

LM ERICSSON SPC TELEPHONE SWITCHING SYSTEMS

# AXE 10



INTRODUCING THE MODULAR CONCEPT  
IN TELEPHONE SWITCHING.

The new generation in SPC telephone switching

Optimization of performance — minimization of total costs

Manageability

Operational Security

Versatility

Cost Modularity

Design

Engineering

Production

Installation

Operation

Local

Tandem

Transit

Combined

Analogue

Local

Tandem

Transit

Combined

Digital

## The new generation Stored Program Control. From Ericsson.

Whether you are planning today's modern telephone networks or the networks of tomorrow, there are three basic requirements you probably have in mind.

First, you need a system that's right from the viewpoint of cost effectiveness.

*Total* cost effectiveness.

Second, you need a system that's right from the point of view of flexibility.

*Total* flexibility.

Third, you need a system that's adaptable to your long-term requirements and the possibly rapidly-changing technology of your network.

*Totally* adaptable.

AXE 10, the new generation SPC, is just such a system.

# System-wide modularity plus digital option.

AXE 10 is a new family of local, tandem, transit and combined SPC exchanges from Ericsson.

Two features in particular make AXE 10 stand out among all SPC systems available today.

One is functionally modular integrated hardware and software.

This alone would be the mark of an outstanding SPC system.

So would the unique future orientation provided by alternative analogue and digital switchblocks.

AXE 10 offers both.

## The importance of functional modularity.

Hard-earned experience over the past ten years has shown the need for SPC systems with greatly improved handling properties and a high degree of software security.

Improved manageability in all areas of design, engineering, production, installation, and operation and maintenance became one of the AXE requirements.

Another factor taken into consideration was that minimization of hardware cost is no longer particularly relevant from a network point of view.

Minimization of *total cost* is.

These objectives have been achieved in AXE through functional modularity.

## Small is beautiful.

The AXE system uses the "black box" principle.

It is divided into small, autonomous modules, each one of which is easy to handle and each of which fits into a standardized pattern of modular interwork.

## Safety first.

Previous generations of SPC systems are characterized by globally accessible data.

Which means any program may access any data.

Which means a high inherent risk of fault dispersion caused by program errors, operator mistakes or equipment malfunction.

The new generation SPC system AXE has no globally accessible data. Should the fault occur, it will be contained within its module and not

dispersed. And AXE has individual memory protection for every piece of data. Offers software security against program errors.

## Cost modularity, technological modularity, mechanical modularity.

The functional modularity of AXE is matched by cost modularity, technological modularity and mechanical modularity.

The four together mean an outstandingly flexible, versatile, wide-range and cost-effective system.

## Subscriber services and administrative facilities.

AXE 10 offers a very wide range of subscriber services.

Perhaps even more important from your point of view, it offers the administrative facilities needed for centralized operation and maintenance.

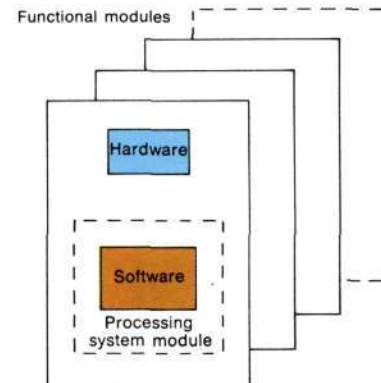
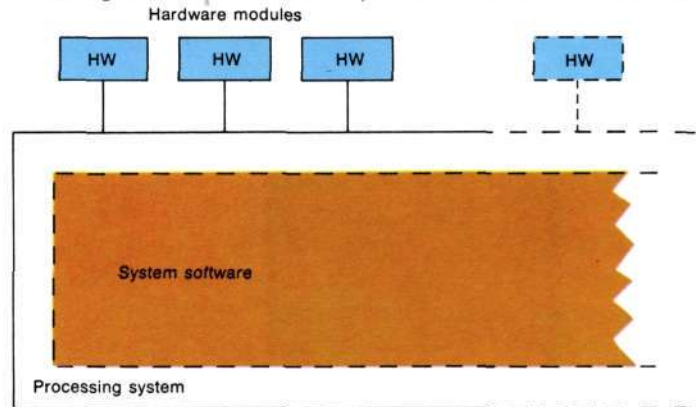
## Preparation for the future.

AXE 10 is unique in offering a choice of switch technology.

There are two types of group selector. One is the analogue reed switch. The other is the digital switch for PCM.

When you think about it in relation to your own needs now and the possible changes you might want to make twenty or thirty years from now, this could be the most cost-effective feature of all in a system designed for cost effectiveness.

Previous generations of SPC. Modular hardware, non-modular software.



The new generation SPC. Functionally modular integrated hardware and software.



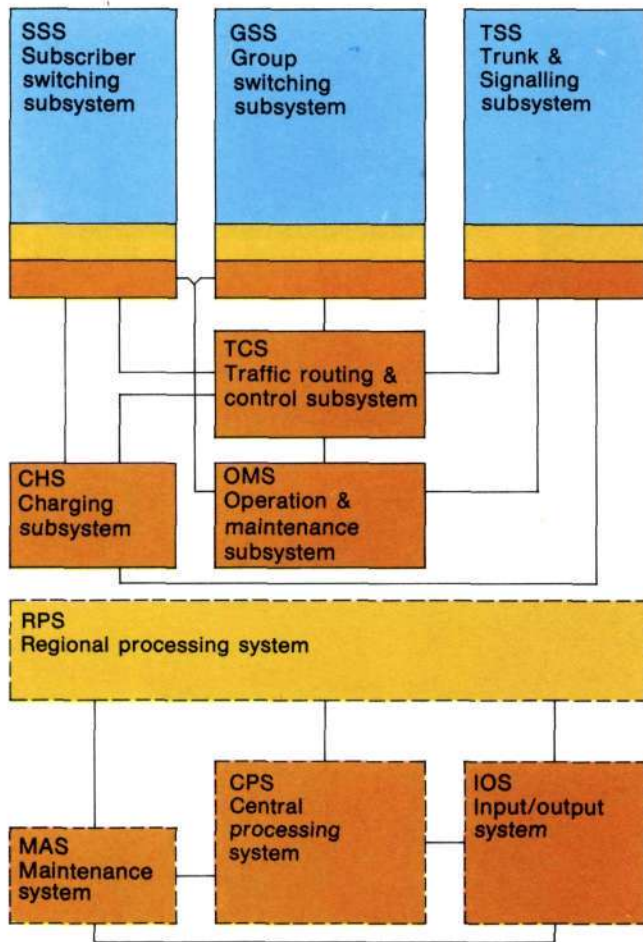
Analogue: 2-wire reed crosspoint switch using a unique method of IC control for operation and latching.

