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Reducing Handoff Blocking Probability in Wireless Cellular Networks- A Review

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***Abstract*—** The continuity of service in an active cell is one of the most important issues in wireless cellular networks. Blocking occurs when a base station has no spare channel to allocate to a mobile user. It can be either new call blocking or handoff call blocking. In this paper, a review is given to better understand handoff blocking probability reducing models. These models prevent dropping of calls and improve quality of service.

***Keywords*—** GSM, WCDMA, handoff, call dropping, handoff blocking probability, call blocking probability

I. INTRODUCTION

With the increased urge for wireless communication for use in satisfactory manner, a promised Quality of Service (QoS) is required, to manage the incoming new calls and handoff calls more efficiently [20]. According to the traditional cellular model, the geographical area is divided into cells, and each of them is controlled by separate Base Station (BS). Different BSs communicate with each other through core network. Mobile Users (MUs) communicate with each other through the corresponding BSs. The communication link from MUs to BS is referred to as uplink. The communication link from BS to MUs is referred to as downlink [21].

Before a MU can communicate with other MUs in network, a group of channels should be assigned [22]. Due to mobility of user, the call has to be transferred from one cell to another to achieve the call continuation. Transferring the active call from one cell to another without disturbing the call is called handoff [22]. It is possible to determine the number of users in different cells in a specified region. As the number of users in the cell decreases, the number of handoffs increases. So, these handoffs must be properly managed.

Call Admission Control (CAC) is performed upon arrival of call request, in order to preserve the Quality of Service (QoS) of existing MUs. This may result in the blocking of the new call requests [21]. Call blocking occurs when a call arrives at a cell and finds no free channel available [24]. Depending on whether the call is a new call or a handoff call, call blocking probabilities are characterized as the new call blocking probability (CBP) and the handoff call blocking probability (HCBP) respectively. The former refers to the call blocking upon the initial connection establishment, whereas the latter refers to the blocking of already accepted in-service calls when they move from one cell to another. When a handoff call is blocked, the call is forced to terminate, resulting in a dropped call.

It is desirable to reduce the call blocking probability (CBP) to obtain better quality of service (QoS). Users hold taken aback view about call blocking because it results to degradation in QoS and developing an efficient model to reduce its probability in cellular networks is a growing research topic aimed at improving overall cellular system performance. However, handoff call dropping probability (HCDP) should be reduced at the expense of increased call blocking probability (CBP). This would, in turn, minimize handoff blocking probability (HBP). Thus, there is a tradeoff between reducing handoff blocking probability (HBP) and new call blocking probability (CBP).

A. GSM (Global System for Mobile Communication)

GSM is a second generation digital cellular system [23]. GSM networks use combination of FDMA (frequency division multiple access) and TDMA (time division multiple access) for efficient utilization of frequency bands. The overall architecture of GSM network is shown in fig 1. The GSM system consist of several functional units including mobile switching centers (MSC), base stations (BSC), base transceiver stations (BTS), an operation maintenance center (OMC) and gateway MSC. GSM mobile terminals communicate, across the air interface, with BTS in the small cell in which the mobile unit is located.

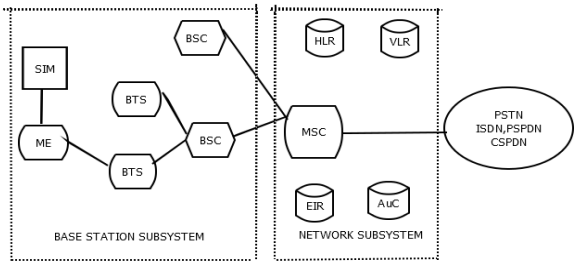

Fig. 1. GSM SYSTEM

The network area is divided into smaller regions called cells. Multiple cells are grouped together to form a location area. BSCs are connected to MSC through radio links. A gateway MSC interface to the PSTN (public switched telephone network). MSC incorporate home location register (HLR), visitor location register (VLR), authentication register (AuC) and equipment identity register (EIR). The HLR stores both permanent and temporary information about each of the mobile unit that belongs to it. The VLR register maintains information about mobile units that is currently in the physical region covered by MSC.

