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Flowchart for Call Management Scheme through Users Mobility Control

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Abstract

The tremendous popularity of wireless technologies during the last decade has created a considerable expansion of wireless networks both in size and use. These facts, together with a great variety of mobile devices and numerous different services that are becoming increasingly resource-demanding, have attracted the attention of many researchers into the area of radio resource planning and optimization. In wireless cellular networks, it is important to develop model or schemes to facilitate effective and efficient utilization of the limited radio resources. In this paper, flowchart for call management scheme through users mobility control is presented. The flowchart along with the analytical expressions pertaining to the scheme are presented and discussed. Particularly, the scheme improves channel allocation to handoff calls for mobile users by considering the direction of their movement. The direction of mobile users with respect to a base station is captured in terms of mobility factor. The mobility factor increases as the user moves closer to a base station. In this case, even if the signal strength of ongoing call of a mobile user is sufficient, it channel allocation can still be retained if its mobility factor is relatively high. In this case, the mobile user will be handed off to the base station it has higher mobility factor value.

Keywords: Signal Quality; Prioritized Handoff; Call Duration; Call Arrival Rates; the Mobility Factor; Radio Resource Management

1. Introduction

With the increased demand for wireless communication systems, a promised Quality of Service (QoS) is required in a satisfactory manner, to manage the incoming new calls and handoff calls more efficiently .Quality of Service (QoS) provisioning in wireless networks is a challenging problem due to the scarcity of wireless resources, i.e. radio channels, and the mobility of users. Call admission control (CAC) is a fundamental mechanism used for QoS provisioning in a network. It restricts the access to the network based on resource availability in order to prevent network congestion and service degradation for already supported users. A new call request is accepted if there are enough idle resources to meet the QoS requirements of the new call without violating the QoS for already accepted calls. Admitting too many users results in a situation where the mutual interference between the connections degrades the QoS for the new user as well for the ongoing connections.

Therefore, admission control play a very important role in providing the user with the requested QoS as well as making an efficient use of the available capacity and preventing the system from an outage situation due to overloading [1].

With GSM communications, a user that initiates or receives a call may move around the area covered by the network. If the mobile user moves from one cell to another, and the call from/to the user has not finished, the network has to handoff the call from one cell to another at the cell boundary crossing without user's awareness of handoff and without much degradation of the service quality. As the demand for wireless communication systems by the users keep increasing, a good quality of service (QoS) is required to manage the incoming new calls and handoff calls more efficiently. 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]. CAC is a key element in the provision of guaranteed QoS in wireless networks. Admission control decision is made using a traffic descriptor that specifies traffic characteristics and QoS requirements. A new call request is accepted if there is free channel in the network resource, and also if the call meets the QoS requirements of new calls without disrupting the QoS for the already supported calls. Too many calls lead to a situation where the mutual interference between the connections degrades the QoS for the new call as well as for the ongoing connections. Therefore, admission control plays a very important role in providing the user with the requested QoS as well as making an efficient use of the available capacity and preventing the system from an outage situation due to overloading [1]. An accepted call that has not completed in the current cell may have to be handed off to another BTS.

Call admission control (CAC) is such a provisioning strategy to limit the number of call connections into the networks in order to reduce the network congestion and call dropping. In wireless networks, another dimension is added: call connection (or simply call) dropping is possible due to the users' mobility. A good CAC scheme has to balance the call blocking and call dropping in order to provide the desired QoS requirements Due to users' mobility; CAC becomes much more complicated in wireless networks. An accepted call that has not completed in the current cell may have to be handed off to another cell. During the process, the call may not be able to gain a channel in the new cell to continue its service due to the limited resource in wireless networks, which will lead to the call dropping. Thus, the new calls and handoff calls have to be treated differently in terms of resource allocation. Since users tend to be much more sensitive to call dropping than to call blocking, handoff calls are normally assigned higher priority over the new calls [3].

The continuation of an active call is one of the most important quality measurements in cellular systems. This process is known as handoff. It is the process of changing the channel (frequency, time slot, spreading code, or combination of them) associated with the current connection while a call is in progress. Usually, this is initiated either by crossing a cell boundary or signal quality degradation in the current channel. Therefore mobile station (MS) can move from one base station (BS) to another, without dropping the call or experiencing difficulties. There are basically two types of handoff principles – the soft handoff and the handoff. If a new BS has some unoccupied channels, then it assigns one of them to the handed off call. Nevertheless, if at the time of the hand off, all the channels are in use, two things could happen; the call could be dropped or it is delayed for a while [4]. Handoff process enables a cellular system to provide such a facility by transferring an active call from one cell to another. Different approaches are proposed and applied in order to achieve better handoff service. The principal parameters used to evaluate handoff techniques are usually forced termination probability and call blocking probability. Mechanisms such as guard channels and queuing handoff calls decrease the forced termination probability while increasing the call blocking probability [5].

