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| *Title:* | **AHG21: Reference picture lists combination syntax** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

In this contribution, the reference picture list combination process is slightly modified to remove redundant signalling. In order to enable bit counting for ref\_pic\_list\_combination(), an encoder-only reordering method for the combined list based on POC distance and QP is implemented in the HM5.0 software. Simulation results using HM5.0 random access testing conditions show that the proposed syntax consistently achieves ~14% reduction in signalling overhead for ref\_pic\_list\_combination().

# Reference picture list combination

Currently in WD5 [1], the reference picture list combination syntax shown in Table 1 is used. Some signalling in Table 1 is redundant, and the revised syntax shown in Table 2 removes such redundancy. Changes are highlighted in yellow. As shown in Table 2, the syntax ref\_idx\_list\_curr only needs to be signaled when L0 (if pic\_from\_list\_0\_flag is 1) or L1 (if pic\_from\_list\_0\_flag is 0) contains more than 1 entry. Additionally, instead of using ue(v), te(v) is a more efficient way to signal ref\_idx\_list\_curr.

1. Current reference picture list combination syntax in WD5

|  |  |
| --- | --- |
| ref\_pic\_list\_combination( ) { | Descriptor |
| if( slice\_type % 5 = = 1 ) { // b slice |  |
| **ref\_pic\_list\_combination\_flag** | u(1) |
| if( ref\_pic\_list\_combination\_flag ) { |  |
| **num\_ref\_idx\_lc\_active\_minus1** | ue(v) |
| **ref\_pic\_list\_modification\_flag\_lc** | u(1) |
| if( ref\_pic\_list\_modification\_flag\_lc) |  |
| for ( i =0; i <= num\_ref\_idx\_lc\_active\_minus1; i++ ) { |  |
| **pic\_from\_list\_0\_flag** | u(1) |
| **ref\_idx\_list\_curr** | ue(v) |
| } |  |
| } |  |
| } |  |
| } |  |

1. Proposed reference picture lists combination syntax

|  |  |
| --- | --- |
| ref\_pic\_list\_combination( ) { | Descriptor |
| if( slice\_type % 5 = = 1 ) { // b slice |  |
| **ref\_pic\_list\_combination\_flag** | u(1) |
| if( ref\_pic\_list\_combination\_flag ) { |  |
| **num\_ref\_idx\_lc\_active\_minus1** | ue(v) |
| **ref\_pic\_list\_modification\_flag\_lc** | u(1) |
| if( ref\_pic\_list\_modification\_flag\_lc) |  |
| for ( i =0; i <= num\_ref\_idx\_lc\_active\_minus1; i++ ) { |  |
| **pic\_from\_list\_0\_flag** | u(1) |
| if ( ( pic\_from\_list\_0\_flag == 1 &&  num\_ref\_idx\_l0\_active\_minus1 > 0 ) | |  ( pic\_from\_list\_0\_flag == 0 &&  num\_ref\_idx\_l1\_activie\_minus1 > 0 ) |  |
| **ref\_idx\_list\_curr** | te(v) |
| } |  |
| } |  |
| } |  |
| } |  |

**ref\_idx\_list\_curr** indicates the reference index of the picture in the reference picture list specified by pic\_from\_list\_0\_flag to be appended at the end of the reference picture lists combination. If ref\_idx\_list\_curr is not present, it is set to 0.

# POC distance and QP based reordering of combined list

In order to compare the numbers of bits used to signal combined list modification syntax using Table 1 and Table 2, a POC-distance and QP based LC reordering method is implemented in the HM5.0 encoder. This encoder-only change performs LC reordering using the following two steps:

1. Sort LC by POC distance between the current picture and the reference picture in increasing order; that is, reference pictures closer to the current picture are given smaller index in LC
2. For entries with the same POC distance, break the tie by sorting the entries based on QP in increasing order; that is, reference pictures coded with smaller QP are given smaller index in LC

Table 3 shows the default LC in HM5.0 and the reordered LC for the Random Access GOP structure used in HM5.0 common testing conditions (without temporal scalability) in Figure 1.

