

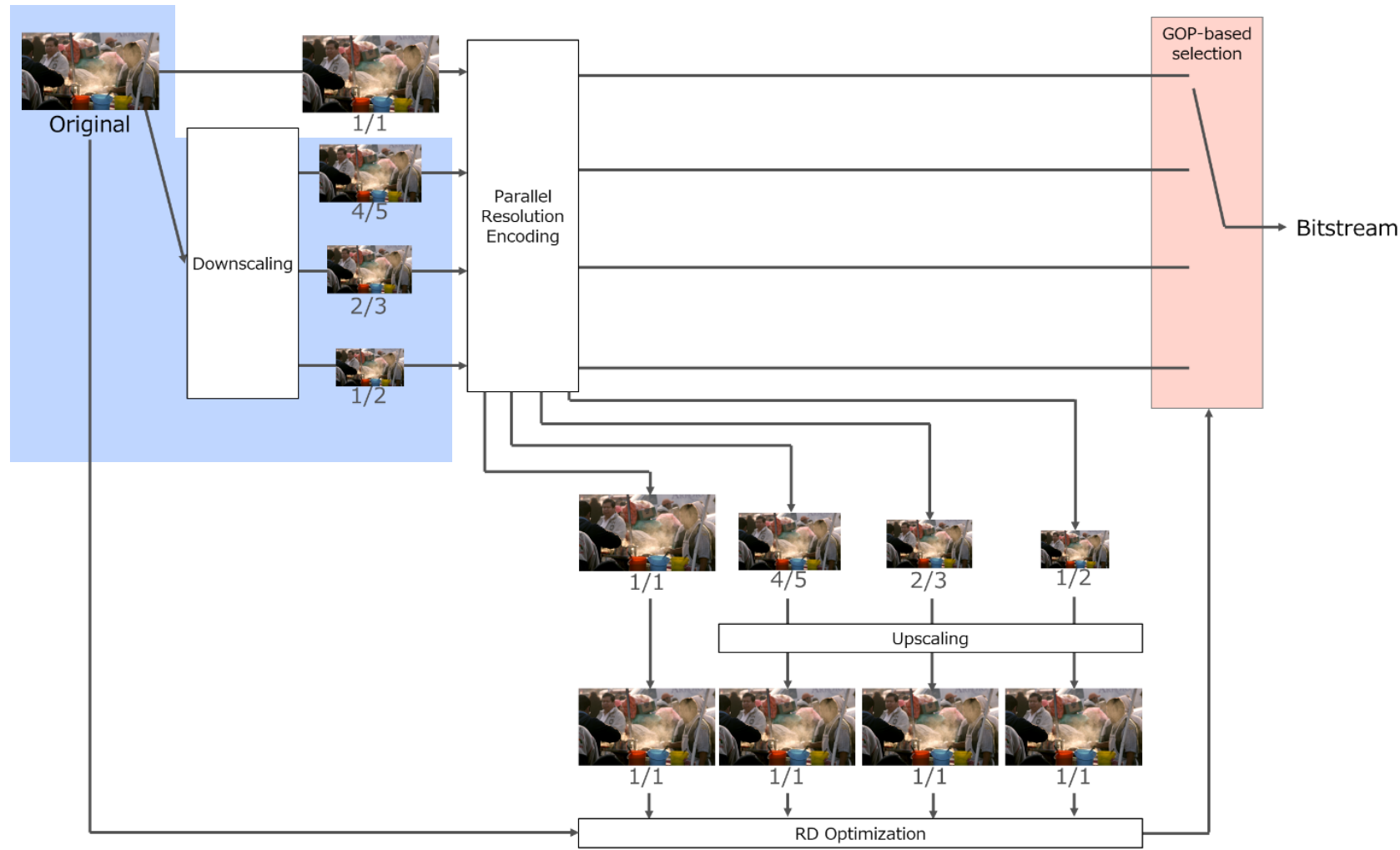
JVET-AE0104

**AHG10: GOP-based RPR encoder control
using parallel resolution encoding**

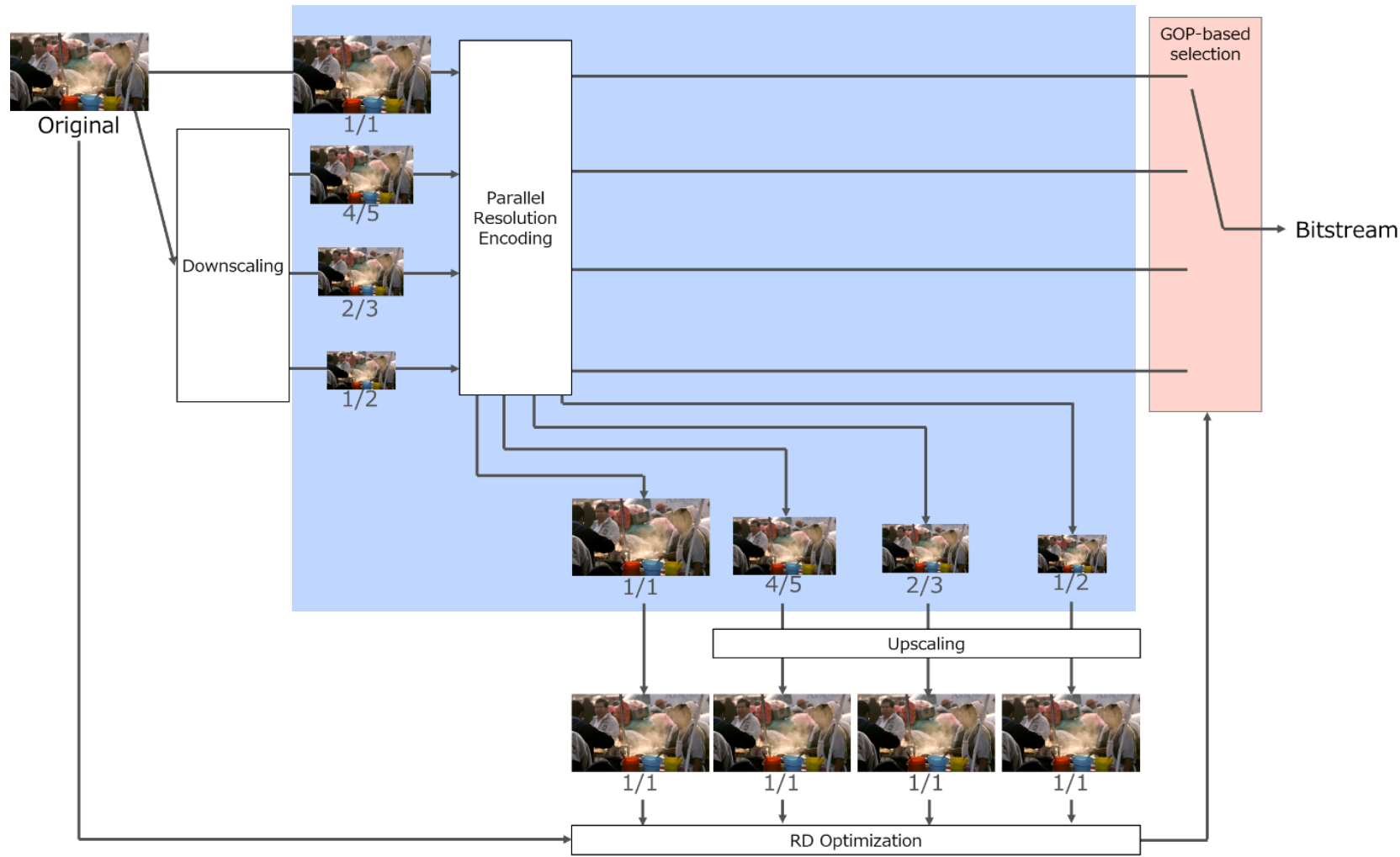
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- In JVET-AB0080, GOP-based RPR control method was proposed in VTM.
 - The encoding picture size is determined based on the QP and self-similarity of the rescaled picture.
 - This approach offers significant advantages in terms of encoding efficiency and computational complexity, it may not always select the most suitable resolution.
- This contribution proposes GOP-based RPR encoder control using RD optimization, aiming to explore the performance limits of adaptive resolution change.

