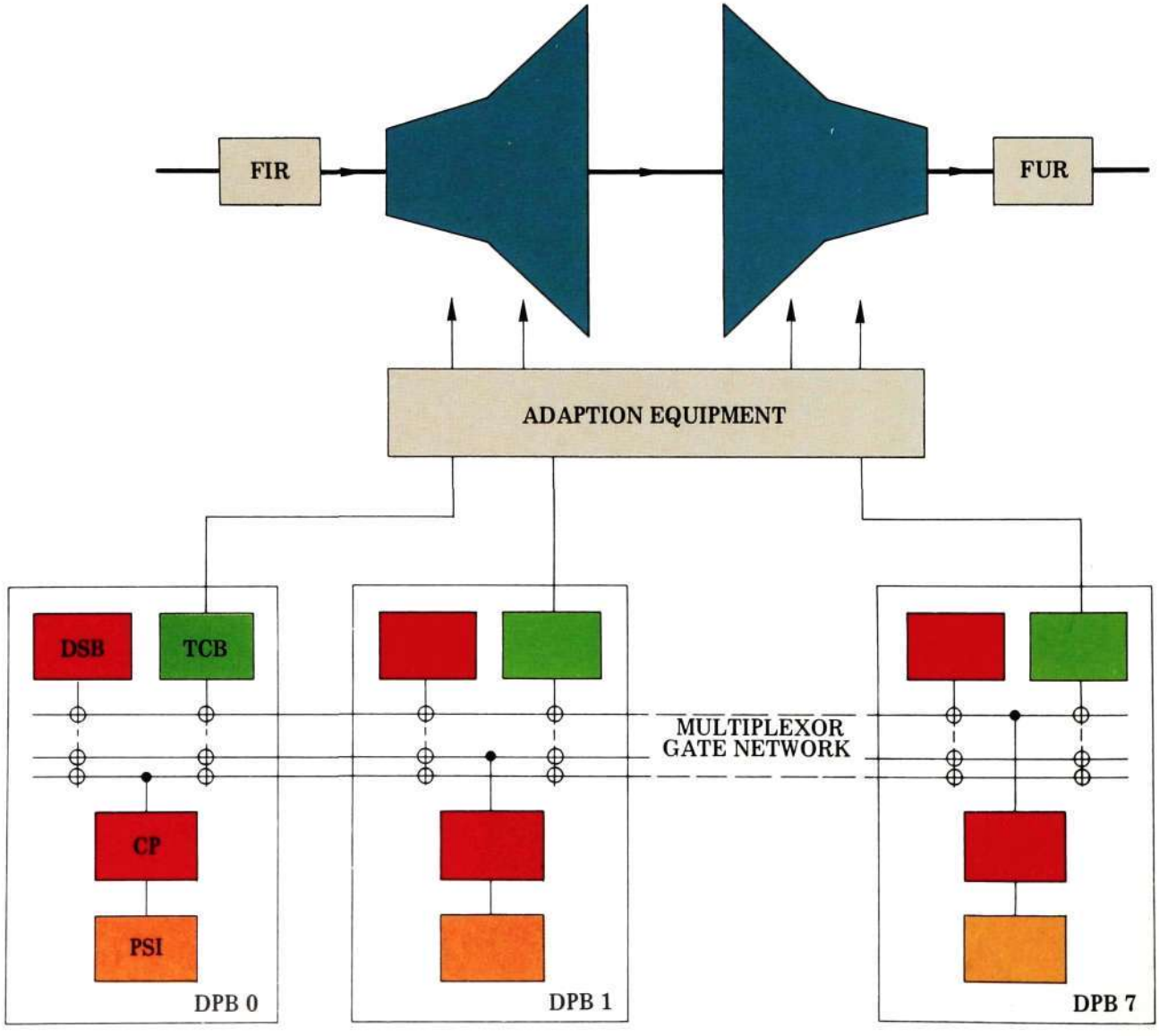
An incomparable multiprocessor control system

A very powerful multiprocessor control system is responsible for the unique size and call handling capacity of AKE 13. The number of data processing blocks may vary from 1 to 8 depending on the traffic load.

Each data processing block DPB has a central processor CP with its own internal program store, containing a full set of the traffic handling programs. Each DPB is assigned to control a certain segment of the exchange via a transfer control block TCB. Data regarding this exchange segment is stored in a data store block DSB in the processing block. This so called load sharing by segmentation permits any part of the switching equipment to be assigned to any data processing block in the most convenient way.

With the help of a multiplexor gate network the central processor will connect itself to the data store block or transfer control block of any other DPB when necessary. Thus each central processor can access any part of the exchange and any part of the data store. The subdivision into data processing blocks reduces processor interference to a minimum.

The structure of the multiprocessor system in AKE 13 combines outstanding capacity with excellent modularity and security.

