

JCTVC-G543

Early SKIP Detection for HEVC

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Summary

- *An early detection of skip mode* to reduce the encoding complexity of HEVC is proposed
- The main concept is that the PU mode in a current CU is determined as *the skip mode at earliest possible stage*
- *This contribution is in the similar concept* with the early skip detection scheme implemented in H.264/AVC MPEG-4 Part 10 reference SW [1]
- It is reported that the contribution reduces *the encoding time by 33% and the decoding time by 2% with BD-bitrate loss of 0.45% on average.*
 - *Verification from JCTVC-G573(ETRI) and JCTVC-G794(Hanyang Univ.)*

[1] B. Jeon and J. Lee, "Fast mode decision for H.264," JVT-J033, Hawaii, USA, December 2003.

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graph TD; SKIP[SKIP mode] --> Inter2Nx2N[Inter 2Nx2N mode]; Inter2Nx2N --> InterNxN[Inter NxN mode]; InterNxN --> InterNx2N[Inter Nx2N mode]; InterNx2N --> Inter2NxN[Inter 2NxN mode]; Inter2NxN --> Inter2NxN_U[Inter 2NxN_U mode]; Inter2NxN_U --> Inter2NxN_D[Inter 2NxN_D mode]; Inter2NxN_D --> InternLx2N[Inter nLx2N mode]; InternLx2N --> InternRx2N[Inter nRx2N mode]; InternRx2N --> Intra2Nx2N[Intra 2Nx2N mode]; Intra2Nx2N --> IntraNxN[Intra NxN mode]; IntraNxN --> IntraPCM[Intra PCM mode]; IntraPCM -- Recursive call --> RC[Recursive call]; RC --> xCompressCU1[xCompressCU]; RC --> xCompressCU2[xCompressCU]; RC --> xCompressCU3[xCompressCU]; RC --> xCompressCU4[xCompressCU];
```
- The flowchart illustrates the recursive call process for video encoding modes. It starts with the SKIP mode, which leads to the Inter 2Nx2N mode. This mode then branches into the Inter NxN mode (dashed box) and the Inter Nx2N mode. The Inter Nx2N mode leads to the Inter 2NxN mode, which then branches into the Inter 2NxN\_U mode and the Inter 2NxN\_D mode. The Inter 2NxN\_D mode leads to the Inter nLx2N mode, which then leads to the Inter nRx2N mode. The Inter nRx2N mode leads to the Intra 2Nx2N mode, which then branches into the Intra NxN mode (dashed box) and the Intra PCM mode. The Intra PCM mode leads to a Recursive call, which then branches into four xCompressCU blocks.

Fig. 1. Encoding process in a current CU( $2N \times 2N$ ) for *HM4.0*

# Remind - Early Skip Detection in JM

- There is a fast mode decision tool in MPEG-4 Part 10 AVC/H.264 reference SW (JM software), namely, an early skip detection [1]
  - In JM software, the partition mode in a current MB is determined as *the skip mode* at earliest possible stage when the encoding results of *16x16 block partition mode* are satisfied with table 1

**Table 1. Early skip conditions in JM software**

1. Reference picture is just previous one
2.  $MVD=(0, 0)$
3.  $CBP=0$

[1] B. Jeon and J. Lee, "Fast mode decision for H.264," JVT-J033, Hawaii, USA, December 2003.

