Proposal of enhanced PCM coding in HEVC
(JCTVC-E192/ M19710)

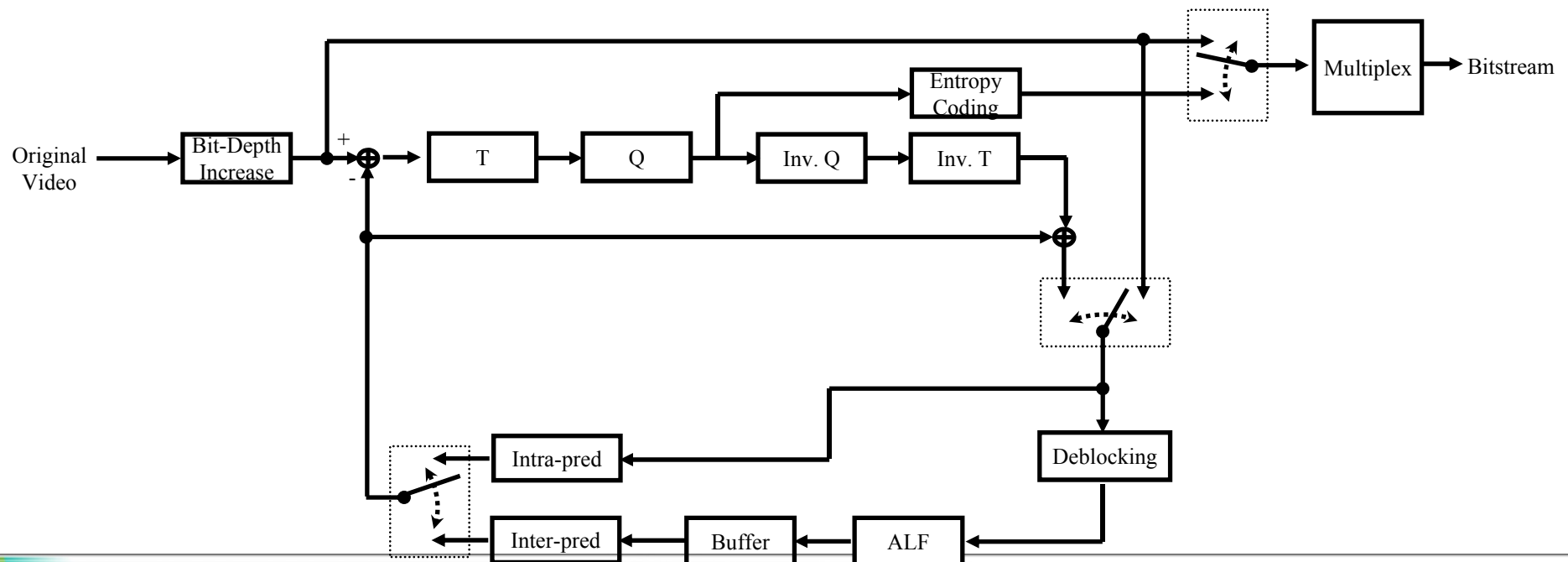**Keiichi Chono**

Hirofumi Aoki

NEC Corporation

Viktor Wahadaniah

ChongSoon Lim

Panasonic Corporation

Summary

- PCM coding

- Two issues of PCM coding
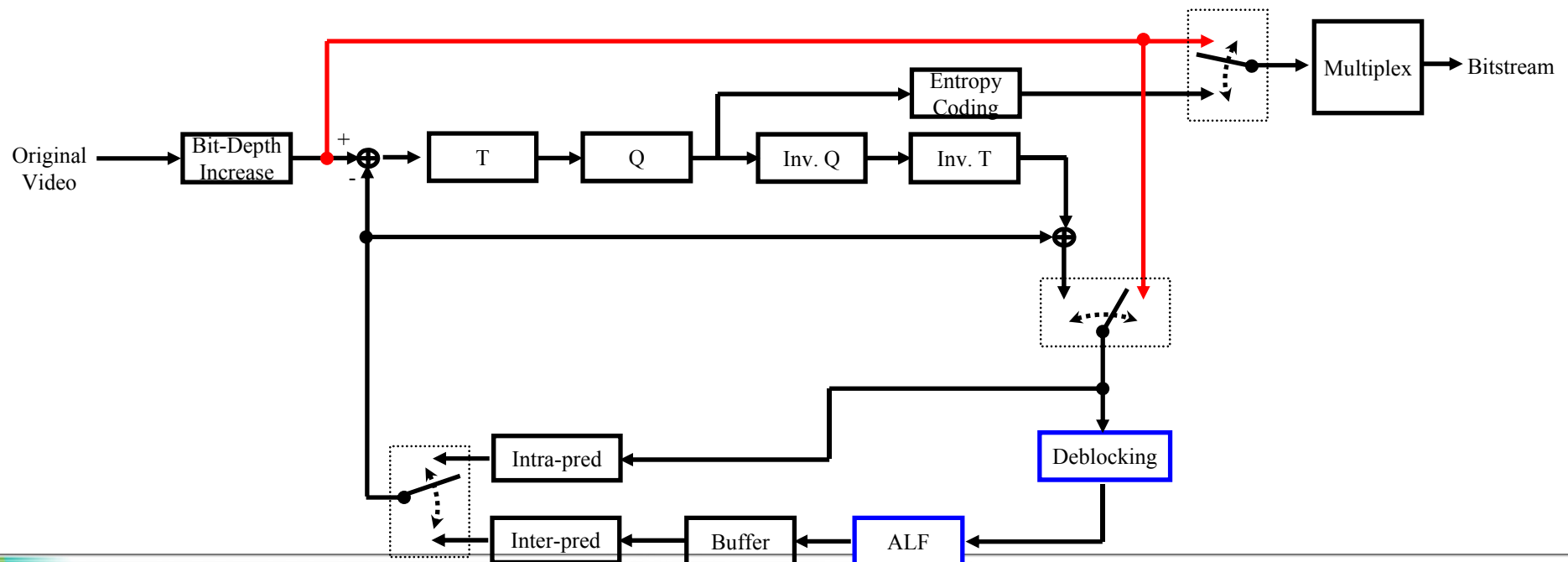
- Propose two SPS syntaxes

