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JCTVC-F214 Parallel deblocking improvement

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Introduction

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- To improve parallel deblocking filter(JCTVC-E181, E224)
  - There are two targets to provide more flexible configurations
    1. Parallel deblocking decision
       - The result of the decision for V filtering has to be stored because of H/V decision on reconstructed samples
    2. Parallel deblocking filter
       - To reduce the dependency between H and V filtering
         - » HM3.0 can remove the dependency between the same directional filtering

- Sony present two approaches to these
  1. H/V filtering on reconstructed samples
  2. Decision with central non-deblocked samples

Proposal1: H/V filtering on reconstructed samples

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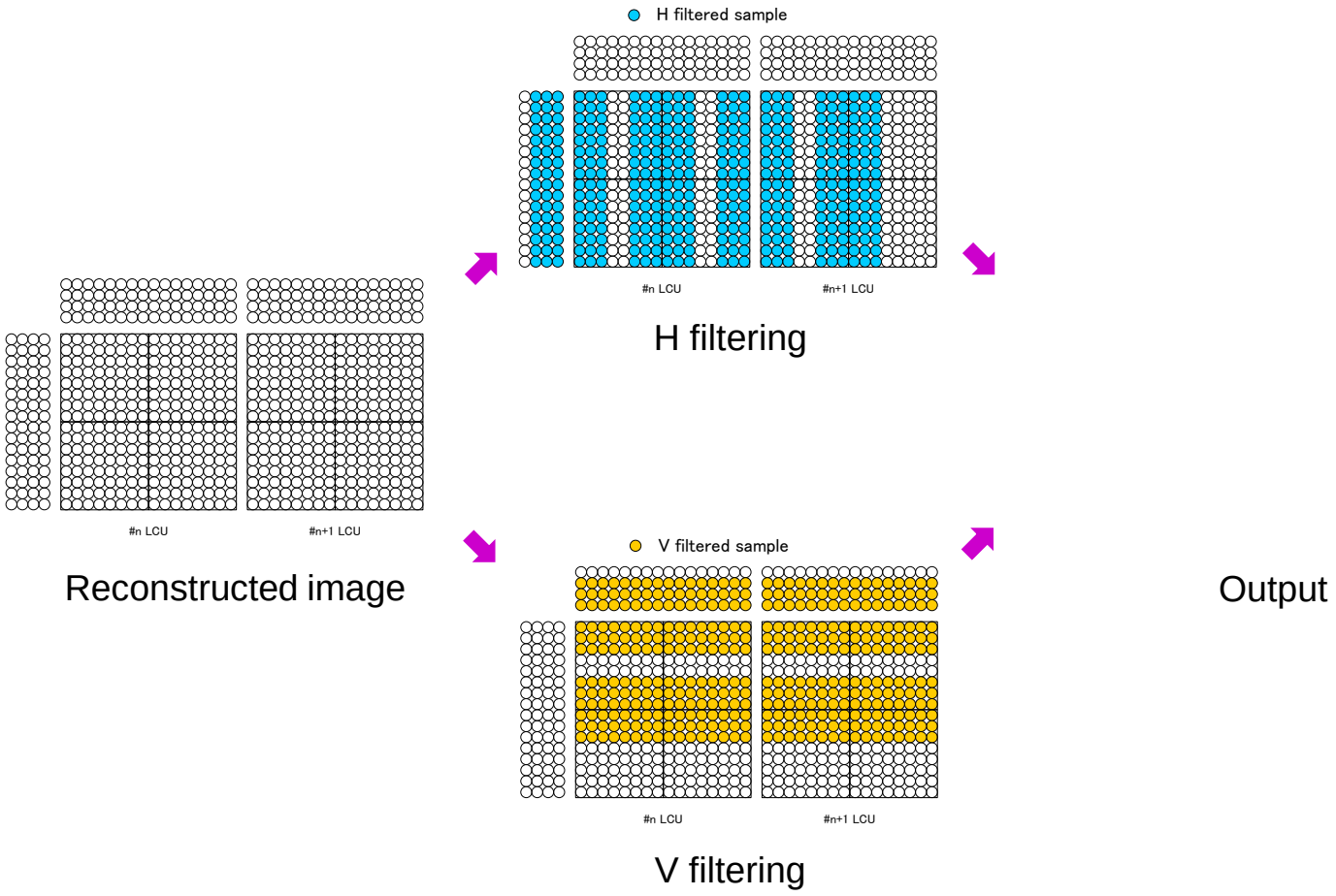
- Both H and V filtering is performed on reconstructed samples in parallel.



