ESTIMATION OF CONGESTION IN GSM WIRELESS NETWORK

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Abstract: The exploding need for wireless communication where the Global System for Mobile Communication (GSM), a digital cellular radio network that uses more advanced technology and handles more subscribers than the analog cellular network has played a vital role has seen to have experienced a perpetual congestion problem at the subscriber end. Many people have subscribed due to its outlined features and all these have led to congestion on the GSM network. These were attributed to exhaustion in radio bandwidth, interference of wireless devices in the overcrowded radio spectrum, and high-capacity radio power-hungry. Models have been proposed, optimization carried out but a little difference with a huge cost. This paper presents an estimation measurement technique with a low-cost estimate on a mobile GSM network using Alcatel Lucent Network Statistics to define top-level KPIs which describe total SDCCH request, total successful SDCCH, and Average TCH channel at the BTS level. The data for the following KPI was collected and analyzed. BTS station sites, Data processing was carried out using MATLAB R2019a, AND SPSS 2019 tool which helped in understanding and analyzing the concept of congestion in the selected K-GSM Network, by estimating Traffic Patterns Congestion control in the network.
Keywords: congestion, data-processing, estimation, kip's, network.

1.0 INTRODUCTION

The non-existent network to the subscriber at the time of making a call is known as congestion. This occurs when there is blocking and no provision of a free path to an offered call ([7]), that is, when a subscriber cannot link a connection to the desired subscriber at the right time. This situation arises when the resources are limited at the service point, which resulted in the barrier called congestion, traffic, or queues. An analytical model for managing uncooperative flows in the internet by re-mapping their utility functions was proposed by Exponential Weighted Moving Average (EWMA) and Weighted Average Loss Indication (WALI) were used to implement the edge-based re-maker in the Network Simulator (NS). This goes a long way to controlling congestion, however, for a proper and good way of controlling congestion, there is a necessity for congestion prediction in a fixed telecommunications network. Optimization Model for Minimizing Congestion in Global System for Mobile Communications (GSM) was employed ([5]). Where he came out with six models for minimizing congestion vis-à-vis: Partnership between government/corporate organizations with GSM operators, Dynamic half rate, National roaming agreement, Regionalization, and Merging of networks ([2]). He concluded that service providers have to monitor and optimize their network continuously. A New Pricing Model for Competitive Telecommunications Services Using Congestion Discounts was worked on ([4]). He presented a model that uses price discounts to stimulate subscribers to withdraw their calls at peak periods to a later time of less congestion; otherwise, the customer is serviced at a higher price. Fuzzy Logic-based Congestion Control where he mentioned an illustrative example of using Computational intelligence (CI) to control congestion using Fuzzy logic was reported on ([6]). Their review and model on CI methods were applied to ATM networks and shows that CI can be effective in the control of congestion. In locating and controlling a congestion area in a network, Common Control Channel, a group of control channels that supports the establishment and maintenance of communication links between the mobile Stations and bases ([1]). In this paper, an estimation measurement was conducted on a particular mobile GSM cellular network in a G-location using the Alcatel Lucent Network statistics and it helped in understanding the concept of congestion in the selected GSM Network, by estimating Traffic Patterns.
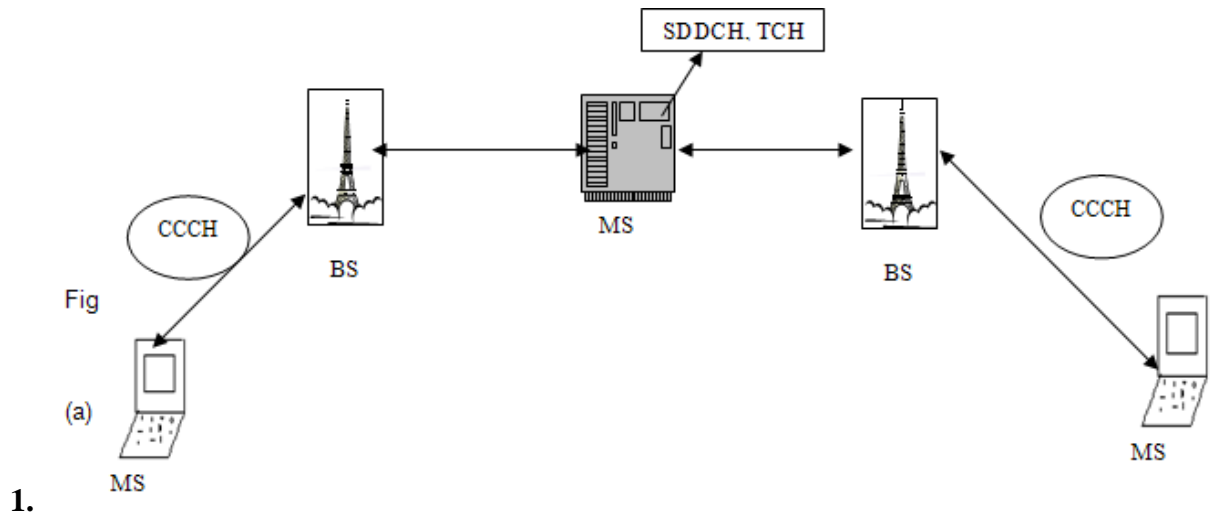
1.