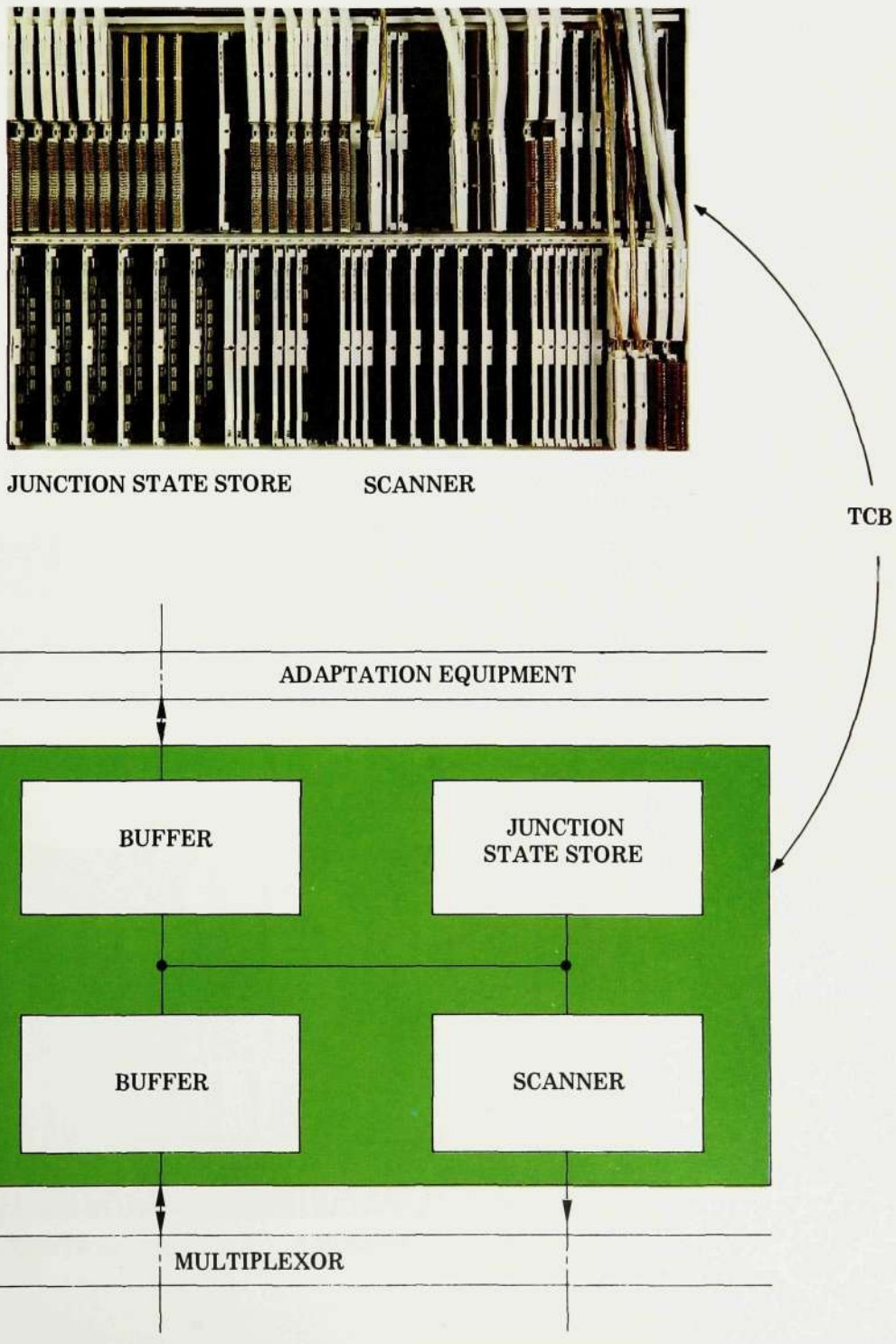


Independent junction line scanners contribute to processing power

Junction line scanning is a frequent but simple routine function, which may add appreciable load to a central data processing system without really needing its intelligence.

In order to increase the effective call handling capacity of AKE 13 a separate, autonomous junction line scanner has been introduced in the transfer control block TCB.

With internal logic and its own data store the scanner detects changes in junction line states corresponding to new calls or terminating call. Relieved of routine line checks, the central processor may allocate more processing power to complex traffic handling functions.



Synchronous duplication for maximum reliability

Each central processor CP in AKE 13 has two identical central processing units CPU. As the activity in both CPUs is controlled by the same clock source, every event in any circuit in one machine is duplicated at exactly the same moment in the other.

Matching circuits connected to critical points in both units will thus immediately detect inconsistencies whenever they appear. Supervisory equipment takes action at once to prevent incorrect data from being dispersed over the system.

This arrangement of the data processing equipment, called synchronous duplication or microsynchronization, offers several advantages such as

- fastest possible fault detection
- simple separation of hardware and software faults
- simplified localization of faults
- minimum loss of traffic capacity when faults occur
- simple introduction of new functions

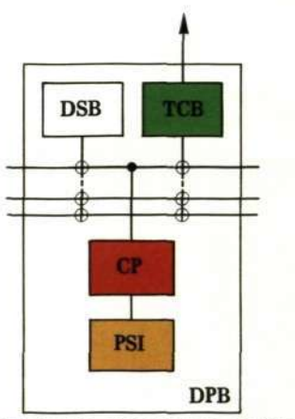
Polymorphic duplication enhances security

In order to enhance security as far as possible, not only the CPUs but all units in the data processing control system are duplicated. Thus each data processing block contains two central processing units, two program store units, two data store units and two transfer control units. The multiplexor equipment is of course also fully duplicated.

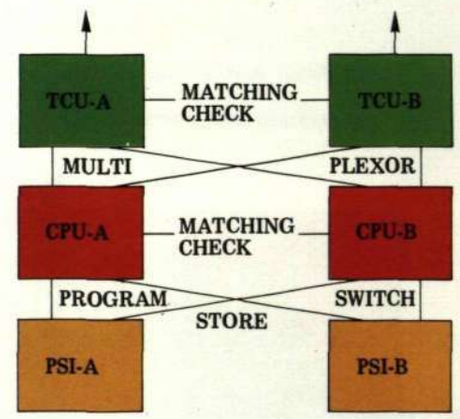
This hardware arrangement implies that the data processing block has two "sides", one A-side and one B-side, each complete in itself and fully able to execute any necessary data processing work.

If these sides worked as separate systems, two simultaneous faults - one in each side - would cause a data processing block to stop. AKE 13 is therefore provided with supplementary bus links between the two sides to permit a working system to be formed even if several units are out of action.

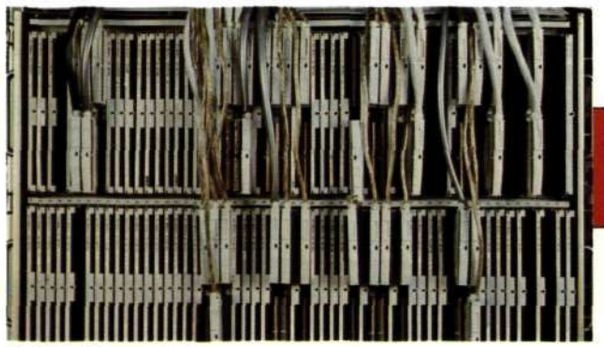
This method, which makes maximum use of the available equipment before system outage is accepted, is called polymorphic duplication.

