



Sample Adaptive Offset with PPS-level Syntax

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Presented by Chia-Yang Tsai
6th JCT-VC Meeting in Torino
14-22 July, 2011

Overall Summary

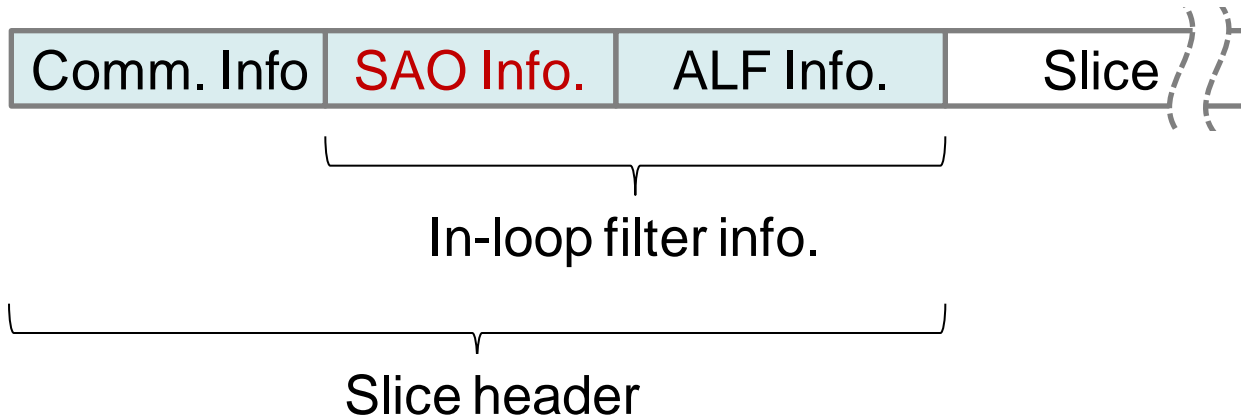
- In HM-3.2, SAO information is in the first slice header when multiple slices per picture is used
 - Long decoding delay for out-of-order slices transmission
 - Similar problem in ALF and was solved by using PPS to signal shared ALF info. (JCTVC-E045)
- For multi-slice pictures, we proposed to signal SAO information in PPS
- In comparison with HM-3.2
 - Almost 0% BD-rate increases
 - Less decoding delay and better parallel processing capability for multi-slice pictures

Outline

- Current slice-level SAO syntax
- Proposed PPS/slice-level SAO syntax
- Simulation results
- Conclusions