Fig 1: MS-MS Communication Network

When any of the three control channels are congested, there can't be any call establishment between the sender and receiver. This failure is called a "Call Establishment Failure" ([5]).

2.0 GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS (GSM)

GSM is a digital, mobile; radio standard developed for mobile, wireless, voice communications. GSM uses a combination of both the time division multiple access (TDMA) and frequency division multiple access (FDMA) ([5]). With this combination, more channels of communications are available, and all channels are digital. The GSM service is available in the following frequency bands: 900-MHz, 1800-MHz, 1900-MHz. A GSM network consists of the following network components: Mobile station (MS), Base transceiver station (BTS), Base station controller (BSC), Mobile switching center (MSC), Authentication Center (AUC), Home location registers (HLR), and Visitor location registers (VLR).
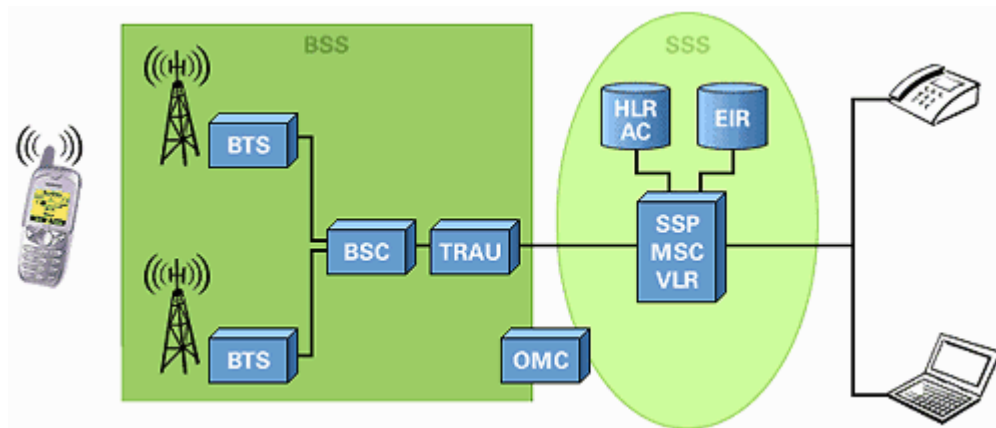

Fig 2: Basic GSM Architecture

The mobile station (MS) is the starting point of a mobile wireless network (Lasisi & Aderinkola, 2018), the MS can contain the following components: Mobile terminal (MT)—GSM cellular handset: Terminal equipment (TE) PC or personal digital assistant (PDA)

The Stand-Alone Dedicated Control Channel (SDCCH) is the channel used for signaling messages. It is concerned with call setup, location update messages, and Short Message Services (SMS). SDCCH congestion has been stipulated by the Nigerian Communication Commission to be less than 10%. This congestion is the first level of congestion experienced by the customer. It measures the relative ease by which the customer seizes a traffic channel to set up a call after a signaling seizure has been successful. The higher this value, the relative difficult it is in making a call. The traffic channel is that channel used by Mobile Station for communication.

