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On cover: The new LM Ericsson manual exchange ADG 101 in hotel reception surroundings.

Centralized Maintenance in Zagreb Telephone District

P. BALASTRIN & A. MANOLA, PTT, ZAGREB

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Centralized controlled corrective maintenance on the principles developed by L M Ericsson for transit centres is being introduced in stages in the Zagreb telephone district. Satisfactory results in the form of higher service reliability and reduced staff have been found already after completion of the first stage. This article describes in broad outline the transition to the new method and its effect on the maintenance organization. Readers who wish to make a closer study of maintenance questions and of controlled corrective maintenance methods, as well as of the associated equipments for national and international traffic, are referred to the bibliography at the end of this article.

Structure of Yugoslavian Telephone Network

For operation of the fully automatic telephone traffic Yugoslavia is at present divided into 17 districts or transit areas (fig. 1). Each district comprises a central zone, with a transit centre of higher order, and a number of subordinate zones

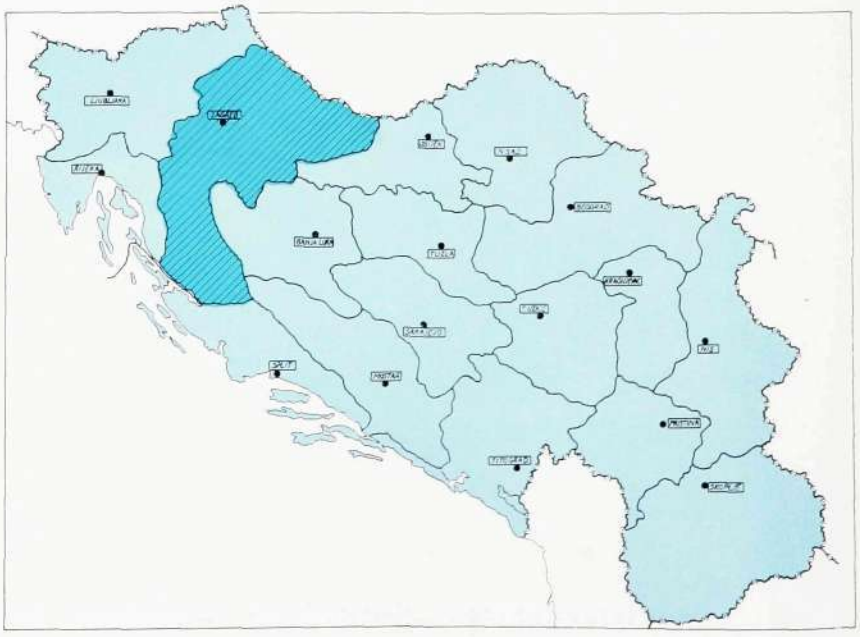


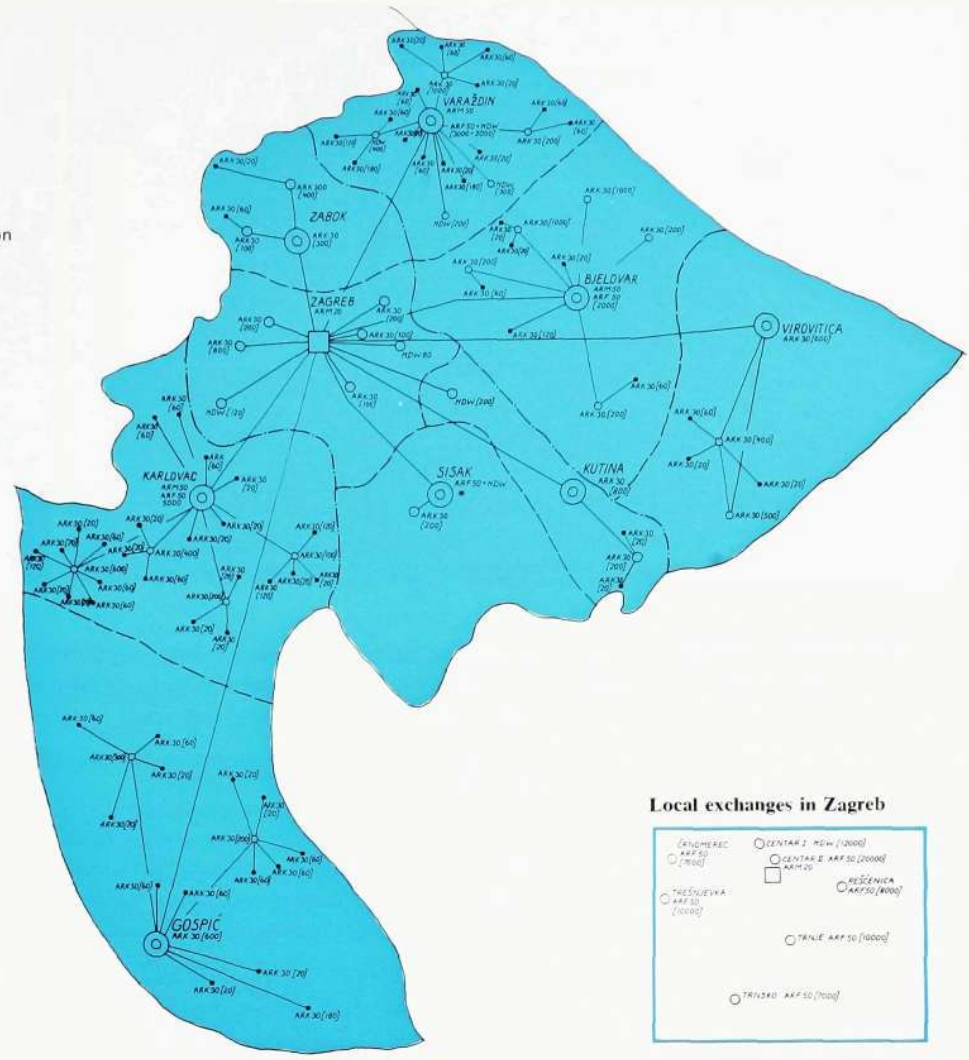
Fig. 1

Telephone districts with district centres, Yugoslavia

Fig. 2

Zagreb telephone district

- District centre
- Zone centre
- Group centre
- Terminal exchange
- District boundary
- Boundary of area under Zagreb PTT administration
- Zone boundary
- Specially equipped



Local exchanges in Zagreb

with zone centre, group centres and terminal exchanges in a star-shaped network. This article deals with the Zagreb district with its nine zones (fig. 2).

Most of the maintenance equipment is located in Zagreb (Centar II exchange) and serves chiefly the Zagreb zone. At the Centar II exchange there are also traffic route testers and important alarm functions for the entire district, as well as the equipment for remote measurement of subscriber lines which is under construction.

Establishment of a Maintenance Centre

Fig. 3 shows the present organization for the maintenance service in the district. All local exchanges of systems ARF 50 and HDW (Hebdrehwähler) in Zagreb are attended. Apart from the permanent maintenance staff, there is a group of technicians who carry out large scale tests of the ARF 50 exchanges. The ARF 20 transit centre is also attended, whereas the group centres and terminal exchanges in the Zagreb zone are unattended. The majority of group centres and terminal exchanges in the other zones of the district are unattended and their maintenance is carried out by staff from their superior zone centre.

In the larger local exchanges of type ARF 50 the maintenance was earlier carried out on a fixed schedule, which included setting up of a specific number of test connections from the automatic exchange tester. At the transit centre, on the other hand, the maintenance work followed mainly new lines from the

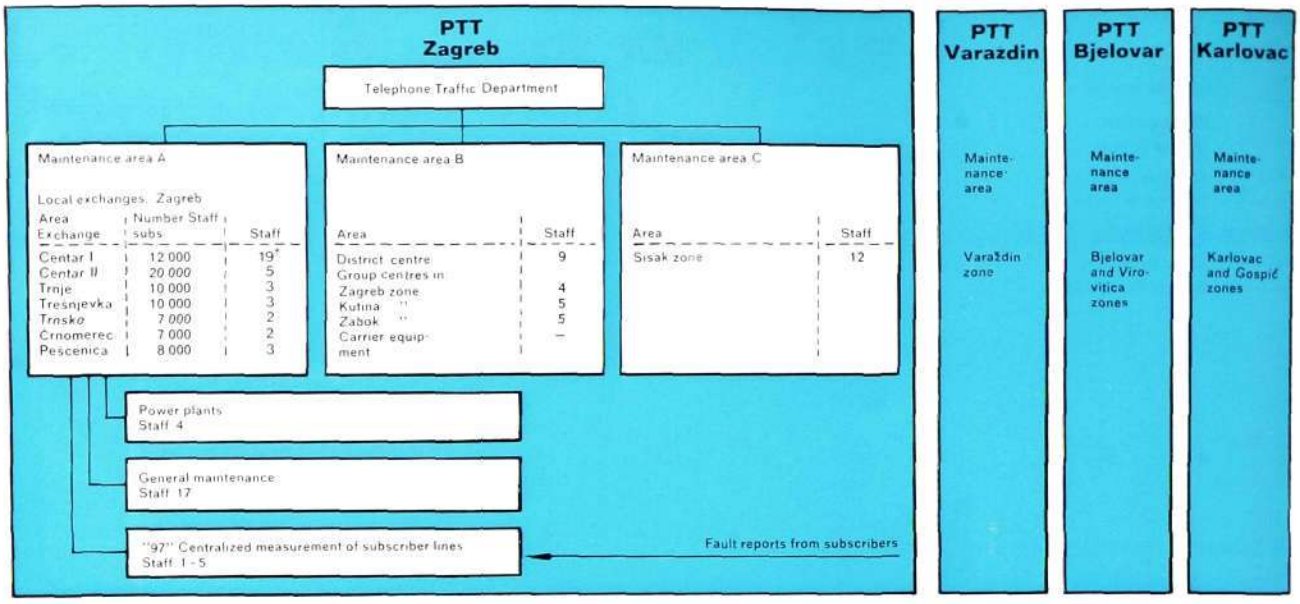


Fig. 3

Maintenance organization, Zagreb district

* **Earlier step-by-step system (approx. 45 years)**

outset, as the necessary supervisory equipments — such as centralograph, statistical counters and automatic exchange and rate testers — already existed in that exchange.

The zone and group centres earlier worked exclusively on the preventive maintenance principle.

With earlier preventive maintenance methods it was difficult to attain a high and uniform quality of service for the automatic telephone traffic concurrently with a saving of maintenance staff. In conjunction with the extension of the exchanges it proved increasingly that modernization in this sphere was necessary.

As early as 1967, therefore, it was decided to establish a maintenance centre at which centralized supervision could be introduced in the Zagreb district in accordance with the controlled corrective maintenance method elaborated by L M Ericsson. This maintenance centre, which was planned in collaboration between the Zagreb PTT and L M Ericsson, contains, among other items, traffic route testers and the necessary equipment for service supervision, route alarm etc. This equipment is described in the following sections.

Introduction of Traffic Route Tester

One of the chief aids in the new maintenance method is the automatic traffic route tester *TVP* which generates artificial traffic. In the largest local exchange in Zagreb, Centar II, there are five TVP for testing of the traffic routes in the district. The service supervision position in the maintenance centre contains equipment for recording and control of TVP. To permit centralized testing of all traffic routes in the local Zagreb area, all other ARF 50 exchanges are equipped with relay selectors *FVA*, *FVB* and, if necessary, test number group selectors *PGV* (fig. 4).

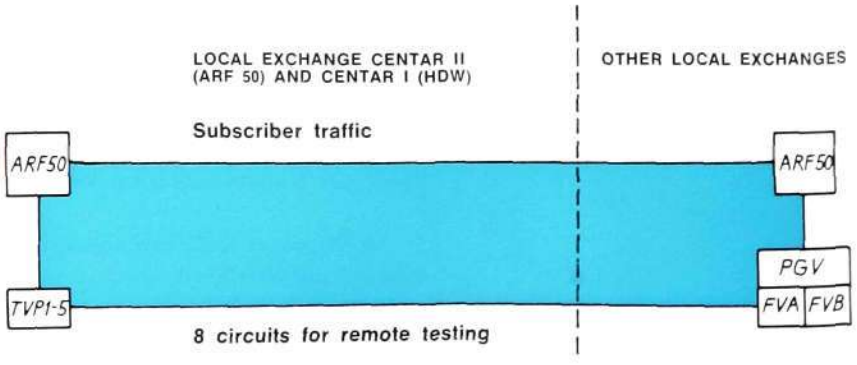
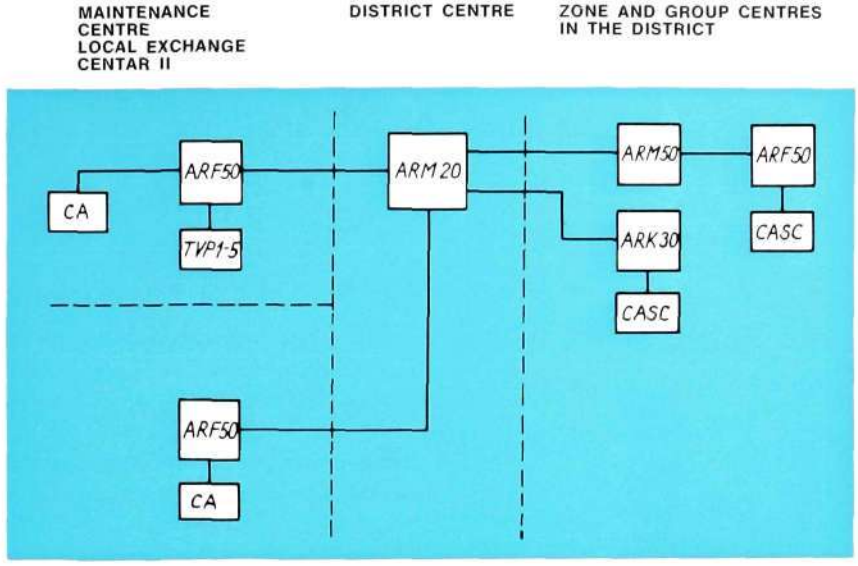


Fig. 4

Remote testing within Zagreb local area

Fig. 5

Remote testing with primary and secondary calls within the district



The test numbers in the Centar I and II local exchanges are directly connected to TVP, whereas the test numbers of the other ARF 50 exchanges are divided into five groups of 10 numbers each and connected to outlets from PVG.

Through the centralized traffic route testing a check is maintained both on the incoming and outgoing traffic and on the local traffic within the zone and group areas. TVP carries out the centralized traffic route testing in cooperation with corresponding code answering devices on normal traffic routes.

For generation of all types of traffic outside the local area there is a code answering device *CASC* which can set up secondary connections to all zone centres in the district and to all group centres in the Zagreb zone. The local exchanges in Zagreb, on the other hand, are equipped with code answering devices *CA*, which have answering functions alone (fig. 5).

Fig. 6 shows an example of the programming of traffic route tester TVP for all automatic telephone exchanges.

To

From

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX		Casc
I	1							36			11										
II																					
III																					
IV				2				31				12									
V					3				32				13								
VI						4		33						14							
VII							5		34						15						
VIII	26			21		23		6		25						16					
IX					22		24		7								17		19		
X								35		8								18			
XI																					11
XII																					12
XIII																					13
XIV																					14 20
XV																					15
XVI																					16
XVII																					17
XVIII																					18
XIX																					19

Subprogrammes

Fig. 6

Programming of a traffic route tester in Zagreb

The groups marked with Roman numerals comprise at most 10 test numbers each. They are as follows:

I—X local exchanges
XI group centres
XII—XIX zone centres

The Arabic numerals indicate the different programmes.

Programmes 1—8 carry out testing of local exchanges in the local Zagreb area. Programmes 11—20 test the traffic routes to the group centres in the Zagreb zone. With the subprogrammes 11—20 in column CASC, secondary test connections are set up from the code answering devices CASC. Programmes 21—26 generate outgoing traffic from the Centar II local exchange to the other local exchanges, and programmes 31—36 from these exchanges to Centar II.

Particular attention was paid in the programming to the simultaneous working of all five traffic route testers. It was thus possible to arrange for the tests to comprise all test numbers or all types of traffic with one combination of programmes.

Controlled Corrective Maintenance

Both large and small automatic telephone exchanges are able to deliver a large number of data for supervisory and recording purposes. So large a quantity of data may readily lead to such an accumulation of information as to delay its evaluation and render difficult the tracing of sources of disturbance. To ensure effective service supervision, a method is required which quickly and clearly indicates the failure rate and the source of failure automatically.

For this reason the principle recommended by L M Ericsson — controlled corrective maintenance which fulfils the aforesaid requirements — was introduced in all telephone exchanges. All central exchange equipments are continuously supervised by means of built-in circuits, and each operational failure is recorded on statistical counters. In addition a failure rate counter *DL* adds up the number of failures, while another counter adds up the number of occupations. When a present failure rate is exceeded, a service alarm is issued which indicates that the devices concerned must be tested and the faults remedied. As long as no service alarm is issued, no tests or preventive maintenance shall be carried out. An exception is the programmed testing with traffic route testers described in the preceding section.

Centralograph Equipment

The Centralograph equipment is used for supervision of connections through the switching stages and for detailed recording of types of fault in the devices concerned. The centralograph equipment is one of the most important aids in a modern maintenance programme. Apart from the existing equipment at the Zagreb transit centre, Centralograph equipment has been installed also in the zone centres of type ARM 50 at Varazdin, Bjelovar and Karlovac.