Digital: space-switch module PC board.

# Functional structure of AXE.

AXE 10 is organized in a four-level functional hierarchy consisting of system, subsystem, function block and function unit.

At the highest level are the switching system APT 210 and the control system APZ 210. The functional block diagram shows this division and the associated subsystems.



## Autonomous module design.

At each level of the hierarchy, the autonomous "black box" modules are linked by standard interfaces to the other modules.

At the unit level only is there any differentiation as to whether the implementation is in hardware or software.

A function block, for example, may be implemented in software or a combination of hardware and software.

## Control system.

The control system is a data processing system with a central processor and a number of

small regional processors.

The software (programs and data) of the switching system APT is stored and processed in APZ.

## Hardware.

The diagram on the righthand page shows the main portions of the hardware structure in relation to the functional subsystem structure.

The importance of autonomous blocks and standard interfaces is that subsystems may be combined in a number of different ways for different applications.

The change of technique within a subsystem will involve no change in the rest of the system.

## Subscriber subsystem.

The subscriber subsystem, SSS, is arranged in modules for 2000 subscribers per group.

Such a group may be located outside the main exchange and serve as a subscriber concentrator.

## Group switching subsystem.

The group switching subsystem, GSS, is shown with reed switch symbols.

While retaining the GSS subsystem interfaces, the reed switchblocks may be replaced by a digital switch including PCM terminals.

For connection of digital lines, digital interfaces are introduced.

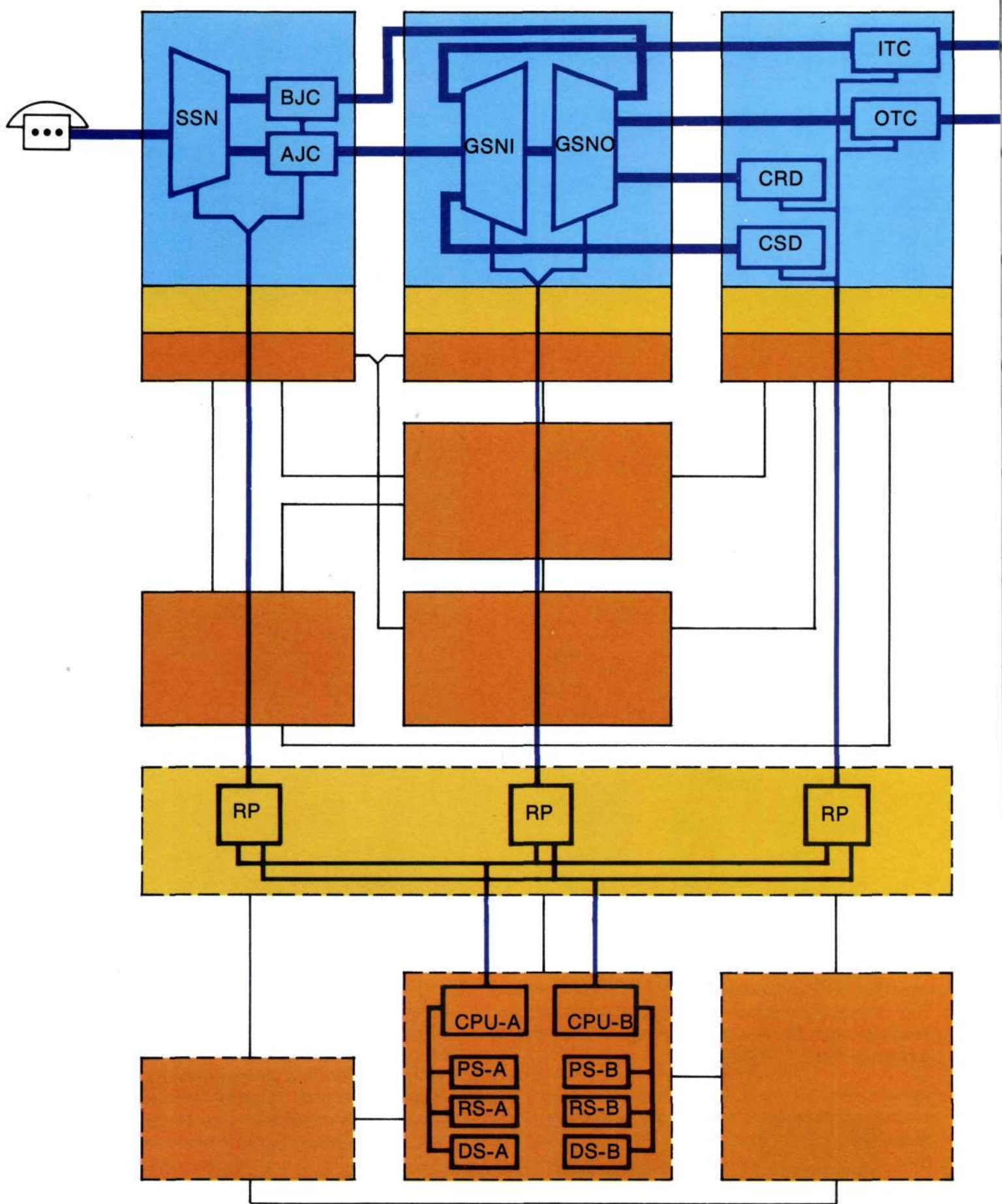
## Trunk and signalling subsystem.

The trunk and signalling subsystem, TSS, will handle a very large variety of line and register signalling schemes.

First choice signalling systems in AXE are MFC (CCITT R2) and common channel (of the CCITT No. 7 type), but virtually all other systems are handled including decadic and different revertive pulsing schemes.

