Telecommunication Standardization Sector
Study Group 15
Experts Group for ATM Video Coding
(Rapporteur's Group on Part of Q.2/15)

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TITLE: Low delay IPB mode transmission using VBR
PURPOSE: Information

1. Introduction

The merit of VBR transmission has long been supposed to consist of the following two factors: 1) constant picture quality, 2) low delay. However, it has been clarified that it is difficult to realize constant picture quality under average bit rate policing whichever UPC method is used[1].

On the other hand, there seems to be remaining possibility to achieve low delay. Currently, coding parameter is limited to M=1 in the case of CBR transmission because of the low delay limitation of 150 msec. In the case of VBR transmission case, buffer delay can be smaller and it may be possible to make use of the merit of adopting coding structures and parameters, the use of which is prohibited in the case of CBR transmission.

2. Calculation of delay

The delay for CBR transmission is calculated as a sum of the buffer delay and the basic delay, which consists of the delay caused by field merging and the delay caused by frame (or field) re-ordering. Of these two delays, the buffer delay is thought to be reduced by using VBR transmission.

Table 1 shows the relationship between coding structures, parameters and the basic delay. If buffer delay can be decreased to 0, even the Frame structure M=3 case satisfies the limitation of low delay for 60 Hz pictures.

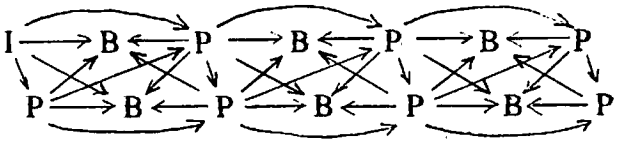
Table 1 Basic delay [3]

Frame Structure	
M=3	8 field period
M=2	6 field period
M=1	2 field period
Field Structure	
M=3	6 field period
M=2	4 field period
M=1	0 field period

Note

Concerning this point, TM5 describes that only M=1 is allowed for the low delay mode[4]. However, the Fi str. M=2 case, which is supposed to be the following structure, still seem to satisfy the limitation of 150 msec for total delay, doesn't it? We are not sure why this mode was prohibited at the low delay mode.

Fi str. M=2



3. Transmission using VBR

Transmitting a fluctuating stream as a stream coded by IPB coding structure using VBR channel means to prepare a periodically fluctuating channel which can be dealt with as a CBR channel in a short period. A stream which fits this kind of channel can be produced as follows, for example.

(1) Code picture in IPB mode according to the fixed target bit rate predetermined for each picture type.
(2) Compensate for the excess bit rate due to the incompleteness of rate control by allowing a delay if the delay is lower than the permissible limit. This means that decoding always starts after the permissible delay corresponding to the permissible limit of the rate control error.
(3) When the rate control error becomes larger than the permissible limit, for example for a scene change case, solve the problem by skipping pictures, or detecting the large error by some means and degrade the picture quality rapidly.

This transmission method satisfies the constraint from the sliding window as a UPC because the periodical amount of code generation is guaranteed, especially in the case that the GOP size is a divisor of the window size. It also satisfies the constraint from the leaky bucket if the bucket size is sufficiently large to accept I pictures which have the maximum instantaneous bit rate.

4. Simulation of buffer delay

The transmission method shown above keeps the transmission amount limit at each timing by absorbing the error of rate control in the temporal axis. If the delay caused by this is larger than the buffer delay for CBR transmission, this method is inapplicable.

A simulation was carried out to evaluate this delay. Figure 2 shows the relationship between the fixed period of fluctuation (window size) and the maximum buffer delay when the stream coded by TM2, M=2, N=15, Fr. str. at 4 Mbps is transmitted by this method. This figure shows that the delay becomes about 30 msec when there is a good relationship between the window size and the GOP size. In this case, Fr str. M=2 and Fi str. M=3 are also within the range of low delay mode. The problem here seems to be the limitation for the GOP size (or for the window size from the network point of view) to ensure good performance.

Another simulation was carried out to investigate decreasing characteristics of the delay by declaring more bit rate than the actual bit rate. Figure 3 shows the result. This result shows, for example, in the case that 4.5 Mbps instead of actual bit rate of 4 Mbps is declared, that the error of the rate control and the gap from the ideal relationship between the GOP size and the window size are completely compensated for by declaring a higher bit rate when the window size is larger than 22 frames.

5. Conclusion

A possibility was shown of achieving the low delay transmission of IPB mode by VBR channel by treating the VBR channel as a channel to offer a periodically fluctuating

transmission bit rate. This transmission method satisfies the constraints from both sliding window and leaky bucket.

Regarding this method, a subject for further study is the need for either a special relationship between GOP size and window size or the declaration of a higher bit rate than the actual bit rate. Concerning this subject, there still remain some network issues to be clarified, especially for tariffing strategy, in order to judge if this method is merits consideration.