Proposal1: H/V filtering on reconstructed samples

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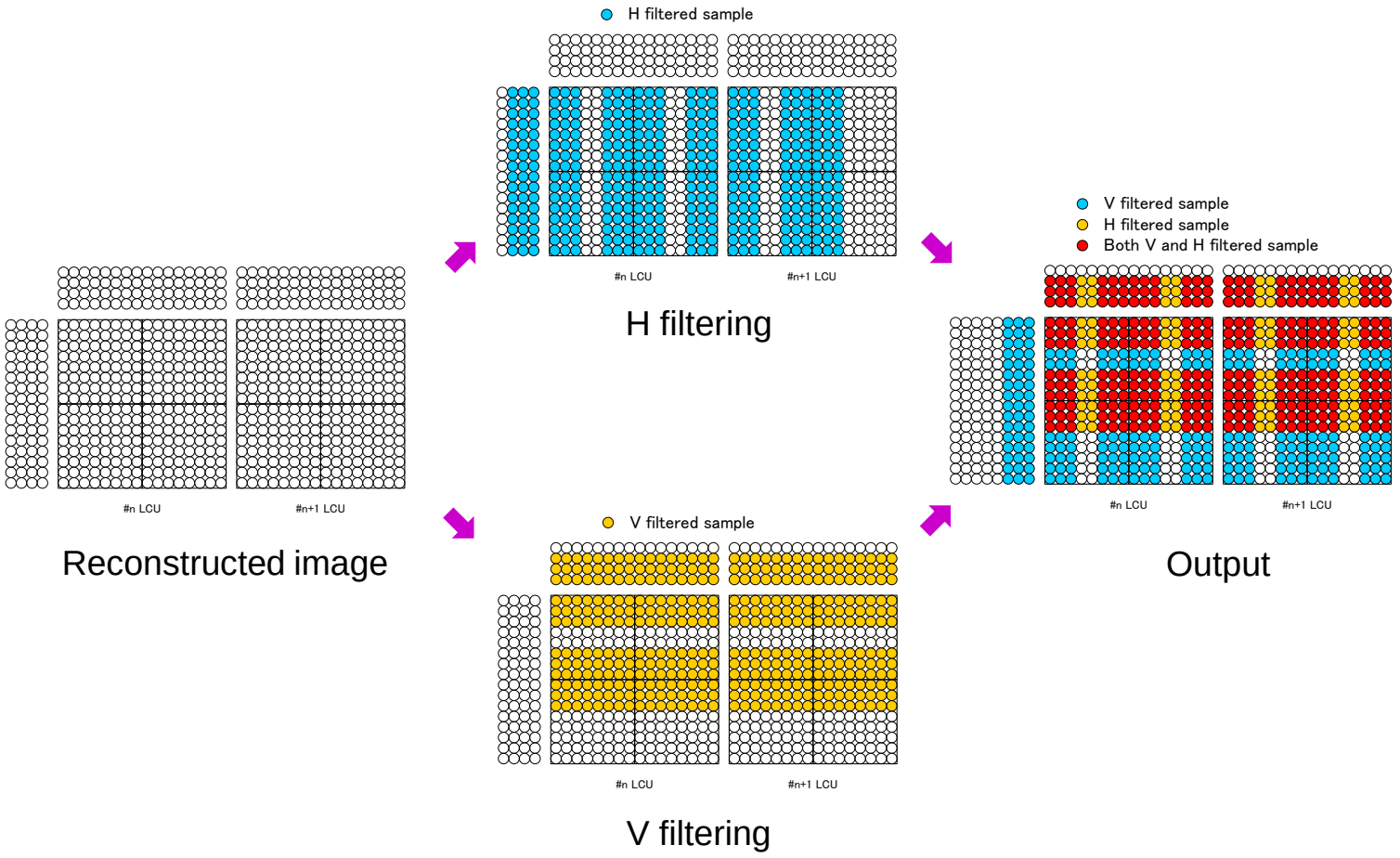
- Both H and V filtering is performed on reconstructed samples in parallel.