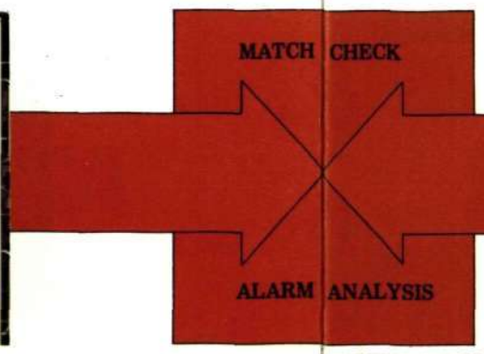


SIMPLIFIED BLOCK DIAGRAM

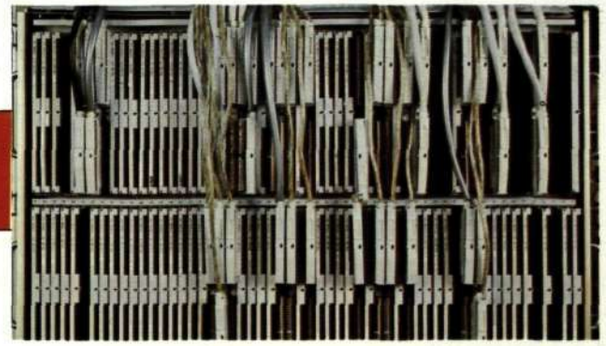


CENTRAL PROCESSOR IN AKE 13


CENTRAL PROCESSING UNIT A



SUPERVISORY UNIT

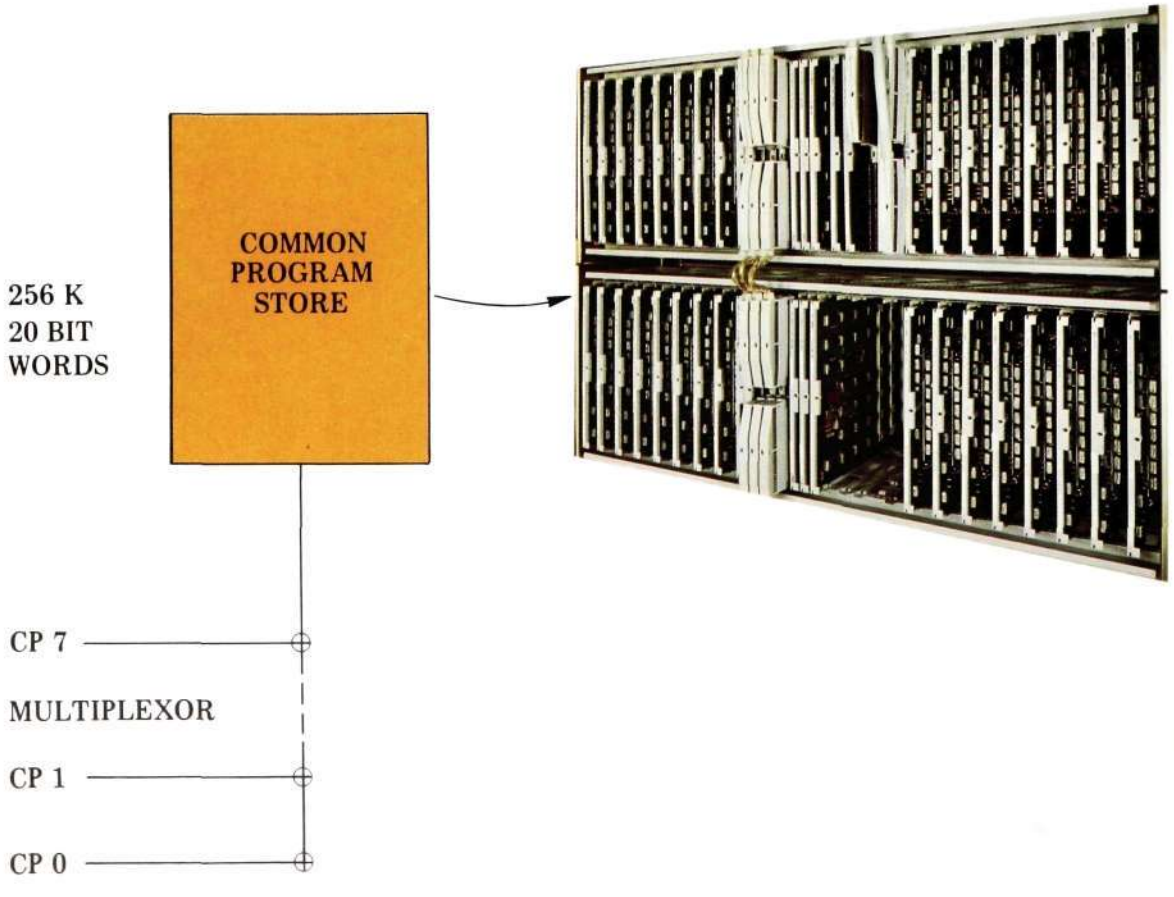

CENTRAL PROCESSING UNIT B

A common program store extends the internal program stores at low cost

In SPC exchanges the designer has to make a compromise between storing programs in external or internal memories. External mass memories are cheap but have long access times, while the opposite is true of internal memories.

A third alternative is offered in AKE 13. Here any central processor may use the multiplexor to reach a common program store PSC, which may store up to 256 K (K = 1024) instructions.

Programs in the common program store may be executed directly without prior transfer to the internal program store PSI of the data processing block. In this way the common store acts as an "extension" of the internal program stores, increasing their effective capacity from 256 K to 512 K instructions.



An exceptional switching network to meet exceptional demands

High-level transit exchanges are exposed to very severe traffic conditions. Multi-channel transmission systems favour large routes, and large routes mean large amounts of traffic combined with high utilization of junction lines.

