

AHG5: Unified intra prediction angles for 4:2:2 chroma format

JCTVC-M0127

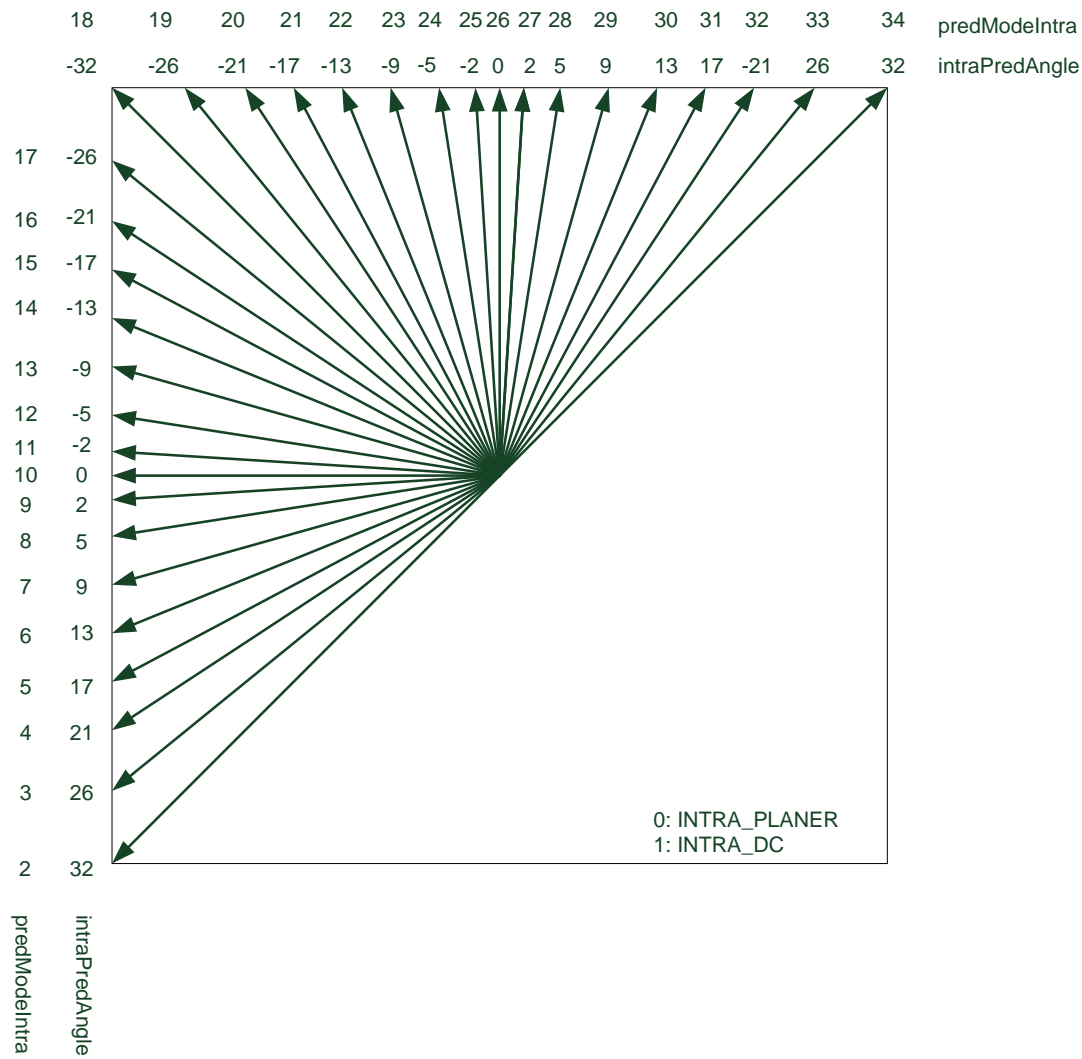
Hiroya Nakamura, Motoharu Ueda, Shigeru Fukushima, Toru Kumakura

