

Parallelized deblocking filter for hybrid video coding

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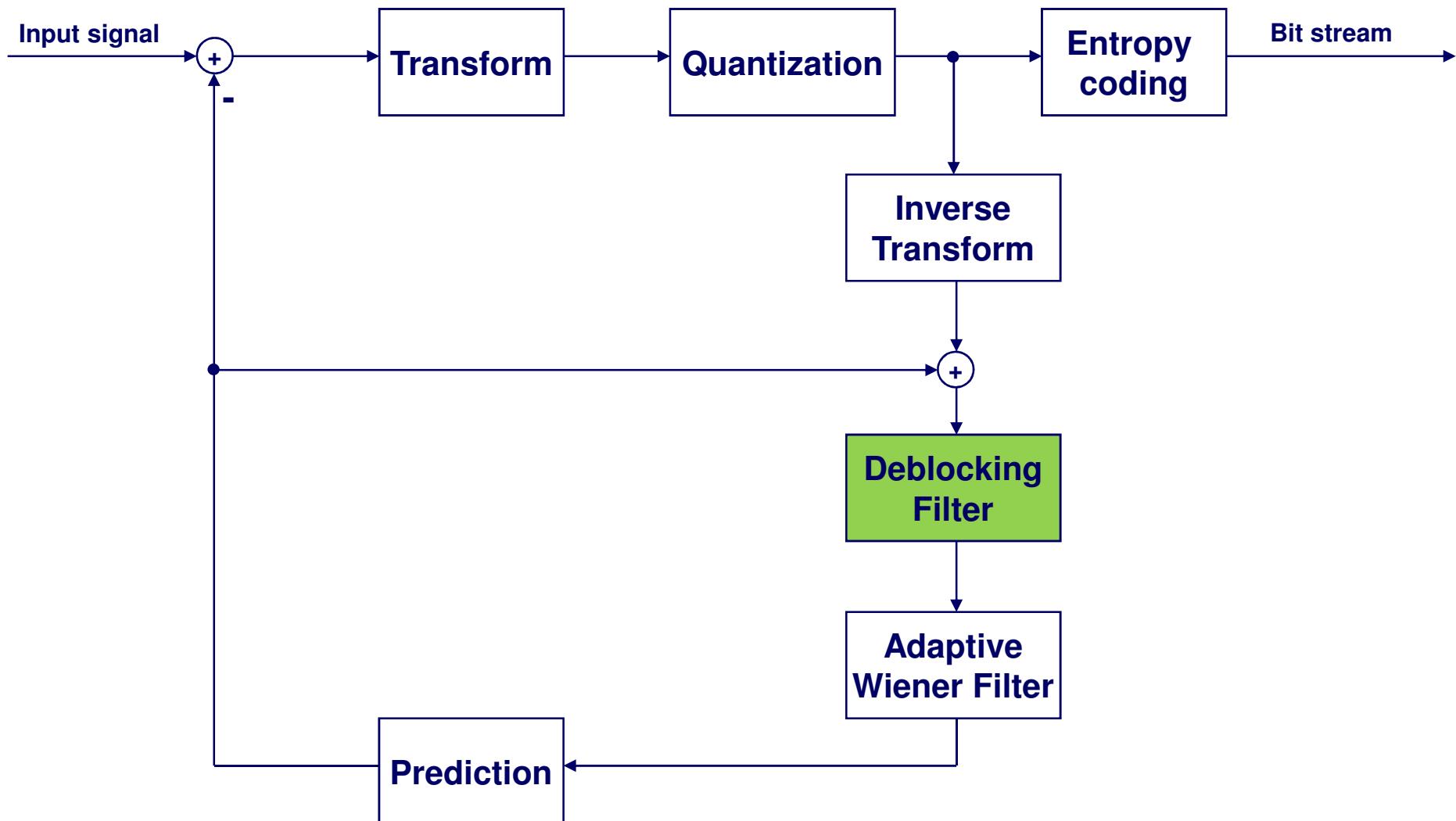
Panasonic ideas for life

VCIP 2011, Tainan City

- Introduction
- Parallel deblocking filter decisions
- Experiments and results
- Conclusion

Generalized block diagram of an HM2.0 hybrid encoder

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HM2.0: Version 2 of test model of the HEVC standardization of ISO/ITU-T

Basic steps of HM2.0 deblocking filter

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- Calculation of decision values d_2 and d_5

- Required samples

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
A	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

