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# Dynamic Channel Assignment technique for minimizing Congestion in a Mobile radio Network

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**ABSTRACT:** Congestion in mobile radio network has been a great challenge due to increase in demand by the mobile users on the limited available channels. Dynamic channel assignment technique was employed in this work to minimize congestion in the network. Twelve base stations were studied and analyzed using some telecommunication traffic Key performance indicators (KPI) such as Call Completion Rate (CCR), Grade Of Service (GOS) and Channel Utilization Percentage (CUP). The result of the analysis was compared with the Nigeria Communication Commission (NCC) regulatory standards. It was discovered that call completion rate (CCR) of all the Base Transceiving Stations (BTSs) investigated were not in accordance with NCC standard. Math lab program for Erlang B model used to evaluate the call congestion and call blocking probability on the network was developed and used in observing the system. The result of analysis of the system based on simulation of Erlang B model showed that the call congestion probability in some BTS were approximately equal to zero while the others were highly congested with higher probability of calls being blocked when fixed channel assignment technique was implemented. The model for the chosen technique for this work (Dynamic Channel Assignment Technique ) was used to simulate the 12 base stations investigated. The result showed lower probability of call congestion when compared with those BTSs with higher probability of call congestion. Thus congestion was minimized and more calls accommodated when compared with fixed channel assignment technique. Algorithm for implementing the technique was developed and modeled using flow graph.

**KEYWORDS:** Channel allocation, key performance indicators, spectrum utilization, Telephone traffic congestion, telephone traffic load.

## 1 INTRODUCTION

### BACKGROUND OF THE STUDY

Traffic congestion in a mobile radio communication system is a great challenge, in terms of the number of subscribers that can successfully access the network at a particular period of time due to limited availability of transmission channels [1]. When the number of subscribers in a network exceeds the maximum network installed capacity, users are bound to experience frequent call blockings. This implies that some subscribers accessing the network will be denied access into the network at that particular period of time especially during busy hours (peak period) of the day as a result of congestion on the network. The effect is deterioration of network service quality, resulting in problems such as queuing delay, interference, frames or data packet losses, degradation of signal strengths and blocking of new calls with reduced network throughput. Furthermore, congestion could also be caused by; lack of adequate number of base stations, reduction in tariff as marketing strategy which will cause users to be making unnecessary calls, additional services and lack of system upgrade.[2].The major cause of congestion in a mobile radio network which is our great concern is limited availability of channels as mentioned earlier. A user that is experiencing congestion will get frustrating signal responses like ‘’the number you have dialed is currently switched off, network or number busy, not available’’ etc., while the phone the user is trying to call is on and active. During festive periods (example Christmas and Easter) in Nigeria, mobile radio network usage is usually higher than in any other month of the year and more problems of congestion are experienced at those times[3][4].

## 2 THEORY OF WORK

### SPECTRUM UTILIZATION IN MOBILE RADIO NETWORKS

In any radio network, the number of possible simultaneous calls that may occur is determined by the available frequency spectrum and the number of channels that can be supported by the available bandwidth [5]. These channels are allocated to base stations which the network uses to provide access to their users in their area of coverage[6]. And because no two users are allocated the same frequency (channel) in the spectrum to avoid interference, this resource is very scarce.

However to ensure that many users are given access to mobile network, frequency re-use technique is used to achieved that by assigning a subset of the total number of channels available to each base station, and controlling the power output of the transmitters. In this way, cellular networks increase capacity (number of channels available to users). Adjacent cells are not allowed to operate at the same frequency since this causes interference between the cells.

### BASE STATION SIGNALS

In mobile telephony a base station provides the connection between mobile phones and the wider network. using the channels allocated to it. When a call is made to a mobile phone, the system already knows the cell location of that phone in its network. The base station of that cell knows in which zone, within that cell, the mobile phone is located. Therefore when it receives the signal, the base station transmits it to the suitable zone site. The zone site receives the mobile signal from the base station and transmits that signal to the mobile phone. [7]

### CHANNEL ALLOCATION SCHEMES

These are methods for allocating channels to users while maintaining an acceptable quality of service (QOS) in a mobile network. The three basic types of channel allocation schemes are:

1. Fixed (FCA)
2. Dynamic (DCA)
3. Flexible

- **Fixed Channel Allocation/Assignment (FCA)**

In Fixed Channel Allocation or Fixed Channel Assignment (FCA) each cell is given a predetermined set of frequency channels. Complex frequency planning to allocate permanently resources.FCA is not well suited for varying traffic conditions (typically, a worst-case capacity allocation is performed).It requires manual frequency planning, which is an arduous task in time division multiple access (TDMA) and frequency division multiple access (FDMA) based systems, since such systems are highly sensitive to co-channel interference from nearby cells that are reusing the same channel. Another drawback with TDMA and FDMA systems with FCA is that the number of channels in the cell remains constant irrespective of the number of customers in that cell. This gives rise to traffic congestion resulting in calls being lost when traffic gets heavy in some cells, while some cells that are not busy will be idle.

- **Dynamic Channel Allocation (DCA)**

In dynamic channel assignment strategy channels are temporarily assigned for use in cells for the duration of the call, provided that the reuse distance constraint is fulfilled. Each time a call attempt is made from a cell the corresponding BS requests a channel from the master switching center (MSC)[6]. The MSC then allocates a channel to the requesting BS. After the call is over the channel is returned and kept in a central pool. To avoid co-channel interference any channel that is not in use in one cell can only be reassigned to another cell in the system if the distance between the two cells is larger than minimum reuse distance. This a more efficient way of channel allocation compare with fixed channel allocation technique. When compared to the FCA, DCA has reduced the likelihood of blocking and even increased the trunking capacity of the network as all of the channels are available to all cells, i.e., good quality of service. The channels are allocated taking into account the following criteria:

1. Future blocking probability in neighboring cells
2. Reuse distance
3. Usage frequency of the candidate channel
4. Average blocking probability of the overall system
5. Instantaneous channel occupancy distribution

This technique requires the MSC to collect real time data on channel occupancy, traffic distribution and Received Signal Strength Indications (RSSI).

DCA can be further classified into centralized and distributed. Some of the centralized DCA schemes are:

1. First available (FA): the first available channel satisfying reuse distance requirement is assigned to the call
2. Locally optimized dynamic assignment (LODA): cost function is based on the future blocking probability in the neighboring cells
3. Selection with maximum usage on the reuse ring (RING): a candidate channel is selected which is in use in the most cells in the co-channel set

- **Spread Spectrum**

Spread spectrum can be considered as an alternative to complex DCA algorithms. Spread spectrum avoids co-channel interference between adjacent cells, since the probability that users in nearby cells use the same spreading code is insignificant [8]. Thus the frequency channel allocation problem is relaxed in cellular networks based on a combination of Spread spectrum and FDMA, for example IS95 and 3G systems. Spread spectrum also facilitate that centrally controlled base stations dynamically borrow resources from each other depending on the traffic load, simply by increasing the maximum allowed number of simultaneous users in one cell (the maximum allowed interference level from the users in the cell), and decreasing it in an adjacent cell. Users in the overlap between the base station coverage area can be transferred between the cells (called cell-breathing), or the traffic can be regulated by admission control and traffic-shaping.

However, spread spectrum gives lower spectral efficiency than non-spread spectrum techniques, if the channel allocation in the latter case is optimized by a good DCA scheme. Especially OFDM modulation is an interesting alternative to spread spectrum because of its ability to combat multipath propagation for wideband channels without complex equalization. OFDM can be extended with OFDMA for uplink multiple accesses among users in the same cell. For avoidance of inter-cell interference, FDMA with DCA or DFS is once again of interest. One example of this concept is the above mentioned IEEE 802.11h

Different DCA techniques can be considered depending on the criterion adopted to select a channel to be assigned in a cell among all available resources.

