H0336 – CE4 Subtest 4.1: Higher granularity of quantization parameter scaling

Tammy Lee, Jeonghoon Park
Samsung Electronics Co., Ltd

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Introduction

- The quantization step size (QStep) of HEVC Test Model
  - QStep increases by approximately 12.25% with each increment of QP
  - QStep doubles when QP is increased by 6
  - QStep mapping is too coarse for fine and accurate rate/quality control
  - QStep mapping is not flexible to fit different application scenario

- Proposed adaptive delta QP signaling on higher granularity of quantization
  - It is proposed to have new **syntax** to signal **delta QP scale**
  - To support the finer granularity as well as the original granularity, the **granularity** of quantization is **doubled**

High granularity QStep mapping (1)

- A straightforward extension of current Qstep mapping
  - Double QP scaling accuracy
  - Qstep increases by approximately 5.95% with each increment of QP
  - Qstep doubles when QP is increased by 12

$$Qstep \approx 2^{\frac{QP-4}{6}}, \text{ with } QP = 0\ldots51 \quad \Rightarrow \quad Qstep \approx 2^{\frac{QP-8}{12}}, \text{ with QP} = 0\ldots103$$

- Quantiser process
  - Inverse quantiser

$$Y_{ij} = (Z_{ij} * DeqScale_{ij}(QP \% 12) << (QP/12)) >> dqbits$$

$$DeqScale[12] = \{40, 42, 45, 48, 51, 54, 57, 60, 64, 68, 72, 76\}$$

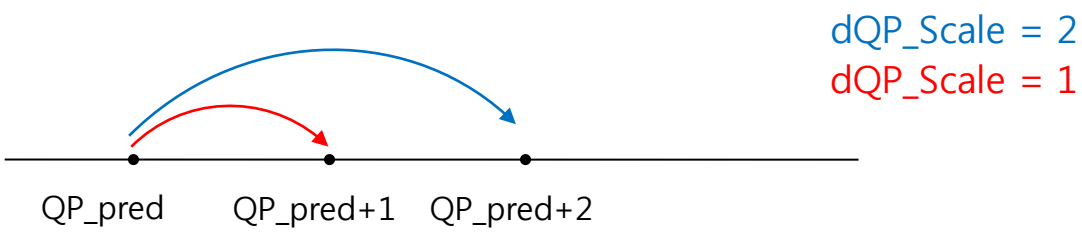
- Advantage of straightforward extension
  - Easy adaptation of other modules that is related to QP
    - Deblocking filter
    - CABAC context model initialization
    - Lambda value (Encoder side)

Adaptive delta QP signaling (1)

- To support the flexibility between better rate/quality control and dQP bits overhead, new **syntax** to signal **delta QP scale** is proposed
  - Slice level QP can be kept as highest level always
  - QP of current CU calculated as

$$QP\_curr = QP\_pred + dQP * dQP\_Scale$$

  - dQP_Scale controls CU-level QP update speed
  - dQP=1 with different dQP_Scale
    - dQP_Scale = 1 → Qstep increase 5.95%
    - dQP_Scale = 2 → Qstep increase 12.25%

