ERICSSON Review

4
1967

ERICSSON REVIEW

Vol. 44 No. 4 1967

RESPONSIBLE PUBLISHER: CHR. JACOBÆUS, DR. TECHN.

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $ 1.50; ONE COPY $ 0.50

CONTENTS

On cover: In the Tunis area L M Ericsson have installed automatic telephone exchanges of crossbar system ARF. The cover shows the Carthage exchange installed in 1962.

Maintenance of Telephone Exchanges in Tunis

HABIB BEN CHEIKH, CHIEF ENGINEER, TUNISIAN PTT

UDC 621.395.722.004.5
LME 154

The installation and cut-over in 1962 of the automatic exchanges in Tunis, comprising 23,000 lines of **L M** *Ericsson's crossbar system* **ARF** *10, were described in Ericsson Review No. 1, 1963. These exchanges were Carthage I (8000 lines), Carthage II (4000 lines), Belvédère (5000 lines), Kasbah (4000 lines), Le Kram (1000 lines) and La Marsa (1000 lines).*

Other exchanges in the area, Megrine (1000 lines) and Hammam-Lif (1000 lines), have since been added. The Carthage, Belvédère and Le Kram exchanges have been extended.

Recently **ARM** *exchanges have been installed in Tunis, Bizerte, Sousse and Sfax, which earlier had* **ARF** *10 equipment. The telephone traffic between these towns is now fully automatic.*

The object of this article is briefly to describe the tests carried out in conjunction with the take-over of the first **ARF** *10 equipments in the Tunis area. It will also deal with the general principles adopted for their maintenance.*

The results in respect of the later **ARF** *and* **ARM** *equipments, which have not yet been taken over, will be reported later.*

Fig. 1
The Carthage exchange in Tunis

Take-over Tests

In accordance with the contract, eighteen months after the cut-overs final take-over tests were made for the local (Carthage, Belvédère, Kasbah) and suburban Tunis exchanges (Le Kram and La Marsa) in order to find out the fault rates of the various equipments.

Simultaneous calls (four for each type of traffic) were made locally and between the exchanges from ordinary telephone sets during normal traffic periods.

For approval the failure rate for each type of traffic was not to exceed 1 %.

Table 1 shows the distribution of the test connections, failures and failure rates. Failures comprise the calls which were not established owing to faults or congestion.

Table 1

From \ To	Carthage I	Carthage II	Belvédère	Kasbah	Le Kram	La Marsa	Special services
Carthage I	1,000 1 0.1 %	1,000 2 0.2 %	1,000 3 0.3 %	1,000 1 0.1 %	1,000 0 0 %	1,000 1 0.1 %	400 0 0 %
Carthage II	1,000 1 0.1 %	1,000 1 0.1 %	1,000 5 0.5 %	1,000 2 0.2 %	1,000 1 0.1 %	1,000 8 0.8 %	400 1 0.25 %
Belvédère	1,000 3 0.3 %	1,000 2 0.2 %	1,000 2 0.2 %	1,000 3 0.3 %	1,000 1 0.1 %	1,000 1 0.1 %	400 4 1 %
Kasbah	1,000 4 0.4 %	1,000 1 0.1 %	1,000 9 0.9 %	1,000 0 0 %	1,000 1 0.1 %	1,000 1 0.1 %	400 2 0.5 %
Le Kram	1,000 3 0.3 %	1,000 1 0.1 %	1,000 2 0.2 %	1,000 1 0.1 %	1,000 0 0 %	1,000 2 0.2 %	400 1 0.25%
La Marsa	1,000 1 0.1 %	1,000 9 0.9 %	1,000 5 0.5 %	1,000 7 0.7 %	1,000 1 0.1 %	1,000 4 0.4 %	400 2 0.5 %

Thus for 38,400 calls 100 failures were recorded, the average failure rate being 0.25 %.

Maintenance Organization

As already mentioned, this study is limited to the maintenance of the Tunis group of exchanges. The general maintenance organization for all *ARF* and *ARM* exchanges in the Tunisian network will be the subject of a future study.

The introduction of the new crossbar exchanges in Tunis and environs called for a radical change of the maintenance principles employed for the earlier rotary switch exchanges. The latter required purely preventive methods with frequent mechanical adjustment of switches and relays; these measures took up much time and necessitated a fairly large staff.

The principles of maintenance for the new Ericsson crossbar exchanges are entirely different. Experience during more than two years of operation has confirmed that these exchanges require no preventive maintenance whatsoever and that the number of fault repair actions is very low, of the order of 15 per 1000 lines per annum.

The now exclusively Tunisian personnel were trained in Sweden by L M Ericsson. This training, which lasted eight months for heads of exchanges and four months for technicians, produced excellent results. After the period in Sweden all the personnel trained there took part in the installation and testing of the exchanges in Tunis. This supplementary training gave them additional experience in preparation for their future tasks.

Carthage, the most important exchange, was chosen as maintenance centre for the group of exchanges concerned (3 in Tunis and 4 in its environs). Carthage has two permanently installed automatic traffic route testers from which test calls can be made on all routes in the zone. The maintenance effort is based on the measured quality of service.

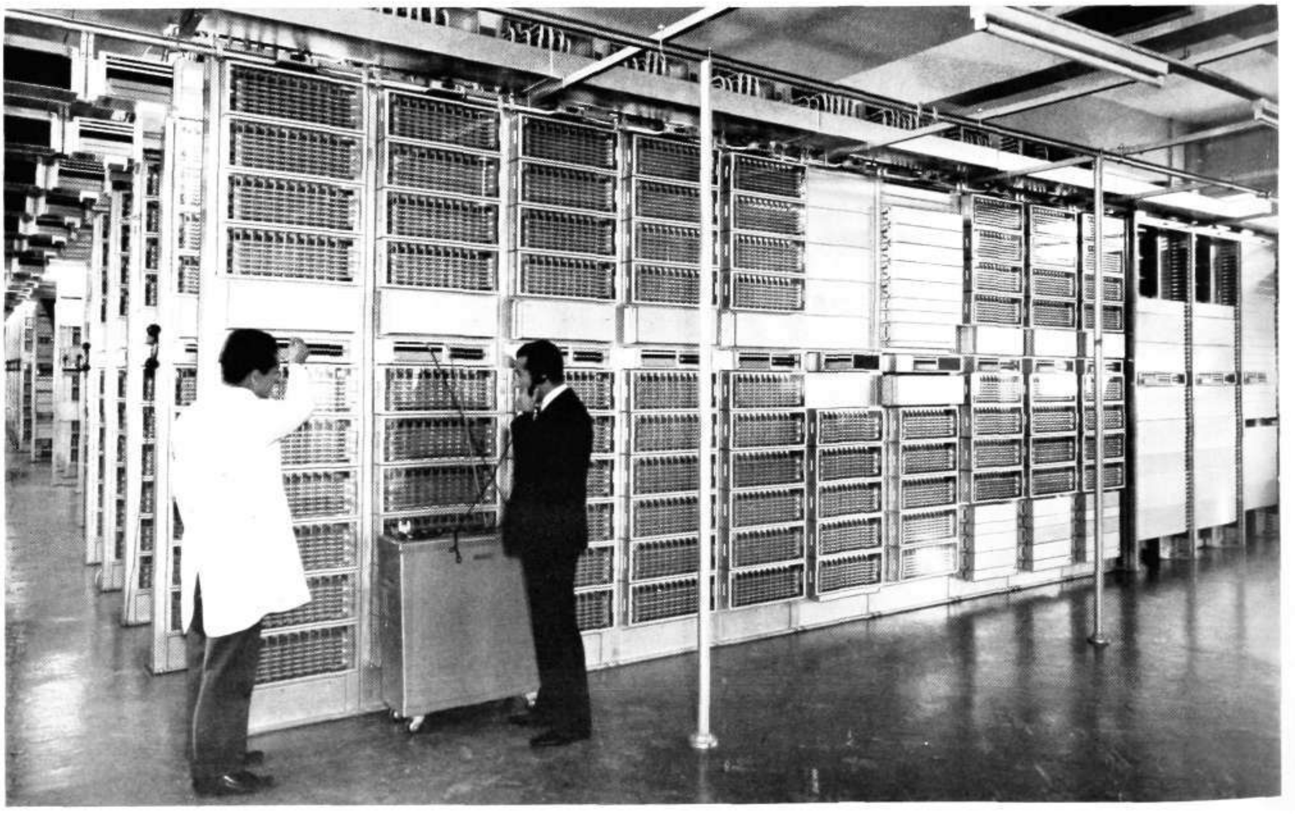
Carthage, with its 12,000 lines and traffic route testers, has six technicians. Three of them are responsible chiefly for the maintenance of the *ARF* equipment. The route tests are done by a fourth technician, and the two others form a maintenance team responsible for tests and fault tracing at exchanges in the environs.

The Carthage personnel work under the supervision of the head of the exchange, who is also responsible for the subscribers' test desk (new subscribers' installations, tracing of faults in subscribers' apparatus etc.) and rentals.

At Belvédère there is a head of exchange and one technician who looks after the maintenance of the 5000-line *ARF* equipment.

At the Kasbah exchange, comprising 4000 *ARF* lines for ordinary subscribers, 2000 *ARF* lines for government departments and 120 operators' positions for trunk and international traffic, there is a head of exchange and two technicians, one of whom is responsible for the maintenance of the *ARF* equipment and the other for the manual equipment.

Fig. 2
The Carthage ARF exchange with a capacity of 12,000 subscriber lines



This trial period in the maintenance organization, with the entire group of exchanges regarded as a single unit, is intended as a step towards a more general maintenance organization comprising all *ARF* and *ARM* exchanges throughout the country.

When the Administration takes over these exchanges in the near future, the maintenance principles will be based on the preliminary experience gained in the Tunis group.

Maintenance Methods

For the present exchanges it was decided that maintenance should be based on a measure of the quality of service from the subscribers' point of view. This implies that testing for faults in individual switching units is done only in response to subscribers' complaints or when the failure rate for a given type of traffic or switching unit exceeds a stipulated value.

Measurement of the quality of service is done with the two aforesaid traffic route testers. These are connected to reserved test numbers (five per 1000-line group) and test all types of traffic in the zone in accordance with a predetermined programme. The test programme is arranged to be completed in about one month. If more than 1 per cent failures is found in any test cycle, immediate action is taken and checks are made with an exchange tester until an acceptable value is obtained.

Table 2 shows the number of calls, failures and failure rate for the various exchanges in a representative test cycle with a traffic route tester.

Table 2

Route	Number of calls	Number of failures	Failure rate
Kasbah-Kasbah	2,874	8	0.27
Kasbah-Carthage I	12,433	38	0.30
Kasbah-Carthage II	11,565	4	0.03
Kasbah-Belvédère	4,215	14	0.33
Kasbah-Le Kram	562	38	6.75
Carthage I-Kasbah	7,540	15	0.20
Carthage I-Carthage I	24,391	24	0.09
Carthage I-Carthage II	9,333	17	0.18
Carthage I-Belvédère	5,473	15	0.27
Carthage II-Kasbah	2,371	6	0.25
Carthage II-Carthage I	3,836	0	0
Carthage II-Carthage II	10,613	4	0.04
Carthage II-Belvédère	5,584	9	0.16
Belvédère-Kasbah	4,442	35	0.79
Belvédère-Carthage I	14,647	17	0.12
Belvédère-Carthage II	5,717	22	0.38
Belvédère-Belvédère	880	0	0
Le Kram-Kasbah	1,000	3	0.3
Le Kram-Carthage I	500	4	0.8
Le Kram-Carthage II	900	9	1.0
Le Kram-Le Kram	600	3	0.5
La Marsa-Kasbah	500	4	0.8
La Marsa-Belvédère	500	5	1.0
La Marsa-La Marsa	4,600	1	0.02

The table snows that the quality of service was below standard on the routes Kasbah–Le Kram, Le Kram–Carthage II and La Marsa–Belvédère. Fault tracing and repairs were therefore instituted on these three routes. The exceptionally high failure rate on the Kasbah–Le Kram route was found to be due to a fault in one of the registers. Other routes were within the stipulated standard and therefore no individual tests or fault tracing were done on them.

Apart from the route tests a periodic check is made of the occupation counters and fault counters for each marker. If the rejection owing to faults is abnormally high for a given marker, immediate action is taken to repair that marker.

No periodic maintenance is done on the switching equipments and only the batteries and switchboard cords are inspected at regular intervals.

Fault statistics

The faults which are considered necessary to repair in order to maintain the desired quality of service are recorded with indication of cause and component concerned.

Table 3 presents a summary of fault reports during a ten-month period. The results for each exchange are shown in Table 4.

From Table 3 it will be seen that the number of faults in switches is very low, 12 % of the total, which signifies about 0.025 fault per switch per annum. In other words an L M Ericsson crossbar switch has, on an average, one fault every 40th–50th year. The corresponding figure per relay is about every 400th year.

Table 3

	Component																						
	Switch					Relay				Miscellaneous													
Cause of fault	Contact	Horizontal	Vertical	Coil	Miscellaneous	Contact	Coil	Armature	Miscellaneous	Resistors	Capacitors	Rectifiers	Tubes, transis.	Meters	Jacks	Cabling	IDF	Cords	Miscellaneous	Total faults	Faults per annum	*Faults/1000 lines/year*	Faults/rack/year
Dust	2					4														6	7		
Adjustment	3	15	15			147		22	4						2		1		3	12	256		
Open	1		5	6		3	9	1	1	2	1	1			7	11	1		1	50	60	2,5	
Soldering		1		3		9	2		12	1					8	34	4		6	80	96	4,0	
Leakage	3	1				20	4	3	3	8	3				12	26	2		1	86	103	4,4	
Wear				1		9	4	3	1	1			19			3			1	41	48	2,0	
Locking								1							1	1		1		4	5	0,2	
Wiring		1												4		8			1	14	17	0,7	
Miscellaneous		1			1					5						1				8	10	0,4	
Total	9	19	20	10	1	192	19	30	21	17	4	1	19	4	29	84	8	1	13	501	602	25,0	0,81
Faults per 100 units/year — Sub-comp.	0,39	0,80	0,85	0,42	0,04	0,16	0,02	0,03	0,02														
Faults per 100 units/year — Components	2,5					0,23				0,01	0,01	0,004	0,45	0,017									

Fig. 3

Test desk for testing subscriber's lines and receiving complaints

Table 4

Exchanges	Lines	Total/10 months	Fault reports per annum			Remarks
			Total	Per rack	Per 1 000 nos.	
Carthage	12,000	310	372	1.1	31	attended
Belvédère	5,000	76	91	0.69	18	attended
Kasbah	4,000	96	115	0.63	29	attended
Le Kram	1,000	13	16	0.50	16	unattended
La Marsa	1,000	6	7	0.22	7	unattended

Table 4 shows an interesting figure, the number of faults per rack per annum, which varies between 0.22 and 1.1 for practically all racks irrespective of the equipment contained on the rack.

The unattended exchanges Le Kram and La Marsa, moreover, have a decidedly lower fault rate per rack than other exchanges.

In conclusion it may be said that the Ericsson *ARF 10* crossbar exchanges in the Tunis area have fulfilled the expectations placed on them in respect both of traffic handling, low failure rate and small maintenance requirement.

