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Intelligent Mobility Control Scheme for Optical Communication System

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Abstract: *The current development in the use of the mobile communication systems and the growth in the population and the location area has necessited the research study in area of an intelligent mobility management scheme, and from the results obtained, it was found that the mobile to mobile call setup times showed a better performance as compared to the fixed network to a mobile call setup and mobile to a fixed call setup times. Moreover, increasing the number of location areas within the switches do not affect the inter-Mobile Service Switching Centres (MSC), handovers and Location updates since the size of the Switch coverage areas remain the same. However, when the Location areas within the switches are increased, the intra-MSC Location updates and handover also increases. Finally, Mobility user Scheme directly affects the signaling traffic for handovers, Location managements, radio resource allocations and routings.*
Keywords*: Mobile communication, Optical, Switching and System.*

I. Introduction

Mobility Control is one of the major functions of a Mobile Communication network that allows mobile phone to function. This is because it enhances the proper and effective tracking of where the subscribers are; allow calls, SMS and other mobile phone services to be delivered to them. In mobile communication system, GSM network is basically a radio network of varying***Cells*** which is referred to as ***Base stations***, where each base station is meant to cover a small geographical area which is part of a specifically defined location area. Thus, if the coverage area of these base stations is integrated/Unified, the GSM network provides radio coverage over a much wider area (Nweke, F. U *et al.*, 2015). The group of these base stations is referred to as a location or a routing area. In mobile communication system, mobility control schemes are very vital in signaling and traffic load analysis. In our age today the influence of mobility on the network performance (e.g., handover rate) will be strengthened, mainly due to the huge number of mobile users in conjunction with the small cell size.

In mobile communications, mobility scheme is involved in several aspects related to signaling and traffic load analysis. Mobile Communicationsmobility control schemes are very crucial in service provision to Mobile Users and is variedly accomplished by the employment of (a) the location management procedures (location update, domain update, user registration, user location etc.) used to keep track of the user/terminal location and (b) the handover procedure which allows for the continuity of ongoing calls. Hence, in this work, GSM call and mobility functionality are defined in terms of ***Service Independent Building Block (SIBs)***, which will enable the close integration of these functionalities with supplementary service SIBs (Sivagnanasundaram S., 1997).

The performance of the above procedures is influenced by the user mobility behavior. Their applicationdirectly affects (a) the signaling load generated on both the radio link and the fixed network (e.g.,location updating rate, paging signaling load, etc.) and (b) the database queries load. Additionally, thehandover procedure affects the offered traffic volume per cell as well as the ***Quality of Service (QoS)***experienced by the Mobile Users (e.g., call dropping). In the System, the estimation of the above parameters, whichare critical for network planning and system design (e.g., location and paging area planning, handoverstrategies, channel assignment schemes, etc.) urge for the development of 'appropriate' mobilitymodels. For the very importance of this work and for the proper explanation of the varying functionality in the communication system, different mobility detail levels are required. In particular as shown below:

- **Location Management Aspects:** Location area planning, multiple step paging strategies, data locating strategies, database query load, etc. Location management related issues require the knowledge of the user location with an accuracy of a 'large scale' area (e.g., location or paging area).
- **Radio Resource Management Aspects:** Cell layout, channel allocation schemes, multiple access techniques, system capacity estimation, QoS related aspects, signaling and traffic load estimations, user calling patterns, etc.

- **Radio Propagation Aspects:** Fading, signal strength variation, handover decision algorithms, etc. The analysis of radio propagation aspects needs accuracy of a 'small-scale' area (comparable to the wavelength level).

MOBILITY CONTROL SCHEME

Before getting to the very details of how a Mobility Control Scheme works and ways to use and manage user activities in a mobile communication, we first have to understand what a Mobility Control Scheme is all about. Therefore, **Mobility Control Scheme** is a comprehensive mobile user system architecture, showing the movement behaviour of the ***Mobile user (MU)***via a range of mobile terminals, operating in both public and private environments (Markoulidakis J.G *et al*., 1997).

