Analysis of GSM Traffic Performance.

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ABSTRACT

This paper investigates GSM traffic performance. It is a case study of one of the leading GSM operators in Nigeria. In this work, efforts were made to assess traffic performance of the network using operational parameters such as network failure, call drop and capacity utilization. Physical measurements of call events on a specific base transceiver station (BTS) were carried out for a period of three (3) days. Results were taken and recorded accordingly. Thereafter, the traffic flow was simulated at the interface with the main switching center (M.S.C). Results from simulation were considered secondary data and this was compared with the initial data recorded. Our findings obtained from this work has highlighted the main causes of incessant failures, imperfection in GSM network and ways to correct these problems for better network operational efficiencies.

(Keywords: traffic, call failure, dropped call, operational efficiency, grade of service)

INTRODUCTION

The GSM revolution in Nigeria started in August 2001 and brought a great change in the face of Information and Communication Technology (ICT) in the country. The GSM deployment into the Nigerian market was universally embraced and found to be relatively efficient at the inception. But with time, operators started experiencing degradation in network performance due to traffic impairment. This paper has investigated GSM traffic performance of one of the leading operators in Nigeria. Presently, users complain of service unavailability, abrupt termination of calls, inability to establish calls, interconnectivity problems, etc.
Performance measurements are tools and methods for traffic data collections, analysis, and observation. Network operators therefore need detailed information about the network performance in order to manage the network efficiently. The information obtained from performance evaluation was used for identifying traffic patterns and distributions to determine the amount of traffic in the exchange and the entire network. Such information therefore provided the base for monitoring Quality of Service (QoS), areas of inadequate services, and solution to the problems. Traffic measurement in a network was categorized into two methods, the active and passive methods. In the active method, control probe traffic was sent along one or more routes in a target network and observing it at the receivers while the passive method involved the collection of real traffic or its statistics at one or more points on a target network and the collected data were analyzed. This active method was used for direct measurement of quality end-to-end communication while the latter was used for direct measurement of network internal statistics (traffic load and matrix).

The passive method was employed in our investigation. Physical measurements of call events on specific base transceiver station were taken for a period of three days. The traffic flow at the interface with the mobile switching center was simulated using a Queuing Scheme Model.

LITERATURE REVIEW

The idea of a cell-based mobile radio system was first conceived at Bell Laboratories in the early 1970s. However, mobile cellular systems were not introduced for commercial use until the 1980s. During the 1980s, analog cellular telephone systems experienced a very rapid growth in Europe, particularly in Scandinavia, and in United Kingdom. In the beginning of cellular systems, each country developed its own system which was an undesirable situation. In order to bring about uniformity in terms of infrastructural needs in telecommunication systems, the conference of European posts and Telecommunication (CEPT) in 1982 formed the Groupe Special Mobile (GSM).

The group was to develop a pan-European mobile cellular radio system that will bring about good voice quality, spectral efficiency, support international roaming, etc. Commercial services of GSM started in mid-1991 and by 1993, there were 36 GSM networks in 22 countries. By the beginning of 1994, there were 1.3 million subscribers world-wide which grew to 55 million by October 1997.

The GSM revolution in Nigeria started in August 2001 and brought a great change in the face of Information and Communication Technology (ICT) in the country. At the inception, the Nigerian Communication Commission (NCC) licensed three major operators namely, ECONET (now ZAIN), MTN, and MTEL. In year 2002 another company called GLOBACOM was licensed to provide GSM services making a total of four operators. Today MTEL is no longer in existence leaving the other three as the major operators in the country. These three major operators have been relatively doing well in the provision of voice and data communication in the country.

METHODOLOGY

The method adopted in this research work is termed as passive method. It involves physical measurement of call events on specific base transceiver station (BTS) for a period of three (3) days. The total number of accepted calls, successful calls, and dropped calls by the network under investigation were recorded. The passive method of measurement entails the collection of real traffic data or its statistics at one or more points on the network. The observed and recorded data from measurement forms part of the primary data for the investigation. To obtain the necessary data for analysis, simulation and measurement were restricted to one base transceiver station (BTS) in the Obalande area of Lagos switching center, and the results recorded forms part of the secondary data which are as presented in Tables 1-3.

ANALYSIS OF RESULTS AND SIMULATION

Results obtained as presented in tables 1-3 above were analyzed and simulated. In the simulation, the following standard assumptions were taken:

Table 1: Traffic Performance Measurement at a BTS in Obalende Area of Lagos. Day One (1).

TIME (PER MINUTES)	TOTAL CALL ACCEPTED	AVERAGE HOLDING TIME (MIN)	NO OF SUCCESSFUL CALLS	NO OF DROPPED CALLS
9.45-10.00 am	783	1.31	200	583
10.00-10.15 am	799	1.30	250	549
10.15-10.30 am	775	1.29	216	559
10.30-10.45 am	735	1.35	300	435
10.45-11.00 am	709	1.28	210	491
11.00-11.15 am	761	1.26	245	516
11.15-11.30 am	900	1.20	300	600
11.30-11.45 am	831	1.32	300	531
11.45-12.00 pm	880	1.35	210	670
12.00-12.15 pm	830	1.30	400	430
12.15-12.30 pm	872	1.15	362	510
12.30-12.45 pm	864	1.37	380	514
AVERAGE	**815**	**1.30**	**287**	**526**

Table 2: Day Two (2).