	Hardware
	Regional software
	Central software

SSN	Subscriber switching network
BJC	B-junctor circuit
AJC	A-junctor circuit
GSNI	Incoming group switching network subsystem
GSNO	Outgoing group switching network subsystem
ITC	Incoming trunk circuit
OTC	Outgoing trunk circuit
CRD	Code receiver device
CSD	Code sender device
RP	Regional processor
CPU-A	Central processor unit, A-side
CPU-B	Central processor unit, B-side
PS-A	Program store, A-side
PS-B	Program store, B-side
RS-A	Reference store, A-side
RS-B	Reference store, B-side
DS-A	Data store, A-side
DS-B	Data store, B-side

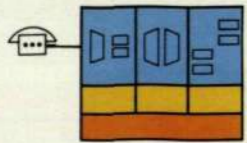


# Building and extending networks with AXE.

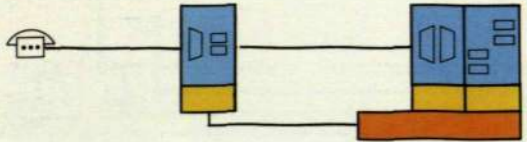
Whatever generation they are, nearly all new exchange systems have to be introduced into the environment of existing networks and existing administrative systems.

AXE has been designed to fit into existing analogue networks as a self-contained switching point without requiring changes in other parts of the network.

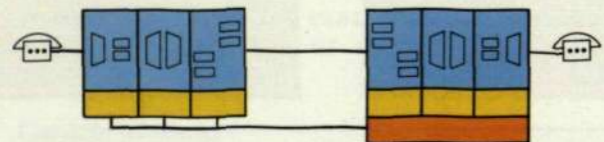
The versatility of the AXE system is shown in some typical analogue network application situations.



1. A new AXE local exchange is introduced as a self-contained switching point. The exchange provides full facilities for traffic handling and operation and maintenance.



2. Introduction of a subscriber concentrator. The concentrator includes the hardware and regional software of the subscriber subsystem, together with the necessary regional processors. The regional software of the concentrator interworks with the central software of the parent exchange via PCM-links.



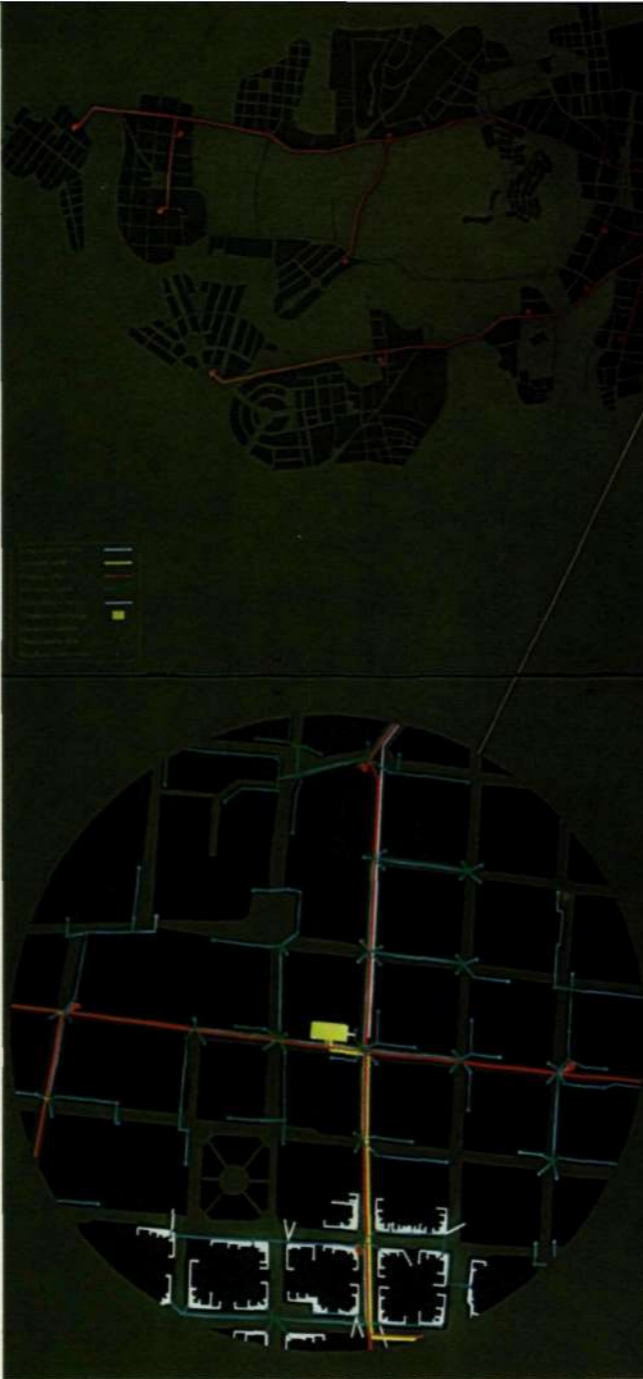
3. As more subscribers are connected to the concentrator, it becomes economic to provide

direct interconnections between these subscribers without going to the parent exchange and back.

The concentrator is then transformed into an independent exchange.

Where the size of this exchange does not warrant its own central processor, the exchange may "borrow" its central processing power by becoming a satellite of the parent exchange.

The regional software of the satellite interworks with the central software of the parent exchange via PCM-links.

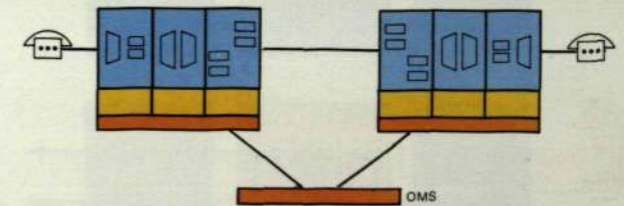


URBAN NETWORK WITH LONG DISTANCE CONNEXIONS



4. The capacity of the central processor of the parent exchange will sooner or later be inadequate to provide the central processing power. The satellite may then be provided with its own central processor and become an independent AXE exchange.

The same central software used in the original parent exchange is used directly in the converted satellite as all exchange dependent data are loaded by commands.



5. As the number of AXE exchanges grows, it becomes economical to centralize the operation and maintenance of the network into one common operation and maintenance centre, interworking with each individual exchange via data links.