In Mobile communication services, services to the MUs (Mobile Users) are provided at any time and at any location regardless of the movement of MUs. In order to setup a call, a MU should be tracked and located. Global System for Mobile communications (GSM) was born from the need by several European countries to introduce a common mobile communication network and overcome the limitations of the existing analogue system. The analogue system was limited in several ways, including its inability to cope with the unprecedented growth in the demand for mobile communications, the use of open channels allowing for easy 'eavesdropping' and 'cloning', the inflexibility in the introduction of value added services and the lack of a common network across Europe, among others.In 1982 the ***Conférence Européenne des Postes et Télécommunications (CEPT***) formed the ***"Groupe Spécial Mobile" (GSM)*** (later to be called Global System for Mobile communications) to define the standards for a new mobile communications system. Although GSM was introduced as an European specific standard, it has been adopted by several countries world wide. The system was required to allow roaming in participating countries, offer services and facilities found in other public networks and use an internationally standardised signaling system for interconnection of mobile switching centres and location registers.GSM as a network is not defined by a set of rigid and stagnant standards. It is a network not only willing to evolve, but by the very nature of its specifications it needs to evolve (Sivagnanasundaram S., 1997).
SIGNALING IN GSM: This is the language used for communication between machines or computers. Therefore, the ability of a network to communicate within its entities and the entities outside its boundary requires signaling. Moreover, signaling refers to all the control signals used within or between communication equipment whose function is to set up communication. Hence, GSM signaling defines the communication between the mobile station and the network. This has been carried out through the network and across the air-interface to the mobile station (Nweke F. U et al, 2015).

For a network to function successfully, it must have the ability to communicate within thenetwork and with entities outside its boundaries. The Mobile Communication network is no exception, but uses a larger variety of signaling protocols and different transport mechanisms compared to other networks. The transportation mechanisms used by GSM signaling protocols are;

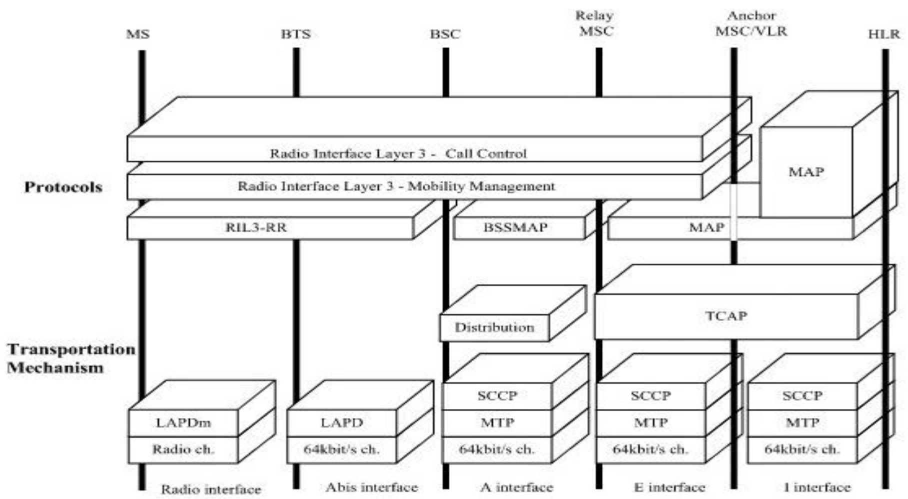

Fig. 1: GSM Signaling Architecture

II. Handovers In GSM Communication Network

Handover (Handoff) management is the process by which a mobile node keeps its connection active when it moves from one access point to another. Connections in GSM may be handed over between the radio channels in the same cell, between channels in different cells under the same***Base Station Subsystem (BSS)*** coverage or between the cells under the coverage of different BSSs and even different***Mobile Switch Centres***

(MSCs) The BSS usually monitors the quality of radio signal received and transmits such results to the MSC that keeps a more global view on the radio channels belonging to its BSS. The MSC may also initiate the need for connection handoff in an attempt to balance out traffic load in the network. Factors that contribute to the decision to execute handover procedures aredeterioration in the radio signal strength, traffic measurement (traffic handover),and mobile station moving out of radio coverage of the current cell and improve global interference levels (Lawniezak .D *et al.*, 1994).

