

# **BoG Report and Unified Proposal on Handling of Unavailable Reference Samples for Intra Prediction**

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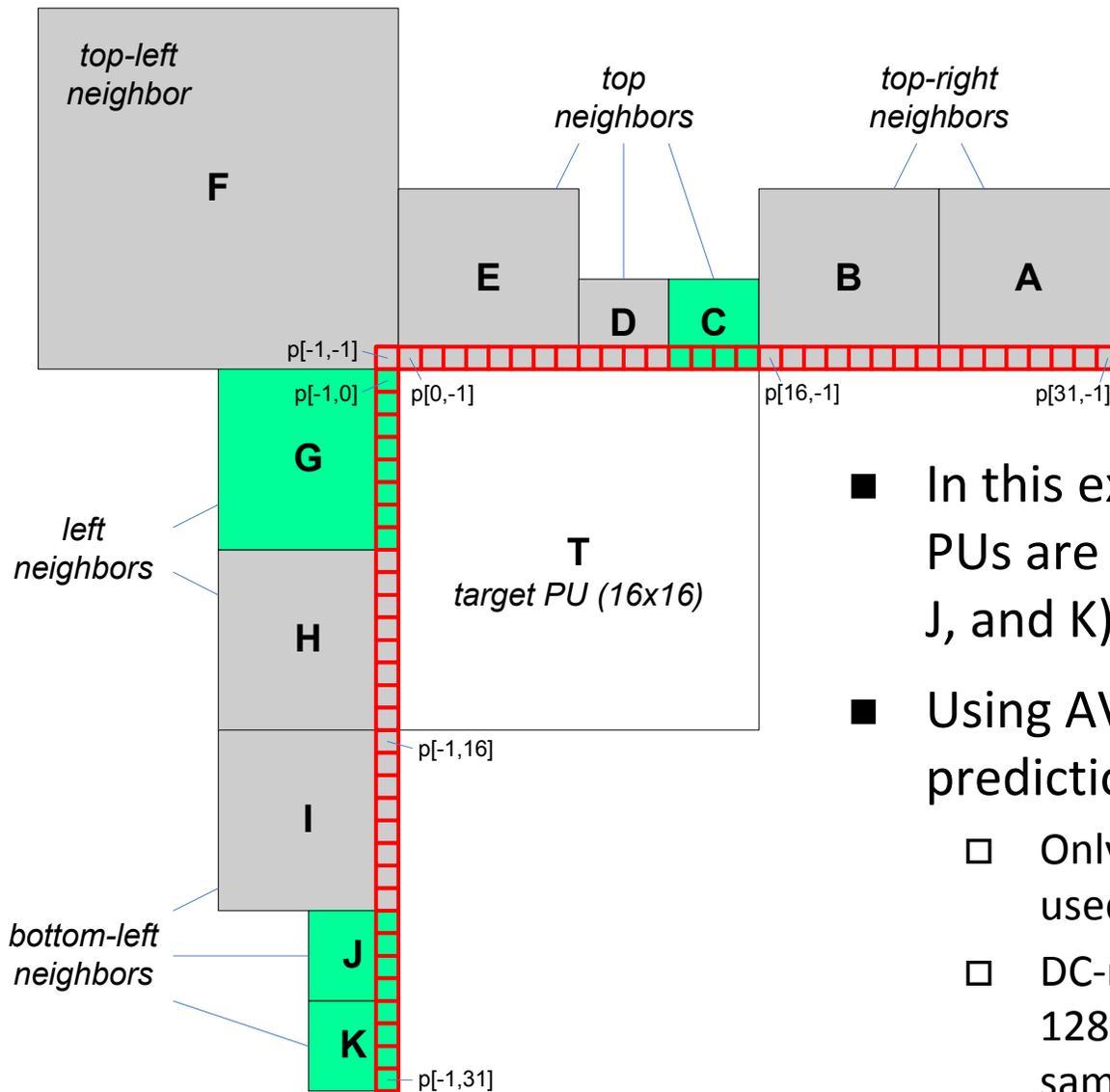
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- AVC-style constrained intra prediction (JCTVC-D086) was adopted in 4<sup>th</sup> JCT-VC meeting and implementation in HM 2.1. The same design fix adapting to HEVC characteristics is proposed in JCTVC-E203 and JCTVC-D386.
- Intra prediction improvement at slice boundary is proposed in JCTVC-E283 (CE4).
- Due to similar nature of proposed solutions, BoG was initiated to unify a single proposal.
- Simple concept (WD modification provided):
  - Firstly, intra prediction reference samples are marked as available or unavailable for prediction. Reasons for a sample to be marked as unavailable for intra prediction include:
    - the sample is outside the picture;
    - the sample is outside the slice;
    - the sample is not intra coded and constrained intra prediction is enabled.
  - If all reference samples are unavailable, we set all prediction pixels to 128. Otherwise, we use either sample repetition or lightweight sample interpolation  $((q + r + 1) \gg 1)$  to make all reference samples available for prediction. That way, the directional intra prediction modes operate in the same way regardless of picture boundaries, slice borders and constrained intra conditions.
- Recommendation: To include the joint proposal in HM 3.0.