1. Overview

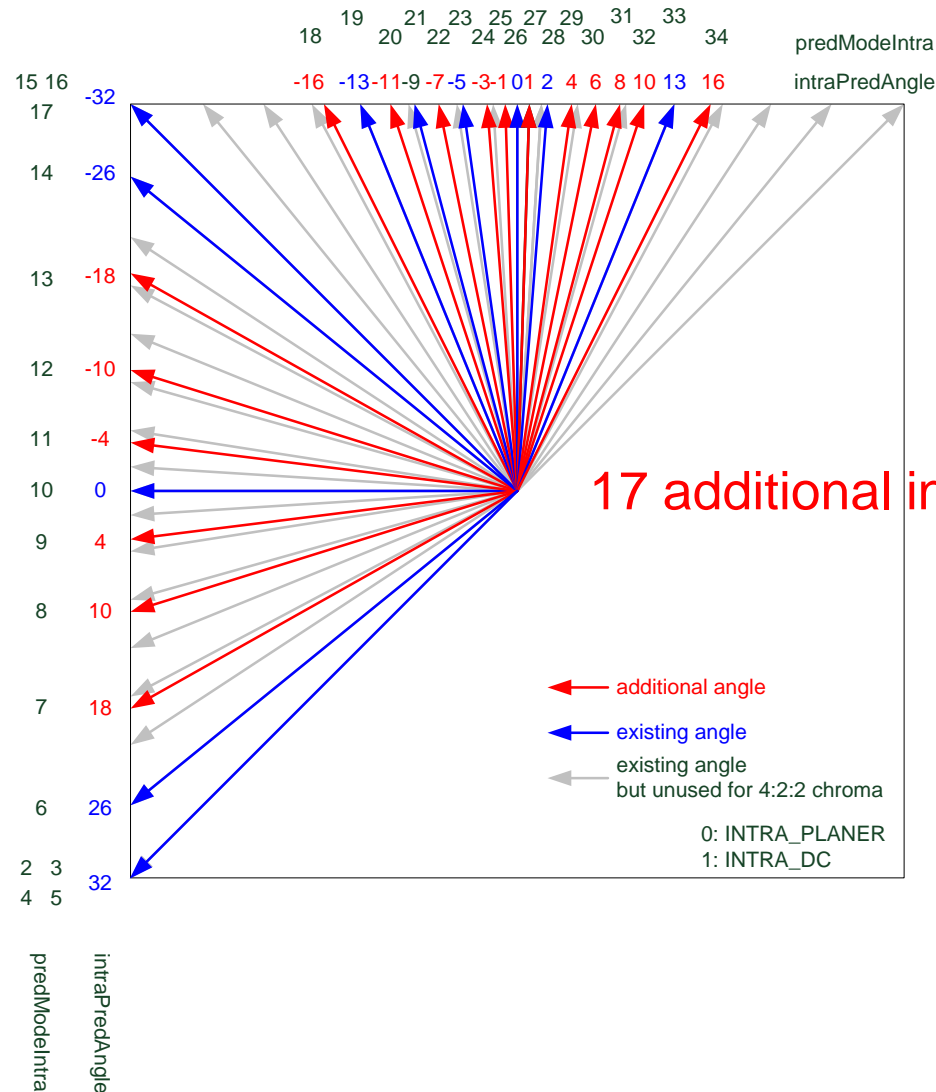
- Motivation
 - Intra prediction angle (HM-10.0-Rext-2.0)
- Proposals
 - Method A and B
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2. Motivation

Intra prediction angle (HEVC version 1)