However, handover carried out to prevent a call from being lost are referred to as rescue handovers. Also confinement and traffic handovers are used to improve the performance of the network and this are initiated for the benefit of the network. In mobile communication system, the decision to initiate rescue handovers is made by the network. This is because the global interference level calculations are made in the network and cell plan is known to the network (Sivagnanasundaram S., 1997).

The decision to initiate rescue handovers is made by the network. This is because global interference level calculations are made in the network and the cell plan is only known to the network. The data on which the network makes its decisions and calculations are supplied by the various mobile terminals. Mobile terminals make measurements of the radio reception levels for the current and neighbouring cells, and report this information to the network. The usual reporting rate is once a minute. Based on these measurements the serving BSC makes the decision to execute a handover. Only rescue handovers are described here.

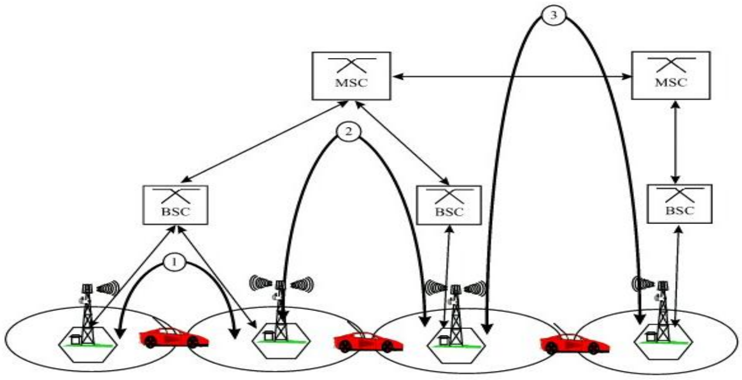

Fig 2: Various scenarios for Handovers.

III. Method

There are different processes to achieve an intelligent mobility management for mobile communication system. Procedures and instruments may simply be pointed out. The Processes used was depending on the location in study. And an explanation of the some vital processes has been vividly explained to a satisfying extent.

Network Simulator; Network Simulator is a software that predicts the behavior and characteristics of a computer network. This is because communication network has become more complex for traditional analytical methods to produce accurate understanding of system behavior, so network simulators are used. Examples of Network Analysis Simulators are VoIP Analysis Simulator, MATLAB, OPNET Simulator, Etc. But in the cause of the data generation, the VoIP Analysis Simulator was used to simulate the data used in the during the cause of this project work.

Voice Over IP (IP Telephony); VoIP is bounded by two important performance metrics. First is the available bandwidth. Second is the end-to-end delay. The actual number of VoIP calls that the network can sustain and support is bounded by thosetwo metrics. Depending on the network under study, either the available bandwidth or delay can be the keydominant factor in determining the number of calls that can be supported. The analytical approach considers important factors as background traffic, traffic flow, call distribution andgrowth factor. For background traffic, network measurements must be performed to determine the traffic ratesin **bps** (bits per second) and **pps** (packets per second) for links directly connected to the router and switches.

Traffic flow has to do with the path that a voice call travels through. Of course, multiple flows to carry voicecalls can exist per network. Call distribution has to do with the percentage of calls to be established within andoutside of a floor, building, or department. In a sense, each flow has a call distribution percentage thatdescribes how many calls are passing through this flow or path in relation to the total calls in the network. As for future growth factor, it depends on the projected growth in users, network services, business, etc.

Principle of Operation

For the most part, these tools use two common approaches in assessing the deployment of VoIP over the existing network. One approach is based on first performing network measurements and then predicting the network readiness for supporting VoIP. The prediction of the network readiness is based on assessing the health of network elements. The second approach is based on injecting real VoIP traffic into existing network and measuring the resulting delay, jitter, and loss. The second approach is sometimes referred to as network emulation. In order to determine the maximum number of calls that can be supported by an existing network whilemaintaining VoIP delay constraint, we devise a comprehensive algorithm that basically determines networkcapacity in terms of VoIP calls.