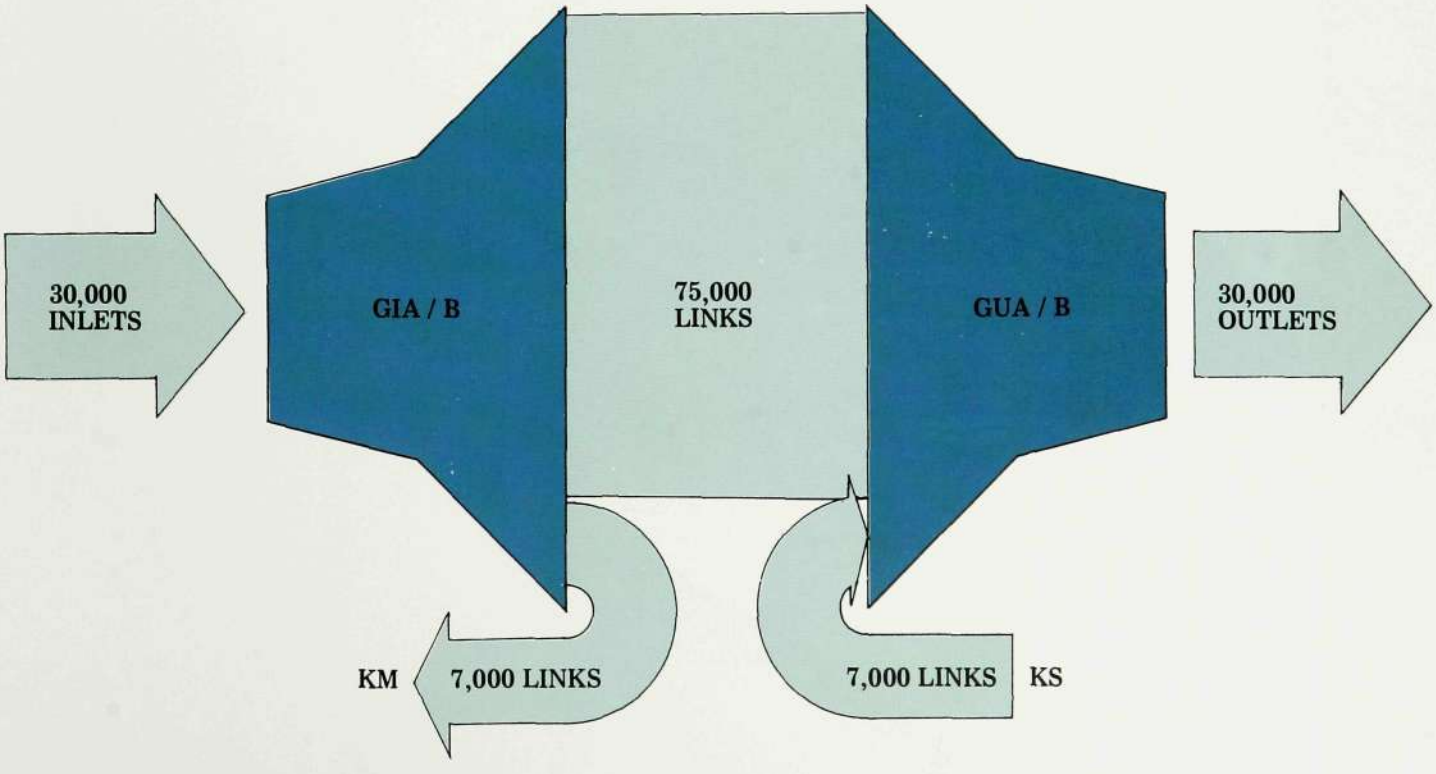
AKE 13 has an exceptional switching network to meet exceptional demands. It is built up of group selector units with 600 inlets (800 inlets if trunk utilization is moderate), 800 links and 1640 outlets. A number of such units are interconnected to form a 4-stage switching network with the requisite multiple capacity. A maximum number of 50 incoming and 50 outgoing units may be employed, offering 30,000 incoming and 30,000 outgoing multiple positions.

The switching network of AKE 13 handles at least 0.8 erlangs per junction at 0.2 % congestion and is insensitive to overload and uneven distribution of the traffic over the multiple.

The switching element is the code switch, which has been chosen because of
- excellent contact properties
- small volume
- reliability
- large number of outlets per vertical, which permits high traffic handling capacity to be combined with an uncomplicated 4-stage network.

As a bonus the code switch has a latching mechanism that eliminates holding currents.

SWITCHING NETWORK IN AKE 13

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320

Practical design

Call handling in AKE 13

AKE 13 consists of a number of blocks. These blocks contain hardware and software, or only software. The large picture shows a hardware representation of AKE 13 with buses and other types of physical connections, while the smaller one shows a simplified block diagram with software connections indicated.

The FIR blocks contain programs that scan the incoming circuits to detect new calls. When a call is detected, FIR calls the central coordinating block COR to reserve a register area where data regarding the call will be stored. The identity of the FIR gives the multiple position, route number, register signalling system and type of code receiver KM.

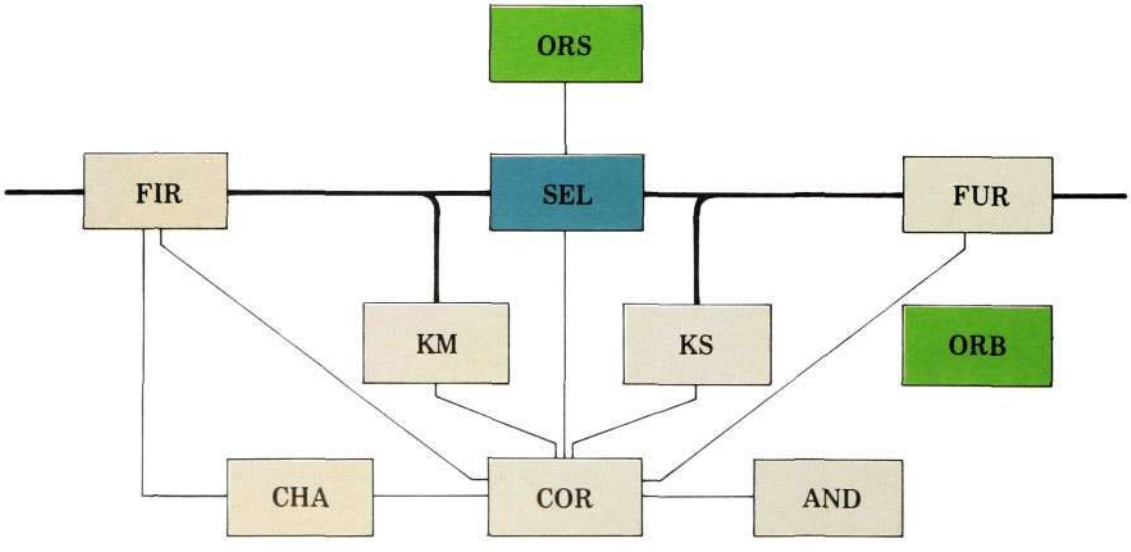
COR orders the selection block SEL to consult switching network data in order to find a free path from the calling FIR to an idle KM of the proper type. SEL finds such a path and orders ORS (operation and release of switches) to operate two code switches in the incoming stage to form the connection. ORS effects the order with the help of hardware devices VMR.

The block KM receives incoming digits and stores them in the register area in COR. COR analyzes digit by digit with the help of the digit analysis block AND and stores the results in the register area. When the outgoing route number is found, the signalling system and type of KS can be determined.