1. POC distance and QP based reordering at the encoder

|  |  |  |
| --- | --- | --- |
| **POC in coding order** | **Default LC in HM5.0** | **Reordered LC** |
| 16 | {8, 6, 4, 0} | {8, 6, 4, 0} |
| 12 | {8, 16, 6} | {8, 16, 6} |
| 10 | {8, 12, 6, 16} | {8, 12, 6, 16} |
| 9 | {8, 10, 12} | {8, 10, 12} |
| 11 | {10, 12, 8, 16} | {12, 10, 8, 16} |
| 14 | {12, 16, 10} | {16, 12, 10} |
| 13 | {12, 14, 8, 16} | {12, 14, 16, 8} |
| 15 | {14, 16, 12} | {16, 14, 12} |



Figure . GOP structure for Random Access

# Simulation results

Table 4 shows the rate distortion performance using the reordered LC for all 3 random access settings in [2]. No significant RD performance difference is observed. Detailed RD data can be found in the attached spreadsheet.

The reordered LC can be signalled using two methods, 1) the current syntax in Table 1, 2) the proposed syntax in Table 2. Table 5 compares the per picture bit count for ref\_pic\_list\_combination() syntax. Table 6, Table 7 and Table 8 compare overall bit counts for each random access period for all test sequences for RA-HE, RA-LC and RA-10 conditions. The software with bit counting functionality can be found in the package in [4]. Due to time constraint, the bit counting functionality was implemented on HM5.0, instead of on HM-5.1-dev-ahg21.

1. RD performance using the reordered LC and the default LC

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE** | | | **Random Access LC** | | | **Random Access HE-10** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A (8bit) | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | 0.1% | 0.1% | 0.0% | 0.0% |
| Class B | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class C | 0.0% | 0.0% | 0.1% | 0.0% | -0.1% | 0.0% |  |  |  |
| Class D | 0.0% | -0.1% | -0.1% | 0.1% | 0.0% | 0.0% |  |  |  |
| Class E |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
|  | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% |
| Class F | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% |  |  |  |

1. Bit counting (per picture) for ref\_pic\_list\_combination(), using Table 1 and Table 2

|  |  |  |  |
| --- | --- | --- | --- |
| **POC in coding order** | **Reordered LC** | **Bit count using Table 1** | **Bit count using Table 2** |
| 16 | {8, 6, 4, 0} | 7 | 7 |
| 12 | {8, 16, 6} | 5 | 5 |
| 10 | {8, 12, 6, 16} | 7 | 7 |
| 9 | {8, 10, 12} | 5 | 5 |
| 11 | {12, 10, 8, 16} | 19 | 15 |
| 14 | {16, 12, 10} | 13 | 11 |
| 13 | {12, 14, 16, 8} | 19 | 15 |
| 15 | {16, 14, 12} | 13 | 11 |

1. Bit counting (per GOP) for ref\_pic\_list\_combination(), per sequence, RA-HE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Sequence | GOP bit count using Table 1 | GOP bit count using Table 2 | Bits saved (%) |
| Class A | Traffic | 347 | 297 | 14.41% |
| PeopleOnStreet | 347 | 297 | 14.41% |
| Nebuta |  |  |  |
| SteamLocomotive |  |  |  |
| Class B | Kimono | 259 | 221 | 14.67% |
| ParkScene | 259 | 221 | 14.67% |
| Cactus | 523 | 449 | 14.15% |
| BasketballDrive | 523 | 449 | 14.15% |
| BQTerrace | 699 | 601 | 14.02% |
| Class C | BasketballDrill | 523 | 449 | 14.15% |
| BQMall | 699 | 601 | 14.02% |
| PartyScene | 523 | 449 | 14.15% |
| RaceHorsesC | 347 | 297 | 14.41% |
| Class D | BasketballPass | 523 | 449 | 14.15% |
| BQSquare | 699 | 601 | 14.02% |
| BlowingBubbles | 523 | 449 | 14.15% |
| RaceHorses | 347 | 297 | 14.41% |
| Class E | Vidyo1 |  |  |  |
| Vidyo3 |  |  |  |
| Vidyo4 |  |  |  |
| Class F | BasketballDrillText | 523 | 449 | 14.15% |
| ChinaSpeed | 347 | 297 | 14.41% |
| SlideEditing | 347 | 297 | 14.41% |
| SlideShow | 171 | 145 | 15.20% |
| **Total bits per GOP** | | **8529** | **7315** | **14.23%** |

