COMMONWEALTH OF AUSTRALIA

COMMUNITY TELEPHONE PLAN FOR AUSTRALIA 1960

COMMONWEALTH OF AUSTRALIA

COMMUNITY TELEPHONE PLAN
for
AUSTRALIA
1960

WITH THE COMPLIMENTS OF

THE DIRECTOR-GENERAL, POSTS AND TELEGRAPHS.
TREASURY GARDENS, MELBOURNE. C.2.

COMMUNITY TELEPHONE PLAN

FOR

AUSTRALIA

1960.

TABLE OF CONTENTS

March, 1960.

POST OFFICE HEADQUARTERS,
JANUARY, 1960.

FOREWORD

The Postmaster-General, the Hon. C. W. Davidson, recently announced that the Government has approved a new telephone policy framed on a long term basis to meet the expansion of Australia and to confer progressively the benefits of new and improved techniques and modern equipment on users of the telephone service.

This publication outlines the new telephone policy and describes the plans which have been evolved for its application. Endorsement of the policy and development of the plan represent a milestone in the history of Australia's telecommunication services.

The plan itself reflects the detailed investigations to which many officers at Headquarters and in the State Administrations have contributed. These investigations were led by a special planning group - The Automatic Network and Switching Objectives (A.N.S.O.) Committee - which was established at Headquarters for the purpose. The Committee acted in association with the controlling officers and staff of the Headquarters Administration. New South Wales and Victoria were represented throughout by State A.N.S.O. Committees. Other States provided special representation as required.

From the established international organisations, and with the collaboration of other telephone administrations, much information was placed at the disposal of the Post Office. The telephone manufacturing industry, through its world-wide connections, conducted studies into major sections of Australian telephone development problems and supplied valuable technical information on modern available switching systems and others being developed. Personal discussion with the industry was facilitated by visits to Australia by representatives of leading overseas manufacturers and visits overseas by Australian Post Office people.

The value of the information so obtained and the contribution of officers throughout the Australian Post Office to the development of the Community Telephone Plan are gratefully acknowledged.

(M. R. C. Stradwick)
Director-General

INDEX

SECTION I - INTRODUCTION

SECTION II - THE NUMBERING PLAN

SECTION III - THE CALL CHARGING SYSTEM

SECTION IV - THE SWITCHING PLAN

SECTION V - MAJOR PHASES OF IMPLEMENTATION

COMMUNITY TELEPHONE PLAN

SECTION 1 - INTRODUCTION.

1. NEW TELEPHONE POLICY.

1.1 A new telephone policy for Australia has been announced by the Postmaster-General, the Hon. C. W. Davidson. The new policy establishes objectives and principles for the long term development of the telephone system towards a fully automatic service in which subscribers will be able to dial their own calls to any other subscriber in Australia.

The new policy was described in a White Paper entitled "Progress - Policy - Plans" issued in August, 1959. Quoting from it, the aims are to :-

"Reduce progressively the number of applicants awaiting connection.

Increase progressively the number of trunk channels on both short and long routes.

Increase the number of automatic telephones.

Provide, eventually, full-time service for all subscribers.

Extend the areas in which local calls may be made.

Enable telephone users to dial any other subscriber within Australia.

Improve the standard of transmission over long channels, particularly in outback areas."

In order to achieve the long term objective of a fully automatic service, a national telephone plan which will guide the course of development has been prepared. One of the first steps necessary is to adopt a rationalised charging system. The introduction of such a tariff structure in two stages - on the 1st October, 1959, and the 1st May, 1960 - was announced at the same time as the new telephone policy.

2. AUSTRALIAN BACKGROUND.

2.1 The importance of telecommunications in this country has been widely recognised and much has been done to ensure the adoption of modern forms of communication and in providing efficient services in all settled areas of the Commonwealth.

Australia's growth has been rapid and since 1949 the rate of population increase has been augmented by immigration. Concurrently with the expansion of Australia's population, the development of primary and secondary industries has resulted in heavy and continuing demands for telephone service.

2.2 Characteristic Features. The combination of advanced telephone development, concentrations of population and comparatively large areas is a special feature of Australian conditions. They are basic factors in national telephone planning on which other factors also have some bearing in predicting population trends and telephone developments.

Details of Australian conditions are given below and in chart form in Figures 1-8 attached:-

Geographical. Australia has a surface area of just under three million square miles. The continent is approximately 2,500 miles from east to west and 2,000 miles from north to south.

Population. Australia's population is approximately 10 millions. Despite the great size of the continent 54 per cent. of the population live in the six capital cities with 38 per cent. in and around the metropolitan areas of Sydney and Melbourne. The capital cities are separated by distances ranging from 400 to almost 3,000 miles.

The population growth and distribution are shown in Figures 1 and 2.

Telephone Development. Australia ranks high in world telephone development. This is shown by the comparison of international statistics in Figure 5.

Advanced economic development and the distance separating centres of population have placed particular accent on communications of all forms. Figures 3, 4, 6 and 7 show the telephone development and traffic statistics for Australia since 1938.

The traffic distribution in mileage categories, shown in Figure 8, demonstrates the community development, around each centre of population, which is a basic factor in determining the form of the national telephone plan.

Predicted National Development. Continuance of Australia's prosperity at reasonable levels may be anticipated. Doubling of the present number of telephone subscribers over the next 12 years and growth to 15 million telephone services in a population of 33 million people at the year 2010 A.D. were allowed for in the development of the plan.

2.3 The Telephone System. Up-to-date transmission and switching practices have been applied in the development of the telecommunications services over the years and telephone policy has been varied as required to enable advantages to be taken of technical progress. In the interests of efficiency and operating economy, mechanisation has also advanced since the first automatic exchange was installed in 1912, until today in a system containing more than two million telephones, approximately 75% are automatic. Automatic switching techniques have been applied to the trunk line system as long distance dialling became possible and the trunk service is highly mechanised under operator control. Trial installations of subscriber trunk dialling facilities are now in service.

The growth and expansion of Capital City networks, beyond the present limits of local service areas and the development of regional areas of Australia with a high degree of community of interest, centred upon the large provincial towns, have led to rising costs of providing and operating the telephone service. This situation presents conditions in which further mechanisation is essential. For economic operation of the telephone service in the future, it is desirable to have subscribers dial their own calls, both local and trunk, to an ever increasing extent. It has been conclusively demonstrated that it is more efficient and economical to spend increasing proportions of available capital funds on automatic equipment and on additional trunk lines than on more manual handling facilities.

3. SUMMARY OF THE COMMUNITY TELEPHONE PLAN.

3.1 The community telephone plan becomes, then, the basic specification for the long term development of the Australian Telephone network. It translates into operational form the policy of extending telephone mechanisation, ultimately for a nation-wide subscriber operated service. By ensuring the soundness of the long term financial investment, taking into account both capital and annual charges, efficient telephone service is expected to be progressively available at lowest possible cost.

3.2 Features of the Plan. The numbering, charging and switching features of the plan are described in Sections II, III and IV respectively and the major phases of implementation are discussed in Section V. Briefly, the main features of the plan are :-

1. Ultimate nation-wide subscriber dialling.
2. National closed numbering scheme, with maximum of nine digits.
3. Numbering Plan Areas to serve subscribers' main communities of interest.
4. Standard service codes.
5. Grouping of exchanges for call charging.
6. Extended local service areas.
7. Automatic multi-metering on trunk calls.
8. Register-controlled, high-speed switching system using automatic alternative routing.
9. Switching centres classified as Main, Primary, Secondary, Minor and Terminal.
10. Maximum of nine links in tandem.
11. Provision for a comprehensive range of subscribers' telephone facilities.

The national plan has far reaching technical implications and, at the appropriate stage in its preparation, the Post Office initiated an intensive investigation into automatic switching systems. As a result, the crossbar type of automatic switching system has been adopted for extending telephone mechanisation.

POPULATION OF AUSTRALIA 1900 — 1959

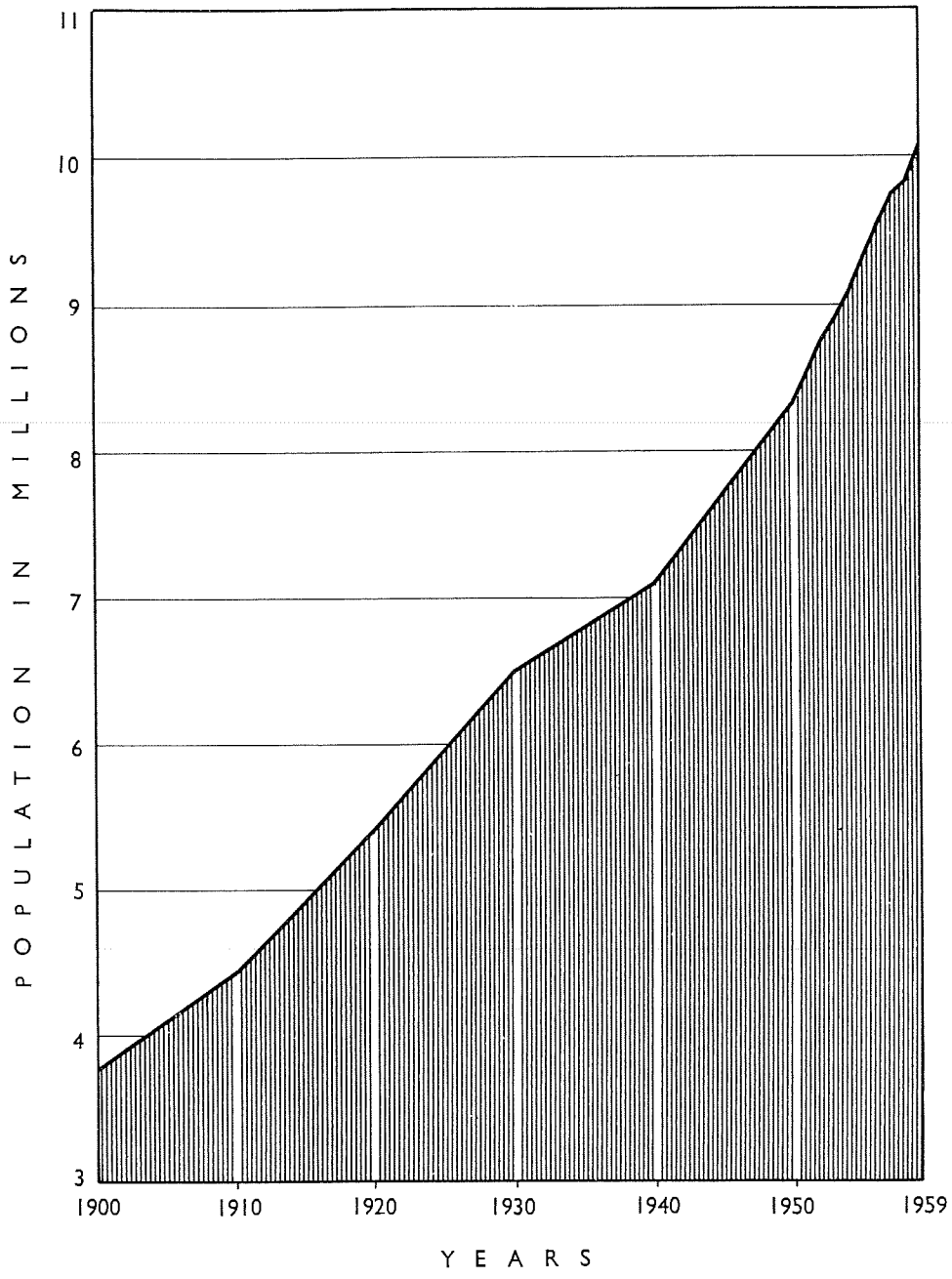
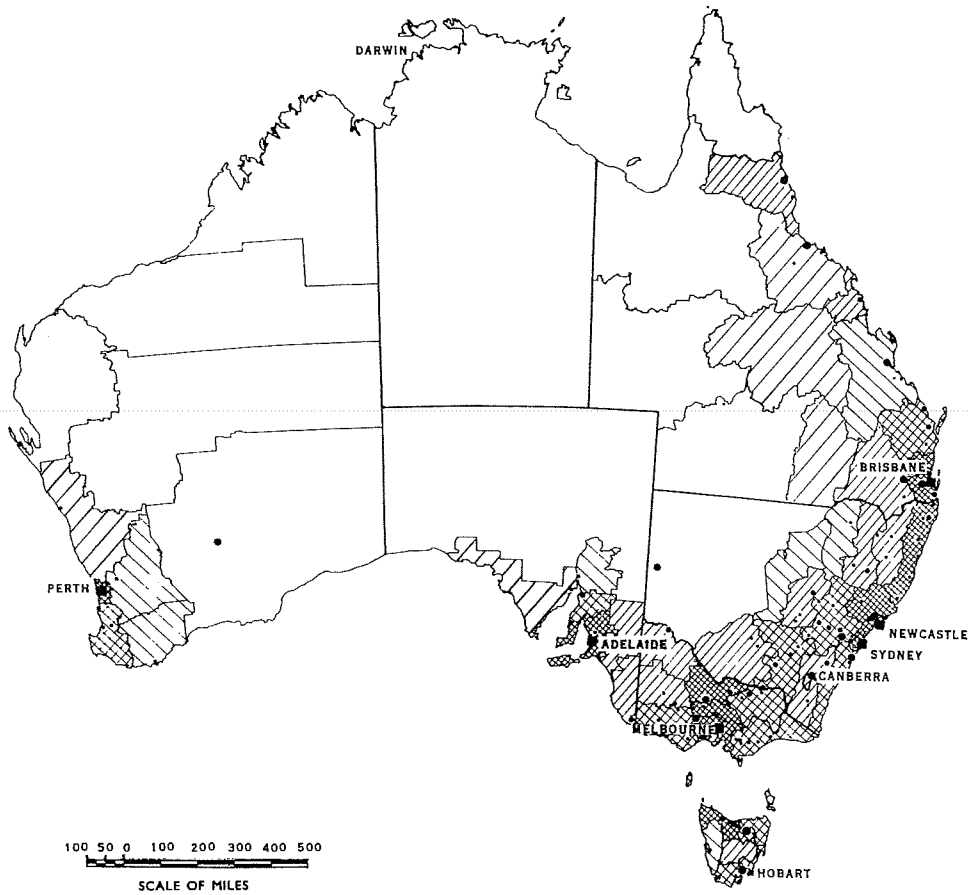


FIGURE I.

POPULATION DENSITY AND DISTRIBUTION

CENSUS 1954



DISTRIBUTION OF CITIES AND TOWNS OF OVER 5,000 PERSONS

- 5,000 TO 10,000 PERSONS
- 10,000 " 20,000 "
- 20,000 " 100,000 "
- Over 100,000 "

DENSITY OF POPULATION OF SMALLER TOWNS AND RURAL AREAS IN STATISTICAL DIVISIONS

- 0 - 0 25 PERSONS PER SQUARE MILE
- 0.25 - 1 " " " "
- 1 - 2 " " " "
- 2 - 4 " " " "
- 4 - 8 " " " "
- Over 8 " " " "

FIGURE 2.

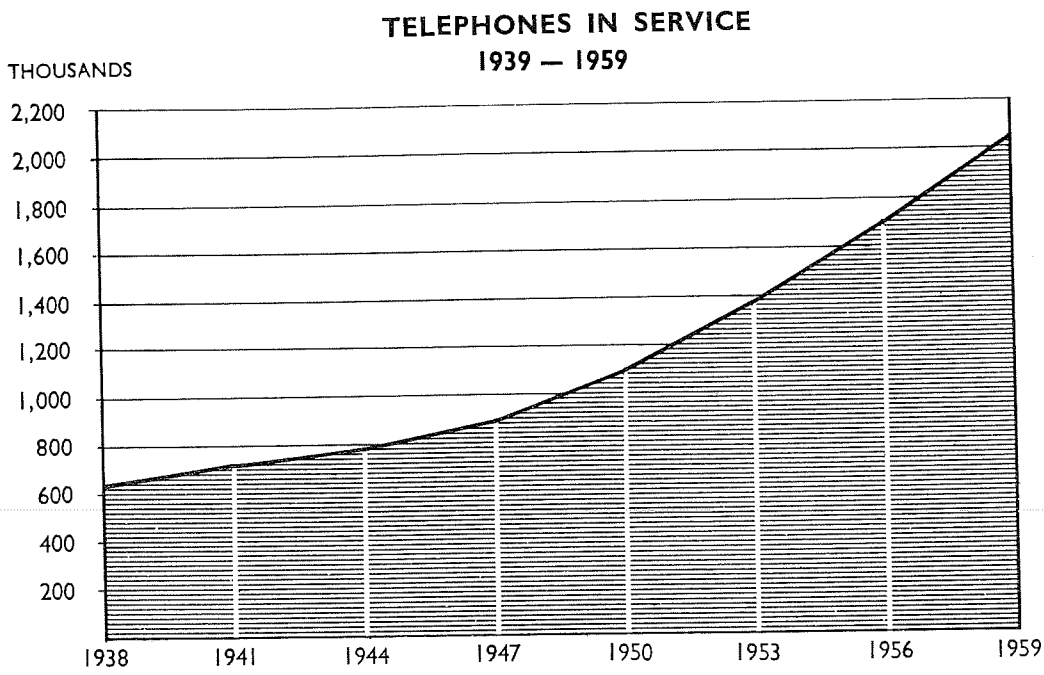


FIGURE 3.

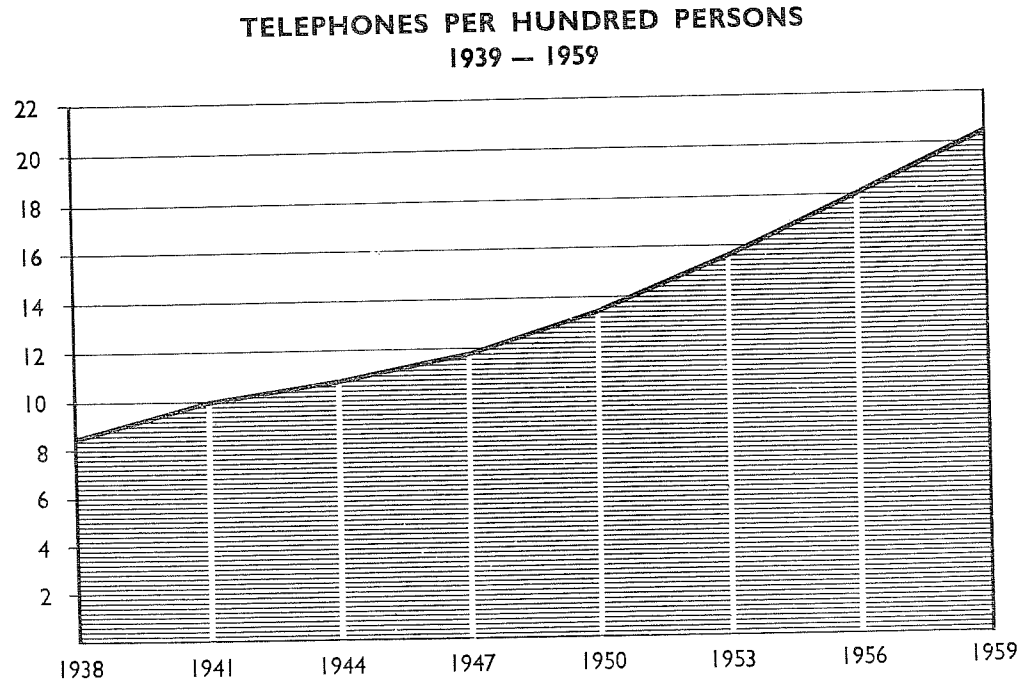
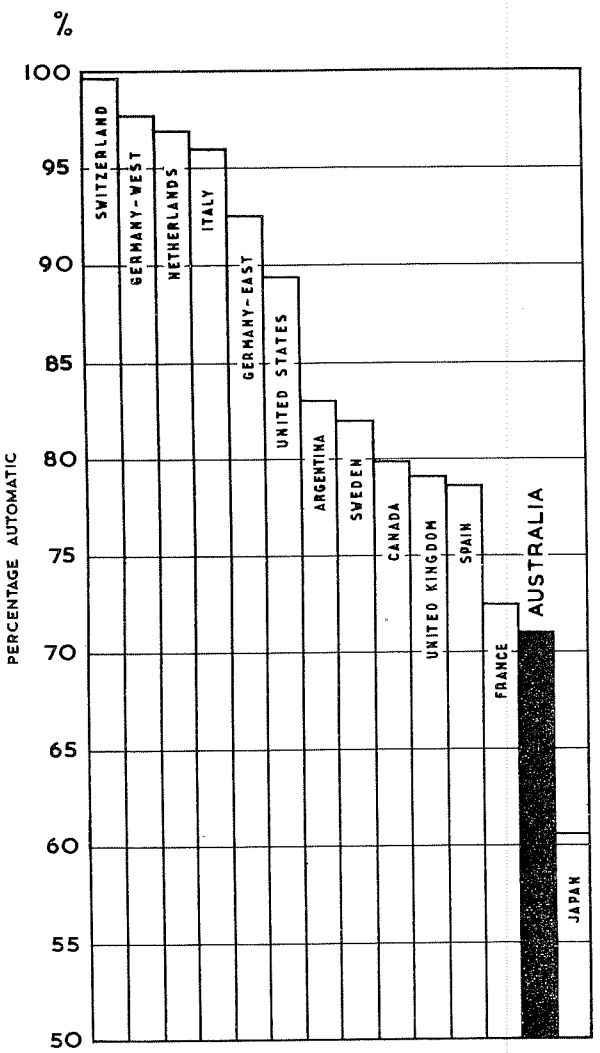


FIGURE 4.