***Table 1 Advantages of Dynamic Channel Assignment Scheme over that of Fixed Channel Assignment***

| S/N | Fixed channel assignment technique | Dynamic channel assignment technique |
|---|---|---|
| 1. | Channels are assigned to cell permanently. | Channels are assigned to cell temporarily. |
| 2. | Incoming call requests are blocked when all the channels in a cell are occupied. | Call request can be assigned to channels in other cells. |
| 3. | Cannot assess channels in other cells even though there are idle channels in those cells. | Can access and use channels in other cells through the serving MSC. |
| 4. | It takes time and cost to create more cells when the congestion is sensed in the network. | Available channels can be utilized thereby distributing traffic load in the network instead of concentrating it in a particular cell while others are less busy. This is done at little or no time and lower cost too. |

**TDMA/FDMA**

In digital cellular networks, multiple access systems are used to allow simultaneous users to share the same channel within a cell. The common methods are time division multiple access (TDMA) and frequency division multiple access (FDMA).

In TDMA, the bandwidth allocated for the channel is divided into time slots - the number of slots depends on the system. Each user is then allocated a slot, and hence multiple users share the same frequency but at different times. In FDMA, the channel is divided into frequency bands, and each user is allocated a different frequency band [8].

## 3 METHODOLOGY

#### ANALYZING THE EFFECT OF TRAFFIC LOAD ON THE NETWORK USING THE KPI

Congestion has also a negative effect on the mobile radio network as it has on network users; it degrades the received signal strength. To determine other effects of traffic load on the network, key performance indicators for quality of service were used to analyze the network. These KPIs are parameters that should be observed closely while monitoring the network. Some of the parameters considered are;

1. $$\text{Grade Of Service (GOS)} = \frac{\text{Number of lost calls}}{\text{Total number of offered calls}} \tag{1}$$
$$= \frac{\text{Blocked Calls}}{\text{Nattempted Calls.}}.$$
2. $$\text{Call Setup Success Rate ( CSSR)} = \frac{\text{N}\alpha\text{ttempt} - \text{Nblock}}{\text{Nattempt}} \tag{2}$$
   Where Nattempt is the number of call attempts and Nblock is the number of blocked calls.
3. $$\text{Channel utilization rate}(\%) = \frac{\text{total no of customers served(in terms of carried traffic in Erlang)}}{\text{total available channels}} \text{x} \frac{100}{1} \tag{3}$$
4. Blocked Calls or call congestion:- The congestion probability or probability of blocked calls was assessed based on the result of simulation of model as in equation 4 and presented in table 2 .

The results of these calculations were presented in table 2 and analyzed as shown in Figs .1 - 5. Some recommended standards from NCC [4] for the KPI considered are listed below:

1. Grade of Service (GOS) 2%
2. Call Completion Rate (CCR) 90%
3. Channels Utilization Rate(CUR) 60%
4. Block Calls 2%

Item 1- 3(GOS, CCR, CUR) were first treated and presented in the table mentioned above, then item 4, which was blocked calls was considered subsequently using the model in equation 4 as discussed below.

#### SIMULATING FIXED CHANNEL ASSIGNMENT TECHNIQUE

The Erlang B call congestion probability model was simulated with fixed channel assignment technique implemented. It showed the behavior of the system in terms of its traffic load variation at every period of time. This traffic model was designed based on the arrival rate and holding time, which was statistical distributed among subscribers making calls within the cell and handover calls. The channels are divided in time and frequency domain.

This model gives the congestion probability in the Erlang loss model i.e. in the M/M/c/0 model. Evaluating the model to be used in this work, some assumptions were made. These assumptions are;

1. There are finite numbers of channels available in the network which is fully available for servicing call request until all channels are occupied.
2. There are infinite numbers of users.
3. Congestion occurs when demand on the network by the users is greater than the available channel capacity.
4. Congestion is proportional to offered traffic load. It increases as offered load increases.
5. The probability of a user occupying a channel (called service time) is exponentially distributed. Longer calls are likely to happen by exponential distribution.
6. The requesting user is allocated channel if available else it will be blocked from gaining access without affecting future arrivals and is free to retry again later.
7. The service call request is based on First–Come-First-Served (FCFS) using the TDMA technique
8. The arrival rate (λ) is assumed to be Poisson and the service time (duration of calls) is also assumed to be exponentially distributed random variable with mean (1/μ) and independence identical distributed.
9. Inter-arrival time of call request does not dependent on each other. The calls can arrive any time.

10. For every user who request for service, there is no setup time and user is given immediate access to a channel if at least one channel is available.
11. There are memory-less arrivals of requests, implying that all users may request for channels at any time including blocked user.
12. No queuing for call requests.
13. Let J be the total number of channels provided or available in a cell. These channels are homogenous, working in parallel and no extra waiting space.
14. Call congestion probability is the Probability of calls being blocked.

As mentioned in the assumption above, Congestion can occur when offered traffic (a) > total number of available channels (j).

And possible state of K (discrete random process representing the number of occupied or busy channels) when the network is congested is given as [9];

K = j

Under these conditions, congestion is proportional to traffic load (demand). As demand increases, congestion also increases.

Evaluating Erlang B model, recall the probability of call blocking or congestion is;

$$\mathrm{P(K = J)} \qquad = \frac{\frac{\mathrm{a^j}}{\mathrm{j!}}}{\sum_{\mathrm{K}=0}^{n} (\mathrm{a})^{\mathrm{K}} \frac{1}{\mathrm{K!}}} \qquad (4)\ [10]$$

Where K is a discrete random process representing the number of occupied or busy channels at discrete time. While P(K) is the probability of observing the system in state (K).

In this work 12 base stations were studied by simulating the model in equation 4 with the aid of Math lab (R2012b). The result was presented in table 3 and analyzed using the graph of Fig 6,. Algorithm for implementing this technique was developed and illustrated using a flow graph as shown in Fig.7.

#### DETERMINATION OF THE EFFECT OF DYNAMIC CHANNEL ASSIGNMENT TECHNIQUE ON THE CONGESTED NETWORK

In dynamic channel assignment technique, the channels are temporarily assigned to cells and are potentially available to be use by any cell. Equation 6 was simulated using the average of the assumed parameter values of the call congestion probabilities of the 12 base stations. The result is presented in table 4 followed by the graph of Fig 9.

$$\text{Mean (arithematic average)} \; = \frac{1}{n} * \sum_{i}^{n} x_i \qquad (5)\ \text{(Edu et al,2009)}$$

:. Average call intensity for BHT = $\frac{1}{n} * \sum_{i}^{n} x_i$

$$= \frac{x1 + x2 + x3 \ldots . + xn}{n} \qquad (6)$$

in this case, x= traffic load of the network, while n = no of base stations.

#### COMPARING THE EFFECT OF FIXED AND DYNAMIC CHANNEL ASSIGNMENT TECHNIQUE

The results of fixed and dynamic channel assignment technique implemented were compared. Table 5 and Fig10 showed the results. The average of the call congestion probability of the 12 Base Stations were calculated using equation 6 above, in this case, x= Congestion probability of each base station, while n = no of base stations.

The result was used to calculate the percentage improvement made when the technique was implemented using equation 7 below;

$$\%\ \text{improvement made} = \frac{\mathrm{Pb_F - Pb_D}}{\mathrm{Pb_F}}\ \mathrm{x} \frac{100}{1} \qquad (7)$$

Where $\mathrm{Pb_F}$ = average congestion probability of the 12 base stations with fixed channel assignment technique implemented.

$Pb_D$ = average congestion probability of the 12 base stations with dynamic channel assignment technique implemented.

The Algorithm for implementation of the Technique employed in this work was developed and represented using a flow graph as shown in Fig 9. The average of the result of congestion probability was calculated and compared with the result of the simulation when the technique was implemented, showing the percentage improvement achieved in this work.

