JCTVC-D094

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Constrained Intra Prediction for Flexible-Sized Prediction Units in HEVC

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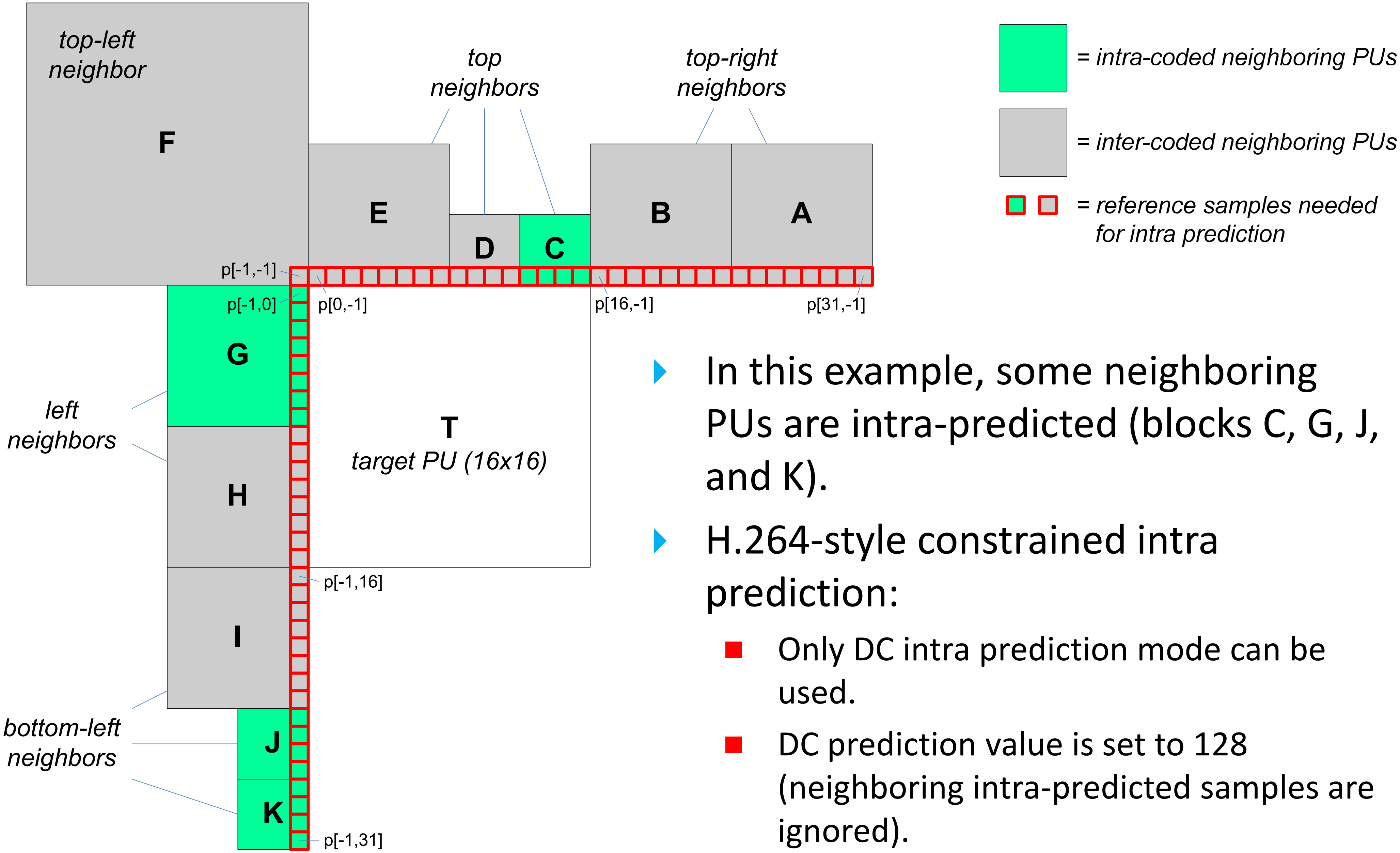
Introduction

- Constrained intra prediction is a useful tool for avoiding error propagation from spatial intra prediction in the event of encoder-decoder mismatch.
- JCTVC-D086 reports the benefits of an H.264-style constrained intra prediction scheme in suppressing visual artifacts when lossy decoder-side memory compression is applied.
- However, H.264-style scheme is overly restrictive for HEVC, as partially available intra-predicted pixels are not used as intra prediction reference sample.
- This contribution investigates the possible improvements over H.264-style constrained intra prediction scheme by adapting the scheme design to HEVC's flexible-sized PUs.

