

The MEDIATEK logo is displayed in white, uppercase letters within an orange parallelogram shape.

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

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The bottom of the slide features a solid orange background with a dense, white line-art pattern of various objects including a pot, a bowl of food, a laptop, a desk lamp, a lightbulb, a camera, and other everyday items.

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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 three 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
- 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:

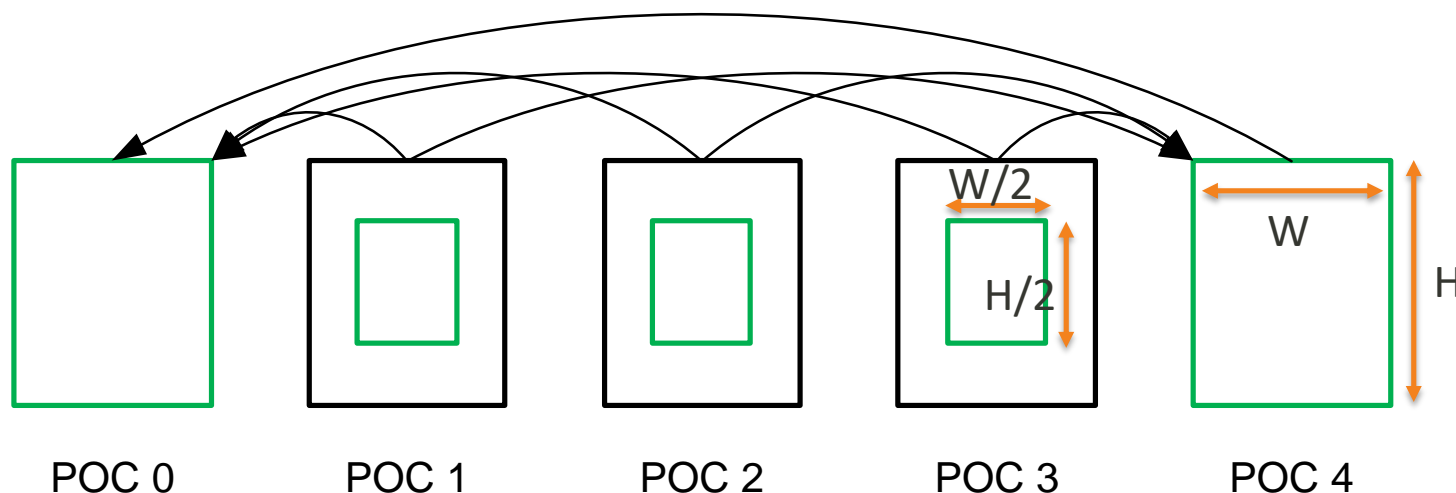
- $$\frac{CurPicWidth \times CurPicHeight}{WorstCaseBlockSize} \times WorstCaseBlockBW =$$

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

- WorstCase Block is 16x4 or 4x16 block
- WorstCaseBlockBW is 506
 - $(16+7) \times (4+7) \times 2$ 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
- $$\frac{\frac{CurPicWidth \times CurPicHeight}{16 \times 4}}{\frac{MaxPicWidth \times MaxPicHeight}{16 \times 4}} \times (16 \times ScalRatioX + 7) \times (4 \times ScalRatioY + 7) \leq$$
- $$\frac{\frac{CurPicWidth \times CurPicHeight}{4 \times 16}}{\frac{MaxPicWidth \times MaxPicHeight}{4 \times 16}} \times (4 \times ScalRatioX + 7) \times (16 \times ScalRatioY + 7) \leq$$
 - $ScalRatioX = refPicOutputWidthL / PicOutputWidthL$
 - $ScalRatioY = refPicOutputHeightL / PicOutputHeightL$

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:

$$\text{PicOutputWidthL} = \text{pic_width_in_luma_samples} - (\text{scaling_win_right_offset} + \text{scaling_win_left_offset}) \quad (74)$$

$$\text{PicOutputHeightL} = \text{pic_height_in_luma_samples} - (\text{scaling_win_bottom_offset} + \text{scaling_win_top_offset}) \quad (75)$$

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:

- $\text{pic_width_in_luma_samples} * \text{pic_height_in_luma_samples} * (16 * \text{refPicOutputWidthL} + 7 * \text{PicOutputWidthL}) * (4 * \text{refPicOutputHeightL} + 7 * \text{PicOutputHeightL})$ shall be smaller than or equal to $\text{pic_width_max_in_luma_samples} * \text{pic_height_max_in_luma_samples} * \text{height} * 253 * \text{PicOutputWidthL} * \text{PicOutputHeightL}$
- $\text{pic_width_in_luma_samples} * \text{pic_height_in_luma_samples} * (4 * \text{refPicOutputWidthL} + 7 * \text{PicOutputWidthL}) * (16 * \text{refPicOutputHeightL} + 7 * \text{PicOutputHeightL})$ shall be smaller than or equal to $\text{pic_width_max_in_luma_samples} * \text{pic_height_max_in_luma_samples} * \text{height} * 253 * \text{PicOutputWidthL} * \text{PicOutputHeightL}$

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 $pic_width_max_in_luma_samples * pic_height_max_in_luma_samples * PicOutputWidthL * PicOutputHeightL$

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:

- $\text{pic_width_in_luma_samples} * \text{refPicOutputWidthL}$ shall be smaller than or equal to $\text{pic_width_max_in_luma_samples} * \text{PicOutputWidthL}$
- $\text{pic_height_in_luma_samples} * \text{refPicOutputHeightL}$ shall be smaller than or equal to $\text{pic_height_max_in_luma_samples} * \text{PicOutputHeightL}$

Conclusions

- Propose three 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
- Suggest to adopt one of the three proposed requirements



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