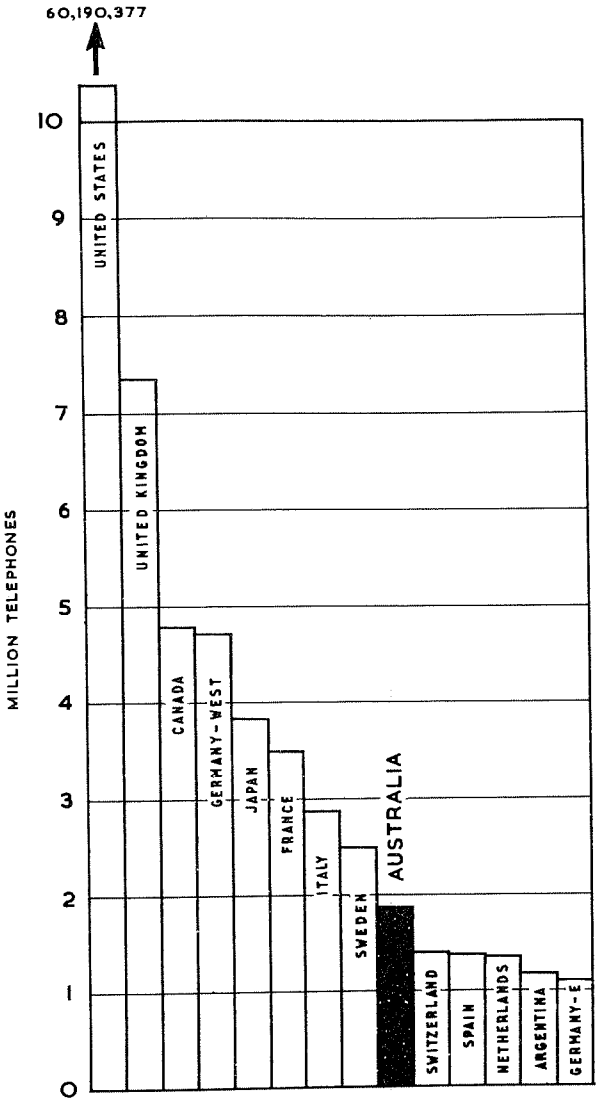
EXTENT OF AUTOMATIC OPERATION

IN COUNTRIES REPORTING MORE THAN
1,000,000 TELEPHONES ON 1ST JAN. 1958



NUMBER OF TELEPHONES

IN COUNTRIES REPORTING MORE THAN
1,000,000 TELEPHONES ON 1ST JAN. 1958



TELEPHONE DENSITY

TELEPHONES PER 100 POP. IN COUNTRIES REPORTING
MORE THAN 1,000,000 TELEPHONES ON 1ST JAN 1958

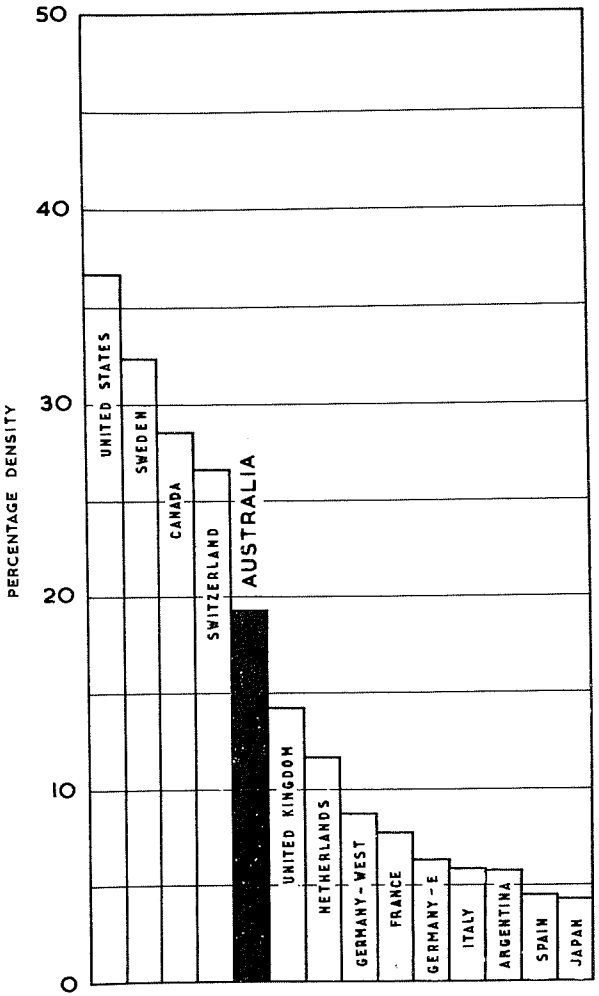


FIGURE 5.

NUMBER OF LOCAL CALLS
1938 — 1958

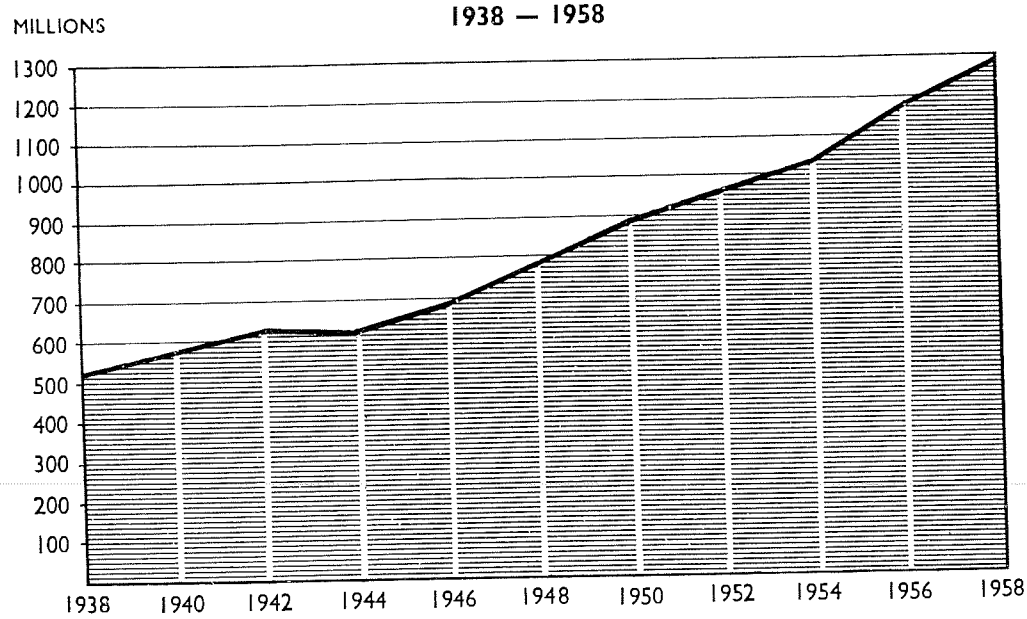


FIGURE 6.

NUMBER OF TRUNK CALLS
1938 — 1958

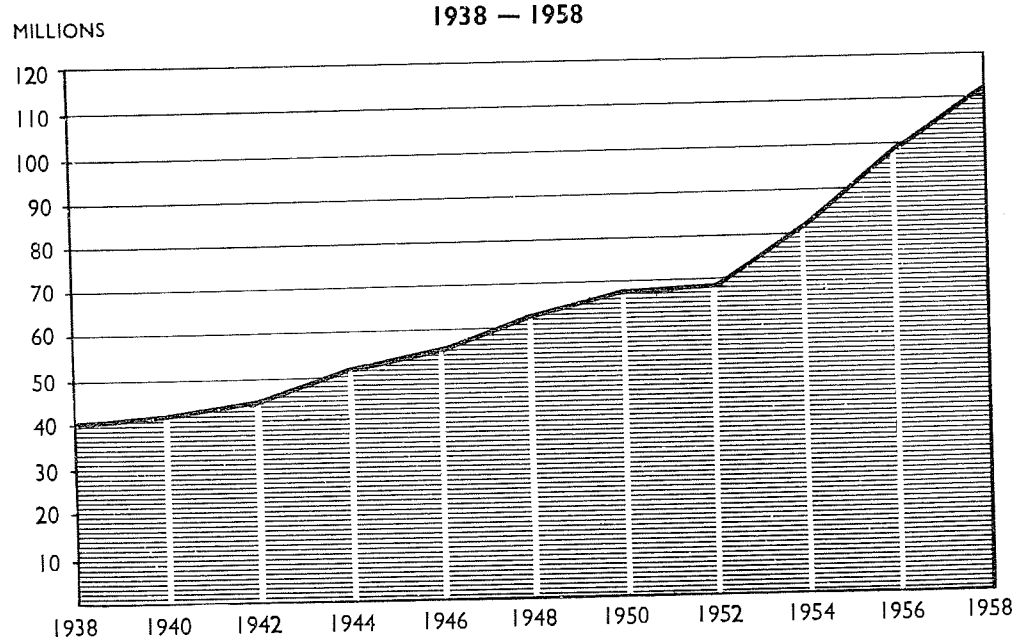
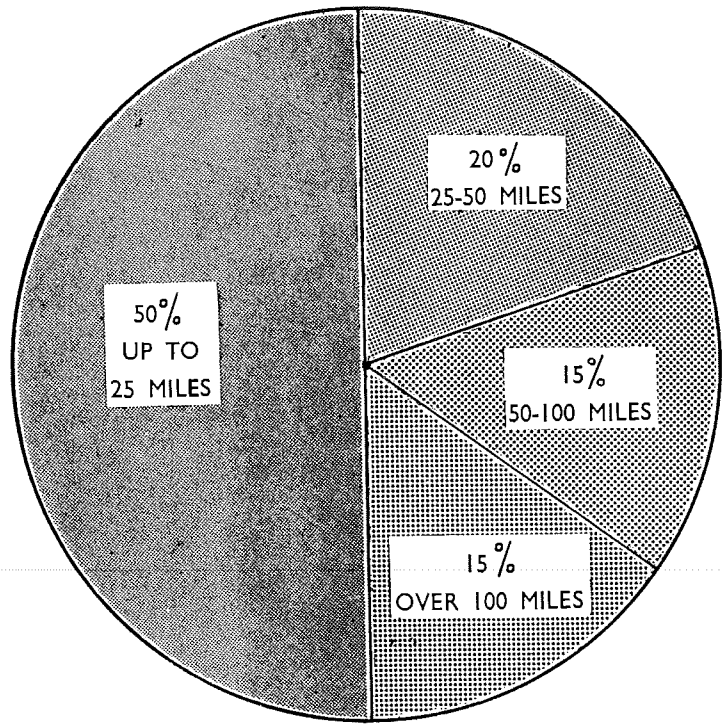


FIGURE 7.



PERCENTAGE TRUNK LINE CALLS IN RELATION TO MILEAGE

MILEAGE CLASSIFICATIONS	PERCENTAGE TO TOTAL CALLS	
	INDIVIDUAL	CUMULATIVE
5 - 10	13.50	13.50
10 - 15	12.73	26.23
15 - 20	15.99	42.22
20 - 25	7.52	49.74
25 - 30	4.80	54.54
30 - 35	3.39	57.93
35 - 40	4.05	61.98
40 - 50	7.78	69.76
50 - 60	4.10	73.86
60 - 80	6.56	80.42
80 - 100	4.20	84.62
100 - 150	4.88	89.50
150 - 200	3.93	93.43
200 - 250	2.08	95.51
250 - 300	0.90	96.41
300 - 350	0.48	96.89
350 - 400	0.34	97.23
400 - 500	1.98	99.21
500 - 600	0.18	99.39
600 - 700	0.12	99.51
700 - 800	0.14	99.65
Over 800	0.35	100.00

FIGURE 8.

COMMUNITY TELEPHONE PLAN

SECTION II - THE NUMBERING PLAN

1. TYPE OF NUMBERING PLAN.

1.1 The numbering plan forms the basis for the systematic numbering of telephone services so that each may be individually identified. It sets the pattern for the operating instructions which enable subscribers to dial their own calls over the national telephone system. A simple plan which may be clearly presented will help subscribers considerably, increase the speed of operation and minimise risk of error. It will avoid the wasteful use of costly trunk lines and switching equipment.

From the technical viewpoint, each telephone number constitutes digital information which, when dialled into the automatic system, enables it to establish the desired connection and to apply the appropriate charge when the called subscriber answers. The numbering is therefore a controlling factor in the design of the switching system equipment. Careful attention to the numbering plan will secure efficiency in equipment design and standards and economy in provision.

Numbers must be kept as short as possible to save time and plant and to avoid errors, but the provision of ample capacity to meet the estimated expansion over a long period without disruptive alterations is essential. Flexibility to meet unforeseen subscriber development and to permit expansion beyond the capacity of the plan must be retained. Finally, it is necessary for the plan to be arranged for progressive application.

These requirements are most satisfactorily met by a numbering scheme in which each subscriber's service is identified by a unique telephone number - the same number being dialled to reach a particular subscriber regardless of the point of origin of the call. This type of numbering is referred to as "closed numbering". It has been adopted for the Australian national automatic telephone system, with a modification providing for shortened numbers on calls within networks covering local communities of interest.

Telephone directory information and procedures under this plan will ultimately become uniform throughout Australia. Directories for any region may be prepared in bulk and distributed throughout the Commonwealth as required. Subscribers may include their national numbers on letter-heads and in advertisements, providing a useful supplement to Departmental directories and simultaneously an advertising feature for the public.

2. DIALLING PROCEDURES.

2.1 If a single closed numbering scheme were applied throughout the Commonwealth it would result in very simple directory instructions but would require subscribers to dial a large number of digits on all calls. Dispersion studies of telephone traffic show that most of the calls originating from any exchange are directed to subscribers within a defined surrounding area. The number of digits to be dialled is greatly reduced, giving lower equipment costs and reduced dialling effort by subscribers, if this traffic is treated separately.

Closed numbering schemes will be established to serve these areas of high community of interest. They will be referred to as Numbering Plan Areas.

Each numbering plan areas is assigned a unique national area code. A subscriber's individual national number thus consists of the area code plus the directory number.

There are two dialling procedures in the national plan. They are :-

(i) For calls within the numbering plan area - dial only the directory number.

(ii) For all other calls - dial the national number, composed of an area code plus the directory number.

Investigations have shown that the average number of digits to be dialled could not be appreciably reduced, nor would any worthwhile equipment savings be obtained by the adoption of numbering schemes requiring more than two dialling procedures. Such schemes would also have the disadvantage of much more complicated directory instructions and they are therefore not favoured.

SECTION II.

3. EXTENT OF NUMBERING PLAN AREAS.

3.1 Examination of traffic dispersion from country exchanges in Australia has shown that approximately 80% of originated traffic remains within a typical secondary switching network. In the switching plan, which is described in Section IV, a secondary network covers the secondary switching centre and its dependent minor switching centres and terminal exchanges. Generally, therefore, a numbering plan area serves a secondary switching network. In some cases, where the community of interest is catered for by a switching network of lower order, smaller numbering plan areas may be used. In others, a larger numbering plan area may serve combined secondary networks.

4. ACCESS CODE.

4.1 When two dialling procedures are used, as described, an access code is required to indicate that the call is going beyond the numbering plan area. A code has therefore been selected from the local number range to provide access to the national dialling system. It is essential that the code be the same at all locations to retain the advantages of national closed numbering. Also, it is desirable that the code be short, preferably a single digit.

In Australia, the most suitable single digits which could be considered are "1", which is not in use for subscriber's numbering, and "0", which is only used to a limited extent. Because of the incidence of false traffic the digit 1 could not be considered for trunk access unless accompanied by protective digits. Accordingly, digit 0 has been chosen as the access code. This is consistent with present local policy and overseas trends.

Since the access digit is uniform throughout the Commonwealth all area codes commence with the digit 0. This simplifies directory instructions.

5. CAPACITY OF NUMBERING SCHEME.

5.1 Optimum capacity of the numbering scheme was determined after studying the likely order and distribution of future telephone demand. Fifty year estimates have been used as a basis for an area code allocation designed to achieve the shortest numbers in both numbering plan areas and the community system consistent with adequate capacity to avoid radical number changes.

5.2 Development Estimates. The estimates of development has been based on studies of future population and telephone density. A 50-year estimate was made for each region of the Commonwealth, weighted on the liberal side, to retain flexibility. The aggregate of these individual studies, which were made separately in each State and subsequently reviewed at Headquarters to achieve reasonable uniformity of approach, result in overall Commonwealth figures of 33 million population and 15.3 million exchange services.

These figures rank with reasonably optimistic estimates of Australian population and telephone density. Numbering allocations made on this basis should, therefore, ensure adequate capacity.

The estimates for each State and the Commonwealth are as follows :-

	ESTIMATES FOR 2010 A.D.		
	POPULATION	SUBSCRIBER DENSITY	EXCHANGE SERVICES
New South Wales	11.0 Million	50 per 100 population	5.5 Million
Victoria	9.8 "	50 " " "	4.9 "
Queensland	4.6 "	40 " " "	1.8 "
South Australia	3.5 "	40 " " "	1.4 "
Western Australia	2.9 "	40 " " "	1.2 "
Tasmania	1.2 "	40 " " "	.5 "
TOTAL	33.0 Million		15.3 Million

5.3 Number of Digits Required. In considering numbering capacity, a precise estimate of the number of exchange services is not required but rather the determination of the range within which the development will occur. With a decimal numbering system, the maximum theoretical capacity of uniform numbering schemes increases tenfold with each additional digit. For example, a 3 digit numbering schemes has a maximum theoretical capacity of 1000 telephone numbers, a 4 digit scheme 10,000 and so on.

As a result of the studies undertaken, a national numbering plan using an access code and a maximum of eight numerical digits with theoretical capacity of 100 million numbers has been adopted. The area code allocation and trial numbering within the numbering plan areas have confirmed that this provides adequate capacity. A margin is available for increased requirements which could be imposed by extensive in-dialling to private branch automatic exchange extensions.

For the shorter numbers to be used on calls within numbering plan areas, development studies show that 5 digit numbering is required for the typical Secondary network. In some cases, where the Secondary network involves a large centre e.g. Canberra, (Australian Capital Territory), Morwell (Victoria), 6 digit numbering will be required. In other cases where the Secondary network is small or where the main community of interest is served by a network of lower order than Secondary, 4 digit or even 3 digit local numbering is used.

The Capital City networks contain the greatest numbers of subscribers. The numbering schemes for these cover the existing unit fee networks and some of the surrounding sub-metropolitan areas. 7 digit schemes are planned for Sydney and Melbourne and 6 digit schemes for the other Capitals.

6. ALLOCATION OF AREA CODES.

6.1 Each numbering plan area is designated by a unique area code which, together with the subscriber's directory number, forms the national number. This national number is dialled when a call is made from another numbering plan area.

Equipment used when national numbers are dialled is simplified if the number of digits which needs to be examined to determine the routing and charging of national calls is kept to a minimum. The trunk switching plans show that generally satisfactory routing will be obtained if sufficient information is provided to identify Main, Primary and Secondary Switching Centres. An examination of the same information is also sufficient to determine charges for the longer distance calls.

