

Mobility Management Scheme for Mobile Communication Systems. A Review

F. U. Nweke, S. I. Anyigor and R. C. Iwu
Industrial Physics Department Ebonyi State University, Abakaliki, Nigeria

Abstract: *An intelligent mobility management scheme for mobile communication systems was studied. From the result obtained, it was discovered that mobile to mobile call setup times showed a better performance as compared to fixed network to mobile call setup and mobile to fixed call setup times. Moreover, increasing the number of location areas within the switch does not affect inter-MSC handover and location updates since the size of the switch coverage area remains the same. And when the location areas within the switch is increased, intra-MSC location updates and handover also increases. Finally, user mobility directly affects the signaling traffic for handover, location management, radio resource allocation and routing.*

Keyword: *GSM, user mobility, handover, subscriber, SMS, mobile phone, mobility management, signaling.*

I. Introduction

Global system of mobile communication, GSM network (i.e. a cellular network) is basically a radio network of individual cells known as base stations where each station covers a small geographical area which is part of a uniquely identified location area. If the coverage area of these base stations is integrated, a cellular network provides radio coverage over a much wider area. The group of these base stations is referred to as a location or a routing area [1].

Mobility management is one of the major functions of a GSM network that allows mobile phone to work. This is aimed to track where the subscribers are, allowing calls, SMS and other mobile phone services to be delivered to them [2,3,4].

II. Signaling in GSM

This is the language used for communication between machines or computers. Therefore, the ability for the 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 [5,6,7].

III. Mobility Procedures in GSM Communication

Mobility procedures are the functionalities required to offer and maintain communication with a mobile user at any given point in time. Due to the convergence for mobile communication and with the rapid growth in the number of subscribers, mobility management emerges as one of the most important and challenging problems for mobile communication systems. The mobility management enables the serving network to locate a mobile subscriber's point of attachment for delivery data packets (i.e. location management), and maintain a mobile subscriber's connection as it continues to change its point of attachment (i.e. handoff management). Table 1 shows the signaling message sizes obtained from a GSM network operator in Nigeria concerning the mobility procedures for different networks architectures. Mobility procedures in GSM network include: setting up of mobile originating calls, setting up of mobile terminating calls, inter-BSC handover, intra-MSC handover, inter-MSC handover and location management. The GSM communication network based mobility procedure is shown in fig 1. [2, 7,8].

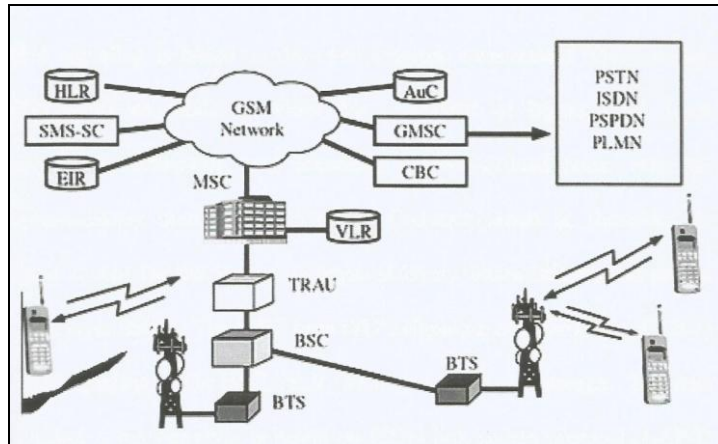


Fig 1: The GSM communication network based mobility procedure

IV. 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 off between the radio channels in the same cell, between channels in different cells under the same BSS coverage or between the cells under the coverage of different BSSs and even different 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 BSSs. The MSC may also initiate the need for connection handoff in an attempt to balance out traffic load in the network. The GSM network architecture is shown in figure 2. Factors that contribute to the decision to execute handover procedures are: deterioration 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 [2, 9].

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 [2].