Route Alarm

The blocking alarm circuits in the outgoing junction relay sets associated with one route are brought together and connected to a route alarm relay set with a capacity of 10 routes. When the number of blocked junction relay sets reaches a predetermined level, a route alarm is issued. The corressponding alarm lamps are placed at the service supervision position or on a panel. Introduction of this type of alarm is in progress at all zone centres in the district and at all ARK 30 group centres in the Zagreb zone.

Transmission of Alarms to Maintenance Centre

All important categories of alarm, such as service and route alarm, are transmitted from local exchanges, group and zone centres to a lamp panel in the maintenance centre. The alarm transmitter *FUR-LT* and alarm receiver *FIR-LT* are connected to ordinary junction circuits, which also carry traffic. The alarm

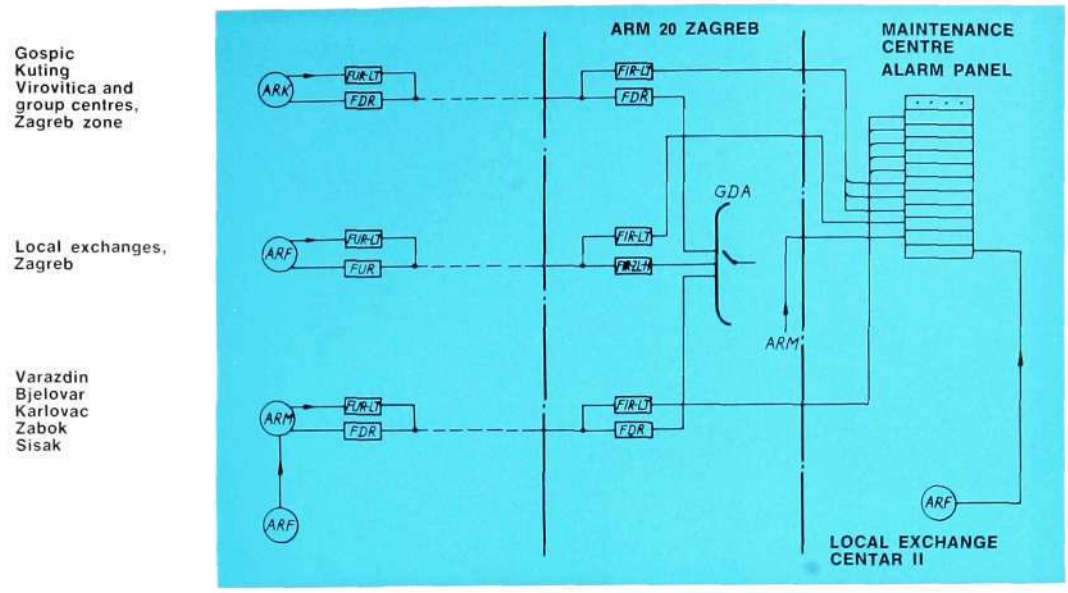


Fig. 7

Principle for transmission of alarm via FUR-LT, FIR-LT

transmission system is adaptable and can be used for circuits with DC or AC signalling and for carrier circuits. Conversations in progress are, of course, not disturbed by the transmission of alarm.

Centralized Remote Measurement of Subscriber Lines

In the local Zagreb area the fault reporting system is centralized and all measurements of subscriber lines and telephone sets take place from a single exchange. The existing equipment, however, is not suited for measurement of subscriber lines on remote exchanges or on exchanges connected via radio links. In conjunction with the construction of a maintenance centre for Zagreb, L M Ericsson's new remote measuring equipment was introduced within the entire area. The equipment operates independently of distance and type of circuit between the exchanges, and of the type of exchange. The measuring equipment consists of an order transmitter and a result receiver *PR-A* and of a number of order receivers and result transmitters *PR-B*. Voltage measurement, check of tones, alarm etc. can be done in addition to measurement of subscriber lines.

PR-A is installed in the Center II local exchange, and every local exchange, group or zone centre has a *PR-B*. *PR-B* receives orders from *PR-A* on normal junction circuits and carries out the desired measurements, transmitting the results back via *PR-A* to the test desk, where the results are shown on a lamp panel.

Results of the New Maintenance Method

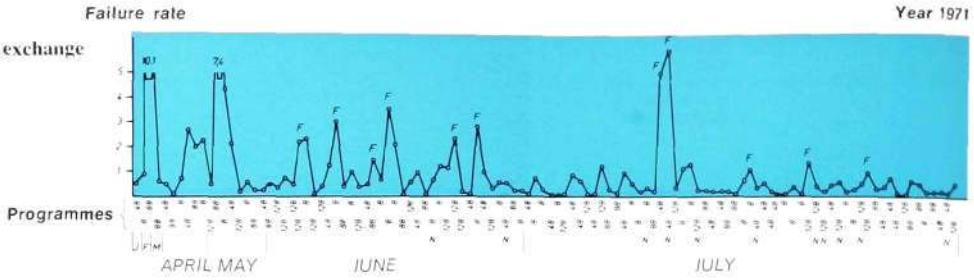
The maintenance centre is designed to allow complete implementation of the new maintenance method in all crossbar exchanges in the Zagreb zone and in the zone centres throughout the district.

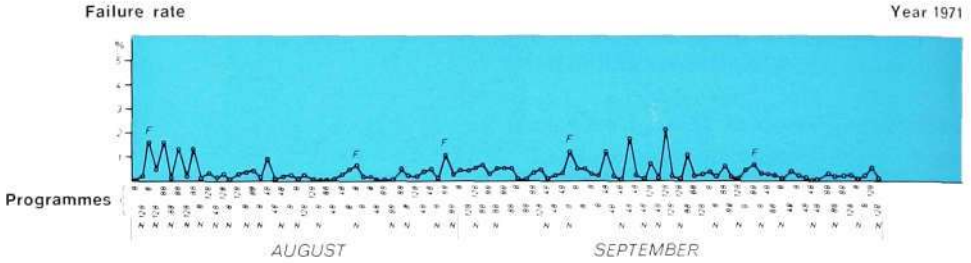
Experience hitherto shows that the new method has a great significance for the present maintenance organization. At some exchanges the number of working hours per connection during 1971 was reduced by about 25 % compared with 1970. Further improvements are expected in the coming years. The Zagreb staff can thus take over maintenance assignments also for the new ARF 102 exchanges.

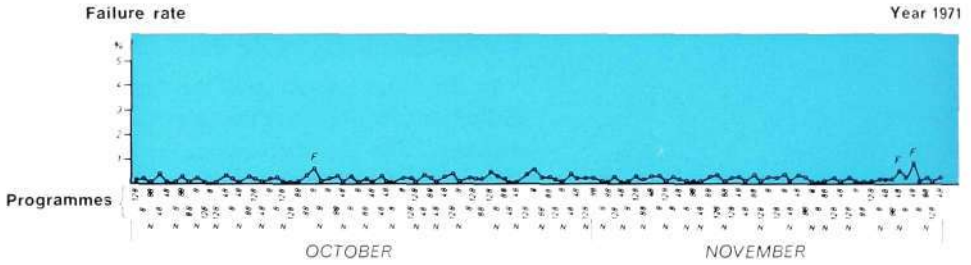
Fig. 8

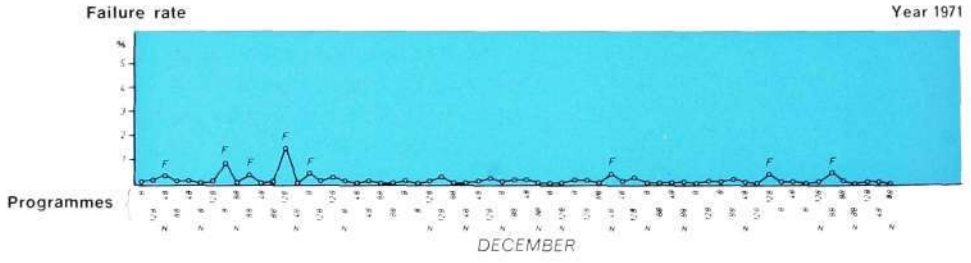
Quality of service at Trnsko local exchange

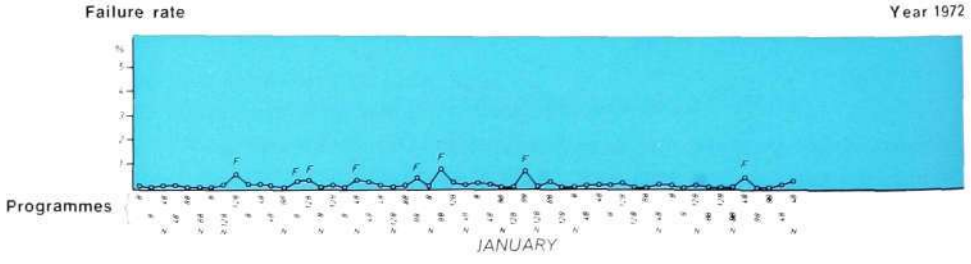
F = Faults repaired
N = Nighttime tests











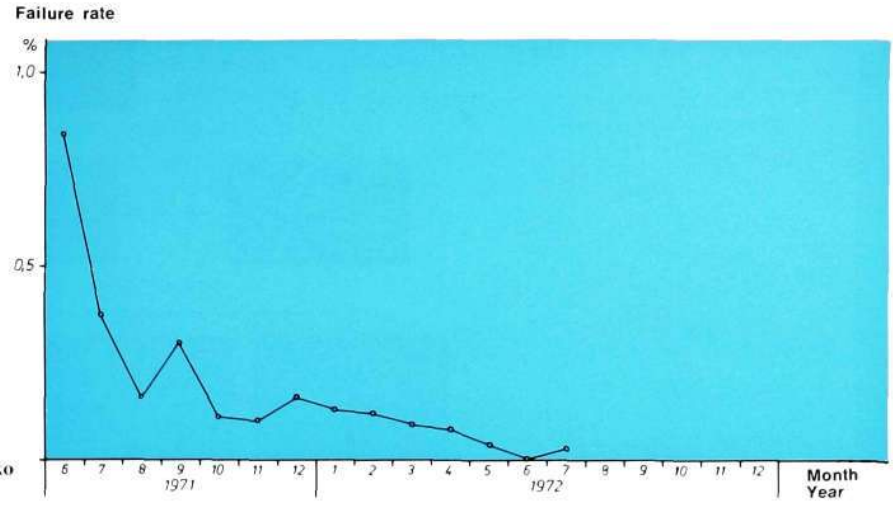


Fig. 9

Monthly average failure rates at Trnsko local exchange

In June 1971 the new maintenance method was introduced for the first time at the ARF 50 local exchange at Trnsko. The daily programmes with the traffic route tester were stopped when the daily rate exceeded 2 ‰; fault tracing was then started. The night programmes, on the other hand, were not interrupted, the results being evaluated on the following day. Fig. 8 shows the results of the quality of service tests. Fig. 9 shows the monthly mean failure rates. Through the adoption of the new method the improvement in quality of service was such that, shortly thereafter, it was decided to introduce the method also at the other crossbar exchanges in the local Zagreb area. There are already certain indications that similar results can be attained at these exchanges as well.

The operational reliability on the Zagreb-Varazdin route was investigated during April—December 1971 with an automatic traffic route tester at Zagreb. At the end of the year the reliability was found to have considerably improved. This is a consequence, in part, of the intense use of traffic route testers and, in part, of the use of the new test and supervisory equipment at Varazdin.

Apart from traffic route tests through the zone centres, similar tests are being made to the group centres of type ARK 30 in the Zagreb zone. The results show an improvement towards the end of 1971.

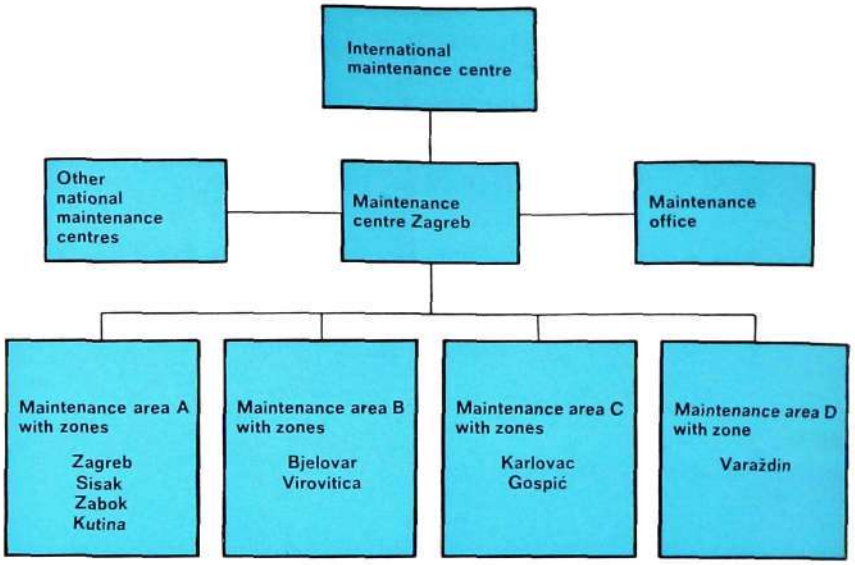
New Maintenance Organization in Zagreb District

All existing local exchanges with 10,000 or more subscribers will continue to be attended, while future exchanges, which almost without exception are being built in new residential areas, will be unattended. These new ARF 102 exchanges will be maintained by the technician group in line with the experience gained from the maintenance centre. The group will also take over certain assignments in the ARF 50 exchanges in the Zagreb zone, as also in ARF exchanges in other zones of the district.

The extension of crossbar group centres in the Zagreb zone involves no increase in maintenance staff. Apart from regular inspections and routine tests of the exchanges, these staff have hitherto worked also on the M.D.F. and made measurements of subscriber lines and telephone sets. Since the introduction of the new maintenance method, on the other hand, the exchanges are visited only as required (TVP indication, alarm, subscriber's complaint or the like) as the *PR-A* and *PR-B* equipments permit centralized measurement of subscriber lines.

Fig. 10

Future maintenance organization, Zagreb district



This also results in a considerable reduction of travel time, which previously amounted to one-third of the total working time. In the future these technicians will also be assigned to work on complicated faults in exchanges in other zones.

In the other zone centres of the district, staff had already been trained in the new maintenance method and additional staff will be trained. The construction of additional maintenance centres, which will also cover the terminal exchanges, is also under preparation. Depending on size, traffic etc. each such centre will cover two to four zones. An international maintenance centre IMC is also planned for the new fully automatic international transit centre *(CT3)* of type ARM 202/4.

Fig. 9 shows the planned future maintenance organization for this purpose.

The existing maintenance centre in Zagreb, with the equipment described, serves the Zagreb, Sisak, Kutina and Zabok zones down as far as terminal exchanges within maintenance area A. Other functions are the checking and coordination of the incoming and outgoing traffic at the zone centres in the district, as also checking of the outgoing traffic to other district centres in the country.

The maintenance centre planned at Bjelovar will superwise all exchanges in the Bjelovar and Virovitica zones(maintenance area B), that at Karlovac will supervise all exchanges in the Karlovac and Gospic zones (maintenance area C), and that at Varazdin all exchanges in the Varazdin zone (maintenance area D).

These centres will be equipped with traffic route testers and will be supervised by the superior centre at Zagreb. Similar supervisory equipments will be provided at the group centres and terminal exchanges.

Summary

The experience hitherto shows that very satisfactory results have been attained with centralized testing and supervision. The maintenance of a considerably larger number of lines has been carried out with the same number of staff, and also with considerably better results. A continued extension of centralized maintenance within the Zagreb district ist therefore planned.

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Field Trial of CCITT Signalling System No. 6 using AKE 13

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UDC 621.395.38
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Eleven administrations are currently engaged in an international field trial of a new telephone signalling system under the supervision of the CCITT. This system, CCITT Signalling System No. 6, will be applicable to all types of international telephone circuits. Overseas Telecommunications Commission, Australia, OTC (A), which is one of the above administrations, is using L M Ericsson's stored program controlled transit exchange AKE 13 for its field trial equipment. The development work for this exchange was performed by a joint OTC-LME team of engineers and programmers and was based on design techniques previously developed by LME for the Rotterdam AKE 13 telephone exchange, which was installed by LME for the Netherlands PTT and placed in service during 1971. CCITT Signalling System No. 6 has been described in detail in publications listed among the references. This article is intended to describe the current status of the development of System No. 6 including the specification and the field trial.

Background to the Field Trial

During the period leading up to 1964 administrations and recognized private operating agencies around the world began to realise that existing international signalling systems would be inadequate to meet the future requirements of the world telephone network. Accordingly CCITT defined the basis for the study of a new signalling system, to be called CCITT Signalling System No. 6.

Stated briefly, System No. 6 was not only to be applicable to all types of international circuits (including TASI derived and satellite circuits), but was also to include all additional facilities which were seen as being desirable for the telephone networks of the future. Amongst these new facilities were:

— automatic repeat attempt;
— echo suppressor control;
— routing signals;
— signals to indicate congestion of equipment or groups of circuits, called-party line conditions and other causes of ineffective calls;
— signals to indicate the calling party's category, etc.;
— network management (administrative) signals;
— the ability to operate equally well in conjunction with en bloc and with overlap numerical signalling;
— the ability to operate with variable numbers of digits both for the country code and the national number without increase of post-dialling delay, due for example, to time-out;
— capacity for adding signals to cater for unknown future requirements.

