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A Framework for the Performance Improvement to Minimize Queuing Delay and Packet Loss Rate in WiMAX 16m Networks

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Abstract. IEEE 802.16m standard redefined with many improvements to offer the users with better Quality of Service (QoS) and seamless mobility. Emerging multimedia services like immersive environments, IPTV applications ,video conferencing, mobile online gaming and 3D virtual world requires reliable communication even in high mobility in heterogeneous network environment, denser area and in cell edges. For this reliable communication and to ensure the QoS, Buffer allocation is the major issue in WiMAX 16m networks. The lack of buffer will degrade the performance in terms of packet loss and queuing delay. In this paper we propose a framework for the performance improvement in terms of fuzzy based dynamic buffer management system to reduce the packet loss rate during WiMax Communication. The main purpose of this scheme is to buffer the user-specific data by adaptively adjusting the size of the buffer based on the traffic situation during communication and handoff process. This is to provide the expected guaranteed QoS for each connection efficiently based on the SNR and RTT assessed through Channel Quality information CQI channel of the User-specific data along with delay sensitivity. With accession from check point constraints where the left out packets will be put up into retransmission during handoff process. All these domains are put forth through Call admission control (CAC) mechanism and a dynamic buffer allocation (DBA) process which directly clears packet sizing and Buffer ranging problems between the sender BS and subscriber BS.

Keywords: Transmission delay, handoff, check point, buffer range.

1. Introduction

The key features of Advanced Wimax 16m networks include (1) increased spectral efficiency and bandwidth (2)improved cell edge (3)performance and mobility support (4) reduced Control and User plane latency and (5) reduced handover interruption time. Orthogonal frequency division multiple access (OFDMA), described as a key technology for Wimax 16m physical layer [9,10], is used to adjust channel bandwidth and to allocate subscriber station (SS) subcarriers according to channel state. OFDMA also allows multiple SSs to use various subcarriers to simultaneously transmit OFDM symbols, so called SOFDMA (Scalable-OFDMA). In a base station (BS), all OFDMA subcarriers are divided into groups (known as subchannels) that are allocated to different SSs with matching bandwidth and quality of service (QoS) requirements [9-11]. In addition, adaptive modulation and coding (AMC) technology allows SOFDMA PHY to facilitate data transmission in a high mobility environment, and makes wireless resources fully utilized. This AMC technology uses the CQI (Channel Quality Information) channel to determine the appropriate Modulation and coding scheme. Based on the CQI channel value, the Wimax 16m Base-Station performs allocation or deallocation of requested bandwidth and Quality of Service to the mobile station.

In wired LAN based network, fixed buffers are used. This increases the Round Trip Time delay for queuing data buffer for sending and receiving data. In this Delay may occur due to the data processing [1],[3] in case of fixed buffer size usage. Many researches has undergone for packet scheduling algorithms and

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buffer management for Wimax16m networks but few have considered QoS and whole bandwidth utilization while working on dynamic scheduling buffer management in a BS. The active queue management proposed in [12] does not give solutions to packet drops. From the viewpoint of Internet service providers, maintaining queue-length stability is also important for maximizing link utilization with reduced buffer requirements. Hence in this paper, we mainly concentrates on the buffer sizing which is to dynamically alter its range in comparison with receiver packet size and with the cut-off packet size. The interoperability for the medium access control using static buffers in mobile subscriber station and in BSs are directly altered through our proposed framework called check-point Retransmission.

This approach reduces the overall round trip time delay of the host connected in a network. Some traditional techniques are also available for estimating the available bandwidth which uses the throughput to provide the estimation for bandwidth. The bandwidth availability estimation is directly related to the throughput that the sender is willing to test at any instant. Packet loss during the communication is actually a better estimate of buffer capacities in the network, than of available bandwidth. Additionally, given the relatively low costs associated with the deployment of a WiMAX 16m network (Supports heterogeneous networking), it is now economically viable to provide last-mile broadband Internet access in remote locations. It is a replacement candidate for cellular phone technologies such as GSM and CDMA, or can be used as an overlay to increase capacity and also considered as a wireless backhaul technology for 2G, 3G, and 4G networks in both developed and developing nations.