# Towards a digital network.

Whether you're the top man ultimately responsible for all decisions in an administration, or whether you're a financial controller, technical director, network planner, switching engineer or operation and maintenance specialist, digitalization has to be on your mind.

Not so much whether you'll go digital.

But more a question of where, when and how.

### Economic advantages.

Digital transmission in telephone networks is now well established.

The attraction of digital switching is that in a network with digital transmission systems (PCM), an integration of switching and transmission is economically advantageous.

And with digital switching in the network, the distances within which PCM transmission systems are economically feasible become much larger.

### AXE makes it easy.

The unique future orientation of the AXE-system is obtained by using the modularity for alternative provision of analogue or digital switchblocks.

The digitalization of a network naturally starts with digital group selectors, both in tandem points and in the local exchanges.

In the latter, the digital group selector also

provides the means for extending digital trunks to decentralized subscriber concentrators.

The digital group selector, GSS-D, uses a TST structure with a central space switching stage and time switching stages on either side. 8-bit PCM words are switched in parallel. The internal speed of the system is 4 Mbit/sec.

In an analogue environment, the GSS-D is equipped with PCM terminals for converting the signals from analogue to digital. When connecting digital lines, a digital interface is used.

The AXE subsystems surrounding a digital group selector are not affected, thanks to the modularity and standard interfaces.

### Digitalization strategies.

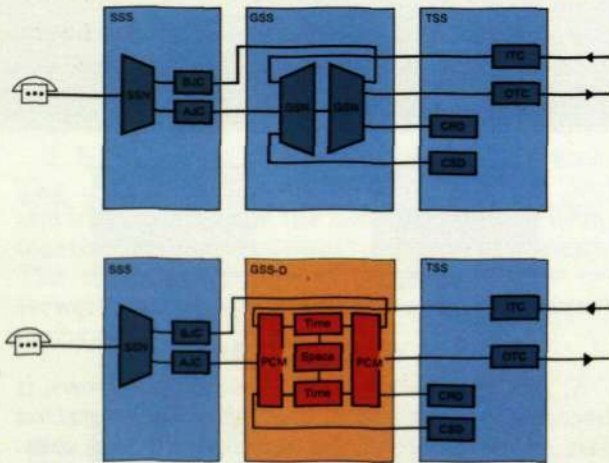
Digital switching and transmission equipment can be introduced into the telephone network mainly in three ways.

It can overlay existing equipment.

It can replace existing equipment.

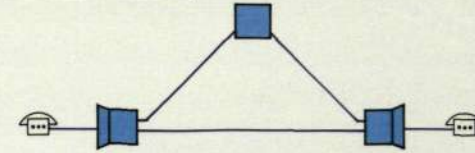
It can be used to extend the network into new areas.

In principle the overlay method means that the analogue network is extended by digital equipment in such a way that an integrated digital overlay network is formed.

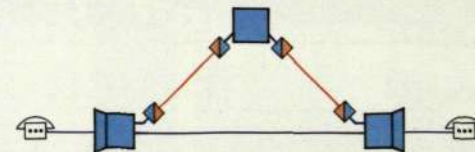


For practical applications, it seems probable that none of the methods will be used exclusively. Rather it is expected that combinations of the methods will be used in different parts and development stages.

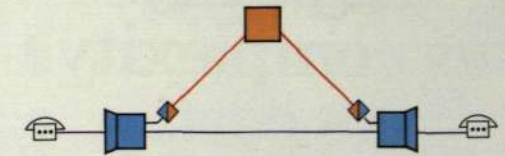
### How to implement your digitalization strategy with AXE.



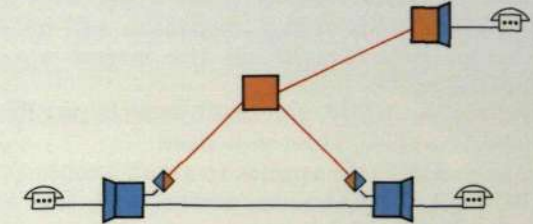
1. The starting point is an analogue network with, for example, two local exchanges and one tandem exchange.



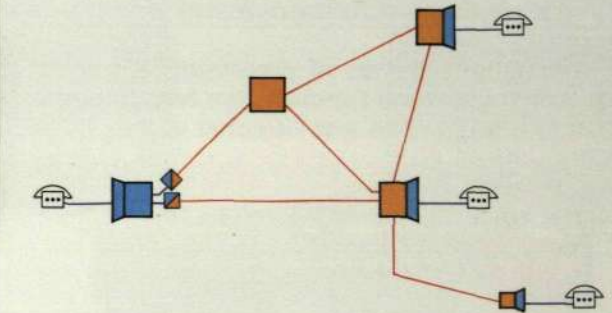
2. Extension of the transmission circuits is made by PCM. The digital signals are converted to analogue before they are switched.



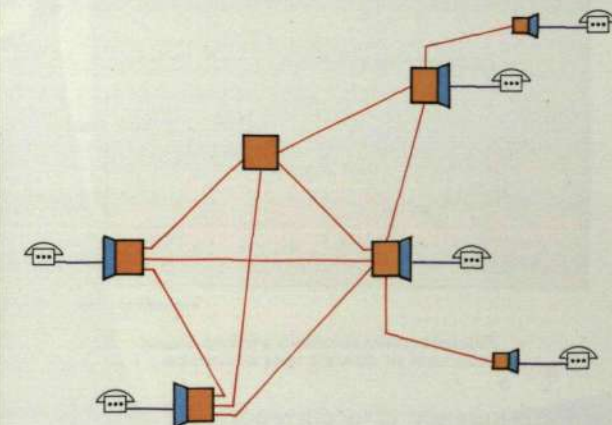
3. Further extensions of the transmission circuits are made by PCM links. The increased digital environment makes it feasible to introduce a digital tandem exchange.



4. A digital local exchange is introduced into the network. Here we get the first complete digital link without A/D-conversion between exchanges.



5. One of the analogue exchanges is replaced by a digital exchange. A remote subscriber stage, a concentrator, is introduced.



6. The result is an all-digital network.

# Capacity vs complexity vs cost.

SPC systems can do almost anything you want them to do.

At a cost.

Naturally administrations want maximum flexibility, a wide range of facilities, easy-to-add few functions and a maximum call handling capacity sufficient for the largest applications.