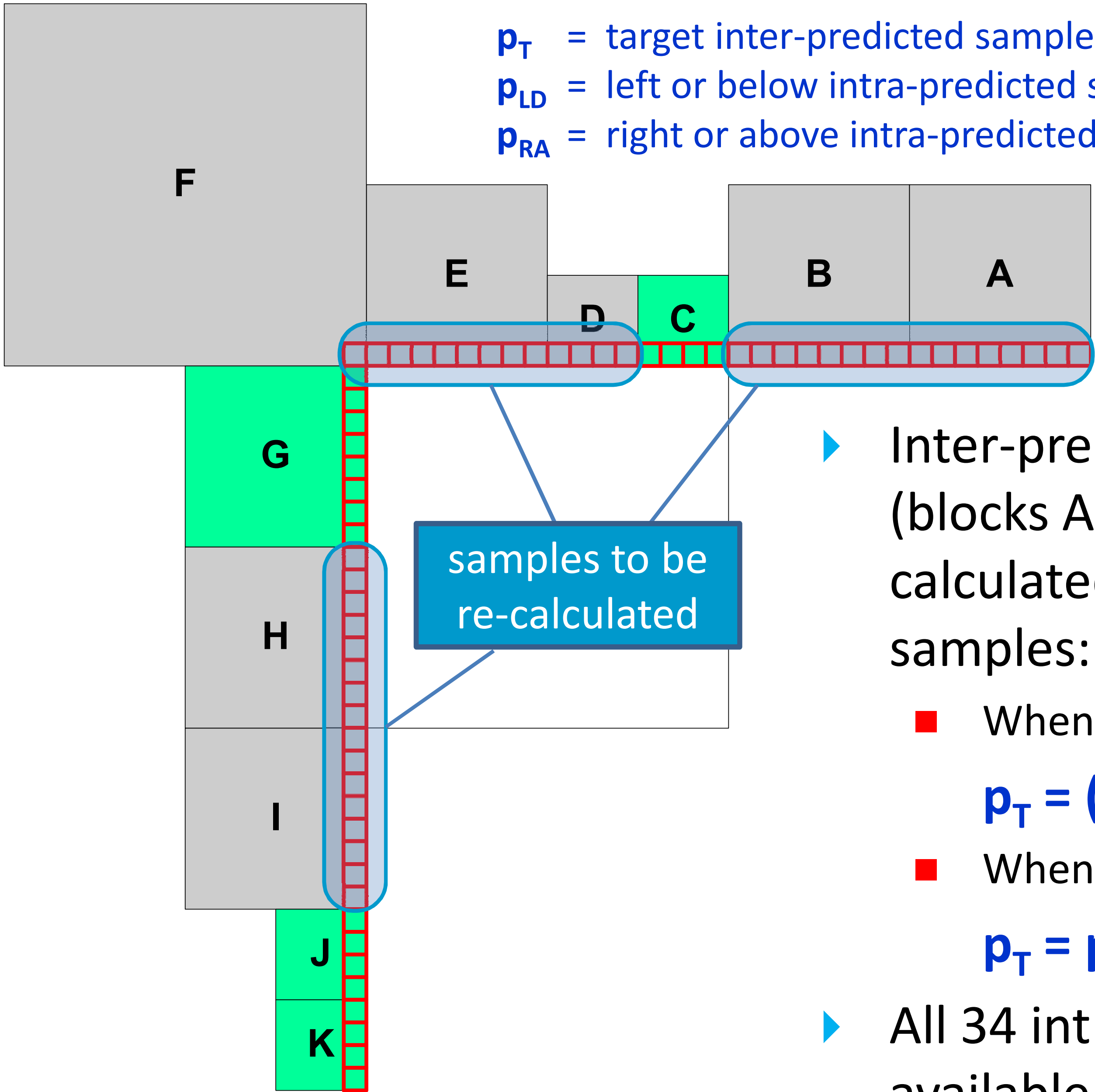
H.264-Style Constrained Intra Prediction Scheme

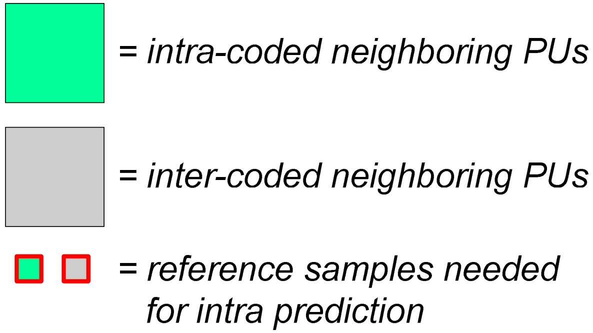


- In this example, some neighboring PUs are intra-predicted (blocks C, G, J, and K).
- H.264-style constrained intra prediction:
  - Only DC intra prediction mode can be used.
  - DC prediction value is set to 128 (neighboring intra-predicted samples are ignored).