The EIR is a database that contains a list of all valid mobile equipments on network, where each mobile station is identified by its international mobile equipment identity (IMEI). It helps in tracking stolen and unauthorized equipments and enhances security. AuC holds the authentication and encryption keys. These are stored in each user SIM card for authentication and encryption over radio channels [23].

Handoff is a critical process. So, GSM handoff was an area to which special attention was paid when developing the standard. There are basically four types of handoffs in GSM system-intra BTS handoff, inter BTS intra BSC handoff, inter BSC handoff and inter MSC handoff.

B. WCDMA (Wideband Code Division Multiple Access)

Wideband Coded Division Multiple Access (WCDMA) has been evolved in the communication industry as the most dynamically adopted 3G technology [25]. WCDMA assists the Bandwidth on Demand. Frequency division duplex (FDD) and time division duplex (TDD) are operation modes that WCDMA supports. The interference in WCDMA system has to be managed by a threshold value. The WCDMA system can accept a huge number of calls. Consequently, it has a soft capacity and this may affect the interference level. It is important to keep in mind the power control in WCDMA. In closed loop transmission power control, the base station makes predictions in a regular manner on the received signal to interference ratio (SIR). These predictions are used to perform a comparison between the estimated values and a target SIR value.

Consequently, base station decides for two cases. Firstly, if the recorded SIR values are bigger than the target SIR value then the base station will instruct the mobile station (MS) to decrease the power. Secondly, if the recorded SIR values are low then the base station will instruct the MS to increase the power. The mobile stations that work on the same frequency with different codes should be power controlled with a same strategy on mobile station [25]. This strategy must avoid over-shouting between mobile station and blocking some area of the cell.

In Code Division Multiple Access (CDMA), radio resources are limited. Each user has a code. The user assigned code needed to be orthogonal to the codes of other users. As the number of users increases, interference between users increases due to which the quality worsens. Hence, a standard should be maintained for providing a high quality service to users. This standard is known as Quality of Service (QoS). The cells arrangement in CDMA is shown in Fig 2.

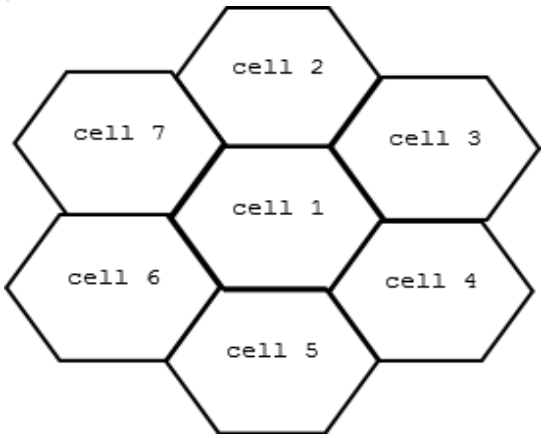

Fig 2. Cells in CDMA

Source:// Code Division Multiple Access for Wireless Communications, Prof. Jeffrey G. Andrews, Wireless Networking and Communications Group (WNCG).Electrical and Computer Engineering Dept., University of Texas at Austin

II. RELATED WORK

In modern era of wireless communication, placing a call request is not so difficult but receiving a call involves much effort in managing the system. Tekinay and Jabbari introduced the concept of prioritization of handoff calls over new calls using channel assignment scheme and buffering strategy [1]. In this, a measurement-based prioritization scheme (MBPS) employing a dynamic priority queuing discipline instead of first-in first-out (FIFO) was used. A handoff scheme, based on queuing for voice calls, was proposed [2]. The Queue accommodates both the originating calls and handoff requests. A strategy to reduce the cost of tracking the mobile host was given [3]. A scheme for queuing and prioritizing handoff calls in queue over new calls was presented [4].

A signal prediction priority queuing (SPPQ) scheme was introduced to improve MBPS algorithm [5]. This was based on both RSS and the change in RSS (ΔRSS) to determine the priority ordering in the handoff queue. The

call blocking calculation in the uplink of a W-CDMA cell based on extension of the EMLM is proposed [6]. The authors assume that calls arrive in the system according to a Poisson process.