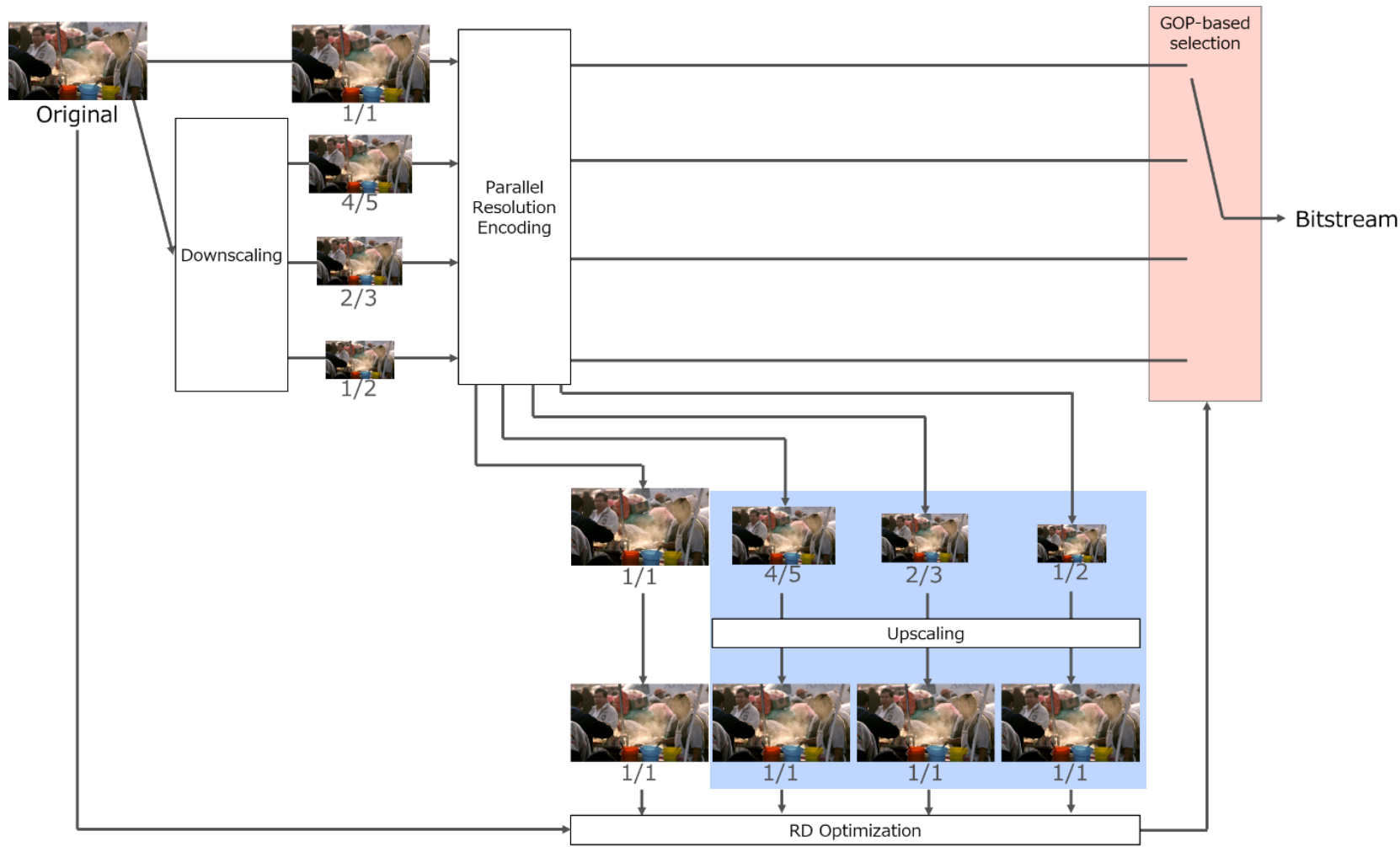
1. The proposed method initially downscales the original pictures into multiple resolutions ($1/2$, $2/3$ and $4/5$) using the downscaling functionality in VTM.