Any misgivings that major faults might interrupt the service for large groups of subscribers or routes can be entirely eliminated. After more than three years' operation one may say that the quality of service has been very good both from the subscribers' and the Administration's point of view despite the fact that, at the smaller exchanges, certain important common control units are not duplicated.

Finally it should be mentioned that the personnel have shown great enthusiasm and conscientiousness in quickly gaining a command of the new technique, both theoretically and practically, and that their achievement has greatly contributed to the excellent results obtained.

European Cooperation in Telecommunications

C. JACOBÆUS, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 001.83:654.1
LME 016.80

This report was presented to the European Telecommunication Conference arranged by the British Council of the European Movement in London on 15–16 June 1967. The report constitutes Appendix III of the main reports to the Conference.

By telecommunications is meant in this report telephony, telegraphy, telex, data transmission, video transmission and video telephony.

The general role of telecommunications in our age

To measure the value of telecommunications in the world today is a difficult task. Telecommunications are a part of modern life, without which our society could not function. All our everyday activities are so intimately associated with telecommunications services of different kinds that we could not do without them. The economic value of telecommunications cannot be assessed, partly because there is no alternative to take their place.

One can approach the problem, however, from another aspect. One must assume that the spread of telecommunications services is related to their use. For the main part, at least in the long-term view, there is a free market for telecommunications. People procure a telephone and use it to an extent dependent on the price of the service in relation to its value to them.

The most important telecommunications service is telephony. This report will start with a few statistical data about the telephone situation in some of the European countries and the United States.

Table 1. Statistical data of telephone situation in some European countries and the U.S.A.

	Telephone Density			Investments average 56–64		Charges	
	Tel. per 100 inh.		Increase 56–64 %	In rel. to GNP %	Per new tel. Sw.Cr.	Local calls Sw.Cr.	Trunk calls 200 km Sw. Cr./3 min.
	1956	1964					
U.S.A.	35.9	46.2	28.7	0.40	5 000	0.26	5.20
Sweden	30.2	41.9	38.7	0.53	3 800	0.10	1.40
U.K.	13.5	17.3	28.1	0.48	6 500	0.12	2.50
Germany	8.2	14.0	70.7	0.45	4 100	0.23	2.80
France	7.6	11.8	55.3	0.30	4 000	0.33	2.25
Holland	11.2	17.9	59.8	0.35	2 600	0.07	0.80
Denmark	20.6	27.6	34.0	0.60	5 300	0.08	1.20
Norway	17.7	23.4	32.2	0.73	8 500	0.18	1.80

Another point of interest would be the running costs per annum, but there is no available statistic in this respect.

The investments have been calculated per added subscriber. This is a simplification since, of course, administrations have expenses for progressive automatization and for meeting the increase of traffic generated by already existing subscribers.

One observes that the difference between countries is very great. It is difficult to explain why the conditions differ so much even in countries of similar structure. There are presumably certain chance phenomena which affect the situation. In some cases, however, purely geographical conditions are obviously an important factor, as also is the population density. It is more expensive to build telephone plant in a sparsely populated, mountainous country like Norway than in a thickly populated, flat country like Holland.

In this report we wish to lay particular emphasis on the conditions in Sweden. After the U.S.A. Sweden has the highest telephone density in the world and is far ahead of other European countries. Despite high wages the investment per new telehone is lower than in any other country except Holland. The tariffs are also low – Denmark and, again, Holland being the only countries with a cheaper telephone service. Sweden's leading position can be traced back to the conditions prior to 1918, when there were two competing administrations which really exerted themselves to provide a service at a low price and which also pursued an extremely active subscriber acquisition policy. This competition resulted in a rationalization of operation and plant construction. The telephone density rose to a high level, tariffs were lowered – all of which advantages have been maintained or further reinforced.

The Swedish telephone administration has been able to preserve a cost-minded attitude and is open to modern efficiency methods. It has been actively supported by the Swedish government, which has accepted that the administration makes free use of depreciation funds for new investments. These depreciation funds have also been generously calculated, being based on the replacement value and not on the booked value.

It cannot be proved that a stimulation of investments in telephony beyond the requirements of "natural growth" provides a greater yield from the national

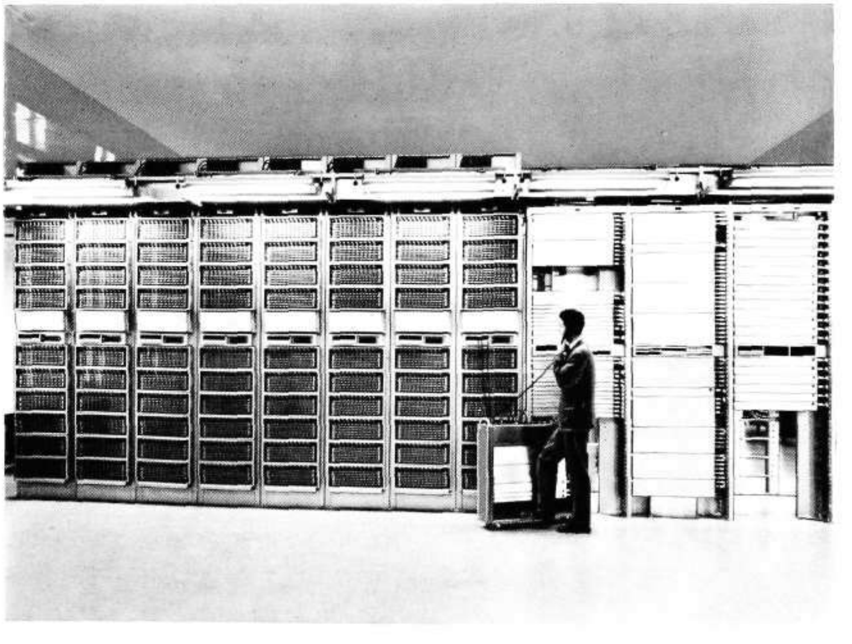


Fig. 1
L M Ericsson ARF exchange in Rotterdam, Holland

point of view than other competitive investments. The Swedish example – since the fusion of the administrations – should, however, show that the advantages of large-scale operation also apply to the telecommunications field. Competition between administrations within a country is in our days unrealistic on structural grounds. The administrations have therefore a great handicap compared with other enterprises which have the stimulus of competition. Cost-mindedness and efficiency must nevertheless be maintained.

Factors which affect the growth of telecommunications

If one regards the growth of telecommunications as a problem of supply and demand and, for the moment, disregards the capital question, one finds that the supply side is dependent partly on the means of production and partly on the supply of manpower. The physical means of production, such as manufacturing points, are hardly a limiting factor. They can at all events be expanded fairly quickly. The capital for such expansion can undoubtedly be found if a fairly long-term, profitable market can be assumed.

The supply of technically trained labour is a problem in many countries. The difficulty is especially in attracting technicians for planning of new plant. The often rigid wage systems of administrations may be an obstruction to recruitment of capable personnel. The remedy should be a more flexible wage system and extended facilities for training, both within the framework of the administration and through normal educational facilities. In many cases the suppliers should be able to offer planning and project management.

Personnel problems may also arise within the operations sector. Apart from the usual training schemes attention should be paid to the rationalization of maintenance and operation. In the planning of plant and in the choice of equipment the decisive factors – apart from the purchase conditions – should be quality, reliability, and simplicity of maintenance.

An important factor is the form for conducting telephone operations. The form of organization existing in Sweden and some of the European countries, namely a commercially operating government department, would appear to be ideal. It may be compared most nearly with a utility undertaking with the government as shareholder. Through its terms of reference the Administration is relatively free within its sphere of activities and in its method of operation. The alternative form of a telecommunications ministry undoubtedly leads to greater bureaucracy and less efficiency. It also becomes dependent on temporary political currents, which does not promote a sound development of telecommunications.

A well managed telecommunications administration should hardly need to count on an increase of personnel for a normal increase in volume of its business – rationalization measures should maintain at least the same rate as the expansion of the business.

The factor which has been most obstructive to growth since the war has been the shortage of capital. Many countries have been unable to make funds available to their administrations for the necessary expansion. Through the continuous industrialization and bureaucratization and, naturally, owing to the rapid rise in the standard of living for all population strata, a demand has been created which could not be met within the narrow limits determined by governments. Waiting-subscriber lists now exist in many European countries. At the same time trunk automatization has been neglected in many places. One of the most important tasks for those who are convinced of the necessity of a first-class telephone service is to find means of improving the capital supply for the administrations. Different means have been tried in different countries. One has been subscriber financing, i.e. new subscribers have had to loan money to the administration as a condition for having a telephone, corresponding roughly to the investment cost for the subscriber line with its share of the switching equipment and installation charges. In other cases suppliers have had to give credit. These courses are obviously emergency solutions and, probably, expensive for the administration. The correct course, naturally, is to convince the government that it is necessary to meet the capital requirement from the national budget or through the capital market in the normal manner. Ministers of finance are best convinced by offering them the prospect of profitable investments, which in turn calls for a method of accounting by the administration in which income, expenditure and profits for each part of the business are based on strictly commercial accounting principles. A particular point to notice is that the postal business must be kept separate from the telecommunications business in the accounts.

On the demand side, we may first consider *tariff questions*. Tariff schedules should be based on purely business principles. The level of tariffs should naturally be such as to bring a reasonable profit. Telephone operations in large cities and also trunk traffic usually result in a very good profit. Rural areas, on the other hand, do not as a rule yield an interest on capital investment. The matter cannot be viewed in this limited light, but it must be considered that urban subscribers also benefit from being able to speak to rural subscribers. The latter, therefore, will further improve the utilization of capital in the urban areas. There are also social reasons for providing sparsely populated districts with telephones on reasonable conditions.

The distribution of income from different parts of the business is greatly affected by the tariff scales. In the same way it is inevitable that the demand within different sections will be influenced by the tariffs. An example may be taken from the telegraph sector. In most administrations telegraphy runs at a loss. The administration attempts systematically to reduce the attraction of telegraphy by raising the tariffs (concurrently with a deterioration of service) and, instead, to stimulate the use of telex, which requires less personnel at the administration.

Politicians may perhaps be tempted to exaggerate the social element in the fixing of tariffs. This imposes a load on the "productive" subscribers, i.e. in business and industry. It is reasonable that the latter should pay something to enable remote subscribers to have a telephone. If the situation is taken too far, however, the subsidizing of these subscribers should be done through the national budget.

For some governments telephony has become a milch-cow. The practice of using a national monopoly relating to a public utility for fiscal purposes is a dubious one. It is also debatable, naturally, whether telephony should carry general taxes of the purchase or surplus value type. The important point is that telephony should not be discriminated in relation to other government or private activities. Ministries of finance should be contented with the satisfactory yield on invested capital that an effectively managed administration can bring them, especially as, with the growth of telephony, the yield becomes still greater.

The demand will naturally be dependent on the services offered by the administration. In the sequel the various telephone services will be considered from the point of view of what is now customary and what subscribers should be entitled to demand now and in the future.

Telephony

In most countries local automatization has advanced very far.

Trunk automatization is also well developed in the industrial countries. Here, of course, the subscribers' demand is for a sufficient number of circuits so that subscriber trunk dialling is not merely an illusion.

The waiting time for a telephone varies in different countries.

It is reasonable that subscribers should not have to wait longer than they have to do for any comparable utility, e.g. a television set. Installation and connecting up should preferably be done in the daytime. This is often impossible, however, in sparsely populated districts.

Push-button dailling instead of ordinary dialling is an obvious advantage to subscribers and should be introduced. Administrations should draw up a plan for conversion to push-button dialling within their respective areas. Subscribers are undoubtedly prepared to pay the extra cost in the form of higher installation charges and charges for calls.

New telephone traffic facilities

New traffic facilities have been introduced in the United States and Sweden in conjunction with the new stored-programme-controlled exchanges. These are as follows:

Abbreviated dialling

A subscriber can be allowed access, by dialling a 2-digit number within a given series (e.g. 70–79), to subscribers of his choice, usually those to whom he makes most calls.

Call-back

A subscriber having dialled the number of a busy subscriber dials a code number and replaces his handset. He is then automatically called back as soon as the called subscriber is free. Thus the need for redialling is not necessary.

Automatic Transfer

The subscriber has the choice of two alternatives. Incoming calls can be automatically transferred either when his line is busy or when incoming calls are left unanswered.

Enquiry and Transfer

During the course of a telephone conversation a subscriber may make an enquiry call to a number within the exchange area. Should he so desire he can also transfer the call to such subscribers.

Conference telephone

The subscriber may initiate and administer a multi-party conference.

Time-Calling or Alarm-Clock Service

The subscriber can register in the exchange the time of day or night at which he wishes to be called. This alarm-clock service requires the dialling of 4 digits in accordance with the international 24 hours practice.

The traffic facilities should be tested and, if a reasonable market can be foreseen for them, the administration should draw up a plan for their introduction.

An important point for the goodwill of a telephone administration is that the special services offered to the public are well organized and well developed. Among these are number inquiries, complaints and repair services in general. The administration should also have a sales department which gives the customers advice as to what they should buy. At one place at least within the country there should be a planning department to assist large firms and institutions in organizing the relation of their internal telephone service to the external service. It is becoming increasingly important that administrations have expert groups of this kind owing to the tendency of large enterprises to work in scattered units and also because modern technical facilities allow several alternatives which must be compared.

Maintenance is neglected in many places. This makes it difficult for subscribers to put through their calls. Repeated call attempts must be made, which results in loss of time and irritation. The quality of transmission may render easy conversation impossible, and so on. It is necessary that administrations do not lower their sights in this respect.

Telex, telegraphy

Telex is the special telecommunications service of the business community. It is also made much of by the administrations, as it is a strongly growing service and provides a good income. Telex is of special importance for traffic with other parts of the world.

The subscribers may demand that administrations plan the service satisfactorily so that subscriptions can be obtained at fairly short notice. This is not the case at present in many places.

Telegraphy is a service which is dying out as the telephone becomes more widespread and provides instantaneous service. Telex has become a better solution for the business community.

Data transmission

Data transmission is a service which is expected to be of very great significance in the future. Administrations are poorly prepared to meet the need, however. It is an absolute requirement that business subscribers shall be able to book circuits for data transmission at different speeds. Alternatively it should be permissible to connect their own data transmission equipments to rented circuits.

Video telephony

The business community will presumably demand video telephony in the future. It is desirable that administrations start to take an interest in this service. Fundamental parameters must be determined in respect of the quality of the picture, i.e. resolution and picture frequencies. A switchable system between moving pictures (human beings) and documents may possibly be required. International standardization is necessary.

Paging system

Demands have been presented for a system which permits access to a person wherever he may be in a country. Administrations should study how such a service should best be arranged. At the same time industry should start research work on the technical requirements.

It should perhaps be pointed out that a person should have the choice of deciding himself whether he wishes to be accessible to paging.

Telecommunications and the aim of the European Movement

This report has hitherto been concerned with aspects of telecommunications services from the national point of view. The reason is, of course, that international traffic cannot function satisfactorily unless there are well organized national telecommunications services. The international service hardly requires any special equipment. It is actually a matter of cooperation between national telecommunication services across the frontiers. This gives rise to technical problems, operational problems and problems for the subscribers.

