Optimization of Traffic in GSM Network: To maintain the Capacity,Quality of Service and Coverage

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***Abstract*— To increase the number of mobile subscribers and 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 (i.e.) expanding POI we can overcome the issues in traffic. The network traffic have been evaluated and optimized by taking the weekday-weekend traffic data and expanding the POI during the POI congestion, in future by doing the E1 Augmentation. In order to achieve the best performance, service providers have to monitor and optimize their network continuously.

Keywords—Point of Interconnection, E1 Augmentation, POI Congestion, monitor and optimize.

I. INTRODUCTION

GSM (Global System for Mobile Communication) 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 TDMA technique for transmitting signals.GSM was developed using digital technology. It has an ability to carry 64 kbps to 120 Mbps of data rates [1]. 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 "*Fig.1*": the network subsystem (NSS), the radio subsystem (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. There are three dominant interfaces, namely, A interface between MSC (Mobile Switching Center) and BSC (Base Station Controller), A-bis Interface between BSC & BTS and an Um interface between the BTS (Base Transceiver Station) and MS (Mobile Station) [2].

There are two types of channels in the air interface: Physical channels- is the time slots (TS). 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: The FR (Full rate) channel is a 13 kbps coded speech or data rate of 9.6,4.8 or 2.4 kbps. HR (Half rate) channel supports 6.5 kbps coded speech or data rate of 4.8 or 2.4 kbps.

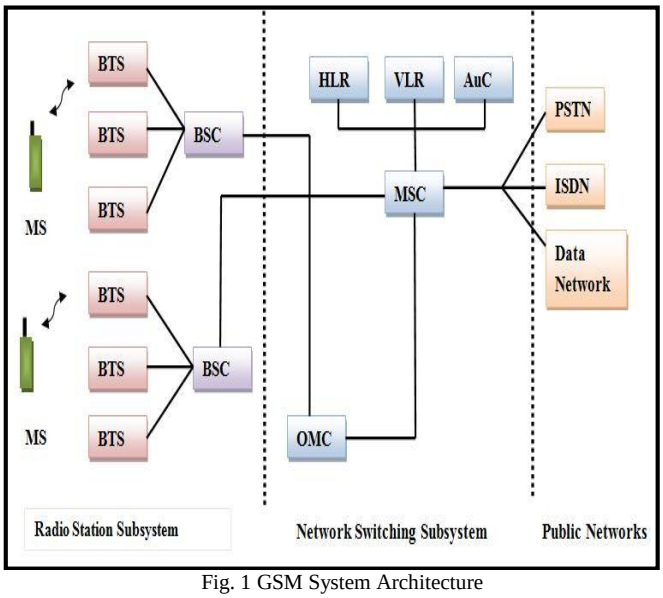

Fig. 1 GSM System Architecture

Presently GSM supports more than one billion mobile subscribers throughout the world. When the number of subscriber increases, network traffic and POI congestion will get increased.POI is the Point of Interconnectivity, every operator makes Interconnection with each other to Terminate Traffic. The Call set up success rate and Answer Seizure Ratio is one of the major KPI (Key Performance Indicator), which should be optimized to improve QoS [3]. The measurement of network quality and call success rates in telecommunications (i.e.) 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 %) is analyzed. And making the decision of augmenting E1 by evaluating the POI congestion% is proposed. The objective of the proposed work is to keep the subscriber satisfied with the delivered Quality of Service by analyzing and reducing the POI congestion.

II. PROPOSED METHODOLOGY

A. *Parameters to be maintained*

During Optimization the main goal to achieve is to maximize coverage and capacity while meeting the Quality of Service as illustrated in "*Fig.2*".Network planning and optimization requires the possibility for a fast evaluation of coverage and capacity.These are the three leading elements of any mobile network [4],

1) *Capacity:* Subscribers or the traffic load that it can handle.
2) *Coverage:* Distance that a wireless network can transmit data at a given data rate.
3) *QoS:* Capability of the cellular network providers to provide a satisfactory service to end users.