To perform the study, CCITT set up Working Party XI/1 (Signalling System No. 6). The work carried out by this working party was issued as a specification by CCITT Study Group XI and presented as a contribution to the IVth Plenary Assembly of CCITT in 1968. The study was described at the Plenary as "a study without any doubt the broadest ever carried out by CCITT or its predecessors, the CCIF and the CCIT".

This specification of System No. 6 was approved and was published in the CCITT White Book, Volume VI. The IVth Plenary Assembly also adopted the proposal to perform field trials of this new system and established the "Joint Working Party of the Field Trials of System No. 6" (GM/FT6).

Administrations or recognized private operating agencies were then invited by CCITT to participate in the Field Trial and the following eleven are directly participating in these trials:

Australia	— APO and OTC (A)
Belgium	— RTT
France	— PTT
Italy	— PTT and Italcable
Japan	— KDD
The Netherlands	— PTT
Federal Republic of Germany	— PTT
United Kingdom	— POC
United States	— AT & T

Signalling System No. 6

General

System No. 6 represents a considerable departure from the earlier principles of telephone signalling. Earlier signalling systems transferred their information over the speech circuit or over a special signalling channel provided in association with each speech circuit.

In System No. 6 all inter-exchange signalling is performed via separate circuits dedicated for signalling and no signalling is performed over the speech circuits. This departure from the normal technique introduced new problems, such as:

— If the signalling link becomes faulty then all speech circuits are out of service. Hence a very high degree of reliability is required on the signalling link(s).

— Because System No. 6 does not signal over the speech circuits there is no check that these are suitable for carrying conversation. Hence it has been judged necessary to introduce a special check of the continuity of the speech circuits.

The main advantages of System No. 6 are:

— The individual line relay sets associated with each speech circuit are simple as they do not send and receive line and register signals.

— The existence of signalling links between exchanges means that the information transferred on these links need not be restricted to information relating to a particular telephone call. The potential has been opened up for the economical introduction of the transfer of additional information relating to the management and statistical performance of the telephone network in addition to signals relating to particular telephone calls.

— The potential for additional signalling capacity also introduces the possibility of economically designing variants of System No. 6 for special applications (e.g. national or regional use) which are fully compatible with System No. 6.

It is interesting to note that the regional and national application of System No. 6 is being studied within CEPT, the European Post and Telecommunications Commission, and that, among other countries, the United States is in the process of designing a national system compatible with the revised international variant currently being specified as a result of the field trial.

Signalling Principles

The introduction of System No. 6 requires the establishment of the two separate parts of the system, the signalling links and the speech circuits.

The signalling links are derived from individual circuits of 3 or 4 kHz nominal bandwidth to which 2,400 b/s data modems are attached at each end. The modems are controlled by signalling terminals which individually generate basic signal units (SUs) of 28 bits in length and consisting of 20 information bits and 8 check bits. All information sent over the link must be converted to this basic format before transmission.

The check-bits are used for error control. Error correction is performed by retransmission of signal messages found faulty.

Information messages can be either lone signal units (LSUs) in which all information is contained in 20 information bits or multi-unit messages (MUMs) in which the information is spread over a number of signal units. Typical LSU and MUM formats are shown in fig. 1.

Fig. 1 a

Format of a lone signal unit (LSU)

XXXXX	XXXX	XXXXXXXXXXX	XXXXXXXX
1—5	6—9	10—20	21—28
heading	signal information	label (identity of the speech circuit)	check

Fig. 1 b

Format of an initial address message (IAM) with three signal units

ISU Initial Signal Unit
SSU Subsequent Signal Unit

ISU	10000		0000		XXXXXXXXXXX		XXXXXXXX
	address message code		ISU code		label (identity of the speech circuit)		check
1st SSU	00	XX	XXXXXXXXXXXXXXXX				XXXXXXXX
	*	**	other routing information				check
2nd SSU	00	XX	XXXX	XXXX	XXXX	XXXX	XXXXXXXX
	*	**	1st address signal	2nd address signal	3rd address signal	4th address signal	check

* SSU indicator
** length indicator

Table 1

Design objectives for handling time (T_h) and cross-office transfer time (T_c)

Type of message		Answer	Other one-unit messages	IAM of 5 SU
T_h in ms	Average	12	25	25
	95 % level	25	60	60
T_c in ms	Average	40	60	120
	95 % level	70	140	200

Signalling Speed

The No. 6 signalling system is intended to be faster than previous signalling systems and hence CCITT has specified in detail target requirements relating to allowable handling and cross-office transfer times at No. 6 exchanges. This has been done to reduce post-dialling delays, especially where many telephone links may be involved in a particular connection. The design objectives for the handling time T_h and the cross-office transfer time T_c are shown in Table 1.

Quasi-Associated Signalling Link Operation

Because of the high-speed of System No. 6 it is possible to tolerate slight reductions in speed by introducing non-associated modes of working where advantageous. The quasi-associated mode of operation introduces a signal transfer point (STP) into a data link. It is most useful where signalling links are established between terminals A and C and between C and B handling System No. 6 traffic (see fig. 2). Using C as an STP, communication between A and B can be established without providing a separate A to B data link. This is done by reserving labels in the A to C and C to B signalling links for communication between A and B. These labels identify the A to B speech circuits.

For quasi-associated signalling between A and B it is not necessary to use exactly the same labels in the two signalling links A to C and C to B as the specification requires an STP to be capable of translating labels during transfer of messages.

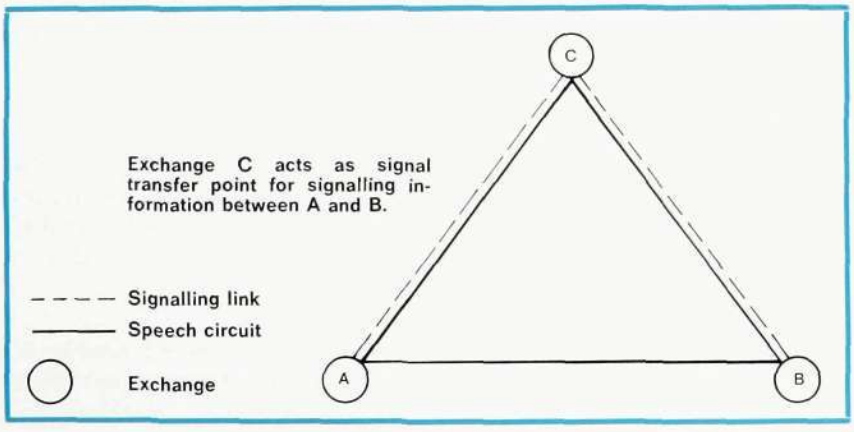

Fig. 2

Quasi-associated signalling

Security of the Signalling Link

It is extremely important that signalling communication is secure when using System No. 6. This is achieved by providing reserve signalling facilities which are used when the regular signalling link becomes faulty or experiences excessive error rates. Since signalling links in System No. 6 are fully synchronous, monitoring of the error rate at each incoming end of the signalling link is used to determine when changeover to a reserve facility is necessary.

When, by means of the error-rate monitor, it has been determined that changeover should occur, changeover procedures are invoked. These procedures are complicated but are designed to ensure that during changover the integrity of the signalling link is maintained and that both ends of the link receive all necessary information to ensure that telephone calls are not lost or disturbed.

Should these changeover procedures not result in speedy re-establishment of communication (e.g. due to processor malfunction or multiple failure of regular and reserve signalling links) emergency restart procedures are invoked. These procedures are intended to re-stablish communication automatically as quickly as possible and to minimise the effect of an emergency situation. Should the emergency restart period be prolonged then all telephone speech circuits served by the failed links must be blocked to subscribers trying to establish telephone calls over these links.

System No. 6 Network Configurations

The basic No. 6 network will consist of a network of data links together with a network of groups of speech circuits between exchanges. The speech circuit network will be conventional in concept and will consist of routes between exchanges dimensioned according to the community of interest for telephone traffic between the exchanges.

The signalling network will however be quite different and will be designed to make use of the high capacity of the individual signalling links. The ability to use quasi-associated operation (as described above) to provide both regular and reserve signalling facilities has created many possibilities for the minimization of the signalling network.

CCITT Activities During the Field Trials

Organization of Joint Working Party GM/FT6

GM/FT6 established its method of working at its first meeting and found it useful to follow the same method at all subsequent meetings. Three subgroups were established:

Sub-Group 1 was entrusted to deal with the field trial timetable, the various polygons of routes to be included in trials and the general organization arrangements. At the 5th meeting of GM/FT6 this Sub-Group was also entrusted with the evaluation of the field trial results and the preparation of the Final Report of GM/FT6.

Sub-Group 2 was entrusted to deal with the defining and specifying of the test methods and procedures to be used during the various phases and stages of the tests.

Sub-Group 3 was entrusted to deal with the additions, deletions and modifications of the System No. 6 Specifications.

Since the IVth Plenary Assembly in 1968 both Study Group XI and Working Party GM/FT6 have held several meetings and have discussed and implemented many alterations to the System No. 6 Specification.

Activities of GM/FT6

As stated above, Sub-Groups 1 and 2 are primarily concerned with the actual field trials whilst Sub-Group 3 is concerned with the System No. 6 Specification. Sub-Group 3 thus attracted a great deal of interest and many contributions have been presented to this group for consideration. These contributions have resulted mainly from difficulties encountered during the design of the field trial equipments and as a result of interworking difficulties arising from varying interpretations of the specification and its intention.

The discussions around these contributions have often been quite lengthy and there have been times when agreement has been difficult to reach. However, there is a genuine desire on the part of the participants to produce a final specification which is flexible and does not unduly restrict implementation techniques.

The most significant changes which have been made to the specification since 1968 are as follows:

— The security arrangements for maintaining communication between two terminals in the event of link failure have been changed considerably. In particular the criteria for determining when a signalling link is faulty have been tightened, automatic and manual changeover procedures have been revised, an emergency restart procedure has been introduced, and signals indicating when a signal transfer point fails have been introduced.

— The continuity check of each speech circuit has been revised to convert it from a backward direction check to a forward direction check and to take into account possible failure of the speech circuit within the switching network of a System No. 6 exchange. This cross-office continuity check may be performed either on a per call basis or by a statistical method.

— Call set-up procedures have been revised to enable more convenient interworking between System No. 6 and Signalling Systems R1, R2 and No. 5 Bis, all of which were approved at the same Plenary Assembly as System No. 6.

— Much greater consideration has been given to the handling of out-of-sequence and unreasonable signals from System No. 6 and the specification has been revised to define in much greater detail actions to be taken at the receiving end of a signalling link when such signals are detected.

— The specification now takes into account certain types of exchange malfunction and defines how such malfunction situations should be handled.

— The format of the System No. 6 signals has been revised to improve the utilization of the 20 information bits in the signal units.

Due to lack of time some of the agreed specification changes will not be tested during the field trials but will be included in the draft final specification. For this reason SG XI at its meeting in March 1972 decided to establish a special drafting group, which is autonomous from Joint Working Party GM/FT6. This drafting party is entrusted with the preparation of the final specification for System No. 6.

AKE 13 in Sydney and Interworking Exchanges

AKE 13 as used in the Field Trial

In the field trial in Sydney OTC (A) is using a L M Ericsson stored program controlled transit exchange AKE 13 equipped with 64 bothway circuits FDR-6 for signalling system No. 6 and a number of circuits for signalling system No. 5 for other international lines as well as MFC and dial pulse circuits for the national network, fig. 3.

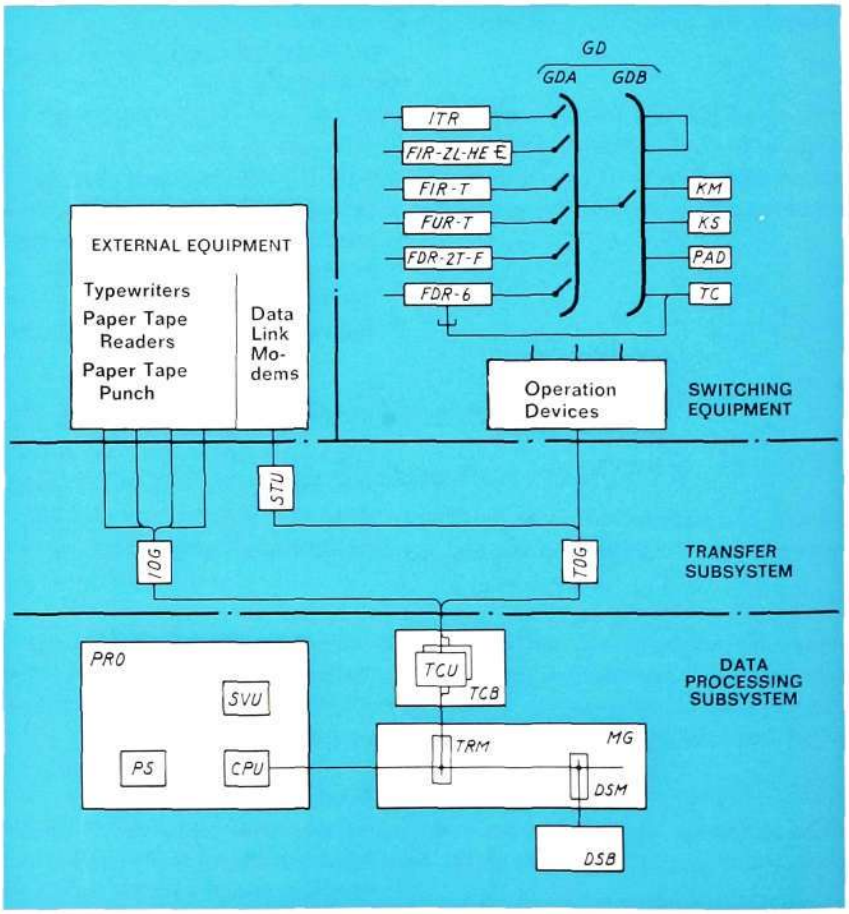

Fig. 3

Block diagram of AKE 13 as used in the field trial

GD	**Switching stage**
ITR	**Connecting device of announcing machine**
FIR-ZL-HE	**2-wire DP-line (incoming)**
FIR-T	**4-wire MFC-line (incoming)**
FUR-T	**4-wire MFC-line (outgoing)**
FDR-2T-F	**4-wire No 5-line (both way)**
FDR-6	**4-wire No 6-line (both way)**
KM	**Code receiver**
KS	**Code sender**
PAD	**Pad**
TC	**Transfer control**
IOG	**Input output control**
STU	**Signalling terminal unit, No 6**
TOG	**Test and operation group**
PRO	**Processor**
PS	**Program store**
CPU	**Central processing unit**
SVU	**Supervisory unit**
TCB	**Transfer control block**
TCU	**Transfer control unit**
DSB	**Data store block**
MG	**Multiplexor group**
TRM	**Transfer multiplexor**
DSM	**Data store multiplexor**

The AKE 13 system is divided into the following main parts:

— Switching Equipment

— Transfer Subsystem

— Data Processing System

The switching equipment is made up of code switches arranged for 4-wire switching, different types of trunk circuits, continuity check transceivers, pads for speech circuits of signalling system No. 6, code receivers etc. as well as operation and control devices for the operation of switches and relays.

The transfer subsystem converts the signals from the data processing system into signals suitable for controlling the operation of the switching and external equipment. It also includes No. 6 Signalling Terminal Unit, STU.

The data processing system contains a processor performing all logic functions necessary for switching the connections, a data store in which all of the exchange data are stored, a transfer control acting as intermediary between the data processing system and the transfer equipment as well as a multiplexor group connecting the data store and the transfer control to the processor.

Interworking using System No. 6 Signalling

The AKE 13 equipment in Sydney is being used to interwork with equipment in UK, USA, Japan, Italy and the Australian Post Office (APO) Research Laboratories. General details of these processing equipments are given in Table 2.

Interworking using Existing Signalling Systems

The Sydney AKE 13 exchange is programmed to handle System No. 5, Loop-disconnect and MFC-signalling (MFC is the national variant of System R2) in

Table 2

General details of field trial processing equipment

Administration	OTC (A) (Sydney)	UK (London)	USA (Columbus)	JAPAN (Tokyo)	ITALY Italcable (Rome)	APO (Melbourne)
Manufacturer of Processing Equipment	L M Ericsson	GEC/AEI	Western Electric	Fujitsu	Bell (Antwerp)	Bell (Antwerp)
Word Size (bits)	16 + 1	16 + 2	20	16 + 1	16 + 1	16 + 1
Size of Core Store	128 K	32 K	300 K	64 K	32 K	16 K
Size of External Store	—	144 K	—	—	—	—
Store Cycle Time, μs	2.4	3—4	6.3	.75	1	2

addition to the System No. 6. The provision of these other signalling schemes enables comparison of performance to be made and also facilitates the System No. 6 testing by connecting the AKE 13 to the national network (MFC signalling), the international network (No. 5 signalling) and to the OTC PABX and test telephones (loop-disconnect).

By using these interworking exchanges many different types of calls may be established and the operation of the AKE 13 system, as well as of the No. 6 signalling system, evaluated.

On completion of the international field trials as specified by the CCITT, national field trials between Melbourne (APO) and Sydney (OTC (A)) are envisaged. During these trials it is hoped to confirm that System No. 6 will satisfactorily interwork with Australian MFC and to examine the suitability of System No. 6 as a national signalling system.

Field Trial Activities

Organization and Facilities

The Field Trial participants co-operate with each other to form polygons. This means that each partner only interworks with 3 or 4 other administrations or recognized private operating agencies.

The aim of the field trials is to test in practice the recommendations of the preliminary specification and to amend these where necessary, so as to produce a thoroughly checked final specification.