Equally naturally, you don't want to pay for a lot more capacity than you need.

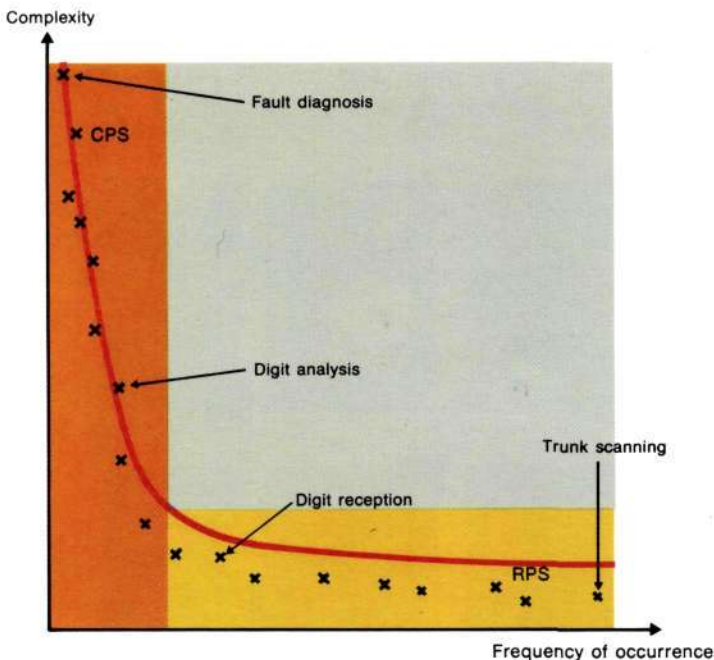
This particularly applies to small exchanges.

Too much processing power and the exchanges become unduly expensive.

At the same time, extension modules in the control system must be reasonably small to correspond with extension modules in the switching equipment.

You want the most favourable cost profile you can get.

Functional analysis of processing power requirements for each function in a telephone exchange result in the sort of curve shown.



Relation between complexity and frequency of occurrence for different types of functions.

The frequency of occurrence illustrates how often a function is performed.

The complexity corresponds to the logical

power required to perform a function.

If one processor furnished the total needs, however, it would have to have logical power and capacity corresponding to the total of the coloured areas.

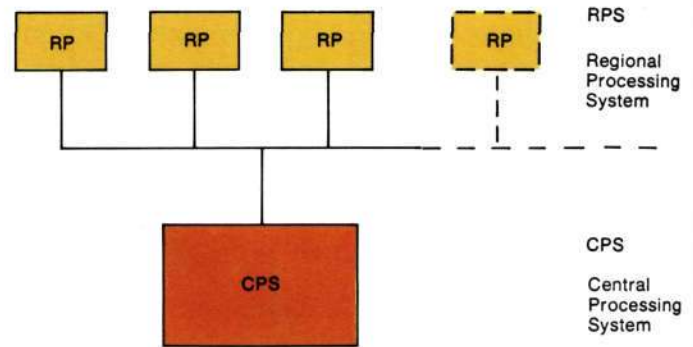
This would mean a control system with no modularity.

It would have the same call handling capacity and cost irrespective of the exchange size.

Not to mention a large portion of unused processing capacity.

## AXE cost modularity.

The answer is the two-level structure of AXE's data processing system.



One central processing system, CPS, handles the complex tasks.

The simple, repetitive tasks are delegated to a pre-processing level, the regional processing system, RPS.

With this organization, the system has a high maximum capacity while retaining a favourable cost modularity as the number of RP's grows with the exchange.



Central processing unit under test.

# Software security matched to hardware reliability.

In AXE, hardware reliability in the control system is provided by a redundancy scheme based on duplication.

The central processor and its associated memories are duplicated and work in a parallel synchronous mode.

Both sides of the central processor are connected to all regional processors.

The duplication method for the regional processors is called load pairing. The load (for example, a number of trunk circuits) is normally divided between the pair. In the event of an RP failure, the healthy RP takes over the full load.

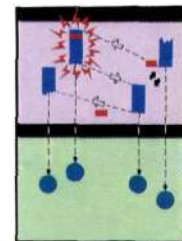
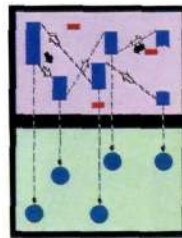
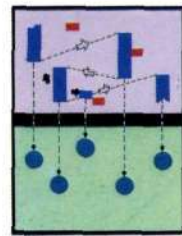
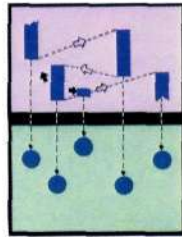
The parallel synchronous mode of the central processor ensures immediate detection and simple localization and isolation of possible hardware faults.

The unique feature of the AXE system is the corresponding reliability obtained in the software system by the concept of software security.

### Software security.

Software security in AXE is based on two principles made possible by the modular structure of the system.

AXE new generation SPC



The size of the missing piece of the telephone illustrates the number of data errors in the system.

The first is that all addressing is microprogrammed via a reference store.

This appreciably reduces programming and thus inherent programming errors.

The second principle is the method of interworking between units via software signals.

This means that the signal information is transferred between units by standard microprograms.

Data of a unit may be accessed only by the program of the same unit.

It is therefore impossible for any given unit to mutilate data belonging to another unit.

Software errors will be contained within the unit where they occur and so are easily and rapidly detected.

This quality of software security provides a "soft" failure mode compared to systems with globally accessible data.

### Traditional SPC.

Here faults may disperse uncontrollably through the system stores.

A program error may introduce data errors in a functionally unrelated module.

When the program of this module, which is assumed to be error-free, accesses the mutilated data, further mutilations may occur.

And do!

System restart will eventually be necessary.

