

AHG16: ON PROPAGATION OF CHROMA CU QP OFFSETS (JVET-Q0267)



Brian Heng, Minhua Zhou, Wade Wan

Broadcom Inc.

CU-Level Chroma QP Offsets

- CU-level control of chroma QP
 - Introduced in JVET-O1168.
 - Similar to delta QP for luma.
 - Chroma QP controlled via relative offsets (rather than predQp / deltaQp)
- Chroma QP offsets only reset at the start of each slice.

7.4.8.1 General slice header semantics

“The variables $\text{CuQpOffset}_{\text{Cb}}$, $\text{CuQpOffset}_{\text{Cr}}$, and $\text{CuQpOffset}_{\text{CbCr}}$, specifying values to be used when determining the respective values of the Qp'_{Cb} , Qp'_{Cr} , and Qp'_{CbCr} quantization parameters for the coding unit containing `cu_chroma_qp_offset_flag`, are all set equal to 0.”

CU-Level Chroma QP Offsets

- Chroma QP Offset Updates:
 - Only changed when `cu_chroma_qp_offset_flag` is present.
 - `cu_chroma_qp_offset_flag` equal to 1
 - New offsets set explicitly.
 - `cu_chroma_qp_offset_flag` equal to 0
 - Offsets set to 0 (no prediction).
 - Not modified otherwise (for example, in non-coded CUs) → Propagation

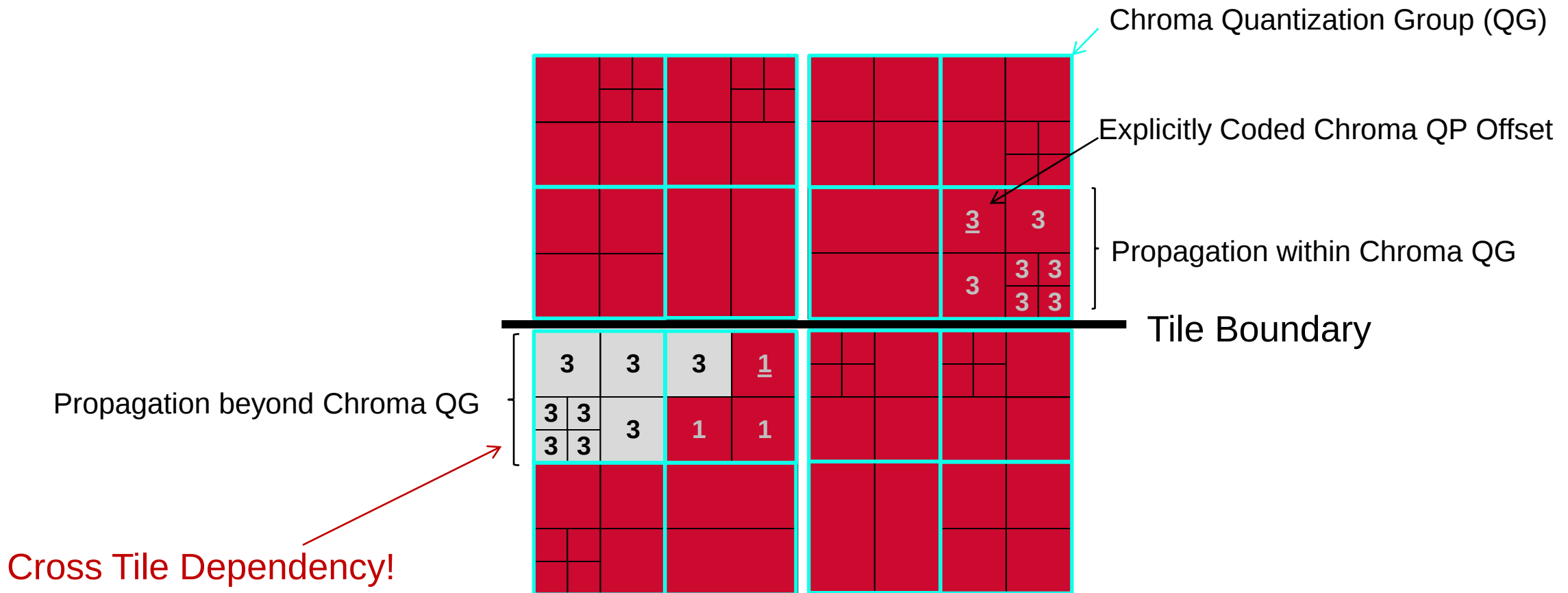
7.4.10.10 Transform unit semantics

When `cu_chroma_qp_offset_flag` is present, the following applies:

- The variables $\text{CuQpOffset}_{\text{Cb}}$, $\text{CuQpOffset}_{\text{Cr}}$, and $\text{CuQpOffset}_{\text{CbCr}}$ are derived as follows:
 - If `cu_chroma_qp_offset_flag` is equal to 1, the following applies:
 - $\text{CuQpOffset}_{\text{Cb}} = \text{cb_qp_offset_list}[\text{cu_chroma_qp_offset_idx}]$
 - $\text{CuQpOffset}_{\text{Cr}} = \text{cr_qp_offset_list}[\text{cu_chroma_qp_offset_idx}]$
 - $\text{CuQpOffset}_{\text{CbCr}} = \text{joint_cbcr_qp_offset_list}[\text{cu_chroma_qp_offset_idx}]$
 - Otherwise (`cu_chroma_qp_offset_flag` is equal to 0), $\text{CuQpOffset}_{\text{Cb}}$, $\text{CuQpOffset}_{\text{Cr}}$, and $\text{CuQpOffset}_{\text{CbCr}}$ are all set equal to 0.

Chroma QP Offset Propagation

- Propagation occurs when:
 - Not the first coded CU in the chroma quantization group.
 - No coded chroma residual in the current CU.



Chroma QP Offset Propagation

- Propagation within Chroma QG
 - Expected behavior.
 - Reduces the overhead when the offsets are not changed often.
- Propagation beyond Chroma QG
 - Only affects CUs without chroma residual.
 - Used to be irrelevant (before JVET-P1001).

Why does the Chroma QP Offset for a non-coded CU matter?