2. Review of Related Literature

2.1. Call Connection and Performance Metrics for Wireless System

In a wireless mobile network, a mobile user is at liberty to migrate from one cell to another and engages call connection in the process. Handoff probability, handoff rate, call dropping probability, call blocking probability, channel utilization, outage probability and call completion rate are often used as metrics to assess the network systems performance [6]. According to [7], many optimization procedures applied to several service aspects are aimed at minimizing the call dropping/ blocking probabilities while trying to increase the utilization of the resources. These procedures include; 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. It has been shown by studies that the performance of wireless systems is affected by a number of propagation factors [8, 9, 10]. These include: Background noise, Fast fading, Shadow fading, Random slow shadowing, Time dispersion, Path-loss variation versus distance, Interference, and Rayleigh effect.

Diffraction we know is the phenomenon due to the effect of a radio wave striking a surface which causes its direction of propagation to change [11]. The loss due to diffraction loss is a function of the obstruction type including high rising buildings or towers. Signal reception is greatly retarded by these factors and this leads to poor services quality. The Rayleigh effect which is also referred to as Rician is the effect which is as the result of fast variation of the level of signals in amplitude and phase. This often is between the transmitting and receiving antennas when there is no line of sight. There are two classes of Rayleigh fading. These are: multipath fading and frequency-selective fading (FSF) [11,12]. Shadowing on the other hand is the effect of diffraction. Weak signal strength can also be caused by destruction interference of the signals from local towers in urban areas or by the construction materials used in some buildings. This often causes rapid alteration of signal strength. Large buildings such as warehouses, hospitals and factories often have no usable signal further than a few meters from the outside walls. This is particularly true for network operating at higher frequency.

2.2. Call Blocking Probability

When a mobile terminal (mobile user) requests service, it may either be granted or denied service. This denial of service is known as call blocking, and its probability as call blocking probability. The overall blocking probability is the weighted sum of the blocking probability of each region. New calls in the soft region are blocked only if both calls are found in the blocking condition [6]. From [13], the overall blocking probability is given as

$$P_b = P_{bH} + (1-P)\, P_{bs}^2 \qquad (1)$$

Where:

P_b is the overall probability, P_{bH} is the probability in the hard region, P_{bs} is the probability in the soft region.

2.3. Handoff Probability

Handoff probability is the probability that a call connection needs at least one more handoff during its remaining lifetime is known. These probabilities are often referred to as handoff probability for a new call or the handoff probability for a handoff call, depending

on whether a call connection is a new call or a handoff call.
According to [6], a new call needs at least one handoff if and only if the call holding time Tc is greater than the residual cell residence time Rc, Tc > Rc.

3. Description of System Model

The M/M/C/C queuing approach from [14] is adopted in this model. The system is considered to be made of many cells. These cells are assumed to be homogenous. This system cell is made of a total of C channels. Priority is given to the handoff calls. This is because mobile users are more sensitive to handoff failure (call drop) than new call blocking. The given priority will be implemented using the Guard Channel method. Out of the C channels of the call, R channels are reserved exclusively for Handoff calls while the remaining M = C-R channels are shared by handoff calls and new calls.

The following assumptions are adopted in this system model.
(i) Both the new call and Handoff arrival rates in the cell form a Poisson process with mean values of λ_N and λ_H respectively. Therefore total arrival rate is $\lambda = \lambda_N + \lambda_H$
(ii) New call and handoff completion time are exponentially distributed with mean rates of μ_N and μ_H respectively. Therefore the effective service rate is $\mu = \mu_N + \mu_H$
(iii) The change in arrival rates is moderate in that the network reaches steady state between any two changes in the arrival rate. Therefore the incoming traffic rate (call arrival rate) is $\lambda = \lambda_N + \lambda_{H.}$

The system model is as shown in Figure 1.

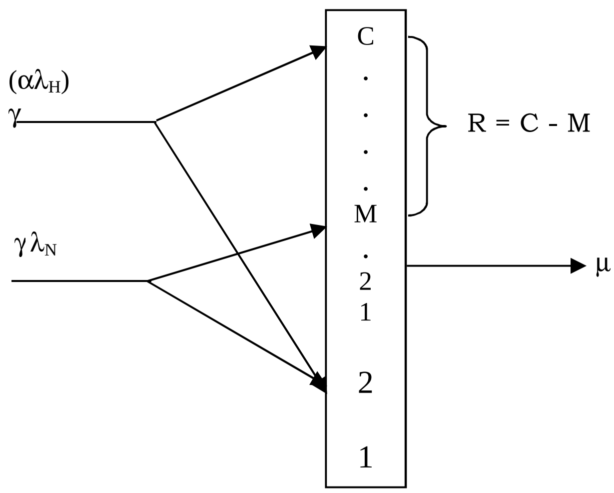

Figure 1: System Model for the new Scheme

$$\lambda_h = \gamma_H \lambda_H \qquad (2)$$

$$\lambda_n = \gamma_N \lambda_N \qquad (3)$$

It is assumed that γ_N and γ_H are the same and denoted as γ. Therefore

$$\lambda_h = \gamma \lambda_H \qquad (4)$$

$$\lambda_n = \gamma \lambda_N \qquad (5)$$

The effective service time for states zero to M is given as

$$\mu = \mu_N + \mu_H \qquad (6)$$

The effective service time for states M+1 to C is given as $\mu_{H.}$

A concept known as mobility factor is employed in this work to maximize the priority given to handoff calls. This factor denoted as α is the ratio between the handoff and new call arrivals. One of the assumptions in this system is that new call arrivals are always greater than or equal to handoff, therefore the mobility factor lies between zero (0) and one (1). That is, $0 < \alpha \leq 1$. The relational activities of this scheme are shown in the schematic flowchart of Figure 2.