1. Bit counting (per GOP) for ref\_pic\_list\_combination(), per sequence, RA-LC

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Sequence | GOP bit count using Table 1 | GOP bit count using Table 2 | Bits saved (%) |
| Class A | Traffic | 347 | 297 | 14.41% |
| PeopleOnStreet | 347 | 297 | 14.41% |
| Nebuta |  |  |  |
| SteamLocomotive |  |  |  |
| Class B | Kimono | 259 | 221 | 14.67% |
| ParkScene | 259 | 221 | 14.67% |
| Cactus | 523 | 449 | 14.15% |
| BasketballDrive | 523 | 449 | 14.15% |
| BQTerrace | 699 | 601 | 14.02% |
| Class C | BasketballDrill | 523 | 449 | 14.15% |
| BQMall | 699 | 601 | 14.02% |
| PartyScene | 523 | 449 | 14.15% |
| RaceHorses | 347 | 297 | 14.41% |
| Class D | BasketballPass | 523 | 449 | 14.15% |
| BQSquare | 699 | 601 | 14.02% |
| BlowingBubbles | 523 | 449 | 14.15% |
| RaceHorses | 347 | 297 | 14.41% |
| Class E | Vidyo1 |  |  |  |
| Vidyo3 |  |  |  |
| Vidyo4 |  |  |  |
| Class F | BasketballDrillText | 523 | 449 | 14.15% |
| ChinaSpeed | 347 | 297 | 14.41% |
| SlideEditing | 347 | 297 | 14.41% |
| SlideShow | 171 | 145 | 15.20% |
| **Total bits per GOP** | | **8529** | **7315** | **14.23%** |

1. Bit counting (per GOP) for ref\_pic\_list\_combination(), per sequence, RA-10

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Sequence | GOP bit count using Table 1 | GOP bit count using Table 2 | Bits saved (%) |
| Class A | Traffic | 347 | 297 | 14.41% |
| PeopleOnStreet | 347 | 297 | 14.41% |
| Nebuta | 699 | 601 | 14.02% |
| SteamLocomotive | 699 | 601 | 14.02% |
| Class B | Kimono | 259 | 221 | 14.67% |
| ParkScene | 259 | 221 | 14.67% |
| Cactus | 523 | 449 | 14.15% |
| BasketballDrive | 523 | 449 | 14.15% |
| BQTerrace | 699 | 601 | 14.02% |
| Class C | BasketballDrill |  |  |  |
| BQMall |  |  |  |
| PartyScene |  |  |  |
| RaceHorses |  |  |  |
| Class D | BasketballPass |  |  |  |
| BQSquare |  |  |  |
| BlowingBubbles |  |  |  |
| RaceHorses |  |  |  |
| Class E | Vidyo1 |  |  |  |
| Vidyo3 |  |  |  |
| Vidyo4 |  |  |  |
| Class F | BasketballDrillText |  |  |  |
| ChinaSpeed |  |  |  |
| SlideEditing |  |  |  |
| SlideShow |  |  |  |
| **Total bits per GOP** | | **4355** | **3737** | **14.19%** |

# References

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# Patent rights declaration(s)

**InterDigital Communications, LLC may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**