- Recommendations

Empowered by Innovation **NEC**

JCTVC-E057 PCM Coding

- Concept is identical to AVC's I_PCM
- Conditionally transmit single-bit syntax "pcm_flag" in PU header when PU is 2Nx2N intra

Empowered by Innovation **NEC**
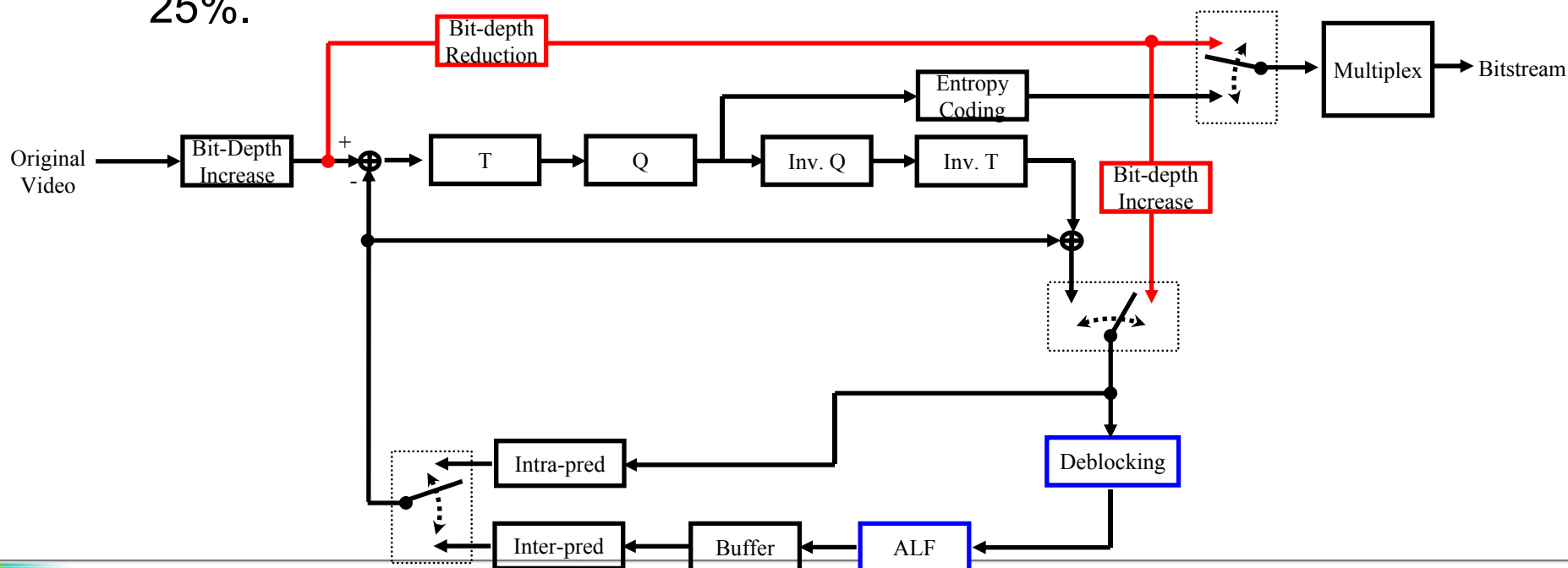
Two issues in PCM Coding in HEVC