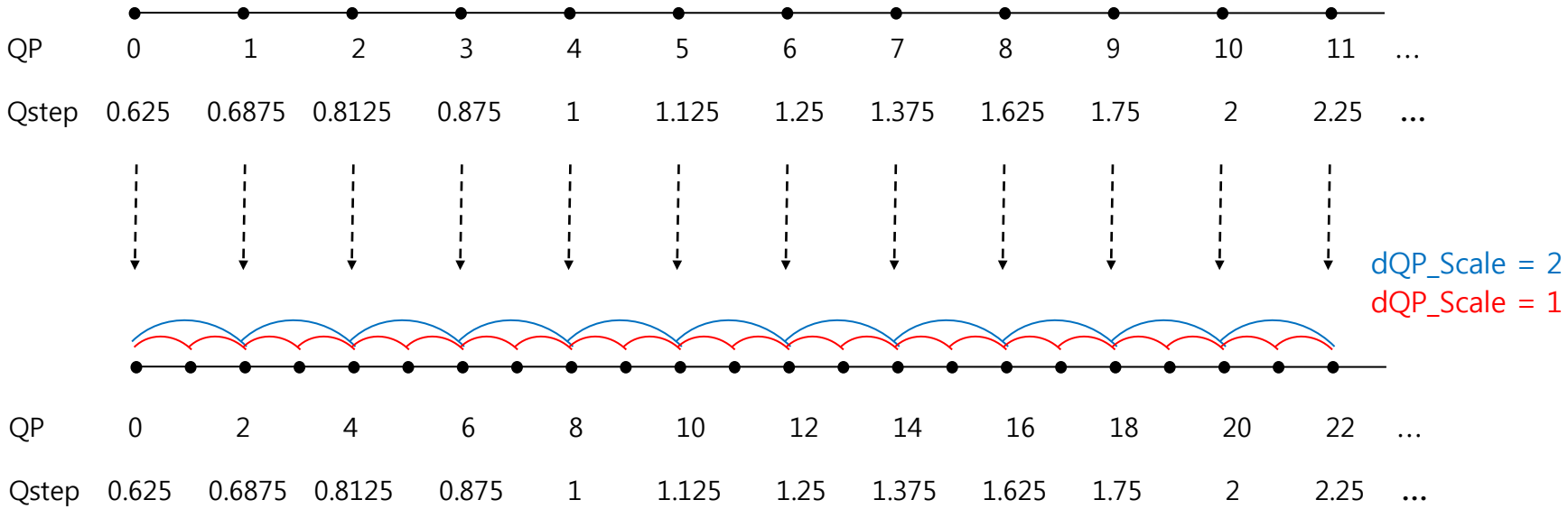


dQP=1 with different dQP_Scale

Adaptive delta QP signaling (2)

- To emulate current HEVC QP mapping solution,
  - Set Slice QP = even value (: doubled value of 22, 27, 32, 37) and dQP_scale = 2

- Example of CU-level QP update speed
  - Slice QP = even and dQP_Scale = 1 or 2



Experimental result

- Experiment on HM5.0
  - Common test configuration QP 44 54 64 74
    (equivalent to 22, 27, 32, 37 in HM5.0)
  - Additional test with QP+1 45 55 65 75
    (equivalent to 22.5, 27.5, 32.5, 37.5 in HM5.0)
  - Bit rate difference (QP+1) vs QP
    - Avg. 15.8 → 7.6%

	Results	AIHE	AILC	RAHE	RALC	RAHE10	LBHE	LBLC	Avg
HM5	BD-rate-Y	-0.3%	-0.3%	0.2%	0.2%	0.4%	0.3%	0.3%	0.1%
	dBitRate	-11.2%	-10.6%	-17.7%	-16.8%	-16.2%	-19.6%	-18.7%	-15.8%
Prop.	BD-rate-Y	0.6%	0.8%	0.6%	0.6%	0.7%	0.6%	0.5%	0.6%
	dBitRate	-4.9%	-4.8%	-8.5%	-8.0%	-8.0%	-9.7%	-9.2%	-7.6%

→ When slice-based QP control is enabled,
the higher granularity supports fine and accurate rate/quality control

Summary

- Double the QStep granularity of HEVC
  - 12.25% -> 5.95% QStep increase with each QP increment
  - Avg. 15.8% ->7.6% bit difference with each QP difference by 1

- Adaptive delta QP signalling with dQP_Scale in slice header
  - Control CU level QStep/QP update speed
    - Trade-off of better rate/qualilty control and dQP bits overhead
  - Slice level high QP mapping granularity
  - Easy adaptation of other modules that is related to QP

Thank you !