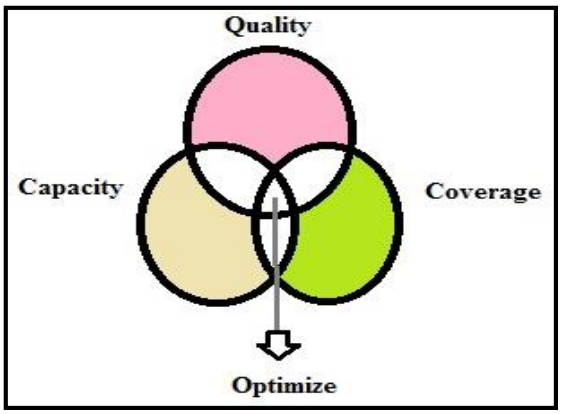

Fig. 2 Important Parameters to maintain

B. *Monitoring of daily traffic 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, Checking the performance of the common channel signaling network. The traffic trend varies based on the offers, new plans etc. The 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 [14]
- 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 IDEA). For E.g. from the "*Fig.3*," if JIO Subscriber is calling IDEA Subscriber it will always pass through POI. If Point of Interconnectivity is congested then Call will not be successful.

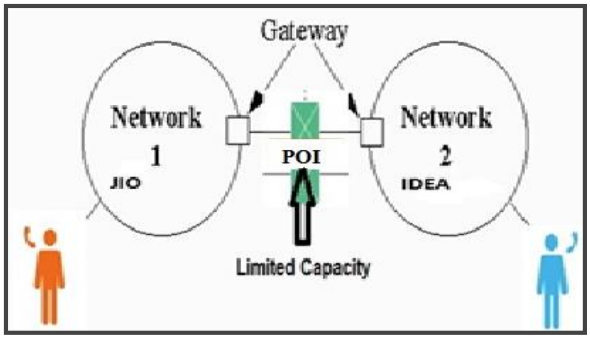

Fig. 3 Point of Interconnectivity

Reliance Jio services were commercially launched on 5th September 2016. On that period JIO Offered Free SIM to everybody and that too with Free Unlimited calls. Daily 2lakh new subscriber are getting added in JIO and millions of calls are coming to the network, which is making POI Congested as shown in "*Fig.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. Idea and Airtel has agreed to expand POI with JIO for traffic optimization.

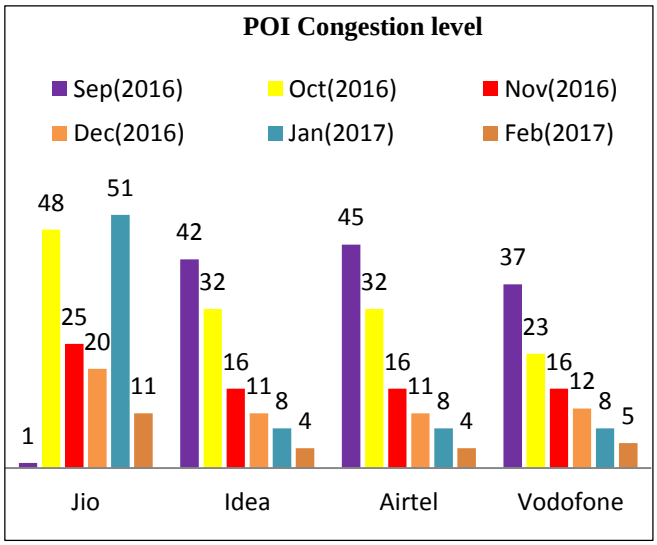

Fig. 4 Level of POI Congestion

C. *Traffic measurement and analysis*

A cellular telephone network must support moving customers, unlike a fixed network[5].Traffic design of a cellular network is a key point of an operator's task [6]. The Traffic which represents hours of calls in Erlang [2]. An Erlang is a unit of telecom traffic measurement, which represents the continuous use of one voice path.

1) Functions of Erlang: 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.

a. *E1 Count Calculation:* E1 count which represents the timeslots, with respect to the need it is get augmented.

- 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 I. CALCULATION OF CAPACITY UTILIZATION

Peak traffic in Erlang	Maximum Erlang handling	Capacity Utilization
330.32	549	60.17
912.28	885	103.08

Capacity Utilization = (Peak Traffic/Maximum Erlang handling) x 100 (1)

According to "Eq. (1)," the Capacity Utilization is calculated on the basis of,

i) By adding 10E1: 885+10E1=1195

Capacity Utilization= (912.28/1195)x100=76.34

ii) By adding 15E1:885+15E1=1350

Capacity Utilization= (912.28/1350)x100=67.57

iii) By adding 20E1: 885+20E1=1505

Capacity Utilization=(912.28/1505)x100=60.61

The Local Maintenance Tool (LMT) or Operation Maintenance Tool (OMT) [5] with an online database is responsible for collection of data on live networks as illustrated in "Table.2". RJIO Outgoing to Idea Incoming POI report shows that the Utilization% in some months crosses the limit. Cellular network can be described as an Erlang's loss system and allowed congestion level (as a percentage) in Erlang's loss system is defined by the Grade of Service (GoS) [7].The simulation is used as the main modeling tool due to the diificulties faced in cellular mobile networks modeling.The analytic results evaluate network performance under a wide range of conditions,which can be computed comparitively easily and are essential in order to be able to use numerical optimization techniques for network design. Thus, in recent years a number of analytical frameworks were developed to obtain more general results and they are much more useful than simulation studies [5,8].