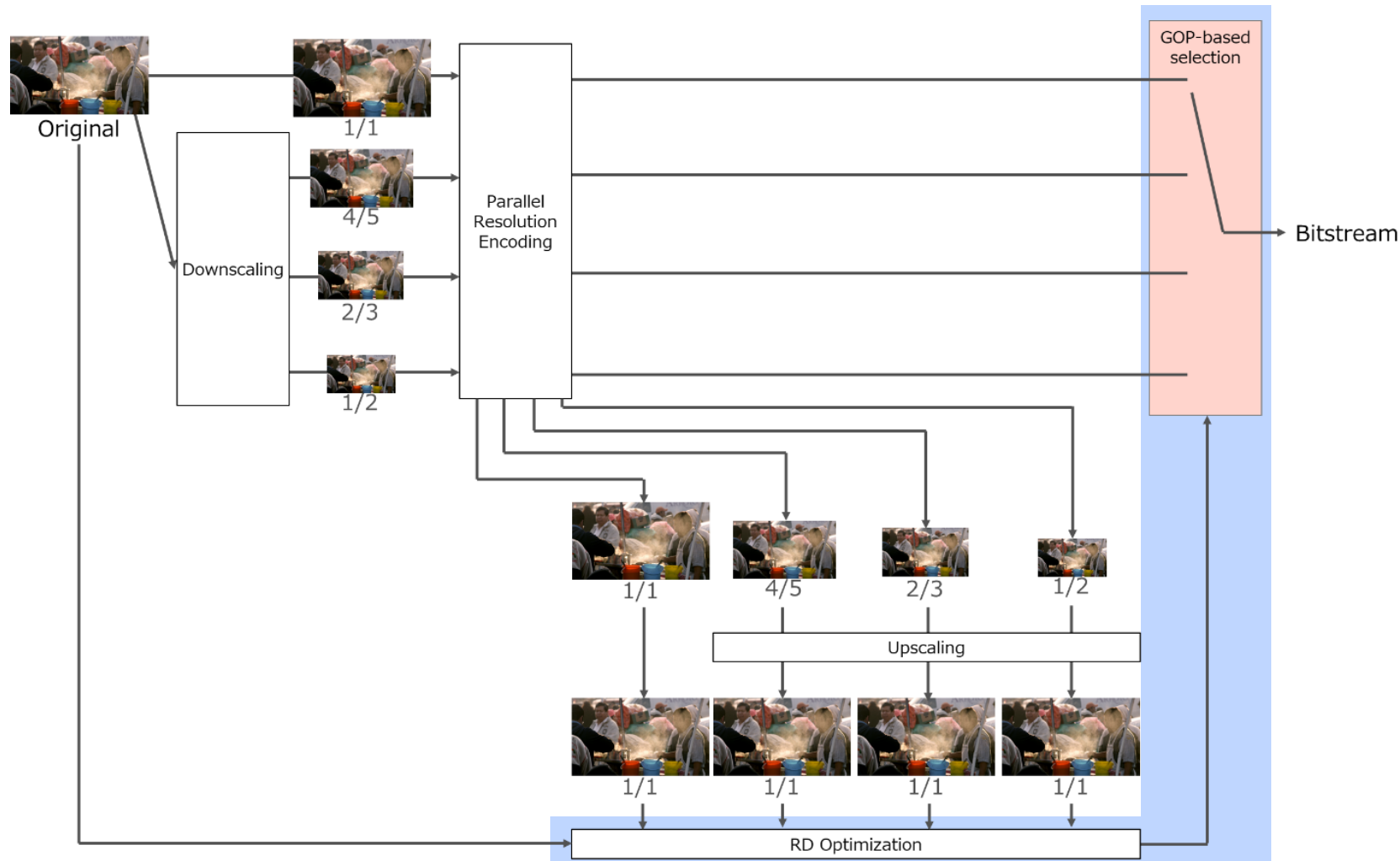
2. This method then performs multi-pass encoding on each of the reduced resolutions (adjusting the QPs by -6, -4 and -2) and the original resolution.



3. After multi-pass encoding, the reduced decoded pictures are upscaled to the original resolution using the upscaling functionality in VTM.