The basis used for selecting area codes is as follows :-

(i) Switching centres of Main, Primary or Secondary classification are recognised by, at the most, 4 digits (including the access digit 0).
(ii) The longest national number consists of 9 digits (including the access digit).

For numbering plan areas with 3, 4, 5, 6 or 7 digits, area codes vary in length to comply with this requirement, as shown hereunder :-

Numbering Plan Area	Number Capacity	Form of Area Code	Typical National Number
3 digits	1,000	0ABCDE	053265-487
4 "	10,000	0ABCD	05434-6326
5 "	100,000	0ABC	0536-4 4418
6 "	1,000,000	0AB	062-33 4433
7 "	10,000,000	0A	03-630 7321

NOTE: The method of referring to the area codes used above, designating the first 5 digits following the access code 0 as ABCDE, will be used when the general treatment of area codes or of their individual digits is being discussed.

SECTION II.

(iii) Although State boundaries are not rigidly observed, the A digits have been allotted generally as follows :-

A = 1 Services
2 Sydney Network
3 Melbourne Network
4 Sydney Primary Area (other than Sydney Network)
5 Victoria
6 New South Wales
7 Queensland
8 South Australia
9 Western Australia
0 Partially allotted to Tasmania. The remainder of the digit is spare.

They have been distributed in accordance with the 50 year development studies and so that the lower digits are allotted generally where the incoming traffic is highest.

The A digit allocation is shown in Fig. 1.

Allotting the A digits to particular regions allows some simplification in routing and charging equipment. As an example, the equipment handling calls originated in Perth for the Eastern States would obtain all the information necessary for routing and charging by examining the A digit of the national code.

The basis for the automatic charging and routing of calls is described in Sections III and IV.

(iv) Within a State, the B digits in the area codes are allocated to areas made up of a number of Secondary switching areas, representing the probable long-term community of interest. In many cases these areas correspond with Primary Switching areas, since these reflect community of interest.

(v) The networks with the heaviest incoming traffic are allotted area codes composed of the lower numbers. For example, Sydney is allotted the A digit 2.

This will result in faster setting up of the large number of calls to these networks with a consequent reduction in the amount of common equipment required and greater convenience to users.

(vi) Generally OABC codes are allotted to Secondary networks. However, where convenient for charging and routing purposes an OABC code is allotted to a large Minor switching network.

The distribution of the OABC codes is of considerable importance in the automatic charging of calls. Automatic charging equipment will examine the national number as far as the C digit to ascertain the charge for long distance calls or to determine whether further digits need be examined to provide more precise charging on the shorter distance calls.

Appendix 1 shows the national numbering allocation of A, B and C digits to particular networks in accordance with these principles and is based on the 50-year estimates of the extent and distribution of telephone development. In preparing the numbering plan, investigations into the closed numbering schemes within the numbering plan areas were conducted simultaneously with the development of the charging plan. The adequacy of the code allocations was tested in the light of all relevant factors. These allocations should therefore remain stable for a long time.

7. PROVISION FOR FUTURE EXPANSION.

7.1 The numbering scheme has been planned with an effective capacity in excess of the estimated 50-year number requirements in order to retain a margin for large-scale unforeseen development. This has been achieved by reserving a substantial proportion of the A digit 0, together with some complete AB combinations on other A digits. In addition, on each individual AB code, the C digits 1 and 0 have not been allocated and other ABC codes have been retained. Ultimate transition to ten digit national numbering (access code followed by nine digits) without necessitating national renumbering is inherent in the scheme.

Unforeseen development might occur in one of two ways :-

(i) The expansion of an existing numbering plan area beyond its planned ultimate capacity.

(ii) The development of areas at present uninhabited and not covered by the national numbering allocation.

7.2 Expansion in a Numbering Plan Area. In the event of the capacity of a numbering plan, for example, a 5-digit scheme covering a Secondary area, being exceeded, there are several alternative courses of action.

(i) Introduce a 6-Figure Numbering Plan in the Area, retaining the OABC Area Code. With this method the full effective capacity of a 6-digit scheme can be attained. The national number would then comprise 10 digits and for this method of expansion to be practicable all national register equipment would need to be capable of handling the longer number. At least this measure of flexibility will be incorporated in the equipment design, not only to cater for this method of expansion of the system beyond 9 digits, but for other reasons such as in-dialling to P.A.B.X. extensions and possible international dialling.

It may prove to be the simplest and most economical method, but requires subscribers to dial longer numbers earlier than the following methods (ii) and (iii).

(ii) Divide the Area into two 5-Figure Numbering Plan Areas each with a separate OABC Area Code. With such a division, traffic between the two numbering plan areas would require, under the standard dialling procedure, the full national number. This could be undesirable since the community of interest between them is likely to be high, particularly as the switching centre for the original network must be included in one or other of the new areas.

(iii) Introduce a 6-Figure Numbering Plan in the Area, using only the OAB digits as the Area Code. Introduction of 6-digit numbering in an area by simply transferring the C digit from the area code and using it as the first digit of directory numbers gives numbering capacity relief since the D digits 1 and 0 can then be used for subscribers' numbers. However, for large scale relief, a new number group, commencing with a spare C digit of the original OAB code, would also be required.

It might be convenient at that stage to bring other numbering plan areas with area codes derived from the same AB digits into the 6-digit scheme, although this is not essential. However, when any of these other numbering plan areas reach saturation, they must either be included in the 6-digit section of the closed numbering plan if this method (iii) of development is used or treated in accordance with method (i).

In the numbering allocation of area codes, C digits are reserved so that this method may be adopted where desirable. Within a State, the B digits in the area codes are allocated to areas made up of a number of Secondary switching areas and representing the probable long term community of interest. In many cases these areas correspond with Primary switching areas since they reflect community of interest. The allocation of B digits in this manner prepares for future expansion of the numbering plan area without increasing the national number beyond 9 digits.

An example of the type of allocation is as follows :-

	Initially, each Secondary Area with a 5-digit numbering plan.		Later, the three Secondary Areas combined in one 6-digit numbering plan area.	
Secondary Area	Area Code	Directory Number	Area Code	Directory Number
No. 1	0703	XXXXX	070	3XXXXX
No. 2	0704	XXXXX	070	4XXXXX
No. 3	0705	XXXXX	070	5XXXXX

If, then, the code 0706 is reserved as a spare to meet development, six digit numbers commencing with "6" could be introduced in the Secondary area where numbering congestion occurs. In this way, the pattern of District charging i.e., discrimination on the OABC code, could be preserved.

Although these methods are given in terms of the expansion of 5-digit areas, similar conditions apply to 6-digit areas. 9. D

7.3 Development of New Areas. It is important to reserve a substantial proportion of the trunk code spectrum because of the possibility of unforeseen development in areas of Australia at present uninhabited. The extent of the reservations made has already been mentioned. Specific examples of such reservations are the retention of complete AB combinations from the A digits allocated to South Australia and Western Australia. These could be utilised in the event of either primary industries or mineral operations developing in the Northern Territory or outback Western Australia. 10. D

8. SERVICE CODES.

8.1 Standard codes for the Department's special services are designed so that subscribers may obtain access to them readily. The range of codes selected provides for :-

(i) the use of the same codes by all subscribers;
(ii) short codes, with the more important services, Emergency and Manual Assistance, having easily remembered codes;
(iii) ample capacity to incorporate new services.

These requirements are met best by reserving the A digit 1 for Services.

The codes for access to the Services in the national telephone system will be :-

000 - Emergency - for Fire, Police and Ambulance.
011 - Manual assistance for trunk line calls.
012 - Trunk enquiry.
013 - Directory information.
014 - Time.
015 - Phonograms.
016 - Services provided by recorded announcements, e.g. 0164 - weather forecasts.
017 - Miscellaneous services requiring the attention of an operator, e.g. as follows :-

0171 - Overseas calls.
0172 - Mobile radio calls.
0173 - Early morning and reminder calls.
0174 - Phonogram enquiries.

018 - Manual assistance for Inter-state trunk line calls at those centres at which Intra-state and Inter-state calls are connected on different suites. Ultimately this code will become spare.
019 - Spare.
010 - Complaints.

The codes have been allotted so that the final digit corresponds, where possible, with the final digit of the existing service codes. This will assist subscribers, and may also reduce the trunking alterations required when the standard codes are introduced.

In large networks, including capital cities, the standard codes for special services provided by recorded announcements (016 series) and for Complaints (010) will not be introduced until equipment is available which will allow segregation of the traffic to these services to safeguard against traffic congestion in exceptional circumstances. Where the Complaints service is introduced on local numbering a short code ending in 00 will be used.

At large country centres most of the codes will be used, but, in the smaller country automatic exchanges, one code only - 011 - may be used to cover all calls requiring the attention of an operator.

9. DEVELOPMENT OF INTERNATIONAL DIALLING.

9.1 With the advances in the methods of providing international circuits by submarine cable and radio and the introduction of international dialling in Europe and North America, it is reasonable to anticipate that Australia will have a requirement for international dialling within the 50-year period. Suitable codes will be available for this purpose from the reservations made in the A digits 0 and 1.

10. DIRECTORY PRESENTATION.

10.1 Quick and accurate operation of an automatic telephone service not only has advantages from a subscriber's viewpoint but also yields economies in plant provision. The design of the national numbering plan is such that it enables the presentation of directory information which is simple for subscribers to understand and use.

10.2 Directory Instructions. In the ultimate scheme, standard directory instructions will apply throughout the Commonwealth. Each subscriber's telephone service will have its own national number consisting of two parts, an area code and a directory or local number. Since each numbering plan area will be assigned its own area code, the national numbers of all subscribers who may inter-dial by using only the number listed in the directory will commence with the same area code.

To make a call subscribers will have to select one of two dialling procedures, namely :-

(i) The dialling only of the directory number shown against the called subscriber's name for calls within the numbering plan area.

(ii) The dialling of the area code plus the called subscriber's directory number for all other calls.

Whilst, ultimately, calling instructions under the new plan will be simple, departures from the standard form of presentation will be unavoidable in the various stages of implementation and it may be necessary, in addition to directory instructions, to issue cards to subscribers showing dialling codes and other appropriate instructions.

SECTION II.

Instructions to allow the subscriber to select the correct one of the two dialling procedures could be, typically, as follows :-

HOW TO MAKE A CALL

Each subscriber's telephone service has its own NATIONAL NUMBER consisting of two parts, an AREA CODE and a DIRECTORY NUMBER.

AREA CODE: The area code for each exchange is shown in the directory e.g. Toowoomba (0762-).

DIRECTORY NUMBER: The number is shown against the subscriber's name, e.g. Smith, J.B. Main Rd. 5 7521.

When the national number is written, these two parts are combined in the following form :-

0762-5 7521.

DIALLING A CALL

If the AREA CODE of the wanted subscriber's national number is the same as that of the telephone you are using, dial only the wanted subscriber's DIRECTORY NUMBER.

For all other calls, dial the full national number, i.e. the AREA CODE followed by the DIRECTORY NUMBER.

If the wanted subscriber's AREA CODE or DIRECTORY NUMBER is not known, dial 012 and enquire from the operator.

10.3 Production of Directories. The directory entries for country subscribers are listed at present under the names of exchanges to which the services connect and, although it is unlikely that the existing set-up will be altered radically in the initial stages, the new plan will lend itself to the listing of entries for all subscribers in a particula numbering plan area in the one alphabetical list.

Depending on the various factors involved, it may be practicable to print separately the numbering plan area lists. This would give flexibility in the production of directories in that, under such an arrangement, sectional directories could be formed by combining the separate lists according to the community of interest between different areas. 11. SU

10.4 All Figure Numbers. All area codes and directory numbers will be presented in figures only, for the following reasons :- 11.

(i) Faster dialling - It is easier to locate a figure on the dial than a letter. Also the fewer symbols shown on the dial the easier it is to find the one required.

(ii) More accurate dialling - Tests have shown that the percentage of wrong numbers dialled increases with the length of the number and also with the number of digits corresponding to each aperture in the dial.

Letters and numbers which sound alike are another source of wrong numbers. Some of those commonly confused are F and X; J, A and 8: B and 3; UU and W.

(iii) Wider number range available - Now that it is necessary to use six and seven digit numbers in Sydney and Melbourne, many codes involving the letters U and W would be too confusing. Also, some combinations of three letters cannot be used. No such restrictions exist with all-figure codes.

(iv) Accounting simplicity - Many processes associated with trunk line dockets and subscribers' accounts lend themselves to automatic treatment. The all-figu presentation will facilitate the application of automatic accounting equipment.

(v) Memory - Extensive tests conducted by the British Medical Council's Applied Psychology Research Unit on the ability of telephone operators to remember long telephone numbers show that all-figure combinations are greatly superior to letter-figure combinations when heard and are only slightly inferior when read. The conclusion was that "..... There is no real advantage in using relatively non-meaningful letter arrangements". Research by the Australian Post Office confirms the conclusions drawn.

Preliminary experiments in the use of all-figure numbers by the Bell Telephone Laboratories show that the ease of short-term memory (that is, the memory involved in reading a number from a directory, then dialling it) of all-figure and letter-figure numbers is about the same. Long-term memory of all-figure numbers is slightly harder than that of the letter-figure numbers used in America and the United Kingdom where the letters are a contraction of an exchange name. However, the practice of committing telephone numbers to memory has been found to be a major source of wrong numbers. Post Office practice is, therefore, to encourage subscribers to consult their directory before calling.

(vi) World trend - There is a world trend towards all-figure presentation, since it is the only practicable international standard numbering system. New Zealand, Honolulu, Argentina, Mexico, Eire, Germany, Sweden, Hungary, Egypt, Pakistan, India, Japan and South Africa, and many other countries use all-figure presentation.

In the United States, at Wichita Falls, Texas, field trials of all-figure numbers are at present being conducted.

The C.C.I.T.T. sub-group studying international automatic operation has recommended -

> "For fully automatic international service, it is preferable that the national numbering scheme should not involve the use of letters (associated with figures on dials) because in many countries dials do not bear letters ....."

11. SUMMARY.

11.1 Summarised, the Australian National Numbering Plan provides for :-

* Numbering plan areas to serve the subscribers' main communities of interest. Generally, these will have 5-digit numbering covering secondary switching areas.
* Each numbering plan area to be designated by an area code.
* The access code 0 to be incorporated in the area code.
* A national closed numbering scheme consisting of the area codes plus the directory numbers.
* Maximum length of a national number, i.e. area code plus directory number, of 9 digits.
* Standard service codes, including an emergency code.

It has the following features :-

* Numbers as short as possible, to save time and equipment and avoid errors.
* Ample capacity to meet expansion over a long period without disruptive alterations.
* Flexibility to permit alterations to meet unforeseen subscriber development.

SECTION II.

* Simple directory instructions for quick and accurate use by subscribers.

* Introduction of the numbering in stages if necessary.

* Economic use of plant.

* Switching and charging functions to be performed automatically, with equipment as simple as possible, consistent with the need for flexibility.

acc
the

obs

NATIONAL NUMBERING PLAN

ALLOCATION OF A, B AND C DIGITS.

ipment as

This appendix shows the national numbering allocation of A, B and C digits. In accordance with the principles outlined in Section II, these will generally be the area codes for the numbering plan areas.

Codes for each State are listed separately although State boundaries are not rigidly observed. The A digits have been allotted generally as follows :-

A = 1 Services

2 Sydney Network

3 Melbourne Network

4 Sydney Primary Area (other than Sydney Network)

5 Victoria

6 New South Wales

7 Queensland

8 South Australia

9 Western Australia

0 Partially allotted to Tasmania. The remainder of the digit is spare.

SECTION II.

APPENDIX I.

NEW SOUTH WALES

Code	Area	Code	Area	Code	Area
02	Sydney Network	0641	Spare	0671	Moree
		0642	Goulburn	0672	Inverell
041	Spare	0643	Crookwell	0673	Glen Innes
042	Wollongong	0644	Goulburn	0674	Armidale
043	Gosford	0645	Marulan-Taralga	0675	Quirindi
044	Nowra)	0646	Spare	0676	Narrabri
	Moruya)	0647	Spare	0677	Gunnedah
045	Windsor	0648	Cooma	0678	Barraba-Bingara-Manilla
046	Campbelltown	0649	Bega	0679	Tamworth
047	Penrith	0640	-	0670	-
048	Bowral				
049	Newcastle	0651	Spare	0681	Spare
040	Spare	0652	Macksville	0682	Coonamble
		0653	Maitland	0683)	Dubbo
061	Allocated in Victoria	0654	Muswellbrook	0684)	
		0655	Taree	0685	Forbes
		0656	Kempsey	0686	Parkes
0621	Spare	0657	Singleton	0687	Bourke-Brewarrina, Etc.
0622	Yass	0658	Wauchope	0688	Nyngan
0623)		0659	Maitland	0689	Condobolin, Etc.
0624)		0650	-	0680	-
0625)					
0626)	Canberra	0661	Spare	0691	Spare
0627)		0662)	Lismore	0692	Hay-Ivanhoe
0628)		0667)		0693	Wagga
0629)		0663	Murwillumbah	0694	Cootamundra-Gundagai, etc
0620	-	0664	Coff's Harbour	0695	Narrandera
		0665	Grafton	0696	Griffith
0631	Spare	0666	Casino	0697	West Wyalong
0632	Spare	0668	Kyogle	0698	Temora
0633	Bathurst	0669	Spare	0699	Young
0634	Cowra	0660	-	0690	-
0635	Lithgow				
0636	Orange			060	Allocated in Victoria
0637	Mudgee				
0638	Wellington				
0639	Rylstone			0545	Deniliquin
0630	-			0881	Broken Hill

VICTORIA

Code	Area	Code	Area	Code	Area
03	Melbourne Network	0551	Spare	0591	Whittlesea
		0552	Portland	0592)	Dandenong
		0553	Warrnambool	0593)	
0511	Spare	0554	Colac	0594	Dromana
0512)		0555	Camperdown	0595	Frankston
0513)		0556	Hamilton	0596	Lilydale
0514)		0557	Casterton	0597	Kilmore
0515)	Morwell	0558	Edenhope	0598	Gisborne-Romsey-Bacchus Marsh
0516)		0559	Spare		
0517)		0550	-		
0518)				0599	Belgrave
0519)		0561	Spare	0590	-
0510	-	0562)			
		0563)	Warragul	0501	Spare
0521	Lorne	0564)		0502	Mildura
0522)				0503	Swan Hill
0523)		0565)	Korumburra	0504	Balranald
0524)		0566)		0505	Kerang
0525)		0567	Wonthaggi	0506	Horsham
0526)	Geelong	0568	Foster	0507	Nhill-Dimboola-Rainbow
0527)		0569	Cowes		
0528)		0560	-	0508	Hopetoun
0529)				0509	Ouyen
0520)		0571	Spare	0500	-
		0572	Maffra		
0531	Spare	0573	Sale		
0532)		0574	Bairnsdale	0611	Spare
0533)	Ballarat	0575	Yarram	0612)	
0534)		0576	Orbost	0613)	Wangaratta
0535	Ararat	0577	Spare	0614)	
0536	Maryborough	0578	"	0615	Myrtleford
0537	St. Arnaud	0579	"	0616	Benalla
0538	Daylesford	0570	-	0617	Alexandra
0539	Ballan			0618	Mansfield
0530	-	0581	Spare	0619	Spare
		0582)	Shepparton	0610	-
0541	Spare	0583)			
0542)		0584	Kyabram	0601	Spare
0543)	Bendigo	0585	Seymour	0602)	
0544)		0586	Numurkah	0603)	Albury
0545	Deniliquin	0587	Cobram	0604)	
0546	Kyneton	0588	Spare	0605)	
0547	Castlemaine	0589	"	0606	Tallangatta
0548	Echuca	0580	-	0607	Corryong
0549	Charlton			0608	Spare
0540	-			0609	"
				0600	-

SECTION II.

APPENDIX I.