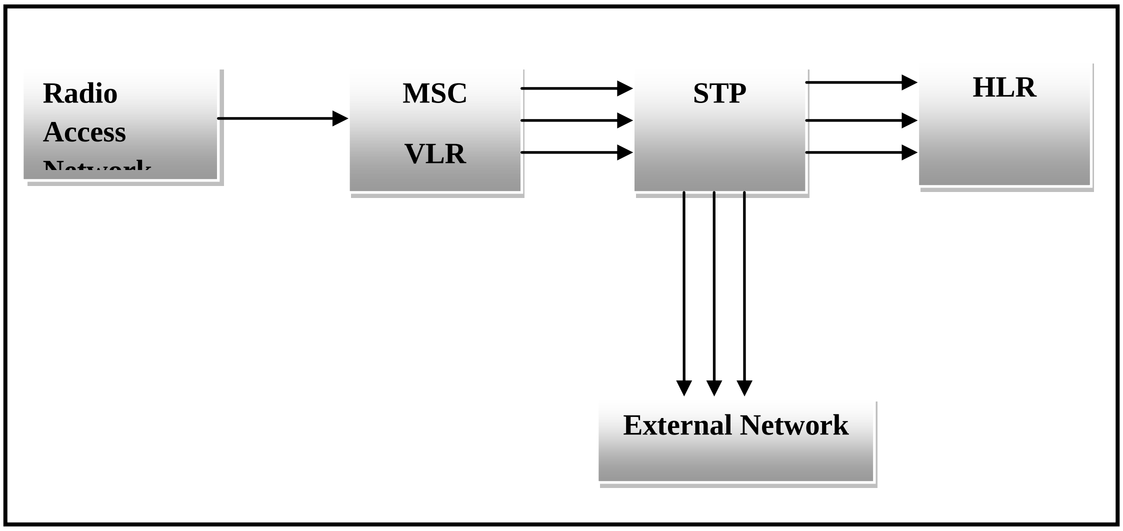

Fig 6: GSM Network architectural implementation in VoIP Simulator.

To account for the external network, the network engineer has to know theworst-case end-to-end delay and bandwidth (which are usually agreed on and guaranteed by the network service provider) between the border points connecting the branches. As a verification and alternative option,the engineer can perform measurement at these border points to determine the actual provided delay andavailable bandwidth. Such an external network can then be *approximately* modeled as a link with a givenbandwidth and delay, or a as a router with a given processing rate and delay. The model for the link isappropriate for a leased line, whereas the router is more appropriate for a data network or the Internet.

IV. Analysis

The volume of signaling traffic generated in the GSM intelligent Network is comprised of local traffic and trunk traffic. And it varies for different physical implementations and hence determines the difference in the qualities of service. The two signaling traffic groups are bi directional at the trunk and local circuits. The mean numbers of these traffics were calculated for each of the call types. The traffic requires that mobility may originate and terminate in other GSM or fixed networks. Hence, the network location centre of switching has been generated from the data node (MSC) experienced per second measured within the period of 24 hours. The data used was resolved from a VoIP Network Simulator the data sample is used for the analysis of mobility behavior of the mobile user over a period of time as was used to calculate the amount of handover and the Location Update per time.

Table1: Mobile user network behavior using network location center per time

NETWORK LOCATION CENTRE	TIME GOTTEN FROM A GSM NETWORK FOR 24HRS
1000	0
1500	5
3200	10
2500	11
2400	12
2500	13
2300	14
2500	15
2800	16
2800	17