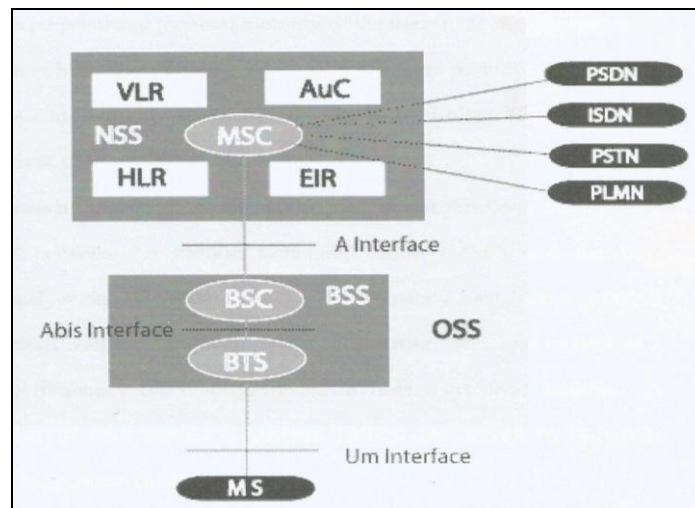


Fig 2: The GSM network architecture

GSM Location Management

For mobile network to offer connectivity to a mobile user, the location of the mobile station needs to be known. The process of a mobile terminal informing the network of its location is known as location update. Then location management enables the networks to track the locations of mobile nodes. Location management has two major sub-tracks: location registration and call delivery or paging. In location registration procedure, the mobile node periodically sends specific signals to inform the network of its current location so that the location database is kept updated. Then the call delivery procedure is used after the completion of location. The call

delivery procedure queries the network about the exact location of the mobile device so that a call must be delivered successfully [4]. To optimize network performance and reduce signaling load on the system, cells are grouped into location areas. This type of arrangement gives the mobile terminal the opportunity to update its location when it enters into a new location area.

User Mobility and Traffic model

The computation of the signaling load on the networks, processing load and the processing delay according to the research objectives are obtained from modeling of the users’ characteristics such as mobility, call arrival rate and call holding time. The user mobility is modeled using fluid flow model which derives the rate of user crossing from an area [2]. This model formulates the amount of traffic out of region to be proportional to the density with the region, the average velocity and the length of the region boundary. Then considering a small portion of the boundary dl of an area, it would be possible to calculate the number of users leaving the area through this boundary element in time, dt . Thus, the number of users crossing the boundary is distributed according to the density

$$dM(d\alpha, dv, dt) = f(v)dv \frac{d\alpha}{2\pi} \rho v \cos\alpha dt dl \tag{1}$$

$$dM(dl, dt) = \frac{\rho}{2\pi} \int_{-\pi/2}^{\pi/2} \int_0^{+\infty} f(v) v \cos(\alpha) dv d\alpha dt dl \tag{2}$$

Where $f(v)$ is the probability density function

$$\text{But } \int_0^{+\infty} f(v) = V$$

Where V is the average velocity

$$\therefore dM(dl, dt) = \frac{\rho V}{\pi} \int \int dl dt \tag{3}$$

Integrating with respect to dl for the boundary of a circle will give the circumference L . Therefore, the rate of crossing out of a circular area is given as

$$\frac{dM}{dt} = \frac{V\rho L}{\pi} \tag{4}$$

Where ρ, V and L represents the density of users, user average speed and length of the perimeter of the given area

V. Simulation Results/Discussion

From table1, the volume of signaling traffic generated in the core network of GSM-IN varies for different physical implementations and hence determines the difference in the qualities of service.

GSM network is used as the baseline for the simulation. Fig 3 was used for the modeling of the network and the four other different physical architectures. The network core signaling was dimensioned for the GSM network to achieve a network with minimal delays in the queues. The loads were also applied to all other dimensioned GSM-IN networks to analyze their performances and the calls to and from a user were set for 0.3 call/seconds. Then the data used for the analysis is table 2. For network B and C architectures, the time taken to conduct inter-MSC handover is comparable with GSM. For other mobility services, inter-MSC handovers experience two times delays for the E and D physical network architectures. Fig 4 and 5 shows the comparison of inter-MSC handover times and comparison of intra-MSC location update service completion times. These times are relative to the average intra-MSC location update for the GSM network with three location areas about 1.3 seconds. Note that intra-MSC location update procedures occur in GSM only when there are more than one location areas that exist within a mobile switching center. The network B physical architecture takes longer time than the GSM to complete the intra-MSC location update, notwithstanding that both have similar performance. The inclusion of service control point in the GSM-IN architecture is responsible for the slight difference in the completion time.

