Adaptive Multimedia System Architecture for Improving QoS in Wireless Networks

Amit Mahajan, Padmavathi Mundur, and Anupam Joshi

Department of Computer Science and Electrical Engineering
University of Maryland, Baltimore County, Baltimore, MD 21250, USA
{

user-level QoS parameters such as resolution and frame-rate, to keep the interface simple for the user. We propose *perceptual-value based analysis* to obtain the value of data received at mobile client.

The paper is organized as follows. Related work in adaptive mobile architectures is presented in Section 2. In Section 3 we describe the architecture of the proposed adaptive system. We present the simulation environment and results in Section 4. The conclusion of the paper is given in Section 5.

2 Related Work

Several projects address the issue of bandwidth variation in wireless networks by providing an adaptive architecture. The MobiWeb project [1], is based on the proxy model in which the proxy layer at the base station (BS) intercepts TCP or UDP streams and applies the appropriate filter. Bandwidth reservation and priority scheme are used to provide continuous smooth audio/video stream. The Odyssey system [2] uses similar proxy based approach to provide smooth audio/video streaming. The system includes client components to request lower fidelity of data. Proxy based system in [3] utilizes MPEG standard features to achieve smoother video delivery. The system uses Resource Reservation Protocol (RSVP) to reserve bandwidth for high priority real-time packets. The PRAYER [4] framework is based on QoS-unaware servers and QoS-aware clients. A concept similar to home network in Mobile IP is used to achieve QoS by dynamic adaptation. Most of the proposed solutions follow proxy based approach, and also rely on the underlying network to provide services like bandwidth reservation and priority routing. Though the approach is transparent to the applications, lack of support from any intermediate network or node can render the architecture useless. For example, in case priority routing is not supported by a router on the transmission path the whole scheme will fail. Moreover, proxy based solutions have scalability problems [5], especially in case of computation intensive proxy functionality like transcoding. Most systems do not use video standard (MPEG and H.26x) features and user preference to maximize the perceptual quality of video. We propose an end-system based architecture which does not depend on either the proxies or the underlying network for additional services.

3 Adaptive Multimedia System Architecture

The block diagram of our end-system based adaptive system is shown in Figure 1. We first list the factors dictating our design and then describe each of the system component.

End-System Based Design The end-system based architecture consists of modules only at the two ends of the networks, namely the mobile client and the multimedia server. Using the mechanism explained next, the client components have the best knowledge of bandwidth available and user preferences. Client's current knowledge of bandwidth is sent to the server. The server will periodically send some control packet at higher bandwidth than reported by the client. Depending on the rate at which the client is able to receive data, any decrease or increase in bandwidth will be detected

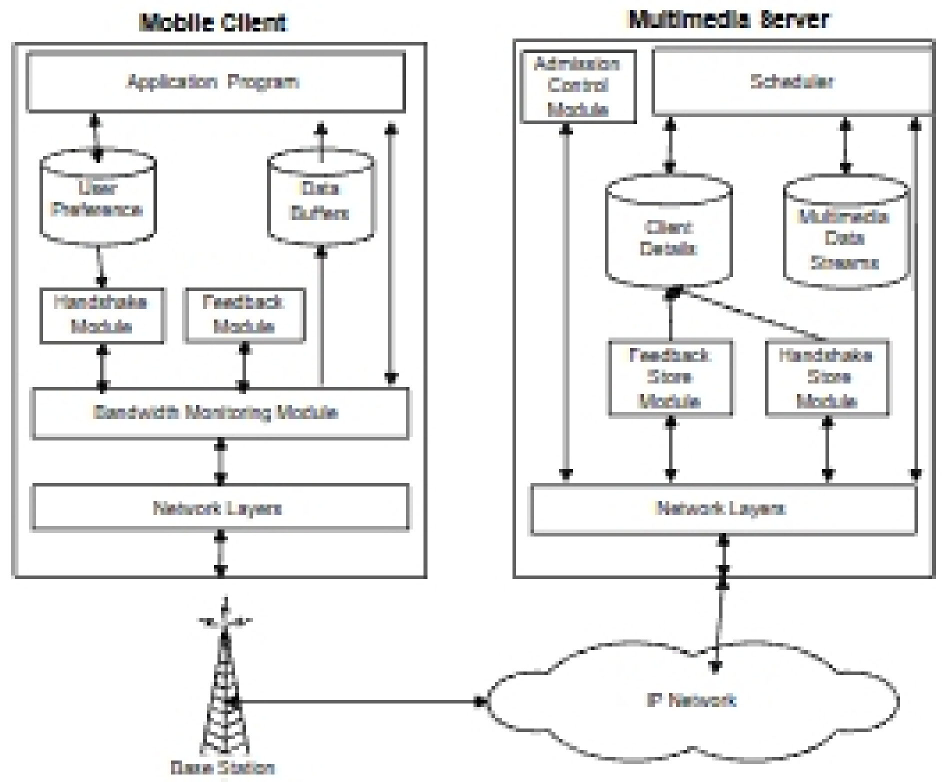

Fig. 1: Adaptive Multimedia System Architecture

by the client.The server components have the best knowledge of the levels of data fidelity stored in the database. Hence a system with participation of both client and server components should yield better results. The two end-systems (client and server) can be relatively easily modified and updated. With the current size of the Internet, it is a quantum task to effect any change in the network. Based on this intuition we have designed the system which does not have any dependency on the underlying network.

Video Standard Features The MPEG and H.26x video standards [6] offer a generalized scalable framework supporting temporal, spatial, and SNR scalability. SNR scalability allows video streams to be divided into two types of layers - base layer and enhancement layer. Multiple enhancement layers can be used to improve the quality of multimedia playback. This division offers a means of gracefully degrading the quality when the bandwidth and other resources are limited and change frequently (Figure 2). With the declining cost of storage, the multimedia server can easily store multiple streams of data encoded at different fidelity levels.

Perceptual-Value Based Analysis In our perceptual-value based analysis we determine the value of data based on user perception and not on quantity of data received. For example, viewing the slides is more important in the case of presentation, and hearing the speech is more important in the case of news. The properties of streaming data received: audio quality, resolution, color, and frame-rate, are compared with the user preferences to compute the perceptual-value. Larger perceptual-values are assigned for data that match user expectations. *Expected Data (ED)* is multimedia data (audio, base layer, and enhancement layer) user expects based on user-preference provided to the system. *Received Data (RD)* is multimedia data actually delivered to the client. *Received-Expected Match Ratio (REMR)* is defined as ratio of bytes matching the user-preference ($B_{RD \cap ED}$) and bytes of RD (B_{RD}), and is used to determine how closely does the RD match the user-preference.

$$REMR(\%) = \frac{B_{RD \cap ED}}{B_{RD}} * 100$$