An Overview of Enhance Bandwidth Management in Cellular Network

H M Isam¹, B L Ong¹, R B Ahmad¹, M Elshaikh¹ and I Al-Mejibli²

¹ School of Computer and Communication Engineering Universiti Malaysia Perlis (UniMAP) Perlis, Malaysia
²University of Information Technology and Communication, Baghdad, Iraq

heba.moh.1990@gmail.com

Abstract. cellular networks have changed our life. However, current cellular network does not have an efficient bandwidth management during congestion. Some of these techniques was used have a few drawbacks such as the performance of the handoff mechanism depends on the channel quality, QoS, bandwidth, delay and speed of the cellular node, the handoff optimizing tend to increase the ping-pong handoff rate, frequency and bandwidth. The paper indicates the promising factors of the handoff mechanisms as decrease delay, enhance speed, saving energy and control bandwidth to achieve better throughput in wireless networks as compared to predecessor networks. How limited bandwidth are segregated among nodes is discussed in details in this paper. We believe that having implemented the proposed enhanced bandwidth management, congestion in current cellular network can perform better.

Index Terms— Bandwidth, Cellular Network, CBR, VBR, UBR, Handoff.

1. Introduction
Since the advancement of technology nowadays especially in cellular networks, cellular communications have produced enormous evolution in the past decade, with an expected growth in the next decade. Cells size should be minimized in order to utilize the limited frequency spectrum allocation to accommodate more subscribers. On the other hand, challenges of fundamental issues in cellular networks are considered as well. Among the main problems in cellular networks is location management, which deal with tracking subscribers during mobility [1]. Cellular networks can be differentiated and categorized using the word “generation”, as we have “first-generation”, “second-generation”, and “third generation”, etc. This differentiation is very important as a big generation difference between each of these technologies [2] as shown in Figure 1.
Mobility is considered as the most vital advantage of a wireless cellular communication system [3], [4]. This requirement is required to support a continuing service for an individual which is attained by featuring handoff from one cell to some other. Handoff can be explained as the procedure of transferring data program of a continuing call in one access indicate another in a homogeneous or heterogeneous cellular network [5]. Handoff is referred as Handover [5]. While a contact is happening, the handoff process is definitely changing the channel (frequency, bandwidth, period slot, spreading code, or mix of them) which can be linked to the current contact connection, on which it is initiated by either crossing a cell boundary or by a deterioration in the standard of the signal in today's channel [4].

The term “cellular” is a widely used and it became the part of our life [5]. It refers to movement or, in general, it is used for cellular devices. Cellular devices became an essential requirement of day-to-day life which is unavoidable. There are several factors that can reduce the appearance of Handoff and improve the cellular connection with the lower cost, lower complexity, high QoS and so on. Among these performance metrics is (handoff speed, bandwidth, handoff delay, packet losses, energy, data rate and etc.). In this article different performance metrics that used to improve handoff technique in cellular network are discussed.

2. Cellular Network with Bandwidth
As we mentioned previously that the cellular is a more used and it be the part of the current life of people. Cellular devices are a main requirement of day to day life which is inevitable. Bandwidth management is important to reduce the appearance of Handoff and improve the cellular connection with the lower cost, lower complexity, high QoS and so on. Selecting Bandwidth management is an essential requirement in cellular networks. An efficient and effective bandwidth management scheme
must perform the QoS provisioning of cellular connections [6]. To handle the network source fluctuations, adaptive bandwidth allocation can change the allocated bandwidth of ongoing calls dynamically, which is now very attractive in cellular communications [7] as demonstrated in table 1.

Table 1. Evaluation Bandwidth of Wireless Technology (Gupta & Jha, 2015)

| Generation | Quantity                |
|------------|-------------------------|
| 1G         | 30KHZ                   |
| 2G         | GSM 200 MHz             |
|            | CDMA 1.25 MHz           |
| 3G         | WCDM 5 MHz              |
|            | CDMA 1.25 MHz           |
| 4G         | LTE (1.4-20) MHz        |
| 5G         | WIMAX mobile (3.5, 7.5 and 10) MHz |
|            | 60 GHz                  |

When a cellular user moves in one cell to another, to be able to provide QoS guarantee the required bandwidth ought to be allocated in the brand-new cell. This element needs to be resolved in the handoff scheme. The primary aim of our function is to supply QoS assurance while optimizing the effective utilization of bandwidth by monitoring the user flexibility and reserving needed bandwidth in places to where the consumer can move. This might bring about reducing premature call service and terminations denials. Here affective usage of bandwidth identifies the percentage of bandwidth in fact used by the phone calls to the bandwidth allocated for communication, as shown in Figure 2.