### RESULT OF THE ANALYSIS OF THE EFFECT OF TRAFFIC LOAD ON THE NETWORK USING KPI

*Table 2: The Average Traffic Key Performance Indicators for 12 Base Stations Investigated*

| S/N | Base Station Identification Name | Busy Hour Calls Attempted (BHCA) | Busy Hour Successful Calls (BHSC) | Busy Hours Blocked Calls (BHBC) | Average Holding Time (Minutes) | CSSR | GOS | Total Offered Traffic in Erlang | Total Carried Traffic in Erlang | Available Channels | Channel Utilization Rates (%) using Carried Traffic Load |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AB0007 | 3075 | 1790 | 1285 | 35.13 | 0.58 | 0.42 | 30.00 | 17.47 | 18 | 166.71 |
| 2 | AB0018 | 2998 | 1041 | 1957 | 26.01 | 0.35 | 0.65 | 21.66 | 7.52 | 10 | 216.61 |
| 3 | AB0019 | 1939 | 1002 | 937 | 36.31 | 0.52 | 0.48 | 19.56 | 10.11 | 12 | 162.98 |
| 4 | AB0126 | 2726 | 2001 | 725 | 23.35 | 0.73 | 0.27 | 17.68 | 12.98 | 4 | 442.03 |
| 5 | OBE07(11) | 1999 | 1043 | 956 | 18.04 | 0.52 | 0.48 | 10.01 | 05.23 | 20 | 50.09 |
| 6 | UK035 (12) | 2605 | 2018 | 587 | 31.34 | 0.77 | 0.23 | 22.68 | 17.57 | 8 | 283.48 |
| 7 | UK071(1) | 2275 | 1208 | 1067 | 29.3 | 0.53 | 0.47 | 18.52 | 09.83 | 9 | 205.73 |
| 8 | AS1430 | 1371 | 615 | 756 | 34.67 | 0.45 | 0.55 | 13.20 | 5.93 | 7 | 188.62 |
| 9 | AB1800 | 1479 | 732 | 747 | 18.38 | 0.49 | 0.51 | 07.55 | 3.74 | 11 | 68.65 |
| 10 | AB 0112 | 1605 | 1102 | 503 | 26.26 | 0.69 | 0.31 | 11.71 | 8.04 | 6 | 195.13 |
| 11 | AB2071 | 1898 | 1295 | 603 | 28.59 | 0.68 | 0.32 | 15.07 | 10.29 | 3 | 502.44 |
| 12 | OBE18 (12 | 2075 | 1168 | 907 | 19.12 | 0.56 | 0.44 | 11.02 | 6.20 | 17 | 64.83 |

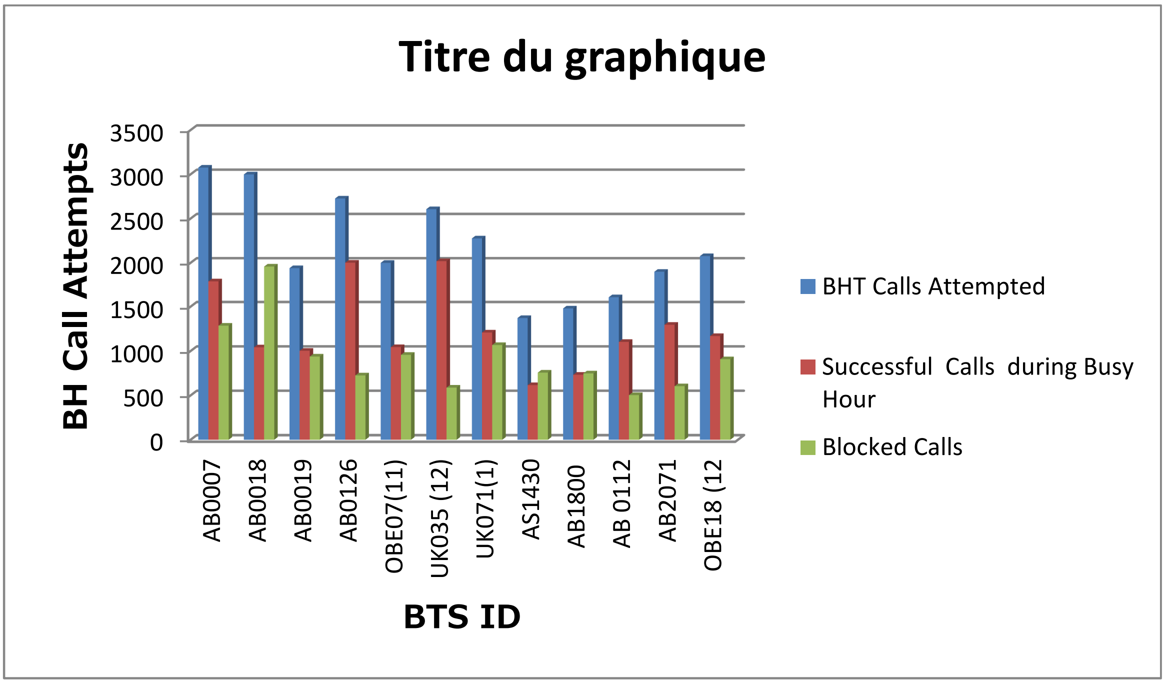



*Fig 1 Presentation of Calls Attempted, Successful and Blocked Calls of the investigated Network.*

1. Key performance indicators were arrived at using the data obtained as in table 2above.
2. The graph of Fig.1 showed the average attempted calls, successful completed calls and blocked calls of the 12 sites considered. From the graph, AS1430 has the lowest calls attempts and completed calls, AB0007 has the highest call

attempts while AB0126 and UK035 (12) has the highest completed call during BH, followed by AB0007. This implies that the rate of channel utilization was high. Any attempt to increase the load further will cause more calls to be blocked. NCC should ensure the operators conform to their standard in terms of channel utilization.

3. AB0018 has the highest call blockings followed by AB0007 and UK071(1) etc. These BTSs are congested during BH.

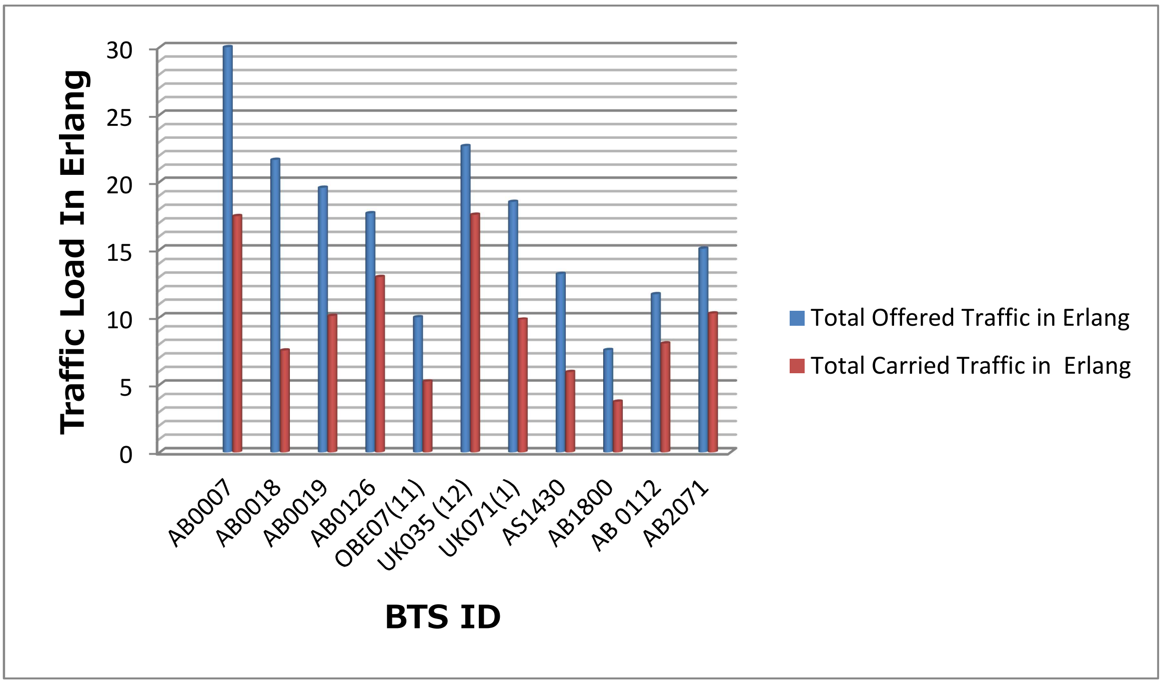



*Fig 2 Offered Traffic and Carried Traffic of the 12 BS.*

Fig 2 presented the relationship between the offered and carried traffic loads for the 12 BS during busy hour. BTS AB0007 had the highest traffic load followed by UK035(12) and AB0018 etc. These BTSs are highly congested; any slight increase in offered traffic will result in more calls being blocked during the busy hour. While BTS AB1800 had the lowest offered traffic load and carried traffic load. Attention should be given to BTS AB0007, UK035(12) and AB0018 while improving the system capacity.

