



# **JCTVC-F292: Recommendations for evaluation of scalable coding**

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# Introduction

- **Draft requirements document based on discussion on mpeg-hevc-ext reflector incorporates in Annex a method proposed by R. Sjöberg for computing scalability gain and cost vs. simulcast**
- **During SVC development, experimental test conditions typically specified required bitrates for particular resolution/frame rate operating points**
  - Example in JCT-P205
  - BD-bitrate/PSNR comparisons were made with scalable anchor, not simulcast and single-layer coding
- **Current test conditions very time and CPU consuming**
- **HM does not contain rate control**

# Discussion

- **For simplicity, discuss 2 spatial layers**
  - Simulcast = low resolution + high resolution layers
  - Scalability = base layer + enhancement layer
- **Rate control/QP selection**
  - Recommend to use a fixed QP differential between base and enhan layers
    - Specifically suggest base layer QP value 2 below enhan layer QP
  - Recommend using identical base layer for scalability and simulcast
  - Recommend using same QP for scalable enhan layer and simulcast low res
- **Unclear what are appropriate inputs to the BD-rate/BD-PSNR calculations**
  - In most cases, when simulcast high res and scalable enhan layer coded at same QP, simulcast high res has higher bitrate and higher PSNR

# Method 1

- Only the scalable enhancement layer and simulcast high resolution layer experimental data points and their bitrates and PSNR values are used in the BD-rate/BD-PSNR calculations
- Same QP to encode simulcast high res and scalable enhan layer
- Neglect impact of the difference in quality between simulcast high res and scalable enhan layer on the base layer
- Tends to magnify the coding gains/losses, because a smaller denominator is used
- Changes in bitrate do correspond more directly to the changes in PSNR of the higher resolution layer
- Scalable high res layer not individual decodable
  - Can't be used to compare to single-layer coding
  - Method not recommended

# Method 1 results for JCTVC-F290 data

High Resolution vs Enhancement Layer						
	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-40.5	-40.8	-44.0	-38.5	-37.4	-39.5
Class B	-31.8	-29.5	-31.3	-28.7	-26.7	-28.2
Class C	-18.8	-14.8	-13.4	-16.4	-14.9	-14.4
Class D	-16.0	-10.9	-9.7	-14.3	-12.4	-12.2
Class E	-34.4	-38.0	-35.3	-31.5	-35.2	-33.8
All	-26.8	-24.8	-24.6	-24.3	-23.5	-23.8

	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-34.5	-32.2	-35.6	-33.7	-28.2	-30.9
Class B	-29.9	-25.6	-26.7	-28.7	-23.0	-23.9
Class C	-21.4	-16.5	-15.0	-20.3	-15.6	-15.0
Class D	-13.6	-8.1	-7.6	-12.9	-8.2	-8.1
Class E						
All	-23.9	-19.4	-19.7	-22.9	-17.8	-18.2

	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-23.8	-23.3	-22.9	-23.4	-20.3	-18.6
Class C	-17.6	-14.7	-14.1	-16.7	-12.2	-11.7
Class D	-10.6	-7.7	-6.9	-10.1	-6.1	-5.6
Class E	-11.6	-11.2	-10.4	-12.0	-9.2	-7.3
All	-16.7	-15.0	-14.4	-16.3	-12.6	-11.5

# Method 2

- **Total bitrates of both layers are considered**
  - BD-rate/BD-PSNR calculations use simulcast low res + high res bitrates and high res PSNR vs. scalable base + enhan layer bitrates and enhan layer PSNR
  - Same base layer for both simulcast and scalable coding
- **As in method 1**
  - Same QP to encode simulcast high res and scalable enhan layer
  - Neglect impact of the difference in quality between simulcast high res and scalable enhan layer on the base layer
- **Method tends to disadvantage scalable coding**
  - Uses the same base layer for both simulcast and scalable, even though the high resolution qualities differ
  - Would expect simulcast low res layer quality/bitrate also to differ, corresponding to the quality differences of the simulcast high res layer

# Method 2 results for JCTVC-F290 data

Simulcast vs Scalable						
	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-24.3	-24.7	-28.5	-23.3	-22.0	-24.4
Class B	-20.2	-17.7	-19.8	-17.9	-16.0	-17.7
Class C	-12.7	-8.6	-7.2	-11.1	-9.5	-9.0
Class D	-11.0	-5.9	-4.6	-9.8	-7.9	-7.7
Class E	-20.5	-24.7	-21.5	-18.7	-23.0	-21.4
All	-17.0	-15.0	-14.9	-15.3	-14.6	-14.9