QUEENSLAND

Code	Area	Code	Area	Code	Area
072)		0751	Spare	0771	Spare
073)	Brisbane Network	0752)	Southport	0772)	
078)		0753)		0773)	Townsville
			(Beaudesert	0774)	
0711	Spare	0754	(Beenleigh	0775	Ingham
0712	Maryborough	0755	Moreton Bay Is.	0776	Hughenden
0713	Bundaberg	0756)	Ipswich	0777	Cloncurry
0714	Gayndah	0757)		0778	Spare
0715	Nambour	0758	Caboolture	0779	"
0716	Gympie	0759	Gatton	0770	-
0717	Kingaroy	0750	-		
0718	Murgon			0791	Spare
0719	Spare	0761	Spare	0792)	Rockhampton
0710	-	0762)	Toowoomba	0793)	
		0763)		0794	Mackay
0741	Spare	0764	Dalby	0795	Biloela
0742	Roma	0765	Oakey	0796	Longreach
0743	Miles	0766	Warwick	0797	Emerald
0744	Charleville	0767	Goondiwindi	0798	Gladstone
0745	Spare	0768	Stanthorpe	0799	Spare
0746	"	0769	Texas-Inglewood	0790	-
0747	"	0760	-		
0748	"			0701	Spare
0749	Dirranbandi-St. George			0702)	Cairns
0740	-			0703)	
				0704	Mareeba
				0705	Innisfail
				0706	Atherton
				0707	Cooktown
				0708	Mt. Surprise
				0709	Spare
				0700	-

SOUTH AUSTRALIA

Code	Area	Code	Area	Code	Area
081	Spare	0861	Spare	0881	Broken Hill
		0862	Port Augusta	0882	Berri
082)	Adelaide	0863	Darwin	0883	Waikerie
083)	Network	0864	Alice Springs	0884	Loxton
084)		0865	Gladstone	0885	Clare
		0866	Port Pirie	0886	Burra
0851	Spare	0867	Ceduna	0887	Saddleworth
0852	McLaren Vale	0868	Woomera-Hawker-Leigh Creek	0888	Peterborough
0853	Gawler			0889	Spare
0854	Nuriootpa	0869	Cook-Oodnadatta		
0855	Mount Barker				
0856	Kingscote	0860	-	0891	Spare
0857	Gumeracha-Mannum			0892	Port Lincoln
		0871	Spare	0893	Streaky Bay
0858	Balaklava	0872)	Mt. Gambier	0894	Kadina
0859	Mallala	0873)		0895	Maitland
0850	-	0874	Naracoorte	0896	Yorketown
		0875	Bordertown	0897	Cowell-Cleve-Lock-Elliston-Wudinna
		0876	Tailem Bend		
		0877	Murray Bridge		
		0878	Spare		
		0879	"	0898	Spare
		0870	-	0899	"
				0890	-
				080	Spare

SECTION II.

APPENDIX I.

WESTERN AUSTRALIA

Code	Area	Code	Area	Code	Area
092)		0961	Spare	0981	Spare
093)	Perth Network	0962	Northam	0982	Katanning
094)		0963	York	0983	Albany
		0964	Wyalkatchem	0984	Narrogin
0911	Spare	0965	Wongan Hills	0985	Wagin
0912	Merredin	0966	Spare	0986	Lake Grace
0913)	Kalgoorlie	0967	"	0987	Spare
0914)		0968	"	0988	"
0915	Bruce Rock	0969	"	0989	"
0916	Spare	0960	-	0980	-
0917	"				
0918	"	0971	Spare	0991	Spare
0919	"	0972)	Bunbury	0992	Geraldton
9010	-	0973)		0993	Morawa
		0974	Bridgetown	0994	Mullewa
0951	Spare	0975	Busselton	0995	Carnarvon
0952	Armadale	0976	Spare	0996	Meekatharra
0953	Pinjarra	0977	"	0997	Port Hedland
0954	Moora	0978	"	0998	Derby
0955	Carnamah	0979	"	0999	Spare
0956	(Rockingham (Medina	0970	-	0990	-
				090	Spare
0957	(Bullsbrook (East (Gin Gin (Mundaring				
0958	Spare				
0959	"				
0950	-				

TASMANIA

Code	Area	Code	Area	Code	Area
0021	Spare	0031	Spare	0041	Spare
0022) 0023) 0024) 0026) 0029)	Hobart	0032) 0033) 0034)	Launceston	0042) 0043)	Burnie
0025	Huonville Kettering- Alonnah- Dennes Point- Taranna	0035 0036 0037 0038 0039 0030	Scottsdale Flinders Is. St. Marys Launceston Sth. Launceston Nth. -	0044) 0045) 0046 0047 0048 0049 0040	Devonport Smithton Queenstown Deloraine King Is. -
0027 0028	New Norfolk Oatlands Copping-Orford- Kempton				
0020	-				

"A" DIGIT ALLOCATION

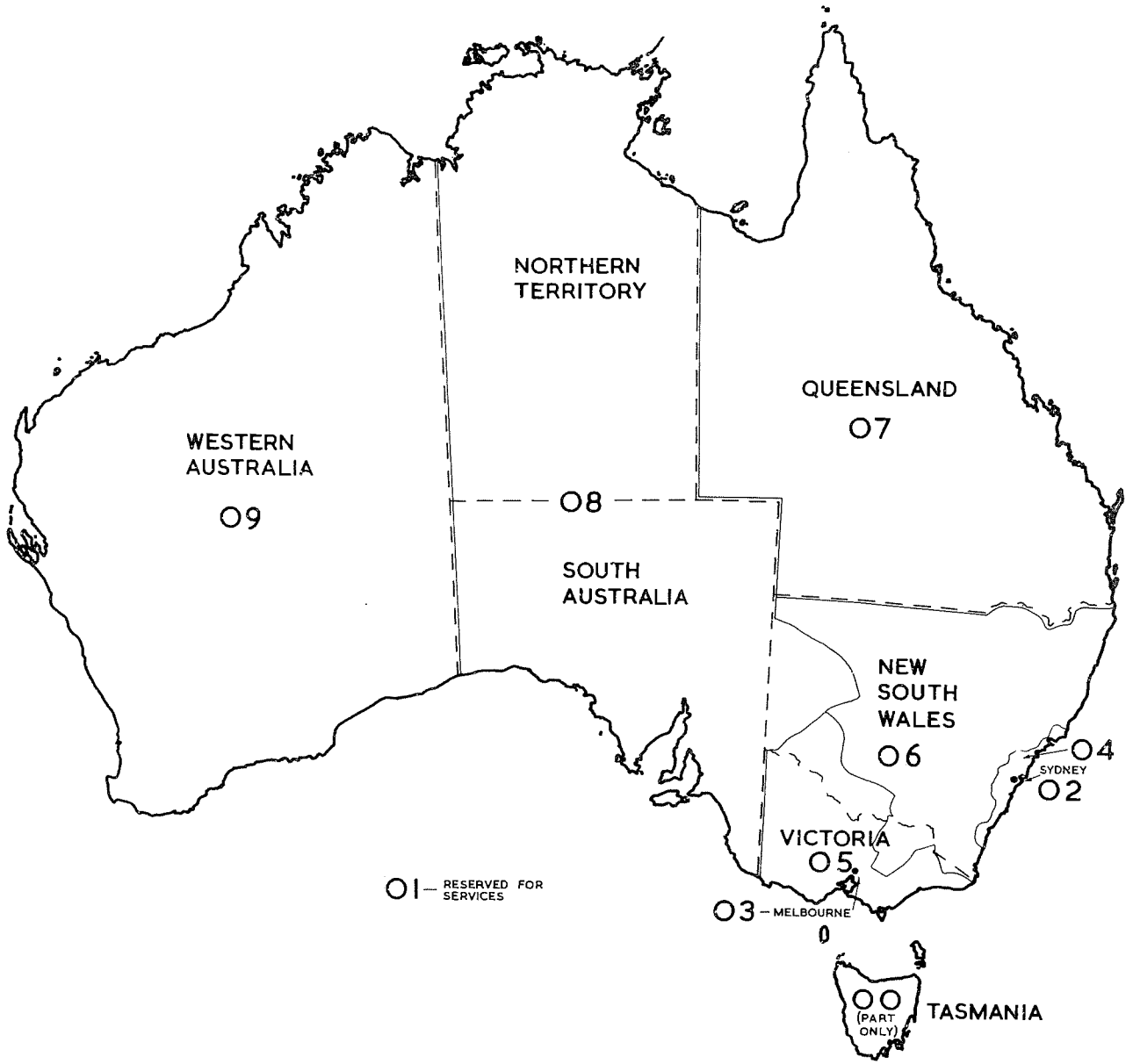


FIGURE 1.

COMMUNITY TELEPHONE PLAN

SECTION III - THE CALL CHARGING SYSTEM

1. BASIS OF EXISTING TARIFF STRUCTURE.

1.1 The measured service rate system is the basis of the telephone tariff structure in Australia. Each subscriber is charged a rental for his telephone service which varies according to certain conditions and is required to pay the prescribed local call and trunk call fees for calls made from his service. The annual base rental for a telephone service depends on the class of service whether business or residence and on the total number of subscribers' lines accessible at the local call fee.

The existing call charging system, which distinguishes between local and trunk calls, is derived from the fundamental layout of a manual network, in which :-

(i) Initially, the subscriber's own exchange catered for his main community of interest.

(ii) There were many direct circuits between exchanges to eliminate intermediate switching by an operator.

(iii) The cost of trunk lines was almost proportional to the circuit length.

(iv) The setting up of a call by operators took a relatively long time, necessitating a fixed time unit for charging.

1.2 Local Call Charging. In metropolitan areas and Newcastle, local call networks are established and calls between all exchanges within a prescribed radius of the General Post Office are charged at the local call fee. In Newcastle the network centre is at Hamilton. The network radius is fifteen miles in Sydney and Melbourne and ten miles in the other metropolitan areas and Newcastle.

In country areas, the local call range embraces all exchanges within a radius of five miles of the calling exchange but, prior to 1924, trunk line charges were incurred on all calls other than those to subscribers connected to the same exchange.

Throughout Australia, local calls are untimed and are charged at a uniform rate of one unit fee.

1.3 Trunk Call Charging. The principle of fixing rates for trunk line calls according to the radial distance between the calling and called exchanges was also adopted in 1924. This replaced rates related to the actual mileage of the trunk lines used to connect the call. It overcame the necessity for altering charges whenever a new trunk route was established between two exchanges. Each exchange in the Commonwealth has its own particular charging distance to every other exchange in the Commonwealth, except in the case of the capital cities where exchanges are grouped in networks.

Over the years, as conversations over longer distances became possible, so additional mileage categories were introduced until the eight rates used in 1902 had grown to 26 in 1951, with the maximum charge applying to calls in excess of 1,300 miles. In 1956, the number of rates was reduced to 22 with the maximum charge applying to calls over 800 miles. In October, 1959, the number of rates was again reduced and, at present, there are 11, the maximum charge being in respect of calls beyond 400 miles. This demonstrates the trend to pass the benefit of economies on to the public as advancing technology enables long distances to be spanned more cheaply.

On manually operated trunk line calls, there is a fixed minimum chargeable period of three minutes. This is designed to cover costs of manual operation in having a telephonist set up a long distance call and record details, including the duration and charge for the call, followed by the clerical work of sorting the docket and finally, billing. For the subscriber, trunk charges based on three minute periods have the disadvantage that for calls of less than three minutes, or less than an exact multiple of three minutes, he pays for a longer period of time than the duration of his conversation. Moreover, lines and equipment are often engaged without absolute necessity because many subscribers are inclined to carry on for a full three minute unit, once such a unit has been commenced.

The recognition of individual exchanges for trunk charging and the large number of steps in the tariff scale does not impose any great difficulty under a manual system because little is involved in applying one scale as against another. They have very important implications, however, for an automatic charging system of the type suitable for this country.

SECTION III.

2. AUTOMATIC CALL CHARGING METHODS.

2.1 In a system where trunk calls are connected manually by telephonists, the operator handling the call records on a docket the particulars of the calling and called numbers and the duration of the call and, from these, the charge is calculated and entered. With a subscriber trunk dialling service, it is necessary to provide special automatic equipment to carry out this charging function.

2.2 Toll Ticketing. One method of automatic charging is known as toll ticketing. Where this is used, the calling and called subscribers' numbers and the date, time and duration of the call are recorded either on a ticket or on some other medium such as perforated tape, magnetic tape. For reasons of economy, it is impossible to provide each subscriber's cir with an individual apparatus to record all these details and the recording apparatus is provided as common equipment to which subscribers have access. This imposes the necessit for equipment to identify the individual calling subscriber's number. The called subscriber's number can be ascertained from the digits dialled. The toll ticketing syste provides for detailed billing of calls but is expensive.

2.3 Multi-Metering. The method of automatically charging trunk calls, which has been adopted most European countries, is that of multi-metering. With this system, the charges for t calls are recorded on the subscriber's meter or its equivalent, as is the case for local calls. The meter registers at intervals according to the charge rate of the call. Separate billing of trunk calls is not practicable in this system and only one total char for all automatically established calls, both local and trunk, is shown on the subscriber account. This is referred to as bulk-billing.

2.4 Application in Australia. The plan for the Australian subscriber trunk dialling system is based on the multimetering method of automatic call charging. By adopting multimetering, call charging equipment costs are kept to a minimum. The system can be introduced in planned stages. In Australia, where the measured rate system applies, individual mete are provided on all automatic services to record local call charges. These will also be utilised for recording trunk call charges. If a flat rate system not involving the recording of local call charges had been in operation, the factors to be considered would have been different.

A feature of trunk traffic in Australia is that although great distances and consequently higher charges are involved on some calls, more than 80% of the trunk calls are made over distances of less than 100 miles. The distribution of calls over the various mileage ra is shown in Figure 8 of Section I. Experience in Australia on the short distance trunk routes which have been equipped with automatic multimetering or where manual methods of applying charges, using techniques similar to multimetering, have been employed indicate that this charging method is acceptable to subscribers. This view is confirmed by experi of many overseas administrations.

A toll ticketing system would have made possible more detailed billing of calls but only an increased cost which would not have assisted in any way the connection of calls. Although, with multimetering, a separate account for each call is not provided, this does not vary from the practice of other utilities which adopt bulk-billing for the supply of water, gas and electricity. However, there are instances such as guest houses or hotels where subscribers find it essential to have details of each call and it will be possible to provide, at an appropriate rental, meters at the subscriber's premises, from which th cost of each call can be calculated.

There will be a requirement, in certain cases, for access to the trunk line network to b barred from a particular subscriber's service. Instances of this could be from some extensions on private automatic branch exchanges or even on individual subscribers' serv Consideration will be given to the provision of this facility to subscribers, where practicable, upon payment of a suitable fee.

The adoption of the multimetering method as the basis for call charging in the subscribe trunk dialling system imposes special requirements for the design of the call rate charg schedule. The main requirement is that the tariff structure should be simplified as muc as possible to achieve the maximum benefits from the new system.

3. FEATURES OF MULTI-METERING SYSTEM.

3.1 With a multimetering system, the call charging equipment must, at the time of the call, ensure that pulses are applied to operate the calling subscriber's meter according to the duration of the call, after having determined the appropriate charging rate.

3.2 Adoption of Periodic Metering for Trunk Calls. On any particular call there are several ways in which pulses could be arranged to operate the subscriber's meter. For instance, a number of pulses could be applied at the start of a call to pre-register the charge for a 3-minute period. In this case, it would be necessary to time each call individually, so that the time of application of each group of pulses would be related accurately to the time of commencement of the call. With large numbers of calls of random time incidence to be handled by equipment individual to each connection, the total investment in exchange equipment for the charging function alone would be considerable.

Another method and the most equitable is periodic metering, in which the meter registers one unit at a time at regular intervals during the progress of a call. The intervals between meter registrations vary with the charging rates for the distances over which the calls are made. Periodic metering has the significant advantage that callers can relate the cost of a call more closely to the period of conversation. Charges for automatic calls are not then arranged in basic 3-minute periods and calls of short duration, even over a long distance, may cost only a very small fee.

This system is relatively simple to apply in practice because less precision is required in the timing of pulses in relation to the start of each call. A common source providing each of the required pulse rates can be used to serve a whole exchange or even a number of exchanges. The greatest difference in charges for calls of the same duration and to the same destination which could result, would be one unit fee. All calls being charged at a particular rate would be connected to one common source of pulses. In this way, the amount of individual charging equipment to be associated with a particular call is kept to a minimum.

In the metering system adopted for Australia the calling subscriber's meter operates once for each effective chargeable call, the first of the regular timed pulses arriving at random is suppressed and there is a fixed interval between subsequent pulses. The frequency of the regular pulses is determined by the particular tariff rate applying to the call.

This modification of the periodic metering system ensures that there will be one registration on all chargeable calls no matter how short the duration. However, the interval between the start of the conversation and the first regular pulse arriving at random can be less than the fixed interval appropriate to the call and to avoid the possibility of the subscriber being overcharged, this first regular pulse is suppressed.

3.3 Number of Charging Rates. Costs of multimetering equipment increase with the number of charging rates in the tariff scale because additional equipment is necessary to make the selection of the rate to be applied from a larger number of alternatives and the pulse generation equipment is more costly. The optimum requirement here is to have sufficient pulse rates generated to yield adequate flexibility for tariff changes, yet to keep the number as low as possible. The number of pulse rates which meets the requirements of the Australian system is 16, with pulsing rates as follows:- 3, 4, 5, 6, 9, 10, 12, 15, 18, 20, 30, 36, 45, 60, 90 and 180 second intervals. It is necessary to ensure that the addition of a limited number of pulse rates can be arranged readily if required at a later stage.

From these rates, an eight step tariff scale represents the most suitable balance at this stage between equitable charging and technical considerations. The eight timed rates, with the addition of the untimed unit fee charge for local calls and free calls to certain Post Office services, such as for "Information", make a total of ten individual charging categories from which the rate appropriate to any call may be selected by the equipment. Limitation to a maximum of ten categories makes most effective provision for the use of automatic switching equipment employing ten point rate selecting mechanisms or a decimal type of signalling in and between exchanges, as used in the present automatic system, for centralised control of automatic charging. Under this system, additional costs would be incurred and complexity introduced if more steps were required in the charging scale.

3.4 Determination of Charge Rate. The charging equipment determines the rate of charge to be applied to a call by examining the digits in the number dialled by the calling subscriber and selecting the appropriate rate from a range of categories in the trunk line tariff scale. It follows, then, that the cost and complexity of the equipment are closely related to the extent of the digital examination necessary and, as discussed, the number of different charging rates in the tariff scale. Because equipment design is influenced to a great extent by the digital examination necessary to determine charges of calls, there must be close co-ordination between the numbering plan and the call charging system.

3.5 Exchange to Exchange Charging. If exchange to exchange charging were employed as in the existing manual system, the charging equipment would have to examine sufficient digits to identify each of the exchanges in the Commonwealth of which there are approximately 7,300. On calls within a 5 digit numbering plan area, as described in Section II dealing with the numbering plan, this would require examination of one (D), two (DE) or three (DEF) digits for exchanges of 10,000, 1,000 and 100 lines respectively; in 6-figure numbering plan areas discrimination on an additional digit would be needed in each case.

For national calls other than those to capital city networks, four (ABCD) five (ABCDE) or six (ABCDEF) digit examination would be necessary for the three sizes of exchange. Exceptions would occur whenever all the exchanges with numbers commencing with the same A, B or C digit were situated in the same mileage category from a particular originating exchange.

Exchange to exchange charging would also require that charging equipment should be individual to every exchange with Subscriber Trunk Dialling facilities. Although to facilitate maintenance and secure some plant economies, it would be possible to centralise charging equipment at switching centres by the use of reverse pulsing, individual charge translations would still be required for each exchange.

3.6 Grouping Exchanges for Charging. For economic reasons then, a national Subscriber Trunk Dialling system with multimetering requires a departure from the principle of exchange to exchange charging and the adoption of a system, somewhat similar to that followed in Australian capital cities for many years, of grouping exchanges so that all exchanges in the group have a common charging basis. The charge for calls between any two exchanges is related to the distance between groups of exchanges to which they belong. Charging equipment need, therefore, only discriminate on sufficient digits to identify the called group of exchanges not the individual exchange. Also, all the exchanges in a group can share common charging equipment which can be centralised at a convenient switching centre. Pulses can be sent back to operate meters at remote exchanges or an indication of the charge rate can be sent back and used at the remote exchange to select the appropriate rate of meter pulses to be applied to the call.

Although grouping a number of exchanges for charging purposes effects economies in equipment, it follows that different rates may apply to calls between exchanges which are the same distance apart. Such anomalies based on distance considerations alone, are most noticeable on short distance calls, particularly in the case of exchanges with adjacent boundaries but which are located in different charging groups. They are not greatly significant on long distance calls. However, the distance between exchanges does not always reflect the cost of connecting the call. Even where the distance between exchanges is the basis for charging, there is still the possibility of a different rate applying between two subscribers' services which are the same distance apart, due to the irregular shapes of exchange boundaries.