TCH availability is a measure of congestion of the Traffic channel measured at the busy hour.

$$TCH = \frac{BusyHourTCHTraffic(Erlang) - AverageTCHTraffic(Erlang)}{BusyHourTCHTraffic(Erlang)} \times 100\% \quad\ldots\ldots \quad (1)$$

Handover is the process in which a cellular phone is handed from one cell to the next to maintain a radio connection with the network. Inter PLMN handover refers to the handover between two different networks irrespective of the radio access system. Intra PLMN handover refers to the handover within the same network regardless of the radio access system. Handover Success Rate is the ratio of the number of completed handovers to the total number of initiated handovers. This ratio can be expressed as a percentage.

$$HandoverSuccessRate = \frac{numberofsuccessfullycompletedhandovers}{Numberofinitiatedhandovers} \times 100\% \quad \ldots (2)$$

Therefore,

$$HandoverFailureRate = 1 - HandoverSuccessRate \quad\quad \ldots\ldots \quad (3)$$

3.0 METHODOLOGY

The Estimation measurements were conducted on K- mobile GSM cellular network, using Alcatel Lucent Network Statistics to define top-level KPIs which describe the success/failure rates of the most important events such as Total call request, total successful call request, total handover request, total successful handover request, total SDCCH request, total successful SDCCH and Average TCH channel at the BTS level. The data for the following KPI were collected and analyzed. BTS station sites, Data processing was done using MATLAB R2019a AND SPSS 2019 tool. The data collection was over a fifty-two (52) week period and categorized into three local Governments. Weekly statistics gave a detailed picture of the network performance and are useful to help spot problems and identify trends as seen from the results.

3.1 Correlation of KPI's

The Correlation Table 1.0 shows the correlation coefficients of the independent variables for an LGA, as prepared by SPSS tools.

Table 1.0: Correlations of the KPI'S K-LGA

		CSR	CSSR	Handover	TCH
CSR	Pearson Correlation	1.000	.966[**]	.801[**]	-.229
	Sig. (1-tailed)		.000	.000	.166
	N	20	20	20	20
CSSR	Pearson Correlation	.966[**]	1.000	.721[**]	-.339
	Sig. (1-tailed)	.000		.000	.072
	N	20	20	20	20
Handover	Pearson Correlation	.801[**]	.721[**]	1.000	.029
	Sig. (1-tailed)	.000	.000		.451
	N	20	20	20	20
TCH	Pearson Correlation	-.229	-.339	.029	1.000
	Sig. (1-tailed)	.166	.072	.451	
	N	20	20	20	20
**. Correlation is significant at the 0.05 level					

