JCTVC-G206

MEDIATEK

CE8.c.4: SAO and ALF virtual boundary processing with cross9x9

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Presented by Yu-Wen Huang
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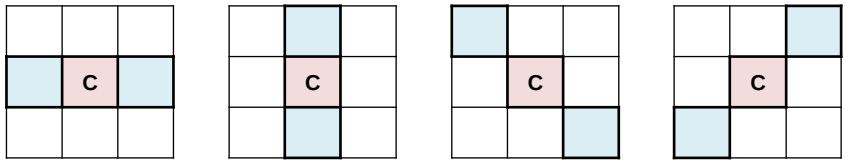
21-30 November, 2011

Overall Summary

- JCTVC-G204, CE8.c.2: Single-source SAO and ALF virtual boundary processing
- JCTVC-G205, CE8.c.3: Multi-source SAO and ALF virtual boundary processing
- JCTVC-G208, CE8.d.1: Snowflake5x5 and cross9x9 for luma and chroma ALF shapes
- In this contribution, CE8.c.2 and CE8.d.1 are combined as CE8.c.4-1
  - BD-rates: -0.3% (gain) to 0.1% (loss)
  - No run time change
  - Slightly degraded visual quality, remove all SAO and ALF line buffers
- In this contribution, CE8.c.3 and CE8.d.1 are combined as CE8.c.4-2
  - BD-rate: -0.4% (gain) to 0.0%
  - No encoding time change, 2-4% decoding time increase
  - Very slightly degraded visual quality, remove all SAO and ALF line buffers

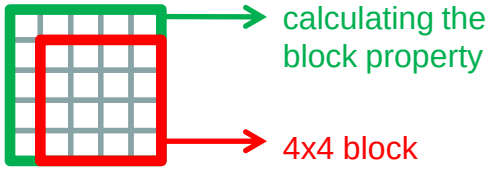
Background Information

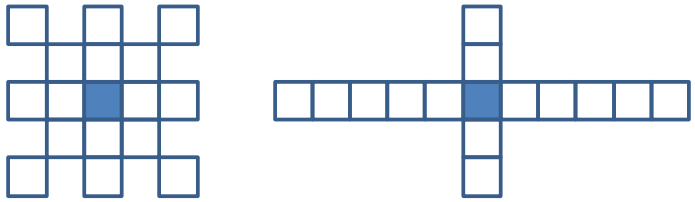
- Deblocking filter (DF)
  - Luma: read 4 pixels and write 3 pixels
  - Chroma: read 2 pixels and write 1 pixel
- Sample adaptive offset (SAO)
  - Edge offset (EO): need a 3x3 window for pixel classification



0-Degree EO | 90-Degree EO | 135-Degree EO | 45-Degree EO

- Adaptive loop filter (ALF)
  - Calculate 4x4 block property for luma
  - Snowflake5x5
  - Cross11x5





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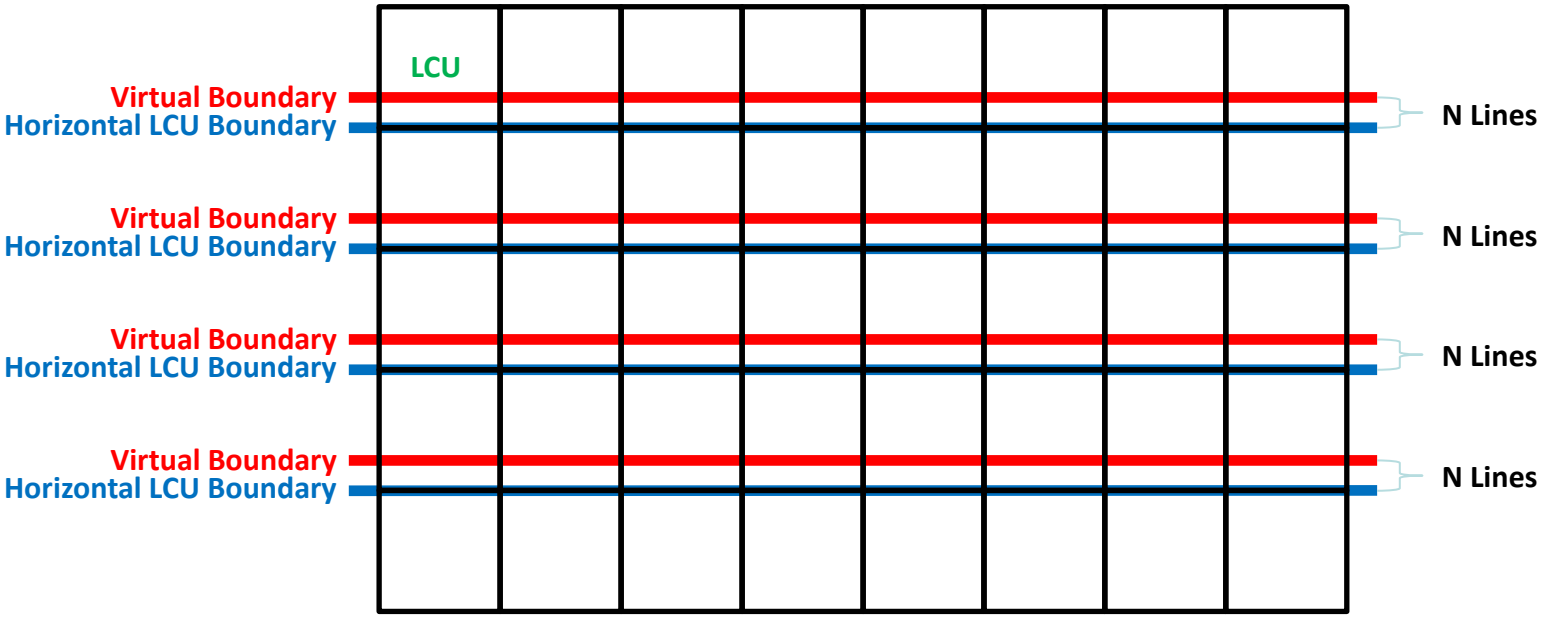
CE8.c.4-1: Virtual Boundary (VB)

