MEDIATEK

AHG9: Bitstream conformance requirement related to RPR scaling ratio for worst case MC memory bandwidth reduction

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Overall Summary

- In current VVC, to support RPR, the worst case MC memory bandwidth is more than doubled compared to RPR-off
- Propose five bitstream conformance requirements to prevent worst case MC memory bandwidth increase
- Requirement 1
  - On scaling window size with considering the effect of interpolation filter
- Requirement 2
  - On scaling window size without considering the effect of interpolation filter
- Requirement 3
  - On scaling window width and height without considering the effect of interpolation filter
- Requirement 4
  - On scaling window width and height without considering the effect of interpolation filter. Considering Max(8, MinCbSizeY).
- Requirement 5
  - Simplification of Method-1
- Suggest to adopt one of the three proposed requirements

Problem Definition

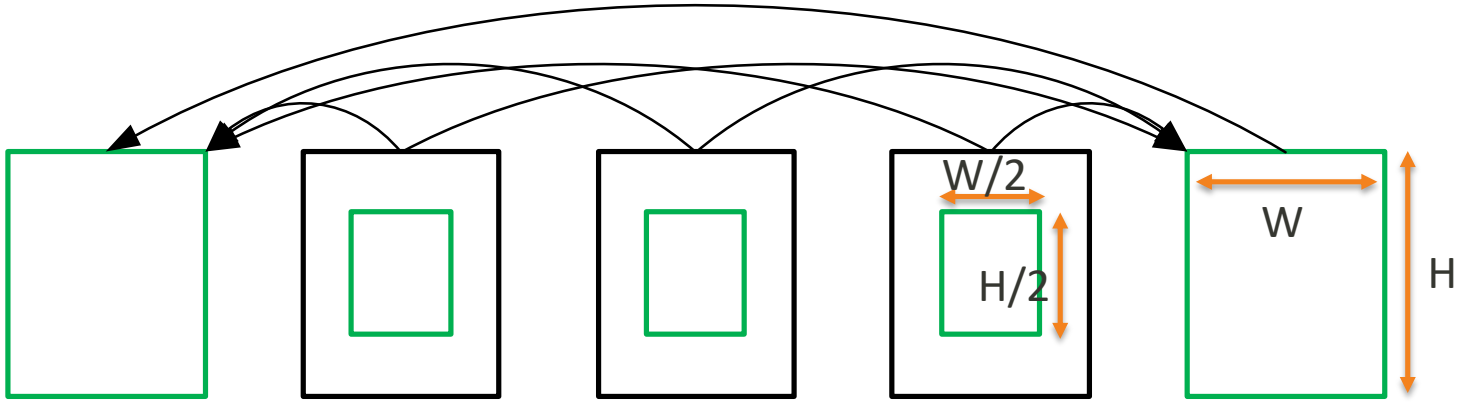
- In video codec implementation, the required MC memory bandwidth (BW) is an important parameter for the entire system
- The worst case MC memory BW:
- $\frac{CurPicWidth \times CurPicHeight}{WorstCaseBlockSize} \times WorstCaseBlockBW =$

$$\frac{CurPicWidth \times CurPicHeight}{BlockWidth \times BlockHeight} \times (BlockWidth + 7) \times (BlockHeight + 7)$$

  - WorstCase Block is 16x4 or 4x16 block
  - WorstCaseBlockBW is 506
    - (16+7)*(4+7)*2 for a 16x4/4x16 bi-predicted block

Problem Definition

- When RPR is used, the worst case MC memory bandwidth will be larger than expected
- For example, if effective scaling ratio is 2 in horizontal and vertical direction, the worst case BW is **2.31x** compared to RPR-off



