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EVALUATION AND OPTIMIZATION OF THE TRAFFIC IN GSM NETWORK- AN EXTENSIVE STUDY

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Abstract

In the present scenario, to increase the number of mobile subscribers the network providers must to keep the subscribers satisfied with the delivered quality of service. Accurate traffic dimensioning plays an important role in telecommunications network planning and design, which is particularly important for the performance analysis of mobile and wireless networks. Backend network is designed and dimensioned based on traffic. Machines are designed for limited capacity to provide unlimited calls. By expanding capacity for incoming traffic at their network end by expanding point of interconnection (POI) we can overcome the issues in traffic. The objective of the proposed work is to increase the number of mobile subscriber and to keep the subscriber satisfied with the delivered quality of service. In this research work, the network traffic have been evaluated and optimized by taking the weekday-weekend traffic data and to do the E1 augmentation and expanding the POI during the POI congestion. From the observed results it was suggested that, in order to achieve the best performance, service providers have to monitor and optimize their network continuously.

Keywords: GSM Network, POI, Congestion, Service Provider, Monitor

1. Introduction

Global system for mobile communication (GSM) is a digital cellular technology used for transmitting mobile voice and data services. GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz timeslots. GSM uses the time-division multiple access (TDMA) technique for transmitting signals and it was developed using digital technology [1-4]. It has an ability to carry 64 kbps to 120 Mbps of data rates and it digitizes and compresses data, then sends it down through a channel, each in its own timeslot. GSM system is basically designed as a combination of three major subsystems as shown in Figure 1. The three major subsystems are the network subsystem (NSS), the base station sub-system (BSS) and the operation support subsystem (OSS). To ensure that network operators will have several sources of cellular infrastructure equipment, GSM decided to specify not only the air interface but also the main interfaces that identify different parts [5-9]. There are three dominant interfaces namely an interface between mobile services switching centre (MSC) and base

station controller (BSC), A-bis interface between BSC and Base Transceiver Station (BTS) and an Um interface between the BTS and mobile station (MS) [10-13]. There are two types of channels in the air interface such as physical channels is the time slots (TS) and logical channels the specific type of information that is carried by the physical channel and its types are traffic channels (TCH) and control channel (CCH). There are again two types of traffic channels such as the full rate (FR) channel is a 13 kbps coded speech or data rate of 9.6, 4.8 or 2.4 kbps and half rate(HR) channel supports 6.5 kbps coded speech or data rate of 4.8 or 2.4 kbps.

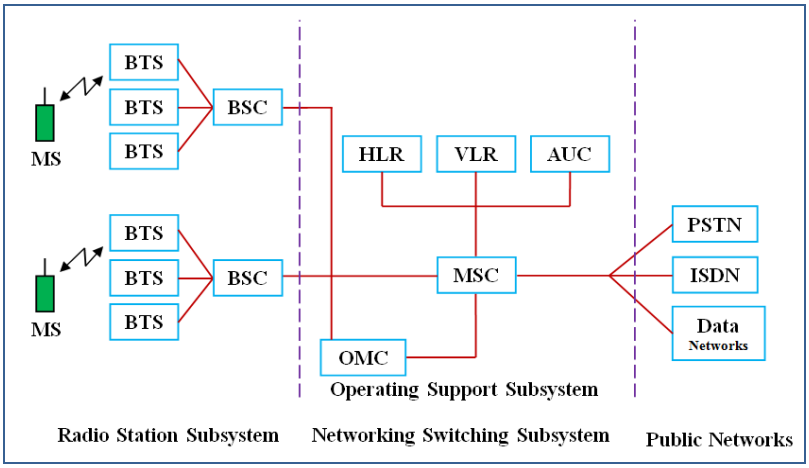

Figure 1 GSM System Architecture

Presently GSM supports more than one billion mobile subscribers throughout the world. While the number of subscriber increases, the network traffic and POI congestion will also increases. POI is the point of interconnectivity where every operator makes interconnection with each other to terminate traffic [14-16]. To provide better quality of service the answer seizure ratio (ASR) must be improved. The measurement of network quality and call success rates in telecommunications which is nothing but percentage of answered telephone calls with respect to the total call volume is called the ASR. Hence, In this paper the efficient way of monitoring the daily traffic at busy hours for maintaining the utilization% between 70-80 % and if utilization% get exceed, the POI congestion must be get reduced by doing the E1 Augmentation is proposed.

