Scalable Video Streaming Server for Mobile WiMAX

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Abstract – The advancements in high-speed networks and video technology have made it technologically and economically feasible to provide video streaming. Among existing wireless standards, WiMAX provides high-data rates and long-range coverage. However, the quality of video streaming over mobile WiMAX networks can drastically be degraded by varying network conditions such as transmission bandwidth. In this study, challenges of video streaming over mobile WiMAX networks are investigated and a video streaming scheme based on the pipelining technique is proposed.

Index Terms — scalable video streaming, pipelining, scalable video coding, mobile WiMAX

I. INTRODUCTION

Video streaming addresses the problem of transmitting video data as a continuous stream [6]. Continuous media such as audio and video content have timing constraints. If during the play-back process data that is required is unavailable, the play-back will pause and this is annoying to the ears and eyes of the viewer [1]. To overcome this problem, bandwidth efficiency and flexibility between the streaming servers and user-devices are important and are a challenge to video streaming systems [6].

Video streaming applications are packet loss tolerant. However, excessive packet loss is not acceptable as it negatively affects the perceived video quality because compressed video stream is sensitive to transmission error [3]. Packet loss is unavoidable in IP networks due to characteristic factors such as network congestion and buffer overflow [4].

Further challenges exist for users of wireless mobile communication such as mobile WiMAX. Due to user mobility, fading, cell-loading and different user locations transmission bandwidth is time varying. Hence, streaming video to multiple users becomes a challenge [3].

Extensive research has been carried out in order to address these problems. A variety of video coding and streaming techniques including scalable video coding (SVC) have been proposed [2]. However, the existing video streaming systems can be improved for better streaming experience.

In this paper, the focus is on how to stream layered video over mobile WiMAX networks. A scheme in which the streaming server uses pipelining technique is proposed. This scheme will provide graceful video quality degradation as available bandwidth decreases.

The rest of the paper is organized as follows. In Section II, the streaming server is discussed. The proposed method is presented in section III. Section IV concludes the paper.

II. SCALABLE STREAMING SERVER

A streaming server plays an important role in offering streaming services. To offer quality services, one of the requirements is that the streaming should process the multimedia data under timing constraints in order to prevent jerkiness in video motion during playback at the clients [4].

In order to achieve scalability and cope with varying network conditions, the streaming server uses two approaches. In the first, there is switching among multiple pre-encoded non-scalable bit-streams. In the second, a single bit-stream that is encoded with scalable video coding is used [1].

In the first approach, multiple bit-streams of the same video with different bit-rates are stored in a server. The user device selects the bit-stream according to its capability and available network bandwidth. The major setback of this approach is that in wireless networks such as Mobile WiMAX, users transmit at different bandwidth since they are located at different positions hence it becomes difficult to support all the users with a single non-scalable bit-stream [3].

In the second approach, the streaming server uses a video stream encoded with SVC. Scalable video coding is a technique that enables a decoder to decode only part of the coded bit-stream [2]. In layered video coding, the bit-stream is arranged in sub layers, base and one or more enhancement layers.

The main objective of SVC is to encode the bit-stream such that video of lower qualities; spatial resolutions, and/or temporal resolutions, can be generated by truncating the scalable video stream [6]. The truncating helps in meeting the bandwidth conditions, terminal capability and quality of service requirements in video streaming applications [2].