Administrations throughout the world have in CCITT an organ for cooperation in technical and operational questions. CCITT has done very extensive standardization work in respect of the technical and operational conditions of international traffic. Extremely close cooperation exists within the CCITT, in which the large suppliers also have a part. The European administrations also have their own organ, CEPT, for special European questions.

When it comes to traffic within Europe, the purely technical questions are hardly in the foreground. Economic solutions exist to the main problems. In the field of operations there are still some problems remaining, associated with fault tracing and maintenance, but it may be expected that standards in these respects will be established by CCITT fairly soon.

If one sees the problems from the subscribers' point of view, a number of desires become apparent. The principle should be that it is as easy to telephone internationally as nationally. At the present there is fully automatic international traffic only between certain European countries, and often covering only the larger cities. The reason is that certain investments are required which are only defensible in major contexts. It is naturally very desirable that this fully automatic traffic should be extended as far as possible. The administrations should be conscious that automatization of this kind always leads to an increase of traffic, which should repay the investment reasonably soon.

One difficulty is tariffs. The ordinary method of charging on subscriber meters does not allow more than a given maximum tariff. The international tariff should be lowered, however, to a level corresponding to the national tariff for the same distances. There is hardly any reason to have higher charges for international calls.

From the charging as well as from the investment aspect the realistic view is to count on semiautomatic traffic internationally for a considerable time to come. The operators are a bottleneck, however, and in many countries it has been difficult to recruit operators with the necessary knowledge of languages. By means of long-term planning of training and recruitment the administrations should make sure that the need can be covered. For large enterprises, hotels, government departments, etc., it will be desirable to have a special service allowing full automatic international traffic from their PABX. The internal operator should have at her disposal one or more circuits to the international exchange, on which she can set up automatic international connections. These circuits could be equipped with special charging devices which could absorb the higher international tariff. In this way the administration could do without most of the international operators.

It is, of course, especially important to have a good quality of transmission on international connections. Otherwise the language difficulties are magnified. Questioning and repetition prolong the conversation – an increase of cost to subscribers which is unwelcome as it lies outside their control. Misunderstandings also become more common.

There should be sufficient circuits, so as to avoid delays. As in national traffic, one may expect a greater flow of traffic if calls are handled immediately – fully or semiautomatically.

Large enterprises have now interconnected their various establishments in PABX networks on a national basis. In future it may be necessary to have international networks of this kind as well. Permanently rented circuits between the units may be possible for major traffic requirements, while in other cases ordinary network circuits can be used.

The length of international numbers owing to the international and national prefixes is a disadvantage. Only in special cases can this be avoided by introducing abbreviated dialling for international calls. One might consider a variant of the old trunk number system which was earlier used in some countries. Large enterprises, hotels etc. in Europe were given numbers in a special series with, perhaps, not more than 5 digits. Access to this number series was obtained through a special prefix. Such subscribers should, of course, also be accessible on their ordinary national numbers. Administrations should study this possibility in conjunction with industry.

The subscribers' wants list also includes a number of practical questions which are becoming increasingly significant the greater the amount of travel and of international contact in general. The business community would like a concentrated telephone directory for Europe, listing subscribers who have large quantities of international traffic. It would also be valuable if the directories were edited in the same way so that there is no difficulty in finding a subscriber in a foreign directory.

It is, of course, important to have standardized dials and keysets. All prefixes should be numerical and not alphabetical. The latter are especially troublesome in international contexts as spelling may give rise to misunderstandings.

Tones and signals are standardized by CCITT and it is desirable that administrations follow the CCITT recommendations. A certain standard in coin boxes would also be desirable, a very important point for travellers.

Among other telecommunications services may be mentioned telex, perhaps the most international service. Duplex traffic now exists between the majority of countries.

In the data transmission field we may expect a great international expansion as well. Here the administrations must tackle standardization questions in conjunction with CCITT. It is important that at least provisional solutions are attained within the near future so that administrations can offer this service internationally.

Telephone Traffic Theory – Present Status and Future Trends

C. JACOBÆUS & A. ELLDIN, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 513.21:654.15.02
621.395.31
LME 807

The purpose, development and methods of telephone traffic theory. Theoretical description of telephone traffic and its counterpart in reality with reference to such factors as traffic variations, stationarity and repeated call attempts. The background necessary for computation of new telephone systems. Service criteria in relation to traffic variations and general objects in view. The present and future use of computers for switch and circuit calculations and theoretical development work. The need for more observations on real traffic for surveying the significance of the seasonal variations of traffic.

The theory of telephone traffic and its applications are used to determine the quantities of switches and circuits needed in a telephone system. The theory is also used to check that a telephone system has the correct traffic structure, i.e. that the system functions in a logical and suitable way in relation to the existing traffic conditions. The creation of an economic and efficient telephone system is, to quite a large extent, dependent on proper application of the arguments of the theory of telephone traffic.

Like all other engineering sciences, the task of telephone traffic theory is to describe the most essential characteristics of the reality. Its applications are used to find the most suitable arrangement of selectors and switching devices and to determine the necessary quantities of these devices. The result of calculations depends partly on how correctly the quantities of traffic have been estimated and partly on how well the plant has been adapted to the variegated requirements of the traffic. Both these factors, in turn, are dependent on the experience possessed of traffic and its variations and on how well this is reflected in the theory. To create efficient and economical telephone systems with the correct traffic structure, therefore, the theory must reproduce the most essential part of the reality.

Telephone traffic theory follows the development of telephony and throughout its history has attempted to describe the characteristic features of telephone systems. Work on the theory started at the beginning of the century when the attempt was made, by mathematical and empirical methods, to determine the number of circuits and the number of operators needed in telephone plant at that time. The initial phase may be said to have terminated with the presentation of Erlang's theories (1909–21). The essential feature and the stroke of genius in Erlang's method is his assumption of statistical equilibrium and of independence between successive calls and between simultaneous occupations, as well as his use of the exponential distribution.

The following phase, between the two wars, saw the breakthrough in earnest of the automatic systems, and the need to be able to calculate the necessary number of switching devices increased. During that period Erlang's theories were studied, accepted and further developed in hard competition with the German school, the advocates of which, Langer and Lubberger, based their theories on more empirical but, theoretically, less clear premises. The main interest was still in calculating the congestion in full availability groups and gradings. During that period important contributions were made by, among others, Vaulot, Fry and, at the end of the period, by the Swede, Conny Palm.

After the second world war the crossbar switching systems based on the link principle were introduced. Estimation of the traffic capacity of link systems placed further requirements on the methods of calculation. It was no longer sufficient to calculate the congestion in a full availability group but it was necessary also to master the traffic distributions in the various switching stages of a link system. This required a stricter systematization of how the distributions for each switching stage should be theoretically described (Jacobæus 1950). A better understanding was obtained of the properties of the various distributions. During that period much work was done on developing expressions which could be simply calculated with the aid of tables and desk calculators.

The introduction of rapid automatic electronic computers has had a great influence on the subsequent development within telephone traffic theory. They proved to be an effective aid both as automatic calculator and for simulating different groupings and were very quickly made use of. In 1955, at the First International Teletraffic Congress in Copenhagen, the Swede, Neovius,[43] presented simulations of a grading carried out on the Swedish computer BESK. Since then innumerable simulations have been made and are today a part of the natural routine for testing of theories and grouping arrangements. Equally important has been the possibility of making numerical calculations in accordance with given formulae. It was now possible to carry out numerical calculations on a number of alternatives and to chart the characteristics of telephone systems. More knowledge and more numerical facts were undoubtedly produced during that period, which started around 1955 and is still proceeding, than had evolved in the past 50 years or so. Today the computer is an essential aid for the telephone traffic technician.

Concurrently with the development of the theory a successive, though sporadic, study has been made of telephone traffic. It is very probable that Erlang came by his pioneering ideas by observing how the number of occupations changed in real traffic. In this way reality may have provided a stimulus for his theories. Other landmarks are the observations of the Englishmen, O'Dell and Berkley, on the congestion in different types of gradings at the end of the twenties. Of very great significance for the future development of telephone traffic theory are undoubtedly the measurements made in 1941 in Stockholm by the Swede, Conny Palm,[28] who studied how the traffic varied during the hours of the day and presented a brilliant theoretical description of this phenomenon. Furthermore all field tests of new systems, made by measuring the traffic properties of the systems in operation, have been of great significance for checking the realism of the theory. In the past few years CCITT's interest in computing the number of international circuits has required measurements on real traffic. This meant studying the significance of the variations in traffic, and especially the seasonal variations. Throughout the whole history of the telephone, moreover, measurements have been carried out in order to discover how the traffic increased and to check that the operational conditions were satisfactory. All this collective experience has provided the backbone and the realism required for a telephone system to function as intended. All observations on real traffic, however, whetted the appetite and indicated that more observations should be made and that still more should be known about traffic.

If one attempts to prophesy the future development of telephone traffic theory, one can guess that it will be characterized by the availability of better, larger and quicker computers. One may also guess that there will be better equipment for collection of observed data from real traffic. Both the computing capacity and the data collection capacity may be expected to increase, and this will lead to a greater knowledge which will influence the future development of the theory. We shall thus be able to build still better and more economical telephone systems. In this development it will often be necessary undoubtedly to reexamine the theoretical description of telephone traffic, how it is generated and how its variations are to be described. Methods of computation and simulation must also be developed to deal with new technical arrangements for telephone systems. At the same time we must investigate what demands can reasonably be placed on the grade of service in a telephone system, having regard to the properties and variation of the traffic and to how the cost of the telephone system is affected by the traffic. Practical rules must be found for how investments in telephone plant should be made at the right point and at the right time. The three factors – system cost, traffic properties and service requirements – are not independent of one another but must be viewed as components of a common complex of problems (fig. 1).

Real telephone traffic and its theoretical description

The basis for the theory of telephone traffic is the theoretical description of real telephone traffic. The theoretical model should describe the most essential features of the traffic. Does it do so?

The first answer to this question must be that the Erlang description provides the most essential features of telephone traffic in a stationary state. By assuming statistical equilibrium and independence between successive calls and between simultaneous occupations, and by using the exponential distribution, a model has been obtained which is a compromise between realism and mathematical simplicity. The model has also proved to tally with reality in certain sporadic observations. It provides satisfactory facilities for varying the assumptions in accordance with the specific conditions which prevail at different points in a telephone system. In this way a practical method has been developed for calculating the necessary number of switching devices, which perhaps would not have been possible if other courses had been adopted.

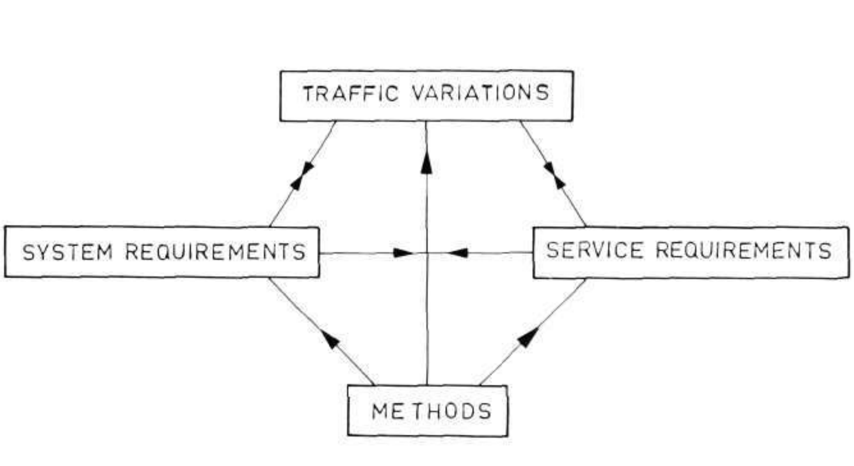


Fig. 1

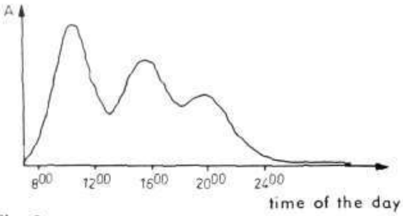


Fig. 2
Variation of the traffic during the day

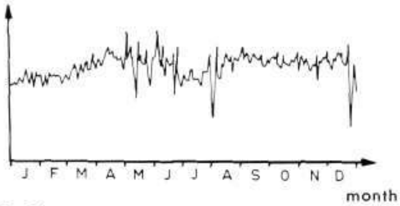
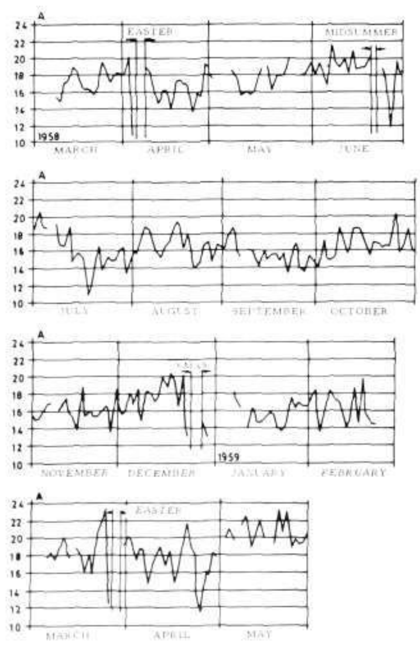


Fig. 3
Daily busy hour traffic flow values during a year

Fig. 4
The busy hour traffic day by day during one year on a trunk route in Sweden (Malmö—Gothenburg 1958—59)



The concept of statistical equilibrium implies that one assumes that the growth in number of occupations and decline in number of occupations are equal. If this were not so, either the growth or the decline would predominate, the traffic would be either infinitely great or there would be no traffic at all.

$$Growth = Decline \tag{1}$$

The probability of the number of simultaneous occupations in a group can generally be calculated as follows.

Assume that the number of engaged devices in a group is denoted p and its probability $[p]$. The intensity of growth is denoted λ_p when there are p occupations and the intensity of decline is denoted μ_p. According to (1)

$$\lambda_{p-1} \cdot [p-1] = \mu_p \cdot [p] \tag{2}$$

By recursions from $p=1$ and upwards

$$[p] = \frac{\prod_{\nu=0}^{p-1} \lambda_\nu}{\prod_{\nu=1}^{p} \mu_\nu} \cdot [0] \tag{3}$$

Obviously

$$\sum_p [p] = 1 \tag{4}$$

where the probabilities of state $[p]$ are summed for all possible states p.

The assumption of exponentially distributed holding times implies that the intensity of decline μ_p is proportional to the number of occupations p:

$$\mu_p = p \tag{5}$$

This applies if one uses the mean holding time in the group as time unit, which is convenient. The call intensity λ_p can be written

$$\lambda_p = A(p) \cdot W(p) \tag{6}$$

where $A(p)$ is the call intensity, which may be assumed to depend on the number of free sources. The expression $W(p)$ is the probability that an occupation can take place when the group already has p occupations. This probability may be assumed to depend on the internal conditions of the group or on the conditions after the switching stage under consideration, while $A(p)$ may be said to be dependent on the conditions prior to the group under consideration.