Random access						
	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-20.0	-17.1	-21.1	-19.5	-12.9	-16.0
Class B	-18.7	-14.0	-15.5	-17.8	-11.8	-12.9
Class C	-14.0	-8.8	-7.2	-13.2	-8.2	-7.6
Class D	-8.9	-3.2	-2.7	-8.3	-3.5	-3.4
Class E						
All	-15.0	-10.1	-10.6	-14.3	-8.8	-9.4

Low delay						
	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-14.9	-14.3	-14.0	-14.6	-11.3	-9.5
Class C	-11.6	-8.6	-8.0	-10.9	-6.3	-5.8
Class D	-6.9	-3.9	-3.1	-6.6	-2.4	-2.0
Class E	-7.1	-6.8	-6.1	-7.6	-4.9	-3.0
All	-10.6	-8.9	-8.3	-10.4	-6.6	-5.5

Single-Layer vs Scalable						
	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	16.2	15.7	9.8	17.6	19.6	15.9
Class B	14.5	18.8	15.9	18.1	20.9	18.5
Class C	21.1	26.8	28.9	23.2	25.3	26.1
Class D	22.0	29.1	30.9	23.4	26.0	26.4
Class E	22.1	15.7	20.7	24.4	17.8	20.3
All	19.1	22.0	22.2	21.4	22.3	22.0

Random access						
	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	22.5	27.1	20.9	22.7	33.0	28.0
Class B	15.8	22.9	20.7	16.8	25.4	23.8
Class C	20.7	28.1	30.4	21.5	28.6	29.4
Class D	24.3	32.2	32.7	24.9	31.7	31.8
Class E						
All	20.3	27.3	26.5	21.0	29.0	28.0

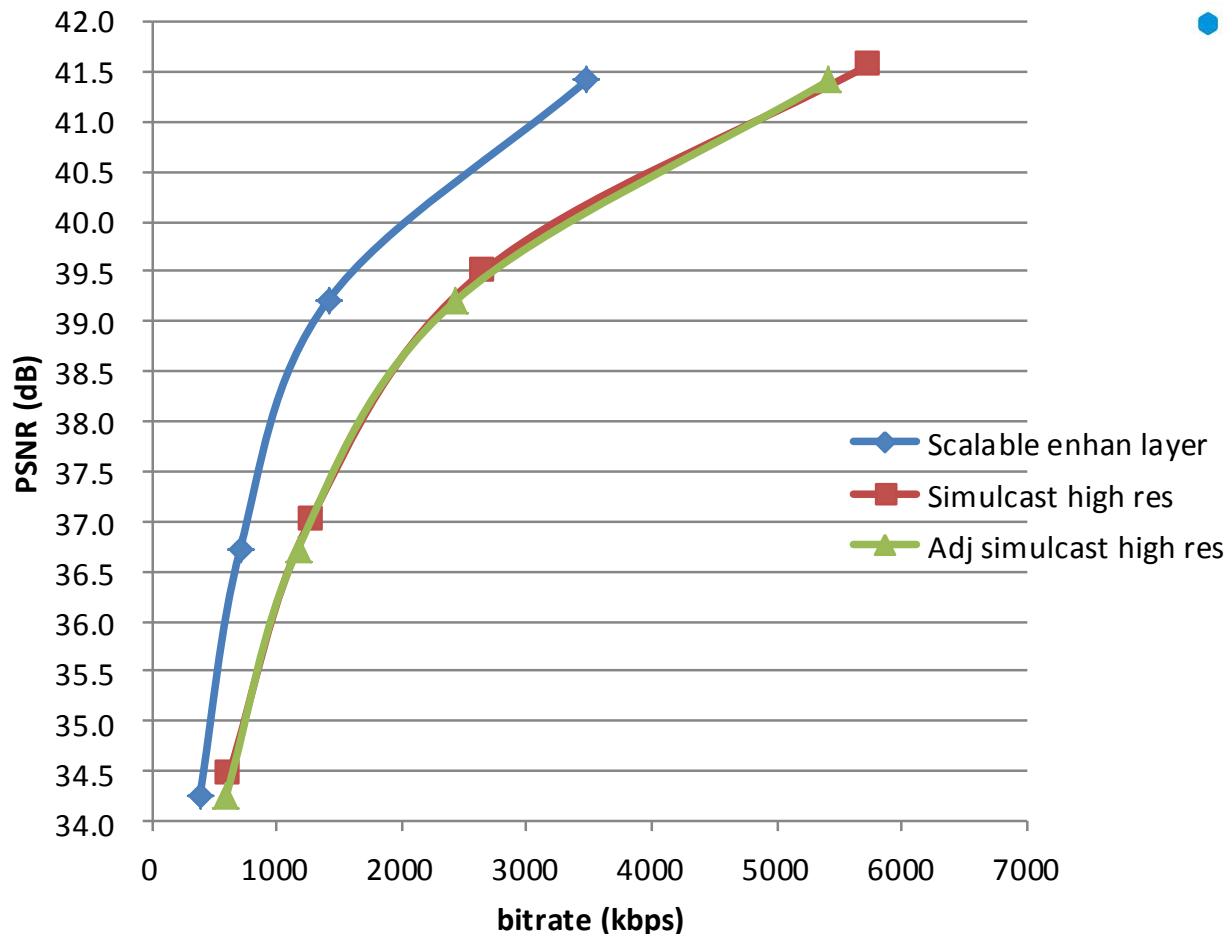
Low delay						
	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	21.3	22.6	23.0	21.6	26.2	28.8
Class C	24.3	28.6	29.5	24.8	31.5	32.2
Class D	26.5	30.9	32.0	26.8	32.8	33.1
Class E	38.4	39.3	40.3	37.3	41.2	44.2
All	26.6	29.3	30.1	26.7	32.0	33.6