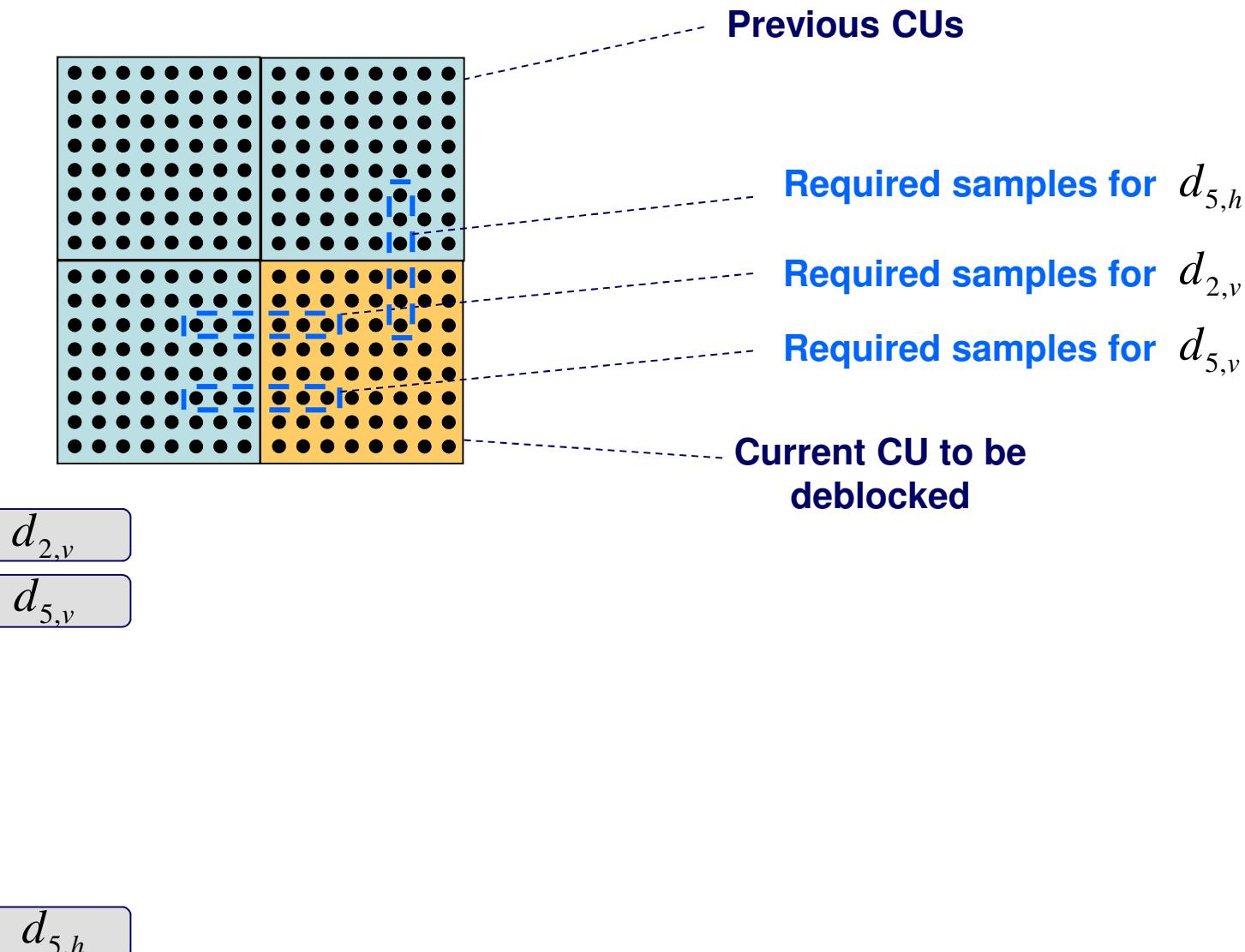
- Deblocking enabled for all 8 lines/columns if $d_2 + d_5 < \beta$:

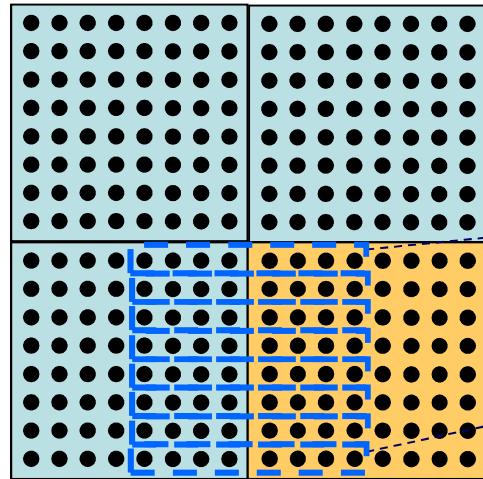
- Decision D_i for each line/column i to select a filter