- N=4 for luma, N=2 for chroma
- Processing a pixel on one side of a VB does not use any pixel on the other side of the VB



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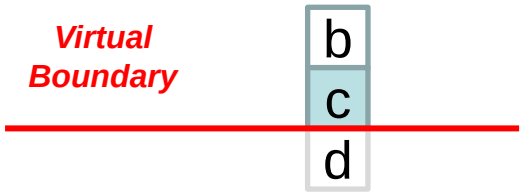
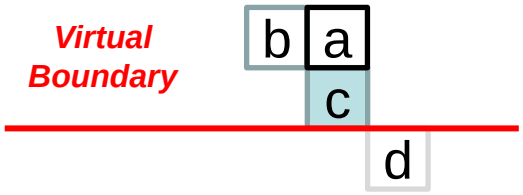
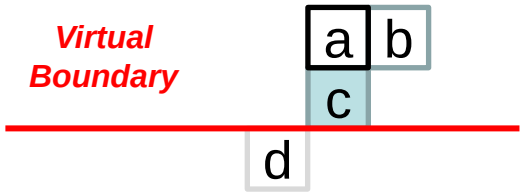
CE8.c.4-1: SAO VB Processing



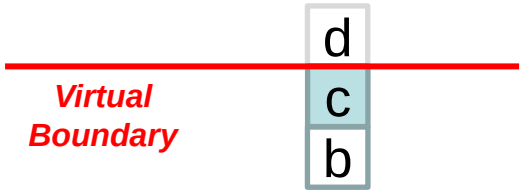
90-degree EO



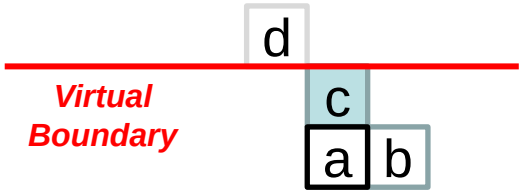
135-degree EO



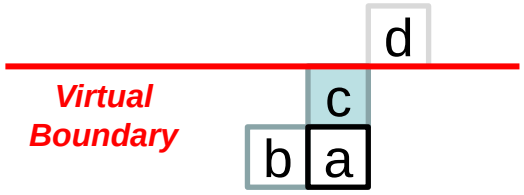
45-degree EO



90-degree EO



135-degree EO

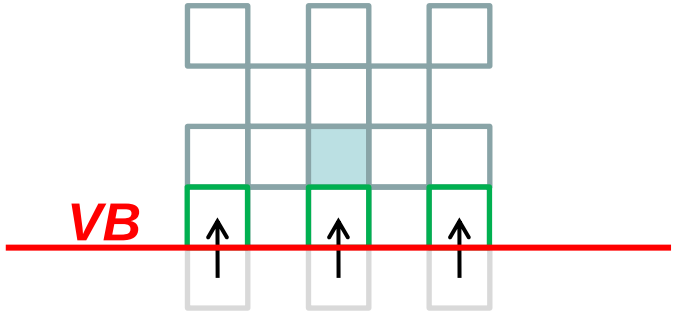


45-degree EO

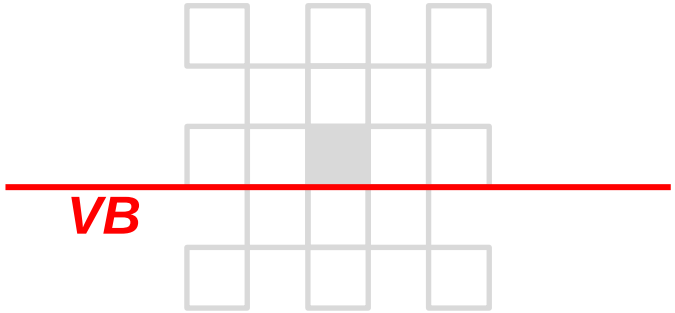
```
if ( ( |c-a| < TH ) && (sanity check is passed) )
    c uses b's offset
else
    c uses zero offset
```

CE8.c.4-1: ALF VB Processing for Above-VB Pixels

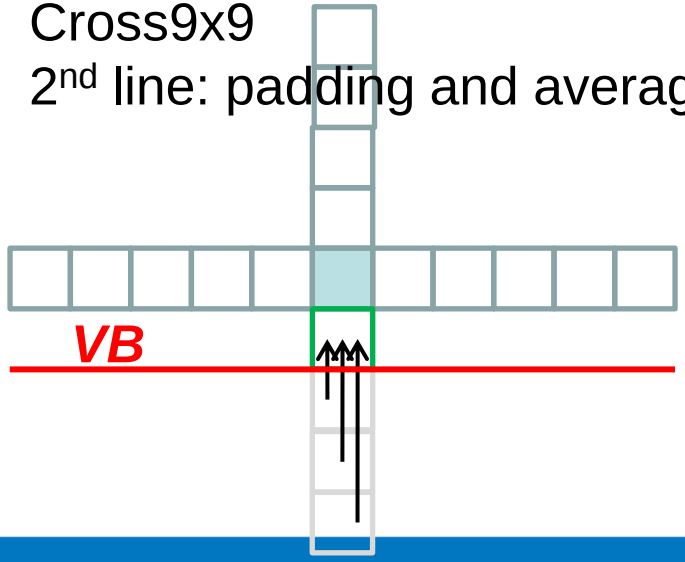
Snowflake5x5
2nd line: padding and averaging



