A REPORT ON TELEPHONE TRAFFIC VARIATION IN JAPAN

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ABSTRACT
This paper presents some results of yearly measurements of telephone traffic in Japan. These measurements show the degree of daily traffic variations is greater than that previously measured.

INTRODUCTION
NTT measured telephone traffic on about 1,000 routes of 25 offices from December 1974 to November 1975, and measured that of 31 offices from April 1978 to March 1979. These measurements show that the degree of daily traffic variations is greater than that previously measured. This variation is attributed to the fact that the number of subscribers is increasing --- at present, these are about 35,000,000 subscribers ---that the percentage of residential customers is increasing and so on. (Figure 1)

This paper shows the results of these measurements.

Traffic Measurements Plan
(1) Sampled offices were selected from among Regional Center, District Center, Toll Center and End Office, taking into account population of the cities in which the offices were located. (For reference, Figure 2 shows office rank and trunk classification (basic trunk))

(2) They were selected on condition that the number of their equipments were not changed over the period.

Measurement items are the mean busy hour traffic (diurnal and nocturnal) for outgoing and incoming circuits for each route in 1975. Measurement items are the mean busy hour calls (diurnal and nocturnal) in offices calls in 1978.

TRAFFIC MEASUREMENTS PLAN
(3) Analysis items are as follow
(a) The number of days in which traffic exceeds the mean traffic of n highest days.
(b) Grade of service on the days when the traffic exceeds the mean traffic of n highest days.
(c) Distribution of office calls in a year.

Figure 2 Office Rank and Trunk Classification (Basic Trunk)

THE NUMBER OF DAYS ON WHICH THE TRAFFIC EXCEEDS THE MEAN TRAFFIC OF N HIGHEST DAYS
Figure 3 shows the number of days in which the route traffic exceeds the mean traffic of n highest days. (n=10,20,30)

It is statistically found that, on about 10% of the routes, the number of days, when the route traffic exceeds the mean traffic of n highest days, are more than n/2 days.

All kinds of trunks have about the same distribution.
GRADE OF SERVICE ON THE DAYS WHEN THE TRAFFIC EXCEEDS THE MEAN TRAFFIC OF N HIGHEST DAYS

In Japan, loss probability of final trunks is based on 1% during the mean busy hour. Table 1 shows the number of routes on which loss probability exceeds 10% during the highest traffic day when calculation of the number of circuits is based on the mean traffic of 30 highest days.

In previous measurements, there were few routes whose loss probability exceeded 10%.

Table 1 shows the number of routes on which loss probability exceeds 10% during the highest traffic day when calculation of the number of circuits is based on the mean traffic of 30 highest days.

Table 1 Number of routes on which loss probability exceeds 10% during the highest traffic day

<table>
<thead>
<tr>
<th>Trunks</th>
<th>1*</th>
<th>Number of routes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=10</td>
<td>n=20</td>
</tr>
<tr>
<td>4 AT</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>6 AT</td>
<td>38</td>
<td>1</td>
</tr>
<tr>
<td>7 A</td>
<td>37</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>118</td>
<td>15</td>
</tr>
</tbody>
</table>

1* Number of measured routes (an example)

Table 2 shows the reason the heavy traffic occurs.

About 60% of these phenomena are caused by typhoon, heavy snow and so on. About 16% of heavy traffic appears after holidays.

Table 2 Number of routes on which heavy traffic occurs

<table>
<thead>
<tr>
<th>Trunks</th>
<th>1*</th>
<th>2*</th>
<th>3*</th>
<th>4*</th>
<th>5*</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 AT</td>
<td>43</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6 AT</td>
<td>38</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7 A</td>
<td>37</td>
<td>13</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>118</td>
<td>14</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

1* Number of measured routes
2* Number of routes on which heavy traffic occurs
3* Typhoon & heavy snow
4* Next days after holidays
5* Other categories

About 60% of typhoon and heavy snow cases occur and 16% of heavy traffic appears after holidays.

Table 2 Reason heavy traffic occurs

Figure 4 (a), (b), (c) show the ratio of the highest day traffic to the mean traffic of n highest days. The ratio distribution differs in different kinds of circuits.

Figure 4 Routes distribution vs. ratio of highest day traffic to mean traffic of n highest days

It is not economical to calculate the number of circuits based only on peak traffic, because there are some routes of which the highest day traffic greatly exceeds the mean traffic of 30 highest days.