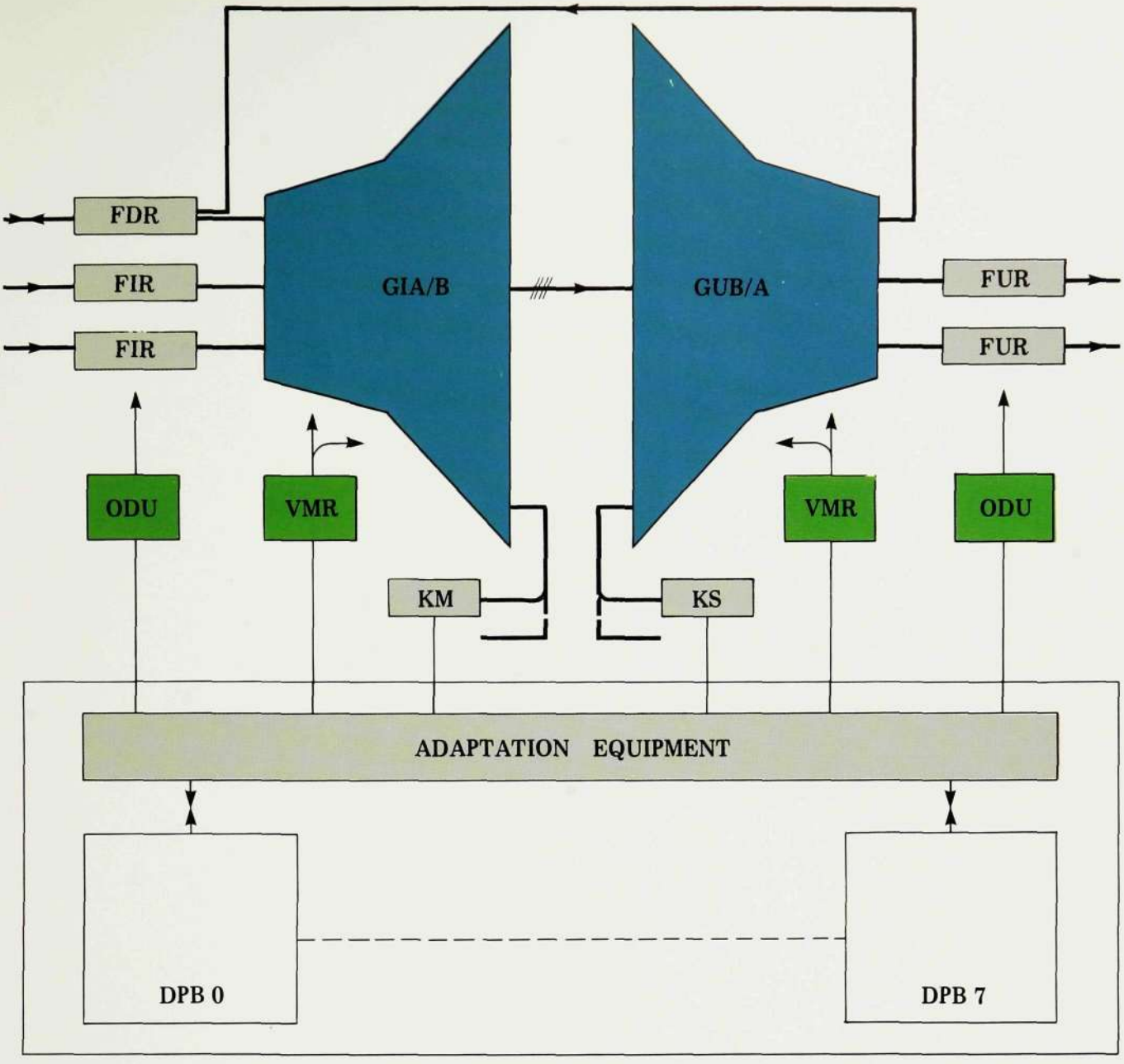
SEL is now ordered to find an idle FUR in the outgoing route, a free path between the calling FIR and the chosen FUR (this path is only marked busy for the moment) and a free path between the FUR and a KS of the proper type. SEL orders ORS to set up the path between KS and FUR.

Now COR has full command of the call, controls the subsequent register signalling and decides when the path already found between FIR and FUR is to be established. Register signalling devices and the register area are marked idle.

During the conversation CHA handles charging while COR supervises the line signalling in order to repeat line signals and to disconnect the junctions when the call is over. Bistable, miniaturized relays in FIR and FUR are operated by relay drivers ODU. When the call is terminated, FIR, FUR and the switches that have been used are marked idle.



MAIN TRAFFIC HANDLING BLOCKS



Maintenance functions in AKE 13

The traffic handling functions in AKE 13 are extremely capable and offer maximum network economy in any large-sized network. In spite of this, the real opportunities of transit exchange software are to be found in the field of maintenance and supervision.

About 50 powerful blocks handle the operation and maintenance in the switching part of AKE 13. They provide supervision of fuses, tone generators, disturbances, congestion, seizures etc., transmission measurements, testing of devices and localization of faults, administrative functions, statistics and traffic regulation.

Applications

AKE 13 in the national network

AKE 13 is suitable for medium to very large 4-wire transit exchanges at all levels of the national long distance network. The maximum capacity is 30,000 incoming and 30,000 outgoing junctions. A suitable combination of parallel or tandem exchanges can be arranged if required.

