

MPEG Transmission Enabled in High Speed Downlink Packet Access



Engineering

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ABSTRACT

Universal Mobile Telecommunications system (UMTS) is a third generation mobile communication system that supports variety of traffic such as voice only, mixed voice and data, streaming video, web requests email etc. Downlink data rates up further increased by the enhanced UMTS known as High Speed Downlink packet Access (HSDPA). Real time streaming video is becoming very popular because of the wide variety of applications it can support, Video applications produce large amount of data as a result they are transmitted in compressed format. This work investigates the performance of streaming MPEG-4 video over the HSDPA channels with varying channel conditions. In particular the performance of HS-DSCH channel for real time video transmission is examined. Simulation results show that Radio Link Protocol (RLC) operating in acknowledges (AM) mode outperforms the unacknowledged mode (UM). UM mode provides timely delivery.

INTRODUCTION

High Speed Downlink Packet Access (HSDPA) supports up to 14Mbps in idle radio conditions. Improvements can be achieved due to the introduction of adaptive modulation and coding, Hybrid ARQ, reduced TTI etc. The video traffic in the uncompressed format needs a huge bandwidth compression techniques like MPEG-4, H.264 are usually employed to achieve transmission efficiency. MPEG-4 is a video-coding standard adopted by most of the mobile communication systems including the UMTS.

The authors examined the impact of the RLC mode of operation and the RLC Block size on the MPEG transmission in UMTS dedicated channels. An integrated tool set is used to evaluate the performance of the UMTS for the MPEG-4 traffic. However, all these studies were done on the UMTS dedicated channels namely the DCH. This research concentrates with the downlink enhancements to the UMTS a new transport channel HS-DSCH is introduced. The MPEG performance was studied and simulated in the Enhanced UMTS (HSDPA) for the varying channel conditions.

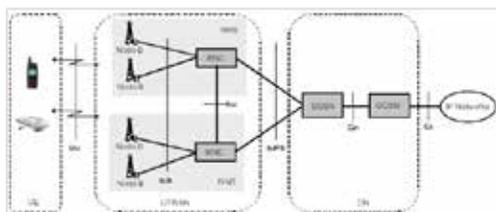


Figure1: UMTS System Architecture
Source: 3gpp.org

Figure1 shows a simplified architecture of UMTS for packet-switched operation consists of one or several User Equipments (UEs), the UMTS Terrestrial Radio Access Network (UTRAN) and the core network. The UTRAN is composed of Node Bs connected to a Radio Network Controller (RNC). The core network, which is the backbone of UMTS, comprises the Serving GPRS Support Node (SGSN) and the Gateway GPRS Support Node (GGSN). The SGSNs route packets to and from UTRAN, while GGSNs interface with external IP networks. UE, which is a mobile station, is connected to Node B over the UMTS radio interface.

UMTS Protocols HSDPA

The HSDPA enhancements rely on a rapid adaptation of transmission parameters to the instantaneous channel conditions. The assignment of radio resources (i.e. scheduling) and HARQ (Hybrid ARQ) functionalities are implemented in a new MAC (Medium Access Control) entity called MAC-hs (MAC-high speed, [3G25321]). The new MAC-hs entity is located in Node B. Re-transmissions can be controlled directly by the Node B, leading to faster retransmission and thus shorter delay with packet data operation when retransmissions are needed.

The MAC layer protocol in the architecture of HSDPA shown in Figure.2, which shows the different protocol layers for the HS-DSCH. The key functionality of the new Node B MAC functionality (MAC-hs) is to handle the Automatic Repeat Request (ARQ) functionality and scheduling as well as priority handling.

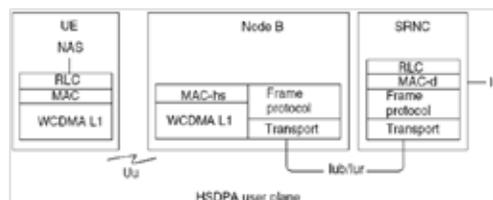


Figure 2: HSDPA Protocols Architecture

SIMULATION MODEL

In order to analyze the performance of MPEG-4 video streaming over enhanced UMTS network simulations were carried out using Eurane simulation tool which is an extension to ns-2. In the simulation model, a UE plays the role of a streaming client and a fixed host is the streaming server located in the Internet. Video streaming uses a family of transport protocols, namely, User Datagram Protocol (UDP); UDP is employed because it provides timely delivery of packets. However, UDP does not guarantee packet delivery. RTP runs on top of UDP, which packetizes and provides in-order delivery of video frames. The video client is to inform video server concerning the received video quality, uses RTCP. In the simulation, it is assumed no interaction between the video client and server. Hence, RTCP and RTP are not modeled, but those functions that are needed such packetization, packet sequence numbering and in-order delivery are added to the UDP model of ns-2.