The call intensity $A(p)$ can be given the following expressions:

$$A(p) = (N-p) \cdot \alpha \tag{7a}$$

$$A(p) = A \tag{7b}$$

$$A(p) = a + b \cdot p \tag{7c}$$

The three expressions for $A(p)$ give a calling intensity which in (7a) diminishes with the number of engaged devices, in (7b) is constant and in (7c) increases with the number of engaged devices. With these three expressions and with $W(p)=1$ we get the three known traffic distributions Engset, Erlang and the negative binomial distribution. This applies to a lost call system in which it is assumed that lost calls do not give rise to renewed attempts.

By giving λ_p for $p=n$ different values ≥ 0, one can in theory distinguish between a lost call and a delay system. In a lost call system

$$\lambda_n=0 \tag{8a}$$

In the delay system

$$\lambda_n > 0 \tag{8b}$$

For a delay system there is a further possibility of varying the assumptions concerning the delay. One may assume that all callers wait until they are served or that waiting callers give up in accordance with some probability distribution (PALM[30]). For a delay system there is also a possibility of varying the handling of the queue. It is customary to calculate mean waiting times and waiting time distributions.

All these variants have been calculated and expressed, and today there is no difficulty in calculating with a computer whatever variant assumption one needs. The applications are not limited to the full availability group, but methods of calculation exist for gradings and link systems and for composite delay systems. The only difficulties, generally speaking, are those of numerical calculation, i.e. how to handle a computer.

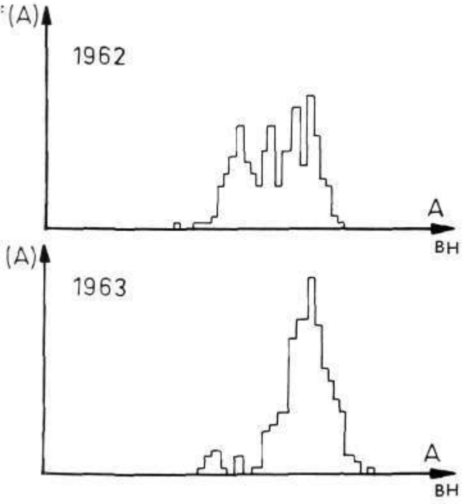
The number of cases and variants studied grows rapidly in the literature.

It follows from the foregoing that the telephone traffic theory has good possibilities of varying its assumptions to correspond to the requirements of variations existing for different groupings. This is a way of trying to bring out the most essential features of telephone traffic. It applies, however, only to traffic in a stationary state.

A study of traffic during lengthy periods shows that it has the following variations:

- Variation during the day with one, two or three peaks (fig. 2).
- The peak traffic may occur at different times on different days.
- The peak traffic varies seasonally with often high values before a public holiday and low values after a holiday, in accordance with human activity (figs. 3 and 4).
- Different weekdays often have systematically higher traffic than others.
- The traffic has a general tendency to increase with time. This increase may differ for high and low traffics (fig. 5).

Fig. 5
Histogram of the busy hour traffic flow for two consecutive years (*BH* = busy hour)



These conditions are described in figs. 2–5. Fig. 6 summarizes the result of traffic values during a lengthy period, both for the time-consistent busy hour and for all 8760 hours during a year. Fig. 7 shows how the congestion in a group may vary during the year.

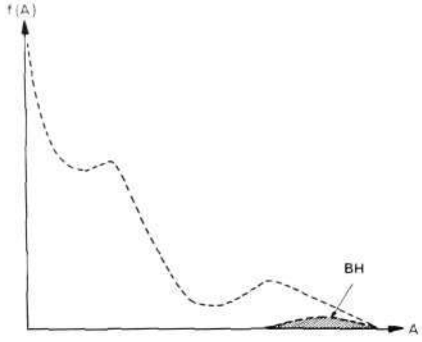


Fig. 6
Hypothetical histogram for all one-hour traffic flow values during a year. The shaded section is the contribution from the busy hours.

The following questions arise. For what traffic values shall calculations be made? What is most important? How is an increase of traffic described? Furthermore, how is the overall variation in a network described when each traffic may be expected to vary separately and there may be a certain dependence or independence between high values, so that they occur simultaneously or not, at several points in the network? These questions can only be answered by extensive observations of real traffic. This is a matter for the future. Only when the traffic variations have been thoroughly charted can one obtain a further insight into the applicability of the Erlang models. It may prove that they need to be extended and modified.

Another constant problem is to check how the methods of calculation agree with reality. The following questions must be answered. What is the counterpart in reality to statistical equilibrium? How much or how little may the traffic change in order that statistical equilibrium may be considered to exist? (Fig. 8) Or can the concept of statistical equilibrium be substituted by a less strict and more realistic condition?

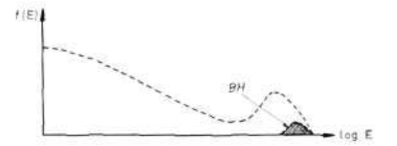
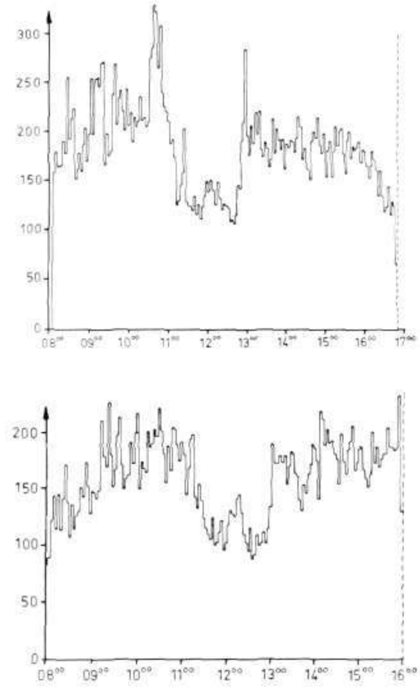


Fig. 7
Hypothetical histogram for the congestion during all hours of one year. The shaded section is the contribution from the busy hours

When we compare theory and reality it must be clearly realized that theory can never reproduce reality in detail, since theory must confine itself to the most essential features of reality. It is therefore necessary to make abstractions in the theories so that they reproduce the main features of a variegated reality. Experience and good judgement of the researcher are important factors in this respect.

When comparing calculated values and values measured from real traffic one encounters a further problem, namely the reproducibility of real traffic. Should one expect to obtain agreement in principle between theory and reality after 1, 10, 100, 1000 observations? It may well happen that real traffic does not repeat itself as quickly as one would expect from theoretical calculations. These conditions have great practical significance for circuit computation. For they determine the margins one must count on in the switch provision. One may perhaps find that the traffic on one day is Erlang-distributed, the text day Bernoulli-distributed, on the third day of negative binomial type.

Fig. 8
Number of calls per 3 minute interval in a PBX during two days. When can the call intensity be considered as stationary?



It may be necessary to modify the theories to some extent as a result of discoveries made later on. Perhaps it will be found that it does not pay to be too precise in all details of the calculation. Other details may prove to be more important.

A consequence of this may be that certain approximations prove to agree better with reality than more exact solutions. This may occur if the theoretical assumptions prove to be less realistic and the approximations correct this condition. Such conditions have in some cases already been found from measurements of real traffic. As a rule, however, an exact solution should give a surer result than an approximate solution provided that the assumptions are truly realistic. Through the increased use of computers it will become less and less necessary to make use of approximations.

A circumstance which has not found a satisfactory description in the classical telephone traffic theory is the occurrence of repeated calls (figs. 9 and 10). It may be possible to work this into existing theoretical models in a practical way by assuming that rejected traffic sources increase their calling rate until they succeed in getting through (ELLDIN[67]). Figs. 11 and 12 show symbolically

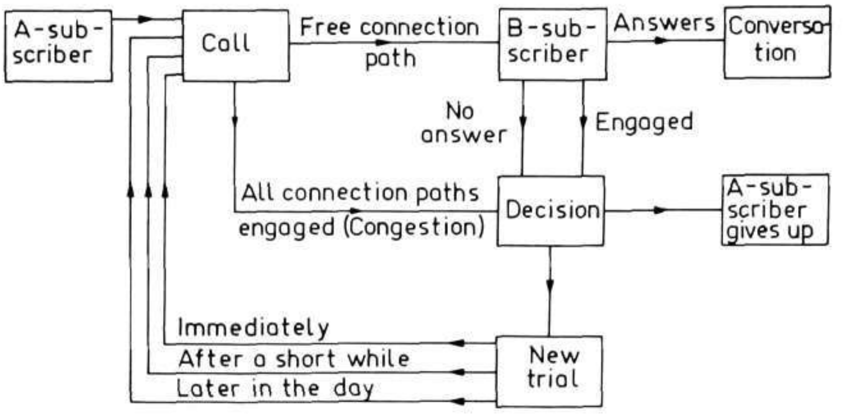


Fig. 9
Possible outcome of a call from a subscriber A to a subscriber B

how all kinds of failures to set up connections between subscribers can be theoretically described by a feedback of repeated calls to the inlets of the considered group.

Computation of new systems

Computation of new systems is one of the main tasks of telephone traffic theory. This requires more than simply the use of computation formulae. Otherwise the result is likely to be unsatisfactory.

For the design and computation of a new system a knowledge is required of the actual traffic, its variations, and the demands it will place on the equipments. One must also be sufficiently well versed in telephone traffic theory to apply it in the correct way. An adequate computer capacity is required so as to be able to examine different alternatives. One must also have practical experience of numerical computations in a computer in order to produce the required numerical data.

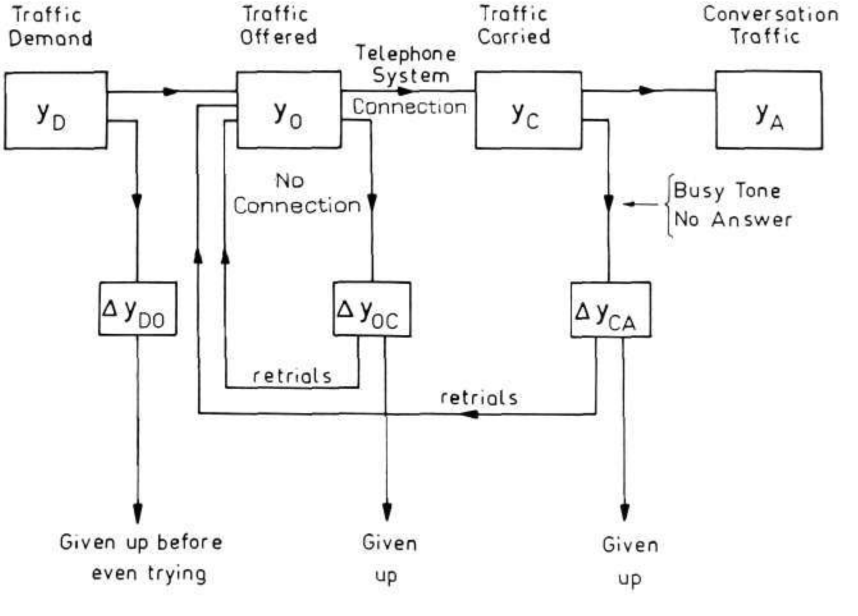


Fig. 10
Development of call intensity in a telephone network

In the past 10–15 years the following types of problems have been solved for L M Ericsson's telephone systems:

- Practical methods for calculation of link systems[32, 36, 40, 42]
- Application to all existing LME systems
- Methods of calculation for marker systems[58]
- Application to all existing LME systems
- Development of general rules for gradings[46, 47]
- Application to existing gradings
- Development of calculation methods for alternative routing[54, 55, 56, 57, 59, 60, 62, 68]
- Application to a large number of projects.

As a basis for this work the following studies and research have been necessary:

- Development of theories for link systems in general and for overflow problems[30, 32, 36, 40, 42, 48, 51, 52, 65]
- General studies of theories governing the properties of overflow traffic [52, 65]
- Theories of gradings, especially for gradings with random hunting[46, 47]
- Theories for delay systems[58]

Experience has been collected from the following sources among others:

- Measurements on equipment in operation[28, 36, 40]
- Measurements of traffic for study of its variations[49, 64]
- Simulations of different switching arrangements[43, 48, 52, 65]
- Study of the accuracy of measured statistical parameters
- Calculation of different grouping methods and determination of optimal groupings under different assumptions
- Development of metods of numerical calculation for different cases.[69]

To fulfil these tasks it would be desirable to have ready-made methods of calculation before the new systems are invented. This means that one should work on a fairly broad basis. This is especially necessary since the modern telephone systems offer so many facilities for variation in design as regards groupings and common control.

A perhaps especially important question is to find out how systems behave under overload. Here it must be taken into account that the various switching stages do not function independently of other parts of the system. A bottleneck at the start of a switching process may protect subsequent parts of the system against overloading. On the other hand the bottleneck near to the outlets of a system may have the opposite effect.

Studies of the overloading conditions also provide information as to where the bottleneck lies and whether the system is uniformly dimensioned.

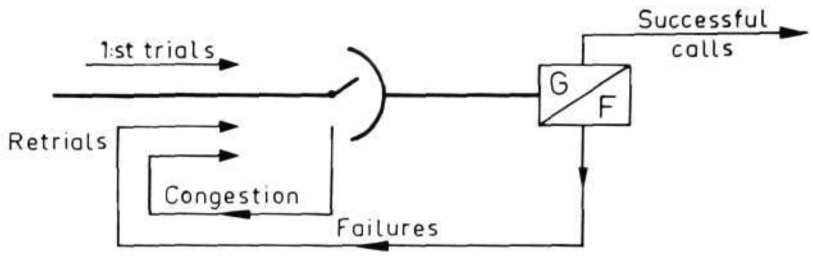


Fig. 11
Symbolical description of a selector stage. Failure and congestion may cause retrials.

Service criteria

The income from telephone traffic derives from the traffic carried. This corresponds to the mean value of the annual distribution shown in fig. 6 for all hours of the year. The expenditure on switching equipment and for extension of the traffic-dependent parts of the telephone system, on the other hand, depends on the peak traffic. It is a minimum requirement that the income from traffic shall carry all costs caused by the traffic including, of course, the capital cost of the plant. An optimal investment, therefore, depends both on the total income and on how high the traffic peaks are and may be expected to be in the future. If too few switches are installed, this might reduce the income to some extent. The subscribers' service demand would also be less well catered for. On the other hand, too many switches make the plant less economical.

There is today no method of determining what is a suitable grade of service in a telephone plant. The number of switches has been calculated in accordance with more approximate, traditional and common-sense methods. The assessment of what is a satisfactory grade of service has thus been non-numerical. The generally accepted and rather arbitrary procedure of specifying a particular level of congestion for some busy hour traffic value has naturally turned out differently well at different places and on different occasions.

$$\left.\begin{aligned} E(A_{BH}) &\leq E \\ P(A > A_{BH}) &= ? \end{aligned}\right\} \qquad (9)$$

Owing to the great variation of traffic the mean utilization per switch in a telephone plant will always be low. It is only during a few hours, say 200 of the 8760 hours of the year, that the plant is really utilized to a high degree. It has hitherto been a question of non-numerical estimation of how high the grade of service should be on these peak traffic occasions. The problem has sometimes been dealt with by overestimating the traffic, so leading to a certain overinvestment, at least at the start of a period of expansion.