TABLE II. TRAFFIC DATA ANALYSIS (RJIO OG TO IDEA IC POI)

Date	E1 Count	NBH Traffic(in Erlang)	Design Traffic with 0.2% GoS	Utilization%
5-Sep-16	NA	NA	NA	NA
26-Sep-16	NA	NA	NA	NA
12-Oct-16	31	950	894	106
24-Oct-16	50	1,501	1,471	102
7-Nov-16	209	5,327	6,361	84
21-Nov-16	299	6,464	7,864	82
5-Dec-16	331	6,558	10,060	65
19-Dec-16	331	6,426	10,060	64
9-Jan-17	331	10,113	10,060	101
16-Jan-17	372	11,223	11,312	99
30-Jan-17	434	11,984	13,215	91
6-Feb-17	453	12,123	13,835	87
20-Feb-17	454	12,237	13,827	79
27-Feb-17	454	12,125	15,281	84

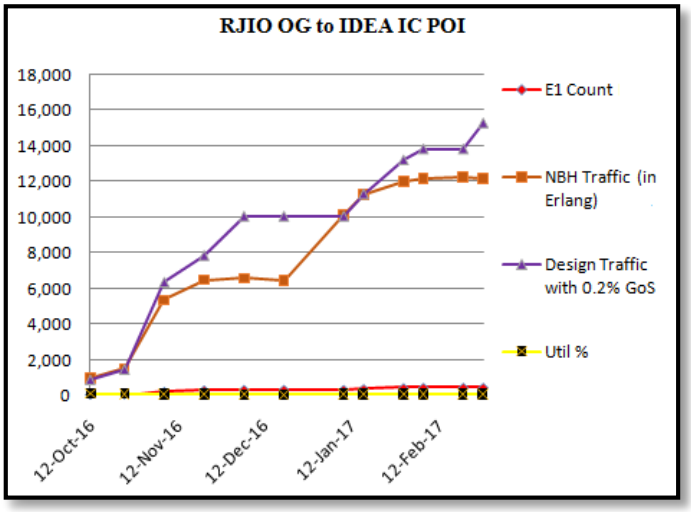

Fig. 5 RJIO OG to IDEA IC POI

By this way the capacity utilization is calculated and making the decision of how much E1 should be added to avoid the congestion. The *"Fig.5,"* shows the rise and fall of traffic data analysis from the month of October 2016 to February 2017.The Idea cellular Ltd which makes the Point of Interconnectivity with the private operators faces the POI congestion. To avoid that further actions are taken place as mentioned in *"Table.3*".

TABLE III. POI CONGESTION REPORT OF IDEA (DEC'16-FEB'17)

Name of Circle and POIs	Dec 2016	Jan 2017	Feb 2017	Action taken report
POI With Private Operators				
Airtel Local CBE	11%	8%	4%	4E1s augmented on 5.12.16. No congestion now.
Reliance Jio	20%	51%	11%	Testing completed for 6 E1s. Augmentation done on 16.1.17.
Vodofone	12%	8%	5%	10E1s augmentation on 13.2.17. No congestion now.

Herewith the POI congestion report of one particular operator gives a clear idea about the action taken place during the rise in congestion%.

III. RESULTS AND DISCUSSION

From the analysis of traffic data in RJIO outgoing to Idea incoming, in some months 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. 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 from the month of October 2016.Even though it makes the availability of affordable and effective communication for citizens. Due to increase in subscriber when compared with an other private operator, the congestion% also get increased. The POI Congestion % is calculated from the traffic analysis, in order to reduce this and to maintain the utilization%, the E1 augmentation has to be taken place in future to avoid call failures. Which is nothing but, by increasing the timeslots the capacity of the network is get increased. And the network utilization% is maintained only by continuous monitoring.