# Method 3

- **Adjust simulcast high res bitrate/PSNR to match the scalable enhan layer PSNR**
- **As in Method 2**
  - Same base layer for both simulcast and scalable coding
  - Same QP to encode simulcast high res and scalable enhan layer
  - Total bitrates of both layers considered
- **Use piecewise linear estimation of  $\log(\text{bitrate})$  vs. PSNR to adjust simulcast bitrate/PSNR values used in BD-rate/BD-PSNR calculations**
  - Adjust simulcast, not scalable point, since simulcast high res layer is independently decodable, while scalable enhan layer depends on particular base layer



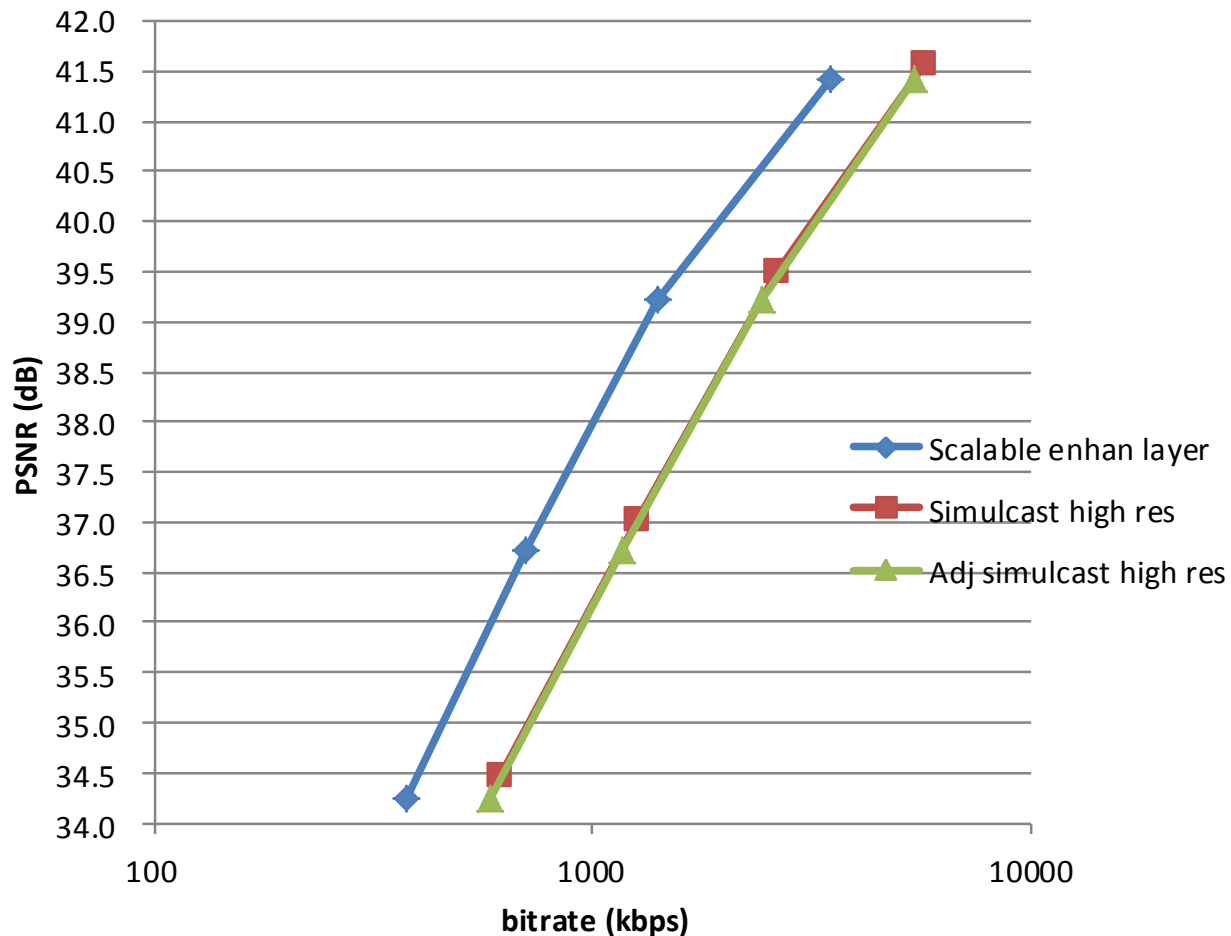
# Bitrate – PSNR curve on linear scale



- Green curve shows estimated point on simulcast high res curve to match scalable enhan layer PSNR

Example: Kimono sequence, Low Delay LoCo from JCTVC-F290

# Bitrate – PSNR curve on log-linear scale



- Almost linear relationship between PSNR and  $\log(\text{bitrate})$
- Use piece-wise linear approx. to estimate points

Example: Kimono sequence, Low Delay LoCo from JCTVC-F290

# Method 3 results for JCTVC-F290 data

	Simulcast vs Scalable					
	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-25.6	-25.4	-25.5	-24.4	-24.2	-24.2
Class B	-21.3	-21.3	-21.3	-19.2	-19.0	-19.0
Class C	-13.3	-13.2	-13.2	-11.6	-11.6	-11.6
Class D	-11.4	-11.3	-11.4	-10.2	-10.2	-10.2
Class E	-22.0	-21.9	-21.9	-20.1	-20.1	-20.1
All	-17.9	-17.9	-17.9	-16.3	-16.1	-16.2

	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-21.9	-21.8	-21.8	-21.4	-21.3	-21.3
