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Title: **A Survey on CBR versus VBR**

Source: DBP-Telekom

Purpose: For discussion

Introduction

This paper gives a survey of all the (known) potentialities that are available to perform videocoding on ATM and comprises their pro's and con's. Finally it gives some important action points to work on, in order to get more clarity.

The different potentialities of coding

In the diagram at the end of the document everything important is collected. Besides coding with constant bitrates it contains four approaches to VBR coding, from which the ones labeled with 2-4 are mainly different in the methods of policing and network management.

method 2:

For the network it is most tempting to perform only peakrate UPC (usage parameter control), because this could be done without much problems and makes a simple CAC (connection admission control) feasible. Unfortunately, to guarantee a certain QOS, the network has to allocate the peak bandwidth for every VBR service and charge accordingly in this case. Without any further actions a VBR codec would then transmit as CBR source at peakrate to optimize it's quality within the rented bandwidth.

A modified network strategy may solve this problem. A "real VBR" with very simple UPC could be made attractive by letting the charge be based on counting cells (or similar methods). This would result in a "leftover bandwidth" that may be used by non time dependent services like those for data transfer. The great advantage of this idea is, that it combines an almost unconstraind VBR with a simple UPC mechanism. On the other hand it creates the need for huge buffers in which the non timedependent cells have to wait for sufficient leftover capacity. A special protocol has to be introduced, that requests the non timedependent services to refill those buffers. Further this method might be a bad deal for the network, when no data cells are available for longer periods of time, and it is not yet clear if the QOS can be guaranteed for the non

timedependent services (parameters that deal with the 'maximum transmission time' might be violated) It has to be studied whether this idea works in practical operation or not, but if it does it's a very good solution.

method 3:

The "conventional" policed VBR algorithms suffer from the fundamental drawback that only short peaks are coded without quality degradation. Long peaks or general fluctuations of the mean bitrate are not covered by these algorithms. This statement is more or less valid for all UPC algorithms that control more than only the peakrate. Always some kind of 'effective datarate' below the peakrate has to be met (with differing definitions for different UPC's). Whether this 'effective datarate' is sufficient or not is only dependent on the average activity of the scene. Similar to CBR coding, the *average* picture quality does consequently always correspond to the *average* (or effective) datarate, only the time constraints are more relaxed. In CBR coding the average bitrate has to be met within a period of time, that is dependent on the buffer length; in the VBR case this time might be much longer (for instance 10-30 sec.) but this does not change the situation in principle. Moreover, compared to openloop VBR the multiplex gain will drop considerably when preventive UPC is utilized.

method 4:

A special kind of network management may partly overcome the problems of method 3. With the so called "Fast Reservation Protocol" it may be possible to renegotiate unfavourable UPC-parameters during the connection. In this way longer peaks or rate fluctuations may be compensated by new parameters. It's not quite clear until now how long such a renegotiation would take and how often it could happen. Further it has to be studied if this procedure is practicable without intermediate decay of picture quality. The decay in multiplexing gain will likely be not as big as in method 3. It has to be studied whether this idea works in practical operation or not.

The results from methods 3 and 4 are not independent of the (preventive) UPC that is performed in the codec. A policing of the mean (among other parameters) is very problematic for the net. It almost seems to be impossible to make a sufficiently long measurement intervall compatible with an accurate and fast recognition of parameter violations. Further, signals that are in line with the negotiation of peak and mean may take a very unfavourable progress (on/off sources, that transmit with peak rate for the maximum permitted period and are than silent until the mean is reached again).

For this reason more sophisticated UPC mechanisms have to be investigated, that are based on parameters that the network is easily able to measure, and that force the sources to a suitable shape.

Anyway, UPC is not a topic video coding should by-pass. UPC will always be present in the codecs as *preventive UPC*, and different methods of UPC could be due to very distinct coding results. To make investigations on VBR coding schemes comparable, a **preventive UPC reference model** is needed.

method 5:

The well known 2-layer coding schemes have some advantages. The UPC is not that critical for these algorithms. When due to a general rate fluctuation the quality of the base-layer is decaying too much, a combination with method 4 should be easy, and most important not critical in timing. Due to the fact that (almost) all high priority cells in the network are constant rate cells, it is much easier for the network to perform the CAC and guarantee a certain CLR (cell loss ratio). An other profit from 2-layer coding could be the theoretically higher network utilisation. Unfortunately in many cases it is compensated or even reversed by the smaller efficienty of the 2-layer coding schemes. Consequently one of the most important action points in the 2-layer area should be the optimization of efficiency. Some publications on that field already exist. They should be collected in a **2-layer reference model!**

As far as we understood certain papers, the network utilisation of 1-layer VBR was compared with 2-layer VBR by setting the CBR part of the 2-layer scheme to zero for a simulation of a 1-layer scheme. This does not seem to be correct! If 1-layer VBR is admitted in an ATM network, only a maximum of about 85% of the full capacity should be exploited to avoid network overflow. Couldn't the remaining 15% still be used by low priority cells? In this case the utilisation of 2-layer VBR would be significantly higher!

Independently of the particular method of VBR-coding attention has to be payed to a common question. From several investigations we know, that at high datarates even uncontrolled VBR does not seem to have much advantage compared to CBR. Further, typical TV (film) sequences with lots of cuts, zooms and pans do not profit very much from VBR. A real gain may be possible in video conference or - telefone scenes. So, an upper bound and/or a restriction to certain kinds of video services might be appropriate for VBR coding.

potentialities | comments | action points