If the grouping of exchanges could be so arranged that they covered areas of uniform shape and size, this would best satisfy charging requirements but the layout of trunk channels and switching equipment does not follow any regular geometric pattern. From the viewpoint of plant provision, to accept charging groups conforming to the layout of the trunk switching system would effect the greatest economies. The areas which the groups would cover following the adoption of this basis, however, would be very irregular in shape and varied in size. They would result in so many distance anomalies that they would be unsatisfactory for charging purposes. Some compromise between the two conditions is essential.

The foregoing aspects of group charging have been given careful consideration in designing the most suitable charging basis for application to the Australian system.

4. GROUP CHARGING PLAN.

4.1 A group charging plan has been designed to meet the requirements of the Australian telephone system, having regard to the characteristics of the distribution of trunk traffic as shown in Figure 8 of Section I. The plan recognises the modern trends for community of interest to extend over a wide range as shown by the large percentage of trunk line calls which are made over short distances up to 20 miles. Under the plan, most of these calls will become local calls. Again, as more than 80% of trunk calls cover distances of less than 100 miles, fairly accurate assessment of the distances involved on these calls is required and the zone charging basis ensures that this is achieved. Less than 20% of calls cover distances in excess of 100 miles and extremely accurate calculation of distances on such long calls is not required. The district charging plan recognises this characteristic and utilises it to achieve significant equipment simplifications.

4.2 Principles of Group Charging. The principles of the group charging system for the Australian network are illustrated in Figure 1. The basis is as follows:-

Local Charging. Exchanges are grouped to form zones. Calls within a zone and to adjacent zones will be treated as local calls.

Trunk Charging - on Zone basis. Zones are grouped to form districts. Calls (other than local calls) within a district and to adjacent districts will be charged at trunk rates based on the distance between zone centres.

Trunk Charging - on District basis. Calls between districts which are not adjacent will be charged at trunk rates based on the distance between district centres.

4.3 Determination of Charging Groups. In the plan the emphasis is on groups of exchanges rather than on geographical areas in referring to the charging groups. Groups of exchanges serve areas in which the subscribers' services connected to the various exchanges are located, but the principle of group charging is such that no fixed boundary lines are intended to define the extent of charging groups. Any new exchanges established will be included in the most appropriate group for charging purposes depending on the economic and community of interest factors influencing the network development.

The trunk switching plan referred to in Section IV, has been evolved having regard to community of interest and the most economic disposition of plant. It therefore provides the most suitable basis for the initial approach to the determination of charging groups. The general principles relating to the grouping of exchanges for charging purposes have been dealt with in Part 3 of this Section and have been applied in determining the zones and districts to be followed in the charging plan.

In practice, the minor switching areas in each secondary area were taken as the starting point. Where possible, the whole of a minor trunk area was included in the one zone. This was not possible in many cases and large minor areas were divided and some small ones combined to form acceptable zones. Under the trunk switching plan, nearly all traffic to and from a minor area routes through the minor trunk centre. This is, therefore, the most convenient location for centralised charging equipment which, at these centres, will be required to determine rates for calls either untimed unit fee, free calls or trunk calls - at least those based on zone charging. In grouping the exchanges in zones the aim was to have the average area covered by a zone approximately 150 sq. miles. Subject to this limition exchanges with similar community of interest were included within the one zone.

In the formation of charging districts, secondary trunk switching networks were taken as the starting point. However, in some cases because of the very large area covered by a secondary network or its irregular shape, it was found desirable to divide a secondary area for district charging purposes. In these cases, a minor switching area generally forms a charging district. Again, because of the small areas covered by some secondary areas, it was found desirable to combine two such areas to form the one charging district.
The charging equipment at switching centres of higher order than minor trunk centres and even at some minor trunk centres as indicated, will be required to determine rates on calls charged on the district basis, in addition to those charged as untimed unit fee, free calls or on a zone basis.

4.4 Extended Local Service Area. The importance of the extent of an individual zone is made much less critical by charging calls between adjacent zones at the same fee as for calls within a zone. By adopting the local call charge of one unit fee for an untimed call, a great deal of existing automatic equipment can be more effectively utilised during the period before special charging equipment is installed.

If a higher fee were applied on calls to adjacent zones, a short call across the limits of a zone would cost more than a longer call within the zone. Short distance trunk calls form the great bulk of trunk traffic and distance anomalies on these would cause adverse subscriber reaction.

By applying a uniform local call charge on calls within a zone and to adjacent zones, a "buffer ring" of local call access is placed around each zone. Not only does this overcome the anomaly mentioned, but the actual shape and size of the zone in which his exchange is located, loses some importance from a subscriber's view point. Of greater importance, is the extent of the limits of zones adjacent to the subscriber's own zone, which comprise the extent of local call access.

Although this still leaves some distance anomalies, trunk charging will not commence until a call goes beyond the adjacent zone and the number of calls affected will be smaller. It is possible, too, that different rentals based on the number of subscribers available at unit fee, may assist in overcoming anomalies.

The extent of the zones has the general effect of increasing the distance over which local calls can be made from any exchange to, typically, between 15 and 20 miles for calls between exchanges near zone centres, but as high as 35 miles in extreme cases.

4.5 Numbering Implications of the Charging Scheme. The charging plan has been carefully co-ordinated with the numbering plan and the extent of the digital examination to determine charge rates is as follows:-

(i) For calls within a numbering plan area, - not further than the E digit.

(ii) For calls beyond the numbering plan area but within the charging district or to adjacent charging districts, where charging is on a zone basis, - not more than the ABCDE digits.

(iii) For calls beyond adjacent charging districts, where charging will be on a district basis, - not more than the ABC digits.

5. SUMMARY

5.1 Summarised, the Australian Call Charging System will provide for :-

* Group Charging on the following basis -

(i) Local Charging: Exchanges will be grouped to form zones, calls within a zone and to adjacent zones being treated as local calls.

(ii) Trunk Charging on a Zone Basis: Zones will be grouped to form districts. Calls (other than local calls) within a district and to adjacent districts will be charged at trunk rates based on the distance between zone centres.

(iii) Trunk Charging on a District Basis: Calls between districts which are not adjacent will be charged at trunk rates based on the distance between district centres.

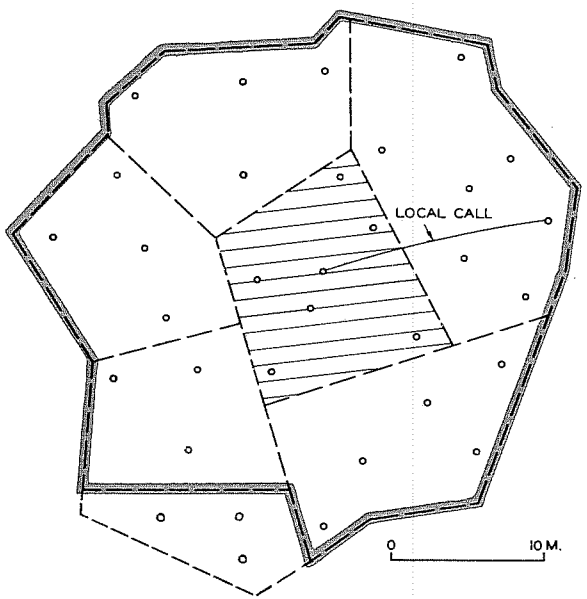
* Extended local service areas. Local calls, on a unit fee untimed basis, will cover many calls up to 25 miles and, in some cases, calls up to 35 miles.

* Multimetering on Trunk Calls. The system will be periodic metering in which the calling subscriber's meter will operate at regular pre-determined intervals during the progress of the call. The intervals between meter pulses will vary with the distance over which calls are made. The calling subscriber's meter will operate once when the called subscriber answers. The first of the regular timed pulses arriving at random will be suppressed and there will be a fixed interval between subsequent pulses.

* Number of Charging Rates. There will be eight timed rates in the trunk tariff structure.

* Subscribers' Facilities. Where practicable, subscribers will be able to have their services equipped with special meters at their premises or have their services barred access to the multi-metered trunk system, upon payment of an appropriate fee.

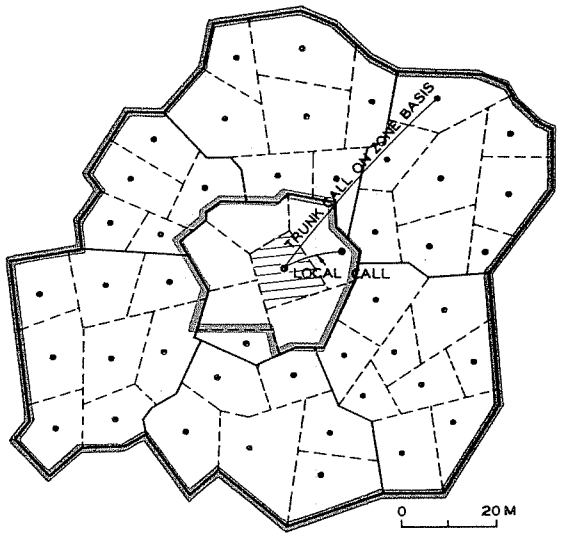
CALL CHARGING PRINCIPLES



LOCAL CHARGING

EXCHANGES ARE GROUPED TO FORM ZONES.
CALLS WITHIN A ZONE AND TO ADJACENT ZONES WILL BE TREATED AS LOCAL CALLS.

SHOWS THE LOCAL CALL RANGE FOR SUBSCRIBERS IN THE SHADED ZONE.



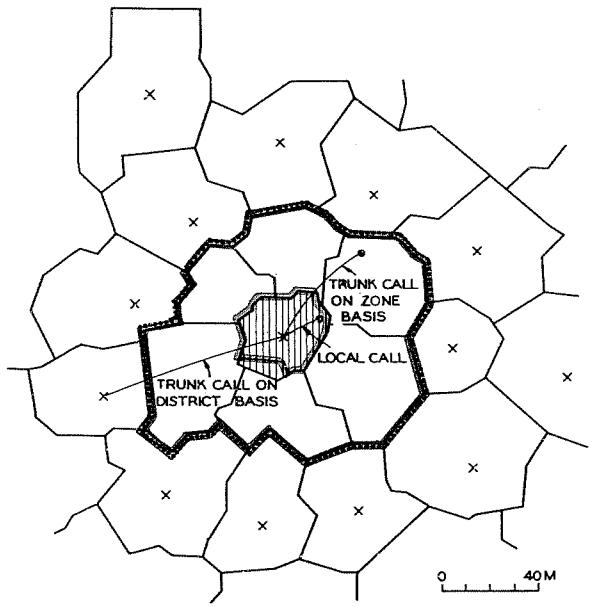
TRUNK CHARGING ON ZONE BASIS.

ZONES ARE GROUPED TO FORM DISTRICTS.
CALLS (OTHER THAN LOCAL CALLS) WITHIN A DISTRICT OR TO ADJACENT DISTRICTS WILL BE CHARGED AT TRUNK RATES BASED ON THE MILEAGE BETWEEN ZONE CENTRES.

SHOWS THE RANGE OF TRUNK CALLS FROM THE SHADED ZONE WHICH WILL BE CHARGED ON THIS BASIS.

SHOWS THE LOCAL CALL RANGE DESCRIBED IN FIG.I.

(this is the inner of the two boundaries)



TRUNK CHARGING ON DISTRICT BASIS.

CALLS BETWEEN DISTRICTS WHICH ARE NOT ADJACENT WILL BE CHARGED AT TRUNK RATES BASED ON THE MILEAGE BETWEEN DISTRICT CENTRES.

SHOWS WHERE DISTRICT TO DISTRICT CHARGING COMMENCES FOR CALLS FROM THE SHADED DISTRICT.

(this is the outer of the two boundaries)

FIGURE I.

COMMUNITY TELEPHONE PLAN

SECTION IV - THE SWITCHING PLAN

1. INTRODUCTION.

1.1 The switching plan described in this Section establishes the basic layout and functional design of the national telephone system for its economic development with extending mechanisation. It is upon the basic structure of the switching plan that the numbering and charging plans are developed. These three elements, in combination, define the national plan.

An automatic telephone system is characterised by the need for speech channels, within and between exchanges and for use by all subscribers, in sufficient numbers for calls to be made with a reasonable probability of success at first attempt.

The realisation of such a service, economically, and on a nation-wide scale, has been made possible by technical developments in telecommunications. These include exchange switching equipment performing automatically all the functions of the present local exchange and manually operated trunk service with call charging; coaxial cable and microwave radio transmission systems; and rapid dialling and signalling systems for the establishment and supervision of calls.

Since the form of the plan and the functional performance of the system equipment are inseparable elements, both these aspects are discussed in setting out the fundamental plan. The basic technical requirements specified leave maximum room for the adoption of new and improved equipment and systems, as the art advances. In preparing the detailed design specifications, incorporating the basic technical requirements, there will be adequate definition of the essential conditions for direct inter-working between existing and new plant.

In the future national telephone system, the trunk and local networks will lose much of their individual identity. The extension of subscriber dialling to the trunk system and increasing application of electronic equipment in local networks are two factors which will cause this increased similarity. The switching plan will advance the integration of the local and trunk networks by the use of similar switching and signalling techniques.

The present service, which has two million telephones connected, handles nearly four million calls a day. The calls not completed within the local exchanges are routed over either extensive metropolitan networks of inter-exchange circuits or the trunk line network of more than 16,000 channels, some of which exceed 2,000 miles in length.

The operator-controlled trunk system has been mechanised to a considerable extent. Operators can now dial over trunk lines directly to subscribers connected to most of the automatic exchanges throughout Australia. The basic routing arrangements which have already been developed in this network will be suitable, with some modification, for subscriber trunk dialling.

1.2 Traffic Routing. Two fundamental characteristics of telephone traffic must be taken into account in the design of an automatic switching system to carry the traffic load in the most economical manner. These are :-

(i) The higher efficiency of large groups of circuits. For groups of circuits providing the same grade of service, the average traffic carried by each circuit increases with the size of the group. As an example, Fig. 1 shows this increase in efficiency for groups providing a grade of service of 1 in 50.

(ii) The diminishing returns from the provision of extra circuits. In the case of a route offered a fixed amount of traffic, if circuits are added one by one, each circuit will contribute a diminishing amount to the traffic carrying capacity of the group. This characteristic is illustrated in Fig. 2 which shows the incremental traffic carried by a group of circuits, offered 10 Erlang of traffic, with the addition of each circuit. It will be seen that the later circuits which must be provided, if the grade of service on this group is to be good, are very inefficient. In the example shown, 17 circuits would be required to give a grade of service of approximately 1 lost call in 100 and the 17th circuit provided would only give an increment of .09 Erlang in the total traffic carried by the group.

Considering characteristic (i), the application of automatic switching equipment at intermediate points in a multi-link connection, in place of manual operators, has made it practicable to reduce the setting up time of connections and improve circuit occupancy. It has also resulted in the building up of larger groups of trunks between these points, by combining traffic for various destinations, thereby further increasing average circuit efficiency.

As a development in the application of automatic techniques, modern switching equipment with its greater flexibility and speed allows the principle of automatic alternative routing to be employed with advantage. This gives the opportunity for alternative choices to be made in the routing of calls, not only at the originating exchange, but at all the intermediate points on multi-link connections. Traffic is first offered to the most direct circuit to the destination exchange, but, if an "all circuit busy" condition is met the call is routed by alternate paths. By this means, the number of routes which must be provided with inefficient "last choice" trunks is greatly reduced. On many routes, circuits are provided for traffic loading only to the point where the remaining traffic is carried more economically over the available alternate routes.

Automatic alternative routing thereby provides a means of securing the most economical handling of traffic by counteracting the condition of the diminishing return described in (ii) above, and by combining residual traffic into larger and more efficient groups.

Alternate routing improves the performance of the switching system in other ways. It takes advantage of the fact that peaks of traffic within the busy hour or even complete busy hours may not coincide for different routes. Peak traffic overflow from different groups to the same alternate route may not therefore occur simultaneously. Also, if there is a breakdown on a route, alternative routing gives some protection to the service.

2. THE SWITCHING NETWORK.

2.1 In Section I, it was shown that the bulk of Australia's population is concentrated in the cities and regions located on or close to the eastern and southern coastline. The telephone traffic is similarly concentrated in these areas. However, the remainder of the population is widely dispersed and it is necessary to provide service to all parts of the continent. The national switching plan, therefore, establishes an optimum traffic routing pattern for inter-exchange connections.

Important questions of the size and location of subscribers' local exchanges, line reticulation and telephone facilities, are related but separate considerations. The local line standards established however, influence the transmission design objective specified for the inter-exchange network. The range of telephone facilities and services provided for the public affect the detailed design of the switching system equipment. In the switching plan described in this Section, the factors relating solely to the economic provision of local exchange services are not discussed.

2.2 The Basic Network of Final Routes. The foundation of the switching plan is the network of final routes. This network inter-connects all exchanges. The final routes are shown by full lines in Fig. 3, and are defined as routes for which no later choice alternate routes are provided. They are equipped with sufficient circuits to ensure that there is only a small probability of lost calls for the traffic offered in the busy hours, thus controlling the overall system grade of service. Because they are generally large groups, the average efficiency of their circuits is high.

2.3 The Classification of Switching Centres. The switching centres must be classified so that tandem connections are made in a systematic manner. This ensures that the design maximum for the number of links which may be connected in tandem, imposed by switching and transmission considerations, will never be exceeded. It also enables the permissible transmission losses to be assigned to individual routes so that satisfactory performance can be given on multi-link connections.

In Australia, with its great distances and particular distribution of population, five classes of switching centre are used in order to take the fullest advantage of the automatic switching system using alternate routing. The centres are classified according to their position in the final route pattern with respect to centres of lesser order. The classification applies to all exchanges, whether located in metropolitan or country networks, and has no relationship to the number of subscribers' lines connected.

The classifications of switching centres, with the standard symbols employed, are shown in Fig. 3 and are defined thus :-

A Terminal Exchange is an exchange which performs no through-switching of inter-exchange circuits.

A Minor Switching Centre switches the final routes for Terminal exchanges only.

A Secondary Switching Centre switches the final routes for Minor switching centres and also, if required, Terminal exchanges.

A Primary Switching Centre switches the final routes for Secondary switching centres and also, if required, Minor switching centres and Terminal exchanges.

A Main Switching Centre switches the final routes for Primary switching centres and also, if required, Secondary switching centres, Minor switching centres and Terminal exchanges.

In referring to the final route connection of an exchange, through its parent switching centre, to the Main switching centre, the term "Final Route Chain" or "Final Chain" is used.

The basic switching plan for the Commonwealth as defined by the network of final routes and the classification of switching centres has been prepared. The classification of the principal switching centres and their final route inter-connection are shown schematically in Appendix I. The Appendix also contains the reference numbers of the switching plan for each State as at specified dates.

In each State, one city is designated as the main trunk centre. The areas served by the main centres, as determined after investigation, are shown in Fig. 6. The areas do not co-incide with State boundaries in all cases. Neither do they coincide completely with the A digit allocations shown in Section II, Fig. 1. This result arises from the different basic objectives governing the design of the numbering and switching sections of the plan. Exact correlation is not necessary, since the plan specifies a register-controlled switching system, in which numbering and routing functions may be separated when required.

In Section II it was shown that the basic network on which Numbering Plan Areas would generally be developed is the Secondary Switching Network. A typical example is shown in Fig. 5.

The relationship between the switching plan and the grouping of exchanges into zones for the call charging system, as discussed in Section III, is another factor in the design of the overall plan.

As with the allocation of the A, B and C digits in the numbering plan, the upper level classifications in the switching plan are expected to be relatively stable for a long period. The major trunk routes are provided between these centres which are located in the principal cities.

The maximum number of links which may be connected together ultimately will be nine. This will occur on terminal to terminal calls using the final routing shown by the full lines in Fig. 3. In the early stage of implementation, the maximum number of links may exceed the planned limit. Tandem connection of two Main to Main links will be used in some cases until channel provision is adequate for a mesh of final routes to be established interconnecting all Main switching centres.

In practice, connections involving the maximum number of links will be extremely rare since most of the trunk traffic terminates within 100 miles and because direct routes will be tried at many switching centres involved in such a connection before the call is connected over the final chain.