YEARLY EXCHANGE TRAFFIC DISTRIBUTION

Figure 5 shows yearly busy hour calls distribution for one exchange arranged in order from busier days. This figure shows traffic congestion which is caused by summer festivals.

Figure 5 Yearly busy hour calls distribution for one exchange

CONCLUSION

Recent traffic measurements show that the degree of daily traffic variations is greater than that previously measured. NTT is now studying to establish the most appropriate service grade specification which reflects the present traffic variations reported in this paper.
TRAFFIC MANAGEMENT IN CONGESTED TELEPHONE NETWORK

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ABSTRACT

Call completion activities propagate throughout the network, both national and international subscriber's direct dialling growth, the effects of completion are being felt throughout the world. This paper examines the problem from various angles particularly with reference to the environment in developing countries and also describes a practical method used to improve call completion.

INTRODUCTION

1.1 In developing countries, telephone traffic suffers from congestion in various stages of the network. Studies carried out in India have helped identify one major reason for congestion viz., the call failures due to called (B) Subscriber Busy. This is of the order of 15% to 20% in developed countries but is as high as 35% to 50% in the metropolitan networks in India.

1.2 This, no doubt, is a result of 'Repeat Call Attempts' also. Many have studied this phenomenon (Mr. Pierre Le Gall, Mr. A. N. Eldin, Mr. J. W. Cohen and many others abroad and Miss B. H. Shanta and Mr. P. X. Roy Chowdhury in India) and contributed greatly to derive theoretical base.

1.3 The main factor is that Call Completion activities propagate throughout the network. When national and international subscriber's Direct Distance Dialling is growing, if call completion is improved in one area, subscribers calling from other areas will get better service.

1.4 There are many sides to this problem.

2. DESCRIPTION OF THE PROBLEM

2.1 TRAFFIC POINT OF VIEW: In metropolitan telephone networks, traffic invariably flows to and from the downtown business area. Observations and analysis lead us to the conclusion that a few big PABX 'invite' large number of unsuccessful call attempts - like 'Killer Trunks'. Table 1 lists some observations, made early this year, of a few subscribers in Delhi during a busy hour.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Erlang Traffic</th>
<th>No.of incoming calls lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.708</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>0.126</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0.315</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>0.791</td>
<td>81</td>
</tr>
<tr>
<td>5</td>
<td>0.087</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>0.581</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>0.133</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>0.182</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>0.549</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>0.749</td>
<td>10</td>
</tr>
</tbody>
</table>

These figures, obviously, include repeat attempts also. When calls are metered, revenue is earned only on completed calls. Hence repeat attempts make wasteful use of our equipment and cause them to depreciate faster. Moreover, we tend to provide more equipment due to 'inflated' traffic. But such increase in equipment does not necessarily increase the call completion ratio - since the problem is more at the subscriber's end.

There has been phenomenal growth (compared to earlier years) in the local networks. Added facilities like National Subscriber Dialling and International Subscriber Dialling etc. have increased the use of the telephone. All these traffic has to terminate at the subscriber's end equipment. That is where the solution is difficult also - in developing countries.

2.2 ADMINISTRATIVE POINT OF VIEW: In developing countries like India, there are long waiting lists for telephone connections due to rapidly increasing Commercial and Industrial activities. When there are so many without 'bread' it is rather difficult to serve 'cake' to the 'Haves'. Thus the traffic problems of existing PABXs get lower priority. Providing additional lines to adequately cater to the traffic is an extremely slow process.

2.3 HUMAN POINT OF VIEW: It is common knowledge that outgoing traffic always gets maximum attention. Loss of Incoming Calls does not, normally, get highlighted in the Subscribers' organisation. For the Telephone Administration also, it is a long drawn out process to identify subscribers, calls to whom have low completion.

Apart from this, even in day to day working, there is a human tendency to complete one's outgoing calls leading to a habit of using maximum number of lines for this.

2.4 It is obvious that the problem will continue in developing countries, for some years to come; hence the search for palliatives.

3 SOLUTION TRIED.

3.1 IDENTIFICATION: As a first step, PABXs with a large number of 'lost' calls at the final stage were identified by connecting meters suitably in the marker or Final Selector Circuits.