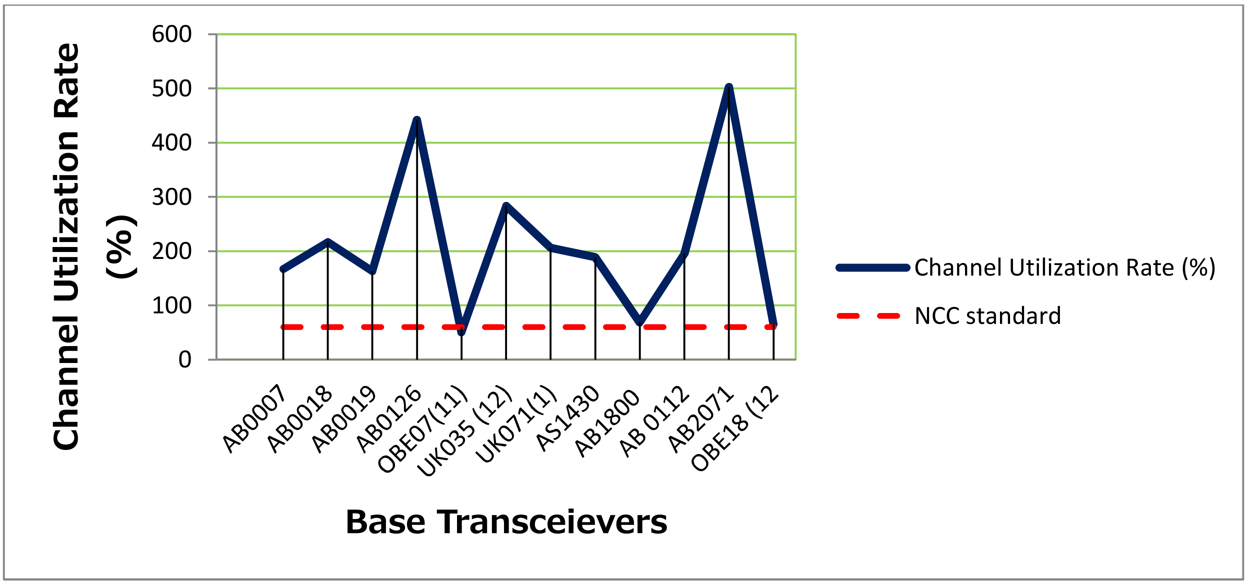



*Fig 3 Comparing Channel Utilization Rate of the Network with the NCC Standard*

Graph of Fig.3 showed the channel utilization of 12 sites. Based on NCC recommendation, the channel utilization rate should be less than 60%. From the graph, the channel utilization rate for BTS; OBE07 (11) in the network conformed to NCC's standard, it was below 60 percent. There will be low call blocking in these BTSs. Whiles the rest are greater than the recommended NCC standard, thus these will result in blocked calls in affected BTSs during the busy hour.

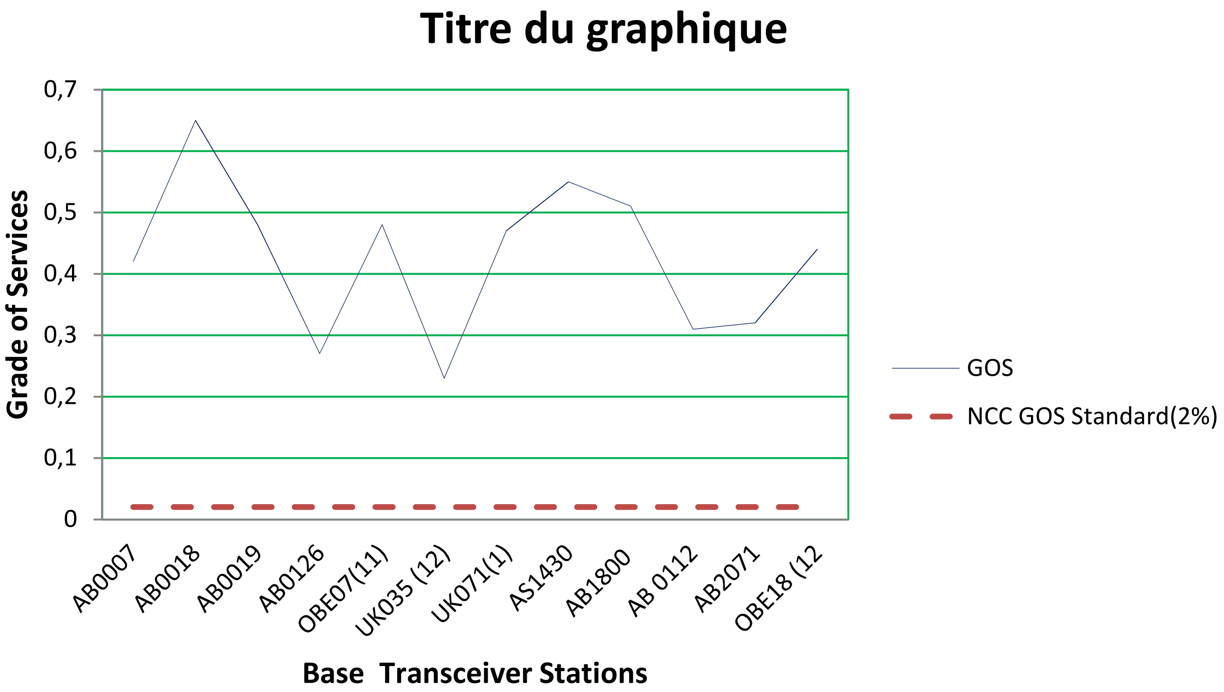



*Fig 4 Grade of Service of the investigated Network compared with the NCC Standard.*

The Nigerian Communication Commission (NCC) recommended value for Grade of Service is 0.02 or 2%. The grades of services of various routes (12 base station s) were presented in table 2 and in Fig..4. The graph showed that all the BTSs are above the NCC recommendation. Therefore these routes may likely experience blocked calls during the busy hours.