2.4 Early-choice Routes. Superimposed on the system of final routes is a network of early-choice routes. An early-choice route is one for which one or more alternate routes are provided. It provides a preferred direct link between any two centres, which can carry a portion of the traffic offered more economically than the alternate routes. The number of channels provided on such routes is determined by economic considerations. The optimum division of the offered traffic between a direct and alternate route occurs where the cost of handling marginal amounts of the offered traffic on either direct or alternate routes is equal.

Examples of early-choice routes are shown by dotted lines in Fig. 3.

2.5 Control of Alternate Routing. The routing of traffic throughout the network of early-choice and final routes will be automatically controlled by the switching equipment so that :-

(i) Calls cannot be routed over one link more than once during the establishment of a connection.
(ii) The design maximum of nine links is not exceeded.
(iii) The transmission loss assigned to early-choice circuits may be as high as possible, within the limits set by the transmission plan.

To achieve this control, the following conditions will be applied :-

(i) At each switching centre, encountered in setting up a call, early-choice routes will be tested in order for a free outlet commencing with the most direct route, before a call is offered to the final route.
(ii) Calls originating in one final route chain and switched to another will then only be switched to exchanges of lower classification in that chain - they will not be switched to centres of higher classification, or to a third chain.

An example of the possible alternate routes for a call between Albury and Wagga, two large centres in New South Wales, is shown in Fig. 4. The diagram shows their relative geographical position and the order in which the outgoing routes are tested at each switching centre.

3. ESTABLISHMENT OF MULTI-LINK CONNECTIONS.

3.1 The development of the national automatic telephone system with closed numbering and a multi-link interconnecting system employing alternate routing can only be accomplished efficiently by the application of "register-controlled" switching equipment.

Switching systems may be considered in two broad categories :-

(i) direct-pulsing systems
(ii) register-controlled systems.

Direct-pulsing systems are based on the principle that selection of an outlet at each stage of switching is made as each digit is dialled by a subscriber. Numbering and routing are, therefore, mutually dependent. The greater the number of switching points encountered in the routing of a call, the greater the number of digits which would need to be dialled by a subscriber. The national plan could not be implemented using the direct-pulsing switching principle exclusively.

Register-controlled systems allow the routing and numbering to be substantially independent. However, even with such systems there are advantages to be gained by a systematic allocation of numbers. The register is a control device which is associated with the connection only during the setting up of a call. It is interposed between the subscriber's dial and the routing selectors. It stores the digits dialled and translates the dialled information into the form required for the connection to be established. The number dialled need only define the destination, the register-translator supplies the information on how best to reach that destination from its own particular location. By using this switching principle simple closed numbering can therefore be used with the type of switching plan described.

Register-controlled switching equipment will be used for the development of the future telephone system. There are many methods of register control, however, and the general specification of the preferred method and of the associated signalling system is as follows.

3.2 Method of Register Control. More than one register will be used in the setting up of a typical connection. A register at the originating exchange, or its parent switching centre, will control the setting up of the connection. It will store the number dialled and will transmit digits on demand from registers at other switching centres involved in the connection. Registers at these centres will call, by special signals, for sufficient digits to allow only their centre's part, in the setting up of the connection, to be performed. At intermediate switching centres on long distance calls these digits will usually be the ABC digits of the national number. Finally, a centre will be reached from which the switching of the call can be completed. A register at this centre may signal for the called subscriber's number from the originating register, or the code receivers in the terminal exchange switching stages may call for the digits from the controlling register.

3.3 Signalling. With the type of register control described above some post-dialling delay may be experienced on calls which traverse a number of links. However, in the past, subscriber-controlled automatic service in Australia has been provided by direct operating switching equipment. Consequently, the public is unaccustomed to post-dialling delay. High speed signalling and switching will be employed with the register-controlled system in both the junction and trunk network to reduce the post-dialling delay to a minimum and so avoid unfavourable comparison between existing and new equipment.

Reduction in the setting up time also means less time during which expensive plant is held unprofitably and, in some cases, a reduction in the amount of common equipment which must be provided.

In the future register-controlled switching system, the inter-exchange signalling functions will be performed by two separate but complementary signalling systems.

3.3.1 Line Signalling. Certain signals are transmitted and received by the individual line relay sets and are not controlled by the common equipment which is temporarily engaged during the setting up of a connection.

Examples of signals of this type will be :-

seizure signal;	answer signal;
clear forward signal;	clear back signal;
release guard signal;	blocking signal.

It will be possible to use many existing types of line signalling systems to provide line signals. Direct current, 50 c/s, in-band voice frequency signalling using suitable frequencies, and out-of-band signalling systems, will all find application in the future network.

3.3.2 Information Signalling. These are the signals exchanged between the common equipments which are temporarily engaged during setting up of a connection.

Multi-frequency code signalling has been selected as the most suitable method for high speed transfer of the information signals in the forward direction. With this signalling method transfer of information at a speed of approximately ten digits per second can be achieved. Each multi-frequency code will consist of two frequencies enabling the signalling to be self-checking and very reliable. Six frequencies in combination are used for forward signals, giving ten codes to represent the decimal digits and five auxiliary codes.

It is clear that multi-frequency codes are required also for backward signals if an indication of terminating conditions is to be provided. Different frequencies will be used, for forward and backward signals so that simultaneous transmission may occur.

3.3.3 Dial Pulsing. Although press button sending devices may ultimately be provided generally with the subscriber's instrument, enabling high speed code signalling to be used, for many years the dial will be the standard signalling device. Dial pulses will therefore be received by the exchange equipment from subscribers' telephones. The existing exchanges which have been developed with direct operating equipment will continue to use dial pulse inter-exchange signalling until economies in plant provision, or restrictions in numbering flexibility, make desirable the provision of a more flexible first stage switch. The exchange concerned will then participate directly in the high speed network.

New Terminal exchanges in the country may also transfer dialled information to their parent centres by means of dial pulsing for simplicity in the design of these normally unattended exchanges.

A considerable amount of trunk signalling equipment designed for dial pulsing is already available. Some of this equipment may find application in providing the "line signalling" function described in 3.3.1 or for the dial pulsing requirement between Terminals and their parents. It is possible also that whilst the major networks are predominantly using dial pulse signalling, early choice routes to them may be satisfactorily equipped with the existing dial pulse signalling equipment.

Fig. 7 shows typical connections between country and metropolitan Numbering Plan Areas. The signalling on each link, the metering pulse transmission and the incorporation of new, modified and existing exchanges in the metropolitan networks are indicated.

4. TRANSMISSION.

4.1 General. Present transmission limits, namely, the overall transmission limit, the local transmission limits, and the trunk transmission limits, provide for a standard of transmission between subscribers which is consistent with that in use in other countries and, in particular, with the recommendations of the C.C.I.T.T. for national sending and receiving transmission objectives. The proposal to introduce automatic switching in the trunk network on a widespread scale, ultimately under the control of the subscriber's dial, has necessitated a re-examination of the trunk portion of the transmission plan.

There are two reasons for this. In the first place, the use of alternate routing and the possibility of as many as nine or ten links in tandem will give rise to transmission problems. Subscribers may obtain successive calls even to the same destination over varying numbers of channels. Transmission planning must provide satisfactory and comparable transmission on all calls. In the second place, since under conditions of subscriber trunk dialling there will be no operator to act as a buffer between the subscriber and the trunk network, it will be necessary to take steps in the engineering plant to reduce the probability of a subscriber encountering an unsatisfactory connection. This will be done by increased use of automatic test and control units but will also involve changes in the transmission plan.

The ideal would be to operate all circuits as zero links since this would make the transmission level independent of the number of links connected. However, to ensure stability of connections and to prevent the unacceptable echo conditions that could arise due to the long distances involved in Australia, all higher-order circuits will be designed to have small attenuation.

Satisfactory stability and echo performance depends to a large extent on the achievement of a relatively high return loss where 4-wire circuits convert to 2-wire circuits and at 2-wire switching offices. It is expected that adequate performance can be achieved in three ways :-

(i) insertion of attenuators between subscribers' lines and 4-wire amplified circuits (stability pad switching)
(ii) impedance matching and correction of 2-wire circuits to nominal 600 ohms, and
(iii) provision of precision balances, associated with some 2-wire circuits.

The detailed make-up of the new transmission plan now being prepared for the trunk network will require the availability of suitable switching facilities which must provide discrimination in switching stability pads and level-adjusting pads.

At transit switching points, true 4-wire switching is preferred. At some lower-order transit switching points the most economical initial switching scheme may be 2-wire while later developments may render 4-wire switching preferable. The initial equipment installation should be sufficiently flexible to allow this change to be made with the minimum of inconvenience.

To ensure satisfactory transmission the plan will specify certain objectives to control -

(i) overall attenuation
(ii) noise
(iii) stability
(iv) echo
(v) crosstalk
(vi) distortion.

4.2 Design Basis. The new trunk transmission plan will provide for small losses in each high order link in the trunk network. Switching pads would be brought into each connection as required. Individual link attenuation rather than overall built up connection attenuation will be specified.

In the development of the Australian transmission plan for the trunk network, due regard is being taken of the need to provide for inter-connection of the Australian network by submarine cables to the networks of other countries. Australia is participating in the work now being done in establishing new standards for the inter-continental network. The Australian transmission plan will be kept compatible with the international recommendations.

Echo suppressors will be required on most international connections. They are unlikely to be necessary on the national network, but their exceptional use on a few very long interstate routes may need to be considered in the light of future experience.

Noise, crosstalk and distortion limits are all recommended by the C.C.I.T.T., and Australian standards will be comparable with these recommendations.

5. SUMMARY.

5.1 Summarised, the Australian switching plan provides for :-

* Extensive use of the principle of alternate routing.
* Early choice routes, on which the number of circuits provided is determined by economics.
* A back-bone system of final routes which are engineered to achieve a good overall grade of service.
* Switching centres classified as Main, Primary, Secondary, Minor and Terminal.
* Maximum multi-link connection of nine links ultimately.
* Register-control of switching, with high-speed multi-frequency codes used for transfer of information.

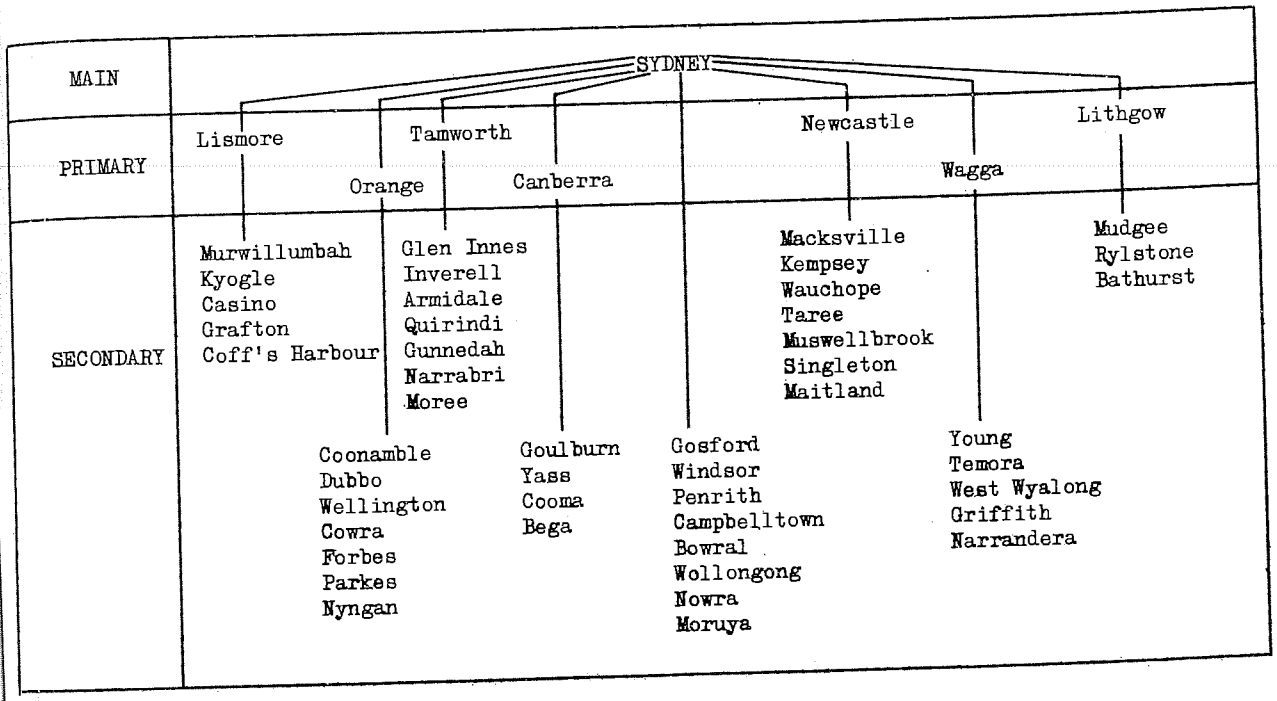
It has the following features :-

* Achieves the most economical use of plant;
* Ensures a satisfactory standard of transmission on all calls;
* Avoids excessive post-dialling delay on calls routed over multi-link connections.

CLASSIFICATION OF PRINCIPAL SWITCHING CENTRES IN AUSTRALIA

The final route pattern interconnecting these centres is shown.

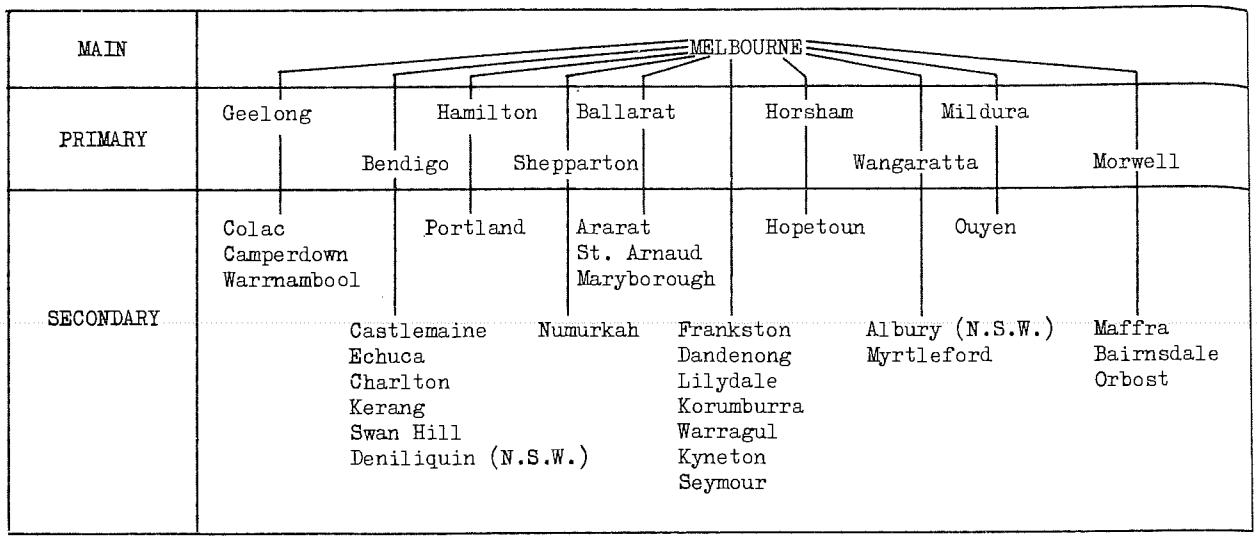
NEW SOUTH WALES (See Drawing CP50 for detail)



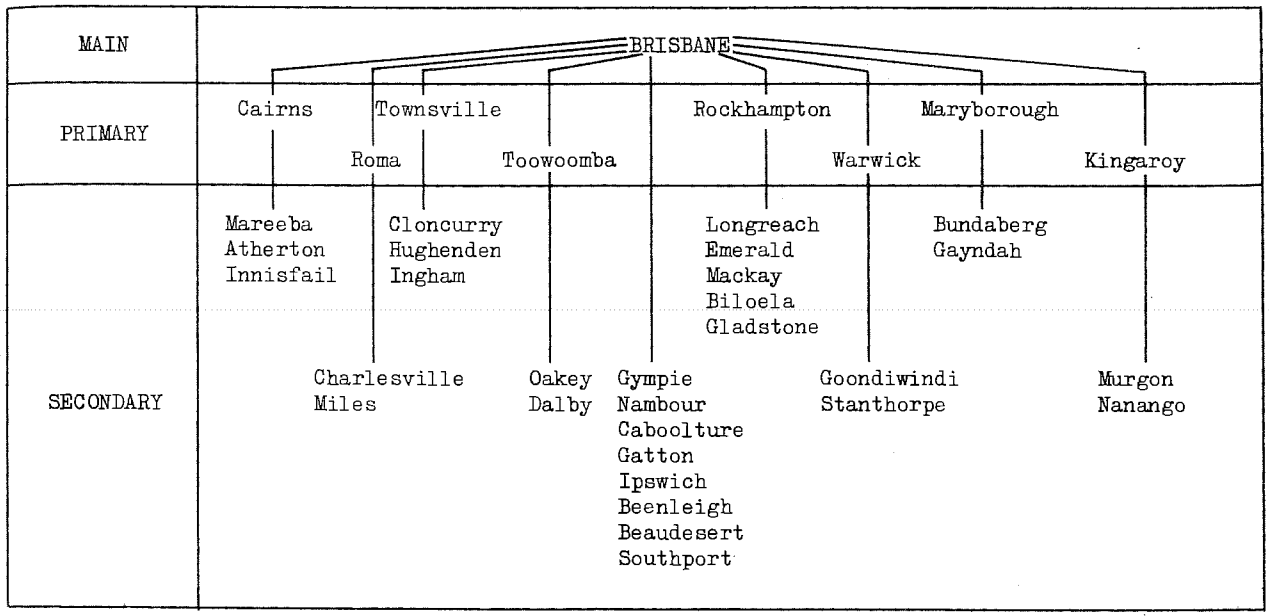
SECTION IV.

APPENDIX I.