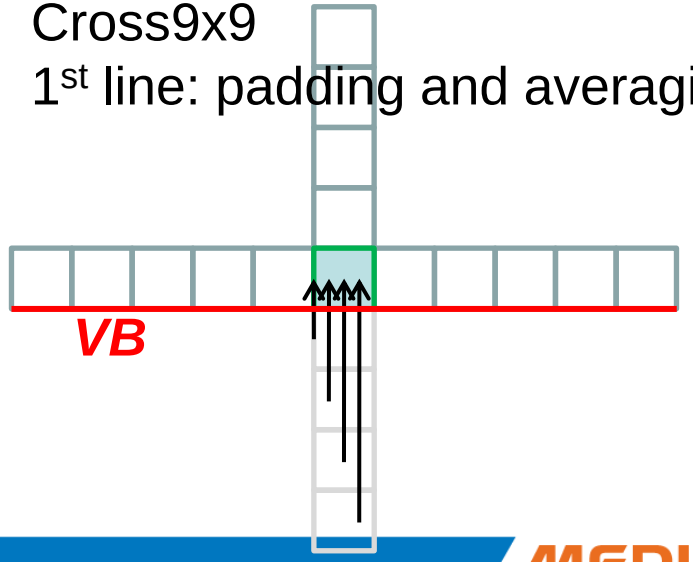
Snowflake5x5
1st line: skip filtering



Cross9x9
2nd line: padding and averaging

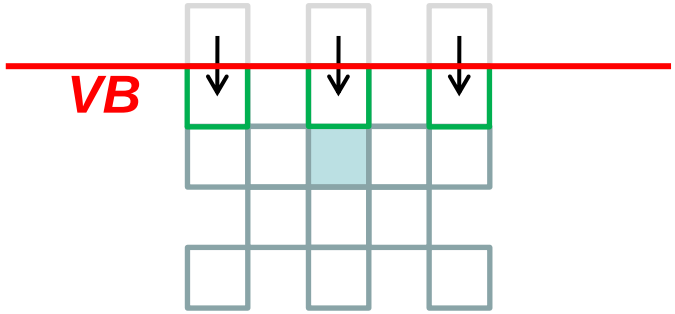


Cross9x9
1st line: padding and averaging

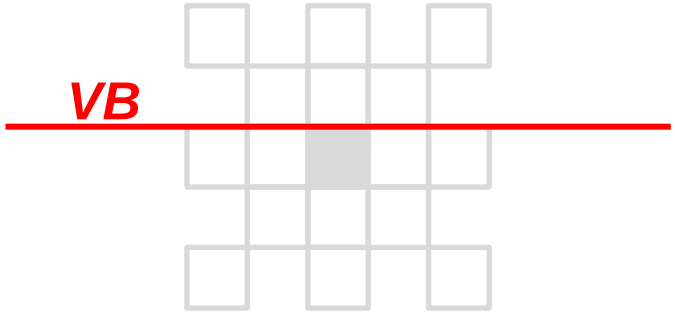


CE8.c.4-1: ALF VB Processing for Below-VB Pixels

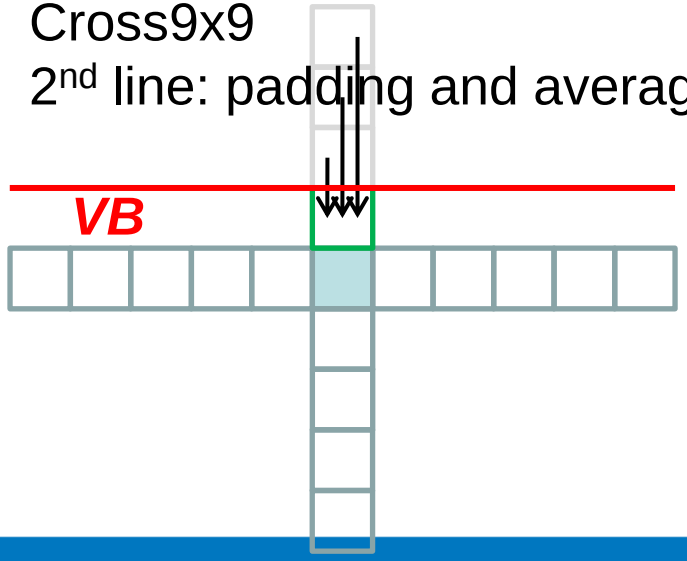
Snowflake5x5
2nd line: padding and averaging



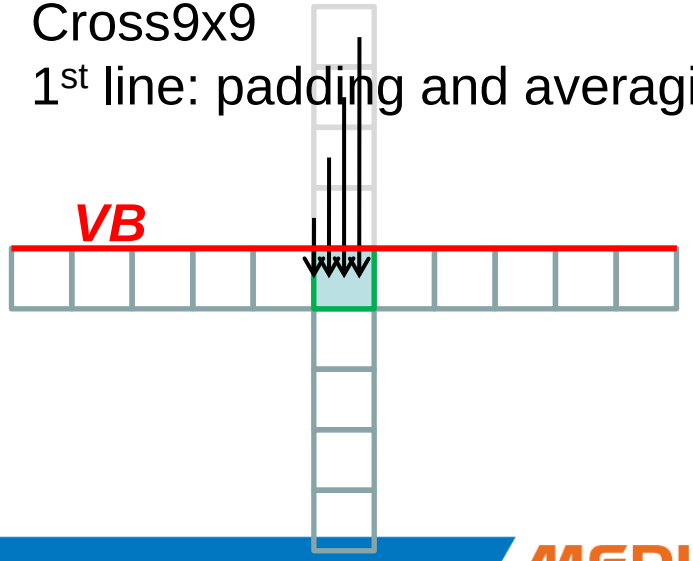
Snowflake5x5
1st line: skip filtering



Cross9x9
2nd line: padding and averaging



Cross9x9
1st line: padding and averaging



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CE8.c.4-1 Results

- Anchor: JCTVC-F900
- BD-rate: -0.3% (gain) to 0.1% (loss)
- Similar rum time
- Slightly degraded visual

JCTVC-G206

	All Intra HE		
	Y	U	V
Class A	0.0%	0.1%	0.0%
Class B	0.1%	0.2%	0.2%
Class C	0.1%	0.2%	0.2%
Class D	-0.2%	0.2%	0.2%
Class E	0.0%	0.4%	0.5%
Overall	0.0%	0.2%	0.2%
	0.0%	0.2%	0.2%
Enc Time[%]	100%		
Dec Time[%]	100%		

	Random Access HE		
	Y	U	V
Class A	0.0%	0.6%	0.4%
Class B	0.0%	0.3%	0.2%
Class C	0.0%	0.0%	0.1%
Class D	-0.7%	0.0%	-0.1%
Class E			
Overall	-0.2%	0.2%	0.2%
	-0.2%	0.2%	0.2%
Enc Time[%]	98%		
Dec Time[%]	98%		