2. Related work

The standard 802.16m is improved with its mobility and transaction compatibilities from its prior work. Handover in IEEE 802.16m systems is hard handover and network-controlled.The key factor to improve the handover procedure in 802.16m is reducing its latency to provide a better end-user Experience and to perform the error free data transmission.

Sachin Lal Shrestha [1] have proposed a algorithm uses hard HO scheme to establish a reliable, fast and seamless HO to satisfy the IEEE 802.16m requirements. They provides a policy to satisfy IEEE 802.16m benchmark of 150msec or less for a hard handover (DO) between two base stations (BSs). To facilitate such fast DO, the target BSs are chosen before DO is sought. Such choice is made based on previously acquired knowledge of human mobility behavior. Before the connection breaks with serving BS, target BS sets up its MAC states to allow instantaneous connection of service flows that are prevalent in the ongoing connection. Once the connection is broken, serving BS redirects the traffic to target BS while MSS, using the ranging parameters provided right before the connection breakup, initiates a connection request to the target BS. Several timers perform as check points so that critical operations are performed in timely manner.

Allan Borges Pontes [2] have addressed the integration of IEEE 802.11 WLANs and IEEE 802.16 WMANs, focusing mainly on the handover management aspects. They describe the architectures, futuristic application scenarios such as the envisioned heterogeneous multihop wireless networks (HMWNs).Also about media-independent handover (MIH) among heterogeneous Networks and how the MIH framework can help handover management for the integrated network.

Kuo-Shu Huang [3] have proposed an integrated system which supports a seamless handoff scheme with the integration of AP selection, call admission control, and IP address allocation. AP selection is accomplished by choosing the AP with the smallest number of users associated with. Both call admission and a new IP address pre-fetch are operated through the DHCP relay. Particularly, Limited Fractional Guard Channel Policy (FLFGCP) for CAC scheme and two additional thresholds, Blocking Probability Threshold (***BPT***) and Dropping Probability Threshold (***DPT***), for the purpose of balancing the blocking probability of new calls and dropping probability of handoff calls are explicitly defined.

B Zhang [4] have done his research in buffer management for outgoing traffic in a WiMax/802.16 SS, to minimize the packet-loss-rate to lower the overall packet-loss-rate caused by a lack of buffer space and to achieve a QoS guarantee for real-time traffic flows.

3. Proposed Methodology

3.1. Check-Point Retransmission framework for WiMAX 16m Handoff

In our proposed system the process of handoff is enhanced with the framework check-Point Retransmission. In addition to 802.16e WiMax standard, we introduce a check points where retransmission works are carried out through the efficient allocation of residual bandwidth for the remaining packets that are blocked or failed through communication errors. The following explanation makes it very clear to understand the whole process of our proposal where it starts with handoff operation in WiMax. Admission control mechanism in our framework allow only the noncompliant applications placed in a quarantined area, or by giving restricted access to computing resources. This admission control in 802.16m allows the unauthorized application not to enter into our system of packet transmission and this whole system is shown in fig.1.

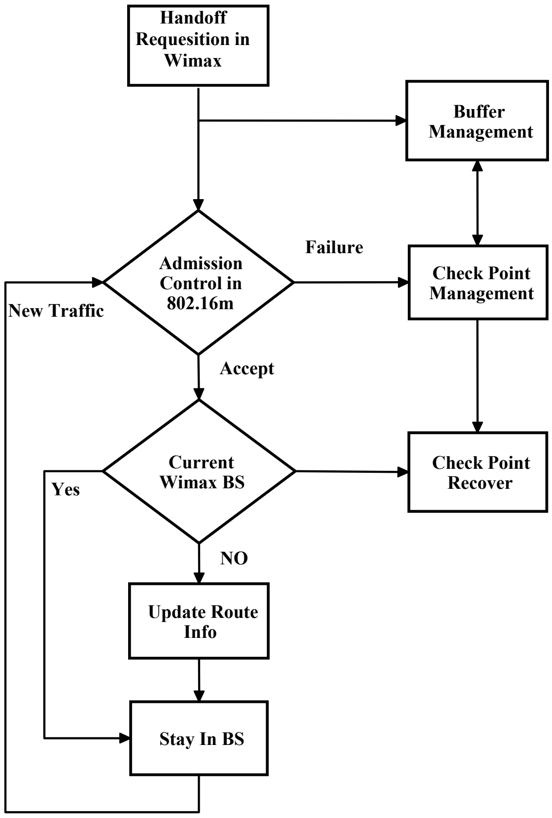

Fig.1: Proposed framework for WiMAX 16m Handoff

Parallel to this, Buffer Manager will concentrates on the size of buffer in servicing BS and the target BS. This process gets input from the acknowledgement whether positive or negative. If acknowledgement is positive, then transmission is successful. Else negative, if there is a failure in data transmission.