Figure 2. Bandwidth reservation with handoff technique [25]

3. Fair Bandwidth

Congestion control is critically very important to real-time applications because a number of these applications consume significant bandwidth network assets severely [26]. The users have to adapt to the obtainable bandwidth of the network, which fluctuates as time passes. Recently, multi-application and bandwidth-intensive services such as for example online interactive gaming, high-definition internet protocol tv, and video-on-demand have obtained a lot of attention among clients [27]. Moreover, because of the rapid development of portable and wise devices, which need high data prices per customer, a robust gain access to network, with the capacity of allowing an end-to-end quality-of-support (QoS) provisioning and a high-speed data transmission is necessary.
The fairness problem which is how to allocate bandwidth to connection beyond their minimum required bandwidth. We assume that if the maximum required bandwidth is not available, then the connection is not accepted by the network. The fairness issue is only interesting when the utility of an application strictly increases when allocating more bandwidth than its minimum required bandwidth. Connections with on/off utility functions are thus ignored in allocating extra bandwidth once they receive.

4. Call Priority

CoS (class of service) since traffic is classed into groups such as high, moderate, and low and the low the priority, the more "drop eligible" is a packet. E-mail and Website traffic is placed in the cheapest categories often. When the network gets occupied, packets from the lowest categories are dropped 1st.

The issue with network concern schemes is definitely that lower-priority traffic may be held up indefinitely when visitors is weighty unless there is enough bandwidth to manage the best load levels. High-priority visitors may be organized under extreme traffic loads even. One solution can be to overprovision network bandwidth.

As the traffic loads increase, router buffers begin to fill, which adds to delay. Thus, call or data priority depend on amount of bandwidth that available, when the bandwidth is limited thus the first priority for data that is in real time as (video, video conferencing) those called (CBR), second priority for data non in real time as (imaging nrt, data nrt and audio) these called(VBR) and at last for data that very less priority as (file transfer, email, fax and remote login) all of these called (UBR).

5. Discussion of Different Performance Metrics That Was Used to Improve Handoff technique in different Types of Wireless Networks

The researcher Rabe A. utilized a velocity-based handoff control in two-tier cellular networks [9]; in this article, the impact on the handoff (HO) amount is ignored whereas network densification is assumed as an important solution to overcome the expanding capacity demand. HO delays may defuse or even deny the advantages introduced by network densification in dense 5G networks [9]. To improve the average rate for mobile users, the paper suggested user-aware HO skipping schemes for two tier cellular network. In order to study the impact of HO delay on the user amount, the authors designed an analytical paradigm to frame the suggested cooperative HO performance of skipping schemes. The designed mathematical framework is built on stochastic geometry and verified using Monte Carlo simulations [9]. QoS, HO delay, and mobile users average rate is improved in this article paper.

In next research paper, a proposal of an adaptive bandwidth borrowing-based call admission management approach for multi-class service is introduced [6]; In this proposal, an adaptive Call Admission Control (CAC) approach for multi-class service wireless cellular networks is presented. The suggested approach utilizes a thorough sharing scheme of all traffic classes for the available bandwidth. The suggested solution is achieved by borrowing of call bandwidth and call preemption methods according to the priorities of the traffic classes. The QoS is achieved in each class by mechanisms to degrade call bandwidth, and call bandwidth upgrading predicated on Max-Min and Min-Max rules for fair resource deallocation and allocation. The strength and performance of the proposed strategy were demonstrated on the simulation outcomes in comparison to other approaches [6]. The proposed results showed a reduction of the dropping probability and blocking probability, and bandwidth utilization enhancement. Moreover, the simulation results showed the performance of the scheme can be enhanced if some parameters, like the utilization threshold and the allowed ratios of traffic classes are carefully tuned to regulate the amount of the provided QoS.