- PCM sample bit-depth is unnecessarily high when BDI is used
- In-loop filtering is applied on samples of I_PCM areas.

Empowered by Innovation   NEC
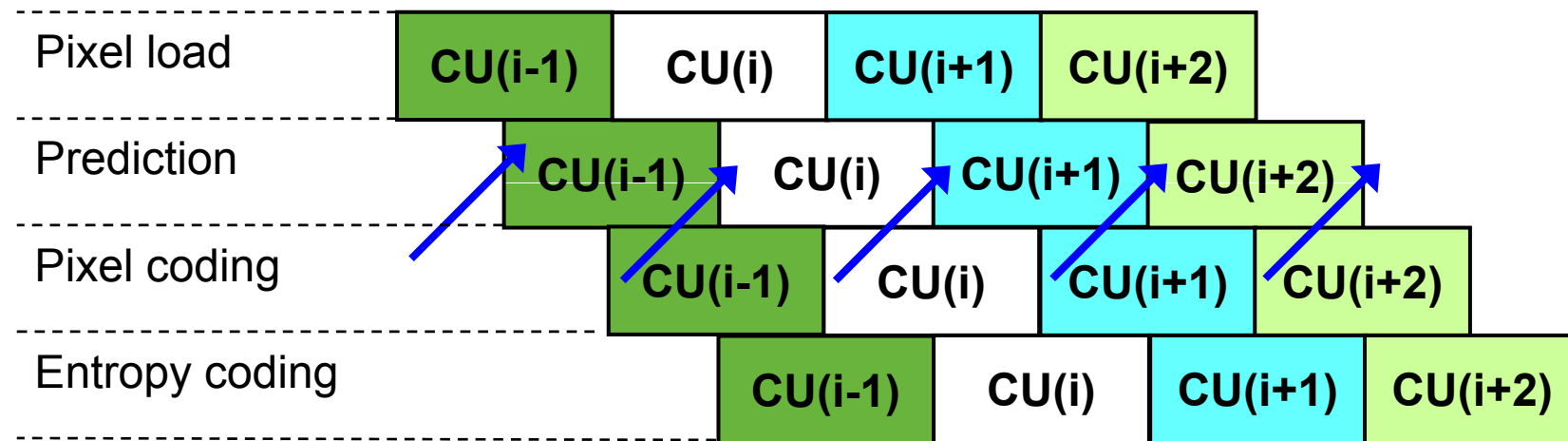
PCM Sample Bit-Depth Issues

- PCM sample bit-depth should conceptually be same as input bit-depth.

  - In current high efficiency coding condition, PCM sample bit-depth is 10-bit even for 8-bit test sequences.

  - LSBs of samples extended by BDI do not have any information about the input sample values and increase the amount of PCM data by 25%.

Empowered by Innovation **NEC**

PCM Sample Bit-Depth Issues (Cont.)

- On the other hand, some encoder implementations may code non-original (e.g. reconstructed) samples as I_PCM samples in order to avoid pipeline stalls. PCM sample bit-depth may be internal bit-depth in such implementations.