Consequently, GM/FT6 divided the field trial into the following phases:

(a) *Preliminary Phase*

Pseudo-random bit error testing of the various types of voice frequency links which may be used as data links.

(b) *Phase A*

Signalling link tests were performed using a standard list of typical messages. These tests endeavoured to determine signalling link performance and reliability and to verify the security of System No. 6 against signalling link failure.

(c) *Phase B*

During this phase, test calls (both manual and automatic) were generated to test numbers in each of the field trial exchanges. These calls were established with varying background loads of simulated traffic to demonstrate the capability of System No. 6 to switch telephone calls and to interwork with other CCITT signalling systems.

(d) *Phase C*

To augment the tests of phases A and B a final phase was planned during which subscriber and operator originated paid traffic would be switched by the field trial exchanges. However, it became apparent that, due to various operational and time limitations, significant phase C testing would not be undertaken.

In addition to the System No. 6 exchange, the following facilities are typically required:

(a) *Interconnecting Circuits*

Included here are the System No. 6 signalling links and their associated speech circuits between the two System No. 6 exchanges, connection with the local network to terminate certain test calls and connection with telephones and special call generating equipment.

(b) *Call Generating and Answering Equipment*

These devices may be manual (ordinary telephone handsets) or automatic devices for establishing switched connections and verifying the connection. In addition to these devices that establish switched calls, special test programs are required to generate simulated calls and to verify the sequence of the messages received. Mutilatd or delayed messages provide an indication as to the operation of the System No. 6 under conditions of loading, not achievable by manual dialling.
This simulated traffic enables a load to be placed on the whole system to verify its proper functioning under normal and overload conditions.

(c) *Communications between Testing Centres*

The communications equipment involved here includes direct access to the international telephone network and the international telex network. Also full-time private circuits connecting to loudspeaking facilities are provided. Conferencing facilities are also required when performing tests involving more than two partners.

(d) *Transmission, Recording and Reporting of Results*

The transmission of results between partners is either by telex or by using the System No. 6 signalling link. This latter method, although not used by the majority of participants, saves considerable time as the data is already in the computer's memory. It also highlights the versatility and flexibility of System No. 6. In operation, a simple program extracts each value to be sent, codes it in binary or BCD as desired by the recipient, formulates it into a System No. 6 message with an illegal label and then transmits it to the partner. It is a System No. 6 requirement that all messages received with an illegal label be typed out (fig. 4). It took as long to write the program to send such messages as it did to prepare a telex of 1 day's results.

Fig. 4

Example of printout received on exchange typewriter console on reception of an illegal message from No. 6 signalling link, showing details of time, link and message

Progress

The field trial has been under way since November 1970 and the AKE 13 equipment has been in operation since then. The first real telephone call between cooperating international partners was, however, not switched until more than one year later. During the intervening period the main field trial activities were:

— Performance of bit error rate tests on the various types of transmission media to be used.

— Establishment of signalling links and checking of synchronisation procedures.

— Exchange of information using traffic generated by test tapes (Test Tape Simulation, TTS, method).

— Measurement of queueing delays and retransmission characteristics in conjunction with controlled error injection and whilst transmitting TTS traffic at varying signalling link loads.

— Checking of all signalling link security procedures (change-over, change-back, emergency restart) and evaluation of performance of these during varying types of signalling link failure.

— Checking and evaluation of procedures for quasi-associated signalling link operation.

After the first period OTC (A) efforts have been associated mainly with evaluating the performance of the No. 6 System under conditions where real test calls are initiated and received. The method used in this connection has been to generate test calls from a special test call generator according to procedures defined by CCITT. Responder, No. 6 speech circuits and signalling links are used exactly as they will be used under real traffic conditions. End-to-end tests are performed by exchanging test tones before releasing connections.

Transit as well as originating and terminating No. 6 switching has been performed.

Observations and Results

General

At the time of writing (July 1972), the international field trials are still in progress and the national field trials have not yet commenced. It is therefore not possible to be definite on all aspects of the System No. 6. However, sufficient data have been obtained from tests on the operation of the System No. 6 signalling link to provide statistically significant results. In general it can be said that the No. 6 System has performed according to prediction and there has not been much occasion to interfere with the basic system. However, many specification ambiguities and errors have been uncovered and progressively corrected by CCITT during the field trial period.

Signalling Link Performance Tests

These tests have revealed that the assumed bit error rate of less than 1 in 10^5 is generally achievable and provides fully adequate operational conditions. Also tests carried out on data links having inferior performance (1 in 10^4) provided acceptable results.

Fig. 5

Example of messages received when a signalling link is taken out of service automatically and subsequently restored to traffic

Signalling Link Security

It has been demonstrated that, with the security arrangements as now specified, it is possible to ensure continuity of service for the speech circuits served by a signalling link in case of failure of that link (fig. 5). The delay to messages when changing over to a reserve signalling link depends on the loop delay of that link and whether it is normally synchronised. In most cases the delay to messages is less than 1 second and is therefore not noticeable to the subscribers using the system.

Should all signalling links fail simultaneously due to a number of transmission system failures, then clearly System No. 6 signalling cannot operate. Provision is made in the Specification of System No. 6 to re-commence signalling on the first link available. This emergency transfer (fig. 6) of the signalling traffic results in the minimum delay to telephone calls.

Fig. 6

Example of messages received when all signalling links to a given destination fail simultaneously and traffic is subsequently restored on one of these

Table 3
Call set-up times

Speech Circuit	Overlap Dialling	En bloc Dialling
No. 5 cable	not possible	3.5 s
No. 5 satellite	not possible	4.3 s
No. 6	1.0 s	1.5 s

Call Set-up Times

Many thousands of calls have now been established and satisfactory switching performance and interworking with other signalling systems has been demonstrated.

It has also been demonstrated that, due to the fast signal transfer of System No. 6, reduced post-dialling delay can be achieved. This advantage may be negated, however, by other signalling systems in an overall connection.

Table 3 lists average call set-up times for a single link connection (Sydney-Tokyo) using No. 5 and No. 6 signalling. The System No. 6 calls used a cable data link which may control satellite as well as cable speech circuits. The System No. 5 calls used en bloc dialling over the existing intercontinental telephone network. All calls were to a 7-digit ordinary Tokyo subscriber.

Operational Facilities

An SPC exchange is capable of performing much of the routine work presently performed by maintenance staff. This has been demonstrated during the field trials where automatic continuity testing of speech circuits is undertaken. Faulty circuits are withdrawn from operation and a repeat test performed. If this second test is successful the circuits are returned to service; if unsuccessful the maintenance staff is alerted.

Similarly, if unreasonable messages are received or if circuits are blocked too long, the maintenance staff is alerted (fig. 7).

Fig. 7
Examples of printouts received when an out-of-sequence message is received relating to a particular telephone call and when a circuit is blocked by the remote end

Whilst the facilities in a working exchange may differ from those provided in a field trial, the field trial environment is satisfactory to evaluate the requirements. In this regard the field trial experience has shown the desirability of having easily read print-outs. In the majority of cases the print-out would be complete and the need for reference to other documents eliminated.

Future Plans

Australia's geographical remoteness from the majority of its communicating partners necessitates the extensive use of facilities such as TASI, satellite circuits and echo suppressors.

Many of the existing international signalling systems are unsuitable for operation with one or more of the above facilities. Hence, CCITT Signalling System No. 5 was chosen as the most suitable for the Australian application.

The rapid growth of international telephone traffic and the imminent introduction of international subscriber dialling on a large scale will require much tighter control of the network to be kept. To do this, it will be necessary to collect more information about the status of the network and the success rate and reasons for failure of telephone calls than is currently possible with System No. 5.

System No. 6 with its considerably increased range of signals and speed, and its spare capacity for additional signals, will enable these and other unknown requirements to be met.

It was with this in mind that OTC (A) called for tenders for a stored program controlled telephone exchange for its new terminal in Sydney. For this plant requiring System No. 6 signalling facilities L M Ericsson's transit exchange AKE 13 equipped for 2,400 circuits has been selected. This exchange is planned to be available for operation late in 1973. In designing this exchange extensive use has been made of experience gained during the field trial.

The implementation of a new signalling system cannot be undertaken unilaterally and so the proposed System No. 6 implementation dates of other countries are of major importance in determining the rate of penetration of System No. 6 in the world telephone network.

To date, a number of countries have indicated their intention to implement System No. 6 as listed below.

Australia (OTC) 1973

Italy (ITC) 1975

Japan 1976

UK 1973

USA (AT & T) 1976

The actual signalling routes that will be established using System No. 6 will depend on the amount of traffic between countries, the types and length of transmission media, the reliability and diversity of the transmission systems.

Conclusion

From the commencement of the field trials in October 1970 weaknesses and defects in the original specification were detected and corrected at subsequent GM/FT6 meetings. The original specification has changed considerably during the field trials and it is believed that the present specification will result in a CCITT signalling system which is capable of being implemented into a wide variety of applications and of interworking with all existing telephone networks.

This signalling system has many new facilities and considerable spare capacity to cater for future requirements. Not only is the signalling system capable of controlling telephone connections but it also has an extensive range of signals available for administrative purposes. This system may therefore be used for communicating between exchanges and administrations but, most important, it is capable of carrying signals which are used for the supervision, management and control of the network.

Subject to the approval of this present specification by the CCITT Vth Plenary Assembly in December 1972, it is expected that System No. 6 will make a significant contribution to telephony signalling.*

References

1. CCITT: *White Book, Volume VI. Specification of Signalling System No. 6.*
2. CCITT: *COM GM/FT6 — No. 77 Revised Signal Unit Formats and Codes.*
3. CCITT: *COM GM/FT6 — 101 Revised Issue No. 4 of the Specifications of Signalling System No. 6 for the Field Trials.*

* The CCITT Vth Plenary Assembly subsequently has approved the revised specification of Signalling System No. 6, which will be included in the new edition of the CCITT recommendations.

Man and Telephony

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The quickly growing volume of telecommunication traffic has necessitated an increasingly wide automatization, and large parts of the international traffic have already been automated. All telecommunication networks in the world will in due course be interconnected to a global telecommunication machine, which will enable subscribers themselves to dial their local, national and international calls.

The public is not interested in the design of the machine, but is interested in the traffic facilities it offers and in the man-machine interaction that is required for the successful establishment of calls. Experience shows that subscribers have difficulties and often fail in their attemps to set up calls. Nationally and internationally (Working Party II/5 of CCITT, CEPT, and Human Factors Symposia) attempts are being made to chart the difficulties and to find ways to facilitate the use of the telephone.

This article should be considered as a personal contribution to the debate, in which some human problems are illustrated and indications are given of means to circumvent them. The aim is to stimulate among the parties concerned within administrations and industry an interest in finding suitable solutions, so that non-technical people can utilize the more and more complicated machine in the proper way to their own advantage. It should be possible, as far as telephony is concerned, to remove the fear that exists for technology in general.

Historical Review

The successive development of telephony has placed increasing demands on the actions to be performed by subscribers.

Subscriber difficulties:
— Subscriber's number?
— Dialling?
— Interpretation of tones?
If one makes a mistake, the wrong person will be called and may be irritated.

Manual Operation

The subscriber merely had to call a specially trained operator, who set up the call for him. In the early days the name of the wanted person was sufficient, but with growing number of subscribers public telephone directories had to be published and the subscriber had to learn to search in the alphabetical lists and give the operator a telephone number instead of name.

Automatization of Big Cities

In big cities the subscribers were connected to a number of exchanges, and manual interexchange switching was time-consuming and expensive. People complained about poor service and Strowger developed his automatic telephone system. Automatization of telephony in big cities was found to be profitable and various switching systems followed. For the public the conversion to automatic operation implied learning of dialling procedures and interpretation of tones. The traffic between cities was still handled manually and nobody thought of nationwide automatization. The big cities were considered as isolated islands and little attention was paid to standardization of the system properties which influenced the man-machine interaction. But this caused no difficulty as long as automatization was confined to local areas.

Nationwide Automatization

The development of transmission technique made it possible to build long distance networks with improved grade of service and faster switching of calls over increasing distances. The rapidly growing long distance traffic has rendered automatization necessary and profitable, and some countries have already completed their national automatization.

In conjunction with long distance automatization the technicians have been forced to consider the properties of already installed equipment and to choose the most economical solutions. They were, however, aware that dialling procedures and tones had to be as similar as possible for a whole country.

For the public the nationwide automatization involved further problems, as countries were divided into numbering areas. On calls within an area only the subscriber number had to be dialled; but to other areas the number was preceded by an area code, and it is easy to make mistakes when passing an invisible borderline between numbering areas.

Worldwide Automatization

The experience of nationwide automatization has been quite satisfactory and now the international traffic as well is being automatized on similar principles.

In the first stage international operators in the country of origin alone connect booked calls to the wanted party in the country of destination. The connection times are shortened, as only one operator is involved and the use of alternative routing improves the utilization and grade of service of the international network. The next step is to add equipment to the national network so that the subscribers can dial their own international calls, but this increases the difficulties:

- It may be difficult to find out which digits should be dialled, namely the country code followed by area code and subscriber number. For technical reasons CCITT has stipulated that for most countries the initial area code digit (0 or 9) shall not be dialled, which confuses many callers and causes mistakes.

- The complete number contains many digits and there is a great risk of digits being omitted or dialled in the wrong order. In some countries one must wait for a second dialling tone.

- After successful dialling the caller may misinterpret tones which deviate from those he is accustomed to.

Automatization over increasing distances thus places greater demands on those who wish to dial various kinds of calls themselves. As we approach full automatization of the global telecommunications network, we can now get a much better survey of the relation man-machine than was possible in earlier development stages.

We must also take into account that people have become much more mobile. For various reasons a movement of population is taking place; for instance people try to get better jobs at other places in their home country or abroad.

Fast and cheap communications bring about increased travel, and a rapid rise in long distance calls can be predicted. At present people dial relatively few

calls from foreign places, but these calls will undoubtedly increase greatly with time. As there are essential differences in system properties in different parts of the global network, a foreign visitor must always find out how to dial a call. He has to follow different procedures than at home and it is no wonder that mistakes are made.

Much would undoubtedly have been different if the technicians of the past had been able to foresee coming developments and tried to standardize system properties which concern the public.

Consequences of Unsuccessful and "Unnecessary" Calls

Through improved design and the introduction of rational corrective maintenance methods, high operational reliability at a reasonable cost is possible and will gradually increase as older and less reliable equipment is replaced. The rate of unsuccessful calls caused by technical faults and congestion can be reduced to a fraction of 1 per cent.

Mistakes made by the caller cause many more errors — according to Swedish operational statistics about 3.5 per cent in national and a much higher figure in international traffic. An interesting British article[1] gives the following estimation of yearly cost caused by unsuccessful or "unnecessary" calls from about 9 million British subscribers:

● No reply	£9.8 million
● Wanted party engaged	£6.8 ,,
● Technical faults and congestion	£2.9 ,,
● Faults made by caller	£4.0 ,,
● Booking of subscriber diallable calls	£2.3 ,,
● Enquiries for numbers listed in own directory	£4.1 ,,
Total	£29.9 million

Even if the estimate is unsure, it shows that high costs are involved and the situation is probably similar in all countries.

A reduction of these cost items is an operational interest, and by proper arrangement and utilization of operational statistics it should be possible to estimate various kinds of costs with sufficient accuracy, so that other parties within administrations and industry can be stimulated to analyse causes and effects and take steps to reduce operational costs. Through statistical follow-up the operations people can find out the efficiency of measures taken.

We may briefly consider chiefly three kinds of measures which influence subscriber behaviour, and thus the last three cost items listed above:

- Standardization and simplification of procedures
- Easily available, brief but intelligible information
- Special services which facilitate use of the telephone or satisfy new needs.

It should also be possible to reduce the first two of these cost items through technical arrangements which diminish the risk of repeated call attempts due to busy or no reply.

Standardization and Simplification of Procedures

For economical reasons it is utopian to believe in essential changes of already installed equipment solely in order to simplify the task for the public, who furthermore might be irritated by apparently meaningless changes. But old equipment will become worn out and gradually replaced by a more modern technique. Through international agreements one should try to standardize certain system properties essential to the ordinary user, so that people will not need to follow a different procedure depending on the place from and to which a call is made in the global network. It should be possible at low cost to prepare new equipment for these standard properties, to be put into operation in due time. Some examples:

Standardized Tones

- Dialling, ringing, busy, congestion and interception tones

Confusing tones on international calls. What tone is that — ringing, busy or some other strange tone?

Variations of tones in different countries are confusing on international calls and may lead to misinterpretation. Properly dialled calls may be prematurely released and tones difficult to interpret will increase occupation time, resulting in an unnecessary, unpaid but expensive extra load.

In Sweden it has been found profitable from the maintenance point of view to replace old signalling machines by electronic signalling devices adapted for CCITT signalling standard.

Dialling of Area Code on Local Calls[2]

When using other people's telephones one must know from what numbering area one is calling. Area code and subscriber number should admittedly be marked on all telephone sets in the public network, but people often forget to look. If the area code is dialled when it should not be, the caller receives information to this effect and must start dialling again; and if the area code is forgotten, the wrong subscriber will be dialled.

Some administrations, however, have arranged that a local call is put through even if the area code is dialled, so as to avoid repeated calls. If the caller is unsure where he is, he can always begin with the area code. This admittedly involves dialling of some extra digits, but the inconvenience of calling a wrong number or beginning once again is avoided.