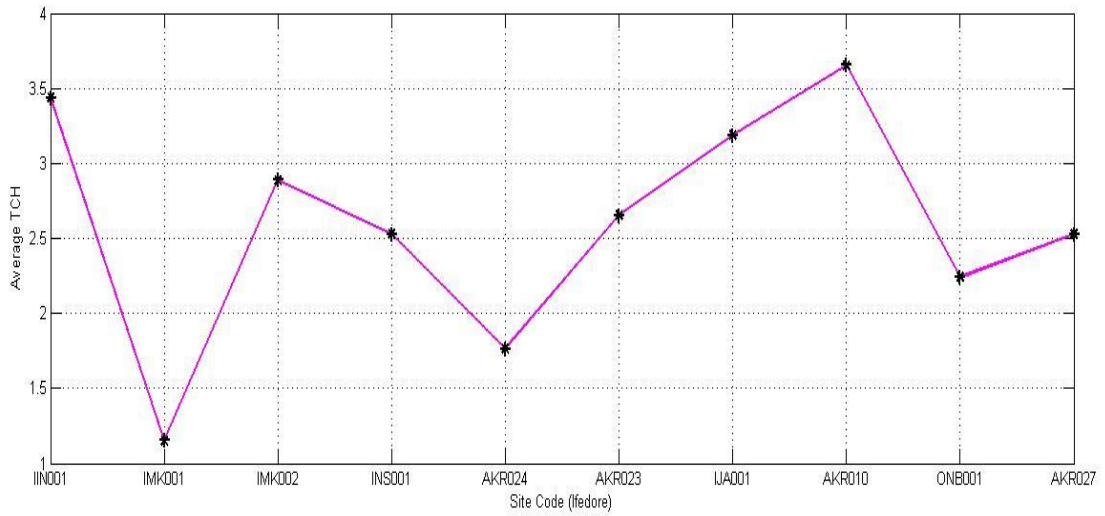**4.0 RESULTS AND DISCUSSIONS**

Figure 3: Traffic Channel: I-Local Government

From the above Graph, the site with the highest traffic channel is observed to be L010, while the site with the lowest traffic channel is seen to be IMK001. Traffic Channel was configured or upgraded based on the increase in the number of subscribers on the particular Base station to ease congestion and to improve call set up success rate.
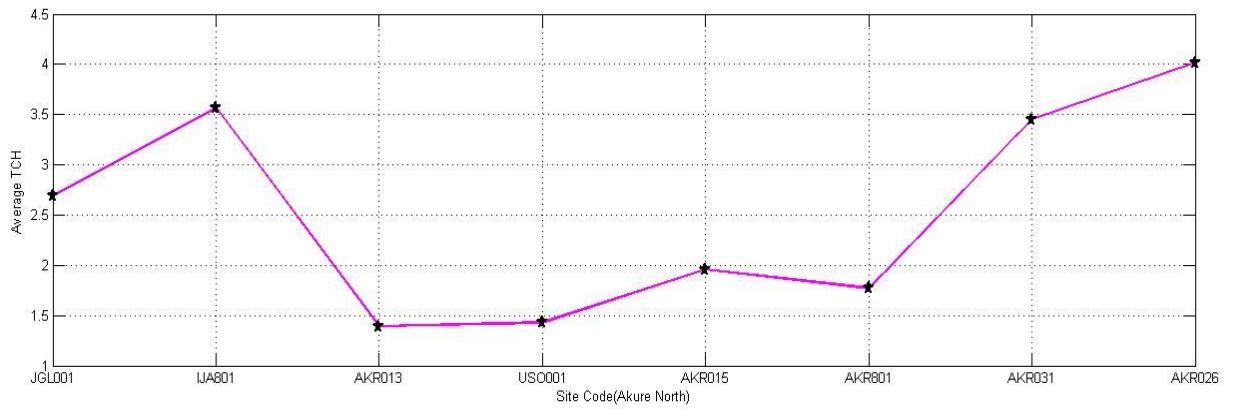

Figure 4: Traffic Channel: AN-Local Government

L026 of AN local government has the highest traffic channel while L013 and UO001 having the lowest TCH are observed to have the same traffic channel element. It can be inferred that the traffic channel is directly proportional to the number of subscribers.
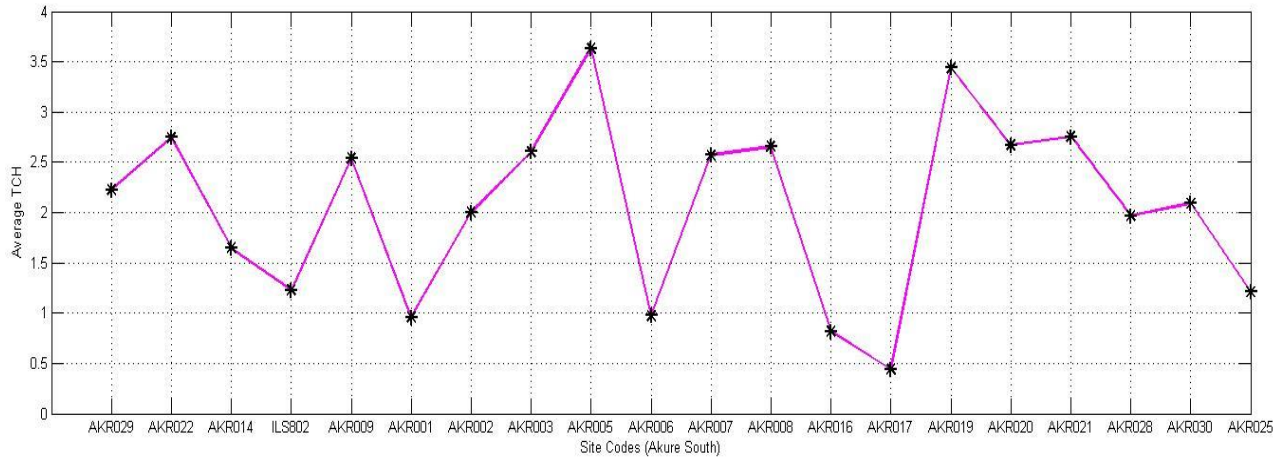
Figure 5: Traffic Channel: AS-Local Government