Intra prediction angle for 4:2:2 chroma in HM-10.0-RExt-2.0



intraPredAngle for 4:2:2 chroma in HM-10.0-RExt-2.0

| predModelIntra | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|-----------------------------|-----|-----|-----|-----|-----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| intraPredAngle | - | 32 | 26 | 21 | 17 | 13 | 9 | 5 | 2 | 0 | -2 | -5 | -9 | -13 | -17 | -21 | -26 |
| intraPredAngle for 4:2:2 | - | 32 | 32 | 32 | 32 | 26 | 18 | 10 | 4 | 0 | -4 | -10 | -18 | -26 | -32 | -32 | -32 |
| predModelIntra | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
| intraPredAngle | -32 | -26 | -21 | -17 | -13 | -9 | -5 | -2 | 0 | 2 | 5 | 9 | 13 | 17 | 21 | 26 | 32 |
| intraPredAngle for 4:2:2 | -16 | -13 | -11 | -9 | -7 | -5 | -3 | -1 | 0 | 1 | 2 | 4 | 6 | 8 | 10 | 13 | 16 |

17 additional intra prediction angle

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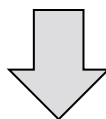
3. Proposals

Proposed method

- Intra prediction angles for 4:2:2 chroma are unified with existing intra prediction angles in HEVC version 1.
- The chroma intra prediction mode is changed for 4:2:2 chroma format
 - Two methods
 - Method A:
The mapped intra prediction mode is applied to
 - the decoding process of intra sample prediction
 - Method B:
The mapped intra prediction mode is applied to
 - the decoding process of intra sample prediction
 - the decision process of scanning order for residual coding (MDCS)
 - Three mapping tables
 - Proposal 1
 - Proposal 2
 - Proposal 3

Chroma intra prediction mode

| intra_chroma_pred_mode[xB][yB] | IntraPredModeY[xB][yB] | | | | |
|------------------------------------|----------------------------|----|----|----|--------------------|
| | 0 | 26 | 10 | 1 | X (0 <= X <= 34) |
| 0 | 34 | 0 | 0 | 0 | 0 |
| 1 | 26 | 34 | 26 | 26 | 26 |
| 2 | 10 | 10 | 34 | 10 | 10 |
| 3 | 1 | 1 | 1 | 34 | 1 |
| 4 | 0 | 26 | 10 | 1 | X |



| IntraPredModeC' | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|------------------------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| IntraPredModeC for 4:2:2 chroma | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 | 17 | 18 | 19 | 20 |
| IntraPredModeC' | | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
| IntraPredModeC for 4:2:2 chroma | | 21 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 31 |