Proposal1: H/V filtering on reconstructed samples

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- Output is obtained by linear sum of both H and V filter as follows

$$P_{OUT} = P_{IN} + C_H*(P_H - P_{IN}) + C_V*(P_V - P_{IN})$$

$C_H(C_V)$ is either 1, 1/2 or 1/4 according to the position from vertical(horizontal) edge

P_{IN}: reconstructed sample value

$C_H*(P_H - P_{IN})$: difference value performed by H filter
P_H : H filtered sample value (same filtering as HM3.0)
C_H : H filter coefficient

$C_V*(P_V - P_{IN})$: difference value performed by V filter
P_V : V filtered sample value (same filtering as HM3.0)
C_V : V filter coefficient

Proposal1: H/V filtering on reconstructed samples

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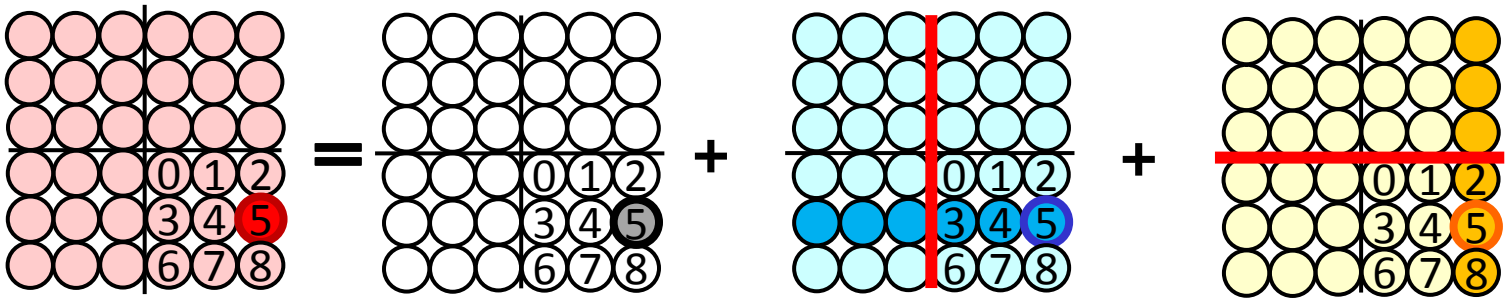
- Output is obtained by linear sum of both H and V filter as follows

$$P_{OUT} = P_{IN} + C_H*(P_H - P_{IN}) + C_V*(P_V - P_{IN})$$

$C_H(C_V)$ is either 1, 1/2 or 1/4 according to the position from vertical(horizontal) edge



P_{OUT} P_{IN} $1/4*(P_H - P_{IN})$ $1/2*(P_V - P_{IN})$

$C_H = 1/4$
(3^{rd} position from vertical edge)

$C_V = 1/2$
(2^{nd} position from horizontal edge)

Proposal1: H/V filtering on reconstructed samples

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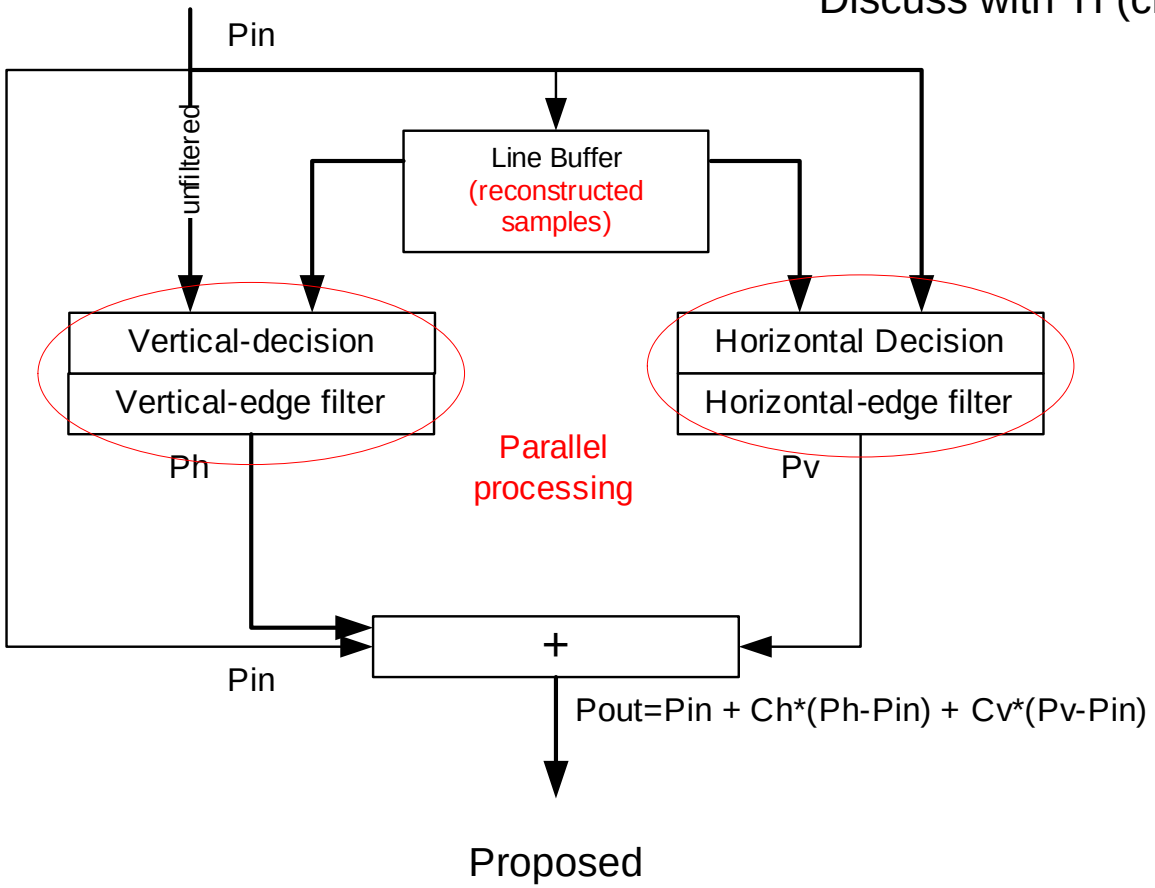
- Block diagram in LCU-based processing