Dynamic buffer sizing is implemented to achieve time delay reduction during retransmission. In our proposed system we use dynamic duffer ranging instead of reducing the congestion window. This can be initiated by monitoring the bandwidth availability periodically. Based on the available bandwidth along with the current packet loss rate, we can dynamically increase or decrease the buffer size. This avoids the unnecessary delay in RTT. Hence data transmission is faster than the before. This process leads our system for efficient throughput of packet transmission, exact utilisation of system resources.

Due to the non availability of the resources, some of the handoff initialization by the mobile stations will be rejected by the Admission control block. Once the admission control process in Retransmission-check rejects the incoming process, it will be sent to check point where it is a point in time, as of which the state of all the packets in the system will be preserved. When the system needs retransmission, it is initialized to the state at a demarcation event. In other terms this functionality of check point comes to consideration, only when there is a transmission failure. The check-point will have the complete log about the number of packets that are sent already, number of packets failed and the number of packets requires retransmission . The check-point will store the time value at which the transmission failure happened during the data transmission.

Once negative acknowledgement is received, analysis is made for check-point recovery. This can be explained by considering a transmission of elementary packets which are 100 in number and during the transmission if the failure occurs at the time value measure at 80^{th} packet the check point clearly holds the number and retransmission will be made with the contingency sequence of packet from where the flow is blocked.

When the admission control mechanism accepts the flow is subjected exclusively to current WiMax BS. From here the handoff will be directed to two cases if WiMax BS is capable of accepting the incoming packets with respect to its size. The ranging is done in the BS's resource allocator which intern referred as buffer manager and stays in the BS subsystem. In extreme case of improper channel of bandwidth allocation the entire routing path will be examined for maximum possible optimal routing process. The new optimal route will updated in the already existing information regarding transmission control parameters like time and check points. Thus efficient routing along with improved handoff is achieved by the way of reducing time delay and packet loss during sending and receiving process at both the BSs thereby we can increase throughput of packet transmission.

3.2. Fuzzy based Dynamic Buffer Management

Traditionally, the Buffer management is utilized mainly to regulate the traffic fluctuations [11]. When a node receives more data to forward, the excess data has to be buffered. When the limited buffer space is full, the congestion occurs, and consequently the received data has to be dropped[12]. The main causes for packet loss in networks are buffer overflows due to congestion. In cases where the underlying traffic has inter-packet dependencies, indiscriminately dropping packets upon overflow may result in very poor performance [13]. The performance is high under infinite buffer and infinite bandwidth assumption, however, in real situations, the performance is worse when the buffer and bandwidth are limited due to the congestion control problem [10].

In order to overcome the above issues, an efficient buffer management scheme is required. Hence we propose a fuzzy based dynamic buffer management in WiMAX 16m networks which performs buffer allocation and packet dropping. This technique operates in the base station (BS) along with the Check-Point Retransmission framework. Our proposed scheme operates in the base station (BS). BS stores the following parameters at different time intervals.

- Maximum available buffer (B_{av})
- Total Buffer under execution process (B_e)
- Number of applications accessing base station(NA)
- Queue length (Q)
- Flow rate(R)
- Receive Signal Strength (RSS)

BS updates the above parameters periodically as per the application requirements. When a buffer request packet (BRP) arrives from a specific application, the request packet is either allocated with available buffer or dropped.

4. System Implementation

In our proposed system framework, the transmission control is implemented in terms of above mentioned 802.16m protocol stack with handoff standards. The following flow will show the entire process in terms of codes with vital admission control mechanism, buffer management and check point management.