Pixel load	CU(i-1)	CU(i)	CU(i+1)	CU(i+2)
Prediction		CU(i-1)	CU(i)	CU(i+1) CU(i+2)
Pixel coding			CU(i-1)	CU(i) CU(i+1) CU(i+2)
Entropy coding				CU(i-1) CU(i) CU(i+1) CU(i+2)

→ Dependency due to intra-prediction

In-Loop Filter Issues

- Main purpose of deblocking filter (DBF) and ALF is to correct distortion associated with lossy compression

- When original uncompressed samples are coded as I_PCM samples, they are distortion free. Therefore in-loop filtering processes should conceptually be skipped.

p_2 p_1 p_0 q_0 q_1 q_2

Disable both ALF and DBF for all samples including p_2, p_1, and p_0

I_PCM containing original samples

Non-I_PCM (intra/inter-predicted)

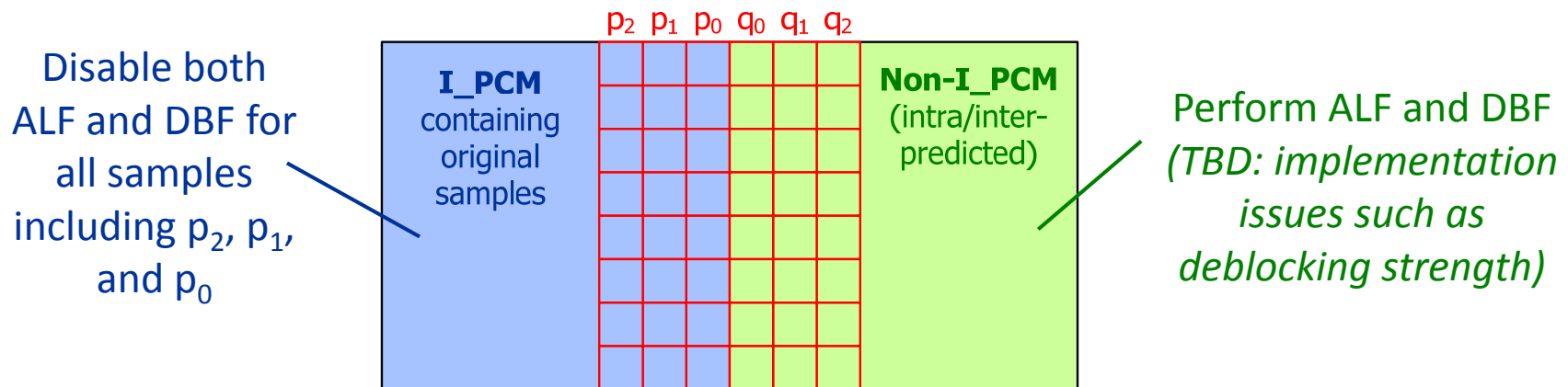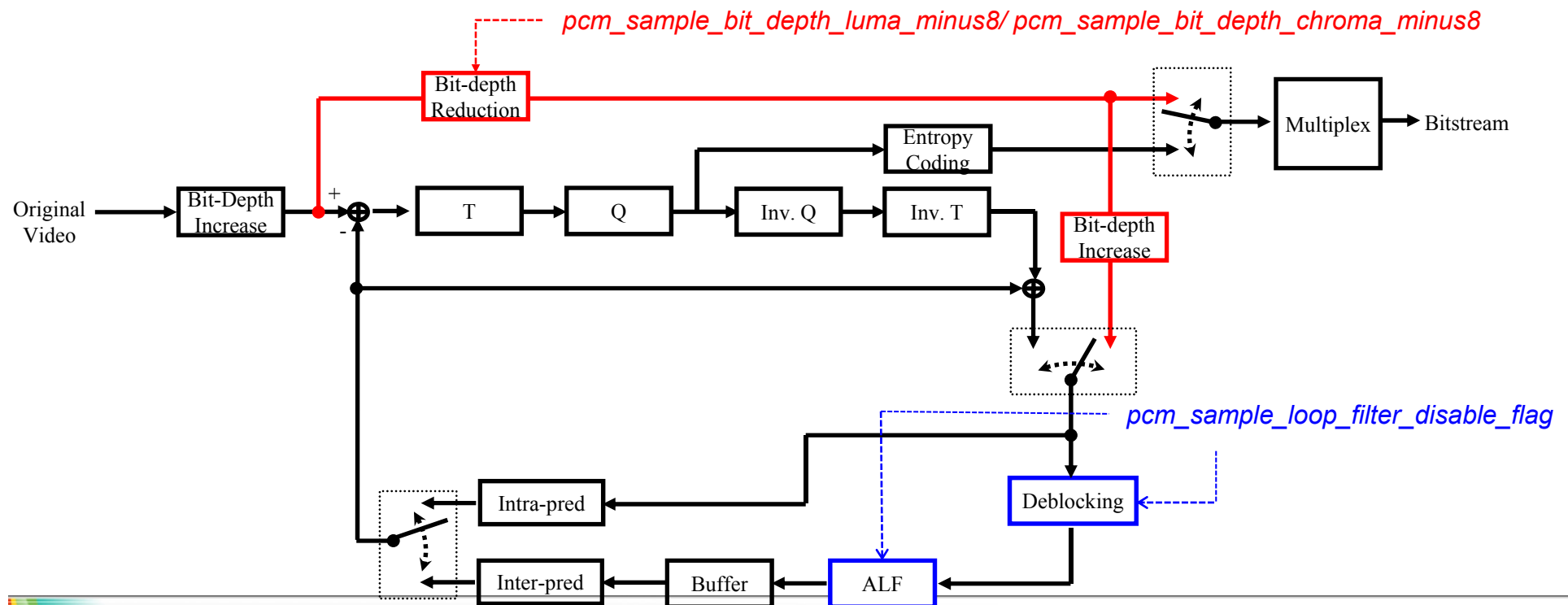Perform ALF and DBF *(TBD: implementation issues such as deblocking strength)*