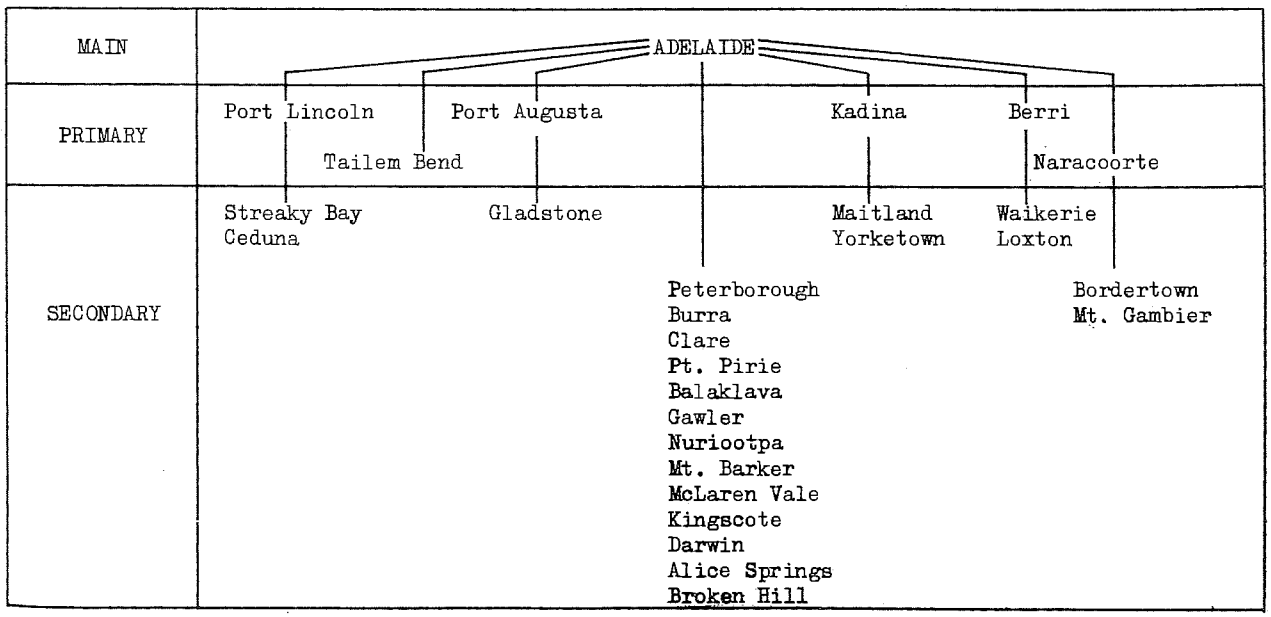
VICTORIA (See Drawing CP52 for detail)



QUEENSLAND (See Drawing CP54 for detail)



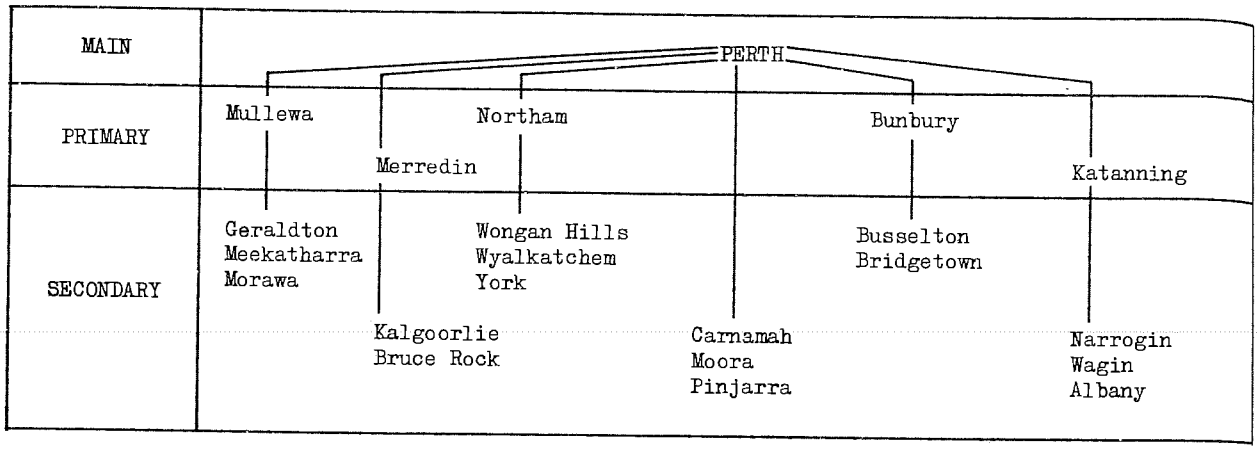
SOUTH AUSTRALIA (See Drawing CP56 for detail)



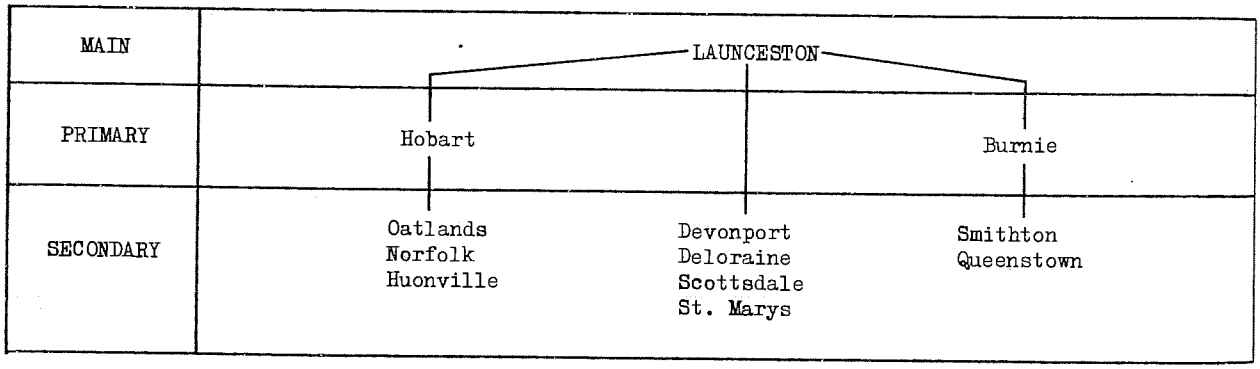
SECTION IV.

APPENDIX I.

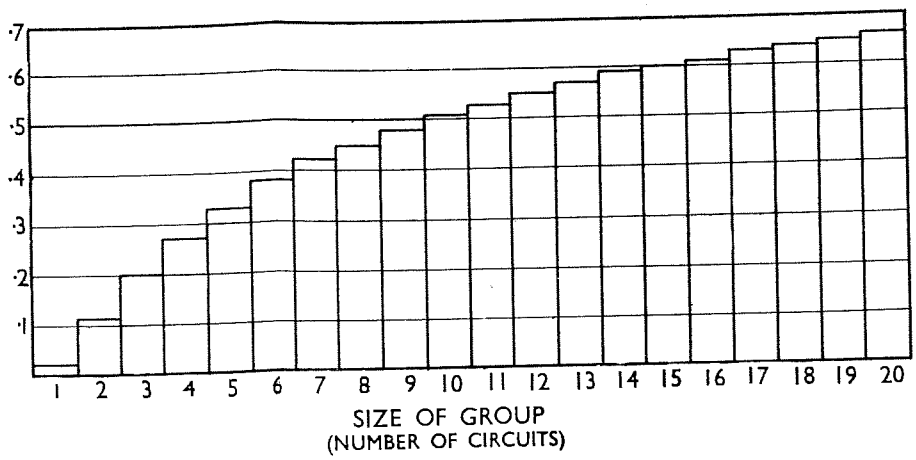
WESTERN AUSTRALIA (See Drawing CP58 for detail)



TASMANIA (See Drawing CP60 for detail)

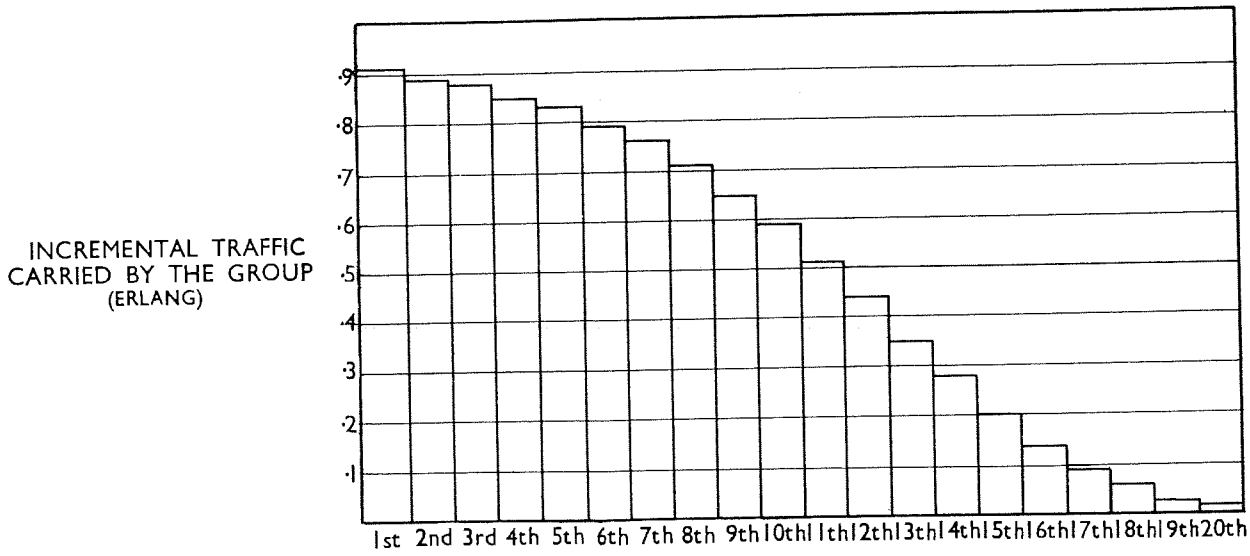


TELEPHONE TRAFFIC



AVERAGE TRAFFIC CARRIED PER CIRCUIT IN DIFFERENT SIZED GROUPS WITH FULL AVAILABILITY AND A CONSTANT GRADE OF SERVICE (IN THIS CASE 1 IN 50)

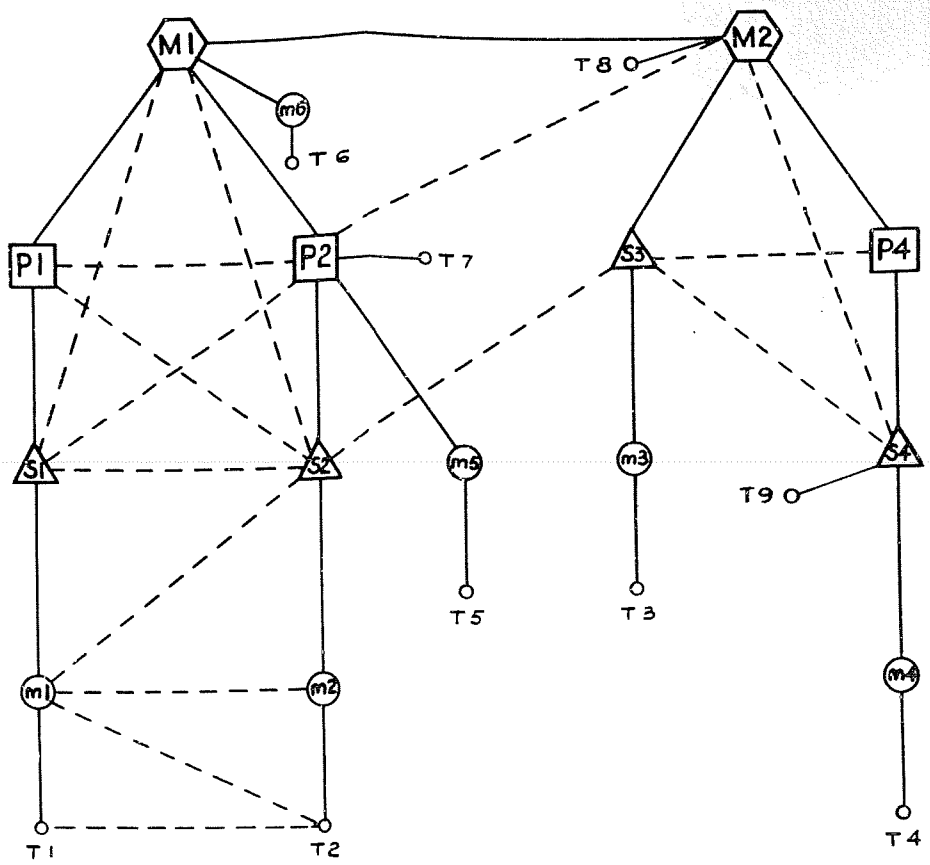
FIGURE 1.



INCREMENT IN THE TRAFFIC CARRIED BY A FULL AVAILABILITY GROUP OF CIRCUITS, WHICH IS OFFERED 10 ERLANGS OF TRAFFIC, WITH THE ADDITION OF EACH CIRCUIT.

FIGURE 2.

ROUTING PATTERN



LEGEND

TRUNK SWITCHING CENTRES

- M — MAIN CENTRE
- P — PRIMARY CENTRE
- S — SECONDARY CENTRE
- m — MINOR CENTRE
- o — TERMINAL

——— FINAL TRUNK GROUP

– – – – TYPICAL HIGH USAGE TRUNK GROUP.

FIGURE 3.

EXAMPLE OF ALTERNATE ROUTING

CALL FROM ALBURY (N.S.W.) TO WAGGA (N.S.W.)

NOTE : FIGURES SHOWN THUS ① INDICATE THE ORDER IN WHICH THE ROUTES ARE TESTED AT EACH SWITCHING CENTRE ON THIS CALL.

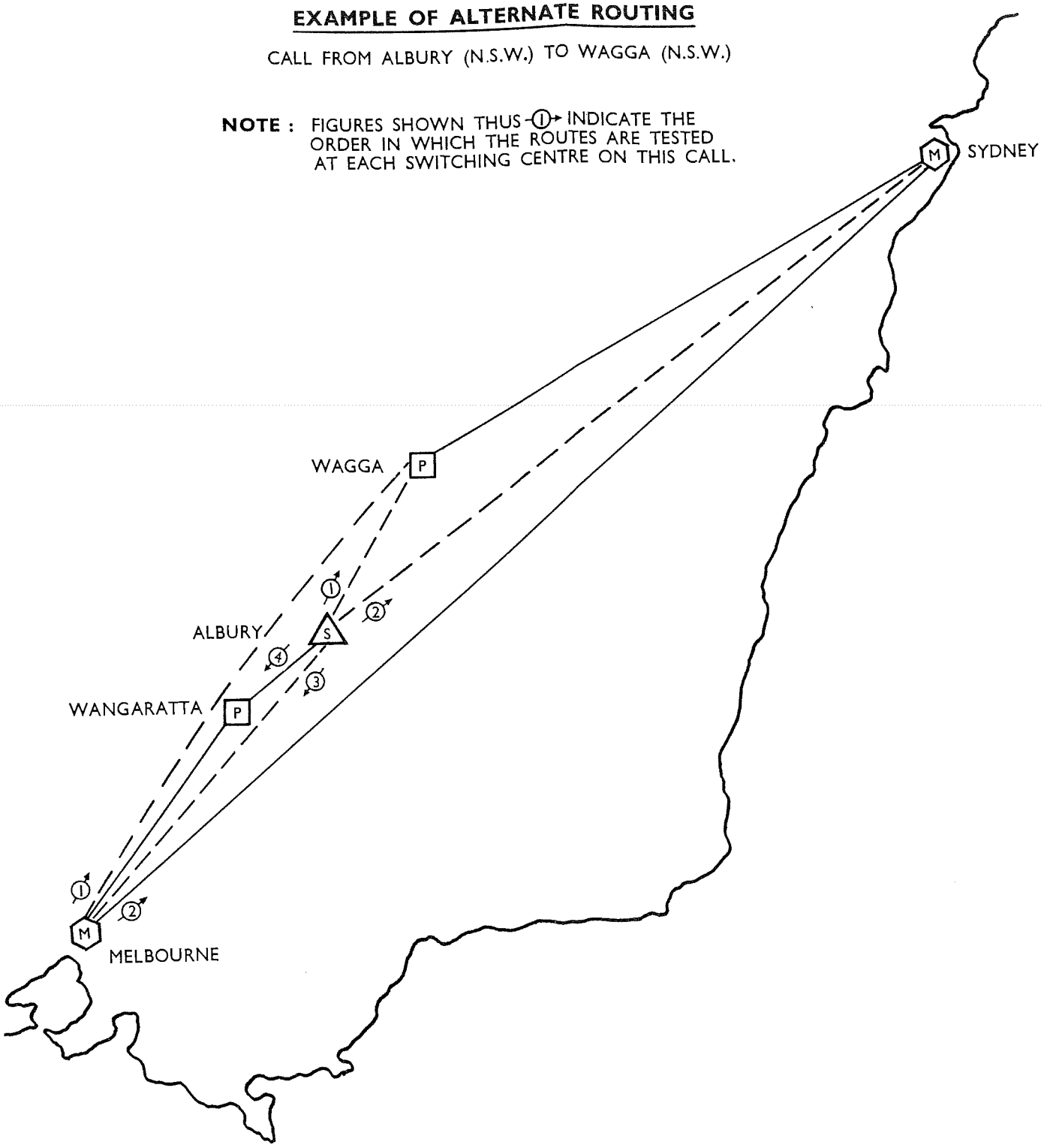
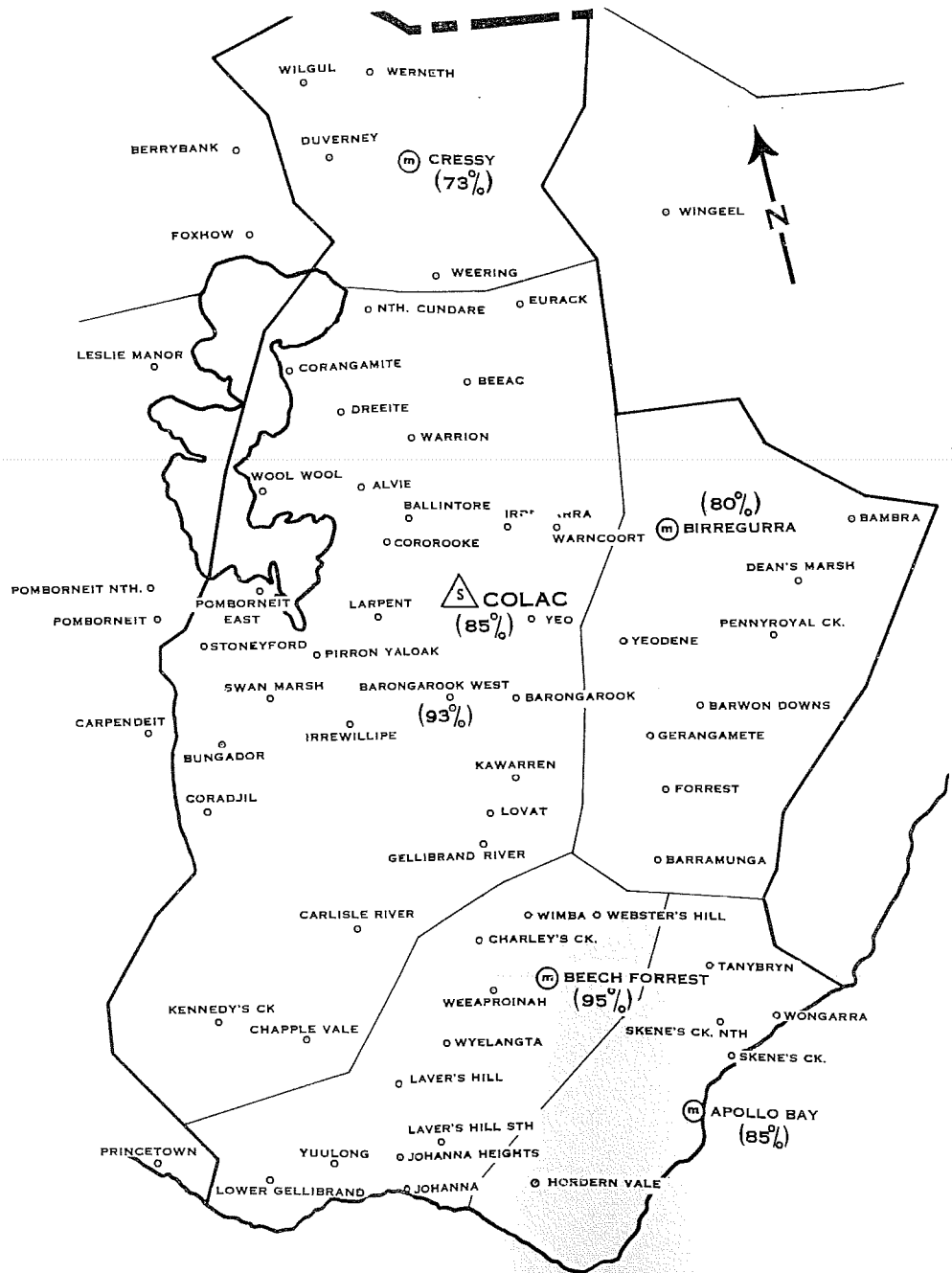


FIGURE 4.

VICTORIA — AUTOMATIC TRUNK SWITCHING PLAN

SOUTH WESTERN GEELONG



SECONDARY SWITCHING CENTRE

MINOR SWITCHING CENTRE

10 15 20 25

SCALE OF MILES

ES TRAFFIC (LOCAL & TRUNK)
ING IN THE SECONDARY AREA
SSED AS A PERCENTAGE OF
AL ORIGINATED TRAFFIC

FIGURE 5.