- Filter F_i each line/column i

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
A	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

- Maximum degree a parallel processing capabilities exploited
- No unnecessary processing steps are performed

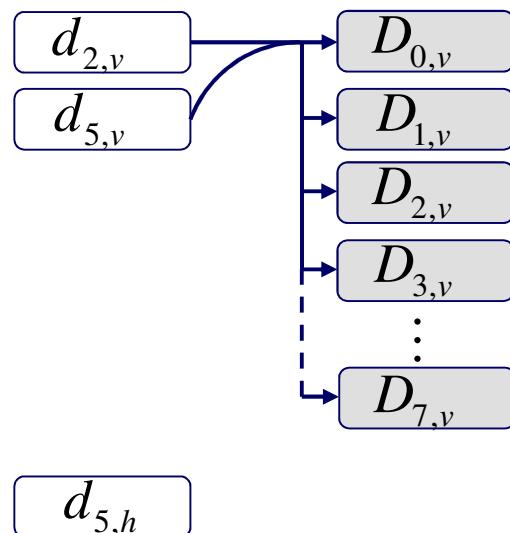


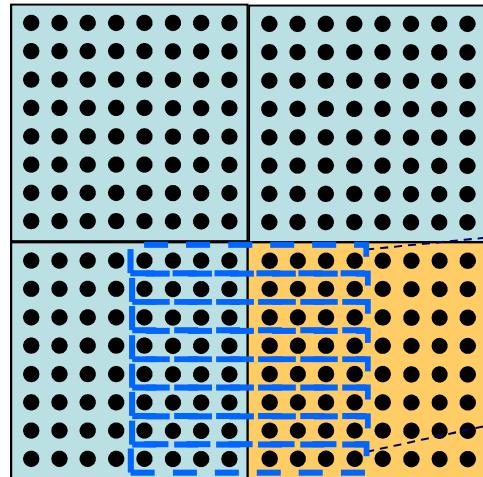