# Proposed Method

- *Similar to the concept* of the early skip detection in JM software
  - The PU mode in a current CU is determined as *the skip mode* at earliest possible stage when the encoding results of *the best one of two inter 2Nx2N modes (Competition & Merge)* are satisfied with table 2

**Table 2. Proposed early skip conditions for HEVC**

1.  $MVD=(0, 0)$
2.  $CBF=0$  for luma and chroma

# Proposed Method - Flow Chart

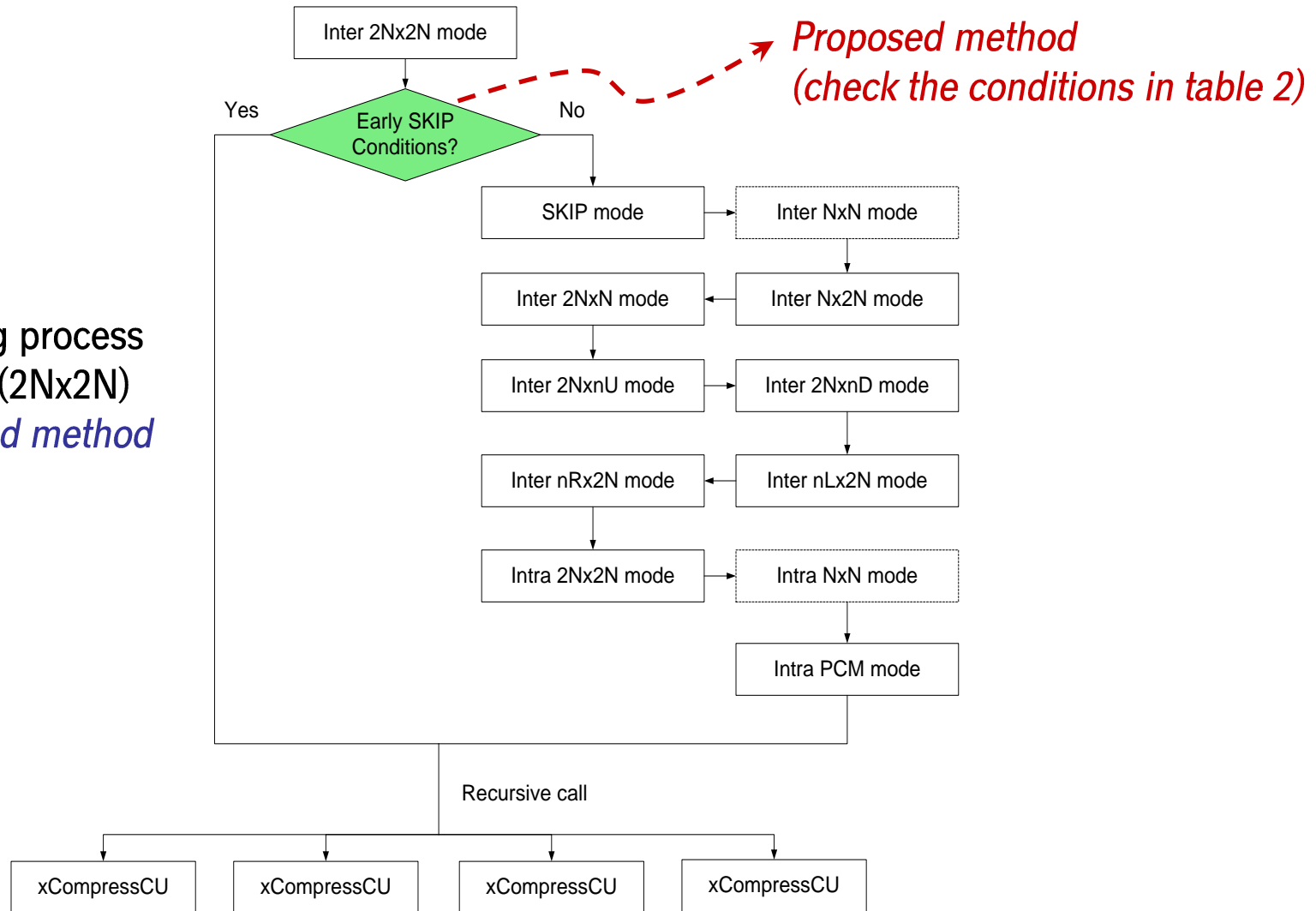


Fig. 2. Encoding process in a current CU(2Nx2N) for *the proposed method*

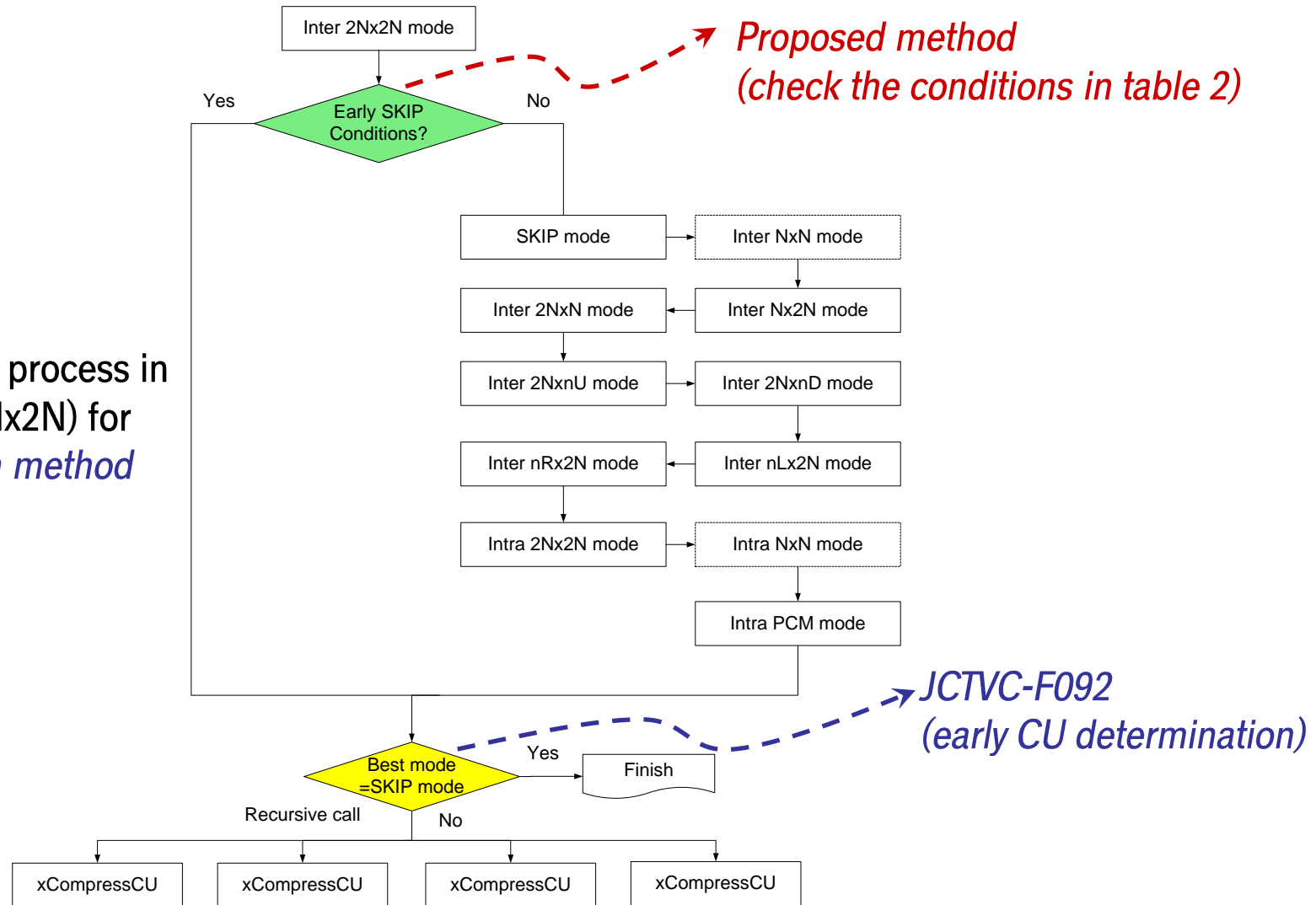
# Combination Method

- A fast mode decision tool was introduced in JCTVC-F092 adopted in the last Torino JCT-VC meeting
  - It is an early detection of *whether a current CU is split or not*
  - CU split process is terminated *if the PU mode in a current CU is skip mode*
- The proposed method can be *easily combined with JCTVC-F092*
  - JCTVC-F092 is for early CU determination
  - This contribution is for fast PU mode decision
- The combination with this contribution and JCTVC-F092 are called as “combination method”



# Combination Method - Flow Chart

Fig. 3. Encoding process in a current CU(2Nx2N) for *the combination method*



# Experimental Results

## ■ Proposed method

- **33%** encoding time saving and **2%** decoding time saving with BD-bitrate loss of **0.45%** on average.