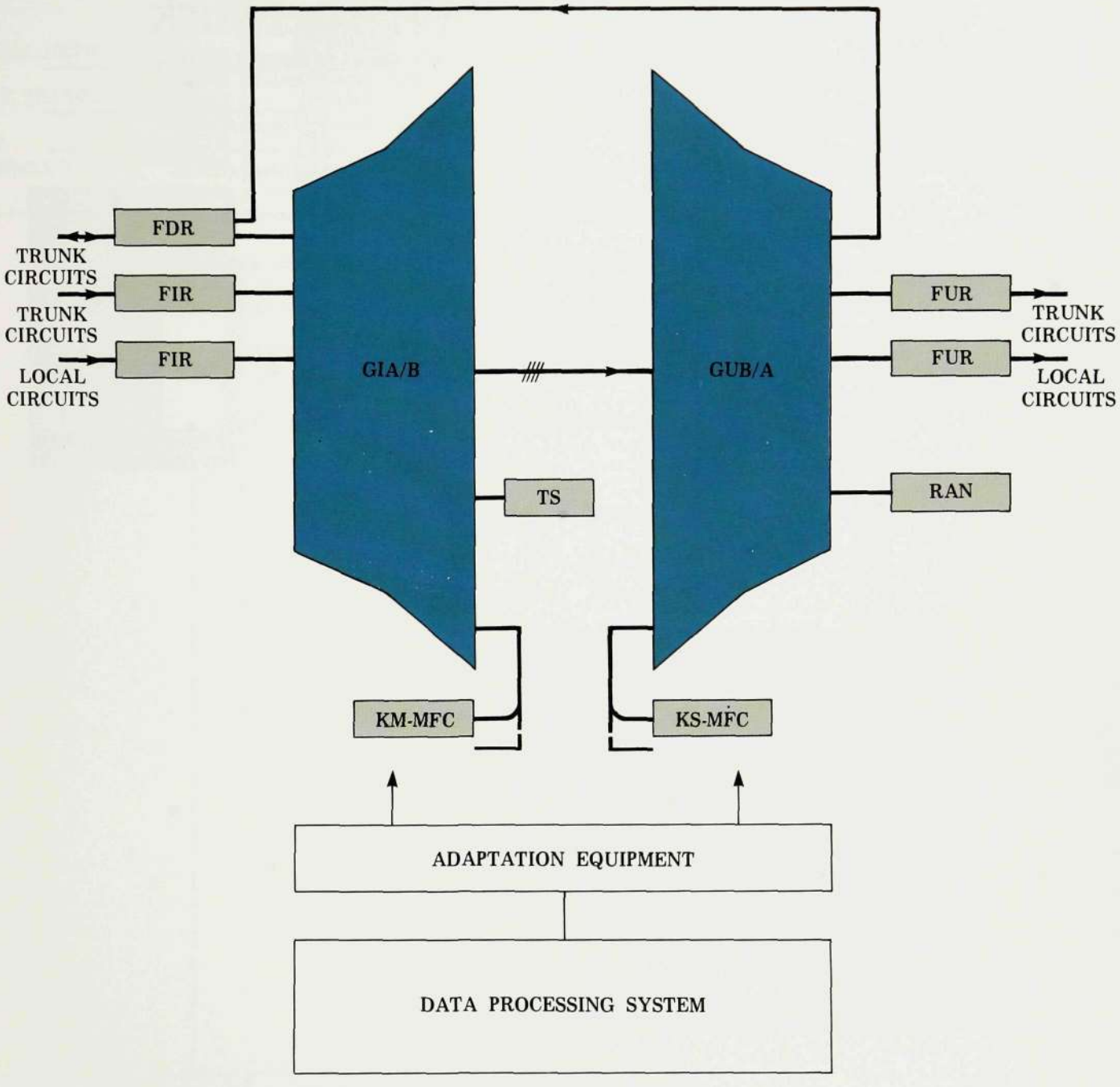
A simple trunking diagram shows how AKE 13 may be applied in the national network. It can be arranged as a one-way or a both-way exchange, but as the ultimate capacity is higher for the one-way variant, this is normally chosen. In this case both-way junctions occupy one multiple position in the incoming stage and one in the outgoing.

Trunks using all types of line and register signalling systems - including PCM and common channel signalling systems - may be connected to AKE 13.

No special finders are needed to connect the code receivers KM and the code senders KS to the junctions, as this is done by the speech path switching network.

Tone senders TS send information tones back to the A-subscriber. Recorded announcement devices RAN provide spoken messages, e.g. news service, weather forecasts or information about vacant or changed numbers.

Charging functions, not indicated in the picture, are comprehensive. Multimetering and toll ticketing with immediate cost information are standard facilities. Tariffs may vary with the zone of origin, as combined analysis on B-number and zone of origin is available. Discount night or weekend tariffs may be used to encourage transfer of calls from high-traffic to low-traffic periods. Information for settlement of interadministrative accounts is valuable when different telephone administrations operate in the same country.


FDR
TRUNK CIRCUITS
FIR
TRUNK CIRCUITS
FIR
LOCAL CIRCUITS
GIA/B
GUB/A
FUR
TRUNK CIRCUITS
FUR
LOCAL CIRCUITS
TS
RAN
KM-MFC
KS-MFC
ADAPTATION EQUIPMENT
DATA PROCESSING SYSTEM

AKE 13 in the international network

AKE 13 is suitable for medium to very large 4-wire transit exchanges in the international network. National and international traffic can be mixed in the same exchange, which is often the case.

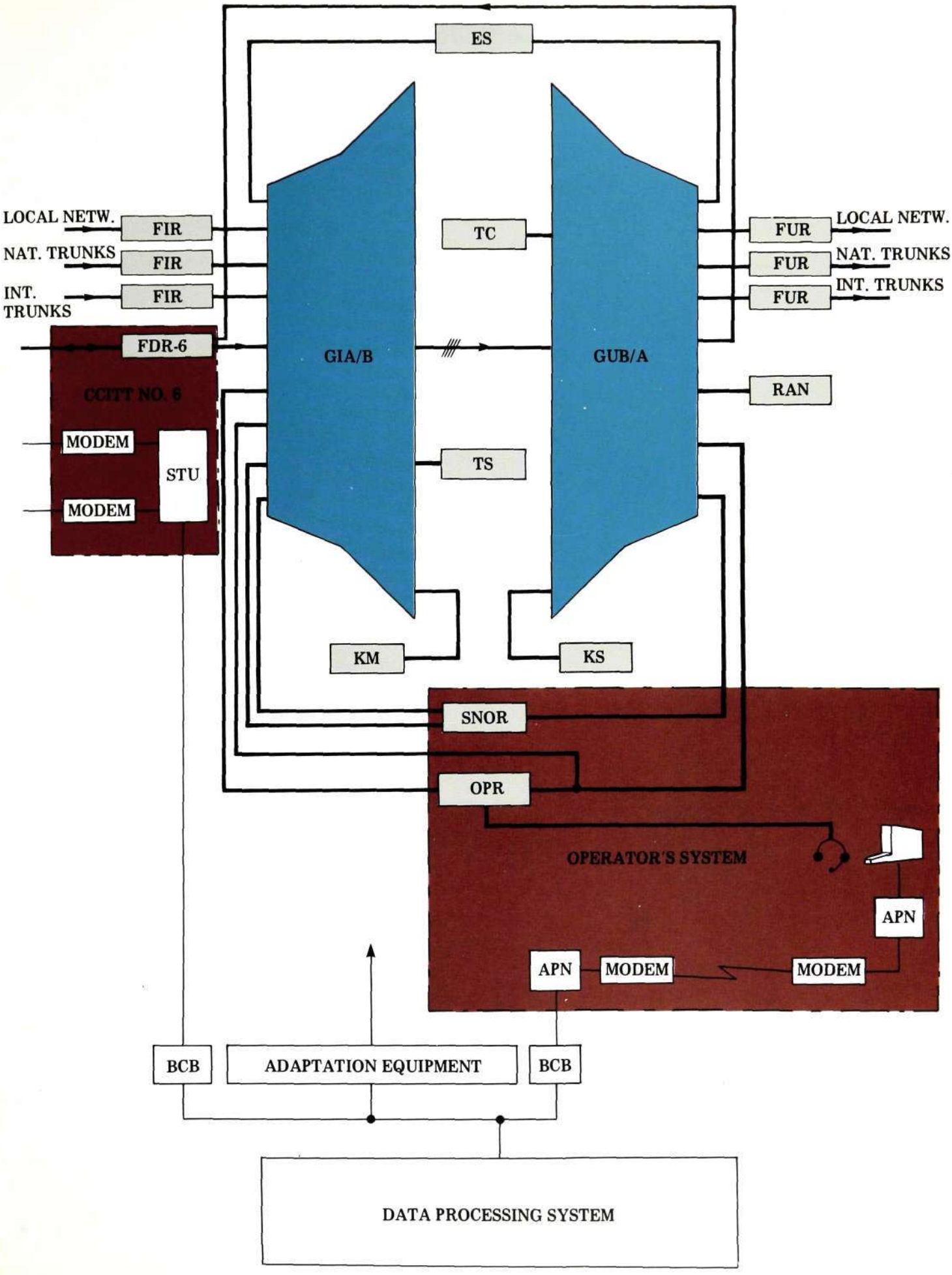
The basic features for national applications are valid also for international AKE 13 exchanges.

