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# Flowchart for Clustered-Based Channel Allocation Management Scheme

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## Abstract

*In the GSM system, several Base Transceiver Station (BTS) are controlled by a single Base Station Controller (BSC). In this paper, the BTSs in a given BSC is referred to as a cluster. In this paper, flowchart for clustered-based channel allocation management scheme is presented. The mechanism is meant to reduce call blocking/dropping to the barest minimum. Usually, traffic intensity value varies from one BTS to another, as it is directly proportional to the number of GSM users that make or receive calls within a particular period of time. In order to maintain a reliable GSM network that will provide minimum call blocking/dropping, the paper presents the flowchart for network resource management scheme that will adopt sharing of traffic loads among BTSs that belong to a particular network cluster. The scheme also considers the following; available channels, mobility factor, offered traffic, number of nearby BTSs, new call arrival rate, handoff call arrival rate and mean call duration. With limited available channels per BTS, instead of blocking a new call or dropping a handoff call whenever a particular BTS reaches its maximum allowable capacity, this newly proposed scheme however checks for a nearby BTS within that cluster that has free channels, and then performs a routine operation that will transfer some percentage of the traffic load to the free nearby BTS. This routine operation therefore allows the BTS to admit more calls.*

**Keywords:** Call blocking; Call dropping; Mobility factor; New call arrival rate; Handoff call arrival rate; Call duration

## 1. Introduction

An issue of great interest in wireless communication system is mobility management. In order to deliver a seamless and efficient call connection service to a mobile user, the location of a mobile user must be determined within a certain time limit (before the service is blocked). The network has to follow the mobile users and allocate enough resource to provide seamless continuing service as the mobile is in motion. This is done without user awareness of the changes in the network facility (such as base station). Mobility management is the system employed therefore to track the mobile users as they move from place to place within the coverage area of the network. Therefore, mobility management is a key component for the effective operations of the mobile wireless networks. There are two operations used to carry out the mobility management analysis on wireless systems. These are: location update and terminal paging. Location update relates to the process

where a mobile user informs the network where it is, while terminal paging is a process that the network attempts to locate a mobile user in the area it was last reported. This area is known as uncertainty area. Both processes which invoke signaling traffic in the signaling networks are used by both processes [1]. It is stated in Fang [1], that the more frequent the location update, the higher the signaling traffic for location updates, while the smaller the uncertainty area, hence the lower the signaling traffic for terminal paging. Noted also is the fact that, the less frequent the location update, the lower the signaling traffic for the location updates, while the larger the uncertainty area, hence the higher the signaling traffic for terminal paging. Therefore, there is of course a tradeoff between these two. It is therefore necessary to try to balance these two kinds of signaling traffic for effective mobility management.

Radio resource management (RRM) plays a vital role in cellular networks to efficiently utilize the limited radio resources while guaranteeing the required QoS for mobile users. Call admission control (CAC) is a fundamental mechanism used for QoS provisioning in a network. It is the rule to admit requested calls maintaining the QoS for the system [2]. Another task of cellular system planning is to design an optimal radio network which provides the largest amount of traffic for a given number of channels at a specified level of quality of service. Accurate traffic dimensioning plays an important role in any telecommunications network planning and is particularly important for the performance analysis of mobile and wireless networks. Traffic models are thus of paramount importance for network planning and design. They are useful in areas such as network architecture comparisons, network resource allocations and performance evaluations of protocols. In this framework, some contributions address how to improve the quality of service in an urban area through the analysis of the real performance data collected from the BSS and propose a generic planning model which would help to evaluate the radio performance of any cellular network [3]. Many optimization procedures applied to several service aspects are aimed at minimizing the call dropping probability while trying to increase the utilization of the resources. This procedure includes; the maximization of service coverage area and of network usage, the minimization of interference and congestion, the optimum traffic balancing among the different frequency layers [4].