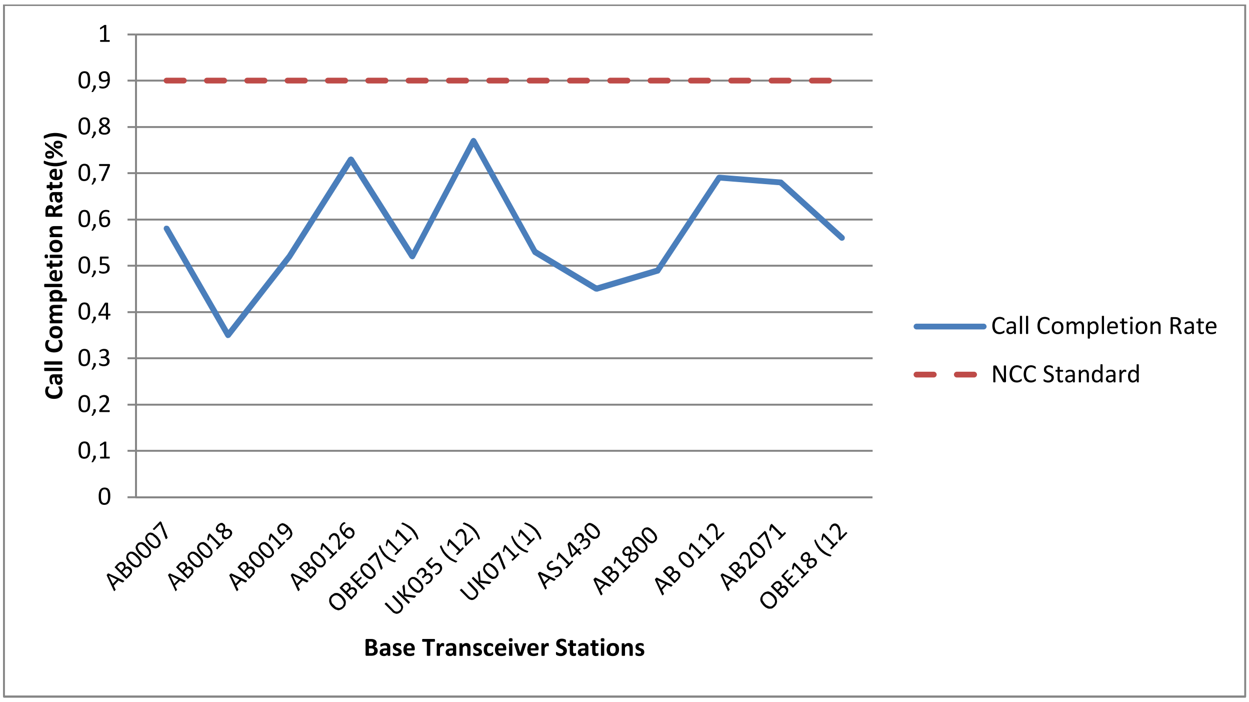



***Fig 5 Successful Call Completion Rate of the investigated Network Compared With The NCC Standard***

The graph of Fig.5 showed the call completion rate in the 12 BTS. The call completion rate is a major key in traffic performance. The recommended standard for Nigerian Communication Commission is 90%. From the graph mentioned above, all the BTSs are below recommended level. This implies that the system has more losses dues to congestion of the network.

## IMPLEMENTATION OF FIXED CHANNEL ASSIGNMENT TECHNIQUE

Results of Simulation of Equation 4 for Fixed Channel Assignment Technique is presented below:

***Table 3 Simulation result of equation.4 of 12 Base Stations using assumed parameter Values by implementing Fixed Channel Assignment Technique***

| BTS ID | Total Offered Load(B) | No. of Available Channels (C) | Call Congestion Probability using Model in equation 3.4 with Fixed Channel Assignment Technique implemented (PbF) |
|---|---|---|---|
| AB0007 | 30.0000 | 18.0000 | 0.4378 |
| AB0018 | 22.0000 | 10.0000 | 0.5757 |
| AB0019 | 20.0000 | 12.0000 | 0.4518 |
| AB0126 | 18.0000 | 4.0000 | 0.7914 |
| OBE07(11) | 10.0000 | 20.0000 | 0.0019 |
| UK035 (12) | 23.0000 | 8.0000 | 0.6718 |
| UK071(1) | 19.0000 | 9.0000 | 0.5626 |
| AS1430 | 13.0000 | 7.0000 | 0.5209 |
| AB1800 | 8.0000 | 11.0000 | 0.0813 |
| AB 0112 | 12.0000 | 6.0000 | 0.5561 |
| AB2071 | 15.0000 | 3.0000 | 0.8140 |
| OBE18 (12 | 11.0000 | 17.0000 | 0.0245 |
| TOTAL | 188.0000 | 116.0000 | - |

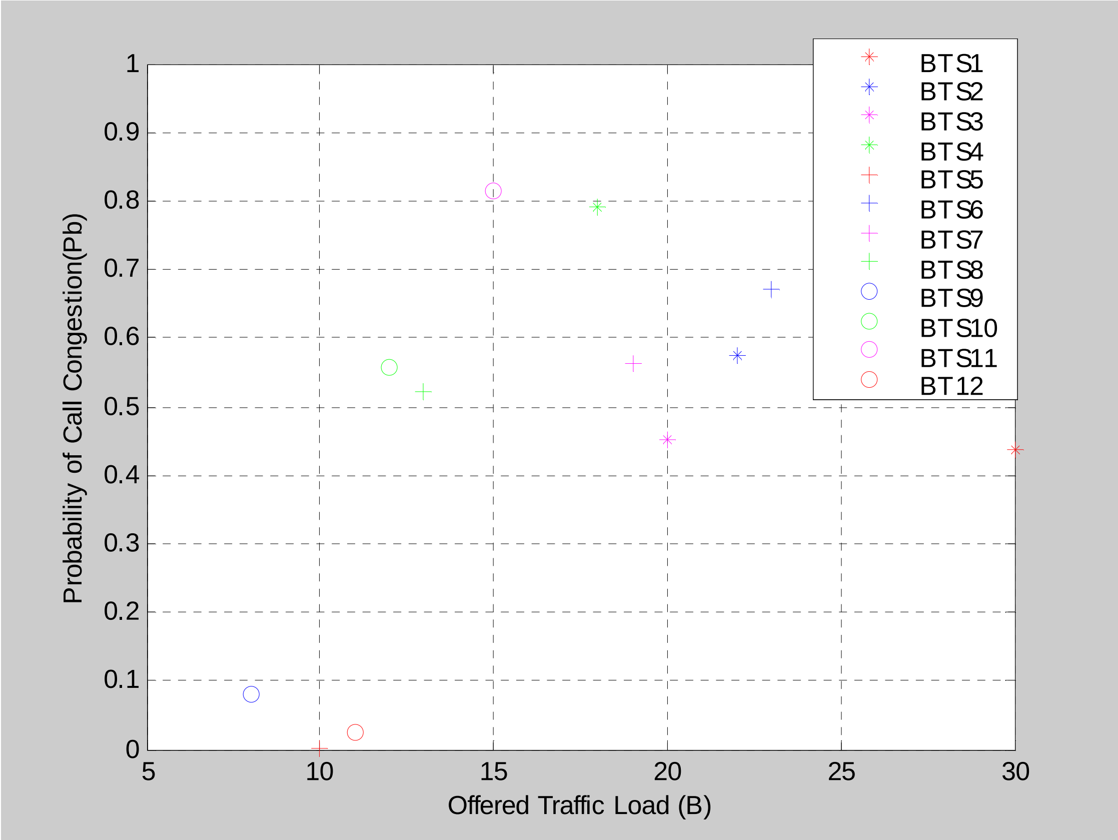



***Fig.6 Graphical representation of the Simulation result for Fixed Channel Assignment Technique implemented on the 12 BTSs using assumed parameters values.***

Fig 6 was generated from the simulation work on equation 4 using assumed parameters for the 12 base stations implementing fixed channel assignment technique. The result indicates that the base station AB2071 have the highest call congestion probability of 81.40% followed by AB126 with 79.14%, while OBE07(11) had the least.