Figures 6, 7 and 8 represent the performance of mobile to fixed network, fixed network to mobile and mobile to mobile respectively. The values obtained are relative to the time taken for equivalent GSM service with one location area. The result showed that the performance of the mobile to mobile calls is better because the ratio of radio interface signaling volume to core network is small compared to mobile to land and land to mobile calls. Also for both mobile originating and mobile terminating, the network C physical architecture generates twice the signaling traffic in core network than the GSM.

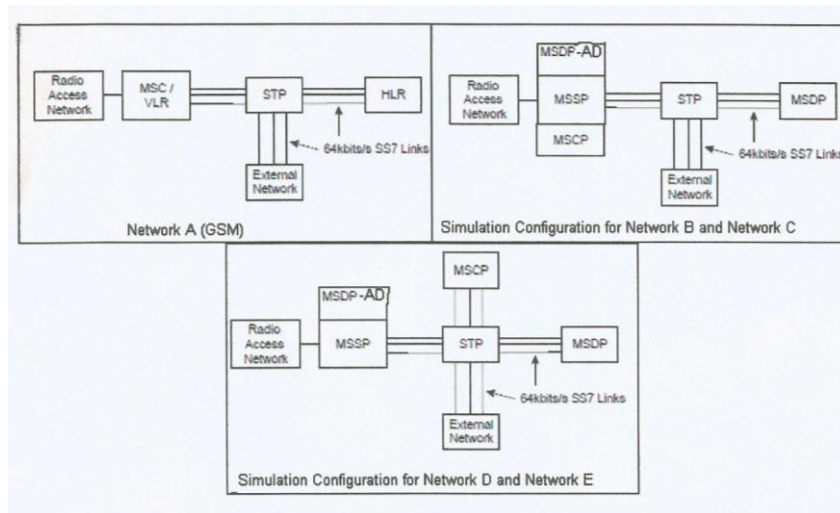


Fig 3: Simulation configurations for different physical implementations

Table 1. Signaling message per second per mobility procedures in Nigeria

Mobility procedures	Physical network architectures				
	A	B	C	D	E
Intra-MSC location update	0	0	292	700	706
Inter-MSC location update	712	732	292	1306	706
Mobile origination calls	92	92	195	829	829
Mobile terminating calls	218	218	410	1136	1136
Inter- MSC handovers	262	315	315	487	487

Table 2. MSC Parameters for signaling load

Parameters	Value
Area covered by the MSC	7319.3 km ²
Number of location areas in MSC	Variable
Size of location areas	Variable
Number of users in switch	500,000
Average speed of mobile users	8 km/sec.
Average number of calls to and fro by user	1 call/sec.
Rate of calls to and fro MSC	140 per second
Rate of mobile originating calls to mobile terminating calls	0.55:0.44
Average call holding time for user	2 mins.
Average number of power for user	2/day/user
Rate of power in MSC	12/sec.
Rate of intra-MSC crossing	Variable
Rate of inter-MSC crossing	15/sec
Rate of inter-MSC handovers	0.05/sec

VI. Conclusion

An intelligent mobility management scheme for mobile communication systems was analyzed. From the result obtained, it was observed that the performance for mobile to mobile call set up times is better as compared to land to mobile or mobile to land calls respectively. The values in the graphs are relative to the time taken for equivalent GSM service with one location area. From the graph, network C physical architecture generates twice the signaling traffic in the core network than the GSM for both mobile originating and mobile terminating.

Reference

- [1]. William C. Y. L. (2006). Wireless & Cellular Telecommunication. McGraw-Hill Publisher, Singapore
- [2]. Sivagnanasundaram S. (1997). GSM mobility management using an intelligent network platform
- [3]. Bafatta M and Schopp (1996). Performance evaluation of IN based mobility management, University of Stuttgart
- [4]. Patnaik G. K. (2005). GSM mobility management
- [5]. Bale M. C. (1995). Signaling in the Intelligent Network, BT Technology Journals, Vol. 13 No. 2
- [6]. Markoulidakis J. G., Lyheropoulos G. I., Tsirkas D. F. and Sykas E. D. (1997). Mobility modeling in third generation mobile telecommunication system. IEEE pers. Comm. pp 41-56
- [7]. Pollini G. P. and Goodman D. J. (1996). Signaling system performance evaluation for personnel communication. IEEE transaction on vehicular technology Vol 45, No. 1