	Low Delay B HE		
	Y	U	V
Class A			
Class B	-0.3%	0.0%	-0.1%
Class C	-0.3%	0.3%	0.3%
Class D	-0.9%	0.0%	-0.4%
Class E	0.1%	0.9%	1.1%
Overall	-0.3%	0.3%	0.1%
	-0.3%	0.2%	0.1%
Enc Time[%]	101%		
Dec Time[%]	101%		

	Low Delay P HE		
	Y	U	V
Class A			
Class B	0.1%	0.3%	0.3%
Class C	0.1%	0.5%	0.2%
Class D	-0.1%	0.3%	-0.2%
Class E	0.2%	1.6%	1.2%
Overall	0.1%	0.6%	0.3%
	0.1%	0.5%	0.2%
Enc Time[%]	97%		
Dec Time[%]	96%		

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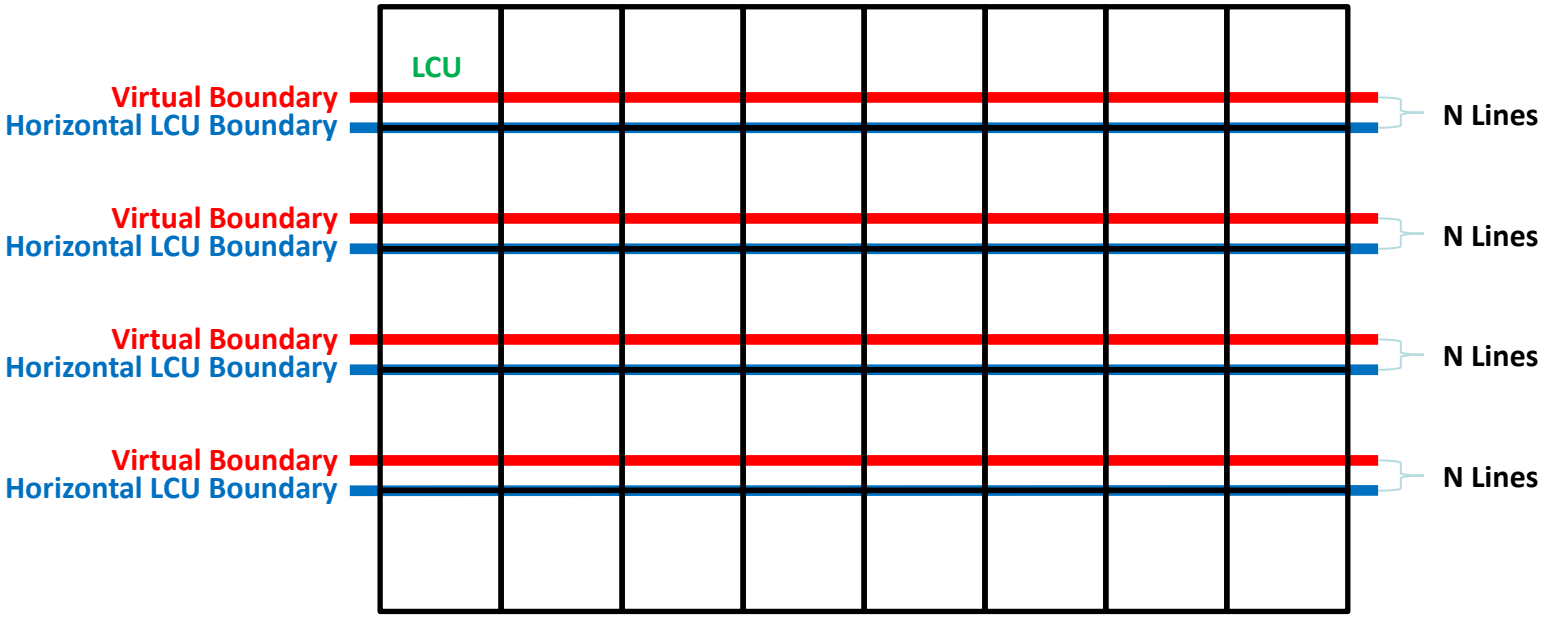
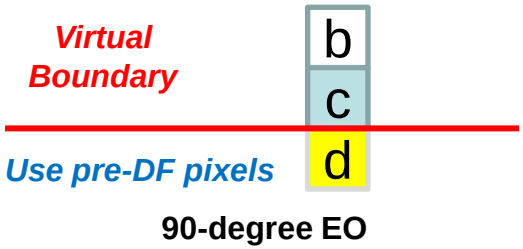
CE8.c.4-2: Virtual Boundary (VB)