Proposed frame work for WiMAX 16m Handoff

Claim: Handoff in WiMax, buffer management, Check-Point management

Step1. Admission Control Mechanism in 802.16m
Admission access (acknowledgement ack)

```
if ( ack == fail)
do(buffer management && check point
management)
for (index packet = 0 to failure packet n)
do ( maintain record of sent packet )

if ( failure == 0 )
do ( clear record )
else
if (failure == 1)
do ( retransmission )
index packet = n to failure packet m)
else ( maintain record of sent packet )
else (ack == accept )
do(current WiMax BS = enable)

Step 2 :
if ( ack == Positive )
 do ( BS record = assign new traffic )
else
if ( ack == Negative )
 do ( route update ) go to Step 2.
```

5. Experimental Study

The conceptual arguments are put forth to prove efficiency standards in 801.16m is exponent when compared to the predecessors. We have presented more accuracy in terms of efficiency statistically. The consideration is made in order to show the advancement of every parameter like time, throughput, bandwidth, PDR, packet delay, admission blocking probabilities and packet loss rate.

In our proposed system with Retransmission-check for the data transmission the exactness is calculated with that of number of packets received in the mean interval of time. The following graphs are showing the analysis resultant of handoff in 802.16m with the green line indication and in 802.16e standard with the red line indication. In both the cases, time measurement is taken at equal interval which in seconds and the throughput is the average rate of successful data delivery over a communication channel. This data may be delivered over a physical or logical link layer, or pass through a certain internetworking node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. This slot is drastically improved with a variance rate of more the 150 packets and show in fig 2.1.

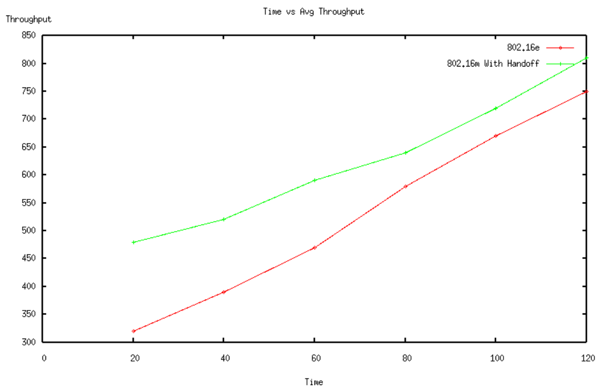

Figure 2.1 Time Vs Avg Throughput

The bandwidth though which the range within a band of frequencies or wavelengths is taken into consideration of our next test case and it is compared with packet delay rate. The amount of data that can be transmitted in a fixed amount of time is measured. And number of packet transmitted in that band is considered when packet loss occurs and the bandwidth is usually expressed in bits per second(bps) or bytes per second. For our system, the bandwidth is expressed in cycles per second, or Hertz (Hz). Due to imprecise handoff and dynamic buffering in both sides of base station the packet delayed rate is improved with intelligent check point management. Fig 2.2 shows incredible declination of packet delay with respect to bandwidth allocated.

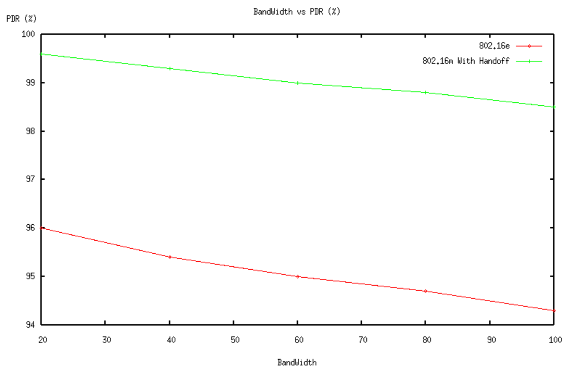

Figure 2.2 Bandwidth Vs PDR

In Fig 2.3 we have shown the increase of efficiency in terms of packet delay with respect to time factor again. In previous standard there is a gradual hike in the delay as the time increases incurring the conclusion that when the system begins its transaction it has least delay and when the traffic increases (time) the delay increases form direct proportionality. In our standard, packet delay is not linear and we got slight deviations and minimum delay because of dynamic buffering and periodic update of routing information for optimal routing path.