From the above graph, we have a larger part of the sites clustered in AS-LG. L017 is observed to have the lowest TCH of 0.43 being a Road coverage site with a smaller number of users while L005 has the highest traffic channel of 3.63 because it's located in the Heart of the Town where we have a larger percentage of subscribers.
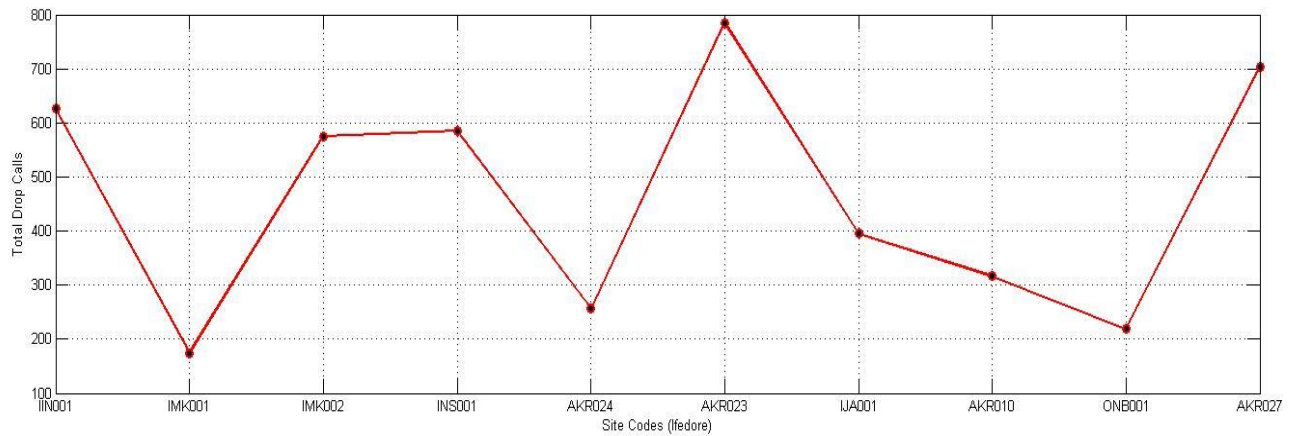

Figure 6: Total Call Drop: I-Local Govt

From the Graph above, the site with the highest Call Drop is L023 having a total call drop of 785 while L001 has the lowest total call drop with a total call drop of 174. Call drop is a KPI that measures the Quality of the Network for the length of time the user is making a Call when either party hasn't terminated the call. Call Drop can be attributed to some factors
Undefined Handover, Faulty Transceivers, Degraded transmission Link, Unavailable TCH resources, Co-channel interference., Blindspot/Poor network Coverage.
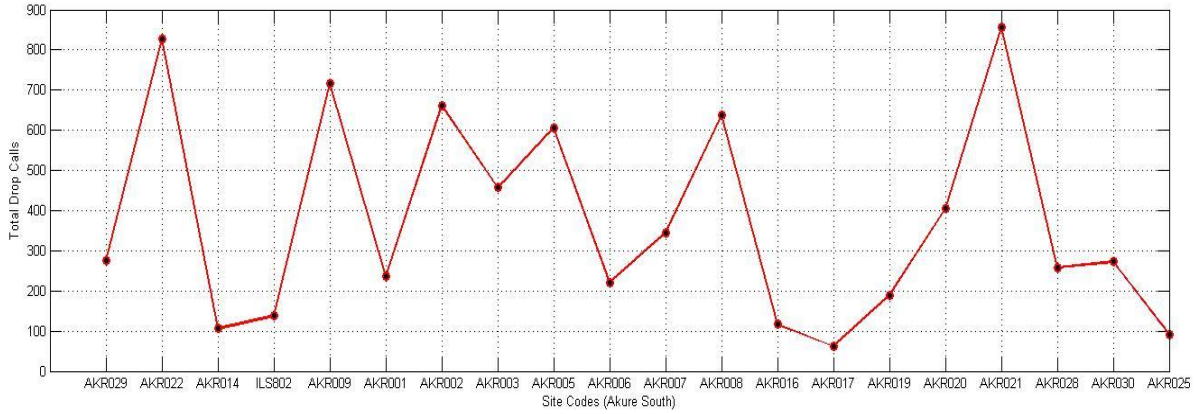
Figure 7: AS-LG Total Dropped Calls