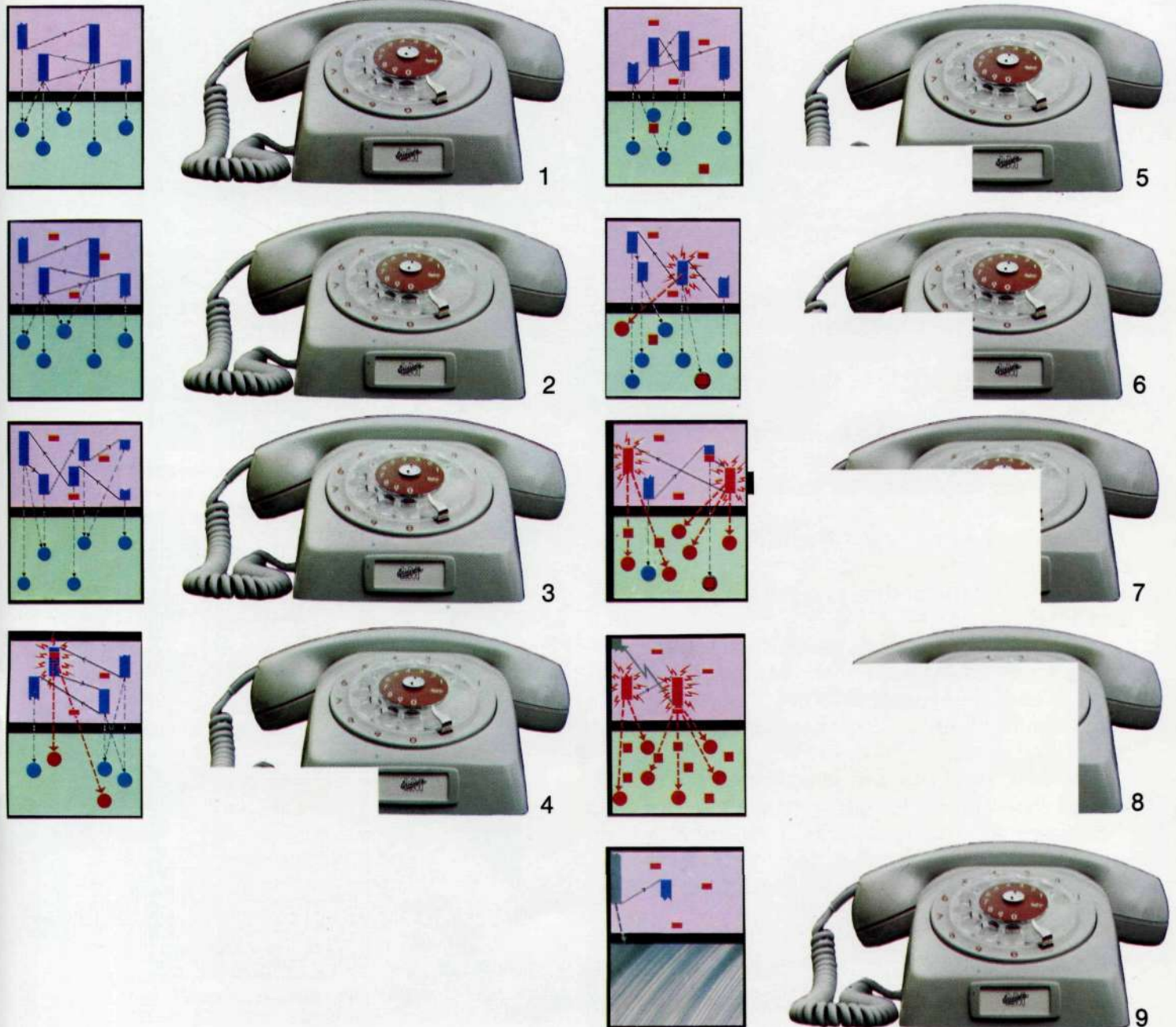
Localization of the original fault has to be performed by software experts.

A long, tedious and costly process.

With AXE, a fault developing in one module can't mutilate data in any other module.

The fault is quickly and easily traced to the module where it occurs. And corrected.

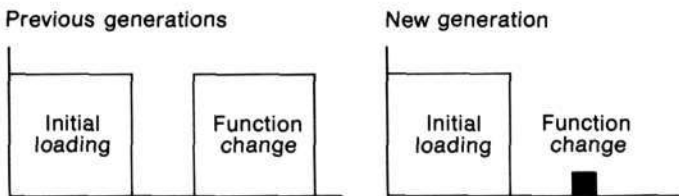
Previous generations of SPC



# With AXE, special software training for maintenance staff is minimized.

Unlike previous generations of SPC, AXE lets you use staff with a low degree of software specialization.

Every module in AXE, whether it's a system, subsystem, function block or function unit, is specified as a "black box".



Comparison between amount of work needed for different generations of SPC. The complete reloading formerly necessary is now reduced to only the function block concerned. No software specialization necessary.

The unique feature is that the modules are not only specified but also *handled* as black boxes. The entire structure of the APZ 210 data processing system has been geared to this concept.

Man-machine communication is simpler than with second generation SPC.

Operators only have to work with standard interfaces.

They don't have to go into internal organization within units.

Every software module is separately compiled and loaded.

All storage allocation is performed by the processor in connection with loading; all object code is completely relocatable.

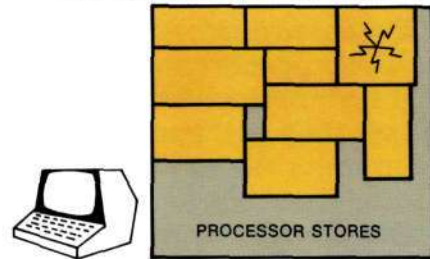
Function changes are therefore very easily performed.

The new modules are simply compiled and loaded into the exchange.

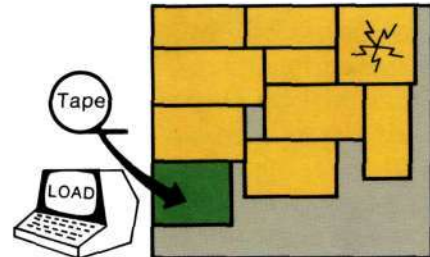
Storage allocation of the new modules is automatically performed.

As a result, new modules are smoothly cut into service.

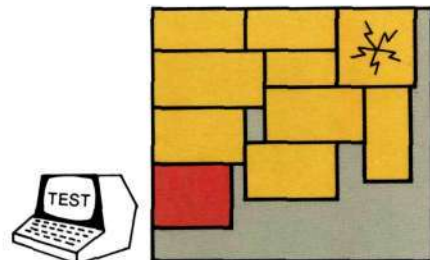
AXE: function changes involving software are made without disturbing normal service.