2900	20
3000	21
2800	22
1700	23
900	24

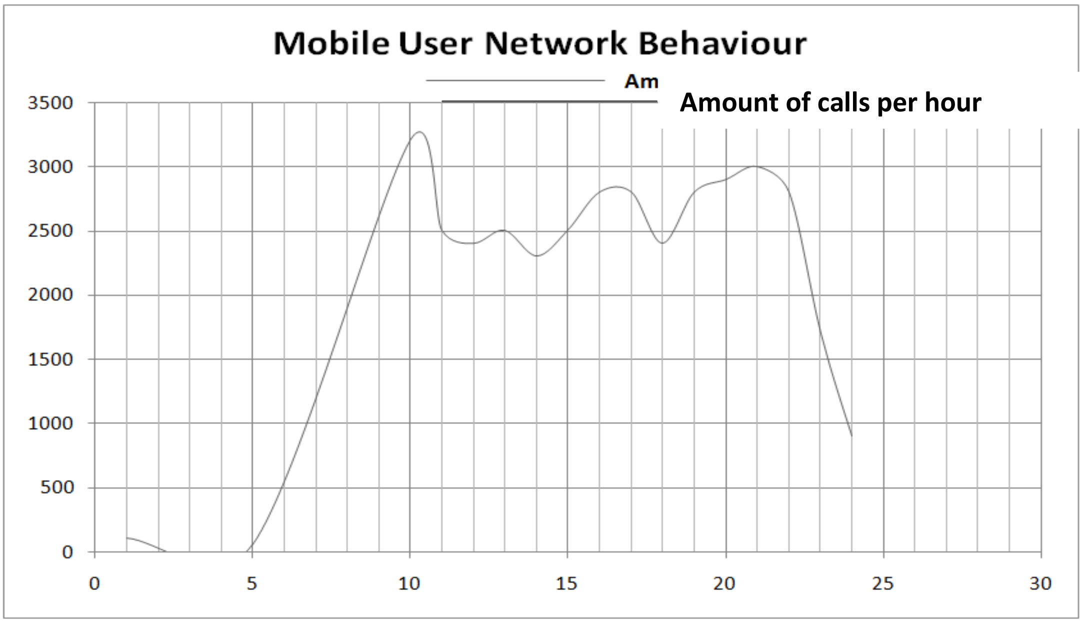

Fig 7. Mobile User Network Behaviour

Table 4 Signaling traffic rate parameters and units

PARAMETERS	UNITS
Amount of cell per Base Station	28
Mobile Station time with different values (Traffic Model)	1hr – 24hr
Amount of mobiles (Mobility Model)	7402
Cell area Perimeter (L)	4km and 8km
Velocity of mobiles (Sm)	30hm/hr
Amount of cells in a location area	6
Mobile station movement (π)	42
Average Number of mobile station per cell	240

V. Discussion

From the graph above, the mobile user call network behavior per hour using the amount of calls flow as the grid line plotted against time in hours. From the illustration, it is seen that during the early hours, call traffic (Number of calls) was low, This is because user mobility is low at that point. But as traffic increased between 8am to 10am which also happens to be when movement is high, the graph also showed the behavior. Then the call traffic became unstable till around 8pm in the night when the call was a little below the maximum. This shows that mobility is directly proportional to user behavior. Hence, around 12pm in the afternoon it was noticed from the graph that call traffic had increased to the peak and mobility was maximum because the amount of persons using the mobile has increased and very tangle amount of people has started both with local and trunk calls. So from the data gotten over this period of time, using the hours used for the sample to calculate for both the Location update and the handovers. However, if there is no communication between the mobile and it's network for a stipulated time, the mobile will generate a location update. This periodic location update allows the system to recover user location data in case of a database malfunction or failure. Mobility models differentiate user movement models. Hence, the location update rate is expressed in Equation 1 below as

$$\varphi = \beta_n \times \varphi_{BC} \times \eta MS \quad (1)$$

Where

$\varphi \longrightarrow$ Rate of Location Update.

$\beta_n \longrightarrow$ The Perimeters Fraction at nth cell of the Location Area.

$\varphi_{BC} \longrightarrow$ Rate of Cell boundary crossing.

$\eta MS \longrightarrow$ Average number of mobile Station per cell.

Hence, Handover parameters are used for describing the number of handover times a mobile device happens during the period of service delivery. This is equivalent to the time of crossing different cell boundaries, the rate of cell boundary crossing is expressed as:

$$\varphi_{BC} = \frac{\gamma}{\eta MS} \quad (2)$$

Where
ηMS ⟶Average number of mobile Station per cell.
γ ⟶ Average number of mobile station entering a cell per unit time.
Therefore, it may be very difficult with such a tractable analyticalexpression to achieve absolute convergence of simulated data with the real life data, so to calculate the averageoutgoing handover rate will be given as

$$\lambda = \frac{\sigma(t)Sm\ L}{\pi} \quad (3)$$

Where,
$\sigma(t)$ →Mobile Station density at a specified time (MS/km^2)
(Sm) → Average velocity of mobile station (km/hr)
L → Cell area Perimeter (km)
λ → Average outgoing handover rate
π → Mobile Station movement which is distributed

From the system architecture, it was observed that the factors that affects location management include; cell size, amount of cell per location area, signaling capacity. It is however assumed that the cells have identical sizes and the base stations assumed to be sited (located) at the centre of each cell.