L021 has the highest total dropped calls with Akr022 almost having the same Call drop pattern, Akr017 has the lowest dropped call with a total of 62. The lesser the dropped calls, the better the network quality.
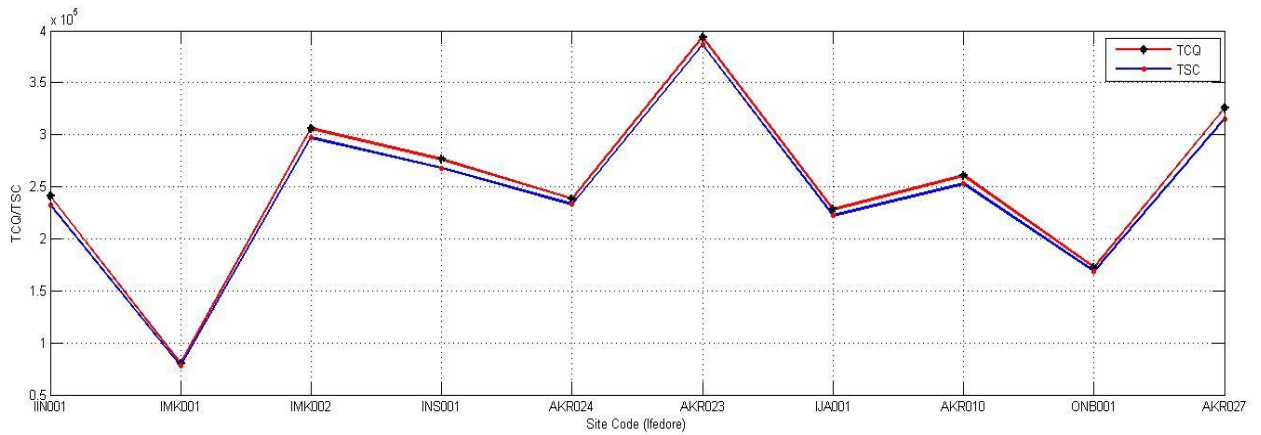

Figure 8: I-LG: Total Call Request/Total Successful Call Request

Total call request and the total successful call is a measure of the call set up success rate (C.S.S.R), this should be greater or equal to 98% of attempted calls. From the data table, only L023 has a CSSR of 98.13%. every other site has lesser values. This can be attributed to factors like,

Unavailable/limited SDCCH channel, Transceiver with low efficiency, SDCCH congestion. More subscribers on the network.
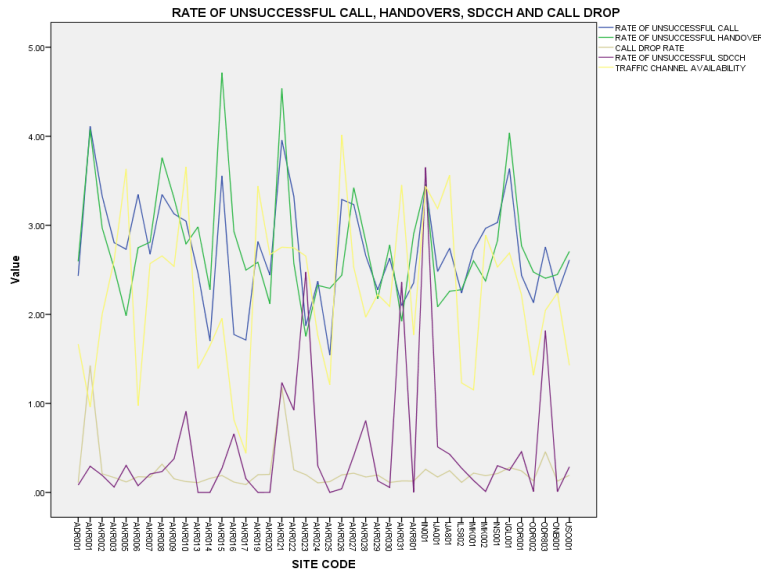
Figure 5

Figure 10: Comparison of call rates.
The figure above compares the rates of unsuccessful calls, unsuccessful handovers, unsuccessful SDCCH, TCH, and call drops for the forty-two (42) different sites at the G-Location.

5.0 CONCLUSION
This paper on Congestion estimation of GSM network shows that performance indices like Call Set up Success Rate (CSSR), Call Drop Rate (CDR), Traffic Channel availability (TCH) and Handover success rate are important in analyzing and delimiting congestion in a network. Factors like Bandwidth, Time Slot, Weather conditions, Terrain\topography of Base Stations cannot be over-emphasized. Also, it was observed that sites with low call requests have a good CSSR and successful handover rate. Sites having six cells have a high TCH rate because their resources are for coverage (900Hz) and capacity (1800Hz).

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