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Experts Group on ATM Video Coding

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Title: Video Clock Recovery
Source: Belgium, France, Germany, Italy, Norway, The Netherlands, Sweden, UK
Purpose: Proposal

Video clock recovery is agreed as essential for higher quality applications. Except in the case of single user database access where the rate of delivery of coded bits can be slaved to the decoder's video clock, absence of video clock recovery forces occasional picture dropping or repetition.

Several mechanisms for video clock recovery are known.

1. Adjustment of decoder video clock to achieve an average receive buffer fullness of one half. Advantage of this method is that no extra information is required from the encoder. There are two disadvantages. The decoder delay is variable which may be important if other video or audio is to be synchronised to it. The decoder buffer needs to be twice the size (annex 1) unless special conditions apply (annex 2). This has delay implications.

2. Encoder buffer fill information is made available to the decoder. Decoder video clock is adjusted so that decoder buffer fill is complement of encoder's. This information is present in MPEG picture headers (and was in early versions of CCITT n*384 kbit/s flexible hardware specification).

3. Encoder video clock frequency is signalled to the decoder. Examples are the locking of the video clock to the transfer (eg transmission line) clock and, where such locking is not possible, the encoding of the difference frequency between suitable multiples/fractions of these two clocks (as in H.120). A disadvantage is that both the video clock and transfer clock need to be within narrow margins to enable the difference to be signalled sufficiently accurately in a reasonably small number of bits. Therefore the method is not generic in respect to video clock and transfer clock frequencies. Even more serious is that the method will not work when the transfer clock is not identical at coder and decoder. This can arise in asynchronous networks.

When several coded bit sreams are multiplexed for transmission which clock should be used for reference - the clock of the comlete multiplex or the rate of the individual stream. With the MPEG multiplex the latter may not be readily available as a continuous clock. Use of the former means that rate of total multiplex must be available when encoding difference frequency. Problems in cases such as subsequently adding foreign language audio channel.

4. Time stamps. This is essentially an extension of 3 above. A third clock is established at the encoder. A count of this third clock is sampled at intervals (not necessarily periodic) and its value notified to the decoder to lock a local clock. Timing events at the coder are then sampled by this third clock. The values are used by the decoder to synchronise its events relative to the version of the third clock at the decoder.

All the methods which recover only the video clock frequency do not by themselves establish optimum end to end delays. Unless the 'proper' sit of data in the decoder buffer is known, the buffer must be (significantly) larger than the permitted encoder buffer excursion.

It should be noted that the problem of video clock recovery is not unique to ATM networks. A solution is required for all transmission (and storage) environments. Therefore any bit fields for this purpose should not be placed in the ATM specific layers.

Table of characteristics

	Method 1 Half buffer aim	Method 2 Buffer fill info	Method 3 Transfer clk ref	Method 4 Time stamps
Delay	Variable, longer	Fixed,known, shortest possible	Fixed, unknown but bounded	Fixed, known, shortest possible
Coder complexity	None	Small	Medium	Largest
Decoder complexity	Smallest	Small	Medium	Largest
Generic against video, transfer clk rates	Yes	Yes	No	Yes
OK with Tx, Rx transfer clks not same	Yes	Yes (slightly bigger decoder buffer needed)	No	Yes? (increased jitter?)
Supports VBR coding	Yes but requires a decoder buffer	Yes? (needs small buffers?)	Yes	Yes?
Supports stored compressed	Yes	Yes	Yes, but some limitations?	Yes

<u>CONCLUSION</u>

From the above discussion and table it appears that the inclusion in the bit stream of data for methods 2 and 4, both of which are provided in MPEG-1, offer the best route. This leaves the decoder designer with methods 1, 2 and 4 to choose from. Method 3 does not appear to be a good approach. However further study is required to verify and extend the scope of the analysis presented here.

<u>Annex 1</u> Reason for twice buffer size.

Consider an encoder which has been sitting with an almost empty or almost full buffer for some time and then abruptly changes to the other extreme. The will have reached half its buffer fill and then need to accomodate the total of the encoder's buffer. Thus the decoder buffer needs to be twice that of the encoder. If video clock were recovered perfectly (AND the the decoder buffer could be the same size as the encoder's.

<u>Annex 2</u> Special case when twice buffer size avoided.

If the encoder's rate control strategy is known (ie defined) then the decoder can calculate what the encoder's buffer fill is. This is then equivalent to method 2.