|             | Random Access HE |       |       | Random Access LC |       |       |
|-------------|------------------|-------|-------|------------------|-------|-------|
|             | Y                | U     | V     | Y                | U     | V     |
| Class A     | 0.2%             | -0.2% | -0.2% | 0.2%             | -0.1% | -0.1% |
| Class B     | 0.3%             | -0.1% | -0.2% | 0.4%             | -0.1% | -0.1% |
| Class C     | 0.4%             | -0.1% | 0.0%  | 0.4%             | -0.1% | 0.0%  |
| Class D     | 0.5%             | -0.2% | -0.2% | 0.4%             | -0.2% | -0.2% |
| Overall     | 0.4%             | -0.2% | -0.2% | 0.3%             | -0.1% | -0.1% |
|             | 0.4%             | -0.1% | -0.1% | 0.3%             | -0.1% | -0.1% |
| Enc Time[%] | 69%              |       |       | 66%              |       |       |
| Dec Time[%] | 98%              |       |       | 100%             |       |       |

# Experimental Results

- Proposed method

|                | Low delay B HE |       |       | Low delay B LC |       |       |
|----------------|----------------|-------|-------|----------------|-------|-------|
|                | Y              | U     | V     | Y              | U     | V     |
| Class B        | 0.4%           | -0.1% | -0.1% | 0.4%           | 0.0%  | 0.1%  |
| Class C        | 0.4%           | 0.0%  | 0.0%  | 0.3%           | 0.2%  | -0.1% |
| Class D        | 0.6%           | 0.5%  | 0.2%  | 0.4%           | -0.2% | 0.0%  |
| Class E        | 0.6%           | 0.2%  | 1.0%  | 0.7%           | 0.6%  | -0.1% |
| <b>Overall</b> | 0.5%           | 0.1%  | 0.2%  | 0.4%           | 0.1%  | 0.0%  |
|                | 0.5%           | 0.1%  | 0.2%  | 0.4%           | 0.1%  | 0.0%  |
| Enc Time[%]    | 66%            |       |       | 63%            |       |       |
| Dec Time[%]    | 99%            |       |       | 97%            |       |       |

# Experimental Results

- Proposed method

|             | Low delay P HE |       |       | Low delay P LC |       |       |
|-------------|----------------|-------|-------|----------------|-------|-------|
|             | Y              | U     | V     | Y              | U     | V     |
| Class B     | 0.5%           | -0.1% | 0.0%  | 0.4%           | -0.1% | -0.2% |
| Class C     | 0.4%           | 0.0%  | -0.1% | 0.3%           | -0.1% | 0.1%  |
| Class D     | 0.7%           | -0.4% | -0.2% | 0.4%           | -0.2% | -0.2% |
| Class E     | 0.8%           | 0.3%  | -0.1% | 0.7%           | 0.0%  | -0.4% |
| Overall     | 0.6%           | -0.1% | -0.1% | 0.5%           | -0.1% | -0.2% |
|             | 0.6%           | -0.1% | -0.2% | 0.5%           | -0.1% | -0.2% |
| Enc Time[%] | 72%            |       |       | 68%            |       |       |
| Dec Time[%] | 97%            |       |       | 96%            |       |       |

# Experimental Results

- Combination method (proposed method + JCTVC-F092)
  - **51%** encoding time saving and **5%** decoding time saving with BD-bitrate loss of **1.67%** on average.