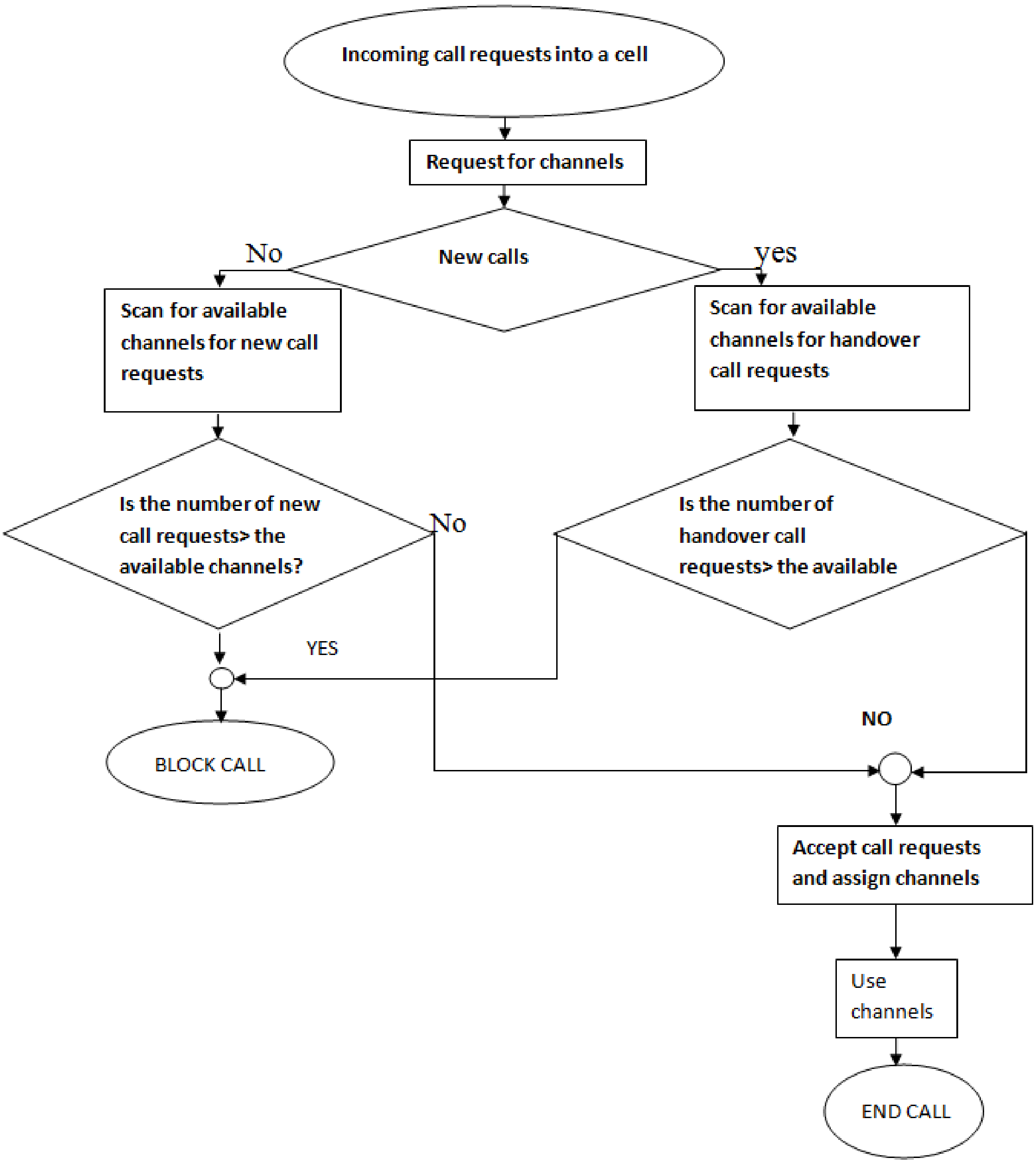



*Fig 7 Flow diagram for the implementation of Fixed Channel Assignment Technique on a Congested Mobile Radio Network*

### ALGORITHM FOR IMPLEMENTATION OF FIXED CHANNEL ASSIGNMENT TECHNIQUE

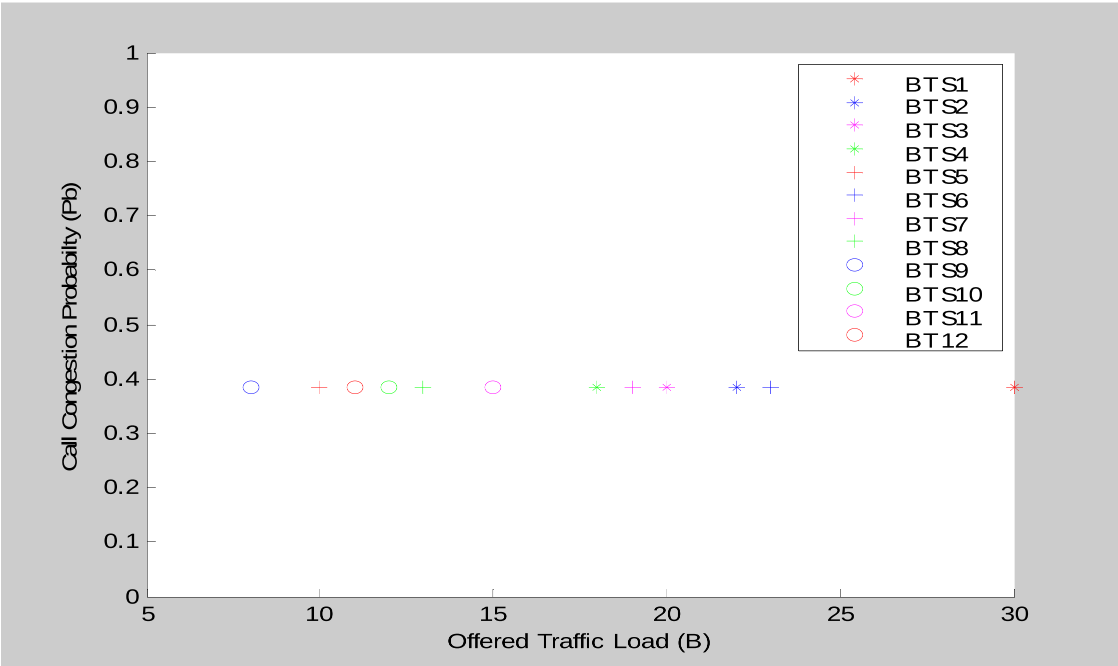
Incoming call requests to a cell
If (new calls or handoff calls)
Scan (if there are free channels)
If (the number of call requests > the available channels), then
Reject/block the call request
Else,
Allocate the free channel for handoff call or new call
Use channel
End call.

### EFFECT OF DYNAMIC CHANNEL ASSIGNMENT ON THE CONGESTED NETWORK

Table 4 Result of the Implementation of Dynamic Channel Assignment Technique using assumed parameter values for the 12 BTS.

***Table 4 Presentation of Simulation Result for the 12 BTS with the Dynamic Channel Assignment Technique Implemented using assumed parameter values***

| BTS ID | Total offered load (Erlang) (B) | No. of available channels (C) | Call Congestion Probability using model in equation 3.4 with the proposed technique Implemented. . (PbD) |
|---|---|---|---|
| AB0007 | 30.0000 | 18.0000 | 0.3858 |
| AB0018 | 22.0000 | 10.0000 | 0.3858 |
| AB0019 | 20.0000 | 12.0000 | 0.3858 |
| AB0126 | 18.0000 | 4.0000 | 0.3858 |
| OBE07(11) | 10.0000 | 20.0000 | 0.3858 |
| UK035 (12) | 23.0000 | 8.0000 | 0.3858 |
| UK071(1) | 19.0000 | 9.0000 | 0.3858 |
| AS1430 | 13.0000 | 7.0000 | 0.3858 |
| AB1800 | 8.0000 | 11.0000 | 0.3858 |
| AB 0112 | 12.0000 | 6.0000 | 0.3858 |
| AB2071 | 15.0000 | 3.0000 | 0.3858 |
| OBE18 (12 | 11.0000 | 17.0000 | 0.3858 |
| Total | 201.0000 | 125.0000 | - |