Hardware and software are available for most of the current international signalling systems, like the following systems specified by CCITT: No. 4, No. 5, No. 6, R1, R2 and R2 digital. CCITT No. 7 for PCM systems will be incorporated in AKE 13, when specified.

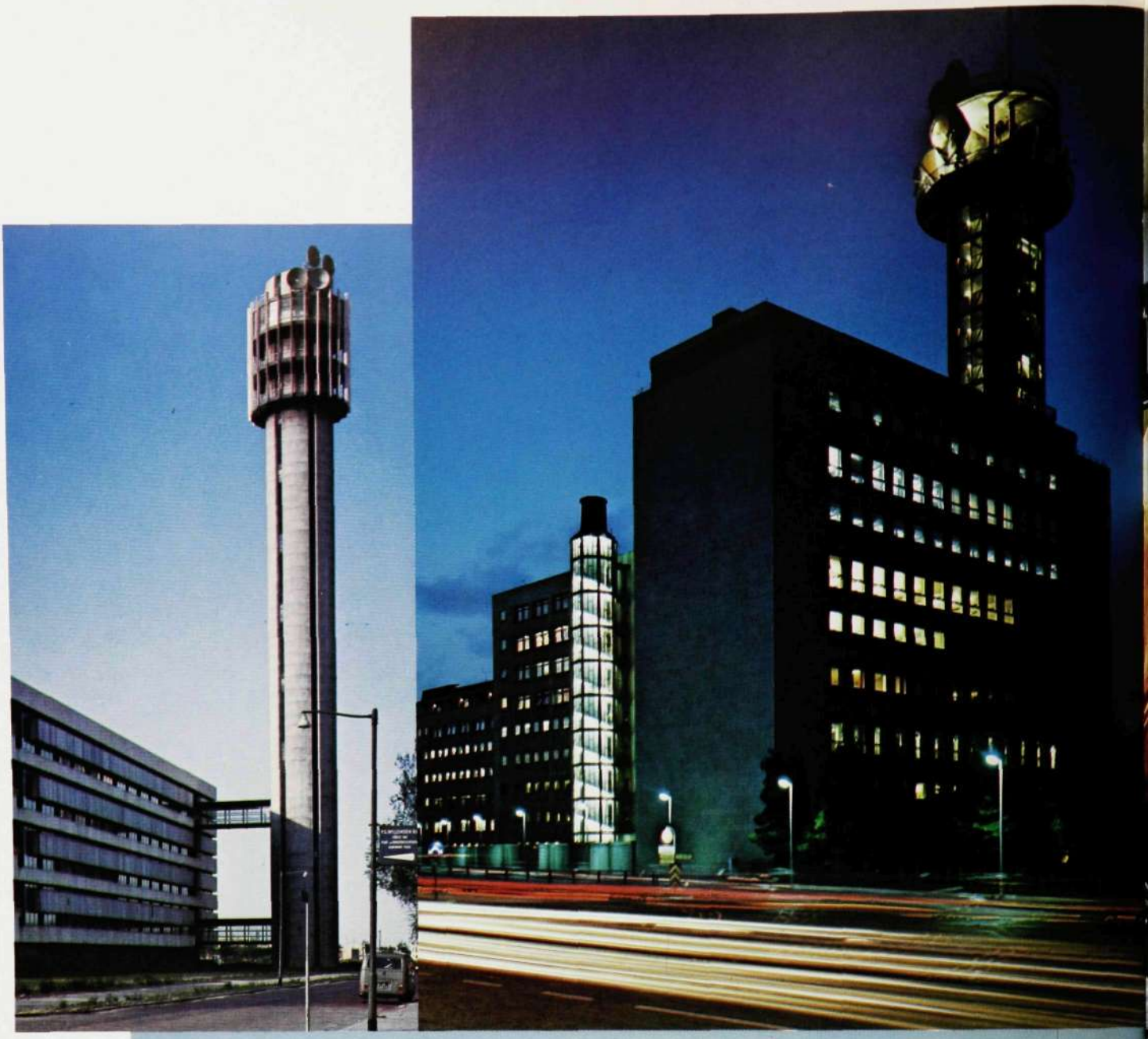
AKE 13 features very sophisticated operator's facilities. The operators' positions are equipped with data screens, which display all relevant information about the call. The SNOR devices that carry the traffic handled by operators are arranged as a common pool to provide flexibility and economy.