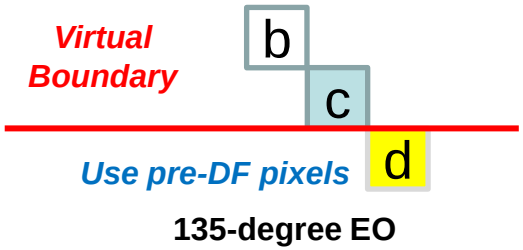
- N=4 for luma, N=2 for chroma
- Processing a pixel on one side of a VB does not use any pixel on the other side of the VB unless it is already in the buffer
- Allow to use pre-DF pixels below the VB when pixels above the VB are processed



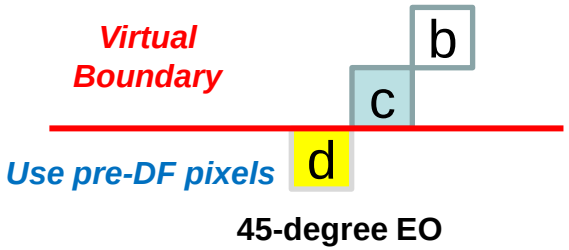
CE8.c.4-2: SAO VB Processing



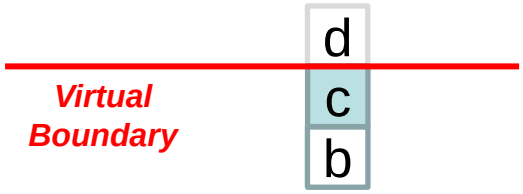
90-degree EO



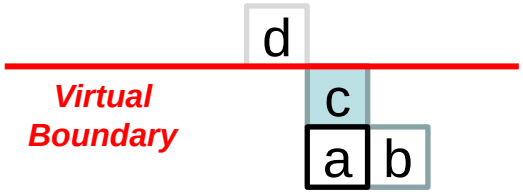
135-degree EO



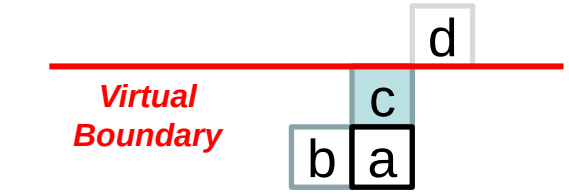
45-degree EO



90-degree EO



135-degree EO



45-degree EO

if ((|**c-a**| < **TH**) && (sanity check is passed))
    c uses **b**'s offset
else
    c uses zero offset

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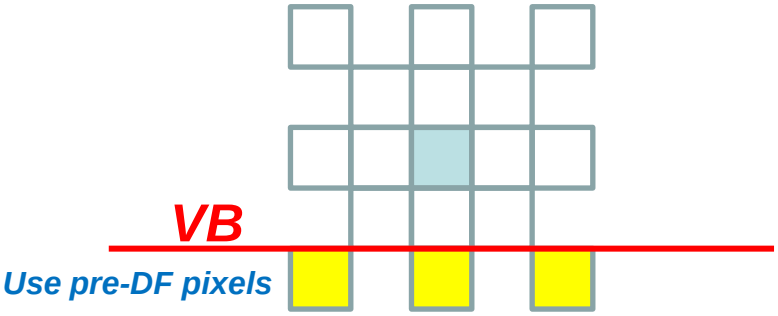
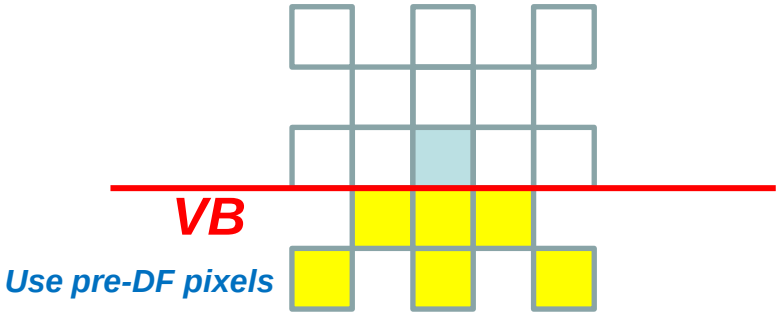
CE8.c.4-2: ALF VB Processing for Above-VB Pixels