Required samples for $D_{0,v}$

⋮

Required samples for $D_{7,v}$

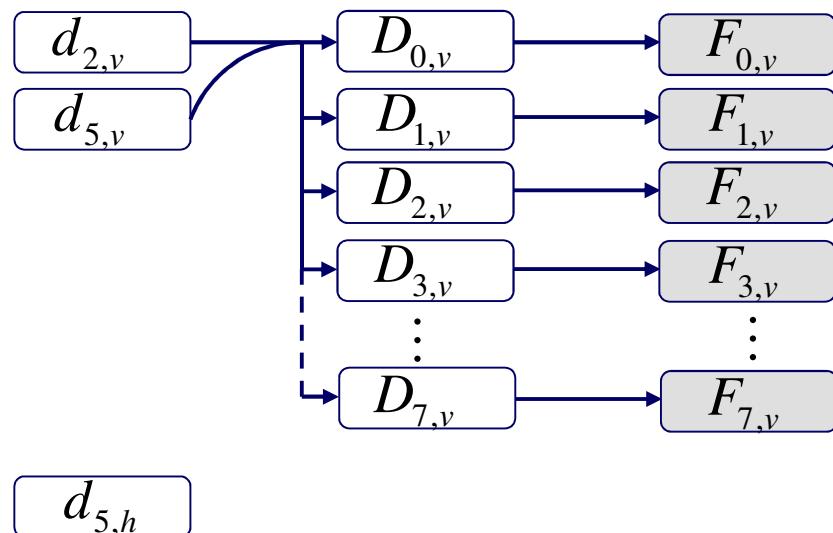


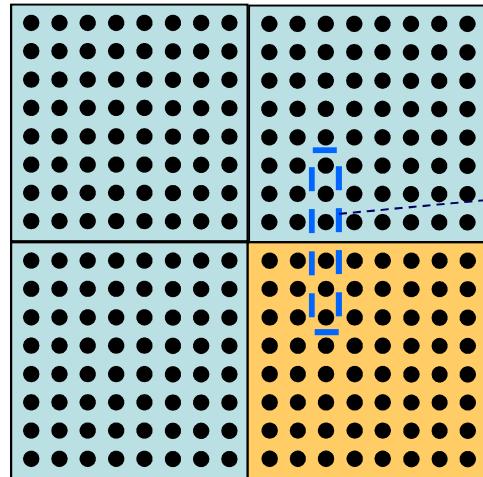


Required samples for $F_{0,v}$

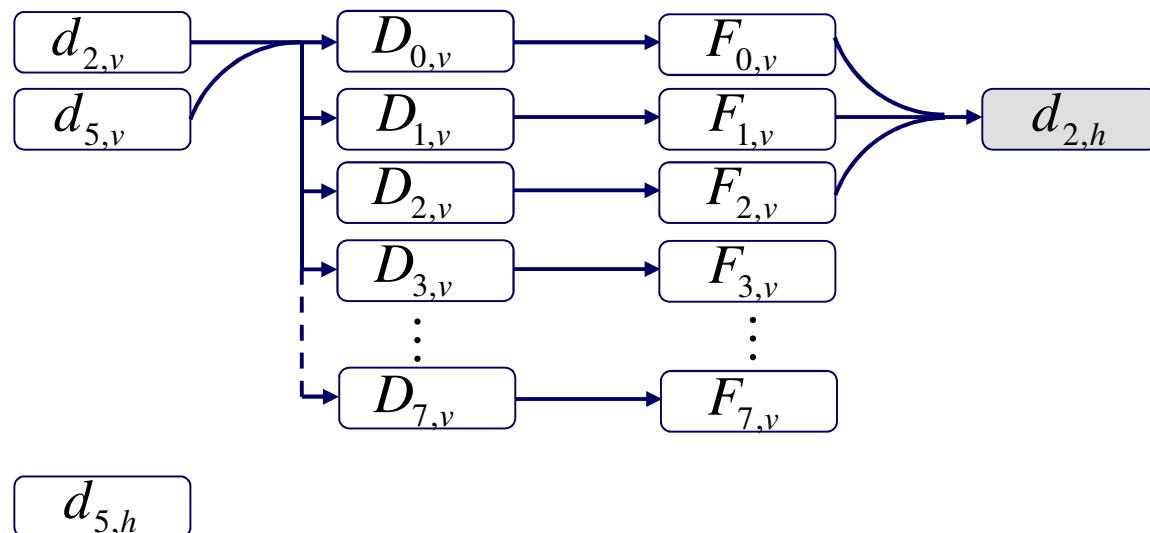
⋮

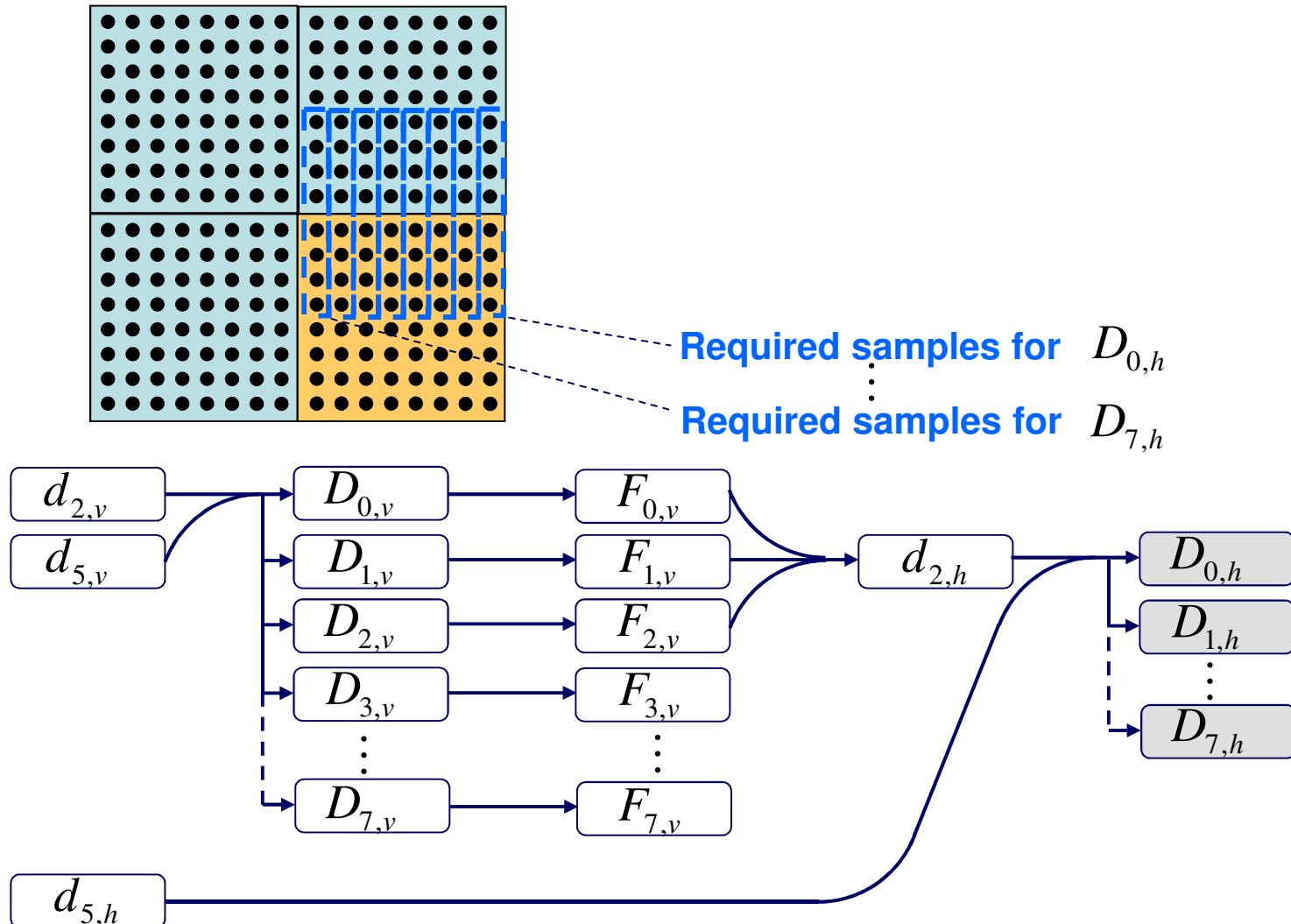
Required samples for $F_{7,v}$

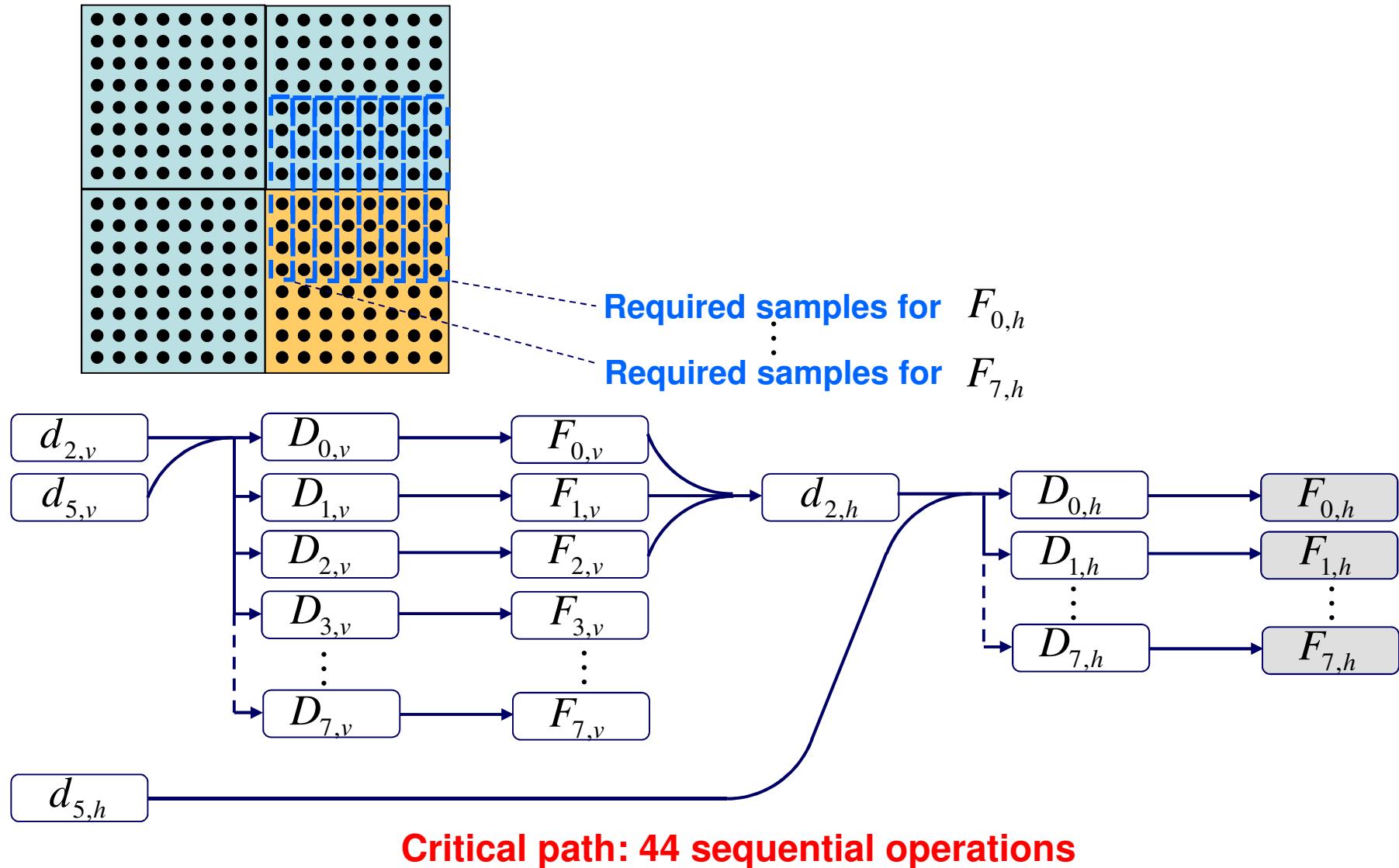