2. Methodology Proposed

During optimization the main goal to achieve is to maximize coverage and capacity while meeting the quality of service as illustrated in Figure 2. These are the three leading elements of any mobile network such as capacity is nothing but subscribers or the traffic load that it can handle, coverage is nothing but distance that a wireless network can transmit data at a given data rate and quality of service (QoS) is the capability of the cellular network providers to provide a satisfactory service to end users.

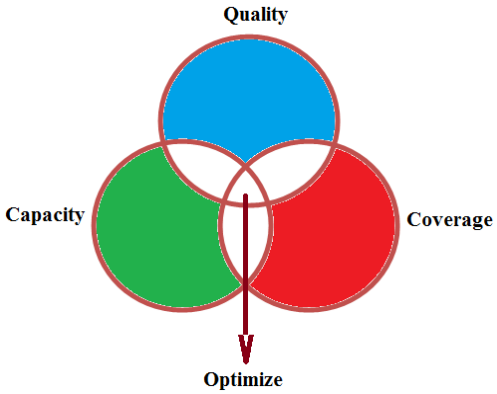

Figure 2 Significant Parameters to Maintain

3. Traffic Monitoring at Peak Hours

Measurement of traffic within a network are used in many fundamental activities such as identification of traffic patterns and trends, calculating the traffic intensity in a specific circuit, monitoring the service, dimensioning and managing the network and checking the performance of the common channel signaling network. The traffic trend varies based on the offers, new plans etc. The international telecommunication union (ITU) recommends that a network traffic analyst must take measurements for the busiest hour of each day for a whole year. To perform calculations in circuit-switched networks several assumptions are made, which is useful to remember that the measurements are averages, and this process deliberately ignores very short term variations in the traffic.

- Calls arrivals follow a poisson distribution
- Holding times follow a negative exponential distribution
- Blocked calls are lost or overflow
- There is statistical equilibrium.

Point of interconnection allows the customers of one service provider say reliance JIO to communicate with the customers of another service provider say Aircel. From Figure 3 it is observed that, if JIO subscriber is calling Aircel subscriber it will always pass through POI. If point of interconnectivity is congested then call will not be successful. Reliance Jio services were commercially launched on 5th Sep 2016. On that period JIO offered free SIM card to everybody and that too with free unlimited calls. Daily more than two lakhs new subscriber are getting added in JIO and millions of calls are coming to the network, which is making POI congested as shown in Figure 4. And other operators are not ready to expand POI due to heavy traffic, free calls from JIO network will increase traffic thus their system will be overloaded, due to this Jio calls are failing. If two operators A and B are not interconnect partners, then it would not be possible for a customer of operator A to communicate with a customer of operator B, other operators need time to expand capacity for incoming traffic at their network end. Aircel and Airtel have agreed to expand POI with JIO for traffic optimization.

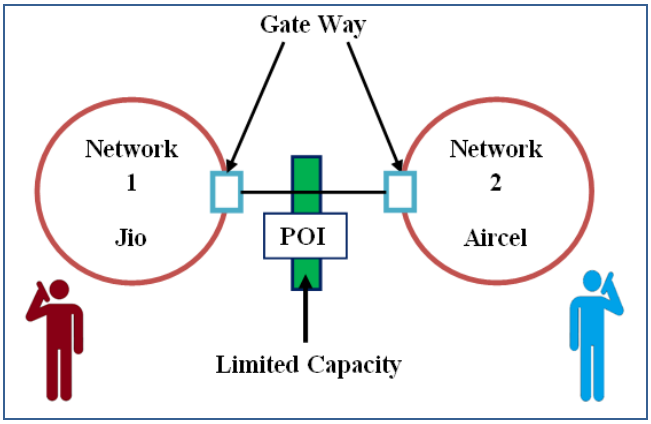

Figure 3 Point of Interconnectivity

4. Traffic Measurement and Analysis

The traffic which represents hours of calls in Erlang is a unit of telecom traffic measurement, which represents the continuous use of one voice path. To successfully design the network topology, to establish the necessary trunk group sizes and to work out how many lines are required between a telephone system and a central office or between multiple network locations.

E1 Count Calculation:

- 1STM(Synchronous Transport Module)= 63E1
- 1E1=0-31(32 Timeslots) were 16th is allocated for signaling. So, 31 Timeslots.
- 1STM=63x31=1953 Timeslots.
- E1 count: 10E1=310 TS, 20E1=620 TS, 30E1=930 TS etc…

- 1E1 carries signals at 2Mbps, i.e. 32 channels carries signals at 64kbps each.
- 1STM= 63E1=63x2Mbps=126Mbps.

