Efficient video transmission based on substream selection algorithm over WIMAX network

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Abstract— ***Broadcasting multiple scalable video streams over Wireless broadband access networks in real time is a challenging Problem, because of the limited channel capacity and variable bit rate of the videos. The main objective of this paper is to transmit the multiple video streams encoded in scalable manner to mobile receivers using MBS feature in WiMAX networks, and Substream selection problem was described which arises when multiple scalable video streams are broadcast based on the Multicast/Broadcast Service feature to a number of buffer size constrained receiver.Selecting efficient video streams to maximize the video quality using Substream selection algorithm.***
Keywords: ***QoS***, *Multicast/ Broadcast Service, WiMAX.*

I. INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) is IEEE 802.16 standards. Wimax Technology works same as Wi-Fi does but more efficient. The data transmission can be routed via Wi-Fi. WiMAX technology provides higher speed connection up to 70 Mbps over the area of 30 miles. There is no need for line of sight connection between subscriber terminals and the base station in WiMAX technology. It will support low latency applications such as voice, video and Internet access at time. WiMAX has the potential to replace a number of existing telecommunications infrastructures. The high data throughput enables efficient data multiplexing and low data latency. Attributes essential to enable broadband data services including data, streaming video and high quality of service (QoS). The performance will enable transparency of quality of service between Mobile WiMAX and broadband wired services such as Cable and DSL.

WiMAX provides fixed, portable or mobile non-line-of sight service from a base station to a subscriber station, also known as customer premise equipment (CPE). This service should deliver approximately 40 megabits per second (Mbps) for fixed and portable access applications. Mobile WiMAX takes the fixed wireless application and enables it like cell phone applications. For example, mobile WiMAX enables streaming video to be broadcast from a speeding police or other emergency vehicle at over 70MPH. It potentially replaces cell phones and mobile data offerings from cell phone operators. It offers superior building penetration and improved security measures over fixed WiMAX. Mobile WiMAX will be very valuable for emerging services such as mobile TV and gaming. The biggest advantage of using WiMAX is its easy deployment in areas (hilly, rural areas) where no other forms of ISP's (Internet Service Providers) are present. WiMAX technology is capable of supporting live or cached streaming of audio, video and data. As multimedia communications are highly bandwidth demanding and error sensitive, delay and jitter are very important parameters. This paper is organized in such a way that the efficient multimedia broadcast framework over mobile WiMAX networks utilizing the MBS features.

The rest of this paper is organized as follows. In Section II, a brief background on video streaming over WiMAX networks, and summarizes the related works in the literature. In Section III, we present an approximation algorithm to efficiently solve our problem. Section IV describes our simulation setup and results. Finally, conclude the paper in Section V.

II. RELATED WORK

A WiMAX system consists of two parts: 1) A WiMAX Base station(BS)-According to IEEE 802.16 the specification range of WiMAX is a 30 mile radius from base station. 2) WiMAX Receiver - The Receiver and antenna could be a small box or Personal Computer Memory Card International Association (PCMCIA) card, or they could be built into a laptop the way Wi-Fi access is today.

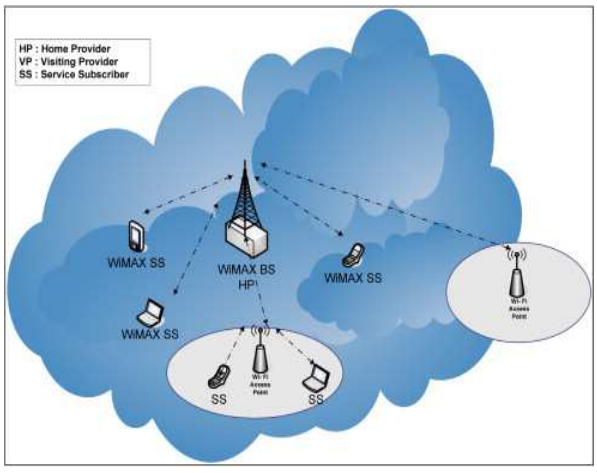

Fig 1: Wimax Network architecture

Figure 1 Explain the basic block diagram of WiMAX technology .A Wimax tower is similar in concept to a cell phone tower. A Wimax base station can provide coverage to a very large area up to a radius of six miles. Any wireless devices within the coverage area would be able to access the internet. It uses the MAC layer defined in standard IEEE 802.16. Each

Base station provides wireless coverage over an area called a cell. Theoretically, the maximum radius of a cell is 50km or 30 miles. The WiMAX Transmitter station can connect directly to the internet using a high bandwidth.