It may be said without exaggeration that a telephone plant always is and should be overdimensioned when an expansion has just taken place. This is, of course, reasonable since additions to the equipment usually take place at fairly long intervals of from six months to five years. On the other hand it may be desirable to reduce the investments and apply them to those points in the system where they are of most use.

A main point at which to keep down investments, of course, is on expensive circuits such as international circuits. It was therefore that CCITT became interested in the question of the provision of international circuits to take

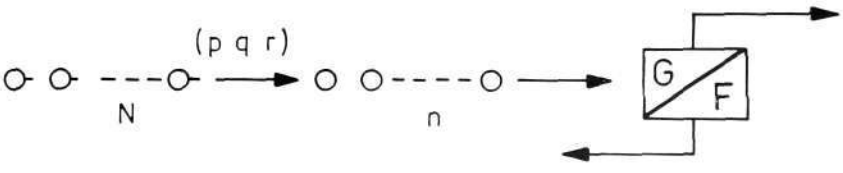


Fig. 12
Full availability group with N sources and n devices. G = (1 — F) is the probability that an occupation in the group leads to conversation. The group has p occupations and q "disturbed" sources. Of the p occupations r do not result in conversation and are of short duration. The r occupations will later become "disturbed" sources with a higher call intensity than the other N — p — q free sources.

into account traffic variations. In 1964 a recommendation was published which takes into account the highest traffic during the year. The recommendation is that the congestion for the average of the thirty highest busy hour values during the last 12 months' period shall be below a given value, E_1 (1 %), and that the mean of the five highest busy hour values during the same period shall be below another value, E_2 (7 %).

$$\left.\begin{aligned} E(\bar{A}_{30}) &\leq E_1 \\ E(\bar{A}_5) &\leq E_2 \\ E_1 &< E_2 \end{aligned}\right\} \tag{10}$$

One may wonder whether it will be considered satisfactory in the future to have congestion standards of the type of (9) and (10). The overall result during a period will be seen from fig. 7, which shows how the congestion varied during a lengthy period. Should not this be recorded and should one not make up a forecast in advance of what this distribution, $f(E)$, will look like? There are no theoretical and technical difficulties in recording and calculating these distributions. The recording can be done by ordinary data processing routines, which include outprint of the distribution. As long as it can be theoretically assumed that the peak traffic is in statistical equilibrium, the congestion can be simply calculated by known methods. The existence of different congestion values is determined by how often the traffic has the corresponding value.

If one knows how the traffic varies, so that it can be described by a statistical distribution, $f(A)$, the existence of a given congestion value, E, can also be described as a frequency function $f(E)$.

The next problem is to decide how high levels of congestion can be allowed and how often. This can perhaps be expressed by means of any of the following service criteria:

$$\bar{E} = \int_A E(A) f(A) \mathrm{d}A \leq E_2 \tag{11}$$

$$\overline{AE} = \int_A A E(A) f(A) \mathrm{d}A \leq E_3 \tag{12}$$

$$\left.\begin{aligned} P(E > E_4) &= \int_{A \geq A_4} f(A) \mathrm{d}A \leq E_4 \\ E(A_4) &= E_4 \end{aligned}\right\} \tag{13}$$

$$P(t_E > t_5) = \int_{t_E \geq t_5} f(t_E) \mathrm{d}t_E \leq E_5 \tag{14}$$

In these formulae $E(A)$ is the congestion at a traffic A for a given grouping arrangement with a given number of switching devices. The frequency function value for a traffic A is $f(A)$. This function can be expressed either as the distribution for the busy hour traffic or for the traffics for each hour during the whole year. Of special interest for the computation, obviously, is the occurrence of high traffic values, as the congestion is a function of the traffic which yields measurable values and contributions to the integrals in (11)–(14) only at high traffics. In the criterion (14) t_E signifies the length of times when congestion prevails. Obviously a longer continuous period of congestion is more disturbing for subscribers than if the same time is divided into shorter intervals, with intermediate periods without congestion.

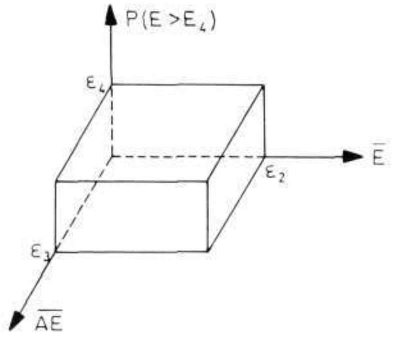


Fig. 13
Three-dimensional service criterion, as given in (11), (12) and (13)

For full availability groups the traffic variation can be expressed by a simple one-dimensional distribution, $f(A)$. For gradings and link systems the conditions may be more complicated. In these cases the traffic from several directions is combined in the same group. It may therefore be necessary to express the traffic variations as a multidimensional distribution, $f(A_1, A_2, \ldots, A_n)$. In principle there is no difficulty in this, but for realistic computation one must know the dependence between the different traffics $(A_1, A_2, \ldots, A_n)$.

An absolute condition for the formulation of new service criteria (computation criteria) is that one acquires experience of how the traffic varies during lengthy periods and how the congestion varies during the same period. The next step is to attempt to describe the variations of traffic by means of some statistical distribution. One also needs to know how this distribution changes with time, i.e. the pattern of the traffic increase. When this has been determined, the next problem is to develop methods of calculation which permit computation of the necessary number of switching devices in accordance with given criteria.

These criteria may be formulated either according to expressions (11)–(14) or as a multidimensional criterion (fig. 13). It seems likely that attempts are made to avoid very high congestion too often, i.e. that a number of criteria will be used of the type (13) in which different values are chosen to limit the upper tail of the distribution of the congestion, $f(E)$, see fig. 7.

When sufficient experience has been gained of the result of used service criteria, one may imagine a further step, namely to determine directly from observations of the service measure at what time the equipment should be extended and by how much. Fig. 14 illustrates an imaginary case of this kind. This lies far in the future, however, and requires many years of measurements and many hours of calculation in a computer before we get that far. It is nevertheless a not too distant goal.

Methods

Computers have been adopted as a necessary aid in telephone traffic technique. There is no reason to suppose that within the foreseeable future we shall be independent of them. It may be expected rather that they will be used still more in the future than they are now. The existing methods of studying theoretical conditions and carrying out practical calculations are therefore being continuously adapted to computer potentials such as they are today and will be tomorrow. Methods of calculation as well as simulation technique will be further developed.

There is a great difference between the way in which the computer is used and the way in which manual calculations were carried out. In today's computers

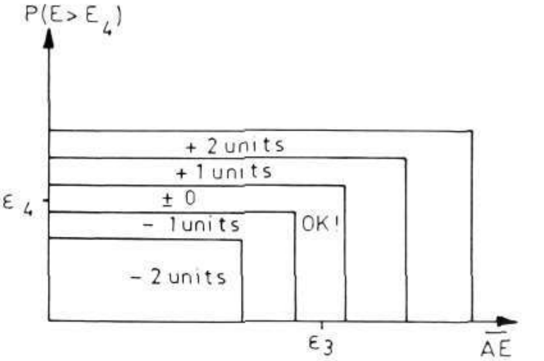


Fig. 14
Rules for change of the number of devices from the situation of the service measure point $[(\overline{AE}, P(E > E_4)]$. The diagram is based on a two-dimensional service criterion according to (12) and (13)

it is usually simplest to make use of recursive and iterative procedures. Simple mathematical operations take an extremely small time, whereas hunting for numerical values in a memory may take a longer time. Much time was earlier spent on simplifying and approximating complicated formulae. Only a small part of this time is now spent on programming the complete expressions. More reliable data are now obtained without uncertain approximations.

To arrive at the searched values in calculations, automatic iterative methods are required. These methods involve convergence problems among others. Certain problems of this kind have already been solved, but new problems are constantly arising as new methods of calculation are developed. The problems apply both to practical and to theoretical calculations.

Of very great significance for the development of traffic theory is the simulation technique. In earlier phases use was made of traffic machines, i.e. analogue machines, which simulated the traffic and the occupations of the switching devices. Among such traffic machines may be mentioned that used by Kruithof (1946)[29] and the Swedish Traffic Machine owned and used by the Board of Telecommunications and L M Ericsson jointly, which was in operation between 1953 and 1965. The Swedish traffic machine was planned by Conny Palm among others.

It was fairly soon realised that simulations could equally well be made on a computer. Kosten (1943, 1949) and Jensen (1952) pointed the way. The Swede Neovius made the first simulation on a telephone traffic problem in 1955. A few years later Wallström (1958) carried out simulations on a two-stage link system. Today the simulation technique is wellknown and widely used. The practical problems of today are how to generate random numbers and how to organize the administration of the simulation programmes so that simulations can be carried out in a reasonable time in a computer.

Simulations in a computer are an efficient tool for checking a theory or an approximation. The result, however, is never more certain than the assumptions on which the simulation is based. Simulations take a longer time today than calculations and can therefore not replace theoretical and practical calculations. The theory is always needed, moreover, to explain what actually happens. A disadvantage of simulations when they were first used was that one forgot to observe real traffic. Everything was described by the computer, and so why should one make troublesome measurements on real traffic!

The development in the computer field hitherto has led to shorter programming and computation time. The processing times have been reduced as computers have become quicker and have got a larger memory capacity. The programming costs, however, are still probably greater than the machine costs. The programming work was reduced through the introduction of problem-oriented languages both for calculation and simulation. It is to be hoped that a further development in this sphere will lead to still simpler programming and that a programming language will be usable on different types of computer.

The situation today, unfortunately, is that a programme language for a computer cannot be simply transferred to another computer. Translated into the telephony field this would mean that a subscriber connected to a telephone exchange made by one manufacturer could not talk to a subscriber connected to another exchange made by another manufacturer. Nor could two subscribers connected to an older and a newer telephone system made by the same manufacturer be able to speak to one another! This shows that there are great advances pending within the programming field in the future. When we get common programming languages, the possibility of borrowing programmes from common libraries will facilitate the work still further.

Final remarks

Telephone traffic theory has from the start been ahead of other applied sciences. Operation research was employed long before the name operation research was coined. Erlang made use of stochastic processes before the concept had been explained theoretically. There is no reason to expect that in the future the theory will remain in strictly rigid forms, but one may expect continued vigorous approaches to the problems from new angles. The significance of a well developed telephone traffic technique is so great that the theoreticians are quite simply forced to produce practically usable results.

A large amount of excellent and ingenious work has been carried out within telephone traffic theory. Today, therefore, we have a very good survey of the traffic conditions. But much remains to be done. It can be done now, since there are computers to help us and since the theory itself is so well developed. In fact it is merely a question of available computer time for attacking still greater problems than hitherto. And the solution to these problems is within reach!

The most time-consuming obstruction to continued development is the need for more measurements. The theory cannot be developed further, it can merely become more complicated unless more experience is collected of real traffic. Realistic results can only be obtained if the building of theoretical models is combined with measurements so that they fertilize one another. By observing real traffic one can distinguish between satisfactory and less satisfactory theories. It is the only means one has when judging whether theory is usable or not.

The continued development will cost money. These amounts, however, should be quickly repaid through the avoidance of overdimensioning. Subscribers will also be given the service intended and which they pay for.

A properly conducted activity within the traffic theory field and correct applications of it is one of the basic conditions for the development of efficient and economical telephone systems.

References

1. Erlang, A. K.: *Probability Calculus and Telephone Calls.* [In Danish.] Nyt Tidsskr. Mat. *B 20*(1909): pp. 33—39.
2. Erlang, A. K.: *Solution of Some Problems in the Theory of Probabilities of Significance in Automatic Telephone Exchanges.* [In Danish.] Elektroteknikeren *13*(1917): 2, pp. 9—13.
3. Erlang, A. K.: *Telefon-Ventetider. Et stykke Sandsynlighetsregning.* Mat. Tidsskr. *B* 31(1920): pp. 25—41.
4. O'Dell, G. F.: *Theoretical Principles of the Traffic Capacity of Automatic Switches.* Post Off. Elect. Engrs. J. *13*(1920): 3, pp. 209—223.
5. Molina, E. C.: *The Theory of Probabilities Applied to Telephone Trunking Problems.* Bell Syst. Tech. J. *1*(1922): 2, pp. 69—81.
6. Langer, M.: *Calculation of Switches Required in Automatic Exchanges.* [In German.] ETZ *45*(1924): 11, pp. 203—208.
7. Rückle, G. & Lubberger, F.: *Der Fernsprechverkehr als Massenerscheinung mit starken Schwankungen.* Berlin 1924.
8. Vaulot, E.: *Application du calcul des probabilités à l'exploitation téléphonique.* Rev. Gén. Elect. *16*(1924): 11, pp. 411—418.
9. Holm, R.: *The Validity of Erlang's Trunk-Congestion Formula.* Post Off. Elect. Engrs. J. *17*(1924/25): 4, pp. 318—321.
10. Erlang, A. K.: *Some Applications of the Method of Statistical Equilibrium in the Theory of Probabilities.* P. 201. Den sjette skandinaviske Matematikerkongress i København 1925, Copenhagen 1926, p. 157.

11. O'Dell, G. F. & Gibson, W. W.: *Automatic Trunking in Theory and Practice*. Inst. Post Off. Elect. Engrs. Paper 1926: 107, 46 pp.

12. Molina, E. C.: *Application of the Theory of the Probability to Telephone Trunking Problems*. Bell Syst. Tech. J. *6*(1927): 3, pp. 461—494.

13. O'Dell, G. F.: *An Outline of the Trunking Aspect of Automatic Telephony*. J. Inst. Elect. Engrs. *65*(1927): 362, 181—222.

14. Vaulot, E.: *Extension des formules d'Erlang au cas où les durées des conversations suivent une loi quelconque*. Rev. Gén. Elect. *22*(1927): 26, pp. 1164—1171.

15. Fry, Th. C.: *Probability and its Engineering Uses*. New York 1928. 2nd ed. 1965.

16. Elliman, E. A. & Fraser, R. W.: *An Artificial Traffic Machine for Automatic Telephone Studies*. Post Off. Elect. Engrs. *22*(1929/30): 1, pp. 31—39.

17. Molina, E. C.: Appendix to: *Interconnection of Telephone Systems—Graded Miultples* by R. I. Wilkinson. Bell Syst. Tech. J. *10*(1931): 4, pp. 561—564.

18. Wilkinson, R. I.: *The Interconnection of Telephone Systems—Graded Multiples*. Bell Syst. Tech. J. *10*(1931): 4, pp. 531—561.

19. Berkeley, G. S.: *Traffic and Trunking Principles in Automatic Telephony*. London 1934; 2nd ed. 1949.

20. Vaulot, E.: *Étude du trafic téléphonique reçu par des lignes explorées dans un ordre déterminé*. Rev. Gén. Elect. *38*(1935): 20, pp. 601—656.

21. Langer, M.: *Studien über Aufgaben der Fernsprechtechnik*. Berlin & München 1936.

22. Palm, C.: *Calcul éxact de la perte dans les groupes de circuits échelonnés*. Ericsson Tech. *4*(1936): 3, pp. 41—71.

