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A Study of GSM Voice Traffic Using Measurement Performance Technique

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Abstract: ***This study investigates the measurement performance technique used to analyze GSM cellular voice traffic, employing the Erlang B formula in live networks under varying conditions. Voice traffic and congestion rates were collected from a range of cell configurations at peak periods. The analysis identified slight differences between measured traffic and calculated traffic based on the Erlang B formula. Data was extracted from a GSM network in Afghanistan for different busy hours and cells with diverse configurations. Metrics such as the total TCH Traffic, TCH Half rate traffic (TCHH), TCH Congestion, available TCH and TCH Availability were considered. These findings contribute significant insights into the effectiveness and accuracy of the Erlang B formula for traffic calculation in GSM voice networks and reveal potential variances when applied in actual network conditions. Further examinations are needed to refine the models, considering the slight differences encountered during the study.***

Keywords: Erlang B, TCH Channel, TCH Traffic

1. Introduction

The Global System for Mobile Communications (GSM) network is Second Generation (2G) mobile communication system. The GSM network architecture comprises of traffic interfaces, signaling protocols and network elements. Mainly GSM architecture is divided into BSS and NSS. Where BSS comprises Base Station Controller (BSC) and Base Transceiver Station (BTS). While NSS is core part comprises MSC, VLR, HLR, and AuC. In GSM network, the air interface lies between Mobile Station (MS) and Base Transceiver Station (BTS). The air interface is made up of physical channels also called timeslots and logical channels; logical channels carry information over the physical channel. There are two groups of logical channels, control channels and traffic channels. The control channels are BCCH, RACH, AGCH, SDCCH and FCCH while the traffic channels (TCH) are full rate and half rate. In mobile communication system the number of available traffic channel is the limitation for the number of subscribers that can access the network at a particular period of time. It has a certain capacity for information transmission and often experience congestion due to high traffic generated by the number of subscribers using or try to gain access to the mobile network. The GSM network subscribers, can access the GSM network using the Mobile Station (MS) situated in a cell. When the MS is switch on, it's recognized by the closest Base Transceiver Station (BTS) using Frequency Correction Channels (FCCHs), transmitted in the downlink direction only. After synchronizing with network MS start decoding BCCH and can initial calls though a set of logical channels. After call initiation subscriber gets dedicated traffic channel (TCH) in order to transmit and receive voice data and thus generate traffic. Erlang B formula is commonly used in planning cell capacity and calculating voice traffic in GSM network. It is applied to number of available traffic channels taking congestion (blocking) into account.

Erlang B:

Among the various types of traffic models which exist, Erlang B is most used. It was conventionally used by Public Switched Telephone Network to dimension trunks; however, it is now used for mobile telephone network (GSM) air interface dimensioning.

Traffic is a term that quantifies usage, and its unit is Erlang. An Erlang defines the efficiency of a traffic resource and represents the total time in hours to carry all calls or thenumber of simultaneous occupations during a specified period of time.

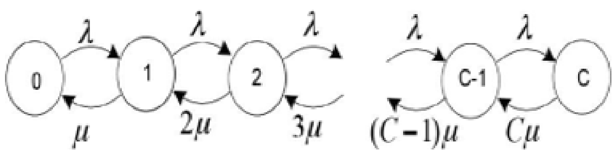
It can be calculated with the following formula: A=N x T / 3600 Erlang Where:
A=Offered traffic from one or more users in the systemN=Number of calls per hour T=Average call time

Erlang B - formula is based on the three elements: structure, strategy, and traffic.

a) Structure: We consider a system of "n" identical channels (servers, trunks, slots) working in parallel.
b) Strategy: A call arriving at the system is accepted for service if any channel is idle. If all channels are busy a call attempt is lost.
c) Traffic: the service times are exponentially distributed (intensity μ), and that the arrival process is a Poisson process with rate λ then the offered traffic is given when the number of channels (the capacity) is infinite.

$$a = \frac{\lambda}{\mu}$$

But practically we have limited number of channels.



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Erlang B formula for blocking probability B, channel "c", and offered load "a" is given by

$$B(c,a)=\pi_c=\frac{\dfrac{a^c}{c!}}{\sum_{n=0}^{c}\dfrac{a^n}{n!}}$$

There are mainly online calculator and tables available to calculate traffic, blocking or required servers.

2. Methodology

In this project, GSM voice traffic and other required counter (KPI) data is obtained from one of GSM network in Afghanistan. The data provided is for different Busy Hour (BH) for cell with different configurations. KPI collected contain the TCH Total Traffic, TCH Half rate traffic (TCHH), TCH Congestion, Available TCH and TCH Availability. Sector configuration data is obtained from OMC - R; which includes number of available TRXs (Radio transmitters) in a cell and configured control and traffic logical channels on these TRXs in each cell.

3. KPI Data

The obtained KPI (counter) data is given in below table. Halfrate TCH Traffic was disabled in order to have exact number of available of TCH channels and TCH availability remained 100% throughout all Busy Hours means no TRX or time slot was down. In each Busy Hour there is observed congestion.