Proposed Method 1

- Requirement on scaling window size with considering the effect of interpolation filter
  - Check the worst case BW for 16x4 and 4x16 blocks
- $\frac{CurPicWidth \times CurPicHeight}{16 \times 4} \times (16 \times ScalRatioX + 7) \times (4 \times ScalRatioY + 7) \leq \frac{MaxPicWidth \times MaxPicHeight}{16 \times 4} \times (16 + 7) \times (4 + 7)$
- $\frac{CurPicWidth \times CurPicHeight}{4 \times 16} \times (4 \times ScalRatioX + 7) \times (16 \times ScalRatioY + 7) \leq \frac{MaxPicWidth \times MaxPicHeight}{4 \times 16} \times (4 + 7) \times (16 + 7)$
  - ScalRatioX = refPicOutputWidthL / PicOutputWidthL
  - ScalRatioY = refPicOutputHeightL / PicOutputHeightL

Proposed Method 1

- After formula simplification
- $CurPicWidth \times CurPicHeight \times (16 \times refPicOutputWidthL + 7 \times PicOutputWidthL) \times (4 \times refPicOutputHeightL + 7 \times PicOutputHeightL) \leq MaxPicWidth \times MaxPicHeight \times 253 \times PicOutputWidthL \times PicOutputHeightL$
- $CurPicWidth \times CurPicHeight \times (4 \times refPicOutputWidthL + 7 \times PicOutputWidthL) \times (16 \times refPicOutputHeightL + 7 \times PicOutputHeightL) \leq MaxPicWidth \times MaxPicHeight \times 253 \times PicOutputWidthL \times PicOutputHeightL$

Proposed Method 1

- Specification change:

The variables PicOutputWidthL and PicOutputHeightL are derived as follows:

$$PicOutputWidthL = pic\_width\_in\_luma\_samples - (scaling\_win\_right\_offset + scaling\_win\_left\_offset) \quad (74)$$

$$PicOutputHeightL = pic\_height\_in\_luma\_samples - (scaling\_win\_bottom\_offset + scaling\_win\_top\_offset) \quad (75)$$

When scaling_window_flag is equal to 1, let refPicOutputWidthL and refPicOutputHeightL be the PicOutputWidthL and PicOutputHeightL, respectively, of a reference picture of the current picture referring to this PPS. It's a requirement of bitstream conformance that the following conditions are satisfied:

– pic_width_in_luma_samples * pic_height_in_luma_samples * (16 * refPicOutputWidthL + 7 * PicOutputWidthL) * (4 * refPicOutputHeightL + 7 * PicOutputHeightL) shall be smaller than or equal to pic_width_max_in_luma_samples * pic_height_max_in_luma_samples height * 253 * PicOutputWidthL * PicOutputHeightL

– pic_width_in_luma_samples * pic_height_in_luma_samples * (4 * refPicOutputWidthL + 7 * PicOutputWidthL) * (16 * refPicOutputHeightL + 7 * PicOutputHeightL) shall be smaller than or equal to pic_width_max_in_luma_samples * pic_height_max_in_luma_samples height * 253 * PicOutputWidthL * PicOutputHeightL

Proposed Method 2

- Requirement on scaling window size without considering the effect of interpolation filter
  - $CurPicWidth \times CurPicHeight \times refPicOutputWidthL \times refPicOutputHeightL \leq MaxPicWidth \times MaxPicHeight \times PicOutputWidthL \times PicOutputHeightL$

When scaling_window_flag is equal to 1, let refPicOutputWidthL and refPicOutputHeightL be the PicOutputWidthL and PicOutputHeightL, respectively, of a reference picture of the current picture referring to this PPS. It's a requirement of bitstream conformance that all of the following conditions are satisfied:

– pic_width_in_luma_samples * pic_height_in_luma_samples * refPicOutputWidthL * refPicOutputHeightL shall be smaller than or equal to pic_width_max_in_luma_samples * pic_height_max_in_luma_samples height * PicOutputWidthL * PicOutputHeightL