Routing and Bandwidth optimization in wireless cellular networks with relays is presented in another article by [14]; The purpose was to quantify the improvement in performance because of
utilizing the set relays in the uplink of the cellular network, where addressing an orthogonal frequency division multiplex (OFDM) based cellular network, because each cell includes a bottom station, multiple cellular users, several relays [14]. This proposal makes enhancement in OFDM optimization of networks with relays. The researchers addressed the simultaneous routing, frequency planning, and power allocation issue with fixed relay infrastructure. They conclude that making the system more equitable while extending coverage is the main advantage relays.

Another research paper is GreenBag: Energy-efficient Bandwidth Aggregation for Real-time Streaming in Heterogeneous Mobile phone Wireless Systems [20]; a promising opportunity for assisting bandwidth-intensive applications, such as high-definition video streaming emerges on recent cellular devices because they are armed with multiple network interfaces such as for example 3G/LTE and WiFi through the use of bandwidth aggregation over LTE and WiFi links. Nevertheless, several challenges eventually accomplish effective bandwidth aggregation in cellular environments such as deployment, hyperlink heterogeneity, network fluctuation, and energy usage [20]. The researcher created an energy-efficient bandwidth aggregation middleware known as GreenBag which will not require adjustments to the prevailing Internet infrastructure and servers; this middleware facilitates real-time data-streaming solutions over asymmetric wireless links. To overcome the pointed-out difficulties, GreenBag utilizes several strategies such as for example medium load balancing, effective segment administration, and energy-aware setting control. A prototype of GreenBag is usually implemented on Android-based mobile devices which hosts the 1st LTE-allowed bandwidth aggregation prototype for energy conserving real-time video streaming [20]. The experiment outcomes acquired for emulated and real-world working space demonstrated that GreenBag achieves great bandwidth aggregation to supply QoS in bandwidth-scarce applications, and energy saving in cellular devices also. Moreover, GreenBag can lower video lag, on a single time consuming just 14-25% reduced energy much better than the non-energy-conscious counterpart in real-globe examinations [20].

The other research paper is Utility-Maximization Bandwidth Adaptation for Multi-Class Traffic QoS Provisioning in Wireless Systems [7]; To handle network source fluctuations, adaptive bandwidth allocation is now promising in cellular communications since it can dynamically change the allocated bandwidth of ongoing calls [7]. In this ongoing work, the experts suggested an utility-centered bandwidth adaptation technique used for multi-class visitors QoS provisioning in wireless networks. The objective of the utility technique is definitely that the accomplished utility of each specific cell can be maximized by assigning each contact a computer program function and based on the network load the bandwidth of ongoing phone calls are improved or degraded. The authors built-in adaptation penalty in to the utility function to handle the unwanted effects of bandwidth adaptation. To judge the overall performance of the proposed technique, simulation experiments were carried out, and results demonstrated that the technique works well in both raising cell utility and reducing the decision blocking and handoff dropping probabilities of cellular networks.

Other research paper is usually performance evaluation of bandwidth-based handoff algorithm for 4G heterogeneous wi-fi networks predicated on WDHOP [22]. In this paper, bandwidth-based handoff algorithm for multiple heterogeneous wireless networks are developed [22]. Usually upper coating applications are more delicate on QoS parameters such as for example bandwidth, delay etc.