TABLE IV. ANALYSIS OF POI CONGESTION% FOR IDEA OG TO RJIO IC POI

Date	POI Congestion%
5-Sep-16	NA
26-Sep-16	36
12-Oct-16	27
24-Oct-16	24
7-Nov-16	11
21-Nov-16	0
5-Dec-16	0
19-Dec-16	0
9-Jan-17	0
16-Jan-17	0
30-Jan-17	0
6-Feb-17	0
20-Feb-17	0
27-Feb-17	0

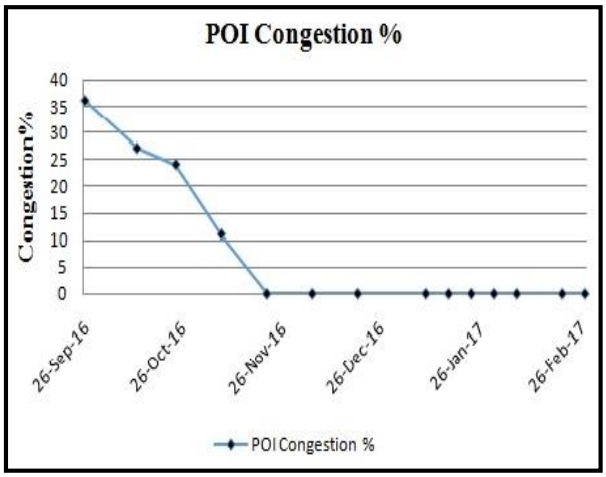

Fig. 6 POI Congestion%

The *"Fig.6,"* and *"Fig.7,"* is compared and analysed that,

i) The POI congestion% is increased on the month of September 2016 and gradually decreased on the month of December 2016 in Idea incoming to RJIO outgoing POI. It practically shows that the usage of network becomes reduced.

ii) The POI congestion% is started increased from the month of October 2016 due to offers and new plans in RJIO incoming to Idea outgoing POI. It practically shows that the usage of network becomes increased.

After analyzing this, the capacity of the network has to be increased by increasing the timeslots.

TABLE V. ANALYSIS OF POI CONGESTION% FOR RJIO OG TO IDEA IC POI

Date	POI Congestion%
5-Sep-16	NA
26-Sep-16	NA
12-Oct-16	26
24-Oct-16	22
7-Nov-16	4
21-Nov-16	2
5-Dec-16	0
19-Dec-16	0
9-Jan-17	21
16-Jan-17	19
30-Jan-17	11
6-Feb-17	7
20-Feb-17	0
27-Feb-17	4

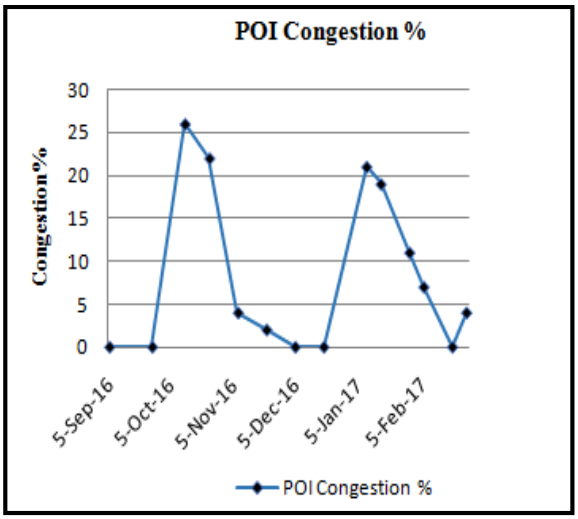

Fig. 7 POI Congestion%

A) Further Steps to be carried out in future

- E1 Augmentation, after analyzing the Congestion%.
- Free ports in Media Gateway are allocated to Transmission team.
- Mux to Mux connectivity from one operator to other.
- KLM mapping.
- To find out the working mode of E1.
- Loop and break checking.
- Circuit Identification Code (CIC) matching.
- Continuity Check for every CIC.

IV. CONCLUSION

The proposed work optimizes the traffic in GSM Network to maintain the three important parameters which is nothing but the Capacity, Quality of Service and Coverage. This paper presents the extensive study of a GSM network utilization of particular operator. The experimental analysis focused on the following parameters i) Network Busy hour traffic (in Erlang), ii) Design traffic with 0.2% Grade of Service, iii) E1 count and iv)Utilization%. These findings prove to be useful to network planning engineers as they provide them the data that help decide on timely and efficient management and investment on infrastructure. Future work is to reduce the POI Congestion and to maintain the utilization% between 70-80% by doing the E1 augmentation, which optimizes the network by improving the call success rate. Further analysis of traffic has to be taken place on the month of March 2017 with the expectation of 0%-congestion to ignore short term variations in the traffic during the peak hour and to maintain the utilization%.

ACKNOWLEDGMENT

Our thanks to the officers of Idea Cellular Ltd who had contributed towards the measurement of Traffic on live GSM Network.

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