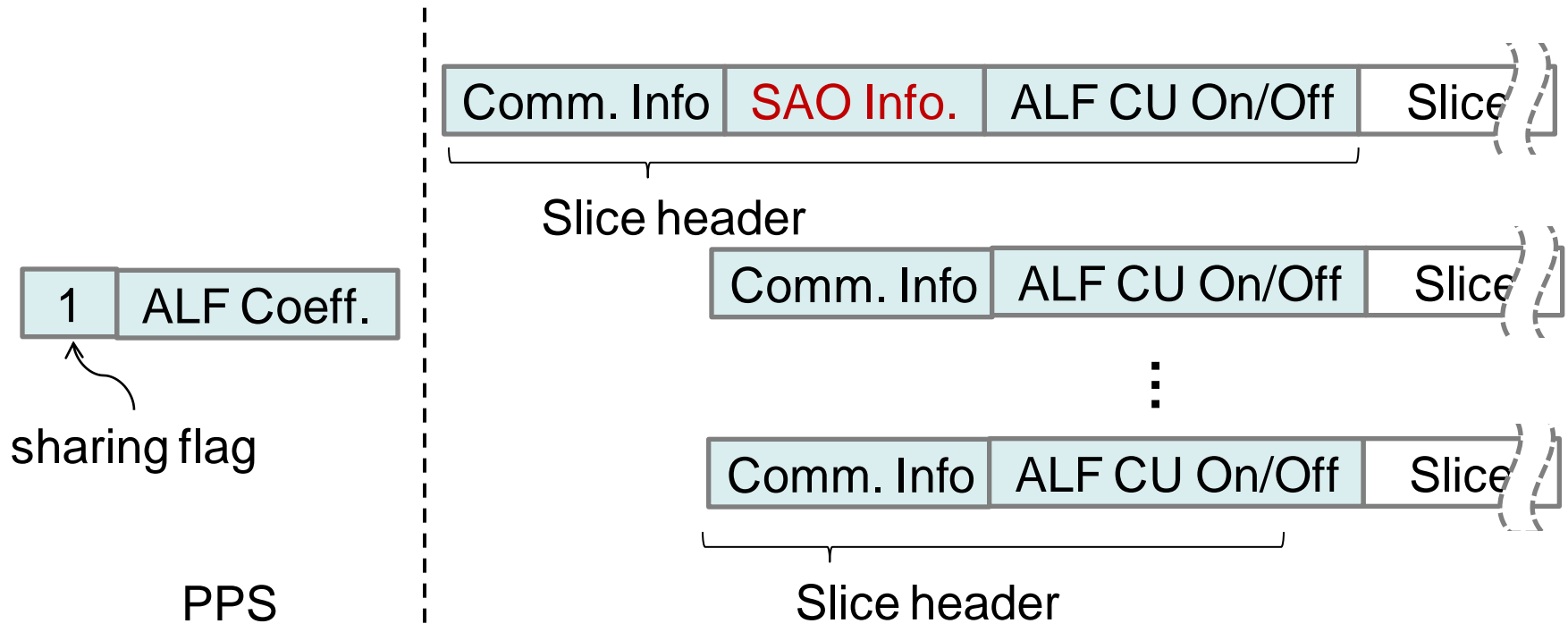
HM: One-slice Picture

- One slice in one picture
- SAO information in the slice header



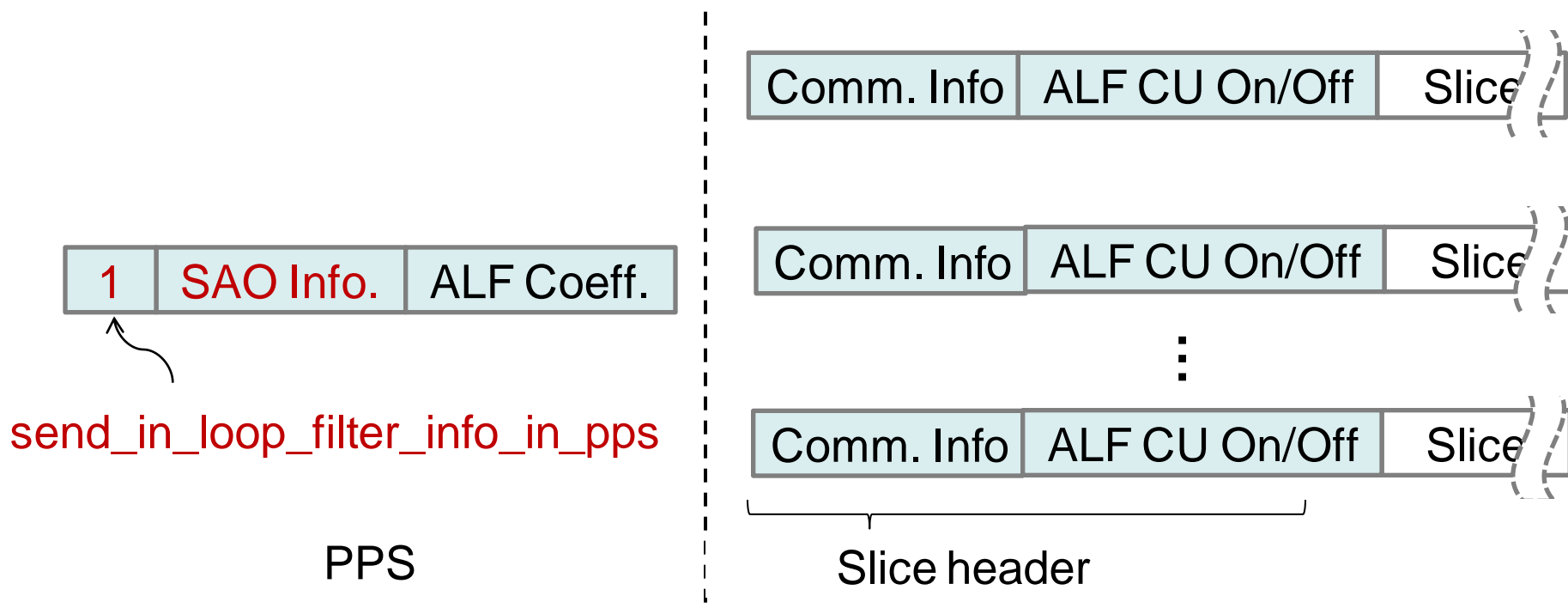
HM: Multi-slice Picture

- Multiple slices in one picture
- ALF coefficients in PPS if the sharing flag is “1”
- SAO information in the first slice header



Proposed: Multi-slice Picture

- Multiple slices in one picture
- ALF coefficients in PPS if `send_in_loop_filter_info_in_pps=1`
- SAO information in PPS if `send_in_loop_filter_info_in_pps=1`**



Simulation Results

- Anchor
 - JCTVC-E700
 - HM-3.2
 - Single slice per picture
- Case 1: SAO information in the 1st slice header
 - Multiple slices per picture
 - Slice granularity = 0 (LCU-aligned slices)
 - 1500 bytes/slice
- Case 2: SAO information in PPS (proposed)
 - Multiple slices per picture
 - Slice granularity = 0 (LCU-aligned slices)
 - 1500 bytes/slice