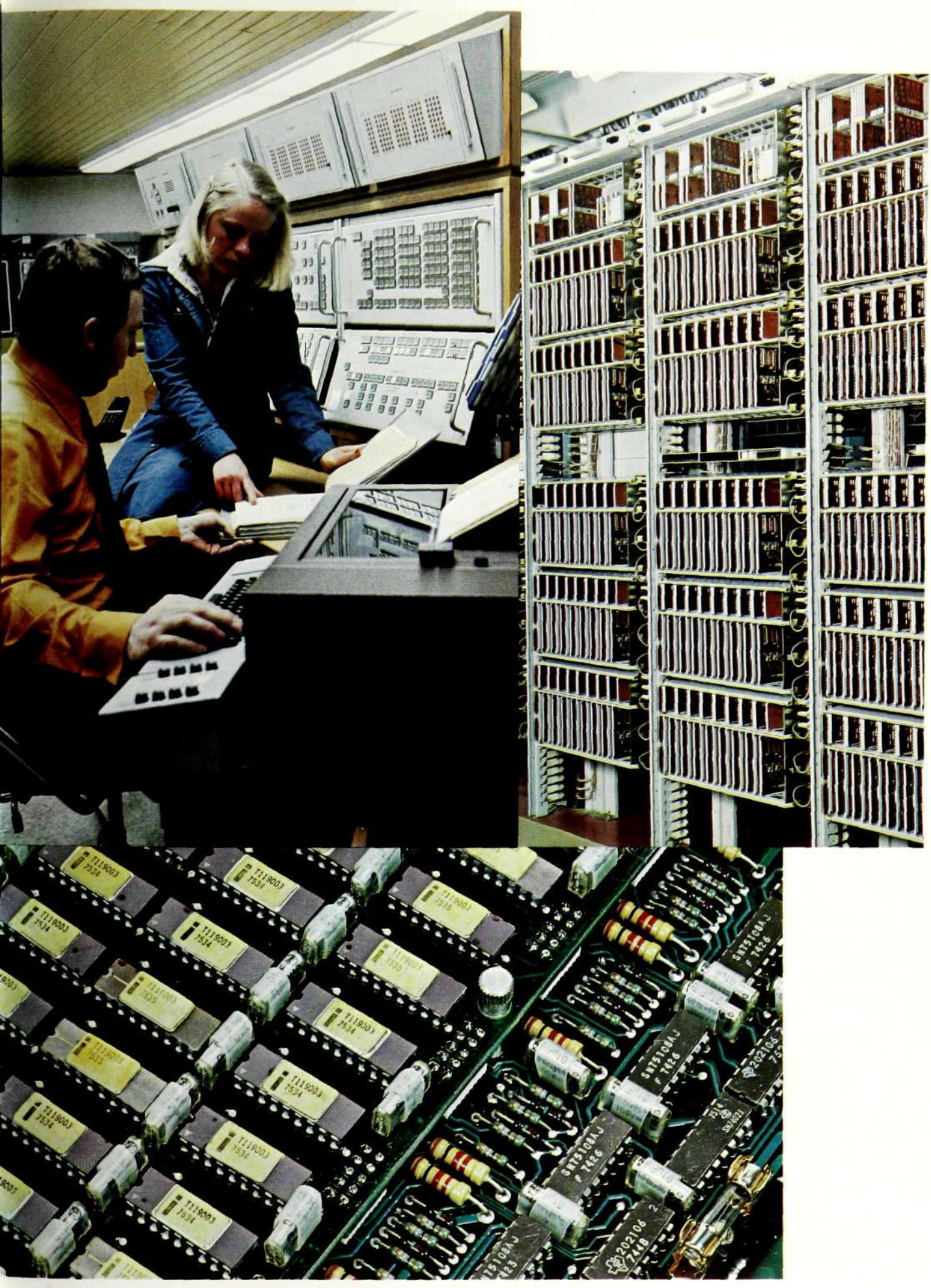
Settlement of interadministrative accounts is accomplished by recording the total call duration for each route and destination according to CCITT recommendations.

Echo suppressors ES are inserted in the speech paths when needed.


ES
LOCAL NETW.
FIR
NAT. TRUNKS
FIR
INT. TRUNKS
FIR
FDR-6
CCITT NO. 6
MODEM
STU
MODEM
GIA/B
TC
TS
KM
KS
GUB/A
FUR
LOCAL NETW.
FUR
NAT. TRUNKS
FUR
INT. TRUNKS
RAN
SNOR
OPR
OPERATOR'S SYSTEM
APN
APN
MODEM
MODEM
BCB
ADAPTATION EQUIPMENT
BCB
DATA PROCESSING SYSTEM

Installations





Technical data

Technical data for AKE 13

Traffic handling properties

No. of inlets per group selector unit	600 or 800
Max. no. of group selector units	50 inc. + 50 outg.
Max. no. of multiple positions	30,000 inc. + 30,000 outg.
Max. traffic at 0.2% internal congestion	24,000 erlangs
Call handling capacity	Up to 700,000 calls/hour
Alternative routing	31 alt. routes
Sequential hunting possible	
Individual selection of all outgoing junctions possible	
Max. no. of register signalling systems	61
Max. no. of line signalling systems	61
Digit analysis	
No. of consecutive digits	8
No. of destinations	2048
B-number store capacity	17 digits
A-number store capacity	9 digits
U-turn control	
Priority	
Traffic discrimination	
Charging	
Multimetering or Toll Ticketing	
Max. no. of rates	255
Max. no. of origins (tariff zones)	255
Max. no. of tariff destinations	255
Charge pulse intervals	0.5 – 1,000 s
Interadministrative settlement of accounts	
Pad switching	
Automatic disconnection of echo suppressors	
Operator's system with video displays	
National and international CLR traffic	
National and international delay traffic	
Code 11 and Code 12 traffic	
Many additional traffic cases and charging alternatives	

Maintenance properties

Supervision of
fuses,
carrier systems,
PCM systems,
tone generators,
switch and relay drivers,
device group disturbances,
congestion,
waiting times,
number of blocked devices,
successful seizures, etc.

Transmission measurements and signalling control

CCITT transmission measurement, method 1 and 2
National and international ATME according to CCITT
Generated test traffic
Call signal check
Code answer

Test of telephony devices and fault localization

Digit analysis control
Circuit tester for automatic test of register signalling equipment
Exchange tester
Routine check of the switching network
Switch path tracing
Desk for test calls and manual measurements

Administration of alarms, blocking of devices, changes of device data, changes of analysis data etc.

Statistics

Extensive charging statistics
Extensive traffic measurement procedures

Regulation of traffic load

Internal load regulation
Traffic diversion (temporary rerouting of traffic)

Data processing control system

Word length	18 bits
Data store capacity per DPB	256 K words
Program store capacity per DPB	256 K words
Common program store capacity	256 K words
Memory extension unit	16 K words
Memory cycle time	0.8 μs
Average instruction time	2.0 μs
Number of instructions	110
Priority levels	10
Primary interval	5 ms
Multiprocessor organization	8 processors

Autonomous scanning of trunk circuits
Duplicated units
Automatic failure recovery and diagnosis
Memory protection
Watch dog system supervision
Parity checks
Integrated circuits (TTL)
Semiconductor memories (MOS)

The contents of this book are subject to revision without notice, due to continued progress in design and manufacture.

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