APPLICATION OF TRAFFIC FORECASTING TECHNIQUES
TO CIRCUIT PROVISION

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ABSTRACT

This paper describes how planning growth rates are determined and applied in the preparation of the estimates of main network circuit requirements on which the provision of plant in the United Kingdom is based. The need for accurate estimating procedures in the circuit provision field is considered and a description given of central and local forecasting procedures, the central controls which are applied and the results achieved.

SIZE OF TELEPHONE SYSTEM

1 The British telephone system comprises some 6,000 exchanges. About 400 of these are trunk exchanges, 360 of which are known as group switching centres (GSCs). Each GSC collects and switches trunk calls between the local exchanges which it serves and the rest of the United Kingdom. The majority of traffic is subscriber dialled. Some 1300M trunk calls were carried by the system in 1969 and in recent years trunk traffic has been rising at about 12 per cent per annum. The main (trunk) network consists of about 150,000 trunk lines on 5,000 routes. There are also about 40,000 routes carrying local traffic.

ANNUAL SCHEDULE OF CIRCUIT ESTIMATES

2 Detailed estimates are prepared annually of the number of circuits from and to every exchange in the United Kingdom. These estimates - known as the Annual Schedule of Circuit Estimates (ASCEs) - show requirements in respect of each route in the UK for 1, 2, 3 and 5 years from the 1 April following its preparation. The first year's requirements constitute the authority to provide the additional circuits required in that year, the second and third year's requirements are used for ordering terminal equipment and other stores, while the fifth year's requirements, extrapolated as necessary, are used to prepare duct, cable, radio link, and transmission programmes. The programmes are then costed, the time scale for the financial expenditure which arises is deduced, and from this the financial expenditure forecasts are derived.

3 To ensure alignment of line plant and exchange equipment provision ASCEs are also used in connection with exchange equipment programmes and designs.

4 ASCEs are the corner stones for a major part of the investment in telecommunications fixed assets. On their reliability depend both the return on the investment and the ability to respond to customer demand. They must reflect national policy and views on growth and take account of the available capital for investment. The work involved is too great to allow them to be prepared at a central point and although the use of computers will go some way to overcoming this, local factors must be considered and allowed for. ASCE preparation is therefore devolved to the 60 Telephone Managers whose offices are located at strategic points throughout the country. For administrative purposes the 60 Telephone Managers are grouped in ten Regions. The estimates prepared by all the differing offices involved must of course be compatible with each other and arrangements must be made to ensure this. It is therefore essential that close control be exercised by central headquarters and that adequate coordination be maintained between all parts of the organisation involved.

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CENTRAL FORECASTING PROCEDURES

5 The basic parameter for planning the Main Network is the forecast made by Telecommunications Headquarters of the overall national rate of growth of traffic for the five year period commencing just over a year ahead.

6 To arrive at this forecast graphs showing the growth trend of full rate effective trunk calls for the country are considered – see Fig. 1.

![Figure 1 - United Kingdom Full Rate Effective Trunk Calls x 10^8 (12 months running total)](image)

Past records show that there is a close relationship between the growth in the number of full rate effective trunk calls and the growth in busy hour traffic on each route. This is used to convert decisions regarding the overall growth in calls to busy hour traffic, taking into account such items as circuit congestion during the busy hour, which forces people to make some calls outside this period. Such calls will probably return to the busy hour when the congestion is relieved. The effect of change in calling habits because of the extension of the five day working week for example, is also taken into account.

8 For planning purposes the following additional allowances are then made and a planning growth rate derived.

8.1 Data Transmission – An allowance for the introduction and growth of data traffic is made as outlined later in this paper.

8.2 Unforeseen growth – A margin is added to cater for additional growth which occurs for reasons which cannot be foreseen when the forecast is made. This is greater in the later years and currently represents roughly a six months margin at the fifth year.

8.3 New Direct Routes – The effect of the provision of new direct routes is that calls are connected over fewer circuits, and this has an effect on the growth of circuit quantities and financial expenditure which must be allowed for.

8.4 Dispersal Factor – An allowance, usually about 1 per cent, is made for the allocation of the National growth rate to individual regions and areas.

9 Recommended national planning growth rates, supported by details and explanations of the various allowances made, the reserve of spare plant in the network and the financial and other effects (for example the effect on manufacturers production) of variations up and down from the proposed planning growth rate are submitted to the very highest levels of the British Post Office for discussion and approval. Such approval provides a firm basis for planning and enables top management to express its view on growth and the commitment of future expenditure before a considerable amount of resultant planning work has been done.

10 Once approved, the growth rate for the UK as a whole is broken down into rates for each Region taking into view the Regional trends and these in turn are then broken down by the Regions into rates for each Telephone Area. Telephone Areas are then responsible for seeing that the total growth which they plan is within fixed limits of the growth allotted to them up to the end of the five year period. This ensures that the growth planned locally conforms to the national approved policy.

LOCAL FORECASTING PROCEDURES

11 Many people, of varying degrees of experience and throughout the country, are concerned with the production of the ASCII. It is therefore of prime importance that important standard procedures are adopted which, if possible, minimise local interpretations and variations in the assessment of individual trends and these are therefore carefully laid down.