A strategy called signal strength for multimedia communications (SSMC) was presented in [7]. The authors calculated a handoff priority for each multimedia service using three values: the static priority value, the degradation rate of the received signal strength (ΔRSS), and the RSS level itself. Furthermore, each handoff request is queued and handled according to its priority value. The result indicated that this strategy can effectively reduce the handoff call dropping probability compared to non-priority schemes.

While most of the works concentrate on the uplink connection, a few papers study the downlink of CDMA systems [8]. The [6] was extended in [9], by incorporating elastic and adaptive traffic. Moreover, call blocking calculation using quasi random-call arrival strategy was also introduced in [10]. In [11], the enhanced model of [10] was used for the calculation of handoff blocking probabilities. In [12] and [13], the model of [6] has been innovatively used with a CAC for handoff traffic. In [14], a model for W-CDMA system employing a soft handoff mechanism has been proposed.

A new handoff queuing technique that handles the channels reserved for handoff calls depending on the current status of the queue was designed [15].This queuing mechanism reduced the dropping of handoff calls. The authors developed a promising handoff scheme using mobile controlled handoff and fractional guard channel techniques [16]. The mobile station measures the signal strength from surrounding base stations and interference level on all channels. A handoff can be initiated if the signal strength of the serving base station is sufficiently lower than that of other base station based on certain threshold. Two models were developed to calculate the blocking probability of new calls and the dropping probability of handoff calls.

Moreover, the prediction of a random user's mobility and Handoff Call Assessment Algorithm (HCA) was developed to utilize the resource efficiently for the Handoff and new calls [17].By using reservation based channel assignment technique, according to call duration we can assign channel groups to user groups so that short duration calls will not be blocked due to long duration calls. Here long duration calls may get blocked. In hierarchical based scheme dual-band cellular mobile communication network is considered where each cell i.e. the macro and microcells are served by different base stations which are situated at center [18]. Call is sent to the macro cell , if user's speed is determined to be fast , else if the user were slow then the call would be sent to microcell to be served. When a call is sent to the microcell but the required bandwidth of the call is larger than the available bandwidth, then the call would be forwarded to the macro cell. But in hierarchical cellular network problems like call setup and signaling protocol for mobile terminal will become complex. Hybrid channel allocation is the combination of fixed channel allocation and dynamic channel allocation [18]. When a mobile host needs a channel for its call, and all the fixed set channels are busy, only then channels from the dynamic set is taken. After using the channels base station must return back channels to MSC otherwise there will not be channels in dynamic set for further requests and call will get rejected [18].

Call blocking can also be reduced using auxiliary stations. When channels of base station (BS) are not free, failure probability can be minimized if the handoff request is served by an Auxiliary Station (AS) closest to the mobile station (MS). The mobile station, being in the auxiliary station, will send requests to the base station within fixed time intervals and when it will find free channels are available in base station it will automatically connect with it, rejecting the connection of the auxiliary station (AS). This process effectively reduces the handoff failure probability. But this approach may result in handoff failure when all the channels of nearest AS are busy. Call transfer time is required when nearest AS has no free channels and call forwarded to second nearest AS [19].

Another technique integrates buffer to the M+G Scheme proposed by Madan et al [20], to prevent congestion in a mobile wireless network. The effect of buffer size under several scenarios will be investigated to evaluate the blocking probabilities of new and handoff calls. This helps further to minimize handoff failure. In [21], the model of [12] was extended by enabling two contingency bandwidth requirements of the arriving calls. If the system is loaded above a predefined threshold, then the call will request less bandwidth compared with the case of below-threshold loaded systems.

III. CONCLUSION

In this paper, different approaches applied to minimize handoff blocking probability in wireless cellular network are discussed. These techniques improved the quality of service provided to mobile users as well as minimized forced termination of ongoing calls in wireless cellular system. These approaches employed handoff queuing and prioritization techniques to provide continuity of service and better bandwidth utilization. However, new call blocking probability is compromised to obtain minimum handoff blocking probability.

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