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RESEARCH ARTICLE

SIZING – UP MEDIUM SCALE TRUNK CIRCUITS FOR BETTER GoS, USING COMPUTER SIMULATIONS

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ABSTRACT

Based on Erlang's traffic formula, a package has been developed in C++ to simulate the size or number of circuits required in a trunk for selected and better quality grade of service(GoS). Package is useful for designing medium scale trunk networks.

INTRODUCTION

Telephone messages are sent and received in spoken forms using telephone handsets. To make this possible the telephone system contains switching elements. Any set of devices and technologies employed in telephone signal transmission constitute a telecommunication system (Richert, 1997). Broad – based communication has turned the telephone network from being primarily a medium for voice communication into a multimedia network able to carry radio and other image – based services, high speed data and other computer – to- computer traffic as well as voice and text (Bello, 1997).

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Therefore telephone service is defined as involving the technology of providing many types of communication services via networks that transmit voice, data, image, facsimile and video by use of both analogue and digital encoding formats (Davis, 1997).

Martens *et al.* (1998) showed that when developing a telephone switch, it is useful to know how long it will take to process the various tasks associated with call processing. In the process of information exchange through a telephone, a switching machine monitors the state of every call in progress, setting up connection between two parties as well as connection for dialling tone, busy tone and ringing (Martens and Alfa, 1998).

For ease of administration, telephone exchanges are zoned into local, trunk and international exchanges. Intercity and wider telephone exchange links are based on trunk circuits. This paper focuses on sizing - up medium trunk circuits for better grade of service (GoS). Medium scale here refers to the range of 50 to 100 enlargs of traffic offered in the busy hour.

THEORETICAL BACKGROUND

The unit of traffic measurement is Erlang which is a dimensionless quantity. It is actually minutes per minute (Kennedy and Davis, 1999). Telephone traffic engineering is complex and has to do with measurement of traffic fluctuations, growth, as well as optimum routing arrangements. If a given amount of traffic is offered to a specific number of circuits and some of the traffic offered fail to secure a circuit, congestion or blocking will occur. The degree of congestion is called grade of service (Kennedy and Davis, 1999). The less the congestion, the more the carried traffic and the better the grade of service. The internationally accepted grade of service for a subscriber – dialed traffic route is 1% (Kennedy and Davis, 1999). This corresponds to a loss of one call in a hundred (ie B=0.01). The basic concept of traffic theory was developed by A.K Erlang in the early 19^{th} century for voice telephony (Ettinger, 1985). According to the theory. If A, represents offered traffic and a, represents the rate at which calls arrive, h, represents holding time, then from Erlang's theory we can say that (A=ah) Erlang. Thus the probability that N Items of equipment are in use or that there is blocking B is given by.

$$B = P(N) = (A/N!) \Big/ \Big[\sum_{K=0}^{K=N} (A^k/k!)\Big] \qquad \ldots\ldots\ldots 1$$

According to Ettinger (1985), in a set of N independent trunks, the traffic offered to any particular trunk is the traffic lost from the preceding trunk. Thus for N = 1, the lost traffic will be the traffic offered to the second trunk; the lost traffic from the second trunk will be that offered to the third trunk and so on. Therefore the traffic lost from the first trunk and hence the traffic offered to the second trunk is equal to $A^2/(1+A)$. The traffic offered to the third trunk is equal to $(A^3/3)/(1 + A + A^2/2)$. Hence expanding equation (1), the traffic offered to the nth trunk is related to the blocking factor **B** by the expression.

$$B = \frac{\dfrac{A^N}{(N-1)!}}{1 + A + \dfrac{A^2}{2!} + \dfrac{A^3}{3!} + \ldots + \dfrac{A^{N-1}}{(N-1)!}} \qquad \ldots\ldots\ldots 2$$

Where **B** is the blocking factor (Grade of service)
A is offered or estimated traffic
N is the number of trunk circuits