## **2. Review of Related Literature**

### **2.1. Call Dropping Probability**

During the life of a call, a mobile user may cross several cell boundaries and hence may require several successful handoffs. Failure to get a successful handoff at any cell in the path forces the network to discontinue service to the user. This is known as call dropping or forced termination of the call and the probability of such an event is known as call dropping probability. This is also known as call incompleteness probability. Call dropping probability is the probability that a call connection is prematurely terminated due to an unsuccessful handoff during the call life. It is one of the key performance indicators (KPI) used by various operators of cellular service for measuring quality of service (QoS). It generally refers to the phenomenon of call/packet dropping in both voice and data networks. Call/packet dropping refers to the event described as the termination of calls in progress before either of the involved party intentionally ends the call [5]. Call dropping leads usually to an undesirable phenomenon known as forced call termination [6]. Mobile users are more sensitive to call dropping than to call blocking at call initiation. Wireless service providers have to design the network to minimize the call dropping probability for

customer care. Call is dropped if there is no available channel in the targeted cell during a handoff, that is, a call is dropped when a handoff failure occurs during a call life. Assuming,  $P_b$  and  $P_h$  are the call blocking probability and handoff blocking probability, respectively. Also  $P_c$  denotes the probability that a call is completed (without blocking and forced termination) [1]. Then the call dropping probability

$$P_d = 1 - P_b - P_c \quad (1)$$

$$p_d = 1 - (1 - p_h)^H, \quad (2)$$

where  $H$  itself is a random variable. Given the call blocking and dropping probabilities  $p_b$  and  $p_d$ , the call completion probability ( $p_c$ ) is given in [1] as

$$p_c = (1 - p_b)(1 - p_d) \quad (3)$$

Intuitively, call completion probability shows the percentage of those calls successfully completed in the network.

## 2.2. Probability of Assigning Channel Successfully

According to [7], it can be concluded that the inter-cell handoff requests come from any direction in the range of 0 and  $2\pi$  degrees with equal probability using the fluid flow model. Assuming the channels have already been assigned to the MUs when a new call or an inter-cell handoff call arrives, the BS must usually form a new beam with some busy physical channel. It is possible that the cell still has channels that can be reused, but none of them can be assigned to the new call, inter-cell handoff call or intra-cell handoff call because of beam area overlapping problem. The situation mentioned above happens when the number of active MUs in the cell,  $n$ , is greater than the number of channels  $N$ . When  $n \leq N$ , some free physical channel can always be found to be assigned to the new call or inter-handoff call.

## 2.3. Handoff Rate

Handoff rate usually is defined as the average number of handoffs undertaken during the actual call connection in the wireless cellular network. This is a very important parameter for network design and traffic characterization [1].

### 2.3.1 Cell Dwell Time of a Mobile User

This is the amount of time a mobile user spends in a cell. Cell residency is a random variable which depends on the user behavior and system parameters, e.g. cell geometry. In [8], design a traffic model based on the two-dimensional fluid flow model is proposed. In the fluid flow model, the mobile units (MUs) are assumed to be uniformly distributed in the whole service area and MU is equally likely to move in any direction. They assumed that the average moving speeds of non-real-time MU and real-time MU are equal, i.e.,  $E[V_n] = E[V_r]$ , where  $E[V_n]$  and  $E[V_r]$  are the average moving speeds of the non-real-time MU and real-time MU, respectively. The average cell outgoing rate of MUs was given by

$$\mu_{c-dwell} = E[V] L \pi A \quad (4)$$

where  $E[V] = E[V_n] = E[V_r]$ ,

$L$  is the length of the perimeter of a cell, and  $A$  is the area of the cell.

The dwell time  $T_{c-dwell}$  (random variable) of a MU is defined as the duration between the times that the MU generates a call and the time that the MU leaves the cell.

In the GSM system, the Mobile Stations (MS) communicates with the Base Station System (BSS) via the RF air interface. The Base Station System (BSS) consists of a Base Transceiver Station (BTS), and a Base Station Controller (BSC). In most cases, several

BTS are located at the same site, this gives rise to two (2) to four (4) sectored cells around a shared antenna tower. BSCs are often connected to BTS via microwave links. The BSC to BTS link is called the Abis interface. Usually about 20 to 30 BTS are controlled by a single BSC. Several BSS will be reporting to the same Mobile Switching Center (MSC) which controls the traffic among many different cells. Each (MSC) is assigned a Visitors Location Register (VLR) where mobile stations which are outside their home cell are listed, so as to enable the network to be aware where to find them. The MSC will also be connected to the Home Location Register (HLR), the Authentication Center (AUC), and the Equipment Identity Register (EIR). These connections of the MSC are to ensure that the system can verify that the users and equipment are legal subscribers. This helps avoid the use of stolen or fraud mobiles. Within the system there are also facilities for Operations and Maintenance (OMC) as well as Network Management (NMC) organizations. The MSC also has the interface to other networks such as Private Land Mobile Networks (PLMN) and Public Switched Telecommunication Network (PSTN) and Integrated Service Digital Network (ISDN) [11].