Retention of Initial Area Code Digit on International Calls

A main cause of unsuccessful international calls is the difficulties callers have in discovering the proper digit sequence to dial. A serious obstacle is that the initial digit of the foreign area code (0 or 9) must at present be omitted for many countries. This permits the addition of one digit to subscriber numbers without troublesome alterations of local registers with limited digit capacity. Should the initial area code digit be dialled by mistake, one is informed accordingly and must dial again.

There are now, however, register designs (for example with tail-eating digit stores) with such a digit capacity that there is no need to omit any digit. In such a case the connection can be completed whether the initial area code digit is

dialled or not. Compare dialling of area code on local calls! A main reason for unsuccessful international calls would then disappear. There is admittedly the inconvenience for travellers, who are accustomed to include the initial area code digit, on visits to places where that is not yet possible, but they will receive an announcement to that effect.

Second Dialling Tone

In most countries there is only one dialling tone to indicate that dialling may begin, but in some countries — for technical reasons — one has to wait for a second tone during dialling, which confuses travellers. Those who are accustomed to the tone will wait in vain when it does not appear and will prolong the occupation time for expensive equipment. Those who do not wait for the tone where it is needed risk an unsuccessful call. As it has been found that the second dialling tone prolongs dialling time, it is likely to disappear in all countries.

Subscriber Information

If a person is to be able to dial various types of call, he must know among other things: what digits to dial, how to dial, and how tones from various parts of the world should be interpreted. Every administration tries to give its users sufficient information based on the national situation, but the methods are far from uniform, which complicates the information search for foreigners. The problems are being studied nationally and internationally[3] with the aim to create global guidelines for the provision of easily available information, so that people will both try and can quickly find what they need. Some of the problems are touched upon below.

Subscriber Listings in Public Telephone Directories

Traditionally a country is divided into numbering areas, each with an area code, and into directory areas, which may be parts of a big numbering area (as in North America) or include many numbering areas, each with its alphabetical listing (per place as in Germany and Holland or for several places as in Sweden). The differences are due to the different economic solutions adopted for automatization of a national network, which resulted in different principles for the planning of national networks and numbering schemes. The consequences for a future global telecommunications machine could not be foreseen.

Normally the subscribers receive only the public telephone directory of the area where they live. For information about people outside that area one needs more directories or must call an enquiries operator. To reduce this inconvenience, a directory area should have a certain geographical size, but there will still be borderline cases.

In big city areas with high telephone density the directories will be rather bulky and unmanageable. Many administrations try to avoid this by reducing subscriber data to a minimum — merely surname, Christian name or initials, and address. Only exceptionally occupation is listed. In this way there will be space for 400—500 subscribers per page and up to a million subscribers on some 1000 pages. A further reduction of the directory cost can be achieved through computerized typesetting, which affect also the subscriber data format.

To find a number in a telephone directory is not always so easy.

In big subscriber listings common surnames — maybe with various spellings — will appear in large numbers. The Stockholm numbering area has more than 10,000 Andersson and — to illustrate spelling variations — nearly as many Erichsson, Erickson, Ericksson, Ericson, Ericsson, Ericxson, Ericzon, Erikcohn, Eriksohn, Erikson, Ericksson, Erikzohn, Erixon, Erixson, Erixsson.

To be able to search for a subscriber one must know the search rules (which are not always self-explanatory) and have sufficient data about the wanted person to decide in which alphabetical directory one should look. The information offered can hardly be called easily available, and it is no wonder that number enquiries increase with telephone density and directory size, causing severe trouble for many administrations. Many subscribers cannot be bothered to search or cannot find information even in their own directory, and the cost of the enquiries service increases in spite of yearly expensive replacements of directories.

Even if far-reaching changes cannot be counted upon in existing automatic networks, having regard to the problems of developing countries an attempt should be made through studies of information search to find global guidelines for, e. g.:

- suitable size of directory areas and their division into numbering areas
- planning of numbering schemes including subscriber numbers, area codes, various prefixes, special service numbers etc.
- suitable borderlines for directory and numbering areas so as to minimize the number of borderline cases
- area boundary information such as maps and/or tabulated place names with reference to directory sections
- space-saving subscriber data for reduction of size of directories
- simple and non-confusing search rules
- listing of homonymous surnames with various spellings

The problems are complicated by the fact that one must take into account changes in the community whereby new administrative boundaries come into conflict with area boundaries in the telecommunications network that have been established for technical and economical reasons. In Sweden, for example, big local government areas are being formed the boundaries of which cross directory and numbering areas in a capricious way. The postal address will be a code number followed by the name of the local government area. If place names disappear, the search for subscriber numbers will be more difficult, as reference must be made to several alphabetical directories in each local government area.

Other Sources for Number Information

Even if certain improvements can be made in public telephone directories, they nevertheless remain imperfect from the information point of view. Other ways must therefore be sought for reducing number enquiries, such as:

Classified Section of Public Directories

The alphabetical listing for each trade and profession can be split up into smaller areas — city districts, suburbs etc. — so that the listings will not be so long and names can be found more easily.

Local Telephone Directories

In areas with high population density the public directories are unfortunately unwieldy and provide poor local service. If smaller areas — a city district or small town with surroundings — are listed, one will get more manageable local telephone directories, often published on private initiative and bought by the public. Through the inclusion of trade advertisements, directories can be sold at a reasonable price. The initiative is praiseworthy, but some directories are difficult to use as the publisher is not a directory expert. An improvement would be gained if administration experts offer advice to private publishers or publish local directories themselves. With computerized directory production, extracts can easily be made from the big data files for the ordinary public directories, so lowering the cost of production of local directories.

In letterheads, advertisements etc. companies notify their telephone numbers, with area code where possible. Many companies also notify their international number and, when in-dialling facilities exist, the extension number to be dialled without invervention of the company operator.

Letter Head Information

Unfortunately many companies dislike the recommended format for "combined" national and international telephone numbers as being too long, which should be considered in future studies.

It should be noted that the reason for "combined" numbers is the confusing omission of the initial trunk code digit on international dialling. If this omission could be avoided, everything would be much simpler, as one would merely have to dial the country code — to be found in a country table — followed by the complete national number taken, for example, from a letterhead. Combined numbers would become superfluous.

Private persons as well often issue information about their telephone numbers by word of mouth or in writing — especially when their number is changed.

The "personal telephone directory" provides easily accessible information and one avoids the necessity of looking through bulky public telephone directories.

Personal Telephone Directories

Oral or written information is the easiest way to get a telephone number, as one avoids the search in bulky directories. A person can, however, only retain a few telephone numbers in his memory and there will be an increasing need for personal telephone directories in which telephone numbers can be listed systematically.

Many more administrations should use this idea and study the question of a suitable layout, and then, through propaganda, convince people of the advantage of personal telephone directories. These should also contain short instructions on dialling of various kinds of calls and interpretation of tones etc.

In this way people would have easily available information in their pockets and would more seldom have to search in bulky public directories or apply for enquiries assistance.

Introductory Pages in Public Directories

Listing of Service Numbers

If there is a common service numbering scheme for a whole country or a directory area, it can be tabulated on an introductory page of the public directory, so that numbers to service operators and other services, such as time, weather, news, alarm clock — sometimes in several languages — can easily be found. Some administrations illustrate the services with pictograms, but that is mostly considered unnecessary.

Dialling Instructions

Too detailed instructions are difficult to follow and are therefore seldom read. Most subscribers have a fair knowledge of dialling, but sometimes need certain information, which should then be easy to find and intelligible.

Directory instructions should therefore be as brief as possible and should contain references to tables for area codes, country codes, call rates etc., and the procedure for dialling local, national and international calls together with explanation of tones etc.

For beginners such instructions may be too meagre and some administrations give detailed information in beginners' brochures. Tape recorders might also be utilized for detailed instructions or information concerning the interpretation of tones. Another way is to call an enquiries operator for more personal service with questions and answers.

Information to Foreigners

The public telephone directory is mainly intended for the nationals of a country and can hardly be used by foreigners and immigrants with insufficient knowledge of the language. Some administrations (for example Finland and Sweden) have therefore introduced a special introductory page with brief instructions in English and one other language. Service numbers to enquiries operators speaking certain languages should also be indicated.

In multilingual countries (such as Belgium, Canada, Switzerland) ordinary dialling instructions are given in several languages.

Detailed information to foreigners can also be given in tourist brochures.

Directory Layout

Even with an adequate linguistic knowledge it may be difficult to find information in foreign directories because of the difference of layouts. Certain items of information are printed somewhere on the introductory pages, others in the alphabetical sections. Much would be gained if the principles could be established for a standard directory layout with the national information arranged in a certain order so that it can be easily found. Instructions should also contain an explanation of symbols used in the directory and the principles used in the alphabetical sections. In the long run standardization would facilitate the finding of informtion, as the same search rules can be applied in many countries.

The dialling information important for all users could be followed by information of less immediate interest, for example, subscription terms, legal regulations, propaganda for special equipment and services.

Other Information Channels

Special Instructions for International Calls

With the introduction of subscriber-dialled international traffic, administrations publish special brochures containing instructions for dialling to various countries and tables containing area codes for important places abroad. These brochures, to which additions are made when automatic service is opened to new countries, are utilized as propaganda for the automatic international service and are distributed to switchboard operators of companies with international relations. Private people can ask for the brochures.

Information before Travelling Abroad

Increasingly commonly before making a visit abroad, people ask the enquiries service for information about dialling in the foreign country and how calls can be made to their home country.

Unfortunately the operators lack sufficient information and cannot always give a proper reply. It would seem to be an important task for the CCITT Secretariat to collect for each country and to distribute to administrations essential information such as:

- area code tables for wholly or partly automatized national networks, or at least the planned trunk prefix
- existing or planned international prefix
- countries with which originating or terminating subscriber-dialled traffic is possible, and planned opening of new relations
- service numbers to enquiries operators with specification of usable languages.

The number of enquiries of this type might be reduced if the national brochure on international dialling also contains some short information on dialling procedures in other countries.

Coin Box Telephone Instructions

Many types of coin box telephone are in use, working on many different principles, for example as regards the coins that can be used, and when and how shall they be inserted. Sometimes there are many types within a small area.

It is true that there are printed instructions in the telephone booths, but the operations statistics still show high error rates because people do not read or misinterpret the instructions.

For a foreigner a coin box telphone is often his first encounter with the telephone system of a foreign country and he is in difficulty if he cannot understand the instructions but must guess at the probable procedure.

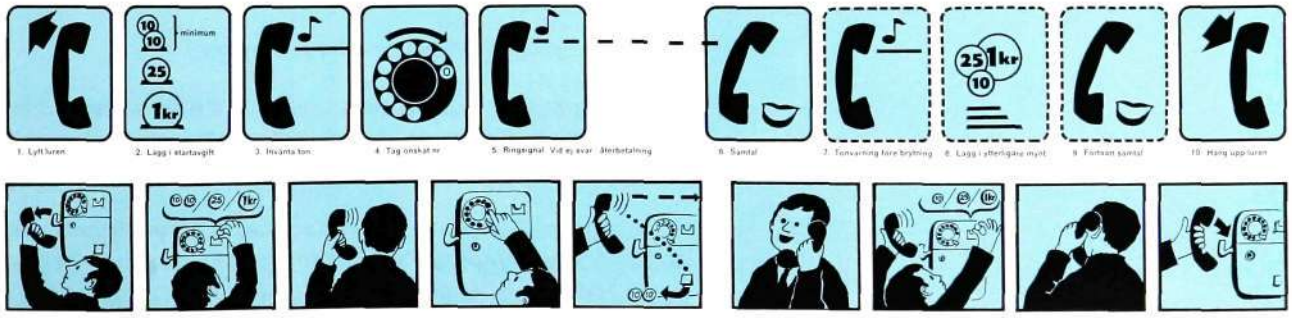
In the past the designers have considered mainly technique and economy, not human abilities and needs and the consequences of increased travel. Through electronic developments it has become possible to simplify the design of telephones and make them less vulnerable to misuse. The technicians should, of course, also try to make telephones more "human" and easier to use. Worldwide standardization of some features seems desirable — for example coin insertion procedures.

Intelligible instructions should, of course, still be provided in telephone booths, but instead of descriptive text it would be preferable to present the successive

Attempt at intelligible instruction for the Swedish coin-box telephone:

— upper row: Symbols with a few explanatory words

— lower row: Illustrations without words



operations in a sequence of self-explanatory pictograms (fig. on p. 147 shows an example). Some trials are under way, the aim being to present information so that people without knowledge of the language can easily and quickly see what to do in a given situation, for example when a mistake has been made.

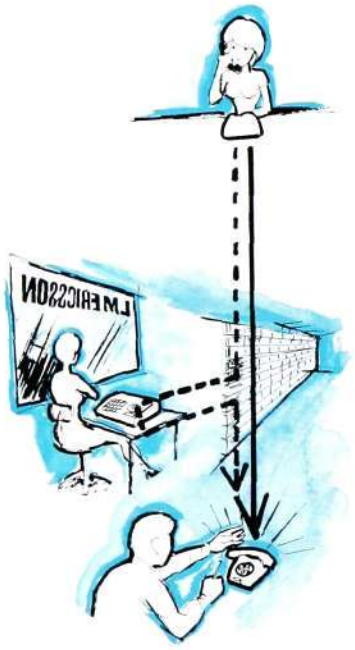
Standardization of pictograms as such seems hardly to be necessary, but rather of the events which need to be illustrated and what additional information should be given about dialling of different types of call.

Propaganda in News Media

Through advertisements in the press and short announcements on radio and TV, administrations notify the introduction of new telephone facilities and services. It would also be desirable to use news media to teach people to utilize the technique, but unfortunately the media show only a half-hearted interest. What can be done to change this attitude?

Subscriber Training

In some countries excellent results have been obtained through training of children at school in the proper use of the telephone. They show a great interest and this seems to be a good way to foster efficient users. Schools are now also beginning to realize that a knowledge of telephoning should be included in the teaching of civics.



In-dialling without intervention of company operator saves
— time and money for the caller
— operator costs for the company

Introduction of New Facilities

Modern telephone systems are equipped for new facilities aimed at simplifying the use of the telephone or at satisfying latent needs, for example

- push-button dialling makes dialling easier and faster
- abbreviated dialling to often called parties
- in-dialling to company extensions without intervention of a switch-board operator (fig. 5)
- various kinds of call transfer, for example follow-me calls; reswitching of calls to another telephone on encountering busy or no reply. A larger number of calls will result in a conversation which reduces unpaid unsuccessful calls and increases circuit availability
- automatic call-back when a busy subscriber becomes free, which reduces repeated call attempts
- signalling of waiting call during conversation
- enquiry, transfer and multiparty calls
- various kinds of line blocking and priority
- automatic alarm clock
- data transfer between ordinary telephones and computers

Many of these facilities have for a long time existed in PBXs, where the information problems are relatively simple, as only a limited number of people must learn the procedures.

It will be much more difficult to introduce new facilities in the public network, as they place a greater demand on people's ability to use the technique properly. Through experiments and field trials the attempt is made to investigate people's

needs and reactions, but the introduction of new facilities in the public network implies modernization of existing equipment. What services can be offered depends, therefore, on the exchange to which subscribers are connected.

Most probably special subscriptions will be required for many of the services which will be used only by a limited number of subscribers, who should also be able to use the services without help, for example:

- *dialling procedures:* abbreviated dialling, initiation of call-back, automatic alarm clock

- *during conversation:* enquiry, transfer, multiparty calls.

For a number of services (change of abbreviated number, call transfer, priority, line blocking etc.) further investigation are needed to find out whether the user himself will be able to manage the procedures or whether service people should be called in.

Depending on the technical solutions and existing or future signalling facilities, the services will be restricted to the local exchange, local numbering area, home country etc. There will be a risk of faulty manipulation and the technique must be such that ordinary telephone traffic is not disturbed and that users are informed whether they have followed the correct procedure or not, which may require new types of tones.

As only certain supbscribers will apply for the special services, the public directory should merely list the services available, while giving complete information in separate brochures. Such brochures can hardly be published for each exchange but should be usable within big areas and preferably within the whole country. This necessitates national standardization of procedures, which should be so simple that instructions can be brief, yet easy to understand. This standardization of procedures and instructions should as far as possible be global, anyhow for services which are switched over the international network or are usable for foreigners.

For some services which will be popular for ordinary people and for foreigners, for example automatic alarm clock or call-back on busy, instructions should be given in the public directories.

Summary

The worldwide automatic telecommunications machine under construction will be manipulated by ordinary people with a poor technical knowledge. An attempt has been made to illustrate some problems and difficulties encountered by people in trying to use a complicated technique, and it is obvious that the goal for further development must be the creation of a human technique with more consideration of man's ability and needs than has been the case in the past. Everything should be done to facilitate human control of the technique — some suggestions are given. Having regard to the rapidly increasing international traffic and increased travel, the problems should be considered not only from the national point of view but also from that of international coordination so as to bring about as far as possible:

- simple and preferably standardized procedures

- global methods for subscriber information.

The problems are rather complex and concern many fields — technique, economy, planning, information, operation etc. — which makes coordination difficult. Close cooperation between various parties within administrations and in-

dustry is needed so that the technique is adapted to and does not run away from man. The knowledge of human problems in complex cause-and-effect situations is often too poor and much would be gained if persons with a lively interest in such problems could be given time and resources to influence others so as to increase their understanding and stimulate them to participate in the desirable coordination of urgent measures.