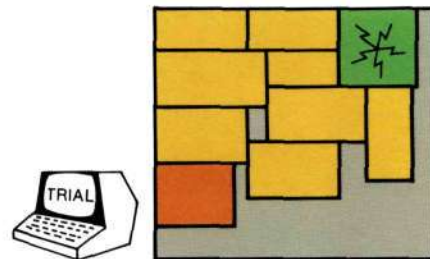
Indicated module to be replaced by a new one with additional facilities.



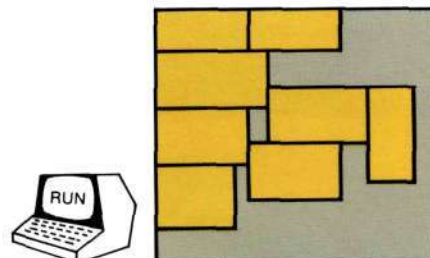
New module loaded. Old one still in service.



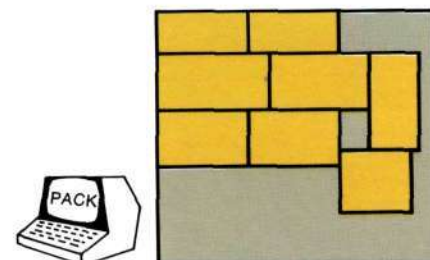
New module under off-line test. Old one still in service.



New module in trial service. Old one in standby.



New module in full service. Old module deleted.



Store repacked.



2640A TERMINAL

HEWLETT · PACKARD

Man-machine communication.

## Modularity from beginning to end.

AXE's system-wide modularity not only simplifies operation and maintenance, but installation as well.

The system's functional modularity makes extensions and the introduction of new functions easy.

With exchange data loaded by commands, the result is reduced lead times and installation costs.

The modular concept is also carried into the mechanical structure.

### Mechanical structure and functional modules.

The mechanical structure and packaging system of AXE 10 has been specifically designed to reproduce the system's functional modularity.

The functional module hardware is assembled within a mechanical frame, the magazine.

As the functional modules vary in size, so do the magazines. The largest houses for example a complete central processor unit. The smallest contains only a few PC boards.

There are no racks in AXE exchanges.

No rack cabling.

No rack documentation.

No rack testing.

Just a simple structure carrying horizontal and vertical cable chutes, together with the horizontal shelves along which the cabling is arranged.

### Magazines shipped fully equipped, tested and ready for operation.

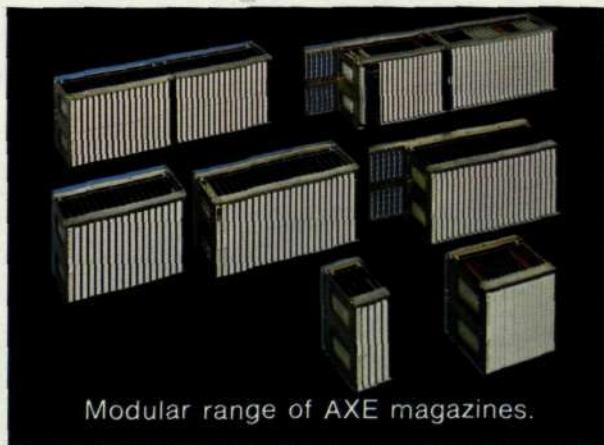
AXE magazines also form documentation and testing modules.

This means the magazines can be tested as functional units in production, with all boards equipped and in the operational software environment.

With most of the testing done during production, installation time for AXE exchanges is short.

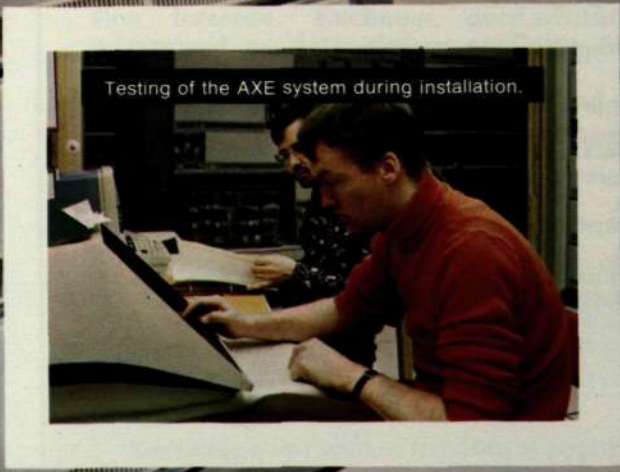
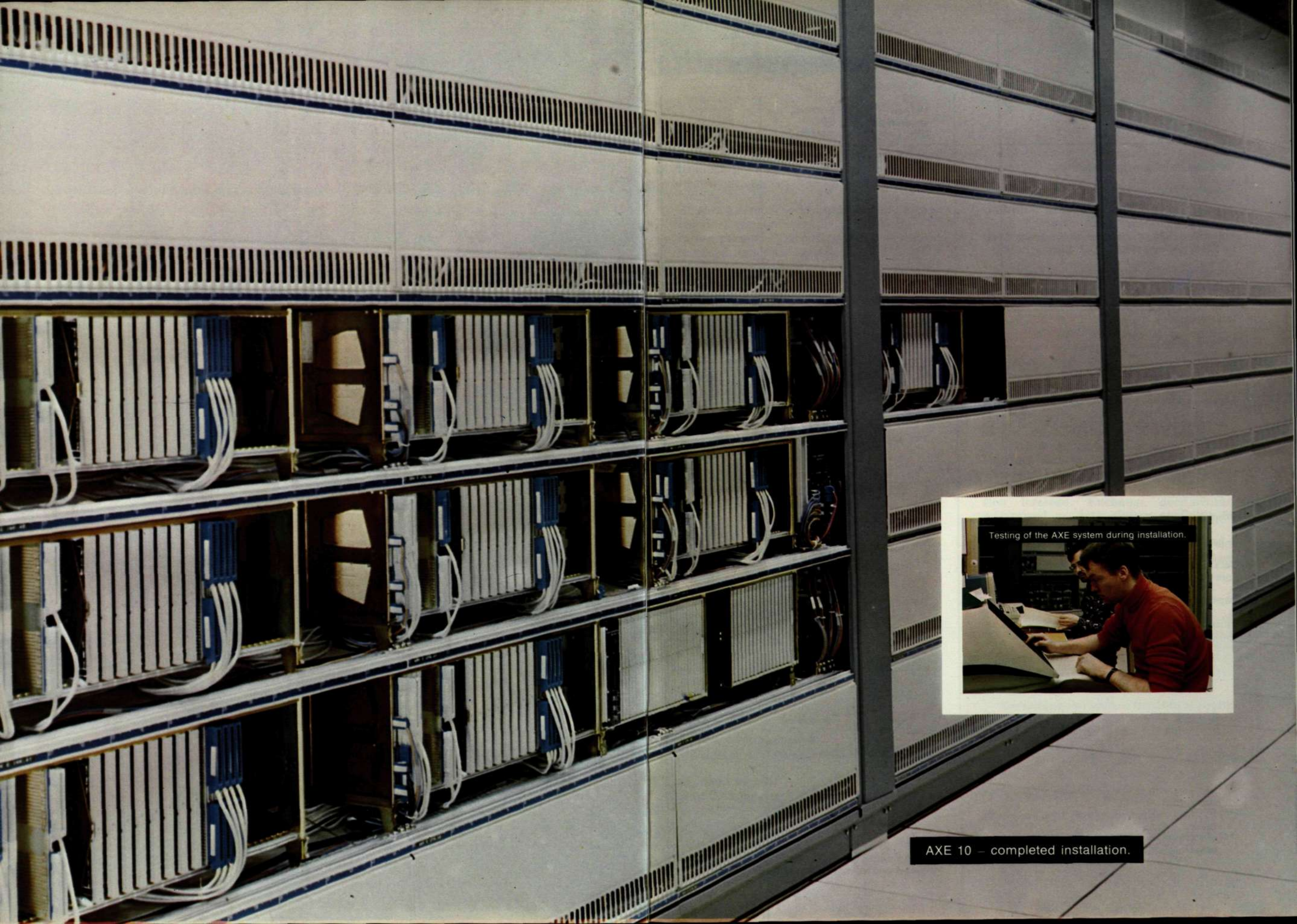
The result is improved manageability.