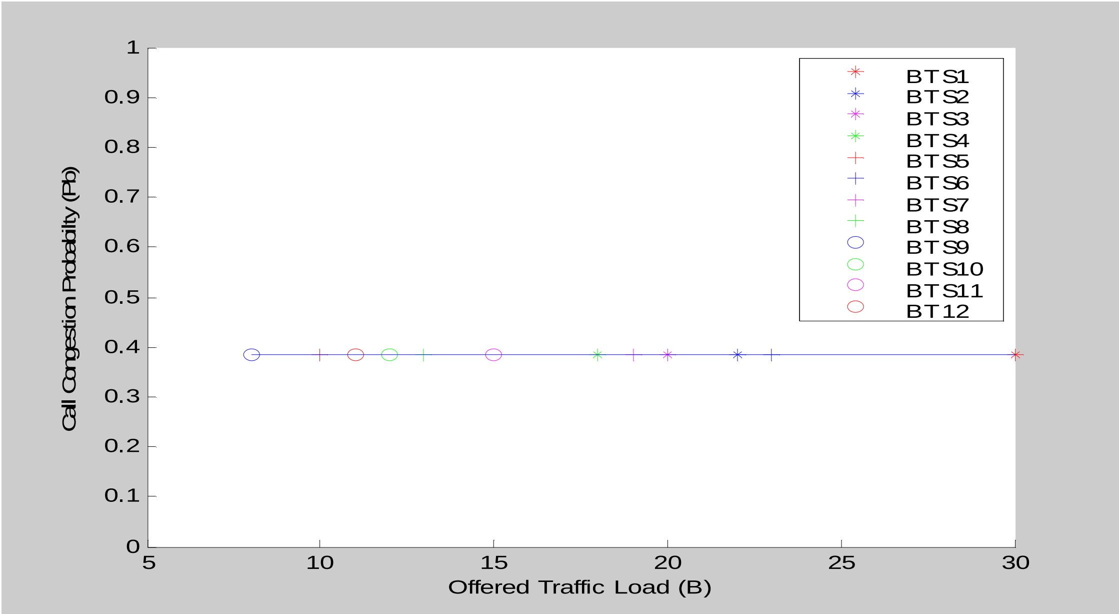
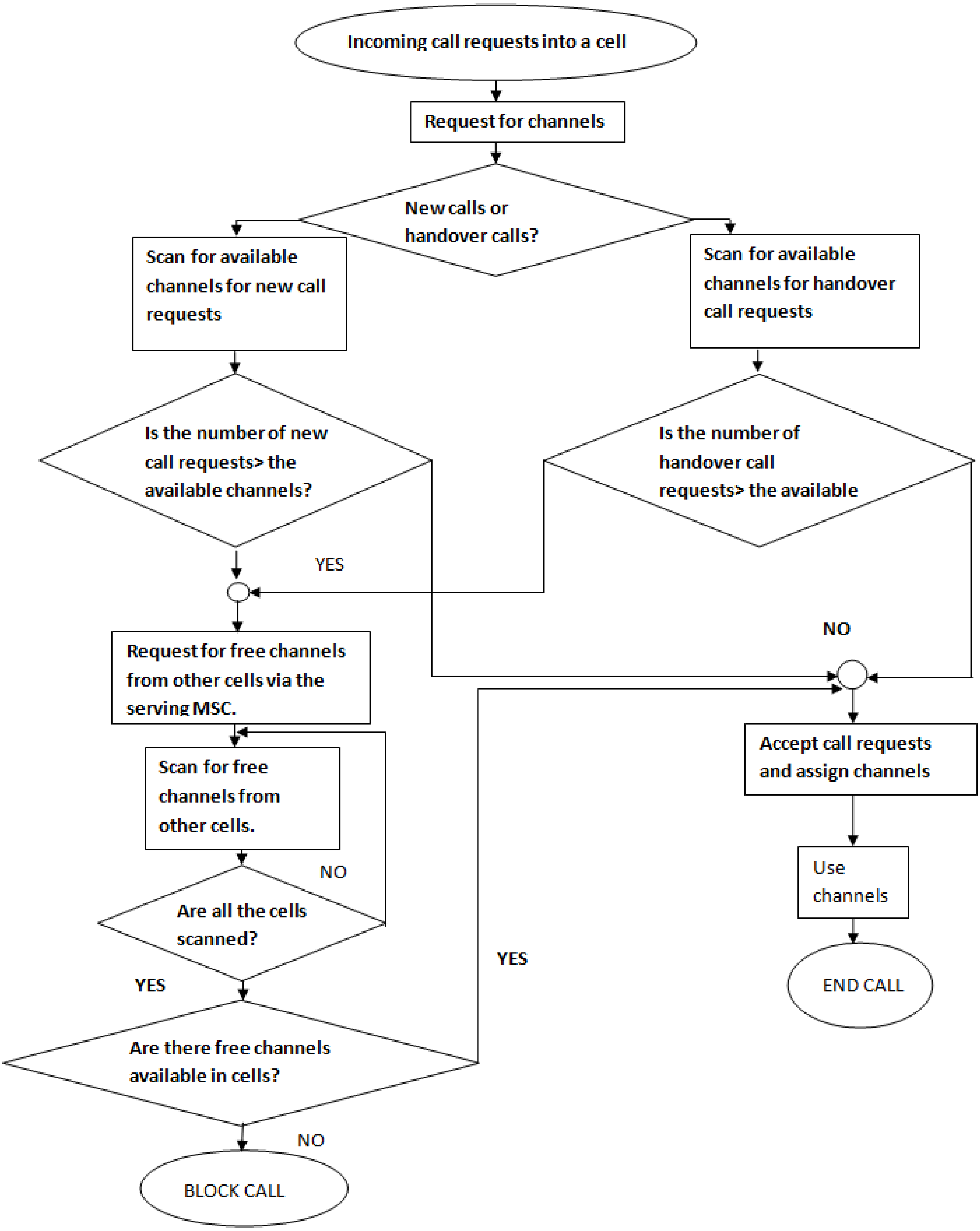



*Fig 8 Graph showing the Simulation Result of the 12 BTS with Dynamic Channel Assignment Technique implemented.*

Implementing the dynamic channel assignment by simulating the model using a developed Math lab code and assumed parameter values, call congestion probability of 0.3858 were distributed uniformly in all the base stations in the network as indicated in table 4 and fig 8. This implies that the traffic load in the network was distributed to all the channels in the network instead of concentrating it to a particular cell thereby increasing congestion and blocking of incoming calls at the peak hour. This technique minimized congestion thus accommodated more calls in the network. Proper planning of the system in terms of channel utilization if given due attention by the network designer will bring congestion on the network to the barest minimum.