Every activity involves a cost; and as long as there are no reliable methods for efficiency control, one can understand the hesitation and failure to act. The British estimate of the cost items, where big reductions seem possible, indicates however that an essential profit can be made by investment in measures such that:

an increasing number of people dare and are able to use the technique properly to their own advantage.

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2. *COM II—No. 33 (CCITT 1968—72) Dialling of trunkcode or not within numbering area.*
3. *COM II—No. 15 (CCITT 1968—72) Instructions for users of the automatic service.*

ADG 101 — Manual Electronic Cord Switchboard

W. PEGERT & R. WALTER, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.655.2
LME 8372

Manual telephony still fills a great need. There are many sectors in which a PMBX has its given place, for example in hotels, small offices and the like with limited internal communication or where the cost aspects are decisive. In order to meet the rising demand for a modern PMBX, L M Ericsson have developed a product based on electronic components and cord winders. The design of the switchboard is suited to an office environment; the switchboard is easily extendable, extra facilities can be added, and it has small dimensions. ADG 101 offers all normal facilities demanded of a modern switchboard, such as automatic ringing, individual line supervision, subscriber metering, and secrecy of conversation.

Capacity and Mechanical Features

The PMBX *ADG 101* has a final capacity of 200 extensions, 16 exchange lines and 18 cord pairs. The system is built up on the modular principle with plug and jack connection, which allows stepwise extension in groups of 20 extension lines, 8 exchange lines and one cord pair. The switchboard is always wired for full capacity.

For a small number of lines only one line box (fig. 1) is required, in which case the capacity is 100 (80) extensions, 8 (16) exchange lines and 18 cord pairs. A second line box can easily be installed when the line requirement increases (fig. 2).

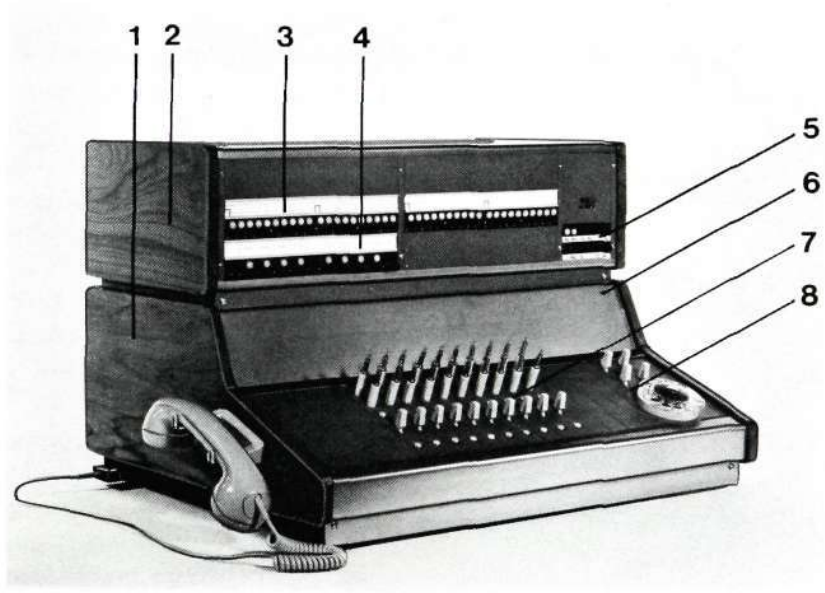


Fig. 1

ADG 101 equipped for 40 extension lines, 8 exchange lines and 10 cord pairs.

1 Basic unit
2 Line box
3 Extension line unit
4 Exchange line unit
5 Control unit
6 Shelf for printed circuit boards with cover plate
7 Switching set
8 Position set

Through the use of electronic components, reed relays, miniature relays, and cord winders instead of cord weights, the switchboard has very small dimensions. Its volume is only one-third of that for floor switchboards of present type. The switchboard can therefore be placed on a desk, counter or the like, and harmonizes well in different environments (see front cover). Operating devices and indicators have been placed, and the colouring selected, to enable the operator to attain optimal results.

ADG 101 can interwork with all types of manual and automatic public systems. By connection of alternative printed circuit boards it can be equipped for automatic or manual ringing.

All units and printed circuit boards are inserted from in front. The entire system of construction, with plugs and jacks and easily accessible wiring points, reduces the cost of installation, extension and maintenance to a minimum. No special tools are required for assembly and connecting up of the switchboard.

Characteristics

The switchboard has been given all facilities required of a modern PMBX, viz.

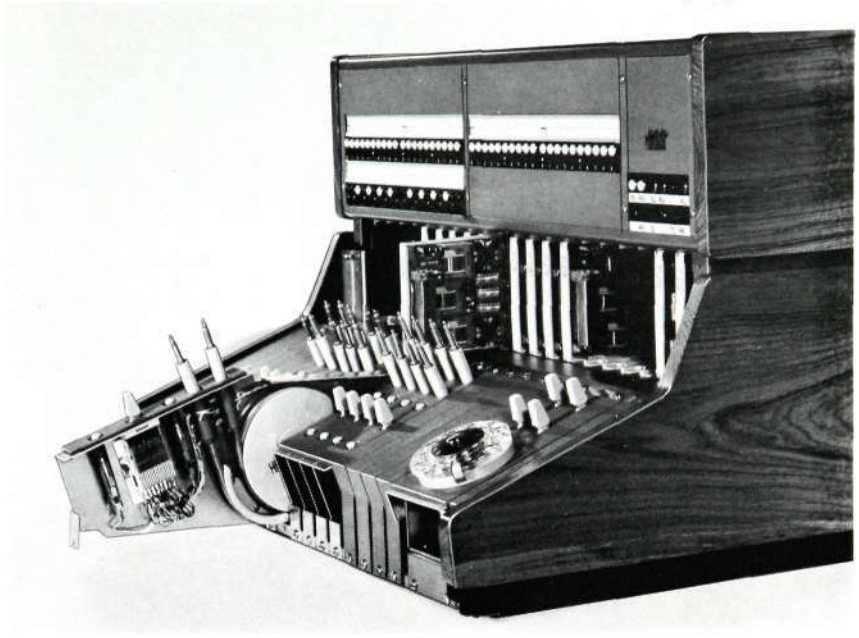
— *automatic intermittent ringing* as soon as the ringing cord is plugged into an extension jack
— *manual ringing signals* can be used, which is of value in hotels, hospitals or similar institutions where automatic ringing may be disturbing at certain times of the day or night
— *ringing* via the answering cord
— *automatic ring tripping* when the extension answers a call
— *ringing tone* to the calling party
— *ringing lamp* to indicate transmission of ringing signals
— *magneto exchange lines* can be installed
— *automatic holding* of exchange lines on incoming calls
— *direct dialling facility* allows an extension to dial a number to the public exchange without operator assistance
— *an exchange line is obtained* by dialling digit 9, whereupon the call lamp flashes
— *subscriber meters* can be installed on exchange and extension lines
— *privacy of conversation* is ensured by the issue of a warning tone to conversing parties when the operator enters a circuit
— *individual current feed* for the extension lines
— *individual supervisory lamps* for answering side and ringing side
— *pilot lamp* for call signals and supervisory signals
— *a discreet buzzer signal* is heard when the pilot lamp lights but is not repeated on new calling and supervisory signals until the operator has completed earlier connections
— *a continuous buzzer signal* can be obtained
— *waiting tone* is issued on a waiting exchange line
— *supervision* of an exchange line by the operator while she is handling other calls
— *a splitting key* enables the operator to speak to one party without the other being able to hear the conversation
— *an enquiry* can be made to the operator in the course of a conversation on an incoming exchange line
— *transfer* of exchange line call to another extension

Fig. 2

ADG 101 with two line boxes equipped for 140 extension lines, 16 exchange lines and 14 cord pairs.

Fig. 3

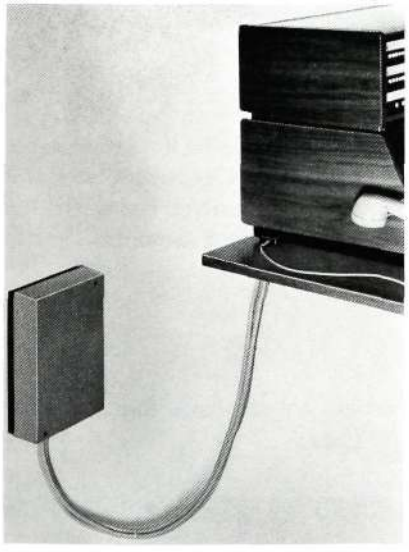
ADG 101 with a switching set and associated printed circuit board partially withdrawn.



— *a mains failure* does not cut off established calls on exchange lines
— *tests* of lamps and cords in the switching sets
— *a lamp test* can be made on the exchange line call lamps; the risk of lost calls as a result of lamp failures is thus eliminated
— *extra jack* for connection of handset for assistant operator
— *blown fuses* are indicated by a lamp signal and disconnectable buzzer signal
— *space* is provided for notes which the operator may need to make and to have readily accessible so as to be able to work efficiently
— *night switching* of exchange lines with ordinary cord pairs to optional extensions
— *no current consumption* when the switchboard is switched for night service

Fig. 4

ADG 101 with incoming cable connected via a terminal box.



Mechanical Design

General

From the constructional and functional aspects the switchboard is divided into two parts, the basic unit and line boxes. In the basic unit there is a shelf for printed circuit boards and a central wiring unit to which all wiring between the various equipment items is concentrated. Position set and switching sets are placed in the basic unit (fig. 3). The line boxes contain extension and exchange line units. In the first line box there is also a control unit.

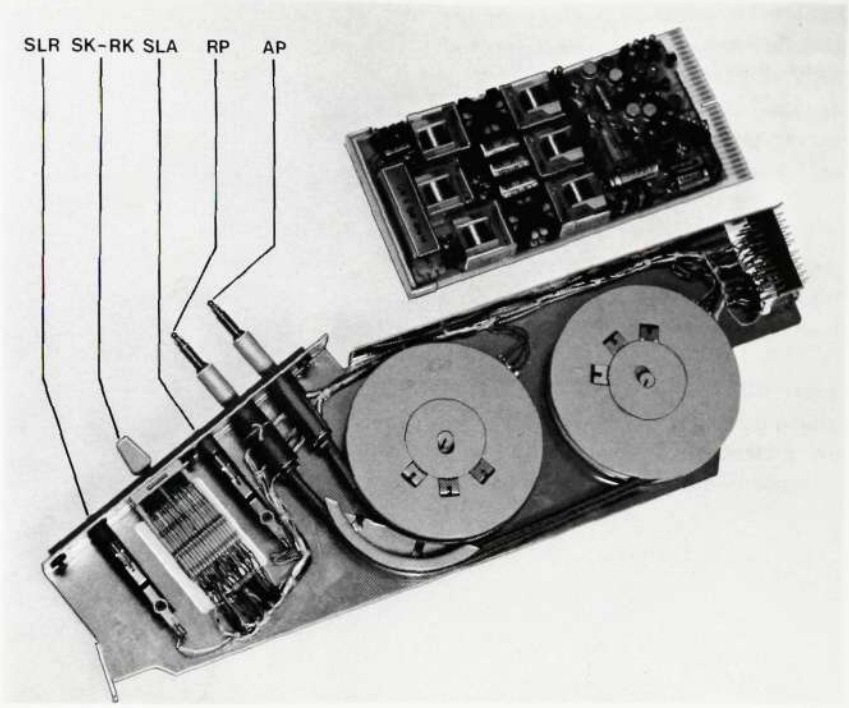
Incoming cable is terminated directly on the line boxes or via wall-mounted terminal boxes (fig. 4).

The sides of the switchboard consist of plastic-coated natural-coloured teak. Fixing plates for the line units and for the top and rear covers of the switchboard are of green-enamelled sheet steel. Switching sets and position sets are framed within anodized light metal sections. Vacant positions are covered with green plastic strips.

Fig. 5

Switching set with printed circuit board.

AP Answering plug
RP Ringing plug
SLA Supervisory lamp, answering side
SK-RK 3-position key with speaking position SK and ringing position RK
SLR Supervisory lamp, ringing side



Switching equipment

The equipment for a cord pair consists of a switching set and a printed circuit board (fig. 5).

The switching set, the front of which is coated with green plastic, contains two cord winders with 3-pole cords and plugs. The plugs have a handle and a protective spiral of grey plastic which, in combination with the construction of the cord winder, greatly diminish the mechanical strain on the cord.

L M Ericsson possess long experience of the use of cord winders from the portable switchboard ABM 10, which has been subjected to very severe field tests. The cord winder is the cornerstone of the ADG switchboard and contributes greatly to its small space requirement. Fig. 6 shows a cord winder specially adapted to ADG 101.

The switching set includes a 3-position key and two supervisory lamps. The body and lever of the key, which is of small dimensions, are of grey plastic.

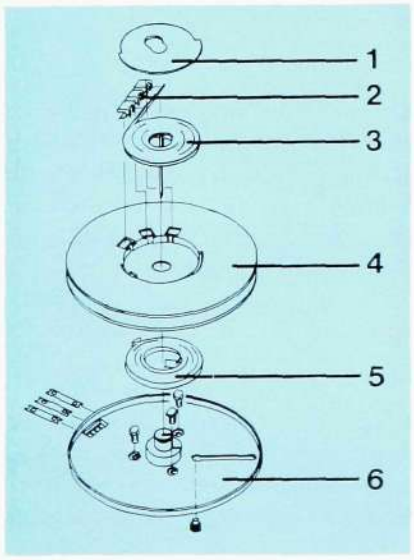
The printed circuit board contains current feed relays and electronic components and the usual operation and control circuits.

Fig. 6

Cord winder.

1 Cover
2 Terminals
3 Helically wound ribbon cable with 3 conductors
4 Wheel
5 Return spring
6 Hub

The ribbon cable (3) connects the terminals (2) to the terminals on the fixed hub (6). The switchboard cord is wound up on the wheel (4) and connected to the terminal (2). When the cord is pulled out, the wheel rotates and the return spring (5) is tensioned. When the cord is released it is wound up on the wheel again by the force of the spring.



Line equipment

The line units are of three types, one for ordinary extension lines (fig. 7), one for extension lines with subscriber's meter, and one for exchange lines. The line unit contains a jack strip and lamp strip and a printed circuit board with line components. The unit for normal extensions is wired for a subscriber's meter, which can easily be added if required at a later stage.

Position equipment

The dial and other common operating devices are combined into a position set. The front is covered with a green plastic plate.

The position equipment also comprises two printed circuit boards placed on the shelf of the basic unit.

Control equipment

Lamps and jacks for complete supervision of operation and for control of cords etc. are placed in a control unit.

Technical data

	Basic unit + 1 line box			Basic unit + 2 line boxes		
Capacity						
Extension lines	80	100	120	200	220	240
Exchange lines	16	8	—	16	8	—
Cord pairs	18	18	18	18	18	18
Dimensions						
Width	62 cm			62 cm		
Height	41 cm			59 cm		
Depth	53 cm			53 cm		
Weight approx.	50 kg			60 kg		

The *operating voltage* is 24 V DC and may vary between 20 and 28 V.

The line resistance for an extension including telephone set may be up to 1,000 ohms, i.e. about 800 ohms for the line loop. The leakage resistance may not be below 15,000 ohms. The limits allowed by the public exchange must also be taken into account, however, as extensions on night service are directly connected as public exchange subscribers.

Current feed is delivered from the public exchange to night service extensions and also to the operator's speaking equipment when exchange line calls are answered. Local current feed is provided on other calls.

The current consumption is:

internal calls	approx. 150 mA
call between operator and extension	approx. 75 mA
ringing to extension	approx. 320 mA

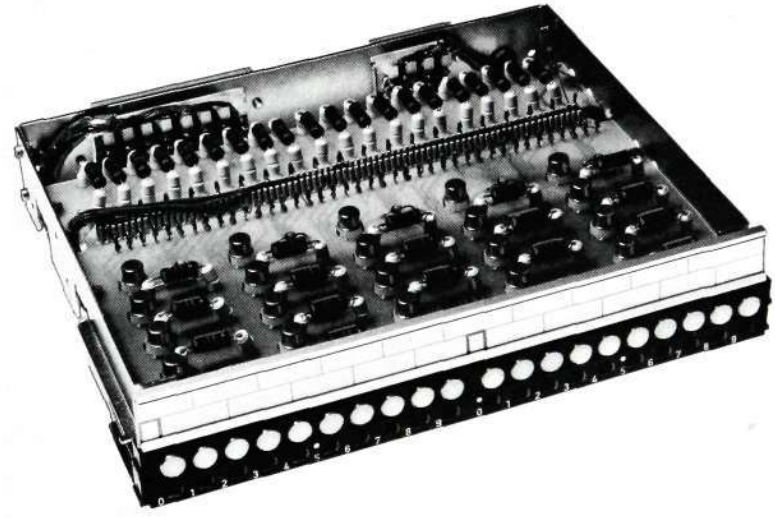


Fig. 7

Line unit for 20 extensions. The lamps are controlled via transistorized call circuits.

Accessories

Power equipment

The following equipment is recommended:

Number of cord pairs	Alt. I		Alt. II
	Battery	Automatic charger	Mains supply unit
—10	c. 15 Ah	BMM 1831	BMN 2121
11—18	c. 30 Ah	BMM 1832	BMN 2122

All units can be connected to mains voltages of 110/127/220 V, 50—60 Hz.

Terminal box

Terminal box *NEF 442* is recommended for line termination. It has a black base plate and grey plastic cover and accommodates 80 pairs. Dimensions: 285 × 195 × 85 mm.