Slide taken from JCTVC-E203

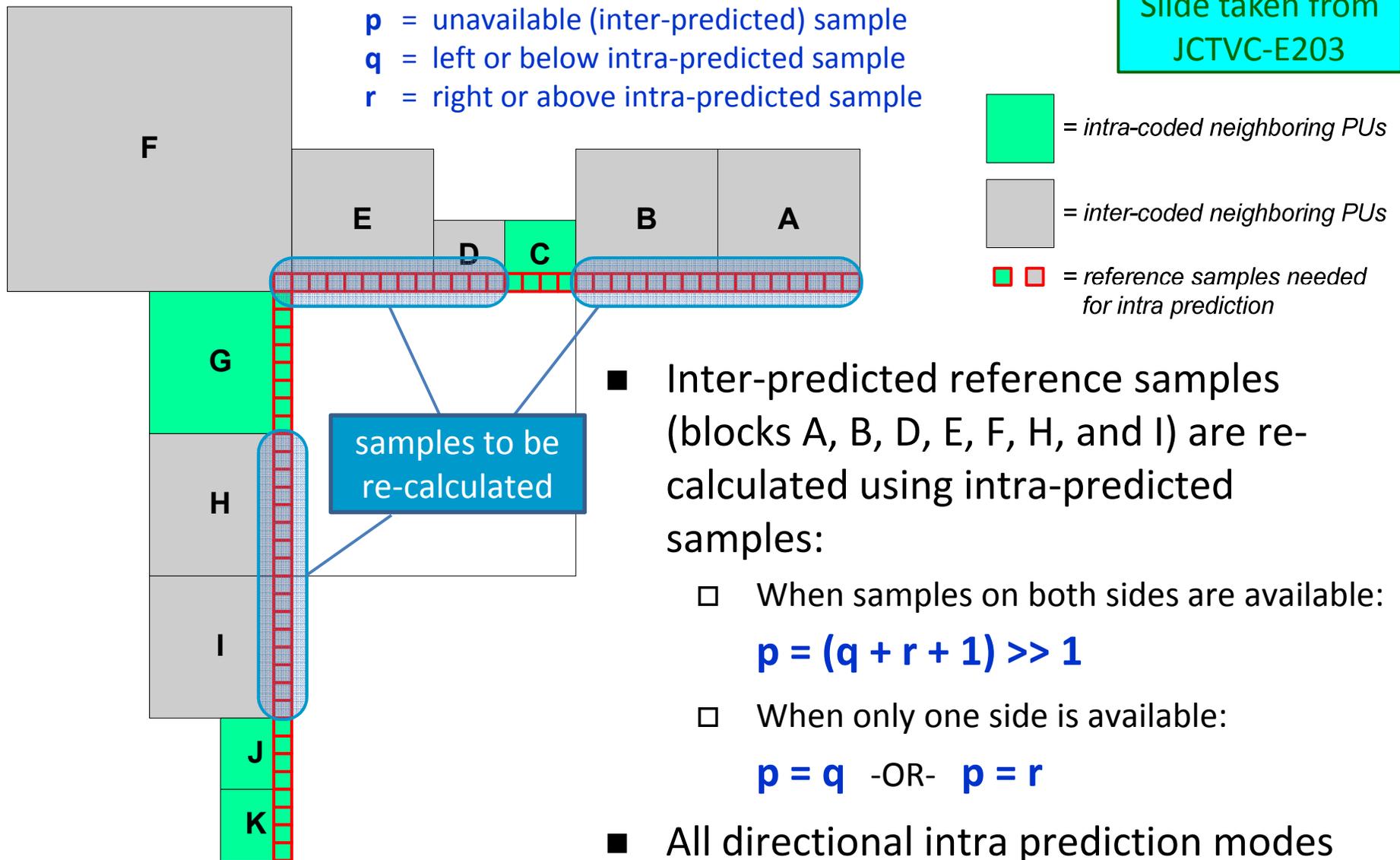


= intra-coded neighboring PUs  
 = inter-coded neighboring PUs  
 = reference samples needed for intra prediction

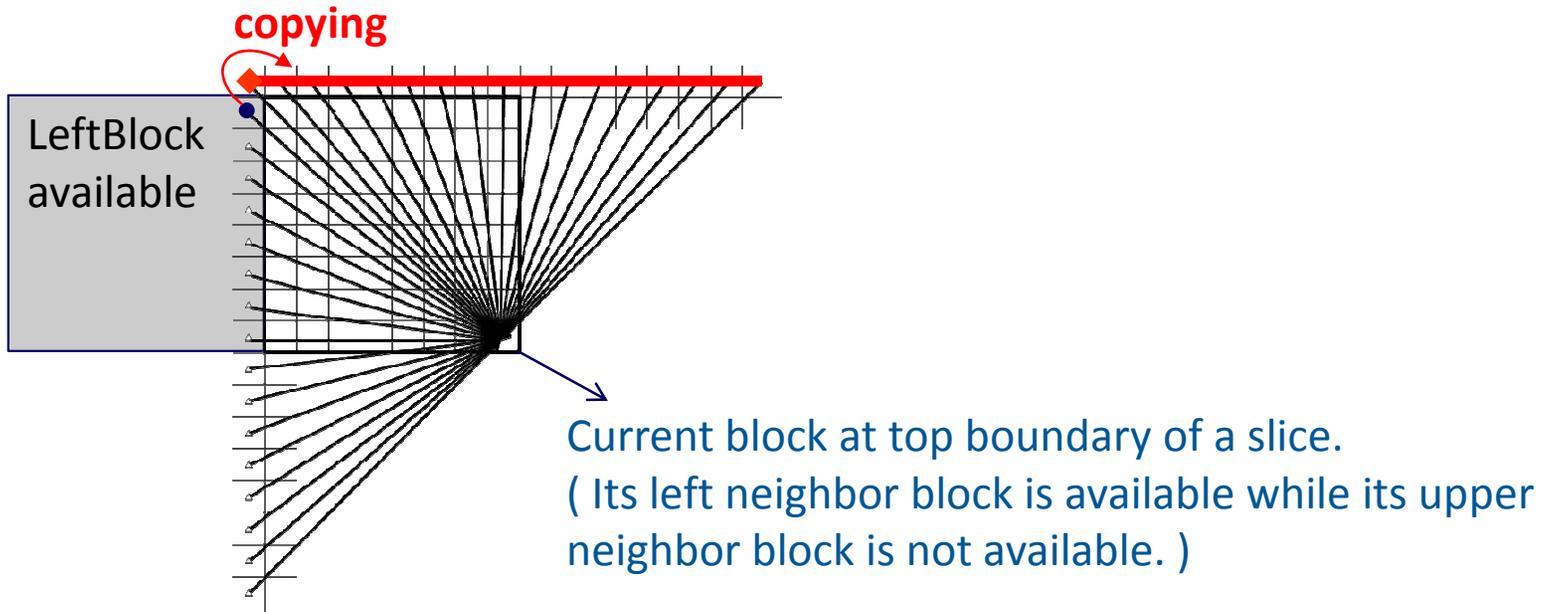
- In this example, some neighboring PUs are intra-predicted (blocks C, G, J, and K).
- Using AVC-style constrained intra prediction:
  - Only DC intra prediction mode can be used.
  - DC-mode prediction value is set to 128 (neighboring intra-predicted samples are ignored).