23. Lubberger, F.: *Beobachtungen, Vorschriften und Theorien der Schwankungen im Fernsprechverkehr*. In: Wahrscheinlichkeiten und Schwankungen, F. Lubberger, pp. 41—65, Berlin 1937.

24. Palm, C.: *Inhomogeneous Telephone Traffic in Full-Availability Groups*. Ericsson Tech. *5*(1937): 1, pp. 3—36.

25. Palm, C.: *Étude des délais d'attente*. Ericsson Tech. *5*(1937): 2, pp. 39—56.

26. Palm, C.: *Analysis of the Erlang Traffic Formulae for Busy-Signal Arrangements*. Ericsson Tech. *6*(1938): 4, pp. 39—58.

27. Kosten, L.: *On the Frequency Distribution of the Number of Discharges Counted by a Geiger-Müller Counter in Constant Interval*. Physica, *10*(1943): 9, pp. 749—756.

28. Palm, C.: *Intensitätsschwankungen im Fernsprechverkehr*. Ericsson Tech. 1943: 49, pp. 3—189.

29. Kruithof, J.: *Rotary Traffic Machine*. Electl. Commun. *23*(1946): 2, pp. 92—211.

30. Palm, C.: *Research on Telephone Traffic Carried by Full Availability Groups*. Tele 1957: 1, pp. 1—107. English ed. [In Swedish 1946.]

31. Vaulot, E.: *Délais d'attente des appels téléphoniques traités au hasard*. Comptes Rend. Acad. Sci. Paris 222 (1946): T 5, pp. 228—269.

32. Jacobæus, C.: *Blocking Computation in Link Systems*. Ericsson Rev. *24*(1947): 3, pp. 86—100.

33. Jensen, A.: *An Elucidation of A. K. Erlang's Statistical Works through the Theory of Stochastic Processes*. In: The Life and Works of A. K. Erlang by E. Brockmeyer, H. L. Hallström & A. Jensen, Copenhagen 1948: pp. 23—100.

34. Kosten, L.: *On the Measurement of Congestion Quantities by Means of Fictitious Traffic*. PTT-Bedrijf *2*(1948/49): 1, pp. 15—25.

35. Broadhurst, S. W. & Harmston, A. T.: *An Electronic Traffic Analyzer*. Post Office Elect. Engrs. J. *42*(1950): 4, pp. 181—187.

36. Jacobæus, C.: *A Study on Congestion in Link Systems*. Ericsson Tech. 1950:48, 66 pp.

37. Inose, H.: *An Artificial Call Generator Employing Random Noise Resistors*. J. Inst. Elect. Commun. Engrs. Japan *36*(1951): 4, pp. 177—181.

38. JENSEN, A.: *Calculations of Loss in Automatic Crossbar Exchanges.* [In Danish.] Teleteknik *3*(1952): pp. 176—200.

39. EKBERG, S.: *The Telephone Traffic Machine.* [In Swedish.] Tele 1953: 3, pp. 150—155. Ibid. Engl. ed. p. 51, 1953.

40. ELLDIN, A. & JACOBÆUS, C. & VON SYDOW, L.: *Traffic Measurements with Lamp Panel.* Ericsson Tech. *10*(1954): 1, pp. 107—187.

41. EKBERG, S.: *Telephone Traffic Research with the Aid of the Swedish Traffic Analyzer.* Tele 1955: 1, pp. 1—29. Engl. ed.

42. ELLDIN, A.: *Automatic Telephone Exchanges with Crossbar Switches. Switch Calculations. General Survey.* Book B 11265, 1955, 3rd ed. 1967, Book No. 18720.

43. NEOVIUS, G.: *Artificial Traffic Trials Using Digital Computers.* Ericsson Tech. *11*(1955): 2, 279—291.

44. WILKINSON, R. I.: *Theories for Toll Traffic Engineering in the USA.* Bell Syst. Tech. J. *35*(1956): 2, pp. 421—514.

45. COHEN, J. W.: *Basic Problems of Telephone Traffic Theory and the Influence of Repeated Calls.* Philips Telecommun. Rev. *18*(1957): 2, pp. 49—100.

46. ELLDIN, A.: *Further Studies on Gradings with Random Hunting.* Ericsson Tech. *12*(1957): 2, pp. 175—257.

47. CARLSSON, S.-G. & ELLDIN, A.: *Solving Equations of State in Telephone Traffic Theory with Digital Computers.* Ericsson Tech. *14*(1958): 2, pp. 221—244.

48. WALLSTRÖM, B.: *Artificial Traffic Trials on a Two-Stage Link Using a Digital Computer.* Ericsson Tech. *14*(1958): 2, pp. 259—289.

49. ELLDIN, A. & TÅNGE, I.: *Long-Time Observations of Telephone Traffic.* Tele 1960: 1, pp. 21—40. English ed.

50. SYSKI, R.: *Introduction to Congestion Theory in Telephone Systems.* Edinburgh & London, 1960.

51. ELLDIN, A.: *On the Dependence between the two Stages in a Link System.* Ericsson Tech. *17*(1961): 2, pp. 183—259.

52. WALLSTRÖM, B.: *Alternative Routing in a Two-Stage Link System, Congestion Theory and Simulated Traffic Studies.* Ericsson Tech. *17*(1961): 2, 261—285.

53. ELLDIN, A. & LIND, G.: *Elementary Telephone Traffic Theory.* (L M Ericsson Dhu 105A Ue) 2nd ed. Stockholm 1964.

54. RAPP, Y.: *Planning of Multi-Exchange Networks with Aid of a Computer. I. Locations and Boundaries of Exchanges in Multi-Exchange Areas.* Ericsson Rev. *39*(1962): 2, pp. 44—47. [Swedish, English, Spanish, German.]

55. RAPP, Y.: *Planning of Multi-Exchange Networks with Aid of a Computer. II. Inter-Exchange Traffic.* Ericsson Rev. *39*(1962): 2, pp. 47—50. [Swedish, English, Spanish, German.]

56. RAPP, Y.: *Planning of Multi-Exchange Networks with Aid of a Computer. III. Planning of Junction Circuits in Multi-Exchange Networks. Some Fundamental Principles.* Ericsson Rev. *39*(1962): 4, pp. 102—104.

57. RAPP, Y. & OLLUS, Y.: *Practical Application of the Planning of Multi-Exchange Networks with Aid of a Computer. Exchange Locations and Boundaries.* Ericsson Rev. *39*(1962): 4, pp. 105—111. [Swedish, English, Spanish, German.]

58. BJÖRKLUND, M. & ELLDIN, A.: *A Practical Method of Calculation for Certain Types of Complex Common Control Systems.* Ericsson Tech. *20*(1964): 1, pp. 3—75.

59. RAPP, Y.: *Planning of Junction Network in a Multi-Exchange Area. I. General Principles.* Ericsson Tech. *20*(1964): 1, pp. 77—130.

60. RAPP, Y.: *The General Plan for a Multi-Exchange Area.* Ericsson Tech. *20*(1964): 2, pp. 171—182.

61. WRIGHT, E. P. G.: *Conclusions and Recommendations of Working Party No. 5 of CCITT Study Group XIII,* Fourth Int. Teletraffic Congr. London 1964, Doc. No. 92.

62. RAPP, Y.: *Planning of Junction Network in a Multi-Exchange Area. II. Extensions of the Principles and Applications.* Ericsson Tech. *21*(1965): 2, pp. 187—240.

63. CCITT, Blue Book, Measurement of Traffic Flow Recommendation E 90, Volume II, pp. 193—194, or, Recommendation Q80, Volume VI, pp. 119—121. The International Telecommunication Union. Geneva, 1965 and 1966, resp.

64. ELLDIN, A. & WESTERBERG, S.: *Traffic Growth and Seasonal Variations in Subscriber Habits. Some Results from seven Years Daily Measurements on two Trunk Routes in Sweden.* Third Int. Symp. on Human Factors in Telephony, The Hague 1966, PTT Bedrijf *15*(1967): 1/2, pp. 175—196.

65. WALLSTRÖM, B.: *Congestion Studies in Telephone Systems with Overflow Facilities.* Ericsson Tech. *22*(1966): 3, pp. 187—351.

66. ELLDIN, A.: *Dimensioning for the Dynamic Properties of Telephone Traffic.* Fifth Int. Teletraffic Congr. New York 1967 and Ericsson Tech. *23*(1967): 3, pp. 305—344.

67. ELLDIN, A.: *Approach to the Theoretical Description of Repeated Call Attempts.* Fifth Int. Teletraffic Congr., New York 1967 and Ericsson Tech. *23*(1967): 3, pp. 345—407.

68. RAPP, Y.: *Planning of Junction Network in a Multi-Exchange Area. III. Optimum Types of Physical and Carrier Circuits.* Fifth Int. Teletraffic Congr., New York 1967.

69. SZYBICKI, E.: *Numerical Methods in the Use of Computers for Telephone Traffic Theory Applications.* Fifth Int. Teletraffic Congr. New York 1967.

ERICSSON News from

All Quarters of the World

(From left) Mr. Gunnar Svala, North Electric Company, and Nr. Kurt Katzeff, L M Ericsson, with their recently awarded IVA gold medals. (Right) Dr. Christian Jacobæus, Technical Director of L M Ericsson.

IVA–Gold Medals for All-Electronic L M Ericsson Exchanges

The Gold Medal of the Swedish Academy of Engineering Sciences (IVA) has been awarded to Mr. Gunnar Svala, North Electric Co., and Mr. Kurt Katzeff, L M Ericsson, for their work within the field of automatic electronic exchanges. The a-auards were the development and at the meeting of the Academy on October 24.

The particular grounds for the awards were the development and delivery of the electronic exchanges for the US Air Force System 412 L. These exchanges were probably the first all-electronic exchanges for permanent use. The contract was completed in 1963 and is still the largest for all-electronic exchanges. The exchanges have also operated extremely efficiently.

The basic development and design work on these exchanges was done at L M Ericsson in 1960–62. North Electric Co. was responsible for all production documentation and matching to American standards. They were also in charge of the production and installation.

The organization of the work on 412 L was throughout in the hands of Svala and Katzeff and now stands out as a pioneering technical achievement.

Earlier LME recipients of the IVA Gold Medal have been Knut Kåell (1940), Sune Överby (1945) and Nils Palmgren (1950).

IVA's Large Gold Medal was awarded in 1941 to Hemming Johansson, Director of LME, and in 1948 to Waldemar Borgquist, Chairman of the Board.

Eight Month Report of the Group's Activities

An interim report on the operations of the Ericsson Group during the first eight months of 1967 was presented in October.

As various measures affecting stated net income are introduced in the final annual accounts, a direct comparison cannot be made for a part of the year.

The statement does not include the results of the telephone operating companies in Argentina and Peru.

An extract from the interim report is printed below.

NEC-United Merger

The Boards of Directors of United Utilities, Inc. of Kansas City, Missouri, U.S.A. (United) and North Electric Company of Galion, Ohio, U.S.A. (NEC), have agreed to propose to their stockholders a merger of NEC into United. The proposal will be submitted at special meetings scheduled to be held in December.

Sales and Order

Group sales for the first eight months of 1967 amounted to $ 269,474,000 compared with $ 230,513,000 for the same period of 1966, an increase of 17 percent. Group sales were distributed as follows: 71 percent within Europe, 18 percent within Latin America and 11 percent in other markets.

Shipments to customers in Mexico and Brazil increased considerably.

Orders booked totalled $ 303 million, exceeding orders booked during the first eight months of 1966 by 14 percent.

The backlog of orders amounted to $ 523,270,000 at the end of August, the highest in Group history. One-third of the backlog will be shipped to customers in Latin America.

Earnings

Group income for the first eight months of the year was $ 32,486,000, amounting to 12.1 % of sales. For the same period in the preceding year the income was $ 31,711,000, 13.8 % of sales. Exchange differences, special adjustments and income taxes are not included in the report.

Hugo Lindberg in memoriam

Hugo Lindberg

Hugo Lindberg died on November 17, 1967.

He was born in Landskrona on December 3, 1896. After graduating from a technical college he continued at the Telecommunications Administration Training Centre and joined the Administration in 1914. In 1921 he transferred to the Board of Telecommunications, where he advanced to First Secretary. During his period at the Board of Telecommunications his services were put to use in many ways, among which as Secretary and Member of the Committee of Inquiry into Rural Automatic Telephony. He also wrote an extensive report on "Conversion of the Stockholm Telephone Network to Automatic Operation". His command of the Swedish language was also drawn upon in his collaboration with Dagens Nyheter from 1926–28 and Svenska Dagbladet from 1928–32.

The then Director General of the Telecommunications Administration, Helge Eriksson, who became President of L M Ericsson in 1942, persuaded Hugo Lindberg to join LME in 1944. It was undoubtedly an important decision for the then 48-year-old Lindberg to start out on an entirely new career in an industrial undertaking. He began as Assistant Director with responsibilities especially for personnel and internal questions, and was appointed a Director of the company in 1950. In 1954 he was appointed Executive Vice President and Deputy for the President and held that appointment until 1963. From 1963 until his death in 1967 he continued to work for L M Ericsson as consultant on questions of which he had particular experience. Hugo Lindberg's greatest achievements were in conjunction with L M Ericsson's great programme of expansion during the fifties and sixties. He showed a sure judgment and great wisdom in the acquisition of sites and properties which were an important integral part of the expansion programme. His great skill as negotiator has often been testified to by his colleagues in the company as well as by his opposite numbers at the negotiating table.

Behind a rather austere facade Hugo Lindberg concealed a genuinely human and very shrewd mind which always tried to coordinate duty with humanitarian considerations.

Hugo Lindberg's capacity was drawn upon by many Ericsson companies, of which he was a member of the board and in some cases chairman. He was also an active member of the board of certain outside companies such as Söderhamns Verkstäder, Svenska Maskinverken and Hansa Mälaren.

In his youth Lindberg was an outstanding athlete, especially in the decathlon. His athletic interests were later concentrated on tennis and he continued to be a skilled tennis-player even after pensionable age. His considerable organisational abilities were also drawn upon in tennis contexts. He was treasurer and chairman of the Executive Committee of the Swedish Tennis Association from 1946 to 1950.

Hugo Lindberg leaves an aching void both among his colleagues at the company and his large number of friends.

He leaves as closest relatives his wife Siri Lindberg, née Lundberg, his son Per Lindberg, Vice President of Asea, and grandchildren.

Sven T Åberg

UAC 1600 Premiere in Stockholm

A process computer system called UAC 1600 has been developed by the MI Division of L M Ericsson.

At the Seventh Exhibition of Instruments and Measuring Techniques held in Stockholm from 6 to 12 November this computer system was shown to the public for the first time.

The process computer system is based partly on technique and experience gained in conjunction with other data processing systems and was developed especially to meet the high requirements of reliability, flexibility and other factors needed in industrial applications.

Process control requires a real time computer with different priority levels for analysing data of different urgencies and quantities received from the process.

Process control units are an integral part of the system. The latter are

Cont. on page 172

L M Ericsson's new computer UAC 1600 for control of industrial processes had its premiere at the Exhibition of Instruments and Measuring Techniques in Stockholm in November 1967. The photograph shows the part of L M Ericsson's exhibit comprising the process computer.

Gunnar Sträng, Swedish Minister of Finance, Visits Ericsson do Brasil...