Jiang et al. [2] proposed a scheme to transmit scalable video streams in which two layers of each video are transmitted separately. The base layer is transmitted as one stream over a reliable channel while the enhancement layer is transmitted as a different stream over a less reliable channel. Conceptually, this work implements a rate adaptive multiple description coding. However, it describes only one stream and it does not address the resource management problem arising in multi stream transmission scenarios.

Reguant et al. [3] considered splitting a video stream into two streams and transmitting them over two different broadcast networks. The first stream is transmitted over a DVB-H network at all times while the second stream is transmitted over WiMAX network most of the time. If the user wants to use some other non-video application in parallel, the stream going through WiMAX is degraded to accommodate that application. This ensures a minimum video quality at all times while maintaining the flexibility of using other applications. WiMAX applications and do not utilize MBS. In contrast, our approach considers a multimedia-intensive system with extensive use of MBS.

Shi et al. [4] propose a burst scheduling algorithm for energy minimization on per subscriber basis for unicast data. The algorithm arranges the mobile subscribers in ascending order based on the ratio of the current data arrival rate to the required data rate. If the current rate is significantly higher than the required rate, the mobile subscriber can go to sleep for some interval. After computing the sleep intervals for all mobile subscribers the bursts are scheduled in a longest interval first manner. After transmission of each burst, the algorithm checks to ensure that the data requirements of all mobile subscribers are being satisfied. The work in [4] is designed for unicast streaming of video and does not consider the multicast/broadcast service. Also the algorithm requires maintaining state information of all mobile subscribers served by a base station.

Liao and Lee [5] suggest a scheduling scheme where the uni-cast data is clustered around the multicast data bursts. They assumed that the burst length and positions for a particular stream is the same in all super-frames.

The work in [6] is designed for unicast streaming of video and does not consider the multicast/broadcast service. Also the algorithm requires maintaining state information of all mobile subscribers served by a base station. Then they present an enhancement to the longest virtual buffer first scheduling algorithm proposed by Shi et al. [6] by clustering the unicast data around the multicast data bursts. Their work evaluates the energy efficiency in a multi-class traffic scenario, whereas our work is focused on the energy efficiency of the video broadcast service.

III) PROPOSED APPROXIMATION ALGORITHM

A) PROBLEM STATEMENT

Consider a scenario where a number of scalable video streams are available at a WiMAX base station. Each stream is to be broadcast using MBS to a group of mobile subscribers. At the WiMAX base station, the MBS module allocates a fixed-size data area in the download section of each TDD frame. All video streams are to be allocated only within this MBS data area. As per the mobile WiMAX standard, each MBS data area can transmit a different amount of data depending on the modulation scheme chosen, which is in turn selected based on the wireless channel conditions. For broadcast applications, a common modulation scheme is selected for a group of subscribers. Thus, each MBS area transmits a fixed amount of data, in effect, creating a fixed bandwidth broadcast channel. Consider a scheduling window composed of a number of MBS data areas. Data from the video streams are to be allocated to the MBS areas in the scheduling window.

Due to the variable bit rate (VBR) nature of the video streams, the aggregate data rates may exceed the broadcast. Channel capacity. Hence, in each scheduling window, need to decide which layers to send for each stream, assume that the base station has enough buffer space to hold the VBR traffic for one scheduling window. Then, the data rates can be assumed to be constant during a scheduling window, but varying across scheduling windows. Since the bit rates and the receiver buffer states change in each scheduling window, the allocation has to be computed for every scheduling window.

Select the optimal subset of layers from each scalable stream to broadcast over a WiMAX network such that: (1) the total data transmitted in a scheduling window does not exceed the window capacity, (2) the average quality of all selected substreams is maximized, and (3) the subscriber play out buffer does not overflow or underflow.

B) SUBSTREAM SELECTION ALGORITHM

The proposed algorithm is called *Substream Selection Algorithm* and is denoted by SSA. The high level idea of the algorithm is as follows.

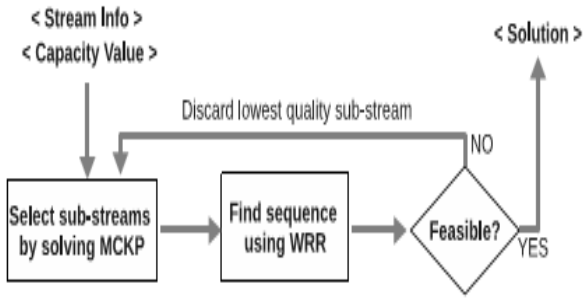

Fig 2: High-level diagram of the Substream Scheduling Algorithm (SSA).