## 2.4. Traffic Intensity

Traffic intensity is defined as a function of the arrival rate and mean call duration [9,10]. The intensity of the arrival process (offered traffic) is given as

$$\rho = \frac{\lambda}{\mu} \quad (5)$$

$\rho$  = traffic intensity in erlang

$\lambda$  = mean rate of calls (requests) attempted per unit time

$\mu$  = mean holding time per successful call

## 3. Model's Description

A system with homogenous cells was considered in this proposed model. Each cell is having  $S$  number of channels and the authors focused their attention on a single cell, called the reference cell. A new call is generated in the reference cell when a mobile user of the reference cell makes a call. When a mobile user holding a channel enters the handoff area of the reference cell from a neighbouring cell, a handoff request is generated. In this model, the call rate is uniformly distributed over the mobile service area. The BSC regularly monitors all the BTSs within its cluster, and therefore moves not more than 8% calls from one BTS to another that has lesser load with respect to the signal strength of the calls. This is done in order to enable balance of loads, and efficiently manage call blocking/dropping.

Figure 1 shows the system model for the proposed scheme which is designed to provide improved calls handling. This scheme ensures efficient utilization of base transceiver station (BTS) which must be a talking BTS.

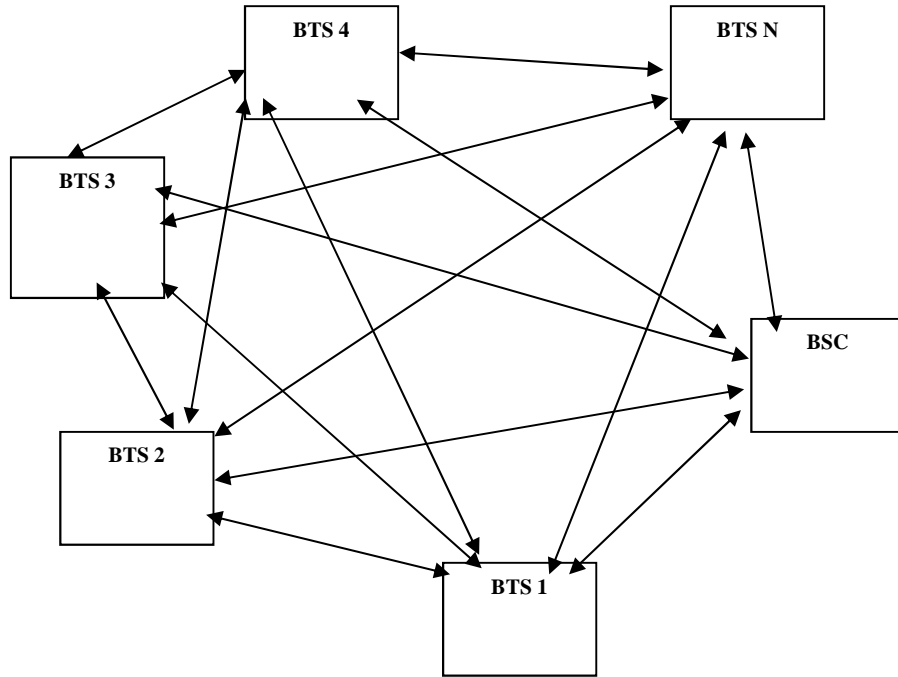


Figure 1: System Model of the proposed scheme

The factors that influence decongestion of the cell are:

- (1) Distance of the MT to the nearby cell ( $d$ )
- (2) Signal Strength ( $\gamma$ )
- (3) Availability of free channel in the nearby cell ( $C_F$ )

The probability of decongestion ( $P_D$ ) varies directly to the signal strength ( $\gamma$ ), availability of free channels ( $C_F$ ) and inversely to the distance of the MT ( $d$ ).

$$P_D = \alpha \frac{\gamma \cdot C_F}{d} \quad (6)$$

$$P_D = K \frac{\gamma \cdot C_F}{d} \quad (7)$$

Meanwhile, the details of the activities of this analysis are as shown in figure 2 which presents them in a relational flow chart. The main purpose of this work is to examine this scheme and determine how frequent the BTSs within the network cluster receive calls and then compare their services with their cost so as to ascertain how useful is the cluster to both network providers and GSM users.

The following symbols were used in the flowchart:

- $\delta$  represent signal strength,
- Q-time represent queuing time, and
- Ch represent channel.