Table 1 Calculation of Capacity Utilization

Peak Traffic in Erlang	Maximum Erlang Handling	Capacity Utilization
330.32	549	60.17
912.28	885	103.08

According to Table1 the capacity utilization is calculated on the basis of,

Capacity Utilization = (Peak Traffic/Maximum Erlang handling) x 100

By adding 10E1: 885+10E1=1195
Capacity Utilization = (912.28/1195) x100 = 76.34

By adding 15E1:885+15E1=1350
Capacity Utilization = (912.28/1350) x100 = 67.57

By adding 20E1: 885+20E1=1505
Capacity Utilization = (912.28/1505) x100 = 60.61

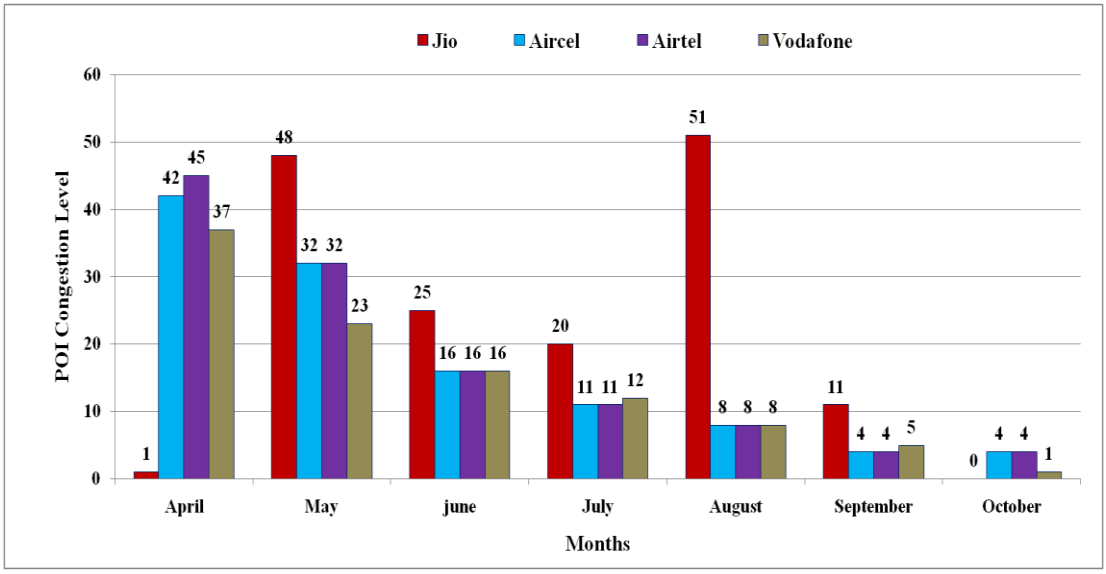

Figure 4 Level of POI Congestion

The local maintenance tool (LMT) or operation maintenance tool (OMT) with an online database is responsible for collection of data on live networks as illustrated in Table 2. In RJIO outgoing to Aircel incoming POI report shows that the utilization % in some months crosses the limit to maintain that E1 Augmentation has taken place.

Table 2 Traffic Data Analysis (RJIO OG to Aircel IC POI)

RJIO OG to Aircel IC POI					
Date	E1 Count	NBH Traffic (in Erlang)	Design traffic with 0.2% GOS	Util in %	E1 Augmented
06.04.2017	NA	NA	NA	NA	0
27.04.2017	NA	NA	NA	NA	0
13.05.2017	31	949	893	106	19
25.05.2017	50	1500	1470	102	159
08.06.2017	209	5325	6360	84	90
22.06.2017	299	6462	7863	82	32
06.07.2017	331	6557	10059	65	0

20.07.2017	331	6425	10059	64	0
10.08.2017	331	10112	10059	101	41
17.08.2017	372	11222	11311	99	62
31.08.2017	434	11983	13214	91	19
07.09.2017	453	12122	13834	87	1
21.09.2017	454	12236	13826	79	0
28.09.2017	454	12124	15280	84	33
07.10.2017	487	12823	14807	87	0
15.10.2017	487	9040	12411	73	0
28.10.2017	487	8603	11230	76	0