4. Finally, this method calculates the RD cost for each resolution to determine the optimal resolution for each GOP.



- RD cost for the i -th resolution

$$L_i = \sum_c^{YCbCr} \sum_t^{GOPsize} w_c (\lambda_{c,t} r_{i,t} + \|X_{c,t} - \widehat{X}_{i,c,t}\|_2^2)$$

- w_c : the weight coefficient for each YCbCr
 - $\lambda_{c,t}$: the value used to encode the original picture of the c -th channel in the t -th frame
 - $r_{i,t}$: the number of bits in the t -th frame at the i -th resolution
 - $X_{c,t}$: the original picture of the c -th channel in the t -th frame
 - $\widehat{X}_{i,c,t}$: the decoded picture of the c -th channel in the t -th frame at the i -th resolution
- For YCbCr evaluation, $w_c = [8,1,1]$ is used in this experiment.

• BD-rate Over VTM-20.2

Random access Main10 (QP22,27,32,37)

	BD-rate Over VTM-20.2				
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1	-2.24%	-0.18%	-2.90%	118%	66%
Class A2	-1.14%	7.42%	5.36%	111%	92%
Class B	0.06%	0.20%	-0.05%	166%	95%
Class C	0.00%	0.00%	0.00%	165%	97%
Class E					
Overall	-0.65%	1.52%	0.48%	143%	88%
Class D	0.00%	0.00%	0.00%	167%	100%

Low delay B Main10 (QP22,27,32,37)

	BD-rate Over VTM-20.2				
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1					
Class A2					
Class B	-0.13%	-0.30%	-0.79%	182%	93%
Class C	0.00%	0.00%	0.00%	173%	100%
Class E	0.00%	0.00%	0.00%	211%	99%
Overall	-0.06%	-0.12%	-0.33%	185%	97%
Class D	0.00%	0.00%	0.00%	167%	101%

All Intra Main10 (QP22,27,32,37)

	BD-rate Over VTM-20.2				
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1	0.77%	2.91%	-4.19%	116%	72%
Class A2	-2.04%	26.32%	17.87%	104%	80%
Class B	-0.01%	-0.14%	-0.19%	149%	91%
Class C	0.00%	0.00%	0.00%	133%	100%
Class E	0.00%	0.00%	0.00%	127%	101%
Overall	-0.21%	4.83%	2.23%	128%	89%
Class D	0.00%	0.00%	0.00%	149%	101%

• BD-rate Over VTM-20.2 GOP-based RPR

Random access Main10 (QP22,27,32,37)

	BD-rate Over VTM-20.2 GOP-based RPR				
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1	-0.89%	3.06%	-0.55%	137%	108%
Class A2	-1.10%	2.31%	1.14%	121%	125%
Class B	-0.11%	0.01%	0.41%	169%	101%
Class C	0.00%	0.00%	0.00%	166%	98%
Class E					
Overall	-0.44%	1.08%	0.25%	151%	106%
Class D	0.00%	0.00%	0.00%	166%	100%

Low delay B Main10 (QP22,27,32,37)

	BD-rate Over VTM-20.2 GOP-based RPR				
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1					
Class A2					
Class B	-0.12%	-0.18%	-0.41%	183%	97%
Class C	0.00%	0.00%	0.00%	173%	100%
Class E	0.00%	0.00%	0.00%	211%	98%
Overall	-0.05%	-0.08%	-0.17%	186%	98%
Class D	0.00%	0.00%	0.00%	168%	100%

All Intra Main10 (QP22,27,32,37)

	BD-rate Over VTM-20.2 GOP-based RPR				
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1	1.20%	3.61%	-3.31%	111%	80%
Class A2	-1.08%	14.50%	11.55%	105%	84%
Class B	-0.06%	0.03%	0.04%	146%	94%
Class C	0.00%	0.00%	0.00%	130%	100%
Class E	0.00%	0.00%	0.00%	127%	101%
Overall	0.00%	3.02%	1.39%	126%	92%
Class D	0.00%	0.00%	0.00%	148%	100%