The structure of a location area is designed so that the perimeter is minimized, given the particular number of cells per location area.

The table below illustrates the signaling traffic rate parameters used for location updates and handover reviews.
Using the given equation 3, we have that:

$$\lambda = \frac{\sigma(t)Sm\ L}{\pi}$$

Where,
$\sigma(t)$ →Mobile Station density at a specified time (MS/km^2)
(Sm) → Average velocity of mobile station (km/hr)
L → Cell area Perimeter (km)
λ → Average outgoing handover rate
π → Mobile Station movement which is distributed

So from the parameters in the table above, I substituted for the units for (λ) Average outgoing handover rate, we have that.

$$\lambda = \frac{240 \times 30 \times 6}{42}$$

$\lambda = 1028$ handover/cell/hr
Then, to calculate the Location Update rate. Recall that

$$\varphi = \beta_n \times \varphi_{BC} \times \eta MS$$

Where
φ ⟶ Rate of Location Update.
β_n ⟶ The Perimeters Fraction at nth cell of the Location Area.
φ_{BC} ⟶ Rate of Cell boundary crossing.
ηMS ⟶ Average number of mobile Station per cell.
But,

$$\varphi_{BC} = \frac{\gamma}{\eta MS}$$

ηMS ⟶Average number of mobile Station per cell.
γ ⟶ Average number of mobile station entering a cell per unit time.
And,

$$\varphi_{BC} = \frac{1}{E_t}$$

Where,
φ_{BC} ⟶ Rate of Cell boundary crossing.
E_t ⟶ Mean cell time.
Then, making γ the subject, so

$$\eta MS = \frac{\gamma}{\varphi_{BC}} \quad \text{i}$$

So we have that,

$$\gamma = \varphi_{BC} \times \eta MS \quad \text{ii}$$

But, we have that if $\varphi_{BC} = \frac{1}{E_t}$ then invariably.

$$\frac{\gamma}{\varphi_{BC}} = \frac{1}{E_t} \quad \text{iii}$$

So,

$$\eta MS = \gamma \times E_t \quad \text{iv}$$

Then finally, we have that the (γ) average number of Mobile Station entering a cell per unit time will be,

$$\gamma = \frac{\eta MS}{E_t} \qquad \text{v}$$

But from the Table 4.3 above $\eta MS = 240$, to call thenumber of Mobile Station entering a cell per unit time, γ recall that$E_t = 24 \times 0.08683$ so,

$$\gamma = \frac{240}{24 \times 0.08683}$$

$\gamma = 115$ ms/hr.

The average number of mobile station entering a cell will per unit time will be then be$(\gamma) = 115$ ms/hr.

Therefore,

$$\varphi_{BC} = \frac{115}{240}$$

$\varphi_{BC} = 1$ Crossing/ms/hr.

Location update rate is given as,

$$\varphi = \beta_n \times \varphi_{BC} \times \eta MS$$
$$= 4 \times 1 \times 240$$

$\varphi = 960$ LU/hr.

That means, the Base station receives 960 Location updates per hour. The evaluation of handover rate and location update rate were obtained at 1028 ms/hr and 960 LU/hr.

VI. Conclusion

The objective of this research work is to obtain an intelligent mobility control scheme for mobile communication system. Hence, this was made possible by the use of the number and volume of mobility signaling traffic as against total traffic and to define mobility in GSM signaling. Therefore in this work, data on call traffic were measured and as well simulated results from VoIP analysis Simulator and calculated resolves. Graphs were plotted to show the behavior of mobility in GSM network in Nigeria.Giving a general Resolution that the Base station as simulated will receive a location update per hour of 960 which will denote that the succeeding handover rate and location update rate were obtained as 1028 MS/hr and 960LU/hr respectively.

VII. Recommendation

This project provides the knowledge required by GSM operators to efficientlymodel an intelligent mobility control scheme for their network. In that there is every need for optimum signaling traffic and effective service utility by the mobile User because improper network resource size willresult to improper signaling. Therefore, further research work is required on the determinationof the effective and efficient network resource size required to handle the mobility of mobilestations.

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