- On the other hand, some encoder implementations may code non-original (e.g. reconstructed) samples as I_PCM samples. Performing in-loop filtering may be useful/necessary in such implementations.

Empowered by Innovation **NEC**

Proposals

New syntaxes in SPS:

• *pcm_sample_bit_depth_xxx_minus8* to allow encoder to transmit PCM sample values with their preferred bit-depth

• *pcm_sample_loop_filter_disable_flag* into SPS to enable/disable both ALF and DBF.

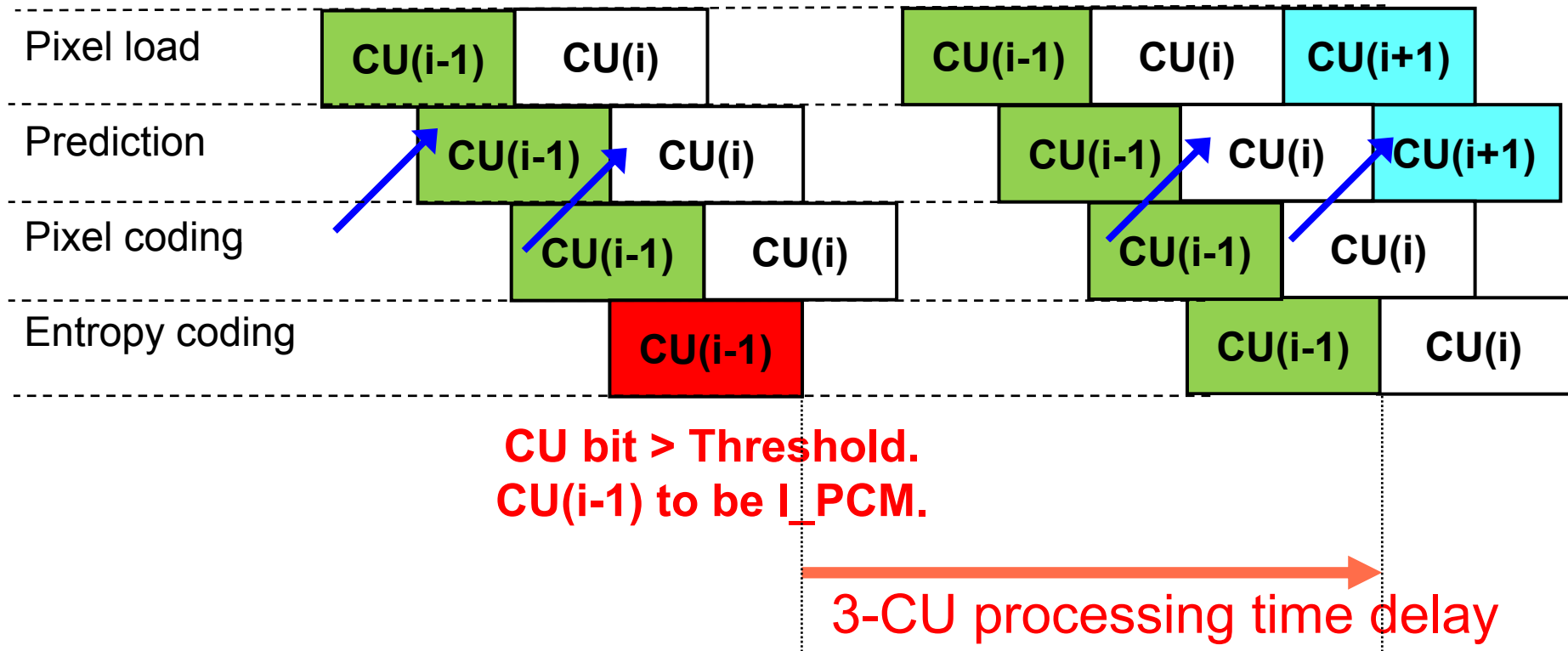Empowered by Innovation **NEC**

Conclusions and recommendations

- PCM coding

- Two issues of PCM coding in HEVC

- Propose two SPS syntaxes

- Recommendations
  - Adopt the JCTVC-E057 PCM coding into HM ver.3
  - Discuss the necessity of the two SPS syntaxes
  - Adopt the SPS syntaxes into HM ver. 3

Empowered by Innovation **NEC**

Empowered by Innovation

NEC

Appendix: Example of pipeline stall

Pixel load	CU(i-1)	CU(i)			CU(i-1)	CU(i)	CU(i+1)
Prediction		CU(i-1)	CU(i)			CU(i-1)	CU(i)	CU(i+1)
Pixel coding			CU(i-1)	CU(i)			CU(i-1)	CU(i)
Entropy coding				CU(i-1)				CU(i-1)	CU(i)

CU bit > Threshold.