• BD-rate Over VTM-20.2

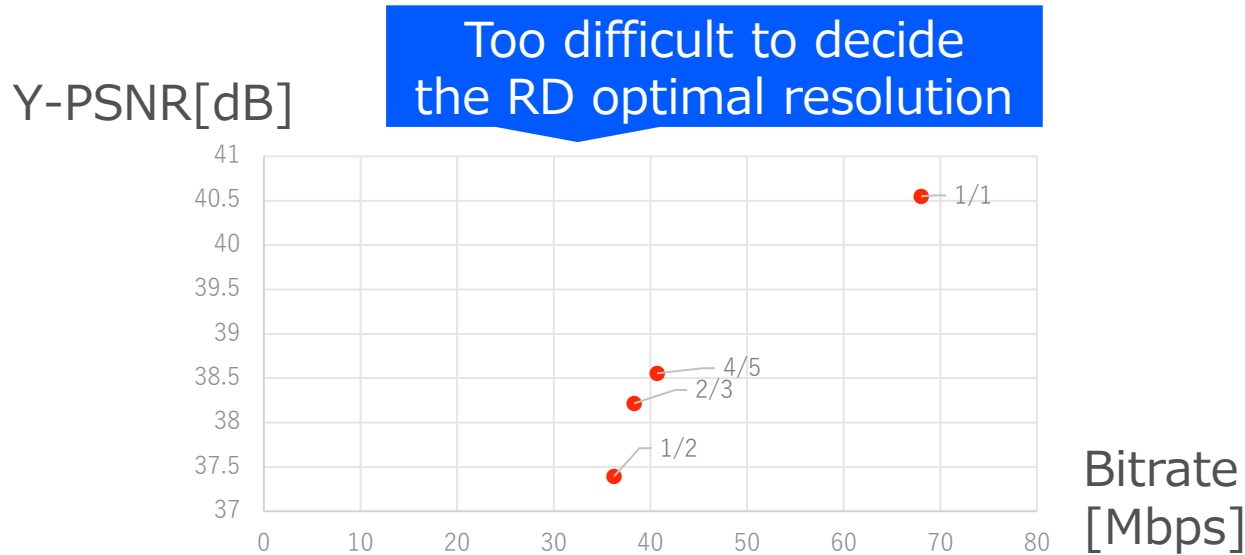
Random access Main10 (QP22,27,32,37,42)						Low delay B Main10 (QP22,27,32,37,42)						All Intra Main10 (QP22,27,32,37,42)					
BD-rate Over VTM-20.2						BD-rate Over VTM-20.2						BD-rate Over VTM-20.2					
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT		Y-PSNR	U-PSNR	V-PSNR	EncT	DecT		Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1	-3.72%	-0.65%	-3.66%	122%	59%	Class A1						Class A1	-0.63%	3.22%	-5.65%	124%	64%
Class A2	-1.47%	7.76%	5.32%	116%	81%	Class A2						Class A2	-2.44%	27.01%	16.57%	109%	71%
Class B	0.08%	-0.01%	-0.52%	173%	90%	Class B	-0.20%	-0.78%	-1.56%	191%	87%	Class B	-0.10%	-0.53%	-0.68%	149%	89%
Class C	0.00%	0.00%	0.00%	165%	97%	Class C	0.00%	0.00%	0.00%	181%	100%	Class C	0.00%	0.00%	0.00%	140%	100%
Class E						Class E	0.00%	0.00%	0.00%	216%	99%	Class E	0.00%	-0.01%	-0.01%	126%	101%
Overall	-1.01%	1.42%	0.16%	147%	83%	Overall	-0.08%	-0.33%	-0.65%	194%	94%	Overall	-0.54%	4.89%	1.63%	131%	85%
Class D	0.01%	-0.01%	0.02%	173%	99%	Class D	0.02%	0.06%	0.06%	176%	100%	Class D	0.01%	0.00%	0.01%	156%	101%

