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| *Title:* | **Quantization matrices in fragmented APS** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

In this document, it is proposed that the quantization matrices are signaled in the Adaptation Parameter Set (APS), with predictions between quantization matrices inside the same NAL unit being allowed. To solve the problem that an APS can be larger than the Maximum Transmission Unit (MTU) size, it is proposed that the APS may be fragmented into multiple NAL units, each of which can be independently parsed and applied.

# Introduction

Creation of a new type of NAL unit was proposed in JCTVC-F907 to signal quantization matrices. In HEVC, if a quantization matrix is signaled for intra/inter and luma/chroma1/chroma2 for 4×4, 8×8, 16×16 and 32×32 blocks, it is necessary to signal 8160 values. The adoption of NSQT further increased this number.

Using the same method as used for AVC (zig-zag scan, first order prediction and exponential Golomb coding of the prediction residual) would require roughly 25000 bits to encode all the 24 quantization matrices. Thus, even when using efficient compression methods, it may not be feasible to fill the data corresponding to the quantization matrices into a single NAL unit of sufficiently small size, in bytes, such that the entire NAL unit can be encapsulated in one transmission unit (e.g., an RTP packet) without being framed by underlying transmission protocols. Such a framing of a NAL unit, e.g. an Adaptation Parameter Set (APS) NAL unit as specified in described in JCTVC-F747, would result in received pieces of the framed NAL unit being useless when a single piece gets lost. Such framing typically happens when the transmission unit size is larger than the Maximum Transmission Unit (MTU) size of the end-to-end transmission path. For example, the MTU size of the Ethernet at the network layer (and hence over most of the Internet) is 1500 bytes. The MTU size of end-to-end transmission path involving wireless networks can be significantly smaller, e.g., 200 to 300 bytes.

To overcome this problem, a fragmentation mechanism is proposed to fragment one APS that contains quantization matrix into multiple NAL units, thus making the design more error resilient, in the sense that any received piece of the quantization matrix parameters is useful regardless of whether other pieces are received.

# Proposed method for signaling quantization matrices

## Syntax

### Adaptation parameter set RBSP syntax

|  |  |
| --- | --- |
| aps\_rbsp( ) { | Descriptor |
| **aps\_id** | ue(v) |
| **first\_aps\_fragment\_flag** | u(1) |
| **last\_aps\_fragment\_flag** | u(1) |
| if( first\_aps\_fragment\_flag ) { |  |
| **aps\_quantization\_matrix\_flag** | u(1) |
| **aps\_sample\_adaptive\_offset\_flag** | u(1) |
| **aps\_adaptive\_loop\_filter\_flag** | u(1) |
| **...**//flags for presence of other types of information in the APS |  |
| } |  |
| if( aps\_quantization\_matrix\_flag ) { |  |
| if( !( first\_aps\_fragment\_flag && last\_aps\_fragment\_flag ) ) { |  |
| **start\_qm\_id** | ue(v) |
| if( !last\_aps\_fragment\_flag ) |  |
| **num\_qms\_minus1** | ue(v) |
| } |  |
| for( i = start\_qm\_id; i <= start\_qm\_id + num\_qms\_minus1; i++ ) { |  |
| **pred\_qm\_flag[** i **]** | u(1) |
| quantization\_matrix\_coefs( i , pred\_qm\_flag[ i ]) |  |
| } |  |
| if( first\_aps\_fragment\_flag ) { |  |
| **…**// everything else than quantization matrix, e.g. SAO and ALF information |  |
| } |  |
| rbsp\_trailing\_bits( ) |  |
| } |  |

## Semantics

### Adaptation parameter set RBSP semantics

There may be more than one APS fragment NAL unit associated with one APS, all with the same value of aps\_id. The first APS fragment NAL unit, identified by aps\_first\_fragmet\_flag equal to 1, contains also the “header” syntax elements, i.e., the flag indicating the presence of different types of information, as well other types of information included in the APS, e.g., ALF and SAO related information. Other APS fragment NAL units of one APS only contain quantization matrix information.

Prediction within one instance of quantization\_matrix\_coefs( ) or across different instances of quantization\_matrix\_coefs( ) within the same APS fragment NAL unit is allowed. However, dependency across different APS fragment NAL unit is not allowed, to ensure that any single received APS fragment NAL unit is useful by itself, even when all other APS fragment NAL units are lost.

**aps\_id** specifies the identifier of the APS.

**first\_aps\_fragment\_flag** equal to 1 specified that the APS fragment NAL unit is the first APS fragment NAL unit of the APS identified by aps\_id. This syntax element equal to 0 specified that the APS fragment NAL unit is not the first APS fragment NAL unit of the APS identified by aps\_id.

**last\_aps\_fragment\_flag** equal to 1 specified that the APS fragment NAL unit is the last APS fragment NAL unit of the APS identified by aps\_id. This syntax element equal to 0 specified that the APS fragment NAL unit is not the last APS fragment NAL unit of the APS identified by aps\_id.

When first\_aps\_fragment\_flag and last\_aps\_fragment\_flag are both equal to 1, the APS identified by aps\_id contains only one APS fragment.

**aps\_quantization\_matrix\_flag** specifies whether quantization matrices are signaled in this APS. This syntax element equal to 0 indicates that quantization matrices are not signaled in this APS and not used for coded pictures referring to this APS. This syntax element equal to 1 indicates that quantization matrices are signaled in this APS and are used for coded pictures referring to this APS. When not present (i.e., first\_aps\_fragment\_flag is equal to 0), this flag is inferred to be equal to 1.

**aps\_sample\_adaptive\_offset\_flag** and **aps\_adaptive\_loop\_filter\_flag** are as specified in JCTVC-F747.

**start\_qm\_id** specifies the identifier of the first quantization matrix signalled in the APS fragment NAL unit. When not present, the value of this syntax element shall be inferred to be equal to 0.

**num\_qms\_minus1** plus 1 specifies the number of quantization matrices signaled in the APS fragment NAL unit. When not present, the value of this syntax element is inferred to be equal to 23 – start\_qm\_id.

**pred\_qm\_flag[** i **]** equal to 0 indicates that the i-th quantization matrix of the APS may be predicted from a quantization matrix with quantization matrix identifier in the range of start\_qm\_id to i – 1, inclusive, in the same APS fragment NAL unit.

# Discussion

In the quantization\_matrix\_coefs( i, mode ) table, the coefficients of a quantization matrix is signaled, wherein the i may be used to derive the size of the quantization matrix and the mode is used to decide whether a quantization matrix is Inter coded (with prediction from a different quantization matrix of the same APS NAL fragment unit) or Intra coded. If mode is equal to zero, spatial prediction such as DPCM may be applied. In such cases, the process of reading the syntax elements related to quantization matrix may be interleaved with spatial prediction. If mode is equal to 1, the current quantization matrix may be predicted from another quantization matrix. Hence, quantization\_matrix\_coefs( i , mode) only has the prediction residual (without the spatial prediction step) signaled.

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