TIME (PER MINUTES)	TOTAL CALL ACCEPTED	AVERAGE HOLDING TIME (MIN)	NO OF SUCCESSFUL CALLS	NO OF DROPPED CALLS
9.45-10.00 am	688	1.42	221	467
10.00-10.15 am	700	1.31	230	470
10.15-10.30 am	670	1.36	250	420
10.30-10.45 am	710	1.20	242	468
10.45-11.00 am	704	1.24	212	492
11.00-11.15 am	760	1.40	238	522
11.15-11.30 am	800	1.32	282	518
11.30-11.45 am	780	1.36	304	476
11.45-12.00 pm	782	1.42	270	512
12.00-12.15 pm	750	1.28	268	482
12.15-12.30 pm	765	1.34	220	545
12.30-12.45 pm	784	1.30	232	552
AVERAGE	**741**	**1.33**	**247**	**494**

Table 3: Day Three (3).

TIME (PER MINUTES)	TOTAL CALL ACCEPTED	AVERAGE HOLDING TIME (MIN)	NO OF SUCCESSFUL CALLS	NO OF DROPPED CALLS
9.45-10.00 am	600	1.26	200	400
10.00-10.15 am	720	1.31	240	480
10.15-10.30 am	660	1.42	220	440
10.30-10.45 am	840	1.35	280	560
10.45-11.00 am	780	1.45	260	520
11.00-11.15 am	960	1.20	320	640
11.15-11.30 am	900	1.32	300	600
11.30-11.45 am	1020	1.36	340	680
11.45-12.00 pm	1160	1.40	386	773
12.00-12.15 pm	1120	1.33	374	746
12.15-12.30 pm	1040	1.28	374	693
12.30-12.45 pm	1140	1.35	380	760
AVERAGE	**912**	**1.34**	**306**	**608**

- The calls arrives at the interface in batches
- No repeat attempts
- The system or interface behaves as a pure loose systems
- About 2/3 of calls accepted are usually dropped or lost.

There were 24 radio channels between the base transceiver station and the base controller station. Now from day 1 result, each observation period lasted for 15 minutes = 900 seconds. The total observation time for the 12 period is 3 hours = 180 minutes. Average holding time for each call is 1.30 minutes = 78 seconds. So in one minute, the total successful calls will be the average number of successful calls per observation period (e.g. 287/15 = 19). This implies that 19 calls arrived at the interface every 60 seconds. Also in 15 minutes, one channel could handle 15 X (60/78) = 12 calls.

This means that 287 calls within the time interval would require 287/12 = 23 channels, and 815 calls would require 815/12 = 67 channels and so on. In essence, this implies that an increase in calling rate would require more channels and subsequently an increase in number of BTS to give subscribers satisfactory grade of service. Also, from the result, if it took 900 seconds for about 815 calls to arrive the main switching center (MSC) and to be processed, therefore one call would arrive at 900/815 = 1.1 seconds. This implies that 1.10 seconds is the mean arrival time of calls at the interface. The Grade of Service (G.O.S) is therefore given as the no of dropped calls over the average no of calls e.g 526/815 = 0.645.

DAY 2

- Observation period = 90 seconds
- Total observation period = 180 minutes
- Average holding time = 1.33mins = 79.8 seconds
- Successful calls per minute = 247/15 = 16 calls
- Channel capacity in 15 minutes = 15 X (60/79.8) = 11 calls
- No of channels required for observed period = 741/12 = 62 channels
- Estimated Grade of Service = 494/741 = 0.67

DAY 3

- Observation period = 90 seconds
- Total observation period = 180 minutes
- Average holding time = 1.34mins = 80.4seconds
- Successful calls per minute = 306/15 = 20 calls
- Channel capacity in 15 minutes = 15 X (60/80.4) = 11 calls
- No of channels required for observed period = 912/12 = 76 channels
- Estimated Grade of Service = 608/912 = 0.67

DISCUSSION OF RESULTS

The results obtained from the passive measurement and the simulated data varies. It is evident from simulated data that this method is good for estimating Grade of Service. The QoS estimated at three different times and days conforms to a value of approximately 0.66 which shows that there is still need for improvement by the operator. Also, the simulated average number of accepted, dropped, successful calls and Grade of Service (GOS) are higher than the average measured values. This is due to the fact that the simulated data reveals the actual or true behavior of the network under investigation, on the assumption that all enabling conditions and infrastructures are in place.

The variance between the observed and simulated data is analyzed to be the main cause of the incessant failures in the network under investigation. From the result, it is very clear and paramount that more base transceiver stations with appropriate radio infrastructures should be built across the network coverage areas for proper transmission between cells. This will also enhance proper handoff call within inter-cells, intra-cells with high signal strength either uplink or downlink.
Having evaluated critically the network under investigation using measured data, the following points are hereby suggested towards improving traffic performance situation:

- The operator should invest heavily in transmission network development and have proper radio planning. This would ensure increased network resilience, improve bandwidth utilization, and alleviation of capacity bottlenecks.
- Additional switching centers needed to be built across the country so as to increase capacity to handle more traffic.
- The operator should upgrade and optimize all existing base stations. If this is done, it will stem call setup failures due to increases in traffic volumes.
- Additional base stations across the country should be built. This would create room for the network to handle more traffic.
- If a particular base station is to be taken "offline" (either for schedule maintenance, repairs and upgrade), all neighboring base stations should have their communication power levels increased. This will increase the coverage area,

thereby reducing congestion and dropped calls.

CONCLUSION

One of the results achieved in this paper is the monitoring of traffic performance on specific areas of the network in order to provide an insight into the capacity utilization of the network system. This is particularly important for areas of high usage where a decision is to be made regarding putting additional capacity, to enable availability of lines to users, also stability and prevention of call dropping especially during conversation. This research analysis provides tremendous insight into the balance of capacity utilization amongst different cells and sectors in the GSM network. If the capacity that is already in place is balanced and utilized efficiently, no doubt would the revenue gain improve appreciably.

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