And another factor in the minimization of total cost that you get with AXE.



Modular range of AXE magazines.

AXE installation in progress.



Testing of the AXE system during installation.

AXE 10 – completed installation.

# New generation

	AXE the new generation SPC.	Previous SPC systems
Functional modularity in design	Yes	Yes
Functional modularity in installation	Yes	No
Functional modularity in operation	Yes	No
Functional changes and extensions function by function instead of complete reloading	Yes	No
All application functions programmed using high level language	Yes	No
Processing system design based on functional modularity principles	Yes	No
Software security	Yes	No
Data addressing and accessing performed by separate instructions	No	Yes
Absolute addresses handled by programmers	No	Yes
Every piece of data provided with individual memory protection	Yes	No
Risk of uncontrolled fault dispersion and data mutilation caused by:		
— program errors	No	Yes
— operator mistakes	Minimized	Yes
— hardware malfunction	No	No *) Yes **)
Data belonging to one functional module accessible from another functional module	No	Yes
Object code (binary) relocatable	Yes	No
Different command categories for differentiated access to the system facilities (protection against malicious operation)	Yes	Possible
Level of system operation and maintenance	Functional	Absolute binary code
Category of personnel required for operation and maintenance	Non-specialized	Specialized
Normal method of correcting errors	Recompilation ***)	Patching

\*) Systems with processors working in parallel synchronism.

\*\*\*) Systems with processors working in load sharing mode.

\*\*\*) of software belonging to the functional module concerned only.

# characteristics.

## AXE subscriber services (partial listing).

- Restricted service — originating (call barring).
- Restricted service — terminating (call barring).
- Absentee service — rerouting to operator or recorded announcement.
- Interception — rerouting to operator or recorded announcement.
- Push button dialling.
- Malicious call tracing.
- Abbreviated dialling.
- Hot line service.
- Subscribers' private meters.
- Priority.
- Hold for enquiry.
- Call transfer.
- Add on conference.
- Call waiting.
- Automatic alarm clock.
- Coin boxes.
- In-dialling to PABX.
- Centralized PABX (Centrex).
- Follow me.
- Call forwarding — on busy.
- Call forwarding — on no answer.
- Automatic call-back.

## Main data.

### Traffic capacity

0.09–0.30 erlangs/subscriber

0.5 –0.8 erlangs/trunk

### Extension module

2,000 subscribers

16 trunk circuits

### Maximum capacity

65,000 subscribers

at 0.10 erlangs/subscriber

100 secs. m.h.t.

### Floor space requirements

10,000 lines — 90 square meters

### Equipment height

2.40 or 2.85 meters

## AXE administrative facilities (partial listing).

- Free number group — covers full exchange.
- Charging schemes: single metering, multi-metering and/or toll ticketing. Metering “electronic” — output on magnetic tape or data link to central processing.
- Comprehensive traffic recording functions — measurement of carried traffic and offered traffic (per address).
- Continuous traffic supervision — provides up-to-the-minute data for network management.
- Standardized Man-Machine Language (CCITT).
- Subscriber and exchange data stored in memories — additions and changes performed by command (teletype, tape).
- Supervision and alarms recorded by print-outs. Complete logging of all parameter changes.
- The last two features provide for centralization of administrative functions to Operation and Maintenance Centers, Charging Centers, etc.
- Functional documentation for different exchanges identical — centralized documentation foreseen. Exchange documentation minimized as data always available from data stores.
- Functional changes and extensions made function by function — complete reloading not required.

## Special “Ericsson Review” Issue.

The AXE 10 SPC telephone switching system has recently been the subject of a special issue of the “Ericsson Review”.

### Articles covered:

“Presentation of AXE 10 Switching System.”

“Introduction of the AXE 10 Switching System in the Telephone Network.”

“AXE 10—System Description.”

“AXE 10—Software Structure and Features.”

“New Packaging Structure for Electronic Switching Systems.”



"CONFIDENCE IS KNOWING YOU'VE  
MADE THE RIGHT DECISION".





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