- [8]. Lawniezak D and Dahlstrom (1994). Evaluation of call set-up and location management procedures in UMTS. RACE mobile Telecommunications workshop, Amsterdam
- [9]. Rehnema (1993). Overview of the GSM system and protocol architecture. Communication magazine IEEE 31(4):92-100

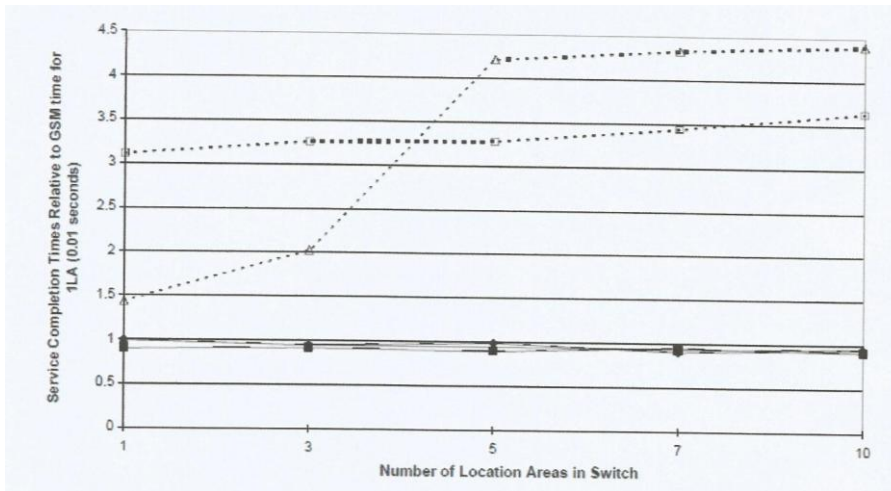


Fig 4: Comparison of inter-MSC location updates service completion time