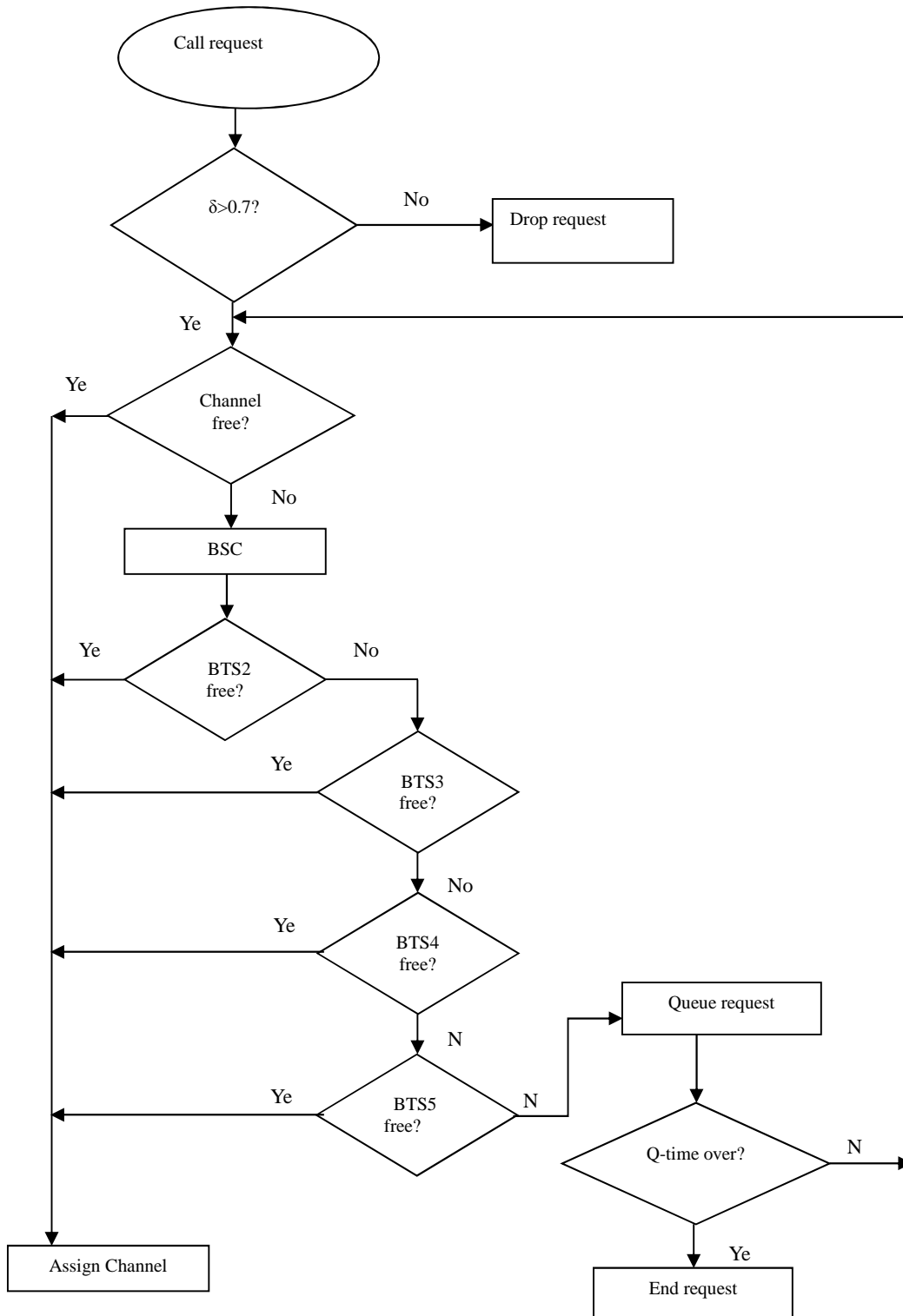


Figure 2: Flowchart of the proposed scheme

#### 4. Conclusion

A flowchart for clustered-based channel allocation management scheme is presented. The proposed scheme provides a quality of service guarantee to both the handoff calls and new calls by maximizing the utilization of the BTS resources to accommodate handoff and new calls in order to improve the overall performance of the network. With the proposed

scheme, call dropping probability will be reduced through better utilization of BTS resources. Importantly, the scheme is suitable only in cities where there is much GSM call arrival rate.

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