12 Records of traffic during the busy hour are taken at regular intervals on every individual route. These records are plotted graphically and a trend line deduced for each separate route. This is then projected as a forecast line and adjustments are made for special conditions such as re-routing of calls to...
produce forecasts of traffic for the next few years — a typical graphical record and forecast is shown in Figure 2.

Figure 2 - Route Graph

Because linear graph paper cannot cope with growth rates above about 6 per cent using a straight line technique the use of semi-log graph paper is specified for route forecasting. Normally only the representative traffic at the beginning of the ASCE 5 year period is read from the graph and we use a transparent gauge (figure 3) which enables the compound growth rate on a logarithmic scale to be read quickly and applied arithmetically to this figure. This minimises the risk of error in reading many points from the graph.

The starting point from which the trend should be projected to derive the representative traffic is defined as the geometric mean of the two highest records relative to the trend line in the last two years.

Figure 3 - Growth Rate Gauge

More than one Area may be involved in the estimate for a particular route which may of course carry traffic from exchanges in any Area. Thus the Area doing the estimates must know of any proposed re-routing, which will be in accord with the national routing plan, and which may add or subtract traffic from the route. If the route terminations are in different Areas both will be concerned with the actual forecasting of the growth of traffic.

Set procedures are used to ensure that the traffic re-routings are known and catered for by all concerned. Where the route terminations are in different Areas, one Area is nominated as the controlling Area and the other Area submits an initial forecast to it. The controlling Area then either agrees the forecast or alters it and notifies the first Area accordingly. Both Areas must then work to the controlling Area's forecast.

To ensure that the sum total of traffic growth on all routes in the UK meets the approved planning growth rate each Area, on completion of the forecasts for all its individual routes, sums the traffic on these routes and if necessary makes a further adjustment to each route forecasting so that the Area's total traffic at the fifth year is within the tolerance limits permitted. New routes may affect the total representative traffic used to determine whether or not the national planning limits are being adhered to and the effects in this respect must be allowed for.

DATA TRAFFIC

Forecasting the effect of data traffic is perhaps the greatest problem in that the past is no guide to the future and there is very little factual information available on which to plan. The British Post Office commissioned consultants from outside the Post Office to consider the future prospects of data transmission and we are at present studying their report. The use of computers is expected to grow very rapidly and thus considerable growth in data traffic can also be expected. The only real figures available for use in circuit forecasting are those relating to the demand for data modems (modulator/demodulators — the interface between the Post Office circuits and the subscriber's equipment) in the immediate future. By making we have estimated that for the period up to 1976, an adequate margin for data will be obtained if we allow an increase of up to 1 per cent per annum in the expected growth of data traffic for speech calls. This is equivalent to a growth of data traffic exceeding 50 per cent per annum.

Data transmission may ultimately be catered for on a completely separate network but no decisions have yet been taken other than to set up an embryo 48 Kbit/sec network between London, Birmingham and Manchester and we have therefore continued to make allowance for data traffic on the telephony network.

COMPUTERISATION

Work is proceeding on the development of a scheme for the production of ASCEs by computer. This scheme will take into account individual GSC growth factors with provision being made for forecasts on individual routes made by Local Managers to be incorporated wherever special circumstances justify. It is expected that the main advantages will be:-

18.1 A more rapid response to change. Forecasts will be based on much more up to date records, because the computer estimating can be done very quickly at a late date.

18.2 The estimates produced within the computer will automatically be available for use in subsequent and other related planning functions, e.g. cable provision, which are performed by the same computer.

18.3 Greater management control of the network.

18.4 No increase in estimating staff in spite of a large increase in the size of the telephony system.

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NEW PROCEDURES
INTRODUCED IN 1964
TOOK EFFECT HERE

+8.0%
+3.9%

-6.2% -16.8% -28.0% -33.7% -30.0% -26.4% -30.5% -58.8%

Figure 4 - Effect of procedures on circuit estimating. The percentages shown indicate the difference between the circuit quantities forecast five years earlier and those actually required during the years given. Minus quantities indicate under-estimating.

CONCLUSIONS

21 The procedures set out in this paper which were adopted in 1964 have generally produced reasonable conformity between forecast and achievement in the short (one year) and medium (five year) periods, and as can be seen from Figure 4, have put an end to a former intolerable situation where the initial estimates were low and demands for circuits were often increased through the period of the estimates. They give central headquarters an adequate control over the planning of the network whilst allowing local considerations to be taken into account. The procedures are flexible and can be and will be modified to meet changing conditions and make use of any additional information which we may obtain.

LONG TERM FORECASTING

19 Long term forecasts are required for assessing individual site, building and duct requirements and also to plan the best long term layout of the overall network. The forecasts for the individual schemes use the fifth year ASCE figures as a starting point and are done on a similar basis to that of short term forecasting. The British Post Office is, however, studying ways of incorporating checks and balances in long term traffic forecasting to ensure a meaningful relationship between connexion forecasts, busy hour calling rate forecasts in erlangs per connexion and busy hour erlang growth rates.

20 A long term study group has also been set up to consider the development of the network beyond 1975 taking into account likely growth and new technological developments and demands so far as these can be foreseen.