Required samples for $d_{2,h}$







- **Deblocking filter of HM 2.0:**

The decision and filtering steps for vertical and horizontal edges are performed dependent on each other

- **Problem:**

Dependencies limit the capabilities for parallel processing

=> Large amount of operations in the critical path

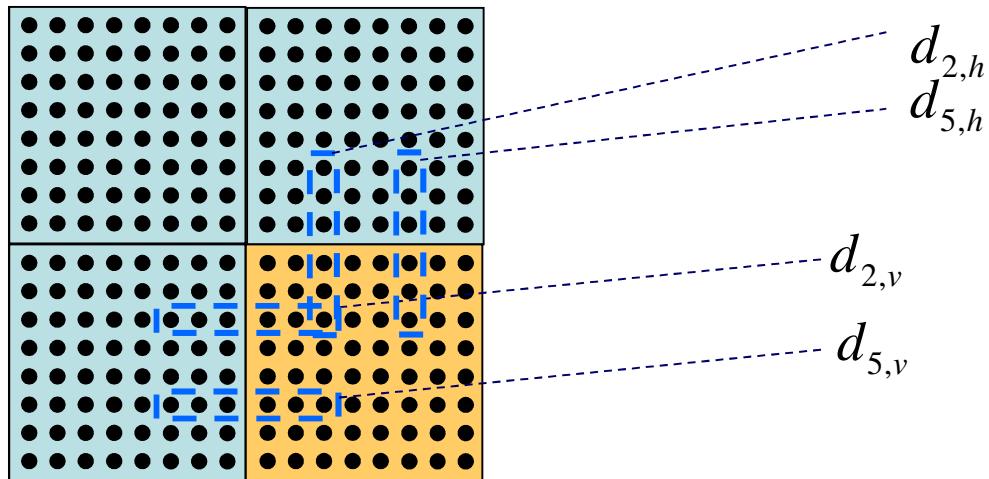