In conjunction with the meeting arranged by the International Monetary Fund in Brazil at the end of September this year Mr. Gunnar Sträng, Swedish Minister of Finance, and his wife visited L M Ericsson's subsidiary company Ericsson do Brasil (EDB) at São José dos Campos outside the town of São Paulo.

The invitation came from the Swedish-Brazilian Chamber of Commerce, which suggested the visit to EDB owing to the company's predominant position among Swedish industrial undertakings in Brazil.

Mr. Sträng arrived at EDB in São José dos Campos on October 3 by helicopter loaned from the Governor of the Province of São Paulo. After addresses of welcome he was shown round the factory — in the photograph he is seen with (left) Ragnar Hellberg, President of EDB, and (right) Robert Bruun, Factory Manager.

EDB's great expansion in the past years has led to an increasing need for space. Building work is therefore proceeding apace. By the beginning of 1968 the factory premises will have been doubled through the addition of a 15,000 m^2 production building, which Mr. Sträng was also able to have a look at.

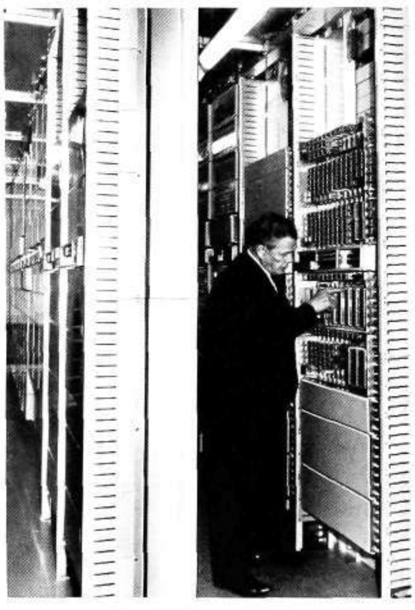
A round-table conference, at which Mr. Sträng showed a special interest in taxation questions, inflation and wages, was attended by Mr. Erik Svedelius, Swedish Consul General in Brazil, Mr. Gunnar Westerberg, Swedish Minister in Rio, and Mr. Arne Hultén, Chairman of the Swedish-Brazilian Chamber of Commerce.

...and Gunnar Lange, Minister of Trade, the L M Ericsson Exhibit at Brno

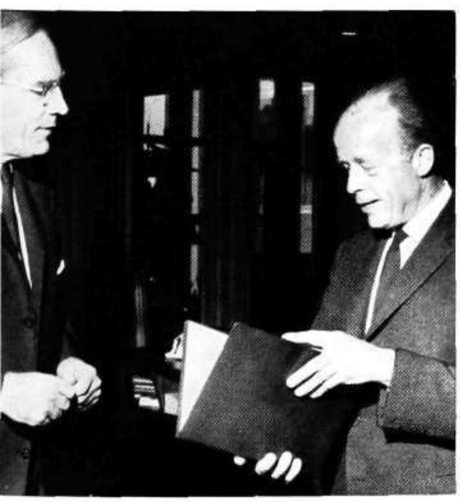
The Ericsson Group was represented for the first time at the Brno Fair in Czechoslovakia, the largest machinery fair in the world, which started in 1959. There were 41 Swedish exhibitors. The Fair lasted from 10 to 19 September and may be regarded as a gateway to the majority of the East European markets. Among the products exhibited by the Group may be mentioned Dirivox and Dialog telephones, Tyfon alarm system and a traffic route tester. The photograph shows Mr. Gunnar Lange, Minister of Trade, being welcomed to the LME stand by Mr. Nils Kallerman, L M Ericsson.

*

Mr. Bjarni Forberg, Iceland PTT, is seen inspecting the new ARF exchange at Grensás, Reykjavik, which was opened on April 1, and was extended to 4000 lines on September 1 this year.



Mr. Erskine Childers, Ireland's Minister of Communications, was on an official visit to Sweden cum holiday from 11 to 30 September. During his tour of the country Mr. Childers visited the Visby and Östersund factories of L M Ericsson. On September 27 he was at the Head Office. Mr. Björn Lundvall, President of LME, presented Mr. Childers with the statutes for a grant to be awarded to an Irish engineer.



*

Ten tons of equipment for the first public crossbar exchange, type ARF 10, of 2000 lines, ordered by GPO, Zambia, in March this year, was shipped by charter aircraft to Lusaka, where it is to be installed. The contract comprises altogether 5000 lines to be installed at two exchanges and is the first order received by L M Ericsson from Zambia. One of the exchanges will be opened at the beginning of 1968.

The photograph shows the equipment being unloaded at the international airport at Lusaka.

Gunnar Beckman in memoriam

Gunnar Beckman

Gunnar Beckman died on August 22, 1967.

He was an unusual man in many respects; he also had an unusual career, mostly within the telephony field. He graduated from the Örebro Technical College in 1924 and then took a course at the Telecommunications Administration. After a brief period with the Administration he went out to Mexico in 1929 and was taken on by the Traffic Division of the Mexican Telefon AB L M Ericsson. Within a short time he advanced to the managership of this important division. In 1930 he became Assistant Director and at the age of 31 head of Empresa de Teléfonos Ericsson. The company prospered under his management and in 1947 was reformed into Teléfonos de Mexico. Beckman realized at an early stage the untenable situation created in Mexico by two competing telephone companies, one owned by L M Ericsson, whereas ITT (Cia Mexicana de Teléfonos) held the majority interest in the other; L M Ericsson also held a minority interest in the latter company. The merging of the Ericsson and ITT companies, for which Beckman worked hard, took place in 1950 with Beckman as president of the enlarged Teléfonos de Mexico.

To be the head of a telephone company in Mexico in which the chief shareholders were two so ardent competitors as Ericsson and ITT was, to be sure, no easy task, but Beckman, with his shrewdness and powers of leadership, was undoubtedly the man to carry if off.

The final solution to the organization of Mexico's telecommunications came at the end of the fifties, largely as a result of Beckman's energetic efforts. L M Ericsson and ITT then sold their holdings in the joint telephone company to a group of Mexican financiers. Gunnar Beckman remained the head of the company. If it had earlier been a difficult task to lead the company through all the Mexican labyrinths, it became even more difficult with a fully Mexican-owned company, of which the main suppliers were still L M Ericsson and ITT.

During the postwar period the company had very great problems, both in financing of the quickly growing business and in negotiations with the trades unions, which were especially difficult during those times of social adjustment. Beckman's greatest triumphs were perhaps in the handling of these negotiations, and there were numerous complicated situations in which his coolness, sureness and negotiating skill warded off apparently inevitable conflicts.

Even if his life's work lay within the telephony field, Gunnar Beckman's multifarious achievements for the benefit of other Swedish companies, both as advisor and as board member, should also be mentioned. Swedes who came to Mexico never needed to apply in vain to Gunnar Beckman for advice and help. He was also Swedish Consul General from 1950 to 1965.

Gunnar Beckman and his wife Margit, née Ljungqvist, were a very hospitable couple – in recent years at their hacienda San Gaspar outside Cuernavaca. They also shared an ardent interest in horse-racing and Gunnar Beckman was an outstanding rider of the audacious kind which was in keeping with his temperament. As he had given nearly forty years of his life to work in Mexico, it was a logical consequence that he became a Mexican citizen about fifteen years ago.

Peace to his memory!

LM Ericsson Exchanges in World Telecommunications Network

An exchange for intercontinental and international telecommunications traffic was opened in July at Kuala Lumpur, capital of Malaysia. The exchange is a link in the development of an all-automatic world telephone network.

Malaysia is in the news in another way as well. The agreement concluded between L M Ericsson and the Malaysian Administration earlier this year, comprising telephone equipment for about 65 million kronor, has now resulted in the first order – an automatic exchange for the local network. It is to be installed in the centre of Kuala Lumpur.

Merger between AB Svenska Elektronrör and AB Rifa

To reinforce the electric components section of the Ericsson Group the Group Management has decided to combine development, manufacture and sale of capacitors, semiconductors, electron and cold cathode tubes, reed switches and similar products within a joint company. AB Svenska Elektronrör is to be merged with AB Rifa for this purpose as from January 1968. The company will operate under the name of AB Rifa.

The President of the new company will be Mr. Torsten Skytt. Mr. Svante Granler will be on the management with the responsibility for coordinating and dealing with questions concerning development, production and sale of electron tubes, reed switches and semiconductors. Mr. Granler will also act as local manager at the company's plant at Bollmora.

UAC 1600...

Cont. from p. 170

designed as modules, so that a unit can be easily constructed to suit each application.

Apart from the delivery of all hardware for an installation L M Ericsson can offer all the required system and programming work. The need for computer-controlled process regulating systems is expected to grow rapidly, especially within the paper and pulp and iron and steel industries. Other areas of interest are ships, hospitals and schools.

Representatives

Please turn page for list of associated and co-operating enterprises and technical offices

• EUROPE •

Austria
Telecom Handelsgesellschaft m. b. H., *1140 Wien*, Schanzstrasse 33, tel: 92 26 21, tgm: teleric, telex: 11638, "11638 TELCOM A"

Belgium
Allumage Lumière S.A. *Bruxelles 7*, 128-130, chaussée de Mons, tel: 229870, tgm: allumalux, telex: 21582, "ALLUMALUX BRU"

Greece
Angelos Cotzias *Athens*, 18, Odas Omirou, tel. 626-031, tgm: cotziasan, telex: 252, "COTZIASAN ATHEN"

Iceland
Johan Rönning H/F *Reykjavik*, P.O.B. 883, tel: 10632, tgm: rönning

Spain
TRANSA Transacciones Canarias S.A., *Las Palmas de Gran Canarias*, Tomas Morales 38, tel: 21 85 08, tgm: transa, telex: 824, "MAVAC LPE"

Yugoslavia
Merkantile Inozemna zastupstva *Zagreb* pošt pretinac 23, tel: 36941, tgm: merkantile, telex: 21139, "21139 YU MERTIL"

• ASIA •

Burma
Myanma Export Import Corp., Import Division (Electrical Stores) *Rangoon*, P.O.B. 403, tel: 146 18, tgm: myanimport

Cambodia
Comin Khmere S.A. *Phnom-Penh*, P.O.B. 625, tel: 23334, tgm: comink

Cyprus
Zeno D. Pierides *Larnaca*, P.O.B. 25, tel: 2033, tgm: pierides

S.A. Petrides & Sons Ltd. *Nicosia*, P. O. B. 1122, tel. 2788, tgm: armature

Hong Kong och Macao
Swedish Trading Co. Ltd. *Hong Kong*, P. O. B. 108, tel: 23 10 91, tgm: swedetrade

Iran
Irano Swedish Company AB, *Teheran*, Khiabane Sevom Esfand 29, tel: 310 66, tgm: iranoswede

Iraq
Usam Sharif Company W.L.L. *Baghdad*, P.O.B. 492, tel: 87031, tgm: alhamra

Japan
Gadelius & Co. Ltd. *Tokyo C*, P.O.B. 1284, tel. 403-2141, tgm: goticus, telex: 2422075, "GOTICUS TOK"

Jordan
The Arab Trading & Development Co., Ltd. *Amman.*, P.O.B. 1, tel: 25981, tgm: aradeve

Korea
Gadelius & Co. Ltd. *Seoul*, I.P.O. Box 1421, tel: 22-9866, tgm: gadeliusco

Kuwait
Morad Yousuf Behbehani *Kuwait, State of Kuwait*, P.O.B. 146, tel: 32251, tgm: barakat

Lebanon
Swedish Levant Trading (Elié B. Hélou) *Beyrouth*, P.O.B. 931, tel: 231624, tgm: skefko

Malaysia and Brunei
Swedish Trading Co. (M) Ltd. *Kuala Lumpur*, P.O.B. 2298, tel: 25316, tgm: swedetrade

Pakistan
TELEC Electronics & Machinery Ltd. *Karachi 3*, 415, Mahboob Chambers, Victoria Road, tel: 52648, tgm: elco

Philippines
U.S.I. Philippines Inc. *Manila*, P.O.B. 125, tel: 88 93 51, tgm: usiphil, telex: 722344, "USIPHIL 7222144"

Saudi Arabia
Engineering Projects & Products Co. *Riyadh*, P. O. B. 987, tel: Murraba 264, tgm: eppcol

Singapore
Swedish Trading Co. (M) Ltd. *Singapore 1*, P. O. B. 2791, tel: 943 62, tgm: swedetrade

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

Trucial States, Muscat Oman
DOLPHIN Trading & Contracting Establisament, *Dubai, Trucial States*, P. O. B. 1566, tel: 0639, tgm: dolphin

Vietnam
Vo Tuyen Dien-Thoai Viet-Nam, *Saigon*, P. O. B. 1049, tel: 22660, tgm: telerad

• AFRICA •

Congo
I.P.T.C. (Congo) Ltd. *Kinshasa 1*, P. O. B. 8922, tel: 5345, tgm: induexpan, telex: 327, "IPTC KIN"

Ethiopia
Mosvold Company (Ethiopia) Ltd. *Addis Ababa*, P.O.B. 1371, tel: 14567, tgm: mosvold

Ghana
R.T. Briscoe Ltd, *Accra*, P.O.B. 1635, tel: 669 03, tgm: Briscoe, telex: 295, "BRISCOE ACCRA"

Kenya, Tanzania, Uganda
Transcandia Ltd. Telecommunications Division *Nairobi, Kenya*, P.O.B. 5933, tel: 27103, tgm: transcanda

Liberia
Post & Communications Telephone Exchange, *Monrovia*, Corner Ashmun & Lynch Streets, tel: 22222, tgm: radiolibe

Libya
ADECO African Development & Engineering Co *Tripoli*, P.O.B. 2390, tel: 33906, tgm: adeco

Mauritius
Mauritius Trading Co. Ltd. *Port Louis*, P.O.B. 201, tgm: agentou

Mozambique
J. Martins Marques & Ca. Lda. *Lourenço Marques*, P.O.B. 2409, tel: 5953, tgm: marquesco

Nigeria
I.P.T.C. (West Africa) Ltd. *Lagos*, P.O.B. 2037, tel: 26531, tgm: consult, telex: 235, "SHELLBP LAGOS"

Sudan
Contomichalos, Sons & Co. Ltd. Engineering & Agencies Dept., *Khartoum*, P.O.B. 866, tel: 77 695, tgm: suconta, telex: 251, "CONTOLOS"

South Africa, South-West Africa
Dryden Communications (Pty.) Ltd. *Johannesburg*, P.O.B. 2440, tel: 838-5454, tgm: qualsteels

Tunisia
Ateliers Mécaniques du SAHEL, *Sousse*, Route de Monastir/Djemmal, tel: 21.011, tgm: amesa

• AMERICA •

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

Bolivia
Johansson & Cía, S. A. *La Paz*, Casilla 678, tel: 25 923, tgm: johansson, telex: 5211, "BOOTH LPZ 5211"

Costa Rica
Tropical Commission Co. Ltd. *San José*, Apartado 661, tel.: 22 55 11, tgm: troco

Dominican Republic
Garcia & Gautier, C. por A. *Santo Domingo*, Apartado 771, tel: 3445, tgm: gartier