MAIN SWITCHING AREAS IN AUSTRALIA

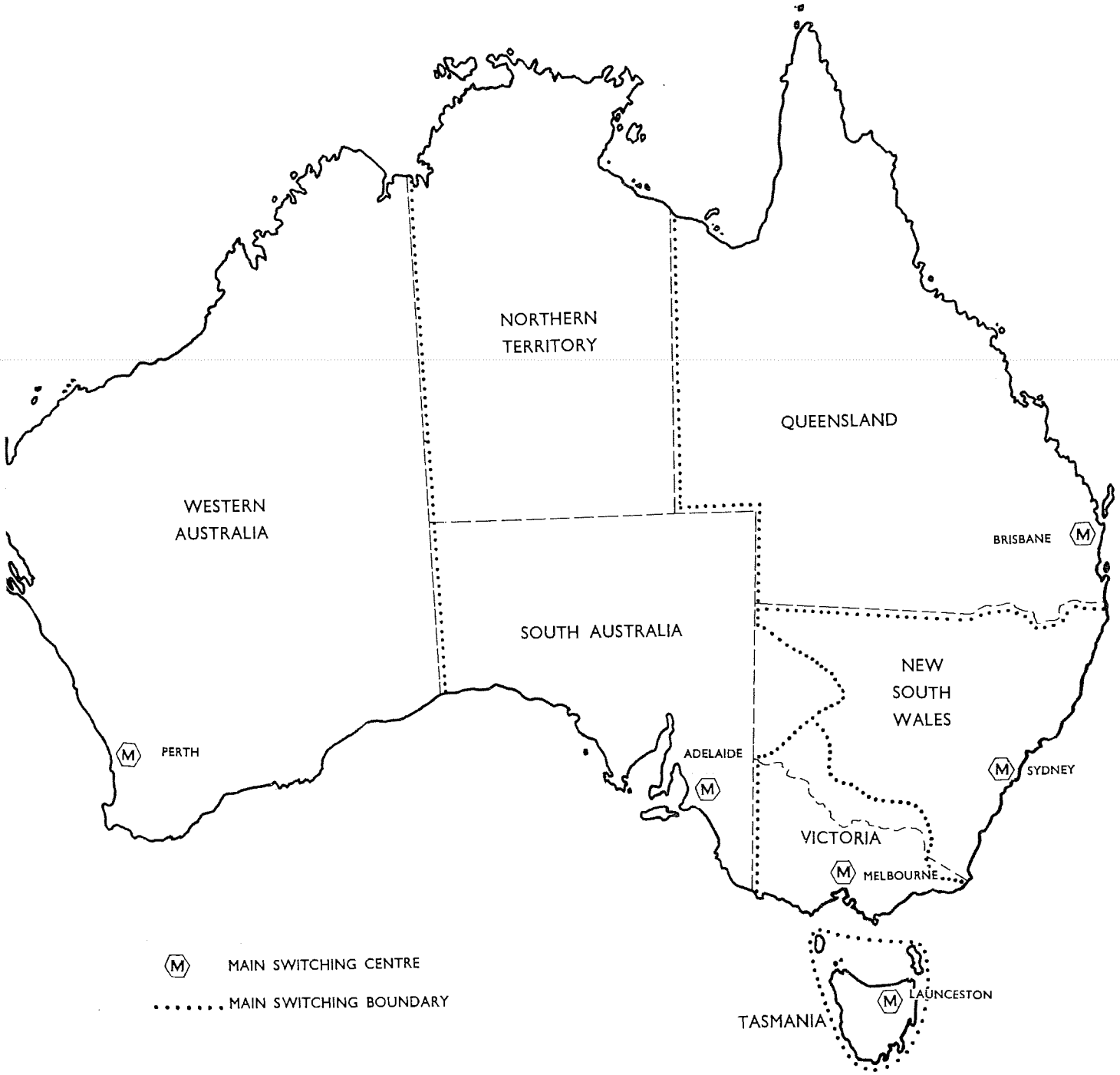


FIGURE 6.

NATIONAL CALLS TO AND FROM METROPOLITAN NETWORKS

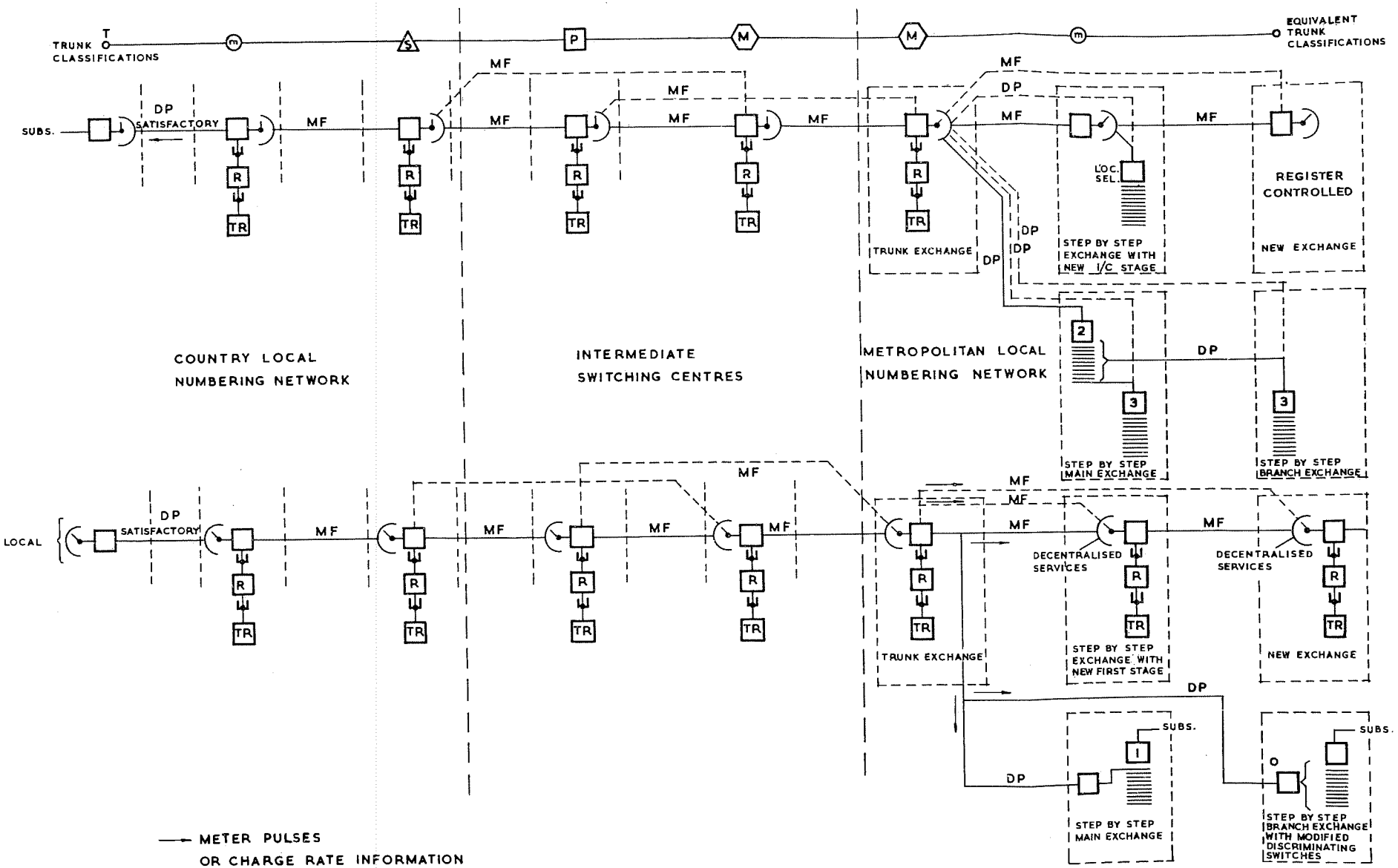


FIGURE 7.

COMMUNITY TELEPHONE PLAN

SECTION V - MAJOR PHASES OF IMPLEMENTATION

1. NEW TELEPHONE POLICY.

1.1 The development of a new national telephone plan with the long term objective of a fully automatic subscriber trunk dialling service has been dealt with in the foregoing Sections. The major phases of implementing the national plan involve action in all Divisions and Branches of the Department, particularly in the Engineering and Telecommunications Divisions, and are discussed briefly in this Section.

During the preparation of the plan, attention was necessarily given to aspects of implementation and a great deal of action has already been completed or is in progress. Much remains to be done to develop plans in detail for smooth and efficient implementation of the plan, of which one of the main features is that it can be introduced in planned stages of development towards the ultimate objective.

The new telephone policy announced by the Postmaster-General in the White Paper entitled "Progress - Policy - Plans" in August, 1959, referred to in Section I, lays the foundations for the future economic and efficient development of the telephone system. It is the first major step in the implementation of the national telephone plan.

2. TARIFF ASPECTS.

2.1 With a subscriber trunk dialling service the adoption of a simplified tariff structure as described in Section III is essential. The main points of the new tariff structure are extended local service areas and the adoption of group charging and multimetering of trunk line calls.

2.2 Group Charging. In order to carry out the grouping of exchanges into charging zones, and the grouping of zones in turn into charging districts, the services of officers with local knowledge of the service, engineering and commercial factors involved in each State were utilised under Headquarters' direction. The task involved consideration of every exchange in the Commonwealth. The group charging scheme necessitated close co-ordination with the national numbering and trunk switching plans and was advanced to the stage where its implications could be ascertained before determining policy.

Work is in progress now within the Administration on the calculation of detailed charges for calls on a zone and district basis and the preparation of advice for distribution to all exchanges.

2.3 Tariff Schedules. In developing the new policy, extensive studies of general tariff aspects were made having regard to the much greater extent of local service areas and the new basis for trunk charging. Amendments to Telephone Regulations are being arranged and a great deal of detailed administrative work is well advanced at Headquarters. Much detailed work is involved in the State organisations, affecting each subscriber's service and every exchange in the Commonwealth.

2.4 Publicity. Introduction of a new system of charging requires publicity for the information of staff and the education of customers. New instructions covering many operational aspects are necessary. Typical publicity measures include information for inclusion in telephone directories, special advice to subscribers and revised public telephone notices. Brochures are being prepared at Headquarters and plans developed to utilise media such as press, radio and television.

3. NUMBERING

3.1 Having prepared 50-year estimates of the extent and distribution of telephone development, an allocation of the higher order numbering was made for the Commonwealth. This allocation of A, B and C digits to particular networks is referred to in Section II.

3.2 Numbering within Areas. The adequacy of the allocations of A, B, and C digits was checked when model numbering within each numbering plan area was carried out in close co-ordination with the charging plan.

SECTION V.

The model numbering scheme, covering each exchange in the Commonwealth is based on full automatic operation with register-controlled switching equipment. It will be of considerable assistance when detailed planning for a particular area is undertaken. The principles discussed in Sections II and III, were the basis for the procedures adopted in allotting the numbering.

Referring to the more general case of 5 digit numbering plan areas, the general procedure adopted was as follows:-

(i) Consider the number and location of charging zones, together with the number of exchanges in each zone having regard to probable amalgamations of existing exchanges or proposed new exchanges. These factors, with the estimated subscriber development for each exchange, comprise the basic data for the allocation of numbering.

(ii) D digits were allotted to the exchange or exchanges serving the Secondary centre, allotting the lowest D digits to the exchanges with the largest volume of terminating traffic. The D digit 0 could not be allotted, being used as trunk access code, and D digit 1 was not allotted at this stage but reserved for possible later use under register control.

(iii) The remaining D digits were allotted in the numbering plan area so that the charging zones are identified by either D or E digits. That is, the F digits for any E digit were not allotted to more than one charging zone. 4.3

Reserve capacity, desirable because of the difficulty of forecasting development accurately for each exchange and the low numbering efficiency where there is a large number of small exchanges, was planned by reserving some of the E digits of each D digit and some of the F digits of each E digit.

(iv) The D digits were allotted in an orderly sequence with the aim of facilitating design of interim numbering schemes and to simplify routing and charging discrimination requirements as far as possible. Each network required examination to determine the optimum arrangement. Where possible, D digits were allotted exclusively to minor switching networks. This enables a certain amount of ultimate numbering to be achieved in early implementation stages with step by step techniques, particularly with regard to the trunking of the main switching centre in the network.

(v) The zones with the smallest volume of terminating traffic were allotted the higher D digits and this principle was generally observed with E and F digits.

(vi) Most country terminal exchanges were designated by DEF codes but when an exchange required more than 3 F digits in the early stages, say 10 years, then a complete E digit was allocated.

4. MANUAL EXCHANGES.

4.1 The full implementation of an automatic subscriber trunk dialling service is a long term objective, and consideration was given in the numbering project to dealing with manual exchanges which will, of necessity, be in operation in the system for many years.

4.2 Numbering. When planning for the introduction of subscriber trunk dialling facilities in an area, each manual exchange will be assigned a unique code in order to provide incoming access. This will consist of the national area code together with an exchange code from the area numbering plan.

Numbering will be used which will facilitate interception when the manual exchange is replaced by an automatic exchange. On conversion to automatic, either the exchange code may be retained or a new code used. The use of a new code would simplify installation and cut-over since work may proceed clear of working levels and interception may be provided at the parent switching centre. However, it may not be practicable to use this method in the case of the larger exchanges numbered with D or DE codes because:

(i) Spare codes may not be available.

(ii) The costs involved in providing a second code for each manual exchange of this size may outweigh the installation difficulties which occur if the manual exchange code were retained.

The charging equipment associated with each zone, in the District containing the exchange and in adjacent Districts, which must examine codes to the D or DE digits would need to be capable of examining extra codes. Also some routing alterations would be required with a new code.

The codes allotted therefore to manual exchanges, where the ten year subscriber development exceeds 300 lines, will consist of D or DE digits followed by the digit 1. No switching stage will be provided to handle this digit; its purpose is to facilitate interception in those cases where the code is retained on conversion to automatic. The codes would be of the form DE1 in five digit numbering plan areas and CDE1 in six digit areas.

Smaller manual exchanges which would be given DEF codes do not incur any changes or complication to the charging equipment if the new code used in conversion is a spare F of the same DE code. These normally would be available and therefore the digit 1 need not be appended to the manual exchange code.

4.3 Methods of Access. Although access to all manual exchanges is required for trunk operators, some restriction is necessary with subscriber-dialled calls, depending on the condition at the manual exchanges.

Some manual exchanges will not be continuously staffed, some will not be served by sufficient trunks and at others neither the circuitry nor the administrative arrangements will be suitable for remote subscriber dialling.

The method of register control described in Section IV will enable access to manual exchanges to be controlled. The appropriate backward signals will be transmitted from the final register encountered in the setting-up to indicate whether or not access is permitted. This does not impose any significant extra requirement on the discriminating ability of these final registers since they will normally be required to examine the exchange prefix digits (D, DE or DEF digits) to effect the routing of the call.

The following sets out alternative treatments of different categories of manual exchanges, which may be used:-

(i) Manual exchanges at which a satisfactory "Called Subscriber Answer" supervisory condition is provided. The C.S.A. signal is returned to the originating exchange to actuate changing equipment which responds as for a call to an automatic exchange. Some CB exchanges are in this class. Subscriber-dialled access may be provided to these exchanges for all incoming calls, provided that the originating exchange is equipped for automatic trunk charging.

(ii) No Automatic C.S.A. Signal.

(a) Manually applied C.S.A. signal. In order to avoid terminal-end docketing, which involves additional accounting work, the C.S.A. signal could be manually applied by the operator. The calls would then be multi-metered as for calls to automatic exchanges. The practicability of the circuit alterations required to provide this facility is being investigated.

(b) Terminal-end docketing acceptable for all incoming trunk calls. The dockets, prepared by the terminal manual operator, would be forwarded to the appropriate accounting centre for the originating exchange.

(c) Terminal-end docketing acceptable only for short-range calls. For these exchanges the trunk codes would be shown only in the directory for the area concerned. However, as the same directory may embrace several numbering plan areas, special instructions would be necessary.

e.g. Fern Creek 0537-622

(May be dialled only by subscribers whose national numbers commence with 0537- . All other subscribers should call their local operator for calls to this exchange).

(d) No satisfactory C.S.A. signal. Terminal-end docketing not acceptable. For exchanges with no C.S.A. signal and where terminal-end docketing is not acceptable, the area codes will not be published in the directory. The exchange listing will be followed by the standard trunk operator code 011, if this is uniformly in use in the directory area, or by the words - "Call your local trunk operator". There may be other reasons for non-publication of a particular exchange trunk code, including a severe shortage of trunk lines to the terminal exchange which would make subscriber-dialling impracticable.

4.4 Operating Facilities. Extended local service areas will result in a much greater percentage of the traffic in an exchange, being handled as local calls. Whilst this will yield operating economies further advantages may be obtained in exchanges with separate local and trunk positions by modification of operating facilities and terminating appearances. Investigation of the possibilities is in progress.

5. SWITCHING EQUIPMENT POLICY.

5.1 Concurrently with the development of the national plan, investigations proceeded in connection with the specifications for equipment to be used in the system. An outline of the probable requirements was given to the principal suppliers of automatic switching equipment and information sought by the Department on system equipment available or under development, which would meet the requirements of the plan. As a result, much valuable information was secured from world-wide resources and senior representatives of overseas manufacturers visited Australia for discussion and to describe and demonstrate new types of switching equipment. Trial installations of new equipment were arranged.

As referred to in Section I, the Department, after thorough investigation has adopted the crossbar system for future development.

Much technical work is required for the application of the system to the Australian network and for the large scale introduction of subscriber trunk dialling facilities.

6. SUBSCRIBERS' FACILITIES

6.1 As the new system is implemented, there will be new requirements for subscribers' facilities. Examples of such requirements, mentioned in Section III, Charging, include the barring of access from some subscribers' services to multi-metered trunk lines and the provision of meters at subscribers' premises to operate in association with the meter at the exchange.

The facilities to be made available on private automatic branch exchanges, including the policy on in-dialling to P.A.B.X. extensions, require determination.

These and other like matters cover a very broad field. Investigations are already in progress, but much remains to be done.

7. PUBLIC TELEPHONES.

7.1 Facilities for callers to use public telephones for multi-metered trunk calls without seeking the help of an operator are desirable. The matter of the type and design of public telephones, incorporating the facilities required for multi-metering, has been under investigation for some time and this work is continuing.

8. NETWORK PLANS.

8.1 The detailed numbering, charging and switching plans which have been evolved as part of the national plan are integral parts of a basic framework within which the planning of individual areas can proceed.

8.2 Sydney and Melbourne Telephone Networks. Comprehensive outline plans are well advanced for the long term development of the Sydney and Melbourne telephone networks. The development of the networks with seven digit operation to cater for the growth in telephones must be co-ordinated with developmental works for the introduction of subscriber trunk dialling. In this way the integration of the existing and new systems in the interests of speed and efficiency will be achieved. The re-design of the telephone networks of these large cities is a major undertaking which will require considerable concentration of effort.

8.3 Outline Plans for other Regional Networks. The national telephone plan covers some 220 regional areas including the Capital Cities, each of which will require detailed plans. The plans will cover a period of approximately 20 years and will show the way the networks will be developed. Intermediate phases require close investigation of saturation dates of existing plant and equipment and appropriate measures directed towards ultimate mechanisation. Work on the plans is being pressed forward so that they my be considered with the preparation of co-ordinated works' programmes. These plans will incorporate information concerning :-

Numbering plan, including special dialling codes.

Switching plan, including both direct and alternate routes.

Junction and trunk channel requirements and provision.

Location of manual assistance centres.

Automatic exchange equipment for local and long distance switching and automatic charging.

Plans for buildings and accommodation.

9. FUTURE PROGRAMMING.

9.1 Developmental projects for the telephone system are arranged as annual programmes of capital works involving considerations of finance, engineering works, sites and buildings. Large quantities of technical plant are required annually. The telephone system is inherently complex and orders for the major items of plant and equipment must be placed one or two years ahead because of the time taken to manufacture and deliver supplies. As indicated in Section IV, the national plan will require the provision, as early as possible, of switching equipment performing additional functions from that at present in use.

The introduction of the zoning plan will yield immediate service and economic advantages by making the maximum use of existing equipment. Some adjustment of the normal developmental programme in the short term will be required, so that as much as possible can be done to prepare for operational conditions at the date of implementation. Other works will be continued subsequently.

It can be expected that traffic will increase on channels between automatic exchanges with local untimed calls when the extended local areas are introduced. Estimates have been made of additional circuits required, what can be provided to enable automatic operation to be introduced, and the cases where it will be necessary to retain operator control of this traffic. Every trunk route in the Commonwealth which connects automatic exchanges and which will become a local link has been analysed.

Apart from short term measures required prior to implementation of the new tariff policy, the features requiring examination to form the basis of future financial policy and works' programming include:-

(i) Levels of demand, priorities, ordering and supply policy.

(ii) Extent of automatic conversion, renewal and modernisation.

(iii) Rate of automatic trunk equipment installations in key centres and introduction of subscriber trunk dialling.

(iv) Level of trunk channel provision, particularly on major routes.

(v) Manual assistance positions - location, type of facilities, number of positions.

SECTION V.

(vi) Introduction of standard service codes and trunk codes.

(vii) Effects on building programme, including relief in present exchanges and reduced manual requirements in proposed buildings.

(viii) Subscribers' facilities and public telephones.

These are the principal requirements having important implications for the major phases of implementation of the long term plans.