- **Approach:**

Increase of parallel processing capabilities by performing all decisions based on the unfiltered signal

=> Less operations in the critical path

Parallelized deblocking for a CU of size 8x8

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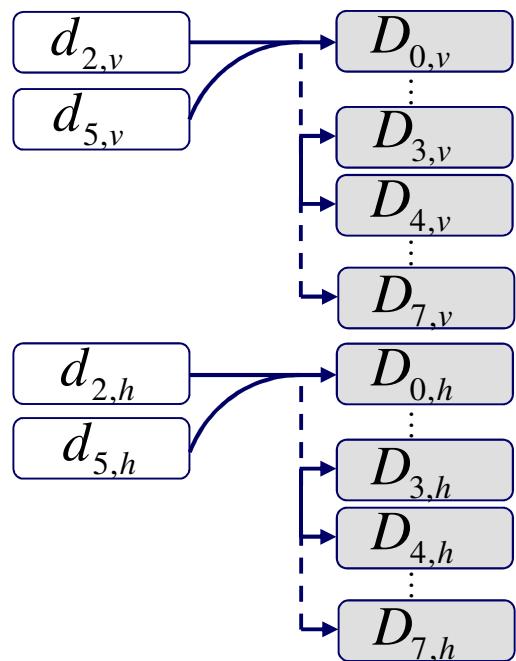
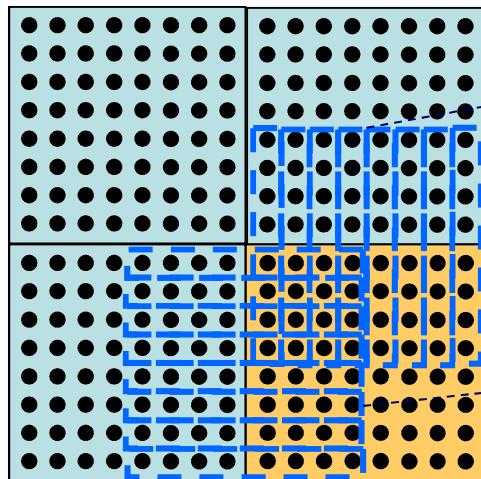