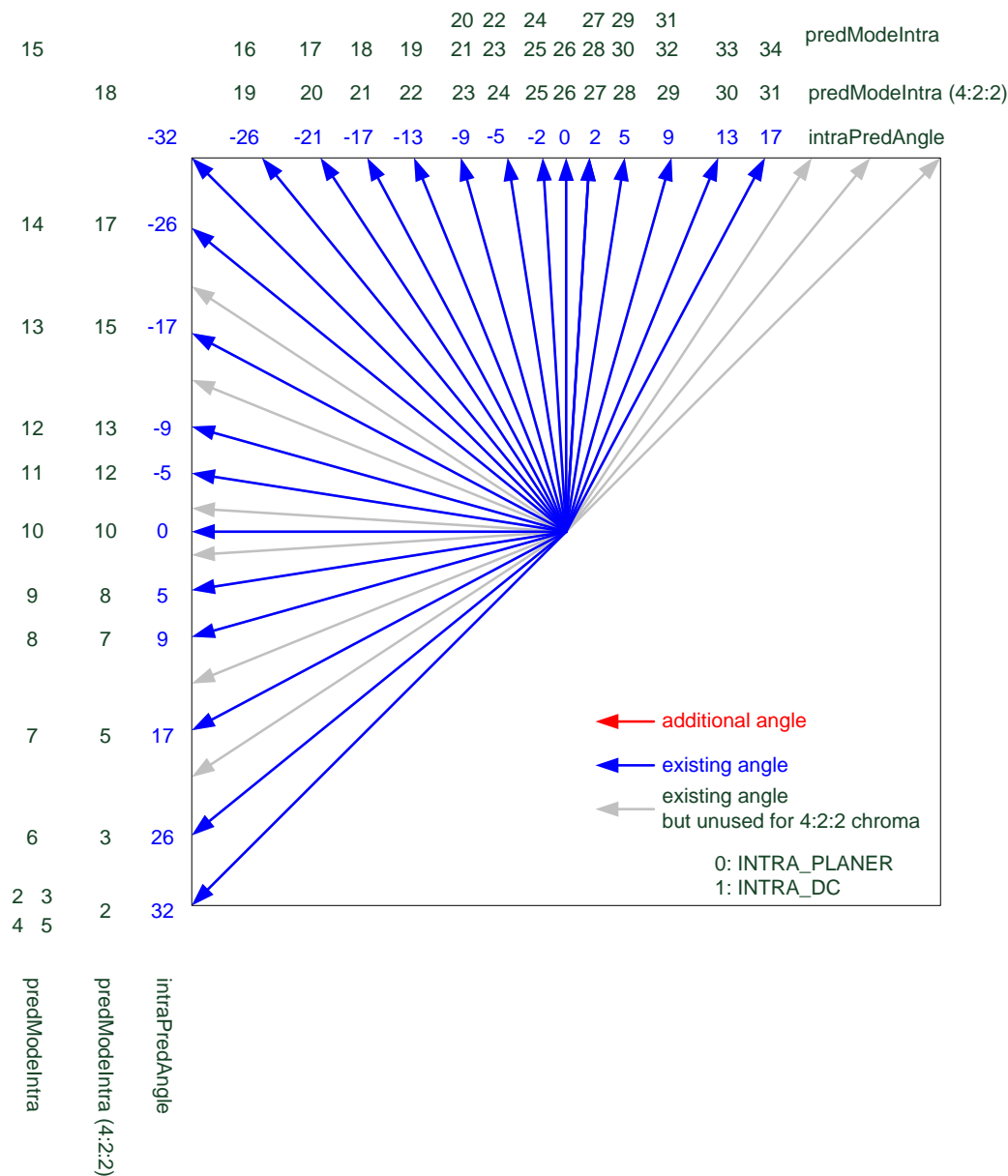
Intra Prediction Mode for 4:2:2 chroma

Proposal 1

| IntraPredModeC' | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|------------------------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| IntraPredModeC for 4:2:2 chroma | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 | 17 | 18 | 19 | 20 |
| IntraPredModeC' | | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
| IntraPredModeC for 4:2:2 chroma | | 21 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 31 |

Intra prediction angle for 4:2:2 chroma

Proposal 1



Intra Prediction Mode for 4:2:2 chroma Proposal 2

| IntraPredModeC' | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|------------------------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| IntraPredModeC for 4:2:2 chroma | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 18 | 18 | 18 |
| IntraPredModeC' | | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
| IntraPredModeC for 4:2:2 chroma | | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 |

Diagram illustrating the mapping of IntraPredModeC' to IntraPredModeC for 4:2:2 chroma. The mapping is shown in two rows of 18 values each. The top row (IntraPredModeC') has values 0 to 17. The bottom row (IntraPredModeC for 4:2:2 chroma) has values 0 to 17. The mapping is as follows:

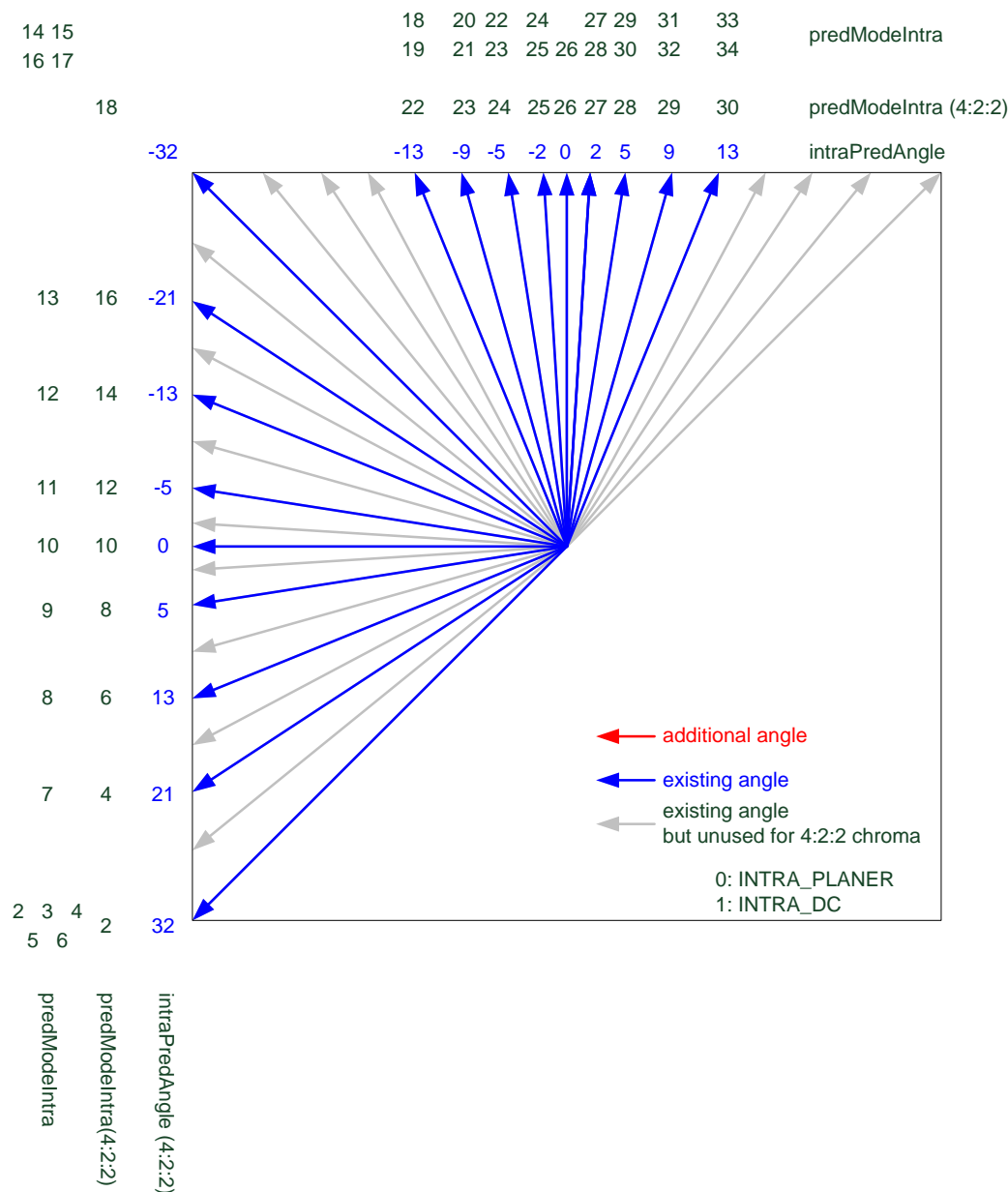
- IntraPredModeC' 0 maps to IntraPredModeC 0
- IntraPredModeC' 1 maps to IntraPredModeC 1
- IntraPredModeC' 2 maps to IntraPredModeC 2
- IntraPredModeC' 3 maps to IntraPredModeC 2
- IntraPredModeC' 4 maps to IntraPredModeC 2
- IntraPredModeC' 5 maps to IntraPredModeC 2
- IntraPredModeC' 6 maps to IntraPredModeC 2
- IntraPredModeC' 7 maps to IntraPredModeC 4
- IntraPredModeC' 8 maps to IntraPredModeC 6
- IntraPredModeC' 9 maps to IntraPredModeC 8
- IntraPredModeC' 10 maps to IntraPredModeC 10
- IntraPredModeC' 11 maps to IntraPredModeC 12
- IntraPredModeC' 12 maps to IntraPredModeC 14
- IntraPredModeC' 13 maps to IntraPredModeC 16
- IntraPredModeC' 14 maps to IntraPredModeC 18
- IntraPredModeC' 15 maps to IntraPredModeC 18
- IntraPredModeC' 16 maps to IntraPredModeC 18
- IntraPredModeC' 17 maps to IntraPredModeC 18