Table- 1: Protocol Simulation Parameters

APPLICATION	MPEG-4 Specifications
UDP	MAXIMUM SEGMENT SIZE (BYTES): 1000 UDP HEADER SIZE (BYTES): 08
IP	IP HEADER SIZE (BYTES): 20 IP packet Loss Rate in the internet: 0%
PDCCP	IP HEADER COMPRESSION
RLC	RLC MODE WINDOW SIZE (BLOCKS): AM, 4096 Payload Size (Bytes): AM 4080, UM 4080
MAC	MAC HEADER BITS: ZERO MAC MULTIPLEXING: NOT REQUIRED
PHY	PHYSICAL CHANNEL TYPE: HS-DSCH TTI: 2ms BLER: Depends on the speed of the environment Error model: AWGN Channel type: 3GPP Vehicular A

Two video clips used for the evaluation and their characteristics are depicted the Figure 6 & Figure 7, the frame size of both video clips is $N = 176 * M = 144$ pixels, which is also known as Quarter Common Intermediate Format. The QCIF format is chosen as it best suites the PDA or wireless devices.



Figure6: Video streaming display

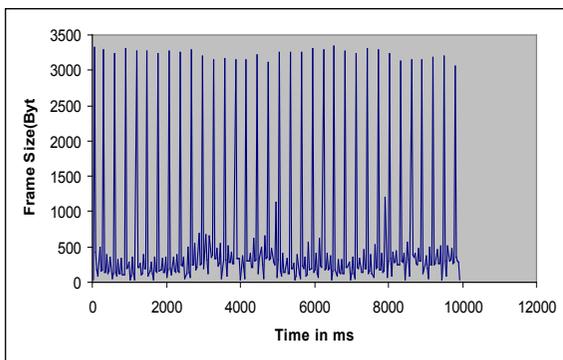


Figure 7: Characteristics of News
SIMULATION RESULTS

Effect of RLC mode

Figure.8 plots the average decoded PSNR for the two clips at the client as a function of the speed. 3GPP Vehicular an environment is chosen. Under ideal radio channel both the RLC modes obtained the same average PSNR, which are 34.58 dB and 34.58 dB for “News”. BLER is proportional to the speed for example a pedestrian will experience a BLER of 10 %, where as a user moving at high velocity (120 Kmph) will experience a BLER of 30 %. The relation to the type of channel (Pedestrian, vehicular etc) and the BLER is however not in the scope of this work.

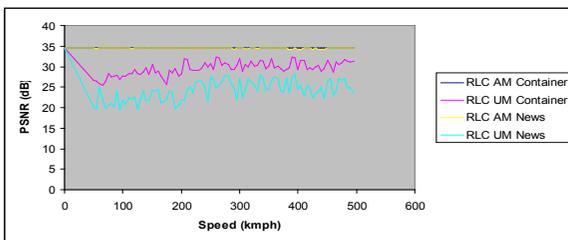


Figure 8: Average PSNR as a function of Speed

As the speed increases the, average PSNR for the AM is superior to UM for both the clips. This could be attributed to the RLC UM mode of operation, which doesn't recover the erroneous RLC blocks. Instead the erroneous RLC blocks are discarded including the contents of the entire IP packets. As a result the decoder at the streaming client has to decode video frames with missing data parts. The video quality is very sensitive to missing data. On the other hand the video quality of the AM is almost constant at 35 dB (approximately) for both the clips. This might be due to the fact that HS-DSCH is a best effort channel which maintains the BLER constant and hence the constant PSNR.

Effect of RLC block sizes

The RLC Block size was doubled from 40 bytes to 80 bytes and the same set of simulation was repeated for the two video clips “only News” shown in Figure.10 the average PSNR for the two video clips news as a function of speed. The plot for the UM mode shows that there is a slight performance gain with the block size of 80 bytes when compared to that with the 40 bytes. This gain can be attributed to the larger RLC PDU size, which means that the number of RLC PDUs required to transmit a particular frame are less when compared with the smaller RLC Block size.

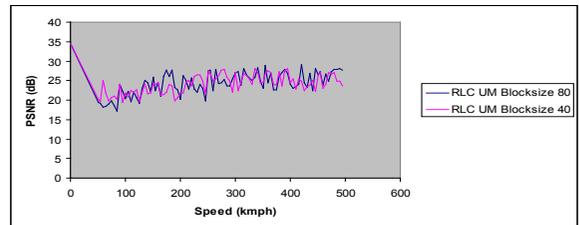


Figure 10: Effect of RLC Block Size “News”

CONCLUSION

Performance of streaming MPEG-4 video over Enhanced UMTS downlink channels with varying user speed was evaluated. Simulation results show that the video quality achieved using UMTS RLC acknowledged mode is superior to unacknowledged mode. It is observed that a larger RLC block size can reduce end-to-end video frame delay which in turn gives performance gain. The distance is used in the propagation loss model, along with a local shadow-fading element. This poses a limitation to the results extending the simulator to support the complete mobility of the UEs.

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