Discuss with TI (cross-checker)



Proposal2: Decision with central non-deblocked samples

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- Decision(including deblocking on/off and strong/weak filter selection) is performed by only two lines

$p3_0$	$p2_0$	$p1_0$	$p0_0$	$q0_0$	$q1_0$	$q2_0$	$q3_0$
$p3_1$	$p2_1$	$p1_1$	$p0_1$	$q0_1$	$q1_1$	$q2_1$	$q3_1$
$p3_2$	$p2_2$	$p1_2$	$p0_2$	$q0_2$	$q1_2$	$q2_2$	$q3_2$
$p3_3$	$p2_3$	$p1_3$	$p0_3$	$q0_3$	$q1_3$	$q2_3$	$q3_3$
$p3_4$	$p2_4$	$p1_4$	$p0_4$	$q0_4$	$q1_4$	$q2_4$	$q3_4$
$p3_5$	$p2_5$	$p1_5$	$p0_5$	$q0_5$	$q1_5$	$q2_5$	$q3_5$
$p3_6$	$p2_6$	$p1_6$	$p0_6$	$q0_6$	$q1_6$	$q2_6$	$q3_6$
$p3_7$	$p2_7$	$p1_7$	$p0_7$	$q0_7$	$q1_7$	$q2_7$	$q3_7$

Horizontal edge

Proposal2: Decision with central non-deblocked samples

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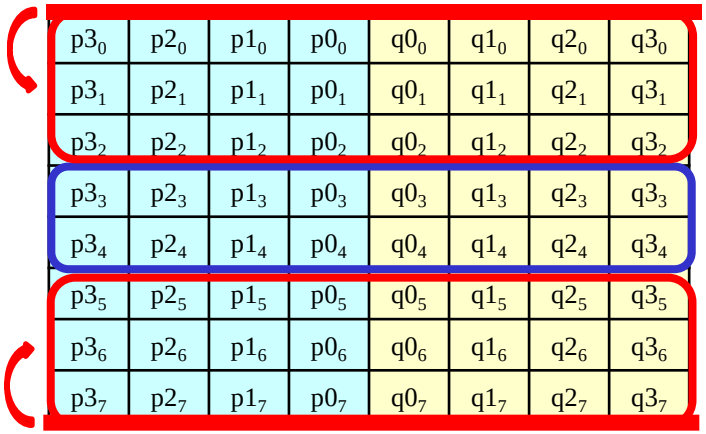
- Decision(including deblocking on/off and strong/weak filter selection) is performed by only two lines



Proposal2: Decision with central non-deblocked samples

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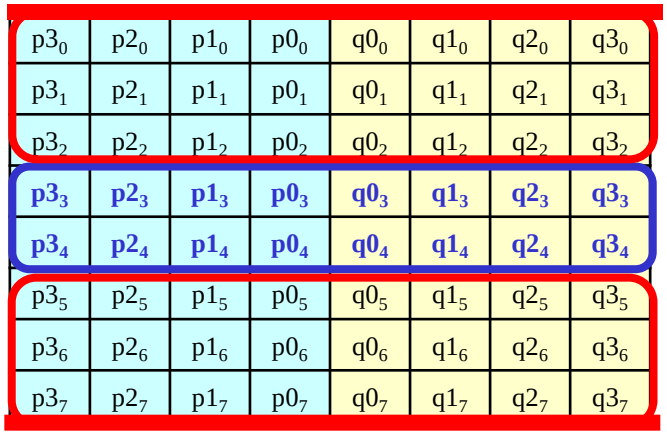

$$d_i = |p2_i - 2*p1_i + p0_i| + |q2_i - 2*p1_i + q0_i| \quad (i = 0..7)$$

	HM3.0	Proposal
Deblocking on/off	**d2**+**d5** < β	**d3**<(β>>1) && **d4**<(β>>1)