➡ Deblocking

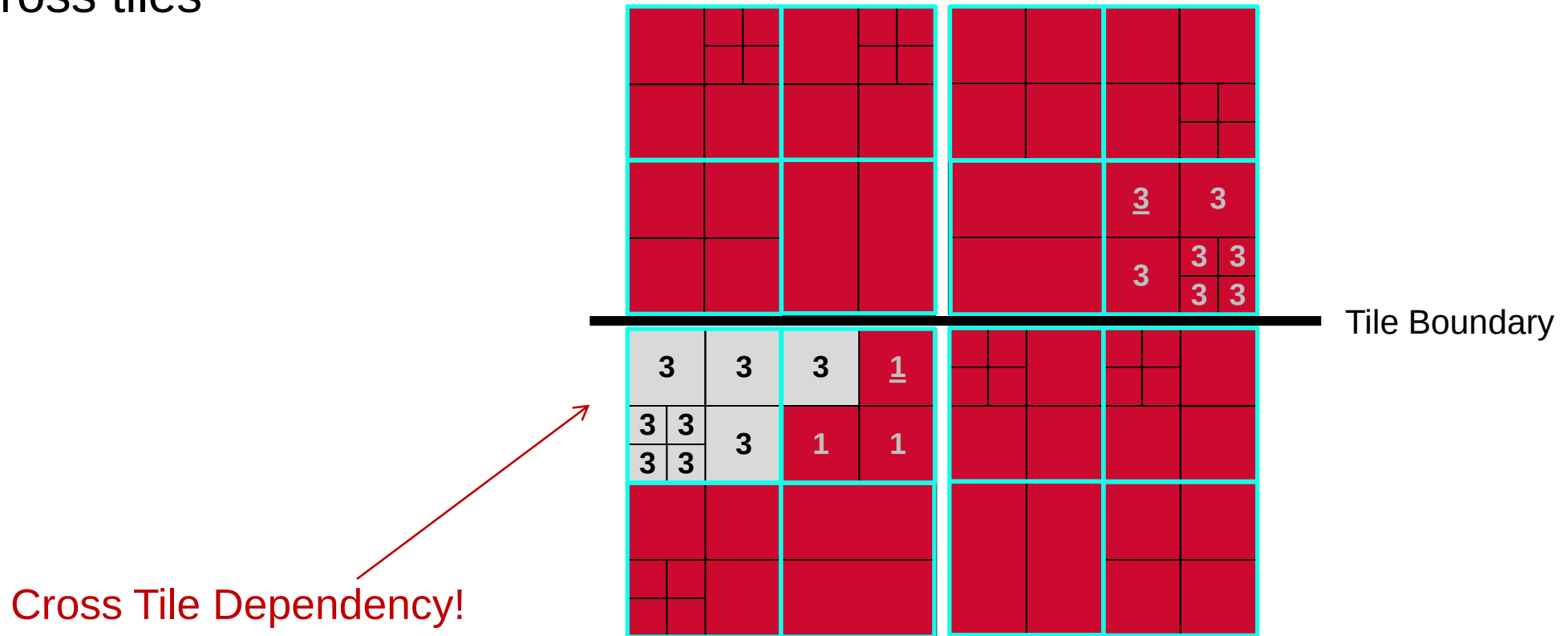
Chroma QP in Deblocking

- JVET-P1001
 - “Chroma QP derivation fix for deblocking filter”
 - Modifies deblocking filter to use the actual chroma QP.
 - Chroma QP for all CUs must be determined.
 - This includes:
 - CU-level chroma offsets.
 - CUs without chroma residual.
- ➡ Chroma QP offsets for non-coded CUs are now important

JVET-P1001 did not consider or define any new process for how CU chroma QP offsets should be derived for non-coded CUs.

Problem: Cross Tile / Wavefront Dependency

- Offsets propagate until the end of the slice.
 - Wrap around at the picture boundary
 - Across wavefront entry points (entropy coding sync)
 - Across tiles



Problem: Cross Tile / Wavefront Dependency

- Bitstream sub-sets (tiles / wavefronts) are not independently decodable.
- Propagation can extend across a large regions:
 - Not contained to just a single deblocker edge at a tile boundary.
- Unacceptable design.

Proposed Solution

- Limit chroma QP offset propagation to a single QG
 - Reset offset to 0 at the start of each new chroma QG.

```
if( cu_chroma_qp_offset_enabled_flag && cbSubdiv <= CuChromaQpOffsetSubdiv ) {  
    IsCuChromaQpOffsetCoded = 0  
    CuQpOffsetCb = 0  
    CuQpOffsetCr = 0  
    CuQpOffsetCbCr = 0  
}
```

- Propagation outside the QG only affects the deblocking of non-coded chroma TUs.
- Consistent with design of existing chroma QP offset syntax.
 - cu_chroma_qp_offset_flag equal to 0 → use 0 (not use previous / predicted).

Conclusion

- After JVET-P1001, derivation of chroma QP for non-coded CU must be well defined.
- Current design breaks cross-tile dependency rules.
- Some process for how to reset / propagate / prediction chroma QP offsets must be considered.
- Proposed solution
 - Reset chroma QP offsets to 0 at the start of each chroma QG.
 - Stop offset propagation from extending beyond the current QG.

Appendix – Current VTM Software Issues with Chroma QP Offsets

- JVET Bug Tracker #785
 - Offsets selected in arbitrary round-robin fashion.
 - Assigned based on spatial position in frame using square shaped QGs (leftover from HEVC).
 - Actual VVC QGs are not square → Enc / Dec mismatches.
- JVET Bug Tracker #786
 - Encoder can only change chroma QP offset when there is chroma residual to send.
 - No process put into place to reset chroma QP offsets in the encoder when there is no chroma residual.
 - Encoder / decoder use different offsets for non-coded CUs, so deblocking introduces mismatches.