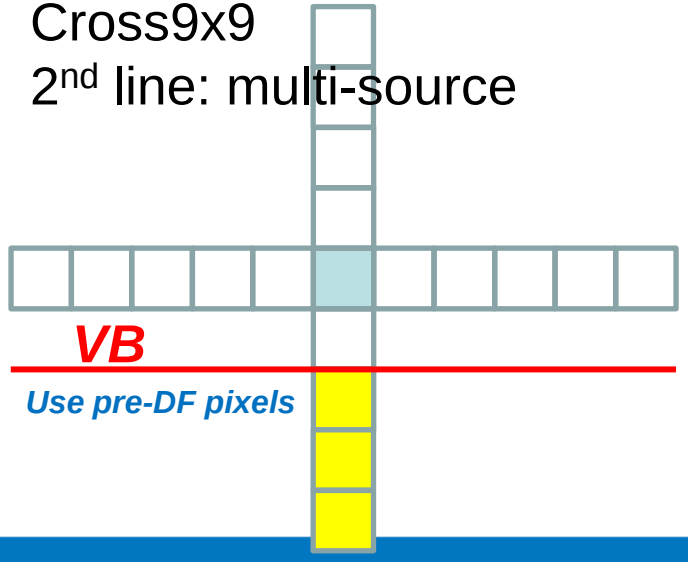
Snowflake5x5
2nd line: multi-source



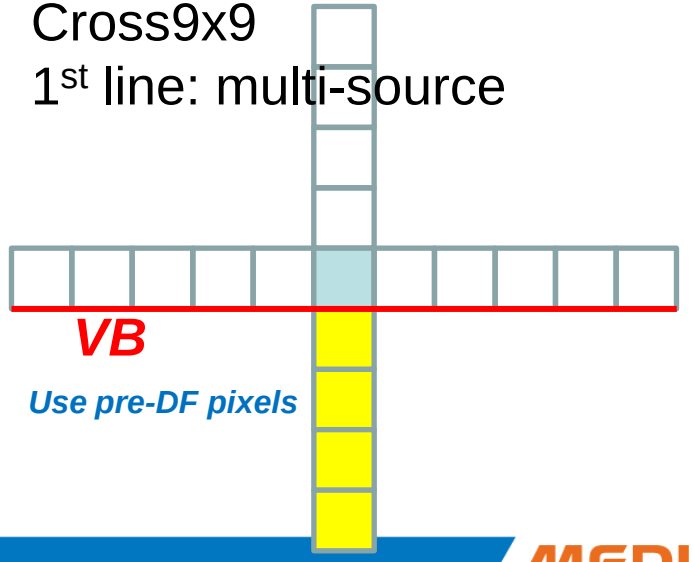
Snowflake5x5
1st line: multi-source



Cross9x9
2nd line: multi-source

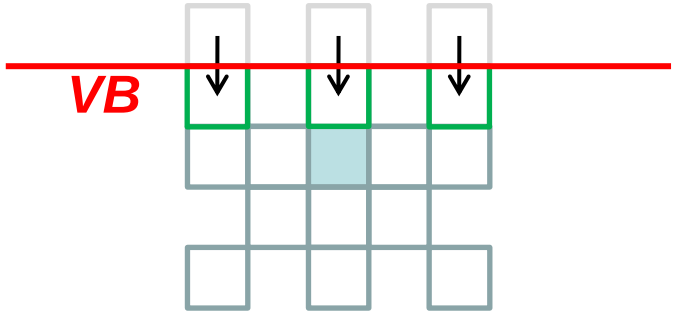


Cross9x9
1st line: multi-source

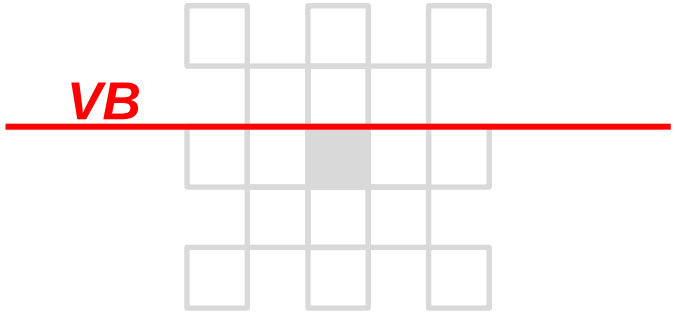


CE8.c.4-2: ALF VB Processing for Below-VB Pixels

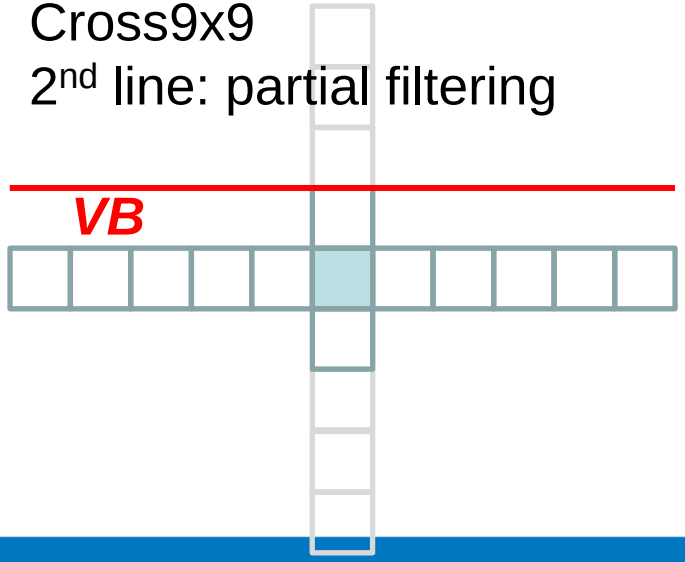
Snowflake5x5
2nd line: padding and averaging



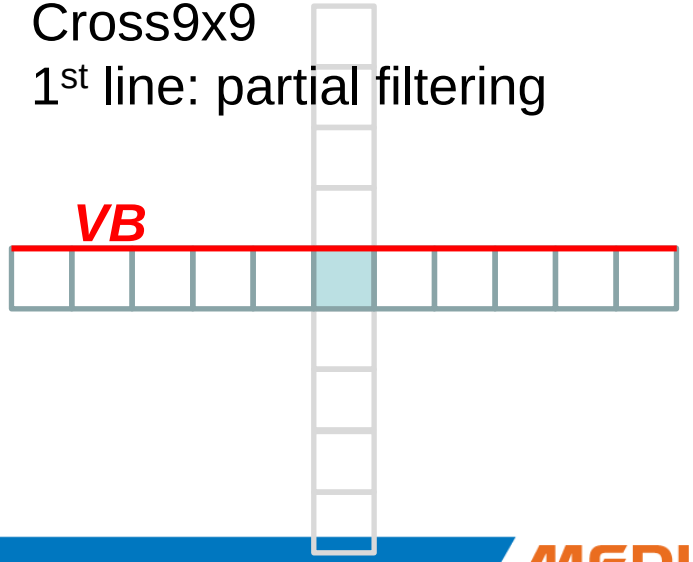
Snowflake5x5
1st line: skip filtering



Cross9x9
2nd line: partial filtering



Cross9x9
1st line: partial filtering



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CE8.c.4-2 Results

- Anchor: JCTVC-F900
- 0.0-0.4% gain
- Similar encoding time
- 2-4% decoding time increase
- Very slightly degraded visual quality

JCTVC-G206

	All Intra HE		
	Y	U	V
Class A	0.0%	0.3%	0.3%
Class B	0.0%	0.4%	0.3%
Class C	0.1%	0.1%	0.2%
Class D	-0.2%	0.2%	0.2%
Class E	0.0%	1.0%	0.8%
Overall	0.0%	0.4%	0.3%
	0.0%	0.4%	0.3%
Enc Time[%]	97%		
Dec Time[%]	102%		