3.2 DISCUSSION WITH SUBSCRIBERS: Detailed discussions were held at the top managerial level in the Subscribers' Organisations. It was explained that the available junctions (trunks linking a PABX to parent exchange) were to be segregated into two groups - like dividing a
highway for the two directions of vehicular traffic. Subscriber's type of business has a great bearing on the proportion of incoming junctions and outgoing junctions. Even in the same industry different subscribers have different needs.

For example, a big Five Star Hotel in downtown Bombay wanted a 50:50 mix of Incoming and Outgoing Junctions. Incoming calls are important for them to get business and Outgoing Junctions are very important for use by their guests. A similar hotel near the Airport wanted a 20:80 mix of Incoming and Outgoing Junctions. For them, the guests come through various Airlines to whom they have 'Hot Lines'. Hence Outgoing Junctions far the use of their guests (most of them in transit) is of great importance.

In the absence of reliable traffic readings (when availability of lines is low, the situation is abnormal) such subjective discussions help a great deal and also create a better understanding between the subscribers and the telephone administration.

3.3 TECHNICAL ARRANGEMENTS: After the discussions and concurrence of the subscriber, available junctions of the PABX were segregated into two groups: Incoming and Outgoing (with reference to the PABX).

INCOMING JUNCTIONS: Description here is of a Strawer Parent Exchange. In crossbar exchange, the problem is simpler.

Incoming Junctions were arranged in 'hunt groups'. Change of numbers, particularly the intermediate ones, was not permitted - since that would break the hunting arrangement. The last choice incoming junctions were given outgoing so as to such a way that the PABX console attendant only can use them during emergent situations. Night Service numbers were re-cast in line with the new arrangement.

OUTGOING JUNCTIONS: These were dispersed throughout the parent exchange in various US Divisions. This was done to disperse the heavy calling rate lines instead of having them converge on and congest one group.

4 ADVANTAGES

4.1 Incoming calls have a better chance for completion - since a certain number of junctions are kept reserved. (Otherwise, the immediate necessity of pushing through outgoing calls would mop up maximum number of lines).

4.2 Hunting time for incoming calls is reduced. This has a good advantage in a Strawer exchange. In an unsegregated context, a final selector has to hunt over outlets engaged on outgoing calls also. When lines are segregated, the outlets connected to incoming junctions appear closer to the selector hunting over them. This reduction in hunting time has a beneficial effect in reducing 'Double Switching' troubles. When too many selectors compete almost simultaneously for an outlet, the time available for switching may be too little for the selectors to exclude one another. This is one of the reasons for 'Double Switching'. In network with heavy traffic and congestion (due to a number of reasons) every little thing counts.

4.3 Outgoing traffic is evenly distributed in the exchange equipment thereby deriving better advantage of the diversity in the business/residence traffic.

4.4 Provisioning of equipment could be more realistic - since Call Completion ratio improves (snowballing effects of repeat attempts are reduced).

4.5 Many times number changes became necessary - for traffic dispersal, for area transfers (transfer of subscribers in an area from one exchange to a new one etc.) In these cases, outgoing numbers can be changed with minimum disturbance to the subscribers (since they need not have entries in the Directory).

4.6 Most important of all, every one in the line is forced to think in terms of the details of traffic flow. So when junctions are added (to the lucky ones!), they can be added in proper groups to optimise the effect.

5 CONCLUSIONS

5.1 While studies were conducted by the Telecom Research Centre, Delhi, the author implemented these pragmatic steps in two networks in India at Bombay and Poona. The subjective reactions of the subscribers (Management and the telephone operators) were encouraging - even after two years after the implementation.

5.2 As expressed by Mr. G.W. Riesz, the type of terminating switching machine does not seem to affect these findings. These steps have proved useful in cases of PABXs connected to crossbar as well as strower exchanges.

5.3 New offerings like 'call waiting' may help call completion ratio to improve, in case of B sub busy conditions. Automatic Answering Devices, 'Call Forwarding' feature etc., may reduce repeat call attempts in case of B Sub No Answer conditions.

5.4 More detailed studies are underway.

6 ACKNOWLEDGEMENTS.
a) Paper by Mr. G.W. Riesz published in
Vol. 2 of 8th I.T.C. - "Factors influencing
the Call Completion Ratio."

b) Papers published by Mr. Pierre Le Gall,
Dr. A.N. Eldin, Mr. J.P. Maury,
Miss B.N. Shanta and Mr. P.K. Roy Choudhury.