Thus if **A** and **B** are known, **N** can be determined iteratively or by any other suitable method. In this paper, the expected value of offered traffic A are given and for any selected value of blocking factor B, the number of trunk circuits N required to carry the traffic is simulated. However, it is necessary to recall that the validity of equation (2) follows the assumptions that:

i. There is statistical equilibrium so that number of calls arriving at the trunk are equal to the number leaving the trunk.
ii There is "pure chance" traffic. That is, calls are distributed accidentally throughout the (busy hour) period so that a call is likely to originate at one moment as the next.
iii. There is a loss in call when all the trucks are engaged and a connection is required. The holding time for such attempted calls is assumed zero and callers give up as soon as their calls are blocked once.

METHODOLOGY

The methodology here is based on decomposing the Erlang's formula of equation (2) into a software "traffic calculator" in C^{++}. This programme or "traffic calculator" computes the number of circuits required to carry a given number of offered traffic **A**, for specified *grade* of service **B.** In other words, when the desired grade of service is specified say 1% or 0.5% for a given value of offered traffic say 50 Erlangs, the programme simulates the exact size or number of circuits required to carry this traffic at the desired value of grade of service (GoS).

The programme:

This programme is written in C^{++} and runs in C^{++} for windows only. Programme is given as :

```
# include < iostream.h>
# include < complex .h>
Main ( )

    Double factorial  ( int);
    Double sum 1 = 0.0, erlang, blk traffic = 0.1, sum 2= 0.0;
     int k, equipment = 150;
    Cout, <<  "please enter erlang factor:";
     C in >> erlang
    For [ k=2; k < equipment ; k ++>
     Sum 1 = pow ( erlang, k) / factorial ( k-1);
    For ( int j = 0, j < = k; j + +)
    Sum 2+ = ( pow( erlang,j)/factorial (j);
        C in >> erlang
        Return O;
  Double factorial ( intK) // computes the factorial value // of K and return to the main
  this line if ( k< 0 //k > 120) return 0.0; // the sentinel value

        Double f = 1.0
        while ( k> 1)
        f*  = k --;
        Return f
```

This programme computes the number of circuits in a way similar to Howard's erlang's B model (Howard, 2002). Typical number of circuits simulated for given block factors (B =0.01 and B=0.005) with offered traffic in enlargs are shown in table 1 (a) and (b). Calculated values were compared with values obtained from Westbay free online traffic calculator written in excel for windows and were found to be similar.

Table 1. Simulated number of circuits required for a block factor of B 0.001

Offered Traffic (Erl)	Number of circuit Required
0.1	2.0
0.5	4.0
1.0	5.0
5.0	12.0
10.0	20.0
15.0	27.0
20.0	34.0
25.0	40.0
40.0	57.0
45.0	65.0
50.0	72.0
55.0	78.0
60.0	84.0
65.0	90.0
70.0	96.0
75.0	102.0
80.0	108.0
85.0	114.0
90.0	120.0

Table 2. Simulated number of circuits required for a block factor of B 0.005

Offered Traffic (Erl)	Number of circuit Required
0.1	3.0
0.5	4.0
1.0	6.0
5.0	13.0
10.0	21.0
15.0	28.0
20.0	35.0
25.0	42.0
40.0	61.0
45.0	68.0
50.0	74.0
55.0	80.0
60.0	86.0
65.0	92.0
70.0	98.0
75.0	104.0
80.0	110.0
85.0	116.0

This programme allows the block factor B (grade of service) to be varied in any way desired for improvement. It is important to mention however, that in a call centre, when the offered traffic in the busy hour is increasing and becoming more than the installed circuits can handle, solution is not always found by increasing the number of circuits. Other factors come into play.

CONCLUSION

A simple package in C++ language has been developed based on erlang's formula for computing the size or number of circuits required to achieve the desired grade of service (GoS) for a given offered traffic. This package is useful for designing medium scale trunk circuit networks.

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