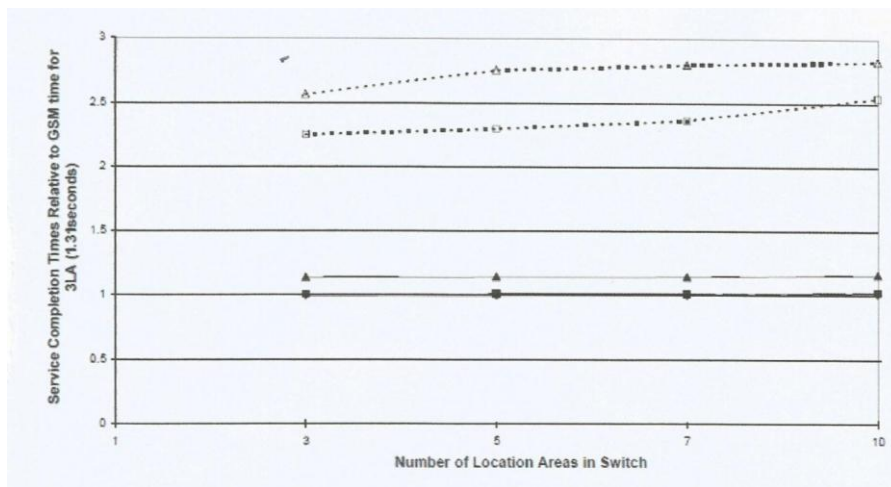


Fig 5: Comparison of intra-MSC location updates service completion times

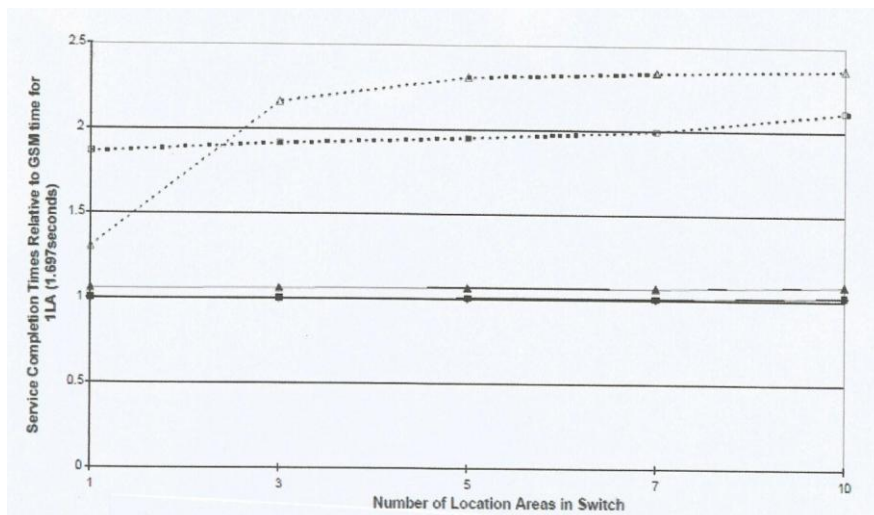


Fig 6: Mobile to Fixed network call set up times

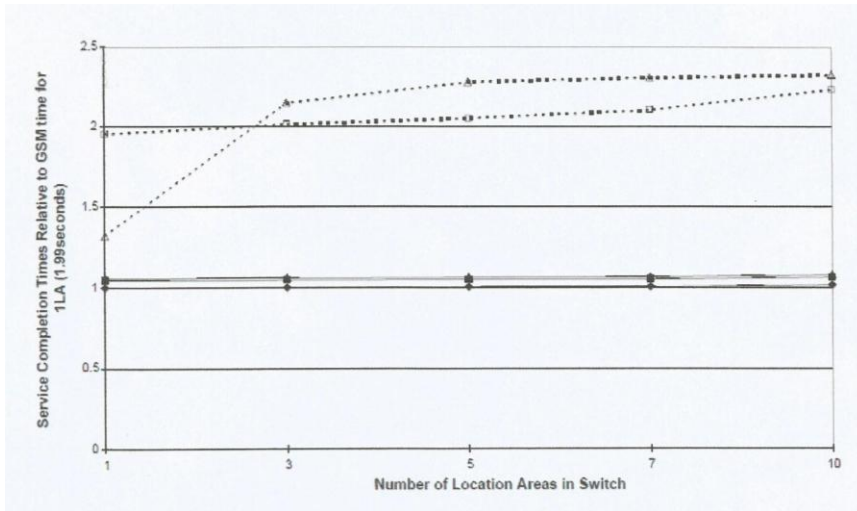


Fig 7: Fixed network to mobile call setup times

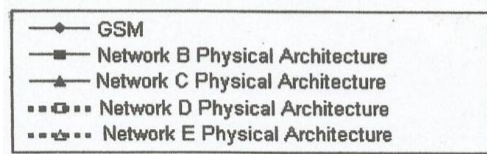
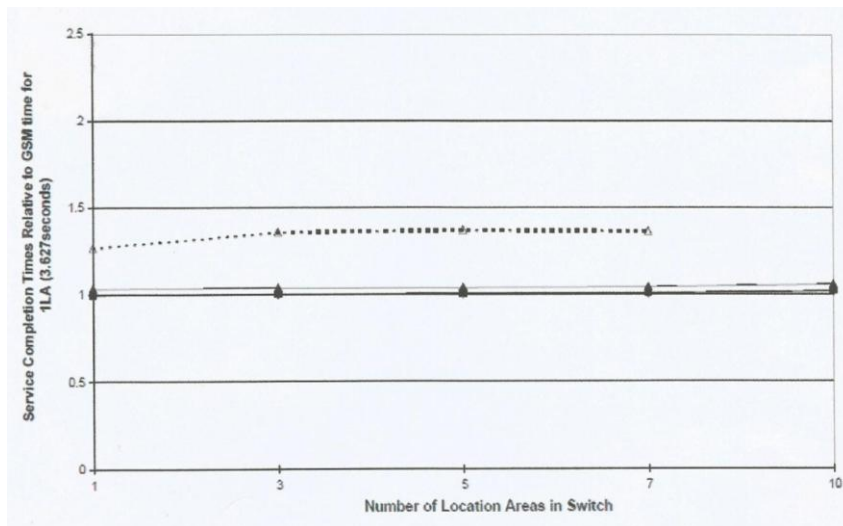


Fig 8: Mobile to Mobile call set up times