MDF

A main distribution frame *NBA* is recommended for switchboards with more than 40 extensions. A MDF without line fuses can alternatively be arranged by duplicating the number of terminal boxes, half of the boxes being used for the line side and the other half for the switchboard side.

Telephone sets

L M Ericsson's normal telephone sets with or without dial can be connected.

Subscriber meters

ADG 101 is wired for connection of subscriber meters. Resettable meter units can be placed in the jack field beside the exchange line units. For the extension lines non-resettable meters are placed in a wall frame. Control equipment on separate racks is required in addition.

Magneto exchange lines

The exchange line equipments can be adapted to a magneto system by the addition of separate equipment.

Summary

L M Ericsson's manual cord switchboards of CB and magneto types were designed more than 20 years ago. Their satisfactory system properties combined with high quality and a flexible mechanical structure have ensured a wide market for these switchboards. There has been an increasing demand, however, for smaller and more compact units of modern external design, as also for new facilities. For this reason the CB type PMBX, ADG 101, has been designed as replacement for ADE 121, ADF 143, 144 and 162.

ADG 101 will soon be followed by a correspondingly built magneto switchboard, ABJ 101, in replacement of ABH 162 and ABK 205, 206.

ERICSSON *News*

from All Quarters of the World

Ericsson Group Operations Nine Months, 1972

Order bookings during the first nine months of 1972 amounted to $ 757,500,000, an increase of 12.5 percent over bookings of $ 673,400,000 during the comparable period of 1971, it is notified in the Group's interim report.

The need for equipment for public networks continued to rise in many of the Group's major markets. In certain markets demand was affected by restrictions on capital expenditures, generally undertaken in order to check continuing inflation.

The market for telecommunications material used primarily in the private sector is more sensitive to economic conditions. Order bookings for internal communication systems, communication radio for vehicles and other equipment for this sector were thus affected by still depressed business conditions in many countries. Cautious tendencies in the building sector in some markets resulted in lower orders for cable and wire.

The increment of new subscribers of the Swedish Telecommunications Administration, as well as the increase in long distance telephone traffic, is currently very low. This circumstance, together with the fact that substantial production occurs in the Administration's own plants, resulted in reduced orders from this customer. Total order bookings from customers in Sweden were substantially lower than during the corresponding period a year earlier.

In the larger foreign markets the increase in order bookings was notably high in Norway, France, Italy and Brazil.

Of the total orders booked, Swedish customers accounted for 17 percent, those in Europe outside Sweden for 48 percent, Latin American customers for 27 percent and other markets for 8 percent.

Competitive conditions in the world market have not changed significantly. However, there now seems to be a certain stabilization of prices. The order backlog, which at year-end amounted to $ 852,200,000, increased to $ 1,010,300,000.

Group sales during the first nine months of 1972 totalled $ 599,440,000, an increase of 16 percent over sales of $ 517,261,000 during the corresponding period a year earlier. Sales in Sweden were somewhat lower, while foreign invoicing increased 23 percent.

Factory deliveries rose during the first nine months of the year. In the Swedish sector of the Group, employment was adjusted downward in conformity with order bookings, resulting in a decrease in the number of employees from 29,160 at the beginning

(cont. p. 160)

Tunisia places $ 5.5 m. telecommunications order with Ericsson

The Ministry of Post and Telecommunications in Tunisia has placed an order worth over $ 5.5 m. with the L M Ericsson Telephone Company. The order comprises Ericsson crossbar equipment to be used both in new automatic exchanges and for extension of existing exchanges.

The contract, the largest yet received by Ericsson in Tunisia, is the fourth in a series of orders placed with Ericsson by the Tunisian telecommunications administration since the country achieved its independence.

(cont. p. 158)

New $ 10 m. plant for L M Ericsson's Norwegian subsidiary

A/S Elektrisk Bureau, a member of the Ericsson Group, has recently moved into a new head office and factory building at Billingstad outside Oslo. The new building represents an investment of about $ 10 m. and houses 800 employees.

In addition to the new factory at Billingstad the Norwegian company has factories at three other locations in the country and employs 2,700 people. The company is expanding rapidly; its order bookings during the first six months of this year were 18 percent higher than the corresponding figures for last year and sales were up 23 percent.

Crown Prince Harald of Norway on a tour of the new Billingstad plant with Eilif Björnstad (right), Administrative Director, and Kjell Kveim (left), Vice Administrative Director.

Large order for LME from Swedish Telecommunications Administration

L M Ericsson has received from the Swedish Telecommunications Administration an order for terminal equipmets for a new type of transmission system which can simultaneously transmit 10,800 telephone connections on line pair in a coaxial cable. The order totals around $ 4 m.

The first order for equipment of similar type was placed by the Administration in 1967, for the Västerås—Örebro route. This equipment has now been installed and forms part of the first commercial connection in the world with so high a capacity. The experience gained from this new system will now be used in the extension of the larger equipments in south and central Sweden.

Large Zambia order to L M Ericsson

The government of the Republic of Zambia has signed a contract with the L M Ericsson Telephone Company for automatic telephone switching equipment. The value of the contract is $ 5.6 m. and includes delivery and installation of equipment for both local and long distance subscriber dialling.

The order is the biggest of its kind ever placed by the Zambian government. It will result in an extensive modernization and expansion of city networks as well as the country's subscriber trunk dialling network including automatization of rural areas.

Compared to other countries in Africa, Zambia has a high telephone density. The contract now awarded will considerably increase this density.

The contract was gained following international bidding, in which many of the world's leading manufacturers of telecommunications equipment participated. Delivery and installation of the equipment now ordered will commence towards the end of next year and be completed in 1976.

The equipment covered by the contract is of the Ericsson crossbar type. Ericsson has previously supplied Zambia with telephone switching equipment for about 5,000 subscriber lines.

Ericsson to start factory in the Republic of Ireland

The L M Ericsson Telephone Company has reached an agreement with the Industrial Development Authority of the Republic of Ireland concerning the establishment of an Ericsson factory for production of telecommunications equipment in Ireland. The new factory will be located at Athlone about 60 miles from Dublin and, when in full production, will provide employment for about 500 people. Ericsson's investment in this new production facility is estimated at over $ 2 m.

Ericsson has been represented in Ireland since 1964 by a subsidiary marketing company and is currently employing about 200 people in that country. It has secured a large part of the market for telephone switching equipment. During the past two years order bookings have amounted to $ 8 m. annually. So far the equipment delivered and installed by Ericsson has been imported from Sweden, but the intention is that the new factory shall supply part of the equipment required for continued expansion of the Irish telephone network.

Ericsson has also concluded an agreement with the Irish Post Office for delivery during the next five years of equipment of the Ericsson crossbar type in quantities roughly equal to those during the last two years.

The Ericsson Group is already operating 36 production units of its own in Sweden and the new Irish factory will be the 33rd production unit outside Sweden.

Substantial telephone equipment order from Lebanon to L M Ericsson

The Telecommunications Administration of Lebanon has placed an order worth over $ 5.5 million with the L M Ericsson Telephone Company for delivery and installation of equipment for automatic telephone exchanges. The installation will be carried out by LME's subsidiary in Lebanon, Société Libanaise des Téléphones Ericsson, which will also be responsible for maintenance, but the equipment will be manufactured by LME in Sweden. The deliveries are to be made over the course of the next two years.

The equipment ordered will be used for extension of existing national and international exchanges as well as for 14 new exchanges.

Since 1951, when L M Ericsson received its first order for equipment for automatic telephone exchanges from Lebanon, the company has delivered equipment serving over 200,000 Lebanese subscribers.

Agreement in the long distance field between L M Ericsson and Norwegian company

The Norwegian company NERA BERGEN A/S and the L M Ericsson Telephone Company have concluded an agreement within the special sector of long distance telephony comprising radio links with associated carrier equipment. The agreement relates to development and marketing. NERA will be responsible for the further development of radio link equipment, which for several years has constituted an important part of NERA's production. L M Ericsson will undertake the further development of the carrier terminals which are used with radio link equipments.

NERA BERGEN A/S have some 400 employees. 80 % of the company's shares are owned by Bergens Industri-Investering A/S and 20 % by the Norwegian state.

Tunisia places . . .

(Cont. from p. 157)

In connection with the signing of the new contract the Tunisian Minister of Post and Telecommunications, Habib Ben Cheik, expressed his great satisfaction with the equipment delivered hitherto and with the Swedish company's contribution in Tunisia, especially within the training field.

The award of the contract to Ericsson coincided with the opening on December 1 of a new automatic telephone exchange for local and trunk traffic in Kelibia in northeastern Tunisia. This inaugural ceremony took place exactly ten years after the first Ericsson-equipped exchanges were cut into service in Tunis.

In October this year Bertil Bjurel, Director General of the Swedish Telecommunications Administration (right) presided at the opening of a 60 MHz telephone connection between Västerås and Örebro. Among the visitors were Björn Lundvall (left), head of the Ericsson Group. To demonstrate the excellent transmission quality of the system, the telephone circuit they were using was arranged to pass no less than 20 times to and fro between Västerås and Örebro — a distance of 1125 miles!

The Board of L M Ericsson recently visited some of the factories in central Sweden. (Left) Ambassador Erik Boheman, Vice Chairman of the Board, and (right) Peter Wallenberg. In the background Lars-Olof Ekeberg (right) conversing with the head of the Ingelsta factory at Norrköping, Åke Bidö.

A new building on the Midsommarkransen site, with a total floor area of about 19,000 m², was ready for occupation in November. It contains laboratories and offices.

A study group from Albania has visited L M Ericsson. (From left) Deputy Director Gambeta, Exportalb, Director Mosho, Agroexport, Deputy Director Joanidhi, Albimport, Deputy Director Gjini, Foreign Trade Ministry, Anadolli, Commercial Counsellor, Albanian Embassy, C.-H. Ström, LME, Deputy Director Sheti, Foreign Trade Ministry, and J. Jahn, LME.

Some of the Swedish members of parliament who visited L M Ericsson in November at a model of the Midsommarkransen plant. To the left Jan-Gustaf Lundh, LME.

L M Ericsson was visited at the end of November by a delegation from Hungary for *discussion of questions of cooperation.* (From left) Andras Tóth, Departmental Manager of the Hungarian State Telephone Factory BHG, Denes Sellö, Director General of BHG, Fred Sundkvist, Vice President of L M Ericsson, István Kulcsár, Technical Secretary of BHG, László Horváth, Director General of the Hungarian Foreign Trade Company BUDAVOX, and Lajos Nágai, Hungarian Commercial Counsellor in Stockholm.

Traffic signalling news

On the second of May this year central equipment was put into use for control and supervision of all street traffic signal installations in Copenhagen. The equipment was delivered and installed by Dansk Signal Industri A/S.

The central equipment controls and supervises the signals with the aid of 26 master controllers. The signals at up to 12 street crossings can be connected via local controllers to each master controller. There are five different signal control programmes. The morning traffic has one programme, the afternoon traffic another, and so on. The central equipment also supervises that the signal switching operations take place at the correct time. Should a fault occur, this is recorded at the police radio centre.

The MI Division Signal Department has installed in Gothenburg a computer for traffic control of an area consisting of 18 crossings. The CWIP (UAC 1605) computer used for this purpose is a processor developed by the Signal Department especially for the controll of railway and street traffic.

The computer controls the traffic signals on the basis of the information received from detectors in the carriageways. The numbers and speed of vehicles decide which among a number of signal programmes is most suited for use at a particular moment. The computer is also able, within the scope of a signal programme, to carry out minor variations under traffic control. It can for example, give one traffic stream at a crossing a longer green period at the cost of other traffic streams at that crossing. This permits very flexible control of the traffic.

The system used in Gothenburg has earlier been tested at 21 crossings within the Odenplan area in Stockholm. The result was that the waiting time for vehicles was reduced on an average 25 % and the number of stops on an average 19 % when the traffic was controlled by a computer instead of a conventional master controller.

The UAC 1605 computer also has a large statistical section which provides the traffic engineers with constant information not only concerning quantities of traffic, queues and mean speeds, but also concerning waiting times and number of stops for vehicles in the area.

Personnel news

On September 15, 1972, Mr Ivar Hilfing, took over the assignments hitherto performed by Mr Ragnar Hellberg on the board of the Italian companies of the Ericsson Group, FATME and SIELTE. Mr Hilfing has been appointed vice chairman of these boards and member of the Management Committees of the two companies. Mr Arvid Westling remains for the time being vice chairman of SETEMER and member of its Management Committee.

From the same date Mr Hellberg has taken over Mr Ivar Hilfing's assignments on, and at the same time been appointed chairman of, the boards of Swedish Ericsson Telecommunications Ltd., Swedish Ericsson Rentals Ltd., and Production Control (Ericsson) Ltd., and managing director and member of the board of Swedish Ericsson Co. Ltd. Mr Hellberg's assignments in the French companies Société Française des Téléphones Ericsson and Rifa S.A. remain unchanged.

Doctorate for member of Ericsson staff

On September 22, 1972,, Thomas Ericsson, of the Long Distance Division, defended his treatise "Unifilar sources and source approximation".

The treatise includes a study of mathematical models of information sources, especially of so-called discrete sources, sources which produce a sequence of signals from a finite alphabet. Telegraphy and data transmission are the practical applications of most immediate interest.

An attempt is made in the treatise to characterize mathematically the relation between model and reality. A study is made also of structural properties of certain classes of source models — so called unifilar models. Finally a study is made of the way in which different models — of different complexity — can be related to one another.

Dr Ericsson's treatise is published in Ericsson Technics No. 3.

Ericsson Group Operations . . .
(Cont. from p. 157)

of the year to 27,630. In the foreign sector the number of employees rose from 37,700 to 42,130. Recruitment was notably high in the subsidiaries in France, Italy and Brazil.

The margin of sales over production costs decreased by 2.1 percent compared with the first nine months of 1971 but was slightly more favourable than that prevailing during the second half of 1971.

Selling, administrative and research and development expenses increased by 5.8 percent, a significantly lower rate than the rise of approximately 16 percent recorded in the two preceding years.

The excess of interest expense over interest income increased by $ 4,200,000 compared with the same period of 1971.

Foreign exchange losses amounted to $ 4,000,000. For the full year such losses are estimated to reach $ 5,200,000. A significant part of these losses were incurred by Ericsson do Brasil (EDB) as a consequence of successive devaluations of the Brazilian currency.

Group income before special adjustments and taxes amounted to $ 64,124,000 (10.7 percent of sales), compared with $ 56,370,000 (10.9 percent of sales) for the first nine months of 1971.

Consistent with the method used in annual reporting, income after minority interests and taxes was $ 25,759,000, equal to $ 2.09 per share, compared with $ 23,187,000, equal to $ 1.88 per share in 1971, based on 12,304,094 shares outstanding in both years.

It is presently expected that total sales for the entire year 1972 will exceed those of 1971 by 11 to 12 percent. Income before special adjustments and taxes is estimated to be somewhat higher than for 1971.

Group investments in property, plant and equipment during the period amounted to $ 52,900,000 as against $ 55,300,000 during the same period a year earlier.

The Swedish sector of the Group accounted for $ 22,600,000, compared with $ 27,500,000, and the sector outside Sweden for $ 30,300,000, compared with $ 27,800,000 in the preceding year.

Current investments to expand or construct plants in France, Italy, Spain and Mexico to meet production requirements in these markets contributed to the increase in capital expenditures outside Sweden.

The Ericsson Group

Subsidiaries, associated companies and technical offices

EUROPE

DENMARK

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GNT AUTOMATIC A/S *DK-2860 Søborg*, Telefonvej 6, tel: (01) 69 5188, tgm: nortelmatic, telex: 27064, "GNT AUTOMATIC KH"

Dansk Signal Industri A/S *DK-2650 Hvidovre*, Stamholmen 175, Avedøre Holme, tel: (01) 49 0333, tgm: signaler københavn, telex: 16503, "16503 DSI DK"

ELMI A/S *DK-600 Gentofte*, Kirkebjerg Allé 90, tel: (01) 45 42 11, tgm: elmiworks, telex: 16600, "FOTEX DK" att. ELMIWORKS

FINLAND

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FRANCE

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F-75-Paris 17e, 147, rue de Courcelles, tel: Paris (1) 227 9530, tgm: eric paris, telex: 29276, "ERICSSON PARIS"

Etablissements Ferrer-Auran S.A. *13 Marseille, (10ème)*, 88, Avenue de la Capelette, tel: (91) 47 4851, telex: 42579, "RINGMA 42579 F"

RIFA S/A
F-62206 Boulogne sur Mer, B.P 146/3, tel: (21) 31 9206, telex: 11431, "BORIFA 11431 F"

F-92 Boulogne sur Seine, 5, Rue Vauthier, tel: (1) 603 0640, telex: 20781, "FARIFA 20781 F"

Thorsmans S.a.r.l.
F-75018 Paris, 3, Passage ruelle, tel: 607 6974

GREAT BRITAIN

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Swedish Ericsson Telecommunications Ltd. *Horsham Sussex*, Viking House, Foundry Lane, tel: (0403) 641 66 tgm: teleric, telex: 877522, "SWEDERIC HORSHAM"

Production Control (Ericsson) Ltd. *Horsham Sussex*, Viking House, Foundry Lane, tel: (0403) 641 66, tgm: productrol, telex: 877522, "SWEDERIC HORSHAM"

Swedish Ericsson Rentals Ltd. *Horsham Sussex*, Viking House, Foundry Lane, tel: (0403) 641 66, tgm: celefon, telex: 877522, "SWEDERIC HORSHAM"

Thorsman & Co. Ltd.
Chorley Lancs, PR6 OLP, Thor House, Yarrow Mill, tel: (02572) 4999

E. B. Marine Communications Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 540 9595, telex: 935979 "EBMAR LDN"

IRELAND

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ITALY

FATME, Soc. per Az. *1-00100 Roma*, C. P. 4025 A. tel: (06) 4694, tgm, fatme, telex: 61327, "61327 FATME"

SETEMER, Soc. per Az. *1-00198 Roma*, Via G. Paisiello 43, tel: (06) 86 8854, tgm: setemer

SIELTE, Soc. per Az. *1-00100 Roma*, C.P. 5100, tel: (06) 577 8041, tgm: sielte, telex: 61225, "61225 SIELTE"

NETHERLANDS

Ericsson Telefoonmaatschappij N.V. *Rijen (N.Br.)*, P. O. B. 8, tel: (01612) 3131, tgm: erictel, telex: 54114, "ETM RIJ NL"

Voorburg 2110, P. O. B. 60, tel: (070) 81 4501, tgm: erictel den haag, telex: 31109, "ETMVB NL"

NORWAY

A/S Elektrisk Bureau *N-1360 Nesbru*, P.B. 98, tel: (02) 78 8060, tgm: teleb, telex: 11723, "TELEB N"

A/S Industrikontroll *Oslo 6*, Grensevejen 86/88, 3. etg., tel: (02) 67 8394, tgm: indtroll

A/S Norsk Kabelfabrik *Drammen*, P.O.B. 369, tel: (02) 83 7650, tgm: kabel, telex: 18149, "KABEL N".

