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QoP/QoS Control for Multiresolution Video Applications over ATM Networks

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Abstract - We present a mechanism of QoP/QoS control in multiresolution MPEG scalable coding structure. The video quality of presentation (QoP) can simply be mapped to the network requirements and the end-to-end quality of service (QoS) is achieved.

1. Introduction

With the development of heterogeneous networks, multiresolution video coding is necessary in various applications. It is important to provide a flexible and scalable framework for multiresolution video services, where parameters of video resolution, quality, and network quality-of-service (QoS) are determined based on the individual requirements of the user equipment and the network resources [1] [2]. Asynchronous transfer mode (ATM) communication is suitable for video delivery because it provides QoS guarantees to ensure the service quality. Thus the network control process can reserve adequate resources in the network to support video delivery based on the QoS parameters. In general, these parameters include the peak rate, the mean rate, the mean burst length, the delay, the jitter, and the cell loss ratio. A negotiation process may be involved in the determination of QoS parameters for efficient utilization of network resources. As long as the video application requests proper QoS parameters, the network should be able to deliver the video signals with guaranteed quality.

The selection of suitable QoS parameters is, however, not trivial for service users. An ordinary user may not have adequate knowledge of ATM networks. Instead, a video service user may only care the video quality of presentation (QoP) which includes the size of the pictures, i.e., the resolution, the fidelity, i.e., the PSNR, and so on. Because QoP directly defines the quality of the user interface to video viewers, it is much easier for users to define the QoP parameters than the QoS parameters. It is also important to investigate the relationship between the QoP and QoS.

2. QoP/QoS control scheme

In this paper, we present a QoP/QoS control mechanism which provides a mapping between QoP and QoS, as well as a negotiation process to discover the best QoS parameters for the network. For multiresolution video systems, we focus on SNR scalable schemes with various video formats, such as HDTV, CCIR, CIF, and QCIF. The input video signal is compressed into a number of discrete layers, arranged in a hierarchy that provides different quality for delivery across multiple network connections. In this QoP/QoS control mechanism, the multicast source produces video streams where each level of streams is transmitted on a different network connection with a different set of QoP requirements, as shown in Figure 1. With this mechanism, a user is able to receive the best quality signal that the network can deliver.

An important advantage of a multiresolution video service is that it provides a conformable QoS requirements and flexible end-to-end QoS guarantees [3] [4]. Figure 2 shows an end-to-end QoP/QoS control model for scalable MPEG video applications on ATM networks. A user specifies a set of QoP parameters based on the terminal capability. The QoP parameters are then mapped to the QoS parameters with the QoP/QoS table which is designed based on the statistics of video sequences. The scheduler checks the QoS parameters to determine whether the tasks are schedulable. If this schedulability test is passed, the admission control process assigns connections to the tasks. On the other hand, a task which fails in the schedulability test will be rejected. Then the replacement process generates a new set of QoP/QoS parameters with lower requirements for end-to-end re-negotiation.

3. Experiment results

We design the QoP/QoS table based on the statistics of several video sequences over a campus ATM testbed. In our experiments, the QoP parameters include the frame resolution and the frame quality. The QoS parameters include the mean bandwidth, the peak bandwidth, and the mean burst length based on FORE ATM application programming interface (API) [5] [6] which we use in our ATM testbed. The experimental video sequences include 'Flower', 'Table Tennis', 'Football', and 'MIT' with CCIR format (30 fps, 704×480 pels, and 4:2:0 chrominance format). These sequences represent a variety of video classes with different motion degrees and texture complexities. CIF and QCIF sequences (30 fps, 352×240 pels and 176×120 pels, respectively) are converted from the CCIR format by downsampling. Table 1 gives a set of

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mapping relations between video presentation quality, represented by QoP parameters, and network traffic specification, represented by QoS parameters. The frame quality is represented by the PSNR with 3 dB difference between two adjacent levels. The mean bandwidth is the average bitrate of video sequences, while the peak bandwidth is the average bitrate of I-frames. The mean burst length is defined as the frame length at the peak rate. All three parameters have the suggested minimum values and the target values. The minimum value is computed by the average of all test video sequences while the target value is set to the maximum value in all test sequences. Thus, the QoS with minimum values should provide satisfactory delivery for typical video sequences while the target values should ensure satisfactory quality in all cases. In our experiments, the target values are very close to the minimum values in most cases. With this QoP/QoS table, the desired video quality can simply be mapped to the network requirements and the end-to-end quality of the video service is achieved.

4. Conclusion

We have presented a QoP/QoS control mechanism and an approach to the establishment of QoP/QoS tables. Any user can easily select the connection requirements with QoP parameters based on the user terminal capability. The mapping table presented in this paper is designed for general video sequences. The same procedure can also be applied to a specific video sequence in the encoding phase. As a result, the dedicated QoP/QoS mapping should give more efficient network utilization. The dynamic QoP/QoS control mechanism, incorporated with the dynamic bandwidth allocation provided by the network, may improve the overall network utilization even further.

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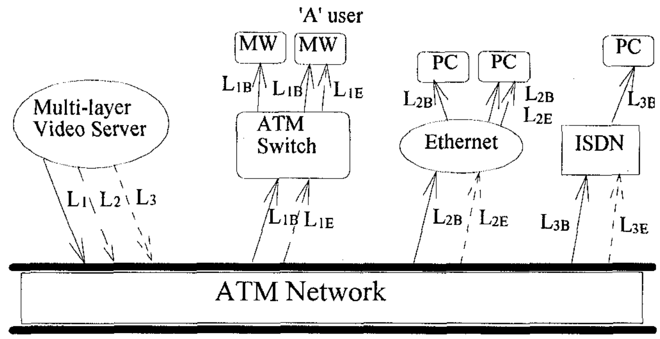

MW : Multimedia Workstation

Figure 1 Multi-layer transmission

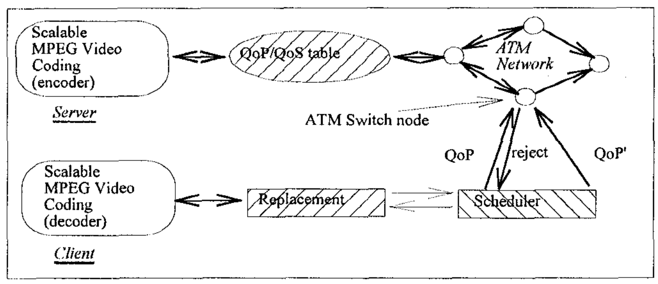

Figure 2 An end-to-end QoP/QoS control model for scalable MPEG video on ATM networks

QoP Parameters		QoS Parameters					
Frame Resolu.	Frame Quality	MMB (Kbps)	TMB (Kbps)	MPB (Kbps)	TPB (Kbps)	MMBL (Kbits)	TMBL (Kbits)
QCIF	low	240	240	366	418	15	20
QCIF	normal	360	360	502	563	23	29
QCIF	high	480	504	642	703	30	37
CIF	low	984	1008	1391	1588	58	78
CIF	normal	1488	1512	1935	2138	85	112
CIF	high	1992	2016	2494	2578	111	146
CCIR	low	3984	4032	5603	6321	218	296
CCIR	normal	5976	6000	7901	8564	322	405
CCIR	high	7992	8048	10320	10824	425	546

Table 1 QoP/QoS mapping table

MMB : Minimum Mean Bandwidth
TMB : Target Mean Bandwidth
MPB : Minimum Peak Bandwidth
TPB : Target Peak Bandwidth
MMBL : Minimum Mean Burst Length
TMBL : Target Mean Burst Length