# Proposed Constrained Intra Prediction

Slide taken from JCTVC-E203



## Improvement 1: Reference Pixel Padding



- Padding process for the unavailable reference pixels
  - Padding with the pixel closest to upper-left corner from its available neighbor block, instead of padding with a fixed DC value
  - The upper-left corner reference pixel is also padded

# Results for Constrained Intra Prediction

- Table shows BD-rates of JCTVC-E203 compared to HM-2.0-dev-nec (rev 597) with constrained intra prediction ON.
- HM 2.1 was not available when simulations were started.

Slide taken from JCTVC-E203

	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.04	-0.24	-0.11	-0.10	-0.18	-0.66
Class B	-0.15	-0.27	-0.32	-0.32	-0.50	-0.45
Class C	-0.29	-0.39	-0.48	-0.48	-0.74	-0.89
Class D	-0.25	-0.28	-0.24	-0.37	-0.59	-0.56
Class E						
All	-0.18	-0.29	-0.29	-0.32	-0.50	-0.63
Enc Time[%]		100%			100%	
Dec Time[%]		100%			100%	

	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-0.06	-0.11	-0.15	-0.11	-0.30	-0.25
Class C	-0.07	-0.13	-0.09	-0.17	-0.34	-0.33
Class D	-0.03	0.22	-0.62	-0.09	-0.26	0.08
Class E	-0.13	-0.68	-0.12	-0.11	0.27	0.02
All	-0.07	-0.14	-0.25	-0.12	-0.20	-0.14
Enc Time[%]		100%			100%	
Dec Time[%]		100%			100%	

Slide taken from JCTVC-E283

- Test conditions
  - LCU=64x64, LCU-aligned
  - 1500 bytes per slice
- Anchor:
  - Huawei's slice implementation
  - (very similar to HM2.0-dev-slice)

## Performance of Improvement1 (Reference Pixel Padding)

	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.3	0.2	0.4	-0.4	0.0	0.1
Class B	-0.4	-0.3	-0.3	-0.5	-0.4	-0.3
Class C	-0.4	-0.4	-0.4	-0.5	-0.7	-0.6
Class D	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5
Class E	-0.6	-0.1	0.0	-0.7	0.0	-0.3
All	-0.4	-0.2	-0.1	-0.5	-0.3	-0.3
Enc Time[%]	101%			103%		
Dec Time[%]	100%			102%		

- BoG produced a single unified proposal for handling of unavailable reference samples for intra prediction.
- Proposed scheme fixes the current HM 2.1 design by adapting to HEVC characteristics.
- Consistent although small BD-rate gains:
  - 0.1-0.3% for constrained intra prediction on RA and LD settings.
  - 0.4-0.5% for multiple-slice on intra settings.
  - No increase in encoding/decoding runtime.
  - No interoperability/combination issue.
- Recommendation: To include the joint proposal in HM 3.0.



**Thank you**

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