Figure 2 below depicts an end-to-end video transmission over the mobile WiMAX network. The streaming server and the mobile WiMAX IP network are interconnected by the IP-Based backhaul network and the last mile transmission is achieved through mobile WiMAX consisting of the base stations and the mobile station. The server adjusts the transmission rate using the bandwidth information from the Base Transceiver Station (BTS)

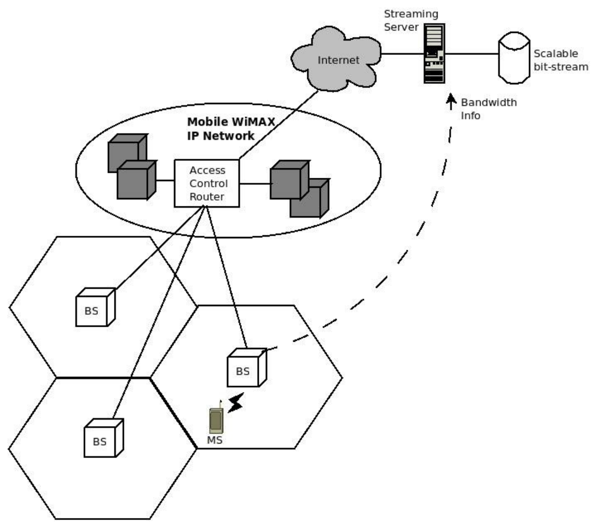

Figure 2: Mobile WiMAX network model [3]

III. PIPELINING DESIGN TECHNIQUE

In computer architecture, there are two basic techniques which are used to increase the instruction execution rate of a processor. In one, the clock rate is increased, thus decreasing instruction execution time. In the other, the number of instructions that can be executed simultaneously is increased. Pipelining uses the latter technique [7].

Pipelining refers to the technique in which a given instruction is broken down into a number of sub-instructions that need to be performed in sequence. Each sub instruction is performed by a given functional unit. The functional units are serially connected and all operate simultaneously [7]. The technique takes advantage of parallelism that exists among actions required to execute an instruction. Hence, the technique improves the performance compared to the traditional sequential execution of tasks [7].

The diagram below shows an illustration of the basic difference between execution of an instruction using pipelining and sequential execution of tasks.

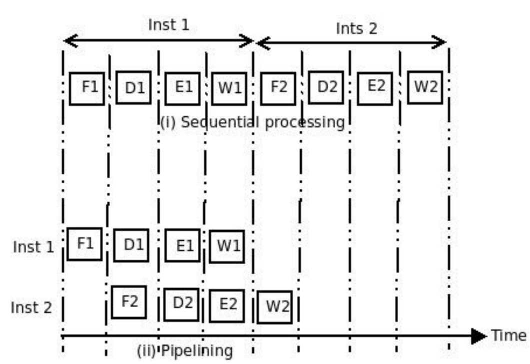

Figure 1: Pipelining vs Sequential Processing [7]

In the above diagram, the instruction is divided into four sub-tasks (fetching F, decoding D, execution E and writing the results W). The total time required to process two instructions (Inst 1 and Inst 2) is five time units if four-stage pipelining is used and is eight time units in sequential processing. Pipelining provides savings in the execution time however, there are some factors (outside the scope of this paper) that need to be considered in order achieve the best results when using this technique [7].

This study is devoted to incorporation of the pipelining technique in video streaming.

IV. STREAM PIPELINING

The adaptive video streaming scheme that is based on the pipelining technique is proposed. The study is aimed at taking the advantages of the pipelining technique. The streaming server will schedule scalable coded bit-stream layers in a pipelining fashion. To achieve bandwidth adaptation, the streaming server will use bandwidth feedback from the WiMAX BTS to make a decision on how to schedule packets from multiple coded bit-stream layers. It is believed that this process will result in an efficient usage of network bandwidth and will be reliable while also providing optimum video quality.

In this study, the proposed scheme will be simulated using OPNET simulation tools. Video trace files will be used to emulate scalable video traffic. Upon completion of the study, an analysis will be made that will determine whether the pipelining technique can successfully be adopted for multimedia streaming.

V. CONCLUSION

Mobile WiMAX promises to be one of the access technologies for the next generation networks because of its mobility, coverage and high data-rates. It is a suitable technology for transmission of continuous media such as video. In this study a new video streaming scheme for mobile WiMAX has been proposed and this study will help in determining whether this pipelining technique is appropriate for video streaming.

VI. REFERENCES

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