Strong/weak filter selection	Independent decision per line	if (line-3 and line-4 are strong)
		8 lines are strong filter,
		else
		8 lines are weak

Result1: H/V filtering on reconstructed samples

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- The difference of BD-rate with HM-3.0 is small
  - It has a small gains for luma and small losses for chroma
  - The run-time increases but the implementation isn't optimized
- The difference in subjective quality is negligible for the same sequences as CE12

※No parameter (β and T_c) is changed

	Intra			Intra LC		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.5	0.1	0.1	-0.3	0.3	0.2
Class B	-0.4	0.1	0.1	-0.1	0.3	0.3
Class C	-0.2	0.1	0.1	-0.1	0.3	0.3
Class D	-0.2	0.1	0.1	-0.1	0.3	0.3
Class E	-0.4	0.0	0.0	-0.1	0.2	0.2
All	-0.3	0.1	0.1	-0.1	0.3	0.3
Enc Time[%]	101%			101%		
Dec Time[%]	101%			104%		

	Random access			Random access LC		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.4	-0.1	0.2	-0.2	0.2	0.3
Class B	-0.3	0.0	0.1	-0.1	0.2	0.2
Class C	-0.1	0.2	0.0	0.0	0.2	0.2
Class D	-0.1	0.1	0.1	-0.1	0.0	0.2
Class E						
All	-0.2	0.1	0.1	-0.1	0.1	0.2
Enc Time[%]	100%			99%		
Dec Time[%]	102%			101%		

	Low delay			Low delay LC		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-0.2	0.1	0.3	0.0	-0.1	-0.2
Class C	-0.2	0.1	-0.1	0.0	0.2	-0.2
Class D	-0.2	0.2	0.2	-0.1	0.0	-0.4
Class E	-0.4	0.5	-0.1	-0.2	-0.2	-0.4
All	-0.2	0.2	0.1	-0.1	0.0	-0.3
Enc Time[%]	100%			100%		
Dec Time[%]	103%			103%		

Result2: Decision with central non-deblocked samples

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- The difference of BD-rate with HM-3.0 is negligible
- The decoding time decreases by 1 to 4%
- The difference in subjective quality is negligible for the same sequences as CE12

※No parameter (β and T_c) is changed

	Intra			Intra LC		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.1	0.0	0.0	0.0	0.0	0.0
Class B	-0.2	0.0	0.0	-0.1	0.0	0.0
Class C	-0.1	0.0	0.0	-0.2	0.0	0.0
Class D	-0.1	0.0	0.0	-0.1	0.0	0.0
Class E	0.0	0.0	0.0	0.0	0.0	0.0
All	-0.1	0.0	0.0	-0.1	0.0	0.0
Enc Time[%]	100%			100%		
Dec Time[%]	99%			98%		

	Random access			Random access LC		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.1	-0.1	0.2	0.1	-0.1	0.2
Class B	-0.1	-0.1	0.0	-0.1	0.0	0.0
Class C	-0.1	0.1	0.0	-0.1	0.1	-0.1
Class D	0.0	-0.1	-0.2	-0.1	-0.1	-0.1
Class E						
All	-0.1	0.0	0.0	-0.1	0.0	0.0
Enc Time[%]	100%			100%		
Dec Time[%]	98%			96%		

	Low delay			Low delay LC		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	0.0	0.2	0.3	0.0	0.0	-0.1
Class C	-0.1	0.1	-0.1	-0.1	0.1	0.0
Class D	0.0	0.4	0.1	-0.1	-0.1	-0.1
Class E	0.2	-0.1	-0.4	0.1	0.1	-0.3
All	0.0	0.2	0.0	0.0	0.0	-0.1
Enc Time[%]	100%			100%		
Dec Time[%]	100%			97%		

Conclusions

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- We, Sony, would like to propose “H/V filtering on reconstructed samples” more strongly
  - This proposal can provide the parallelization of H/V filter in LCU-based processing and is helpful to reduce the buffer (including one for the result of the decision) in LCU
  - This proposal can be harmonized with other proposals, such as decision, luma/chroma filtering and filtering with a long tap length

- This proposal is cross-verified by TI and SKT/SKKU
  - Proposal-1 is cross-verified by TI (JCTVC-F445)
  - Proposal-2 is cross-verified by SKT/SKKU (JCTVC-F267)