|                | Random Access HE |       |       | Random Access LC |       |       |
|----------------|------------------|-------|-------|------------------|-------|-------|
|                | Y                | U     | V     | Y                | U     | V     |
| Class A        | 1.5%             | -1.0% | -1.2% | 1.7%             | -0.8% | -0.7% |
| Class B        | 2.1%             | -0.9% | -0.9% | 2.3%             | -0.9% | -0.8% |
| Class C        | 2.0%             | -0.3% | 0.1%  | 2.2%             | -0.3% | 0.1%  |
| Class D        | 2.2%             | -0.7% | -0.4% | 2.4%             | -1.0% | -0.6% |
| <b>Overall</b> | 1.9%             | -0.7% | -0.6% | 2.2%             | -0.7% | -0.5% |
|                | 1.9%             | -0.7% | -0.6% | 2.2%             | -0.7% | -0.5% |
| Enc Time[%]    | 51%              |       |       | 44%              |       |       |
| Dec Time[%]    | 96%              |       |       | 98%              |       |       |

# Experimental Results

- Combination method (proposed method + JCTVC-F092)

|                | Low delay B HE |       |       | Low delay B LC |       |       |
|----------------|----------------|-------|-------|----------------|-------|-------|
|                | Y              | U     | V     | Y              | U     | V     |
| Class B        | 1.5%           | -0.6% | -0.6% | 1.5%           | -0.7% | -0.6% |
| Class C        | 1.2%           | 0.1%  | 0.0%  | 1.0%           | 0.2%  | 0.0%  |
| Class D        | 1.5%           | -0.5% | -0.3% | 1.1%           | -1.1% | -1.1% |
| Class E        | 1.9%           | -1.2% | -0.3% | 1.8%           | -2.1% | -1.3% |
| <b>Overall</b> | 1.5%           | -0.5% | -0.3% | 1.4%           | -0.8% | -0.7% |
|                | 1.5%           | -0.5% | -0.3% | 1.4%           | -0.8% | -0.7% |
| Enc Time[%]    | 48%            |       |       | 45%            |       |       |
| Dec Time[%]    | 95%            |       |       | 95%            |       |       |

# Experimental Results

- Combination method (proposed method + JCTVC-F092)

|                | Low delay P HE |       |       | Low delay P LC |       |       |
|----------------|----------------|-------|-------|----------------|-------|-------|
|                | Y              | U     | V     | Y              | U     | V     |
| Class B        | 1.8%           | -1.0% | -1.0% | 1.7%           | -1.0% | -1.1% |
| Class C        | 1.3%           | -0.3% | -0.4% | 1.1%           | -0.5% | -0.5% |
| Class D        | 1.7%           | -1.8% | -1.3% | 1.4%           | -1.6% | -1.6% |
| Class E        | 1.6%           | -2.3% | -1.5% | 1.4%           | -2.5% | -2.4% |
| <b>Overall</b> | 1.6%           | -1.3% | -1.0% | 1.4%           | -1.3% | -1.3% |
|                | 1.6%           | -1.3% | -1.1% | 1.4%           | -1.3% | -1.3% |
| Enc Time[%]    | 56%            |       |       | 49%            |       |       |
| Dec Time[%]    | 94%            |       |       | 93%            |       |       |

# Conclusion

- This contribution proposes an early detection of SKIP mode
- The proposed method achieves
  - Reduction of encoding time by 33% and decoding time by 2%
  - Only a negligible loss of luma BD-bitrate 0.45%
- The proposed method can be easily applied in current HM4.0, and combined with JCTVC-F092
  - Modify less than 10 lines in HM 4.0 source code
- We thank ETRI and Hanyang Univ. for crosschecking our proposal
  - JCTVC-G573 , JCTVC-G794