Class B	-20.1	-20.2	-20.1	-19.4	-19.4	-19.2
Class C	-14.9	-14.9	-14.9	-14.2	-14.2	-14.2
Class D	-9.5	-9.5	-9.5	-9.0	-9.1	-9.1
Class E						
All	-16.1	-16.2	-16.1	-15.5	-15.5	-15.5

	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-15.9	-16.0	-16.1	-15.8	-15.8	-15.8
Class C	-12.2	-12.2	-12.2	-11.6	-11.6	-11.6
Class D	-7.4	-7.4	-7.4	-7.1	-7.1	-7.1
Class E	-7.9	-7.8	-7.9	-8.1	-8.1	-8.2
All	-11.4	-11.4	-11.4	-11.1	-11.1	-11.1

	Single-Layer vs Scalable					
	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	16.2	15.7	9.8	17.6	19.6	15.9
Class B	14.5	18.8	15.9	18.1	20.9	18.5
Class C	21.1	26.8	28.9	23.2	25.3	26.1
Class D	22.0	29.1	30.9	23.4	26.0	26.4
Class E	22.1	15.7	20.7	24.4	17.8	20.3
All	19.1	22.0	22.2	21.4	22.3	22.0

	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	22.5	27.1	20.9	22.7	33.0	28.0
Class B	15.8	22.9	20.7	16.8	25.4	23.8
Class C	20.7	28.1	30.4	21.5	28.6	29.4
Class D	24.3	32.2	32.7	24.9	31.7	31.8
Class E						
All	20.3	27.3	26.5	21.0	29.0	28.0

	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	21.3	22.6	23.0	21.6	26.2	28.8
Class C	24.3	28.6	29.5	24.8	31.5	32.2
Class D	26.5	30.9	32.0	26.8	32.8	33.1
Class E	38.4	39.3	40.3	37.3	41.2	44.2
All	26.6	29.3	30.1	26.7	32.0	33.6

# Recommendations

- **Recommend use of method 3 for assessment method**
  - Scalable coding shows slightly higher bitrate savings with Method 3 than with Method 2, although significantly less than with Method 1
- **Recommend use of fixed QP offsets for layers, rather than specifying target bitrates**