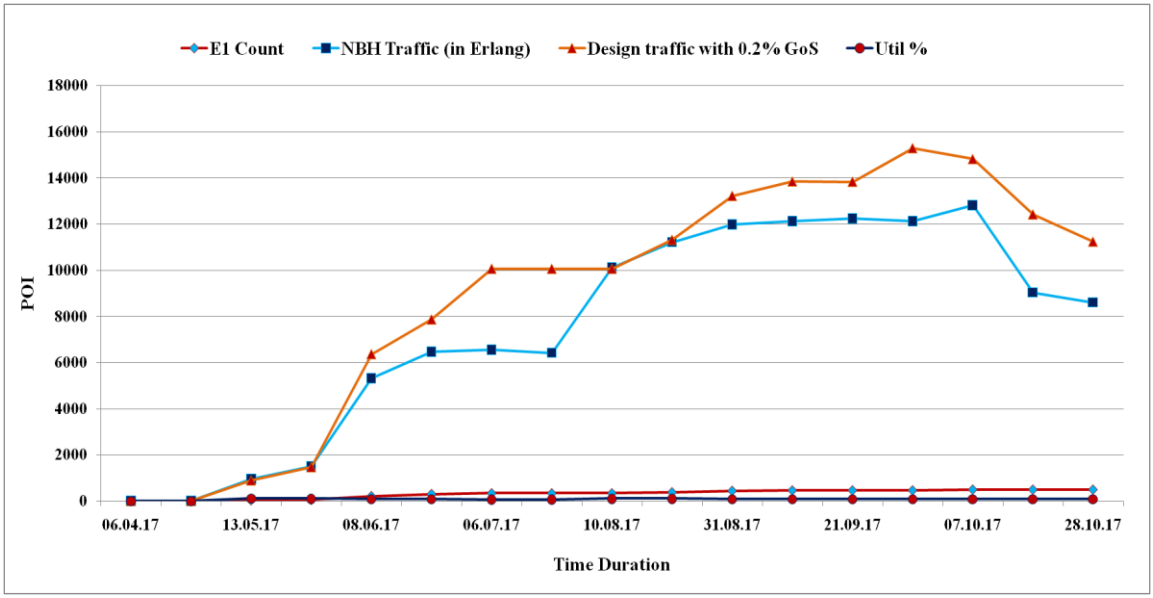

Figure 5 RJIO OG to AIRCEL IC POI

By this way the capacity utilization is calculated and making the decision of how much E1 should be added to avoid the congestion. The figure 5 shows that the percentage of utilization is maintained by increasing the E1 count. The Aircel which makes the point of interconnectivity with the private operators faces the POI congestion. To avoid that further actions are taken place and the actions report are mentioned in Table 3.

Table 3 POI Congestion Report of Aircel

POI with Private Operators				
Name of Circle and POIs	**July 2017**	**Aug. 2017**	**Sep. 2017**	**Action taken report**
Article Local CBE	11%	8%	4%	4 E1s augmented on 05.07.2017 No congestion now
Reliance Jio	20%	51%	11%	Testing completed for 63 E1s Augmentation done on 16.01.2017
Vodafone	12%	8%	5%	10 E1s augmentation on 13.02.2017 No congestion now

Further steps to be carried out are

a) Free ports in media gateway are allocated to transmission team
b) Mux to Mux connectivity from one operator to other has to be done
c) KLM mapping
d) The device panel in local maintenance terminal is used to find out the working mode of E1.

e) Loop and break checking is used for diagnosing transmission problems. Testing from end to end for every E1.
f) Circuit Adding: (Circuit Identification Code). The CIC provides information about where the voice part of the call is carried - on which trunk and in which timeslot. For POI from one operator to other CIC matching should be done.
g) Continuity check has been done for every CIC.

KLM is the value used to identify which E1 are working on. Unless the KLM matches there will be no communications between one operator to another operator. KLM in transmission related to synchronous digital hierarchy (SDH) signals synchronous transport module (STM). KLM is the specific value assigned to the E1 node as shown in Table 4, which is to be matched for proper traffic routing.

- K describes TUG-3 group (1-3)
- L describes a TUG-2 group inside a TUG-3 (1-7)
- M describes a TU-12/VC12/E1 inside a TUG-2 (1-3)

Table 4 KLM Mapping

STM	TUG-3	TUG-2	VC-12 (→E1)	KLM
1	1	1	1	1.1.1
2	1	1	2	1.1.2
To…				
63	3	7	3	3.7.3

5. Results and Discussion

From the analysis of traffic data in RJIO outgoing to Aircel incoming, the capacity utilization crosses the limit it further causes the congestion in the network and makes the call success rate to go down. The call setup success rate is one of the key performance indicators (KPI) used by the network operators to assess the performance of their networks. It has the direct influence on the customer satisfaction with the service provided by the network and its operator. The operators of telecommunication networks aim at increasing the call setup success rate as much as practical and affordable.