Reference

[1] T. Tanaka, et al " A study on comparison between VBR and CBR video service in ATM environment ", ICC '92
[2] Doc. AVC-271
[3] ISO/IEC JTC1/SC2/WG11 MPEG 92/251
[4] TM5 (Doc. AVC-491b), p.93

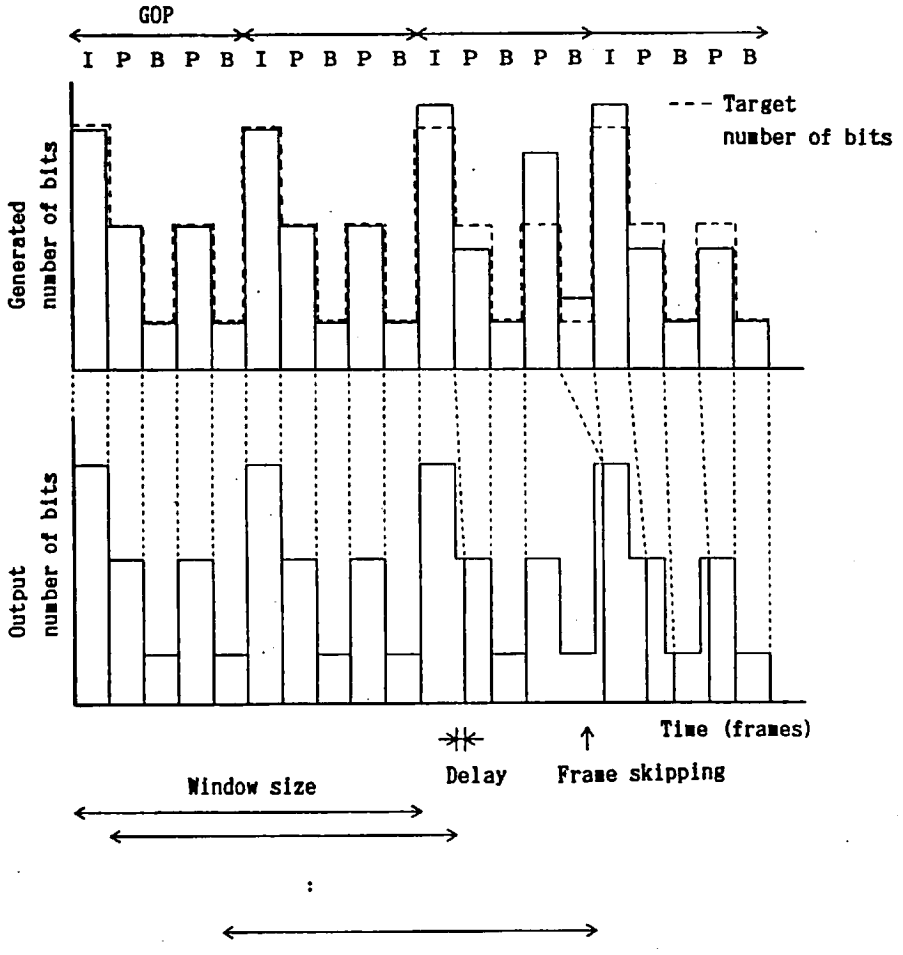


Fig. 1. VBR transmission method

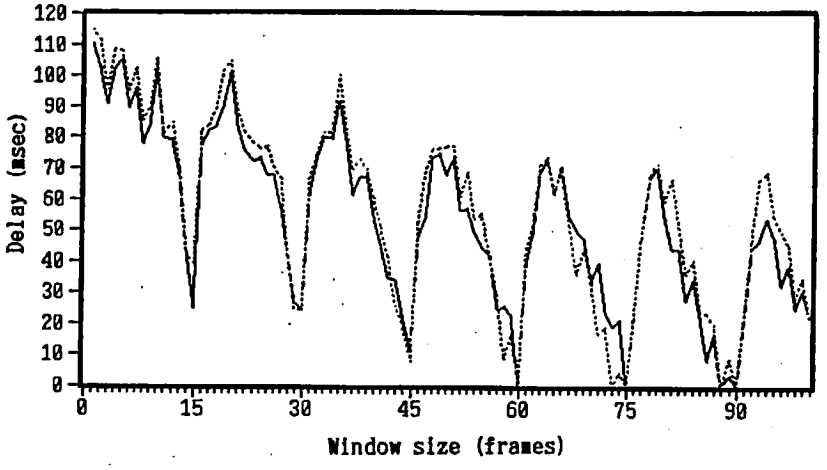


Fig. 2. Window size and delay time
(Declared rate : 4.100Mbps)

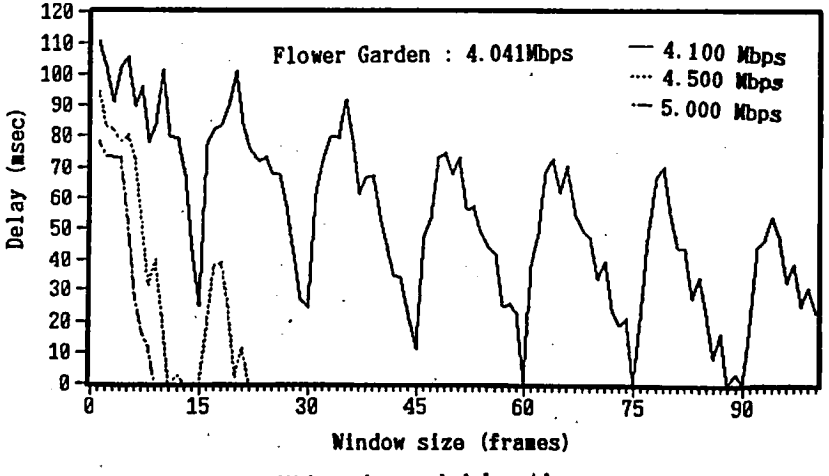


Fig. 3. Widow size and delay time
(Higher declared rate than actual rate)