A/S Telesystemer *Oslo 6*, Tvetenveien 32, Bryn, tel: (02) 68 7200, tgm: telesystemer, telex: 16900, "ALARM N"

POLAND

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PORTUGAL

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SPAIN

Industrias de Telecomunicación, S.A. *Getafe*, Paseo Felipe Calleja 6, tel: 295 2100, tgm: ericsson, telex: 22666, "ERIGE E"

L M Ericsson, S.A. *Madrid 5*, Bernadino Obregón 25, tel: 467 8700, tgm: ericofon, telex: 23333, "23333 LMESA E"

SWEDEN

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ELLEMTEL Utvecklings Aktiebolag *S-127 25 Skärholmen* Box 249, tel: (08) 97 0220

Bjurhagens Fabrikers AB *S-200 12 Malmö*, Fack, tel: (040) 93 4770, telex: 3123, "BJURHAG S"

AB Rifa *S-161 11 Bromma 11*, Fack, tel: (08) 26 2600, tgm: elrifa, telex: 10308, "ELRIFA STH"

L M Ericsson Instruktionsteknik AB *S-117 47 Stockholm 44*, tel: (08) 68 0870, tgm: instruktec

L M Ericsson Telemateriel AB *S-135 01 Stockholm-Tyresö 1*, Fack, tel: (08) 712 0000 tgm: ellem, telex: 10920, "10920 LMSBO/S"

Sieverts Kabelverk AB *S-172 87 Sundbyberg*, tel: (08) 28 2720, tgm: sievertsfabrik, telex: 1676, "SIEVKAB S"

Svenska Radio AB *S 102 20 Stockholm 12*, Fack, tel: (08) 22 31 40, tgm: svenskradio, telex: 10094 "SRA S"

AB Thorsman & Co. *S-611 01 Nyköping 1*, Box 149, tel: (0155) 810 00, tgm: thorsmanco

AB Transvertex *S-145 53 Norsborg*, Fittja industriområde, tel: (08) 710 0935

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E B Marine Nachrichtentechnik GmbH, *Hamburg 70*, Mühlenstieg 5, tel: (0411) 652 9831, telex: 212076

Thorsman & Co GmbH, *D-4796 Salzkotten*, Lange Strasse 4, Postfach 96, tel: (05258) 8450

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New Delhi 24, No. 15,Community Center, Suraj Parbat, tel: (011) 63 1637, tgm: inderic

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Ericsson Telephone Sales Corporation AB
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IRAQ

Telefonaktiebolaget L M Ericsson, Iraq Branch *Baghdad* P.O.B. 2388, Alwiyah, tel: 960 07, tgm: ellemco

KUWAIT

Telefonaktiebolaget L M Ericsson, Technical Office *Kuwait, State of Kuwait*, P.O.B. SAFAT No. 5979, tel: 42 0074, tgm: erictel

LEBANON

Société Libanaise des Téléphones Ericsson *Beyrouth* B.P. 8148, tel: 25 2627, tgm: ellem, telex: ELLEM 20876 LE

MALAYSIA

Ericsson Talipon SDN BHD *Shah Alam, Selangor, Batu Tiga Industrial Estate*, P.O.B. 28, Tel: Kuala Lumpur (03) 36 1821, tgm: kuleric, telex: 265, "ERICMAL KLTX 265"

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TUNISIA

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Cia Argentina de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Cia Entrerriana de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Industrias Eléctricas de Quilmes S.A. *Quilmes FNGR*, 12 de Octubre 1090, tel: 253 2775, tgm: indelqui buenosaires, telex: 0122196, "CATEL BA"

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Rio de Janeiro, Caixa Postal 3601-ZC-00, tel: (021) 221 7477, tgm: ericsson, telex: 031839, "ERICSSON RIO"

Fios e Cabos Plásticos do Brasil S.A. (FICAP) *Rio de Janeiro*, caixa postal: 1828, tel: (021) 391 4550, tgm: ficap, telex: 031485, "FICAP RIO"

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Ericsson de Colombia S.A. *Bogotá*, Apartado Aéreo 4052, tel: (92) 41 1100, tgm: ericsson, telex: 044507, "ERICSSON BOG"

Fábricas Colombianas de Materiales Eléctricos Fácomec S.A. *Cali*, Apartado Aéreo 4534, tel: 42 1061, tgm: facomec, telex: 55673, "FACOMEC CLO"

COSTA RICA

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Guayaquil, Casilla 376, tel: 30 0900 tgm: ericsson

Cont. on next page

Subsidiaries, associated companies and technical offices (Cont. from preceding page)

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Latinoamericana de Cables S.A. de C.V. *Mexico 12 D.F.*, Apartado Postal 12737, tel: 549 0844 tgm: latincasa, telex: 017234, "ERICSSON TLA" PARA LATINCASA

Teleindustria, S.A. *Mexico 1, D.F.*, Apartado Postal 1062, tel: 565 7033 tgm: ericsson, telex: 017234 "ERICSSON TLA"

Telemontaje, S.A. de C.V. *Mexico 1, D.F.*, Apartado Postal 1062, tel: 576 4044, tgm: ericsson, telex: 017234, "ERICSSON TLA" PARA TELEMONTAJE

PANAMA

Telefonaktiebolaget L M Ericsson, Oficina Técnica de Panamá *Panama 5, R.P.* Apartado 4349, tel: 64 3600, tgm: ericsson, telex: 368674 "368674 SONITEL"

PERU

Cia Ericsson S.A. *Lima*, Apartado 2982, tel: 31 1005, tgm: ericsson, telex: 3540202, "ERICSSON 3540202"

Soc. Telefónica del Perú, S. A. *Arequipa*, Apartado 112-1012, tel: 6060 tgm: telefonica

EL SALVADOR

Telefonaktiebolaget L M Ericsson, Technical Office *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson

URUGUAY

Cia Ericsson S.A. *Montevideo*, Casilla de Correo 575, tel: 91 2611, tgm: ericsson, telex: 398228, "ROULEMENT UY" PARA MELANDER

USA

The Ericsson Corporation *New York, N.Y. 10017*, 100 Park Avenue, tel: (212) 685 4030, tgm: erictel, telex: 620484, "ERICTEC 620484"

Ericsson Centrum Inc. *New York, N.Y. 10016*, 16, East 40th Street, tel: (212) 679 1000, tgm: erictel, telex: 620149, "ETELSAC 620149"

VENEZUELA

Cia Anónima Ericsson *Caracas*, Apartado 70516, tel: (02) 34 4661, tgm: ericsson, telex: 21530, "21530 ERIC VEN"

Alambres y Cables Venezolanos C.A. (ALCAVE) *Caracas*, Apartado del Este 62107, tel: (02) 33 9791, tgm: alcave, telex: 22845, "22845 ALCAVE VE"

AUSTRALIA & OCEANIA

AUSTRALIA

L M Ericsson Pty Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: ericmel, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: ericsyd, telex: AA 21358 "ERICSYD"

Boroko, Papua New Guinea, P.O.B. 5602, tel: Port Moresby 565 66, tgm: ericpor, telex: Port Moresby 153

Teleric Pty. Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: teleric, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: teleric, telex: AA 21358, "ERICSYD"

Conqueror Cables Pty. Limited *Dee Why, N.S.W. 2099*, P.O.B. 69, tel: (02) 982 3344, tgm concab sydney, telex: 24305, "CONCAB AA 24305"

A.E.E. Capacitors Pty. Ltd. *Preston, Victoria 3072*, 202 Bell Street, P.O.B. 95, tel: (03) 480 1211, tgm: engiquip melbourne, telex: 31001, "AEEMELB AA 31001"

Representatives

EUROPE

AUSTRIA

Electro-Diesel Handelsaktiengesellschaft, Abteilung Telecom *1160 Wien*, Postfach 98, tel: (0222) 43 5956, tgm: teleric, telex: 75976, "75976 TELECOM A"

BELGIUM

Allumage Lumière S.A. *Bruxelles 7*, 128-130 Chaussée de Mons, tel: (02) 23 9425, tgm: allumalux, telex: 21582, "ALLUMALUX BRU"

GREECE

Angelos Cotzias *Athens, 18*, Omirou Street, tel: (021) 62 6031, tgm: cotziasan, telex: 215252, "215252 CTZS GR"

ICELAND

Iohan Rönning *Reykjavik*, P.O.B. 5300, tel: 840 00, tgm: rönning, telex: 2040, "ROENNG IS"

CANARY ISLANDS

TRANSA Transacciones Canarias S.A.

Las Palmas de Gran Canarias, Tomas Morales 36, tel: 21 8304, tgm: transa, telex: 95052, "95052 CASTI E"

Santa Cruz de Tenerife, Tirso de Molina, 2 "Edificio Dulcinea", tel: 22 9240, tgm: transa

YUGOSLAVIA

Merkantile Inozemna Zastupstva *Zagreb* P.O.B. 02-1027, tel: (041) 41 6655, tgm: merkantile, telex: 21139, "21139 YU MERTIL"

Beograd, Gospodar Jevremova 46 tel: (011) 63 2878, tgm: merkantile, telex: 11263, "YU MERKAN"

ASIA

BAHRAIN & UNITED ARAB EMIRATES

Yusuf Bin Ahmed Kanoo *Bahrain, Arabian Gulf*, tel: 40 8188, tgm: kanoo, telex: BHN 215

BURMA

Myanma Export Import Corp., Agency Div. *Rangoon*, P.O.B. 404, tel: 112 58, tgm: myanagent telex: UBMEIC BM 2005

CAMBODIA

Comin Khmere S.A. *Phnom-Penh*, P.O.B. 625, tel: 233 34, tgm: engineer

CYPRUS

S.A. Petrides & Sons Ltd. *Nicosia*, P.O.B. 4522, tel: 427 88, tgm: armature, telex: 2308, "ARMATURE"

HONG KONG AND MACAO

Swedish Trading Co. Ltd. *Hong-Kong*, P.O.B. 108, tel: 23 1091, tgm: swedetrade

IRAN

Irano Swedish Company A. B. *Teheran*, Khiabane Sevom Esfand 29, tel: 31 4161, tgm: iranoswede

JORDAN

The Arab Trading & Development Co. *Amman*, P.O.B. 6141, tel: 259 81, tgm: aradeve

KUWAIT

Morad Yousuf Behbehani *Kuwait, State of Kuwait*, P.O.B. 146, tel: 42 7071, tgm: barakat, telex: 2048, "BEHBEHANI KUWAIT"

LEBANON

Swedish Levant Trading *Beyrouth*, P.O.B. 931, tel: 23 1624, tgm: skefko

OMAN

Muscat Trading Company *Muscat* P.O. B. 127, tel. 458, tgm: tijarah, telex: MB 258 MUSTRAD

PAKISTAN

Panasian Marketing Service Ltd. *Karachi*, P.O.B. 3941, tel: (90) 51 2051, Ext. 53, tgm: panasian

PHILIPPINES

Asia Industries Inc. *Makati, Rizal*, M.C.C. Post Office 1322, tel: 87 7011, tgm: usi asia, telex: 7222233, "7222233 AII PH"

SAUDI ARABIA

Engineering Projects & Products Co. Ltd. (Eppco)

Riyadh, P.O.B. 987, tel: 222 22, tgm: eppcol

Yeddah, P.O.B. 1502, tel: 222 22, tgm: eppcol

Dammam, P.O.B. 450, tel: 222 22, tgm: eppcol

SYRIA

Constantin Georgiades *Damas*, P.O.B. 2398, tel: 266 73, tgm: georgiades

TAIWAN

Trans-Eurasia Enterprise, Ltd. *Taipei*, P.O.B. 3880, tel: 51 7039, tgm: esbtrading

REPUBLIC OF VIETNAM

Vo Tuyen Dien-Thoai Vietnam *Saigon*, P.O.B. 1049, tel: 226 60, tgm: telerad

International Business Representative *Saigon*, 26—28, Hai Ba Trung Street, tel: 226 60, tgm: ibur

AFRICA

ETHIOPIA

Mosvold Company (Ethiopia) Ltd. *Addis Ababa*, P.O.B. 1371, tel: (01) 101 00, tgm: mosvold, telex: 21090, "MOSFIRM ADDIS"

KENYA, TANZANIA, UGANDA

The Old East African Trading Co. Ltd. *Nairobi, Kenya*, P.O.B. 30013, tel: 271 61, tgm: broche, telex: 22261, "OLDEAST NAIROBI"

LIBERIA

Telecommunications Authority *Monrovia*, P.O.B. 9039, tel: 222 22, tgm: radiolibe, telex: 4211 TLX BOOTH LIB

LIBYA

ADECO African Development & Engineering Co*Tripoli*, P.O.B. 2390, tel: 339 06, tgm: adeco

MALAWI

Business Machines Ltd., *Limbe*, P.O.B. 5557, tel: Blantyre 513 52, tgm: falt, telex: 342, "FALT LIMBE"

MOZAMBIQUE

J. Martins Marques & Ca. Lda *Lourenço Marques*, P.O.B. 2409, tel: 24953, tgm: marquesco

NIGERIA

Communications Associates of Nigeria Ltd. (Comsac), *Ilupeju (Lagos)*, P.M.B. 1129, tel: 322 06 tgm: comdec lagos

SOUTH AFRICA

NAMIBIA

Dryden Communications (Pty.) Ltd. *Johannesburg, South Africa*. P.O.B. 2440, tel: 838 5454, tgm: qualsteels, telex: 430094, "430094 SA"

SUDAN

El Rahad Trading Corporation *Khartoum*, P.O.B. 866, tel: 776 95, tgm: suconto, telex: BHN 251

ZAIRE

I.P.T.C. (Zaire) Ltd. *Kinshasa*, P.O.B. 8922, tel: 253 45, tgm: induexpan, telex: 327, "IPTC KIN"

AMERICA

BAHAMA ISLANDS

Anglo American Electrical Company Ltd. *Freeport, Grand Bahama*, P.O.B. 104

BOLIVIA

Prat Ltda *La Paz*, Casilla 4790, tel: 277 12, tgm: prat, telex: PRAT BX 5363

COSTA RICA

Tropical Commission Co. Ltd. *San José*, Apartado 661, tel: 22 5511, tgm: troco

DOMINICAN REPUBLIC

Humberto García, C. por A. *Santo Domingo*, Apartado 771, tel. 682 3645, tgm: gartier

GUATEMALA

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: (021) 622 57, tgm: nilspira, telex: 4172, "PIRAGU"

GUYANA

General Supplies Agency *Georgetown*, tel: 638 38, P.O.B. 375, tgm: benwiks

HONDURAS

Quinchón Leon y Cía *Tegucigalpa*, Apartado 85, tel: 251 71, tgm: quinchon

NETHERLANDS ANTILLES

S.E.L. Maduro & Sons Inc. Merchandise Dept. *Willemstad, Curaçao* P.O.B. 304, tel: 130 00, tgm: madurosons, telex: CU 92

NICARAGUA

Roberto Teran G. *Managua*, Apartado 689, tel: 224 00, tgm: roteran

PANAMA

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PARAGUAY

S.A. Comercial e Industrial H. Petersen *Asunción*, Casilla 592, tel: 44 124, tgm: pargtrade

EL SALVADOR

Dada-Dada & Co. *San Salvador* Apartado 274, tel: 21 7940, tgm: dada

SURINAM

W.E. van Romondt's Trading Company Ltd. *Paramaribo*, P.O.B. 1837, tel: 728 31, tgm: vanromondt

TRINIDAD, W.I.

Leon J. Aché Ltd. *Port-of-Spain*, P.O.B. 276, tel: 323 57, tgm: achegram

AUSTRALIA & OCEANIA

NEW ZEALAND

ASEA Electric (NZ) Ltd. *Wellington C. 1.*, P.O.B. 3239, tel: 706 14 tgm: asea, telex: 3431, "ASEAWELL NZ 3431"