Case 1: SAO Info. in 1st slice header

| | HE-AI | | | LC-AI | | |
|---------|------------|------------|------------|------------|------------|------------|
| | Y | U | V | Y | U | V |
| Class A | 4.9 | 7.6 | 5.5 | 3.6 | 9.1 | 7.7 |
| Class B | 5.6 | 5.8 | 4.6 | 5.1 | 7.5 | 7.5 |
| Class C | 5.3 | 5.7 | 6.0 | 5.3 | 7.2 | 7.4 |
| Class D | 3.3 | 4.1 | 4.5 | 3.7 | 4.7 | 5.0 |
| Class E | 8.4 | 6.8 | 7.3 | 7.6 | 13.7 | 12.2 |
| All | 5.4 | 5.9 | 5.4 | 4.9 | 8.1 | 7.7 |

| | HE-RA | | | LC-RA | | |
|---------|------------|------------|------------|------------|------------|------------|
| | Y | U | V | Y | U | V |
| Class A | 6.1 | 12.8 | 9.8 | 3.8 | 9.8 | 9.2 |
| Class B | 4.8 | 6.7 | 4.7 | 4.1 | 6.6 | 5.9 |
| Class C | 3.9 | 5.5 | 5.2 | 3.5 | 4.8 | 4.6 |
| Class D | 2.2 | 2.7 | 3.0 | 1.8 | 2.3 | 2.5 |
| Class E | | | | | | |
| All | 4.3 | 6.9 | 5.6 | 3.4 | 5.9 | 5.6 |

| | HE-LD | | | LC-LD | | |
|---------|------------|------------|------------|------------|------------|------------|
| | Y | U | V | Y | U | V |
| Class A | | | | | | |
| Class B | 3.5 | 6.1 | 4.0 | 2.8 | 4.0 | 3.3 |
| Class C | 2.5 | 3.9 | 3.8 | 2.2 | 2.7 | 2.5 |
| Class D | 1.4 | 2.3 | 2.3 | 1.1 | 1.4 | 1.7 |
| Class E | 1.2 | 1.1 | -0.3 | 0.8 | 5.3 | 3.1 |
| All | 2.3 | 3.7 | 2.7 | 1.8 | 3.2 | 2.7 |

Case 2: SAO Info. in PPS (proposed)

| | HE-AI | | | LC-AI | | |
|---------|------------|------------|------------|------------|------------|------------|
| | Y | U | V | Y | U | V |
| Class A | 4.9 | 7.6 | 5.5 | 3.6 | 9.1 | 7.7 |
| Class B | 5.6 | 5.8 | 4.6 | 5.1 | 7.5 | 7.5 |
| Class C | 5.3 | 5.8 | 6.1 | 5.3 | 7.2 | 7.4 |
| Class D | 3.4 | 4.1 | 4.5 | 3.7 | 4.7 | 5.0 |
| Class E | 8.4 | 6.8 | 7.4 | 7.7 | 13.7 | 12.2 |
| All | 5.4 | 6.0 | 5.5 | 4.9 | 8.1 | 7.7 |

| | HE-RA | | | LC-RA | | |
|---------|------------|------------|------------|------------|------------|------------|
| | Y | U | V | Y | U | V |
| Class A | 6.1 | 12.9 | 10.0 | 3.9 | 9.8 | 9.2 |
| Class B | 4.8 | 6.8 | 4.7 | 4.2 | 6.6 | 6.0 |
| Class C | 3.9 | 5.5 | 5.3 | 3.6 | 4.9 | 4.7 |
| Class D | 2.2 | 2.8 | 3.1 | 2.0 | 2.5 | 2.7 |
| Class E | | | | | | |
| All | 4.3 | 7.0 | 5.7 | 3.4 | 6.0 | 5.7 |

| | HE-LD | | | LC-LD | | |
|---------|------------|------------|------------|------------|------------|------------|
| | Y | U | V | Y | U | V |
| Class A | | | | | | |
| Class B | 3.5 | 6.2 | 4.2 | 2.8 | 4.0 | 3.3 |
| Class C | 2.5 | 3.8 | 4.0 | 2.2 | 2.7 | 2.5 |
| Class D | 1.4 | 2.5 | 2.5 | 1.2 | 1.5 | 1.9 |
| Class E | 1.3 | 1.5 | -0.2 | 1.0 | 5.5 | 3.3 |
| All | 2.3 | 3.8 | 2.9 | 1.9 | 3.3 | 2.8 |

- Average 0% BD-rate increases for luma
- Average less than 0.1% BD-rate increases for chroma

Cross Verification

- We thank SHARP for crosschecking our proposal
 - JCTVC-F700
- BD-rate and enc./dec. time are confirmed

Conclusions

- Transmit SAO information in PPS for multi-slice pictures
 - Avoid long decoding delay
 - Increase parallel processing capability
- Use `send_in_loop_filter_info_in_pps` to signal SAO information in PPS
- Compared with HM-3.2, the proposed method has almost 0% BD-rate increase