CU(i-1) to be I_PCM.

3-CU processing time delay

→ Dependency due to intra-prediction

Empowered by Innovation **NEC**

Appendix: Benefits of PCM bit-depth syntax

> • PCM bit-depth reduction and increase avoid yielding # of bits far exceeding input data size

| | QP | HE Intra | | | | | | | | | | Relative dec. [%] |
| | | Proposal with pcm_bit_depth=internal_bit_depth | | | | | Proposal with pcm_bit_depth=input_bit_depth | | | | | |
		kbps	PSNR Y	Enc T [s]	Dec T [s]	Com. Ratio	kbps	PSNR Y	Enc T [s]	Dec T [s]	Com. Ratio	
	0	47400	99.99	118.47	0.48	1.30	37799	99.99	118.49	0.41	1.05	83.85
Sandstorms	2	47399	99.99	116.75	0.48	1.30	37066	99.99	116.80	0.37	1.03	77.43
	7	47400	99.99	111.40	0.47	1.30	37167	99.99	111.35	0.37	1.03	79.91
	12	47401	99.99	104.84	0.48	1.30	37799	99.99	104.80	0.39	1.05	80.75
	17	36426	49.15	98.14	1.51	1.00	37167	99.99	97.20	0.45	1.03	29.87
	22	29675	43.44	90.36	1.44	0.81	29442	42.93	90.57	1.42	0.82	98.89
	27	24461	38.73	82.01	1.23	0.67	24461	38.73	81.93	1.25	0.68	101.30
	32	20699	33.97	75.66	1.11	0.57	20699	33.97	75.54	1.11	0.58	100.00
	37	17469	29.35	71.18	1.05	0.48	17469	29.35	71.12	1.05	0.49	100.00