Arrows indicate the mapping from IntraPredModeC' to IntraPredModeC for 4:2:2 chroma. The mapping is as follows:

- IntraPredModeC' 8 maps to IntraPredModeC 6 (delta -1)
- IntraPredModeC' 9 maps to IntraPredModeC 8 (delta -1)
- IntraPredModeC' 10 maps to IntraPredModeC 10 (delta +1)
- IntraPredModeC' 11 maps to IntraPredModeC 12 (delta +1)
- IntraPredModeC' 12 maps to IntraPredModeC 14 (delta +1)
- IntraPredModeC' 13 maps to IntraPredModeC 16 (delta +1)
- IntraPredModeC' 14 maps to IntraPredModeC 18 (delta +1)
- IntraPredModeC' 15 maps to IntraPredModeC 18 (delta +1)
- IntraPredModeC' 16 maps to IntraPredModeC 18 (delta +1)
- IntraPredModeC' 17 maps to IntraPredModeC 18 (delta +1)

Intra prediction angle for 4:2:2 chroma

Proposal 2



Intra Prediction Mode for 4:2:2 chroma Proposal 3

| | | | | | | | | | | | | | | | | | | |
|------------------------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| IntraPredModeC' | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| IntraPredModeC for 4:2:2 chroma | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 21 | 21 |
| IntraPredModeC' | | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
| IntraPredModeC for 4:2:2 chroma | | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 |

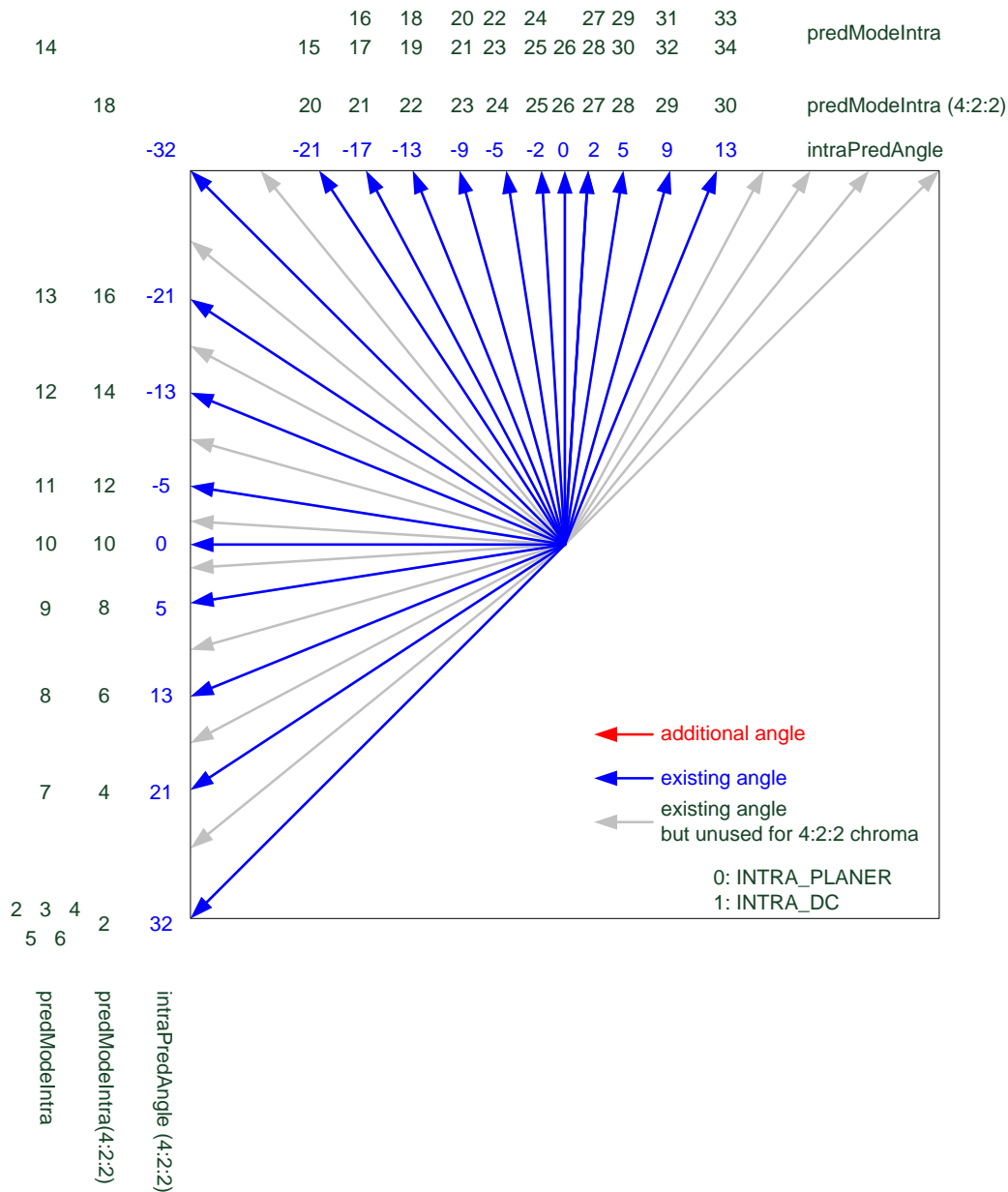
Diagram illustrating the mapping of IntraPredModeC' to IntraPredModeC for 4:2:2 chroma. The mapping is shown in two rows of 18 values each. The top row shows IntraPredModeC' values (0 to 17) and the bottom row shows IntraPredModeC values (0 to 34). The mapping is as follows:

- IntraPredModeC' 0 maps to IntraPredModeC 0
- IntraPredModeC' 1 maps to IntraPredModeC 1
- IntraPredModeC' 2 maps to IntraPredModeC 2
- IntraPredModeC' 3 maps to IntraPredModeC 2
- IntraPredModeC' 4 maps to IntraPredModeC 2
- IntraPredModeC' 5 maps to IntraPredModeC 2
- IntraPredModeC' 6 maps to IntraPredModeC 2
- IntraPredModeC' 7 maps to IntraPredModeC 4
- IntraPredModeC' 8 maps to IntraPredModeC 6
- IntraPredModeC' 9 maps to IntraPredModeC 8
- IntraPredModeC' 10 maps to IntraPredModeC 10
- IntraPredModeC' 11 maps to IntraPredModeC 12
- IntraPredModeC' 12 maps to IntraPredModeC 14
- IntraPredModeC' 13 maps to IntraPredModeC 16
- IntraPredModeC' 14 maps to IntraPredModeC 18
- IntraPredModeC' 15 maps to IntraPredModeC 20
- IntraPredModeC' 16 maps to IntraPredModeC 21
- IntraPredModeC' 17 maps to IntraPredModeC 21

Arrows indicate the mapping from IntraPredModeC' to IntraPredModeC. The mapping is as follows:

- IntraPredModeC' 8 maps to IntraPredModeC 6 (-1)
- IntraPredModeC' 9 maps to IntraPredModeC 8 (-1)
- IntraPredModeC' 10 maps to IntraPredModeC 10 (+1)
- IntraPredModeC' 11 maps to IntraPredModeC 12 (+1)
- IntraPredModeC' 12 maps to IntraPredModeC 14
- IntraPredModeC' 13 maps to IntraPredModeC 16
- IntraPredModeC' 14 maps to IntraPredModeC 18
- IntraPredModeC' 15 maps to IntraPredModeC 20
- IntraPredModeC' 16 maps to IntraPredModeC 21
- IntraPredModeC' 17 maps to IntraPredModeC 21