#### ALGORITHM FOR IMPLEMENTATION OF THE DYNAMIC CHANNEL ASSIGNMENT TECHNIQUE

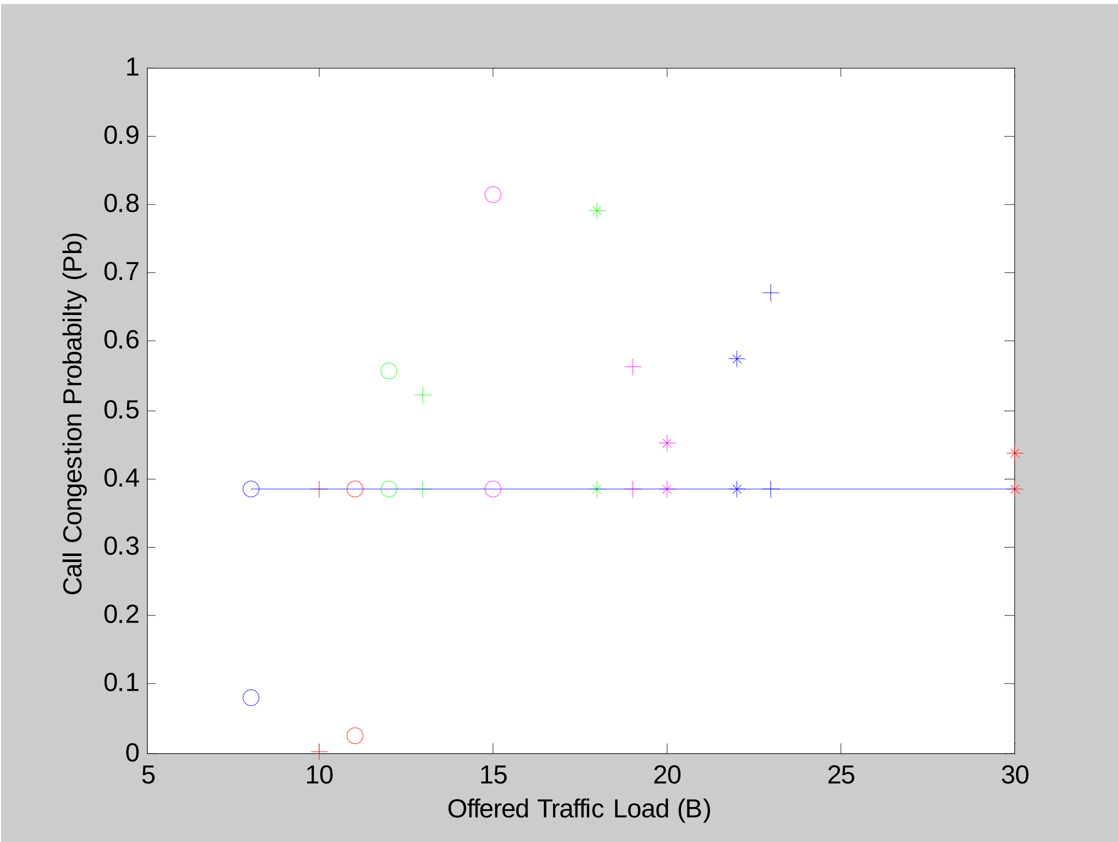
Incoming call requests to a cell
If (new calls or handoff calls)
Scan (if there are free channels)
If (the number of calls ≤ the available channels), then
Allocate and use free channels
Else
Request for channels from other cells through the serving MSC
Scan the cells
If no channel
Reject/block the call request
Else,
If (there is any free channel)
Allocate the free channel for handoff call or new call
Use channel
End call.




Comparing the Result of the Simulation of Fixed Channel Assignment and Dynamic Channel Assignment Technique using assumed values

*Table 5: Simulation Result of Call congestion probability showing the implementation of Fixed Assignment and Dynamic Channel Assignment Technique for the 12 Base Stations using assumed parameter values.*

| BTS ID | Total Offered Load (Erlang) (B) | No. Of Available Channels (C) | Call Congestion Probability on the network with Fixed Channel Assignment Technique implemented using the Model in equation 3.4 (PbF) | Call Congestion Probability on the network Dynamic Channel Assignment Technique the Model in equation 3.4 (PbD) |
|---|---|---|---|---|
| AB0007 | 30.0000 | 18.0000 | 0.4378 | 0.3858 |
| AB0018 | 22.0000 | 10.0000 | 0.5757 | 0.3858 |
| AB0019 | 20.0000 | 12.0000 | 0.4518 | 0.3858 |
| AB0126 | 18.0000 | 4.0000 | 0.7914 | 0.3858 |
| OBE07(11) | 10.0000 | 20.0000 | 0.0019 | 0.3858 |
| UK035 (12) | 23.0000 | 8.0000 | 0.6718 | 0.3858 |
| UK071(1) | 19.0000 | 9.0000 | 0.5626 | 0.3858 |
| AS1430 | 13.0000 | 7.0000 | 0.5209 | 0.3858 |
| AB1800 | 8.0000 | 11.0000 | 0.0813 | 0.3858 |
| AB 0112 | 12.0000 | 6.0000 | 0.5561 | 0.3858 |
| AB2071 | 15.0000 | 3.0000 | 0.8140 | 0.3858 |
| OBE18 (12 | 11.0000 | 17.0000 | 0.0245 | 0.3858 |
| TOTAL | 188.0000 | 116.0000 | 5.4898 | 4.6296 |
| AVERAGE Pb | | | 0.4575 | 0.3858 |




* =BTS1 (A0007) + = BTS8 (AB1430) += BTS7 (AB0711)
* = BTS2 (AB0018) o= BTS9 (AB1800) += BTS6 (AB0351)
* =BTS3 (AB0019) o= BTS10 (UK035(12)) O= BTS12 (OBE18(12)
* =BTS4 (AB0126) o= BTS11 (OBE07(11)) += BTS5 (AB2071)

***Fig 10 Comparing Fixed Channel Assignment and Dynamic Channel Assignment Technique with parameters Less than the actual parameters values from the experiment done.***

The graph of fig 10 contain graph for fixed channel assignment technique and that of dynamic channel assignment technique. This was generated using Mathlab code in appendix C. The plot with blue line across the point shows the dynamic assignment technique implemented while the other scattered point showed fixed channel assignment technique. Looking at the graph, there are base stations with lower call congestion probability while in others is higher. Comparing the system with fixed and dynamic channel assignment technique implemented, the graph of Fig 10 and table 5 showed that the call congestion probability and probability call blocking for the entire system was brought to 0.3858. This result was evenly distributed in the entire system, thereby distributing the load on the network than concentrating it to a particular cell and decreasing call congestion probability and probability call blockings in some base stations during busy hour. This technique gave room for utilization of available resources at lower cost instead of over loading some cells while some cells are less busy.

The average of the call congestion probability and probability call blocking is higher in fixed than in dynamic channel assignment technique as shown in the result of the simulation. The percentage improvement in this case was 15.67% when the dynamic channel assignment technique was implemented this calculated using equation 7above.

## 4 Conclusion

Congestion control in mobile radio network is a continuous process since the demand on the limited available channel by mobile users increases daily. This requires efficient and effective planning towards utilization of the limited available resource in order to minimize congestion and improve network performance quality. This paper used dynamic channel allocation to achieve that.

The result showed that call congestion probability in the network was minimized, thereby accommodating more calls when compared with the result of the fixed channel assignment technique implemented at same time.

## References


[1] Regis, J. (2002). ''Broadband Telecommunication Handbook 2nd Edition, McGraw Hill'', page 126-186, 326-412.

[2] Deshpande Vivek, Prachi Sarode, Sambhaji Sarode, (2010), ''Root Cause Analysis of Congestion in Wireless Sensor Network'', International Journal of Computer Applications (0975 - 8887) Volume 1 – No. 18, pp 28-29.

[3] Alese B.K., Ph.D, Kuboye B.M., and O. Fajuyigbe, Ph.D., (2009),'' Congestion Analysis on the Nigerian Global System for Mobile C (GSM) Network'', The Pacific Journal of Science and Technology Volume 10. Number 1, pp266-267.

[4] Nigeria Communication Commission Technical Report,3/9 /2010,pp5-6 http://www.ncc.gov.ng

[5] Adrian B, Cornel B. and Georgeta B., (2010) "Mixed traffic models for Dimensioning Radio Resources in GSM/GPRS Networks" WSEAS Transaction On Communications,ISSN:1109-2777,Issue 3,Volume 9,pp 233-242.

[6] Cho D., Lee S., Lee D., Lee W. and Shim D.,(2006), "A Dynamic Channel Allocation Mechanism in Cellular Mobile Networks for Ubiquitous Environment Based on Time Constraints", Proceedings of Computational Science and Its applications, pp. 491-498.

[7] Akut e. k., s. m. Sani,(2013), '' identification and modeling of dominant causes of congestion in a fixed-line network'' international refereed journal of engineering and science ISSN 2319-183x, volume 2, issue 1,pp.10.

[8] www.en.wikipedia.org/wiki/channel_allocation_schemes,7/6/15.

[9] Adrian .B., Cornel B, Eugen .M. and Georgeta .B., (2009). "Traffic models and Associated parameters in GSM/(E)GPRS Networks" WSEAS Transaction On Communications,ISSN:1109-2742,Issue 8,Volume 8,pp 830-840.

[10] Ward Whitt ( 2002), ''Advance Topic queueing Theory:focus on customer contact centers''

[11] Edu C.N, Elom M.C, Ezeora J.N., Olo E.E, Okoro N., Oshim S.N., Ugama J.O., Uguru B.N.,(2009),'' foundation mathematics for higher education'', second edition, ISBN 978-978-48862-2-2, pg349.