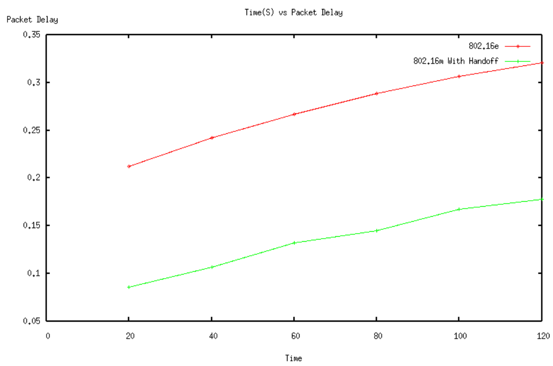

Figure 2.3 Time Vs Packet delay

Through admission blocking probability, the handoff is subjected to current WiMax BS and target BS reducing the probability more than 20 percent and is shown in fig 2.4. Eventually fig2.5 indicates the vital packet loss rate which is taken into account with respect to bandwidth allocation and it showing that the rate of packet loss is directly proportional to size of bandwidth utility.

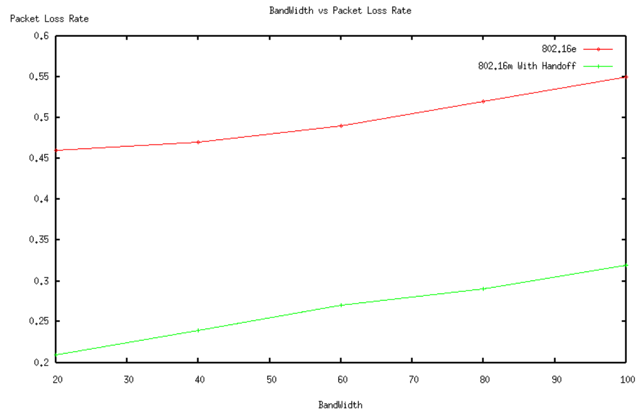

Figure 2.4 Bandwidth Vs Admission Blocking probability

All these works of experimental studies were carried out with NS-2 where the WiMax standards have verified through code and the parameters of the resultant graph is extracted through NS-2. The area of operation in WiMax handoffs and BS analysis are made under coverage region of 1500X300 consisting of 25 mobile hosts and their buffer ranging parameters with respect to packet size sent between those mobile BSs. Thus all the values which are necessary for the study is collected and simulation is made according to the outcome for the experiment and accuracy in performance evolution is given evidently.

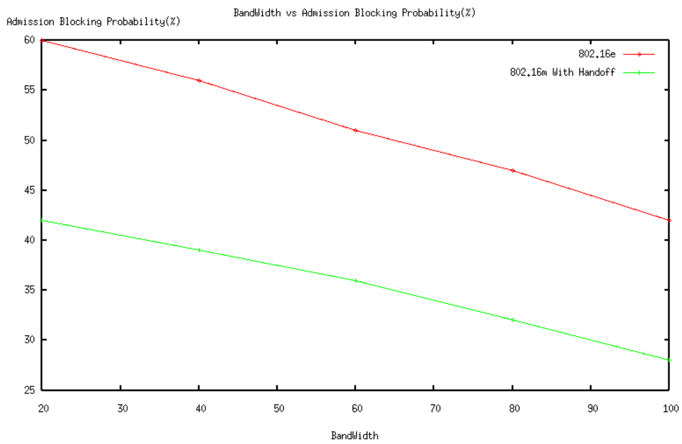

Figure 2.5 Bandwidth utility Vs Packet loss rate

6. Conclusion and Future Work

Our framework for the performance improvement to minimize queuing delay and packet loss rate in WiMAX 16m Networks , delivers elevated liveliness of bandwidth across the transmission medium with efforts from 802.16m handoff and check point mechanism. Hence we can achieve dynamic buffer ranging for the failure recovery process through mechanism of check point. This suggests that the proposed model and utilization of optimization routing may be useful in terms of dynamically altering buffer ranging and handoff thereby increasing profitability of increased throughput, efficient usage of buffer, reduced overall round trip time delay and dynamically changing buffer size based on the available bandwidth according to specific Quality of Service constraints. In future proposed work, the existed framework can be enhanced using Fuzzy based dynamic buffer management. The main advantage of going for fuzzy based approach is to reduce the packet loss rate during Wimax communication and handoff process.

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