Table 5 Analysis of POI Congestion %

Date	POI Congestion %
05.04.2017	NA
26.04.2017	NA
12.05.2017	26
24.05.2017	22
07.06.2017	4
21.06.2017	2
05.07.2017	0
19.07.2017	2
09.08.2017	21
16.08.2017	19
30.08.2017	11
06.09.2017	7
20.09.2017	0
27.09.2017	4
06.10.2017	0
14.10.2017	0
27.10.2017	0

In mobile networks this is achieved by improving radio coverage, expanding the utilization capacity of the network and optimizing the performance of its elements, all of which may require considerable effort and significant investments on the part of the network operator. When comparing with the other private operators RJIO has reached the congestion higher on the month of May 2017. Even though, it makes the availability of affordable and effective communication for citizens. Due to increase in subscriber the congestion% also get increased compared to other operators. From the Table 5 and Figure 6 the analysis shows that on the month of July 2017 it maintains the capacity utilization with 0% of congestion. The POI congestion % is get calculated from the traffic analysis before the process of augmenting E1. By increasing the timeslots the capacity of the network is get increased. And the network utilization% is maintained only by continuous monitoring.

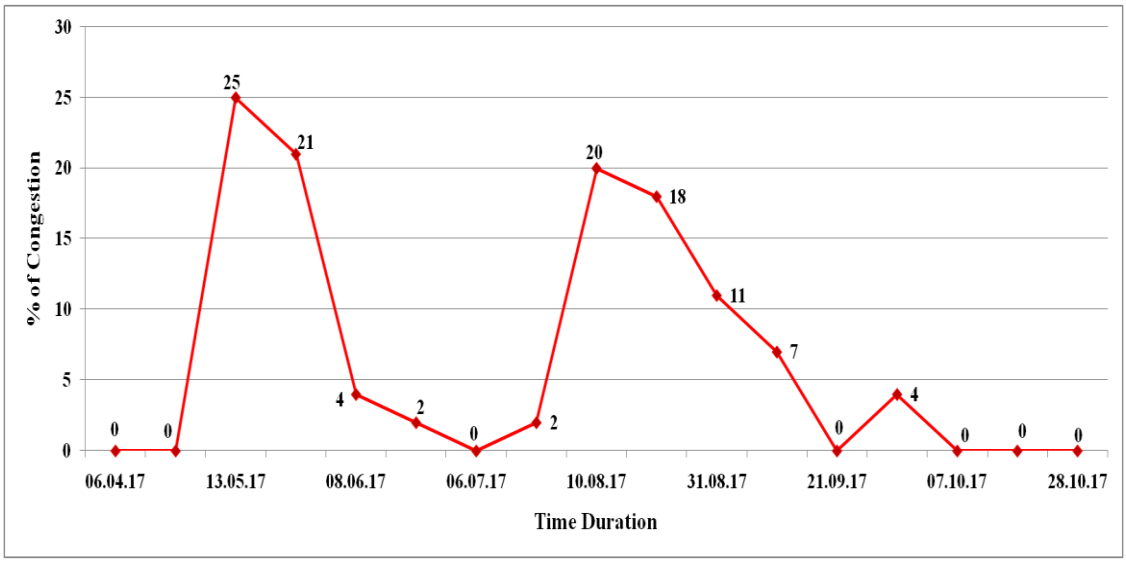

Figure 6 Congestion % of POI

6. Conclusion

In our proposed work optimizes the traffic in GSM network presents the results of an extensive study of a GSM network utilization of particular operator. The experimental analysis focused on the parameters of network busy hour traffic (in Erlang), design traffic with 0.2% grade of service, E1 count and percentage utilization. These findings prove to be useful to network planning engineers as they provide them the data that helps to decide on timely and efficient management and investment on infrastructure. The observed results showed that the % of utilization increases due to increase in subscribers. It happens for the reason in one particular operator on that particular day due to offers, new plans, festivals etc. By doing E1 augmentation we found that the POI congestion is reduced and the % of utilization is maintained between 70 to 80% and also it optimizes the network by improving the call success rate.

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