Guatemala
Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: 62258, tgm: nilspira

Guiana
General Supplies Agency *Georgetown*, P.O.B. 375, tgm: benwlks

Honduras
Quinchón Leon y Cia *Tegucigalpa*, Apartado 85, tel: 2-5171, tgm: quinchon

Jamaica and Brit. Honduras
Morris E. Parkin *Kingston*, P.O.B. 354, tel: 24077, tgm: morrispark

Netherlands Antilles
S.E.L. Maduro & Sons, Inc. *Willemstad, Curaçao* P.O.B. 304, tel: 11200, tgm: madurosons

Nicaragua
Sonitel Centroamerica S.A. *Managua*, Apartado 1271, tel: 4476, tgm: sonitel

Panama
Sonitel, S.A. *Panama*, R.P., Apartado 4349, tel: 5-3640, tgm: sonitel, telex: 134, "PA 134 SONITEL"

Paraguay
S. A. Comercial e Industrial H. Petersen *Asunción*, Casilla 592, tel: 9868, tgm: pargtrade

El Salvador
Dada-Dada & Co. *San Salvador* Apartado 274, tel: 21 66 66, tgm: dada

Surinam
C. Kersten & Co. N. V. *Paramaribo*, P.O.B. 1808, tel: 4444, tgm: kersten

Trinidad, W.I.
Leon J. Aché Ltd. *Port-of-Spain*, 100 Frederick Street, tel: 32357, tgm: achegram

USA
State Labs. Inc. *New York, N.Y 10003*, 215 Park Avenue South, tel: (212) 677-8400, tgm: statelabs, telex: 8676996, "ROMCO PGH" (For electron tubes only)

• AUSTRALIA & OCEANIA •

New Zealand
ASEA Electric (NZ) Ltd. *Wellington C. 1.*, P.O.B. 3239, tel: 70-614 tgm: asea, telex: 3431, "ASEAWELL NZ 3431"

The Ericsson Group

Associated and co-operating enterprises and technical offices

Please turn page for list of further sales offices

• EUROPE •

Denmark

L M Ericsson A/S *København F*, Finsensvej 78, tel: Fa 6868, tgm: ericsson, telex: 9020 "ERICSSON KH"

Telefon Fabrik Automatic A/S *Søborg*, Telefonvej 6, tel: 69 51 88, tgm: automatic, telex: 5264, AUTOMATIC KH"

Dansk Signal Industri A/S *København F*, Finsensvej 78, tel: Fa 6767, tgm: signaler

A/S Tele-Center *2600 Glostrup*, Sandager 8, tel: 96 18 88, tgm: telekommun

Finland

O/Y L M Ericsson A/B *Helsingfors*, P. O. B. 13018, tel: A 8282 tgm: ericssons, telex: 12546, "ERICSSON HKI"

France

Société Française des Téléphones Ericsson *F-92-Colombes*, 36, Boulevard de la Finlande, tel: Paris (1) 242 35 00, tgm: ericsson colombes, telex: 62179, "ERICSSON CLOMB" *F-75-Paris (17e)*, 147, rue de Courcelles, tel: Paris (1) 227 9530, tgm: eric paris

Centrum Electronic S. A. *Paris 17e* 32, Rue Legendre, tel: 267 30.10, tgm: centrumfrance

Great Britain

Swedish Ericsson Company Ltd. *Twickenham Middx*, Regal House, London Road, tel: POPesgrove 8151, tgm: teleric

Production Control (Ericsson) Ltd. *Twickenham Middx*, Regal House, London Road, tel: POPesgrove 8151, tgm: teleric

Centrum Electronics Ltd. *London S.W.I.*, tel: SLOane 0451, tgm: celefon telex: 2613, "CELEFON LDN"
Centrum Rentals Ltd. *London S. W. I.*, Terminal House, Grosvenor Gardens, tel: Sloane 0451, tgm: celefon, telex: 2613, "CELEFON LDN"

Ireland

L M Ericsson Ltd. *Dublin 2*, 32, Upper Mount Street, tel: 61931, tgm: ericsson, telex: 5310, "ERICSSON DUBLIN"

Italy

FATME, Soc. per Az. 00100 *Roma*, C. P. 4025 Appio, tel: 4694, tgm: fatme, telex: 61327, "61327 FATME"

SETEMER, Soc. per Az. *Roma*, Via G. Paisiello 43, tel: 868.854, tgm: setemer

SIELTE, Soc. per Az. *00100 Roma*, C. P. 5100, tel: 577 8041, tgm: sielte

Netherlands

Ericsson Telefoonmaatschappij, N.V. *Rijen (N.Br.)*, tel: 01692-3131, tgm: erictel, telex: 54114, "ERICTEL RIJEN"

Voorburg-Den Haag, P.O.B. 3060, tel: 81 45 01, tgm: erictel-haag, telex: 31109, "ERICTEL DENHAAG"

Norway

A/S Elektrisk Bureau *Oslo 3*, P.B. 5055, tel: Centralbord 46 18 20, tgm: elektriken, telex: 1723, "ELEKTRIKEN O"

A/S Industrikontroll *Oslo 6*, Grenseveijen 86/88, tel: Centralbord 68 34 64 tgm: indtroll

A/S Norsk Kabelfabrik *Drammen*, P.B. 500, tel: 83 76 50, tgm: kabel

A/S Norsk Signalindustri *Oslo 3*, P.B. 5055, tel: 46 18 20, tgm: signalindustri

A/S Telesystemer *Oslo 6*, Plogveien 3 B, tel: 68 62 95, tgm: gyllingsystem

Portugal

Sociedade Ericsson de Portugal Lda. *Lisboa*, 7, Rua Filipe Folque, tel: 571 93, tgm: ericsson

Spain

Cia Española Ericsson, S. A. *Madrid 13*, Torre de Madrid, Plaza de España tel: 241 14 00, tgm: ericsson, telex: 27369. "7369 ELEME E"

Sweden

Telefonaktiebolaget L M Ericsson *Stockholm 32*, tel: 08/19 00 00, tgm: telefonbolaget, telex: 19910, "19910 ERICTEL S"

Casa Konsult AB *Älvsjö*, Huddingevägen 417—19, tel: 08/47 25 65, tgm: casakonsult

AB Ermi *Karlskrona 1*, tel: 0455/230 10, tgm: ermibolag, telex: 4819, "ERMI KKR"

AB Rifa *Bromma 11*, tel: 08/26 26 10, tgm: elrifa, telex: 10308, "ELRIFA STH"

Instruktionsteknik AB, *Stockholm 44*, tel: 08/68 08 70, tgm: instruktec

L M Ericsson Data AB *Solna*, tel: 08/83 07 00, tgm: ericdata, telex: 10 93, "ERICDATA STH"

L M Ericsson Telemateriel AB, *Stockholm-Tyresö 1*, Fack, tel: 08/712 00 00 tgm: ellem, telex: 1275, "1275 TELERGA S"

Sieverts Kabelverk AB *Sundbyberg*, tel: 08/28 28 60, tgm: sievertsfabrik, *telex: 1676*, "SIEVKAB STH"

Svenska Radioaktiebolaget *Stockholm 12*, tel: 08/22 31 40, tgm: svenskradio, telex: 10094, "SVENSKRADIO STH"

Switzerland

Ericsson Telephone Sales Corp. AB, Stockholm, Zweigniederlassung Zürich *8032 Zurich*, Postfach, tel: 325184, tgm: telericsson, telex: 52669, "TELERICSSON ZCH"

Turkey

Ericsson Türk Ticaret Ltd. Sirketi *Ankara*, Rumeli Han, Ziya Gökalp Cda., *tel: 123170, tgm: ellem*

Istanbul, Istanbul Bürosu, Liman Han, Kat 5, No. 75, Bahçekapi, tel: 22 81 02 tgm: ellemist

Izmir, Izmir Bürosu, Kisilkaya Han, Kat 3. No 13, Halit Ziya Bulvari, tel: 378 32, tgm: ellemir

West Germany

Deutsche Ericsson G.m.b.H. Telematerial, *4 Düsselorf-Roth*, Postfach 136, tel: (0211) 63 30 31, tgm: erictel, telex: 8586871, "8586871 ERIC D"

Centrum Electronic Handels-GmbH, *3 Hannover*, Dornierstrasse 10, tel: 63 10 18, tgm: centronic, telex: 922913, "922913 CELEC D"

• ASIA •

Hong Kong

Telefonaktiebolaget L M Ericsson Technical office *Hong Kong*, P. O. B. 134781 tel: 23 10 91, tgm: elleme

India

Ericsson Telephone Sales Corporation AB *Calcutta 22*, P.O.B. 2324, tel: 45 44 94, tgm: inderic

New Delhi 16, L25, South Extension *Part II, tel: 626505 tgm: inderic*

Indonesia

Ericsson Telephone Sales Corporation AB *Bandung*, Djalan Ir. H. Djuanda 151—153, tel: 8294, tgm: javeric

Djakarta, Djalan Gunung Sahari 26, tel: OG 48531, tgm: javeric

Iraq

Telefonaktiebolaget L M Ericsson, Technical office *Baghdad*, P.O.B. 493, tel: 914 54, tgm: ellemco

Kuwait

Telefonaktiebolaget L M Ericsson, Technical office, *Kuwait, State of Kuwait*, P. O. B. 5979, tel: 26 855, tgm: erictel

Lebanon

Telefonaktiebolaget LM Ericsson, *Technical office Beyrouth*, *Rue du* Parlement, Immeuble Bisharat, tel: 252627, tgm: ellem, telex: 876, "ELLEM BERYT"

Thailand

Ericsson Telephone Corp. Far East AB *Bangkok*, P.O.B. 824, tel: 58041-,43 *tgm: ericsson*

• AFRICA •

Egypt (UAR)

Telefonaktiebolaget LM Ericsson, Technical office Egypt Branch *Cairo*, P.O.B. 2084, tel: 46581, tgm: elleme

Ethiopia

Telefonaktiebolaget L M Ericsson, Technical office, *Addis Ababa*, P. O. B. 3366, tel: 492 60, tgm: ericsson

Kenya

Telefonaktiebolaget L M Ericsson, Technical office, *Nairobi*, P.O.B. 9063, tel. 271 06, tgm: ellem

Morocco

Société Marocaine des Téléphones Ericsson *Casablanca*, 38, rue Mohamed Sedki, tel: 788-75, tgm: ericsson

Rhodesia, Botswana and Malawi

Ericsson Telephone Sales Corporation AB, *Salisbury, Rhodesia*, P.O.B. 2891, tel: 25 737, tgm: ericofon

Tunisia

Telefonaktiebolaget LM Ericsson, Technical office, *Tunis*, Boite Postale 780, tel: 240520, tgm: ericsson

Zambia

Ericsson Telephone Sales Corporation AB *Ndola*, P. O. B. 2256, tel: 3885, tgm: ericofon

• AMERICA •

Argentine

Cia Ericsson S.A.C.I. *Buenos Aires Casilla de Correo 3550, tel: 332071*, tgm: ericsson, telex: 0122196, "CATEL BA"

Cia Argentina de Teléfonos S. A. *Buenos Aires*, Belgrano 894, tel: 332076, tgm: catel, telex: 0122196, "CATEL BA"

Cia Entrerriana de Teléfonos S. A. *Buenos Aires*, Belgrano 894, tel: 332076, tgm: catel, telex: 0122196, "CATEL BA"

Industrias Eléctricas de Quilmes S. A. *Quilmes FNGR*, 12 de Octubre 1090, tel: 203-2775, tgm: indelqui-buenosaires, telex: 0122196, "CATEL BA"

Brazil

Ericsson do Brazil Comércio e Indústria S. A. *Rio de Janeiro* C. P. 3601-ZC-00, tel: 43-0990, tgm: ericsson, telex: 310, "ERICSSON RIO"

Canada

L M Ericsson Ltd. *Montreal 9. P.Q.*, 2300 Laurentian Boulevard City of St. Laurent, tel: 331-3310, tgm: caneric, telex: 1-2307

Gylling (Canada) Ltd. *Montreal*, 1203, IBM Building, 5, Place Ville Marie

Chile

Cia Ericsson de Chile S. A. *Santiago*, Casilla 10143, tel: 82555, tgm: ericsson

Colombia

Cia Ericsson Ltda, *Bogotá*, Apartado Aéreo 4052, tel: 411100, tgm: ericsson, telex: 044507, "ERICSSON BOG"

Costa Rica

Telefonaktiebolaget L M Ericsson, Technical office *San José*, Apartado L. M. E., tel: 21 14 66, tgm: ericsson

Ecuador

Teléfonos Ericsson C. A. *Quito*, Casilla 2138, tel: 16100, tgm: ericsson
Guayaquil, Casilla 376, tel: 16892 tgm: ericsson

Mexico

Teléfonos Ericsson S. A. *Mexico D. F.*, Apartado 9958, tel: 464640, tgm: coeric, telex: 0177485, "ERICSSON MEX"

Latinoamericana de Cables S.A. de C.V. *Mexico 12 D.F.*, Apartado 25737, tel. 49 36 50, tgm: latincasa

Teleindustria, S. A. de C.V. *Mexico I, D.F.* apartado 1062, tel: 464640, tgm: ericsson, telex: 0177485, "ERICSSON MEX"

Telemontaje, S. A. de C. V. *Mexico 1, D.F., Apartado Postal 1062, tel:* 46 78 11, tgm: ericssonmexicodf, telex: 0177485, "ERICSSON MEX"

Peru

Cia Ericsson S. A. *Lima*, Apartado 2982, tel: 34941, tgm: ericsson, telex: 3540202, "ERICSSON 3540202"

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

El Salvador

Telefonaktiebolaget LM Ericsson, Technical office *San Salvador*, Apartado 188, tel: 21-7640, tgm: ericsson

Uruguay

Cia Ericsson S. A. *Montevideo*, Casilla de Correo 575, tel: 92611, tgm: ericsson

USA

The Ericsson Corporation *New York, N.Y. 10017*, 100 Park Avenue, tel: 68 54 030, tgm: erictel, telex: 620484, "ERICTEC 620484"

L M Ericsson Centrum Inc. *New York, N. Y. 10016*, 16, East 40 Street, tel: 6791001, tgm: erictel, telex: 620149

North Electric Co. *Galion, Ohio 44833*, P.O.B. 688, tel: (419-)468—2420, tgm: northphone-galion-ohio, telex: 987-428, "NORTELEC GAON"

Venezuela

Cia Anónima Ericsson *Caracas*, Apartado 3548, tel: 543121, tgm: ericsson telex: 734, 734, "ERICSSON VE"

• AUSTRALIA & OCEANIA •

Australia

L M Ericsson Pty. Ltd. *Broadmeadows, Victoria*, P.O.B. 41, tel: 309 2244 tgm: ericmel, telex: AA 30555

Rushcutters Bay N.S.W., 134 Barcom Avenue, tel: 31 09 41, tgm: ericsyd

Teleric Pty. Ltd *Broadmeadows, Victoria* P.O.B. 41, tel: 309 2244, tgm: teleric, telex: AA 30555

Rushcutters Bay N.S.W., 134 Bacrom Avenue, tel: 31 09 41, tgm: teleric

ESSELTE AB. STHLM 67