	Random Access HE		
	Y	U	V
Class A	0.0%	0.7%	0.5%
Class B	-0.1%	0.9%	0.6%
Class C	-0.1%	0.1%	0.1%
Class D	-0.7%	0.1%	0.0%
Class E			
Overall	-0.2%	0.5%	0.3%
	-0.2%	0.5%	0.3%
Enc Time[%]	99%		
Dec Time[%]	102%		

	Low Delay B HE		
	Y	U	V
Class A			
Class B	-0.4%	0.4%	0.1%
Class C	-0.4%	0.0%	-0.1%
Class D	-0.9%	-0.4%	-0.4%
Class E	0.0%	1.1%	0.9%
Overall	-0.4%	0.2%	0.1%
	-0.4%	0.2%	0.1%
Enc Time[%]	100%		
Dec Time[%]	102%		

	Low Delay P HE		
	Y	U	V
Class A			
Class B	-0.1%	1.0%	0.7%
Class C	0.0%	0.1%	0.3%
Class D	-0.1%	-0.1%	-0.5%
Class E	0.0%	1.1%	1.1%
Overall	-0.1%	0.5%	0.3%
	-0.1%	0.5%	0.3%
Enc Time[%]	99%		
Dec Time[%]	104%		

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Conclusion

- CE8.c.4-1
  - Combine single-source SAO and ALF VB processing and snowflake5x5+cross9x9
  - Remove all line buffers
  - 0.3% gain to 0.1% loss
  - Slightly degraded visual quality
- CE8.c.4-2
  - Combine multi-source SAO and ALF VB processing and snowflake5x5+cross9x9
  - Remove all line buffers
  - 0-0.4% gain
  - Very slightly degraded visual quality