Proposed Method 3

- Requirement on scaling window width and height without considering the effect of interpolation filter
  - $CurPicWidth \times refPicOutputWidthL \times \leq MaxPicWidth \times PicOutputWidthL$
  - $CurPicHeight \times refPicOutputHeightL \leq MaxPicHeight \times PicOutputHeightL$

Proposed Method 3

- Specification change:

When scaling_window_flag is equal to 1, let refPicOutputWidthL and refPicOutputHeightL be the PicOutputWidthL and PicOutputHeightL, respectively, of a reference picture of the current picture referring to this PPS. It's a requirement of bitstream conformance that all of the following conditions are satisfied:

– pic_width_in_luma_samples * refPicOutputWidthL shall be smaller than or equal to pic_width_max_in_luma_samples * PicOutputWidthL

– pic_height_in_luma_samples * refPicOutputHeightL shall be smaller than or equal to pic_height_max_in_luma_samples * PicOutputHeightL

Full-HD and Quarter Full-HD Case

- Full-HD size: 1920x1080
  - Scaling window size is 1920 x 1080
- Quarter Full-HD size: 960x540 → 960x544
  - However, 540 is not multiple of 8. The picture height is changed to 544
  - Scaling window size is 960 x 540
- Height constraint:
  - $CurPicHeight \times refPicOutputHeightL \leq MaxPicHeight \times PicOutputHeightL$
  - 544 x 1080 > 1080 x 540

Proposed Method 4

- Requirement on scaling window width and height without considering the effect of interpolation filter
- Considering the effect of $Max(8,\ MinCbSizeY)$
  - $(CurPicWidth - Max(8,\ MinCbSizeY)) \times refPicOutputWidthL \times \leq MaxPicWidth \times PicOutputWidthL$
  - $(CurPicHeight - Max(8,\ MinCbSizeY)) \times refPicOutputHeightL \leq MaxPicHeight \times PicOutputHeightL$

Proposed Method 4

- Specification change:

– (pic_width_in_luma_samples – Max(8, MinCbSizeY)) * refPicOutputWidthL shall be smaller than or equal to pic_width_max_in_luma_samples * PicOutputWidthL

– (pic_height_in_luma_samples – Max(8, MinCbSizeY)) * refPicOutputHeightL shall be smaller than or equal to pic_height_max_in_luma_samples * PicOutputHeightL

Proposed Method 5

- Using 8x8 block for deriving the constraint. After formula simplification:
- $CurPicWidth \times CurPicHeight \times (8 \times refPicOutputWidthL + 7 \times PicOutputWidthL) \times (8 \times refPicOutputHeightL + 7 \times PicOutputHeightL) \leq MaxPicWidth \times MaxPicHeight \times 225 \times PicOutputWidthL \times PicOutputHeightL$

Proposed Method 5

- Spec change:

When scaling_window_flag is equal to 1, let refPicOutputWidthL and refPicOutputHeightL be the PicOutputWidthL and PicOutputHeightL, respectively, of a reference picture of the current picture referring to this PPS. It's a requirement of bitstream conformance that the following conditions are satisfied:

– pic_width_in_luma_samples * pic_height_in_luma_samples * (8 * refPicOutputWidthL + 7 * PicOutputWidthL) * (8 * refPicOutputHeightL + 7 * PicOutputHeightL) shall be smaller than or equal to pic_width_max_in_luma_samples * pic_height_max_in_luma_samples height * 225 * PicOutputWidthL * PicOutputHeightL

Conclusions

- Propose five bitstream conformance requirements to prevent worst case MC memory bandwidth increase
- Requirement 1
  - On scaling window size with considering the effect of interpolation filter
- Requirement 2
  - On scaling window size constraints without considering the effect of interpolation filter
- Requirement 3
  - On scaling window width and height constraints without considering the effect of interpolation filter
- Requirement 4
  - On scaling window width and height without considering the effect of interpolation filter. Considering Max(8, MinCbSizeY).
- Requirement 5
  - Simplification of Method-1
- Suggest to adopt one of the three proposed requirements

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