6. Performance Metrics That was Used to improve Handoff Technique in Different of Wireless Networks
This section contains a comparison between different networks environments, approach with contributions of the papers, as show in table 2.
| Year | Ref. | Environments | Approach | Contribution |
|------|------|--------------|----------|--------------|
| 2018 | A Novel Handoff Necessity Estimation Approach Based on Travelling Distance | Cellular Network & WLAN | Handoff Necessity Estimation (by MATLAB Simulator) | • QoS.  
• Reducing the unnecessary HO.  
• QoS.  
• Traffic Load.  
• Flexibility & Connectivity for Network. |
| 2017 | Performance Analysis of Bandwidth Based Handoff Algorithm for 4G Heterogeneous Wireless Networks Based on WDHOP. | Heterogeneous Wireless Network | Bandwidth Based Handoff Algorithm. | • Lower Complexity.  
• Better Throughput for users  
• Saves Energy.  
• BW Aggregation.  
• QoS. |
| 2017 | Virtual Soft-Handoff for Cellular Heterogeneous Networks | Cellular HetNet. | VSHO Technique | • BW Upgrading.  
• QoS. |
| 2013 | GreenBag: Energy-efficient Bandwidth Aggregation for Real-time Streaming in Heterogeneous Mobile Wireless Networks. | Mobile Network | GreenBag Architecture. | • QoS. |
| 2011 | An Adaptive Bandwidth Borrowing-Based Call Admission Control Scheme for Multi-Class Service Wireless Cellular Networks. | Wireless Cellular Network | Call Admission Control (CAC) | • BW Upgrading.  
• QoS. |
| 2005 | A Capable Location Prediction and Bandwidth Reservation Scheme for Multimedia in Mobile Cellular Networks. | Mobile Network | mobility predictive bandwidth reservation scheme. | • QoS.  
• Throughput. |
| 1998 | An Adaptive Bandwidth Reservation Scheme | Wireless Network | Adaptive Bandwidth Reservation Scheme. | • BW.  
• QoS. |
Pie Chart
This section shows the classification of performance metrics that used over the years, Figure 3.

Figure 3. Performance Metrics Pie Chart

8. Proposed solution
After the studied of the cellular network and see the performances matrices affecting them, noticed there is a problem in the speed of accept new calls and handoff calls where this can cause loss of calls but for each problem there is a solution. There are two major factors which have to be considered for the nice reservation of bandwidth seriously. Initial is, how bandwidth ought to be assigned at first to each cell and just how many quantities of users is there in each cell to keep up the QoS through the entire connection life. Our objective is usually to find the free obtainable bandwidth in virtually any cell and offer it compared to that cell where it needs, keeping the QoS for the incoming contact. This concern distribution of bandwidth is principally divided in three parts:

1. Constant Bit Rate (CBR): Jobs that can tolerate no delay are assigned the CBR priority. These jobs are provided same number of bits every frame. For example, viewing a video reel definitely requires some blocks in every frame [28]-[30].

2. Variable Bit Rate (VBR): Jobs that may produce different sized packets at different times are assigned VBR priority. They are provided with a variable number of bits varying between a maximum and a minimum in different frames. e.g. a document may be compressed differently by different machines. Transmitting it will be a variable transmission [28]-[30].

3. Unspecify Bit Rate (UBR): These jobs are the least priority jobs. The network does not promise anything but simply tries its best to transmit it. From then on, we maximize the capability utilization by assigning any available free bandwidth to the prevailing cell according to user demand. If the bandwidth and frequency of the calls is controlled correctly, it helps to avoid of these problems [28]-[30].

This section focuses on the propose algorithm of enhance bandwidth of handoff technique. Proposed technique includes two algorithms:

1. Sufficient bandwidth algorithm.
2. Insufficient bandwidth algorithm includes:
   a. Sub algorithm 1.
b. Sub algorithm 2.
c. Sub algorithm 3.

Thus, when the bandwidth request is equal to available bandwidth all calls will accepted without any problem but if the available bandwidth is not enough to cover all bandwidth requested from a call, the bandwidth available will divided depend on priority of calls. Thus, that will help to accept all calls without any call’s loss and delay.

The proposed algorithm function taking into consideration the good bandwidth which we’ve initially assigned to each cell, meaning that, we are enhancing the at first assigned bandwidth by using bandwidth reserve further. This algorithm provides high velocity, lower hold up and high QoS for fresh calls and handoff phone calls by allocating reasonable bandwidth and the number of users.

The next Figure 4 illustrates the proposed algorithm described above fully.

**Figure 4. Proposed algorithm**
9. Conclusion
In this paper more and different performance matrices in different type of wireless networks are discussed. Handoff technique may have drawbacks as the performance of handoff mechanism depends on the QoS, Speed of cellular nodes, bandwidth, Energy and delay, the handoff optimizing depend on to increase the bandwidth, ping-pong handoff rate and handoff prediction techniques. Therefore, solution to these issues is discussed in details in this paper. The implementation of the proposed mechanism is believed to improve the performance of cellular network during congestion.

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