Table I

Sector	TCH Traffic (Erl)	TCH Congestion Rate	Available TCHs	TCH Availability Rate
KBLC025_2	7.672	3.697	8.825	100
KBLC025_2	8.483	2.094	9.246	100
KBLC025_2	8.354	1.574	9.186	100
PRNP007_1	23.586	20.151	23.694	100
PRNP007_1	23.26	9.307	23.444	100
PRNP007_1	23.119	5.558	23.458	100
SMGC004_3	19.592	5.645	19.762	100
SMGC004_3	18.892	4.253	19.303	100
SMGC004_3	17.433	3.862	19.418	100
TKRP018_2	25.497	20.48	25.767	100
TKRP018_2	25.765	17.184	25.849	100
TKRP018_2	25.478	10.357	25.676	100
KPSP004_1	21.52	1.08	24.217	100
KPSP004_1	22.81	2.47	24.207	100
KPSP004_1	23.74	5.24	24.556	100

4. Sector Configuration

The number available of TRXs and configured control and logical channels obtained from OMC - R are given in below table. Number of time slots is calculated as
Number OF Time Slots = Number of TRX * 8

Number available TCH Traffic channels are calculated as

Number of TCH Channel = Number OF Time Slots – (Time slots occupied by Control Channel)

Time Slots occupied by Control Channel = BCCH + Number of SDCCH + Number of static PDCH

Table II

SECTOR	# Of TRX	# Of TIME SLOT	# Of BCCH	# Of SDCC H	# Of STATI C PDCH	NET # Of TCH
PRNP007_1	4	32	1	3	4	24
KPSP004_1	4	32	1	2	4	25
KBLC025_ 2	2	16	1	3	2	10
SMGC004_ 3	3	24	1	2	1	20
TKRP018_2	2	16	1	3	2	10

Table TCH traffic/capacity in Erlang is found out for calculated number of THC channels according to observed blocking on the cell from Erlang B table, given in below table.

Table III

Sector	TCH Congestion Rate	# OF Available TCHs	Traffic at Observed Congestion rate (Erl)
KBLC025_2	3.697	10	5.79
KBLC025_2	2.094	10	5.131
KBLC025_2	1.574	10	4.849
PRNP007_1	20.151	24	26.571
PRNP007_1	9.307	24	21.436
PRNP007_1	5.558	24	19.381
SMGC004_3	5.645	20	15.595
SMGC004_3	4.253	20	14.832
SMGC004_3	3.862	20	14.579
TKRP018_2	20.48	10	9.788
TKRP018_2	17.184	10	9.082
TKRP018_2	10.357	10	7.605
KPSP004_1	1.08	25	16.264
KPSP004_1	2.47	25	17.994
KPSP004_1	5.24	25	20.142

5. Result/ Conclusion

The study results, as presented in this paper, indicate a difference between the measured traffic and calculated traffic derived from the Erlang B table at the congestion rate, thus demonstrating variances in the analysis of GSM cellular network voice traffic. This was determined through a nuanced calculation that entailed subtracting the calculated traffic on TCH from the measured traffic on the same channel.

While the traffic data acquired from the Measurement Performance Technique varied according to differences in cell configurations and busy hours, it was observed that the measures employed consistently illustrated a higher measured traffic as compared to the calculated one

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derived from the Erlang B table.

To illustrate, several sectors such as KBLC025_2 and TKRP018_2 exhibited substantial differences between the measured and calculated traffic. In the case with sector KBLC025_2, for instance, the difference ranged from around 1.9 to 3.5 erlangs, and sector TKRP018_2 presented even more significant discrepancies, with differences up to approximately 17.9 erlangs. Notably, certain sectors, particularly PRNP007_1, showed an inverse trend with calculated traffic marginally exceeding measured traffic by roughly 3 erlangs. This reinforces the notion that discrepancies exist, and fluctuations can occur in either direction.

In conclusion, it is evident that while Erlang B remains a fundamental tool in GSM traffic analysis, these results highlight the existence of inconsistencies between practical measurements and theoretical calculations. These observations underscore the importance of improving existing models for real - time traffic analysis and accommodating for these identified discrepancies. This is critical for enhancing network planning and management by offering more accurate and adaptable assessments of voice traffic in GSM networks. Further research and investigation is suggested to refine these modeling tools and ensure renewable efficiency in this rapidly evolving field of mobile communication.

It is obvious from Table IV that measured traffic is higher than calculated one obtained from Erlang B table at the same congestion rate.

Table IV

Sector	Measured Traffic on TCH	Calculated Traffic on TCH	Difference b/w Measured & Calculated (Erl)
KBLC025_2	7.672	5.79	1.882
KBLC025_2	8.483	5.131	3.352
KBLC025_2	8.354	4.849	3.505
PRNP007_1	23.586	26.571	- 2.985
PRNP007_1	23.26	21.436	1.824
PRNP007_1	23.119	19.381	3.738
SMGC004_3	19.592	15.595	3.997
SMGC004_3	18.892	14.832	4.06
SMGC004_3	17.433	14.579	2.854
TKRP018_2	25.497	9.788	15.709
TKRP018_2	25.765	9.082	16.683
TKRP018_2	25.478	7.605	17.873
KPSP004_1	21.52	16.264	5.256
KPSP004_1	22.81	17.994	4.816
KPSP004_1	23.74	20.142	3.598

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