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SOURCE : Japan
TITLE : Clarification of Low Delay Descriptions
PURPOSE : Proposal

1.Introduction

Though it has been recommended to adopt skipped pictures to keep the low buffering delay performance for steady state, some ambiguous parts in the low delay description still exist. This contribution is clarifying these ambiguous parts.

2.Problem

When we consider the skipped pictures for low delay, we can find the following problems unsolved.

- How should the decoder operate when an S-picture comes ?
- How should the vbv_delay field for an S-picture be set ?
- When should the data for an S-picture removed in VBV ?

3.Decoding operation

Decoder's operation for an S-picture is already described in the semantics of picture_coding_type field (9.3.5 Picture Layer / Test Model 3, Draft Revision 2) as " When S-picture, there should be no data for below the slice layer, and the decoder does not take time to display them. ". For clarity, however, this part is preferable to be written with more precise expression, as shown in Annex.1.

4.Value of vbv_delay field for an S-picture

Encoder should assure not to occur buffer overflow nor underflow by indicating the decoder's data removing timing using vbv_delay field. And the precise value for an S-picture also can be set. But when picture skipping takes place, it is no worth decoder's understanding the value of vbv_delay field. Moreover the purpose to send the header of S-picture is to keep the continuity of TR(temporal reference).

So for expanding the freedom of encoder control, the value of vbv-delay field for an S-picture should be allowed to be arbitrary and decoder should ignore the value of vbv_delay field for an S-picture.

5. Data removing timing for an S-picture in VBV

It is clearly described in the item 5 of VBV specification, as " Sequence header, group of picture layer data elements and headers of skipped pictures which immediately precede a picture are removed at the same time as that picture. ". But this description seems not to be reasonable.Why picture skipping takes place is to come a large picture. And to send data for a large picture, it takes extra time that is basically for sending data for subsequent pictures. It is very reasonable that all process for the transient state ends before the data for a non-skipped picture begin to be processed. So all the header data for S-pictures should be removed with the data for a large picture.

Considering this issue connecting with previous issue, the value of vbv_delay for a large picture should be decided by treating headers for S-pictures as a part of the preceding large picture.

6. Proposal of modification

Reflecting above discussion, we propose to modify the semantics for **picture_coding_type** as in Annex.1, the semantics for **vbv_delay** as in Annex.2, decoding operation in the Appendix H.1.2 as in Annex.3 and VBV specification Item 5 as in Annex.4.

7. Conclusion

Some modifications are proposed to clarify the description of Low Delay coding.

The current discussion is for the case of constant bitrate operation. So VBV consideration and picture skipping for the VBR environment need further study.

END

Annex.1 Proposed modification to the **picture_coding_type** (Modified parts are written in italics.)

picture_coding_type--The picture_coding_type identifies whether a picture is an intra-coded picture(I), predictive-coded picture(P), bidirectionally predictive-coded picture(B), intra-coded with only DC coefficients(D), or skipped picture(S) according to the following Table. D-pictures shall never be included in the same video sequence as the other picture coding types. *When a picture is coded as S-picture, there should be no data for the slice layer or below, and the decoder should not take time to display it to achieve low delay during the steady state.*

picture_coding_type	coding method
000	forbidden
001	intra-coded(I)
010	predictive-coded(P)
011	bidirectionally-predictive-coded(B)
100	dc intra-coded(D)
101	skipped(S)
110	reserved
111	reserved

Annex.2 Proposed modification to the **vbv_delay** (Modified parts are written in italics.)

vbv_delay--The vbv_delay is a 16-bit unsigned integer. For constant bitrate operation *and non-skipped picture*, the vbv_delay is used to set the initial occupancy of the decoder's buffer at the start of play so that the decoder's buffer does not overflow or underflow. The vbv_delay measures the time needed to fill the VBV buffer from an initially empty state at the target bit rate, R, to the correct level immediately before the current picture is removed from the buffer.
The value of vbv_delay is the number of periods of the 90kHz system clock that VBV should wait after receiving the final byte of the picture start code. It may be calculated from the state of the VBV as follows:

$$vbv\_delay_n = 90000 * B_n^* / R$$

where:

$n > 0$

B_n^* = VBV occupancy immediately before removing picture n from the buffer but after removing any group of picture layer and sequence header data that immediately precedes picture n.

R = bit rate

When a picture is coded as S-picture, value of this field can be arbitrary , and decoder should ignore the value of this field. The value of vbv_delay field for a picture preceding S-pictures should be decided by treating headers for S-pictures as a part of the preceding large picture.
For non-constant bitrate operation vbv_delay shall have the value FFFF in hexadecimal.

Annex.3 Proposed modification to the decoding operation in the Appendix H.1.2 (Modified parts are written in italics.)

Decoding operation
The following decoder is assumed

1) The decoder and the encoder have the same video clock frequency as well as the same picture rate, and are operated synchronously [current VBV specification]. Some means are

provided externally to achieve this synchronism, e.g. by using sampling clock information contained in the picture header, AAL, time stamp.

2) It has a receiving buffer of size B, which is given in the vbv_buffer_size field in the sequence header [current VBV specification].

3) It receives coded data at a constant rate and writes in the buffer [current VBV specification].

4) The buffer is initially empty [current VBV specification].

5) *When picture_coding_type field in the picture header shows current picture is a non-skipped picture,* decoding starts after filling the buffer for the time specified by the vbv_delay field in the video stream [current VBV specification].

6) At decoding timing with the same interval as that of encoder, all of the data for the *non-skipped* picture which has been in the buffer longest is instantaneously removed, instantaneously decoded and starts to be displayed [current VBV specification].

7) If there is no complete data for a coded picture, there takes place no decoding operation and the most recent decoded field is displayed repeatedly [TM2 specification].

8)When picture_coding_type field in the picture header shows current picture is a skipped picture, decoder ignores the value of vbv_delay field and does not take time to display this picture [TM3 specification].

Annex.4 Proposed modification to the VBV specification Item 5 (Modified parts are written in italics.)

This item applies to case that some pictures are not coded nor transmitted.

Encoder may wish to realize low delay buffering delay with allowing occasional picture skipping. It will regulate its information generation by setting a virtual buffer size Bl smaller than B for stationary pictures. The VBV operates as follows;

All of the data for the non-skipped picture which has been in the buffer longest is instantaneously removed. Then after each interval all data of the non-skipped picture (at that time) has been in the buffer longest is instantaneously removed. *Sequence header and group of picture layer data elements which immediately precede a picture and headers for skipped pictures which immediately follow the picture are removed at the same time as that picture.* At some decoding timing where picture skipping takes place in the coder, there will be no sufficient data to remove. In that case, no data removing takes place.

During the stationary state with low buffering delay, the VBV occupancy immediately after immediately after each picture is removed shall lie between zero and (Bl-R/P).

To meet this requirement the number of bits dc for coded picture just before the steady state (including any preceding header and group of picture layer data element) must satisfy;

no skipped picture	Bp - Bl + R/P < dc < Bp
one skipped picture	Bp - Bl + 2R/P < dc < Bp + R/P
two skipped pictures	Bp - Bl + 3R/P < dc < Bp + 2R/P
n skipped pictures	Bp - Bl + (n+1)R/P < dc < Bp + nR/P

where:

Bp:VBV buffer occupancy just before removing the data
Bl:VBV buffer corresponding to low delay operation
R :bit rate
P :picture rate