$d_{2,v}$
 $d_{5,v}$

$d_{2,h}$
 $d_{5,h}$

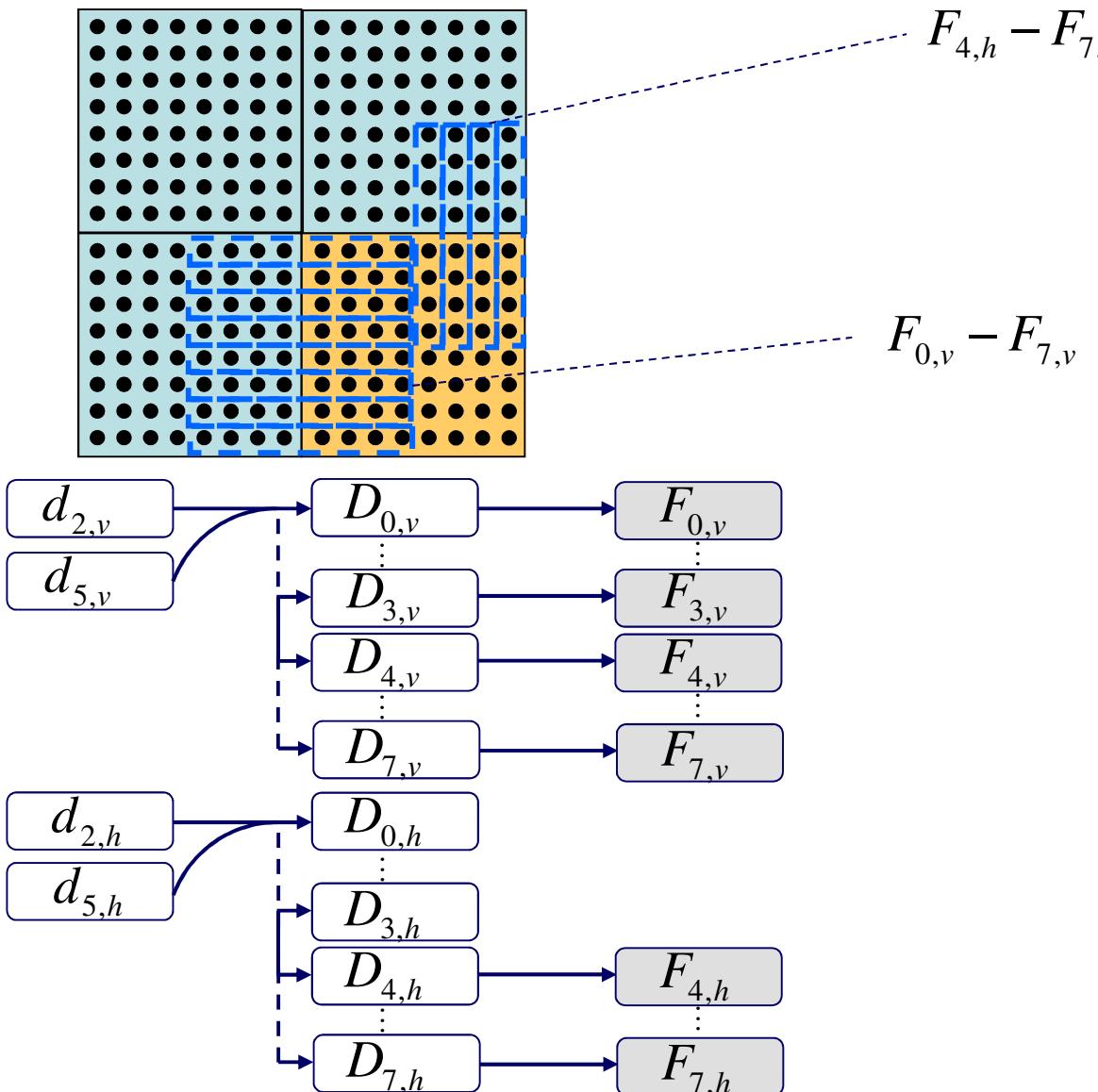
Parallelized deblocking for a CU of size 8x8