• BD-rate Over VTM-20.2 GOP-based RPR

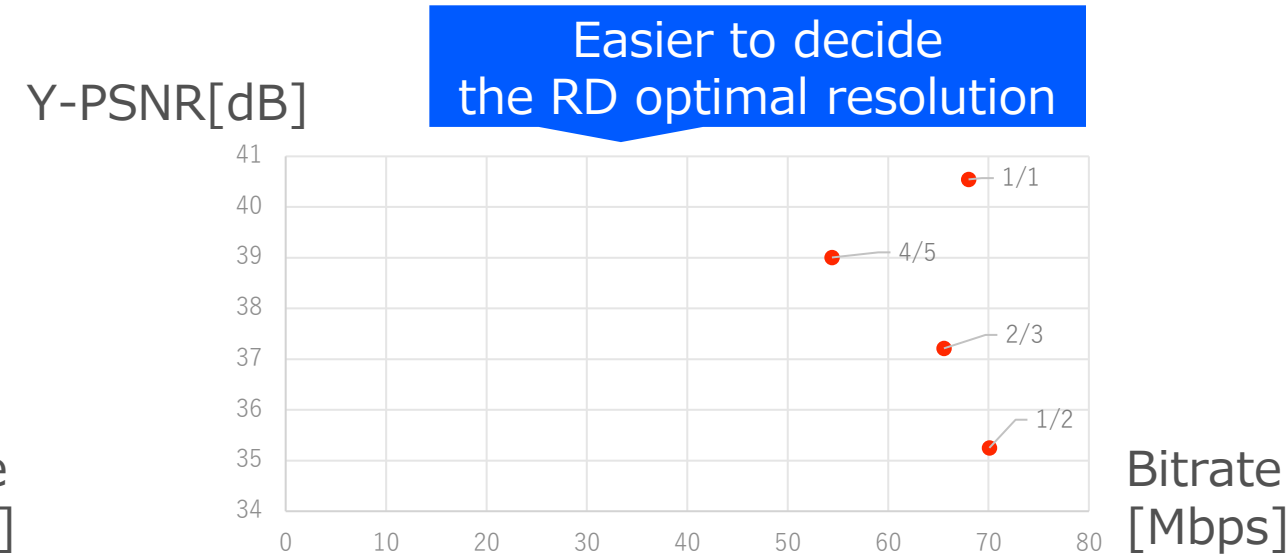
Random access Main10 (QP22,27,32,37,42)						Low delay B Main10 (QP22,27,32,37,42)						All Intra Main10 (QP22,27,32,37,42)					
BD-rate Over VTM-20.2 GOP-based RPR						BD-rate Over VTM-20.2 GOP-based RPR						BD-rate Over VTM-20.2 GOP-based RPR					
	Y-PSNR	U-PSNR	V-PSNR	EncT	DecT		Y-PSNR	U-PSNR	V-PSNR	EncT	DecT		Y-PSNR	U-PSNR	V-PSNR	EncT	DecT
Class A1	-0.43%	3.10%	0.32%	149%	111%	Class A1						Class A1	0.28%	5.16%	-3.66%	115%	77%
Class A2	-0.97%	1.74%	0.62%	135%	126%	Class A2						Class A2	-1.17%	13.36%	10.14%	109%	79%
Class B	0.09%	0.16%	0.54%	178%	101%	Class B	0.04%	-0.20%	-0.50%	193%	94%	Class B	-0.01%	0.07%	0.03%	144%	94%
Class C	0.00%	0.00%	0.00%	165%	98%	Class C	0.00%	0.00%	0.00%	181%	100%	Class C	0.00%	0.00%	0.00%	135%	100%
Class E						Class E	0.00%	0.00%	0.00%	217%	98%	Class E	0.00%	-0.01%	-0.01%	125%	101%
Overall	-0.25%	1.02%	0.37%	159%	106%	Overall	0.02%	-0.08%	-0.21%	195%	97%	Overall	-0.15%	3.10%	1.09%	127%	91%
Class D	0.01%	-0.01%	0.02%	170%	99%	Class D	0.02%	0.06%	0.06%	176%	100%	Class D	0.01%	0.00%	0.01%	155%	100%

- Campfire for the AI configuration of QP 27

➤ Default QP offsets (-2, -4, -6)



➤ Adjusting QP offsets (-4, -8, -12)



➤ Adjusting the QP offsets has been found to improve the BD-Rate.

(For Campfire, the BD-Rate improved from 0.68%/24.25%/-5.05% to -0.64%/1.15%/-0.38%)

- Further study is needed to extend the method to select multiple QP values and chroma QP offsets for each resolution to achieve better encoding performance.

- This contribution proposes GOP-based RPR encoder control using parallel resolution encoding.
- This method is especially beneficial for 4K resolution in the RA configuration.
 - -2.24%/-0.18%/-2.90% for Class A1
 - -1.14%/ 7.42%/ 5.36% for Class A2
- In the future, the proposed method could be further extended to select multiple QP values and chroma QP offsets for each resolution for better encoding performance.
- Thanks to Ericsson for crosschecking!