Intra prediction angle for 4:2:2 chroma Proposal 3



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4. Experiments

Simulation results of Proposal 1

Simulation results of Proposal 1A

| | All Intra Main-tier | | | All Intra High-tier | | | All Intra Super-High-tier | | |
|-------------|---------------------|-------|-------|---------------------|-------|-------|---------------------------|------|------|
| | Y | U | V | Y | U | V | Y | U | V |
| YCbCr 4:2:2 | 0.0% | -0.1% | -0.1% | 0.0% | -0.1% | -0.1% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 101% | | | 101% | | | 101% | | |
| Dec Time[%] | 100% | | | 100% | | | 99% | | |

Crosscheck: JCTVC-M0383 by Canon

Crosscheck: JCTVC-M0372 by Mitsubishi

Simulation results of Proposal 1B

| | All Intra Main-tier | | | All Intra High-tier | | | All Intra Super-High-tier | | |
|-------------|---------------------|-------|-------|---------------------|-------|-------|---------------------------|-------|-------|
| | Y | U | V | Y | U | V | Y | U | V |
| YCbCr 4:2:2 | -0.1% | -0.1% | -0.1% | -0.1% | -0.1% | -0.1% | 0.0% | -0.1% | -0.1% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | | 100% | | |

Crosscheck: JCTVC-M0372 by Mitsubishi

Simulation results of Proposal 2

Simulation results of Proposal 2A

| | All Intra Main-tier | | | All Intra High-tier | | | All Intra Super-High-tier | | |
|-------------|---------------------|------|------|---------------------|------|------|---------------------------|------|------|
| | Y | U | V | Y | U | V | Y | U | V |
| YCbCr 4:2:2 | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 101% | | | 101% | | | 101% | | |
| Dec Time[%] | 100% | | | 100% | | | 100% | | |

Crosscheck: JCTVC-M0383 by Canon

Simulation results of Proposal 2B

| | All Intra Main-tier | | | All Intra High-tier | | | All Intra Super-High-tier | | |
|-------------|---------------------|------|------|---------------------|------|------|---------------------------|------|------|
| | Y | U | V | Y | U | V | Y | U | V |
| YCbCr 4:2:2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | | 100% | | |

Simulation results of Proposal 3

Simulation results of Proposal 3A

| | All Intra Main-tier | | | All Intra High-tier | | | All Intra Super-High-tier | | |
|-------------|---------------------|------|------|---------------------|------|------|---------------------------|------|------|
| | Y | U | V | Y | U | V | Y | U | V |
| YCbCr 4:2:2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 101% | | | 101% | | | 100% | | |
| Dec Time[%] | 98% | | | 98% | | | 98% | | |

Crosscheck: JCTVC-M0372 by Mitsubishi

Simulation results of Proposal 3B

| | All Intra Main-tier | | | All Intra High-tier | | | All Intra Super-High-tier | | |
|-------------|---------------------|------|------|---------------------|------|------|---------------------------|------|------|
| | Y | U | V | Y | U | V | Y | U | V |
| YCbCr 4:2:2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | | 100% | | |

Crosscheck: JCTVC-M0372 by Mitsubishi

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5. Conclusion

Proposed method

- In this proposal, intra prediction angles for 4:2:2 chroma are unified with intra prediction angles for luma and 4:2:0/4:4:4 chroma.
No additional intra prediction angles for 4:2:2 chroma are required.
- Each intra prediction mode for 4:2:2 chroma is derived from intra prediction mode for luma and 4:2:0/4:4:4 chroma using a mapping table before the decoding process of intra sample prediction.
As a result, only existing intra prediction angles in HEVC version 1 are required as intra prediction angles for 4:2:2 chroma.
In Method B, decoding process of intra sample prediction is used without changing from HEVC version 1.
- It is recommended that this proposal be adopted into HEVC Range Extensions Text and HM-RExt.