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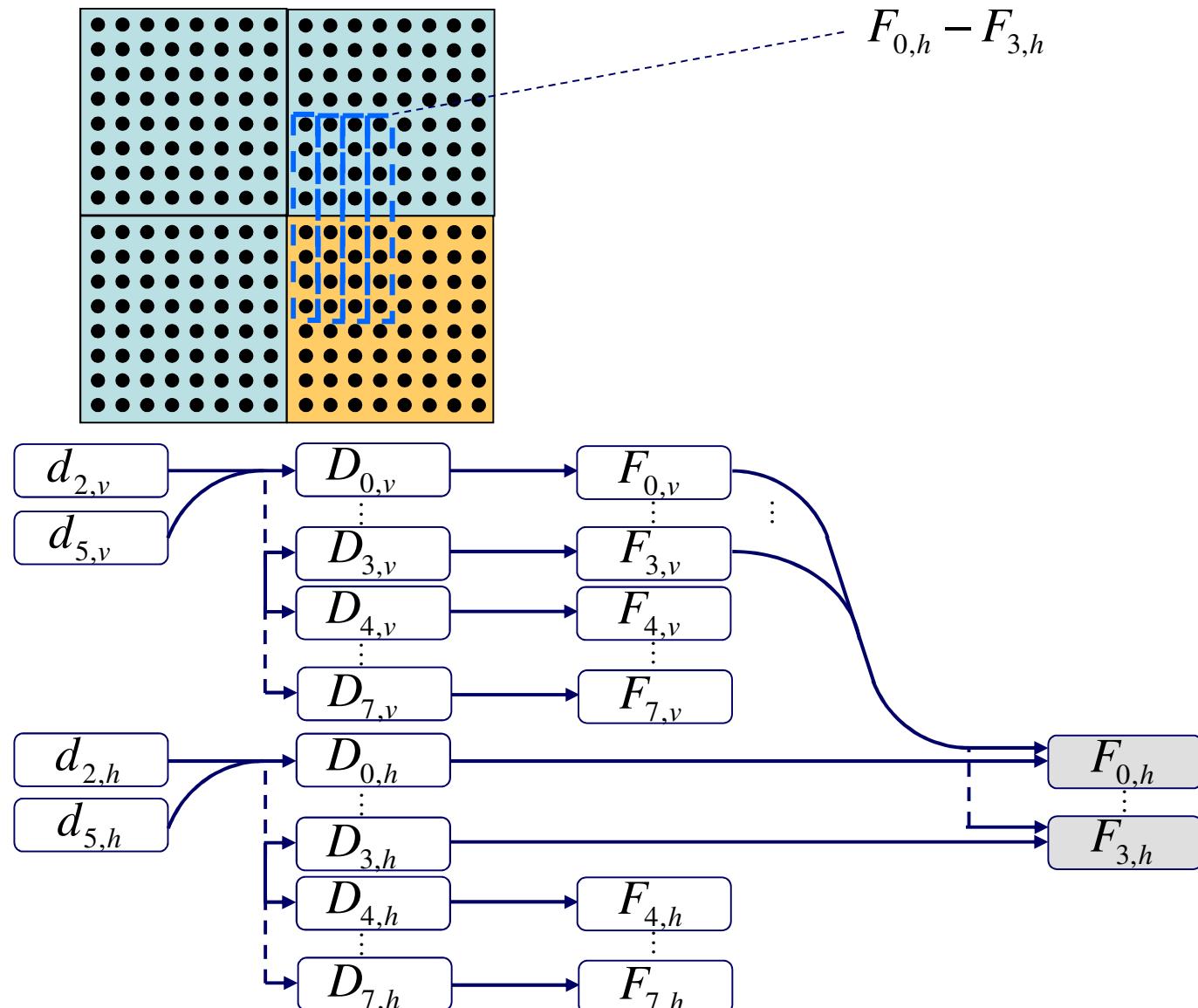
Parallelized deblocking for a CU of size 8x8

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Parallelized deblocking for a CU of size 8x8

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Critical path: 32 sequential operations (Reduction of 30%)

- Implementation into HM 2.0
- Simulation under conditions used in HEVC standardization

- Same coding efficiency
- Same subjective quality

A. Norkin et. al. "BoG report on subjective viewing test for deblocking filter proposals", Joint Collaborative Team on Video Coding of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, doc. JCTVC-E501, Geneva, March, 2011

- Increase of parallel processing capabilities of the deblocking filter by decisions performed based on the unfiltered signal

- Results compared to HM2.0:
 - Reduction of sequential operations in the critical path by 30%
 - Same coding efficiency
 - Same subjective quality

- Application
 - Adopted in HEVC standardization of ISO/ITU-T
 - Further parallelization being evaluated in current core experient CE12