Initially find a set of near optimal substreams thereby given the data capacity of a scheduling window. Simply allocate them to the MBS areas in the frames of the scheduling window. If no feasible allocation is found, then reduce the problem instance by discarding the Substream with Lowest quality among all substreams. Then, solve the optimal Substream selection problem again for the reduced set of substreams. This cycle is repeated until, either a feasible *a* solution is found, or none of the substreams are selected. Once a solution is found the frame allocation is done in a modified weighted round robin manner. The block diagram of this general scheme is shown in Figure 2.

IV. SIMULATION RESULTS

A) WIMAX BASE STATION TRANSMISSION

Implements a point-to-multipoint Wimax multimedia broadcast simulator and evaluated our algorithm in it using actual scalable video traces. For the WiMAX network parameters use the 16-QAM modulation scheme with 3/4 convolution turbo coding and 10MHz channel frequency width. Each TDD frame is 5ms, for a one-second scheduling window i have to allocate data to 200 TDD frames. Also, assume that within each TDD frame, MBS data area of 50kbps is considered. This gives us a broadcast channel bandwidth of 10Mbps. At the receiver side, assume a buffer limit of 512kbps.

For generating the video traffic use 10 raw video files. For each video generate a 10 minute workload by starting from a random initial frame and then repeating the frame sequences. Then encode the videos into H.264/SVC format. Encode each stream into four PSNR scalable layers using the medium grain scalability (MGS) feature and tune the encoding parameters such that the substreams have average bit rate between 100kbps and 2.5Mbps. The first step is to create a node for video transmission, followed by configuration of nodes. Moreover, all nodes for packet transmission are checked for traffic .Some energy losses may occur due to traffic. It can be eliminated by energy efficient Substream allocation algorithm.

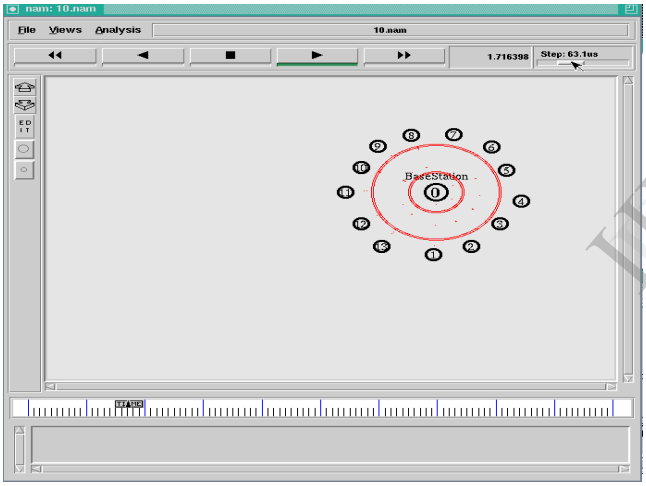

Fig 3: Wimax Base Station Transmission

Each packet is transmitted from base station to mobile subscriber. . The first step is to create a node for video transmission, followed by configuration of nodes. Moreover, all nodes for packet transmission are checked for traffic .Some energy losses may occur due to traffic. As shown in figure 3.

Parameter	Value
Simulator	NS-2.29
Routing protocol	ACO
Data payload	64 bytes/packet
MAC	IEEE 802.16
Antenna	Omni directional antenna
Radio propagation model	Two ray ground
Time of simulation end	10.0sec
Channel type	Wireless channel
Traffic type	CBR

Table 1: simulation parameters

B) THROUGHPUT

Throughput refers to how much data can be transferred from one location to another in a given amount of time.

$$Throughput = \frac{Number\ of\ bytes\ received * 8}{End\ file - start\ file}$$

By using above equation calculate the throughput for the network.

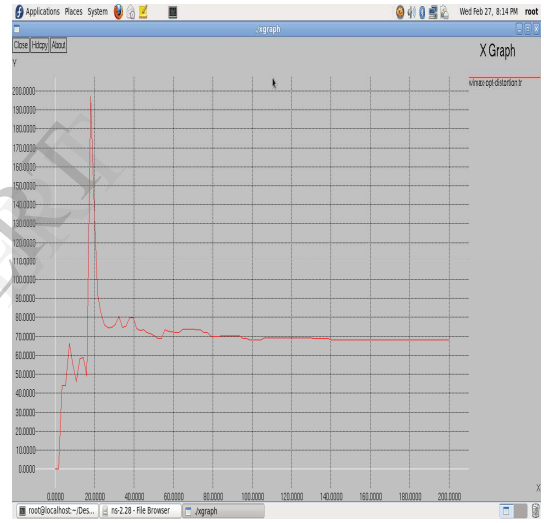

FIG 4: THROUGHPUT

V. CONCLUSION

The framework for multicasting scalable video streams over mobile WiMAX networks was found out. It enables the network operator to transmit higher quality video or more number of video streams at the same capacity.

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