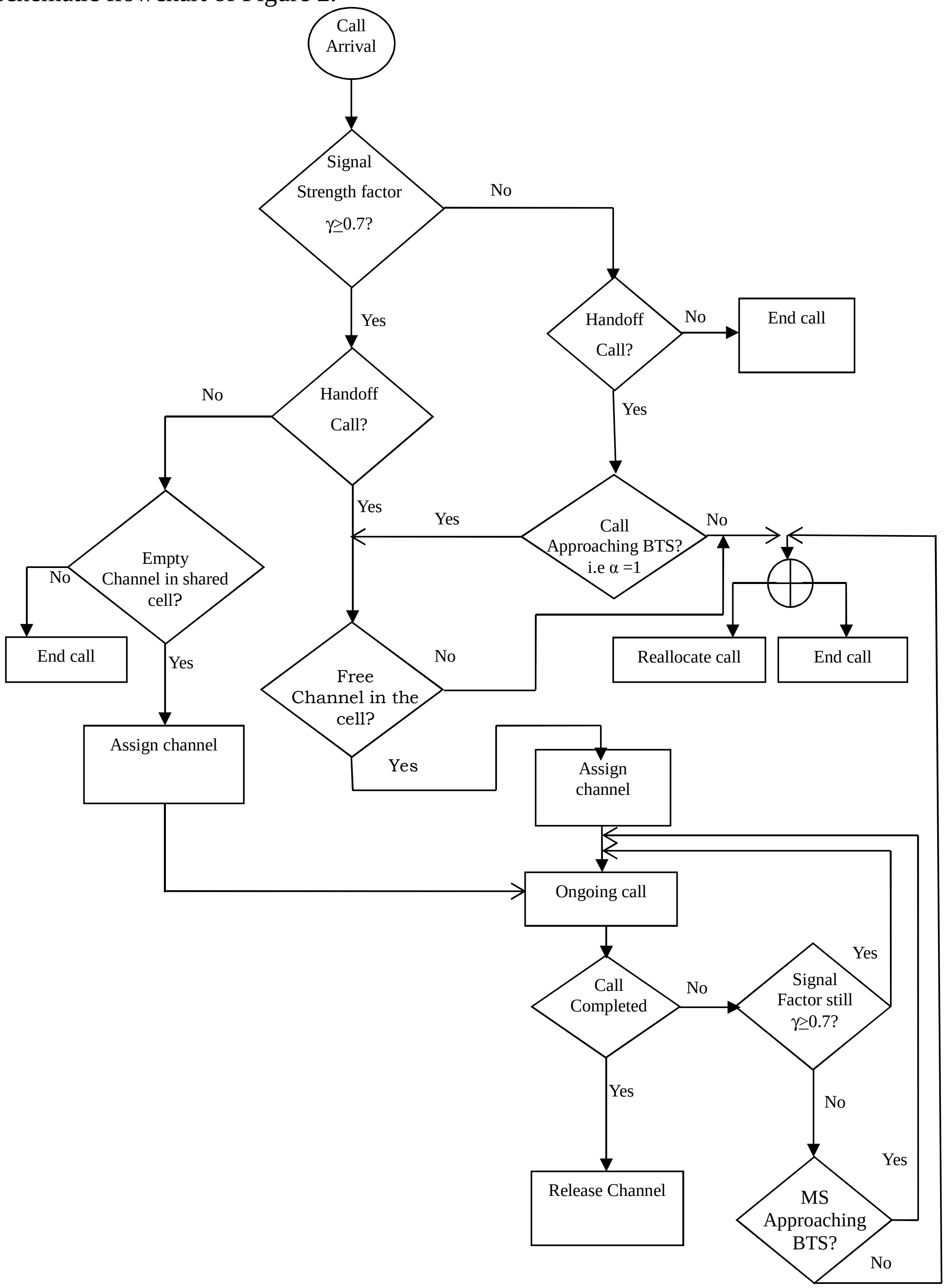

Figure 2: Schematic flowchart of the new scheme

The proposed scheme is based on the idea that if the mobile terminal is approaching the base station, the poor signal handoff request can be accepted with probability α that increases as the mobile terminal approaches the base station. The assumption is that the signal quality will improve as it nears the base station. In essence, this scheme ensures that α is always tending to one (1). This scheme is a prioritized handoff scheme which puts into consideration signal strength, number of channels, call duration, call arrival rates and the mobility factor.

4. Conclusion

This paper presents an approach for improving the QoS for handoff calls by handling the poor signal quality request effectively. The mechanism uses a mobility factor to determine if an ongoing call with poor signal strength can still be accommodated. Particularly, the mechanism ensures that mobile users with ongoing call and poor signal strength can still be sustained in the network and eventually handed off to a base station that the mobile user has a high mobility factor.

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