Proposed Constrained Intra Prediction Scheme

p_T = target inter-predicted sample
p_{LD} = left or below intra-predicted sample
p_{RA} = right or above intra-predicted sample





- Inter-predicted reference samples (blocks A, B, D, E, F, H, and I) are re-calculated using intra-predicted samples:
  - When samples on both sides are available:

    $$p_T = (p_{LB} + p_{RA} + 1) >> 1$$

  - When only one side is available:

    $$p_T = p_{LB} \quad \text{-OR-} \quad p_T = p_{RA}$$

- All 34 intra prediction modes remains available to be used.

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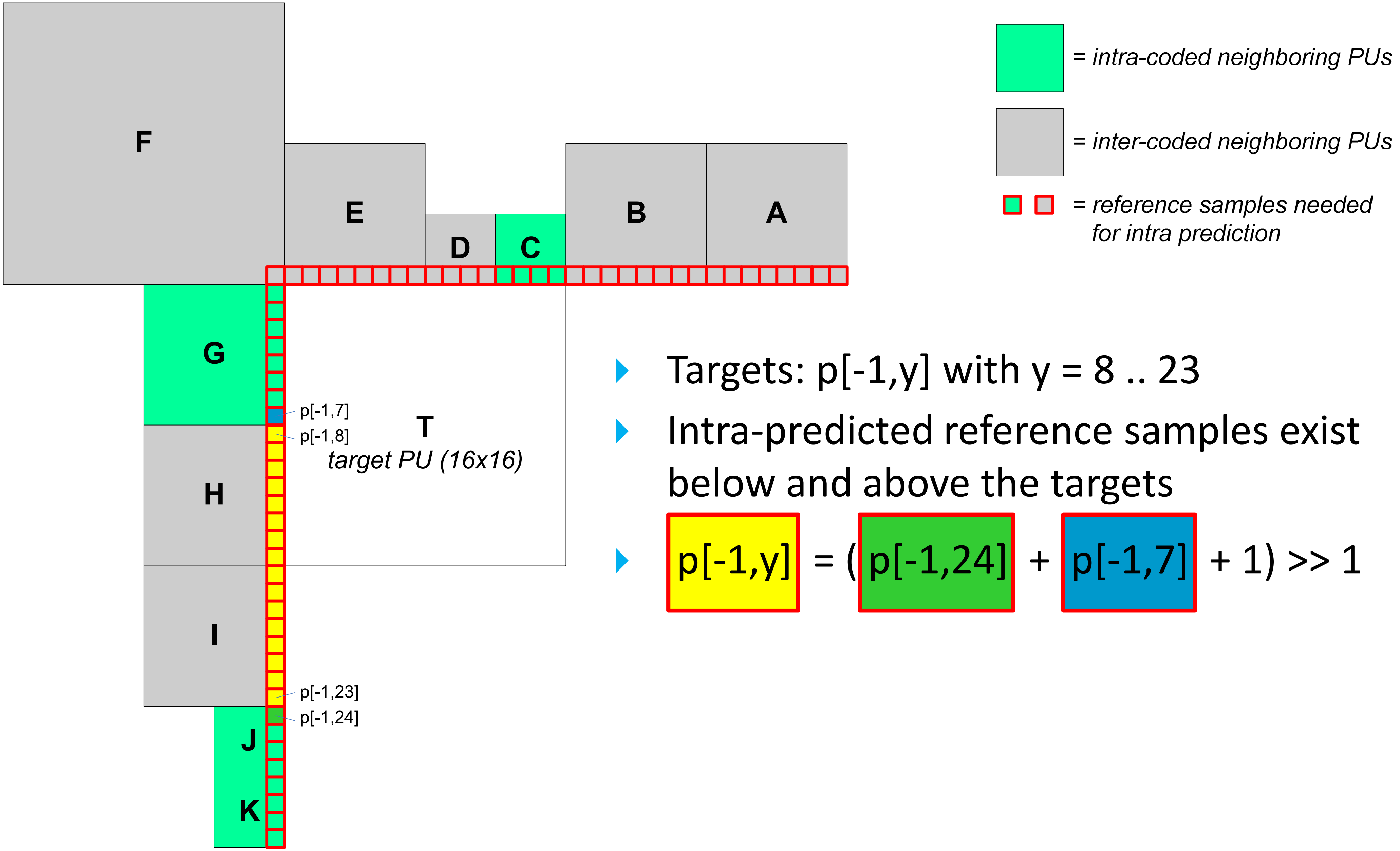
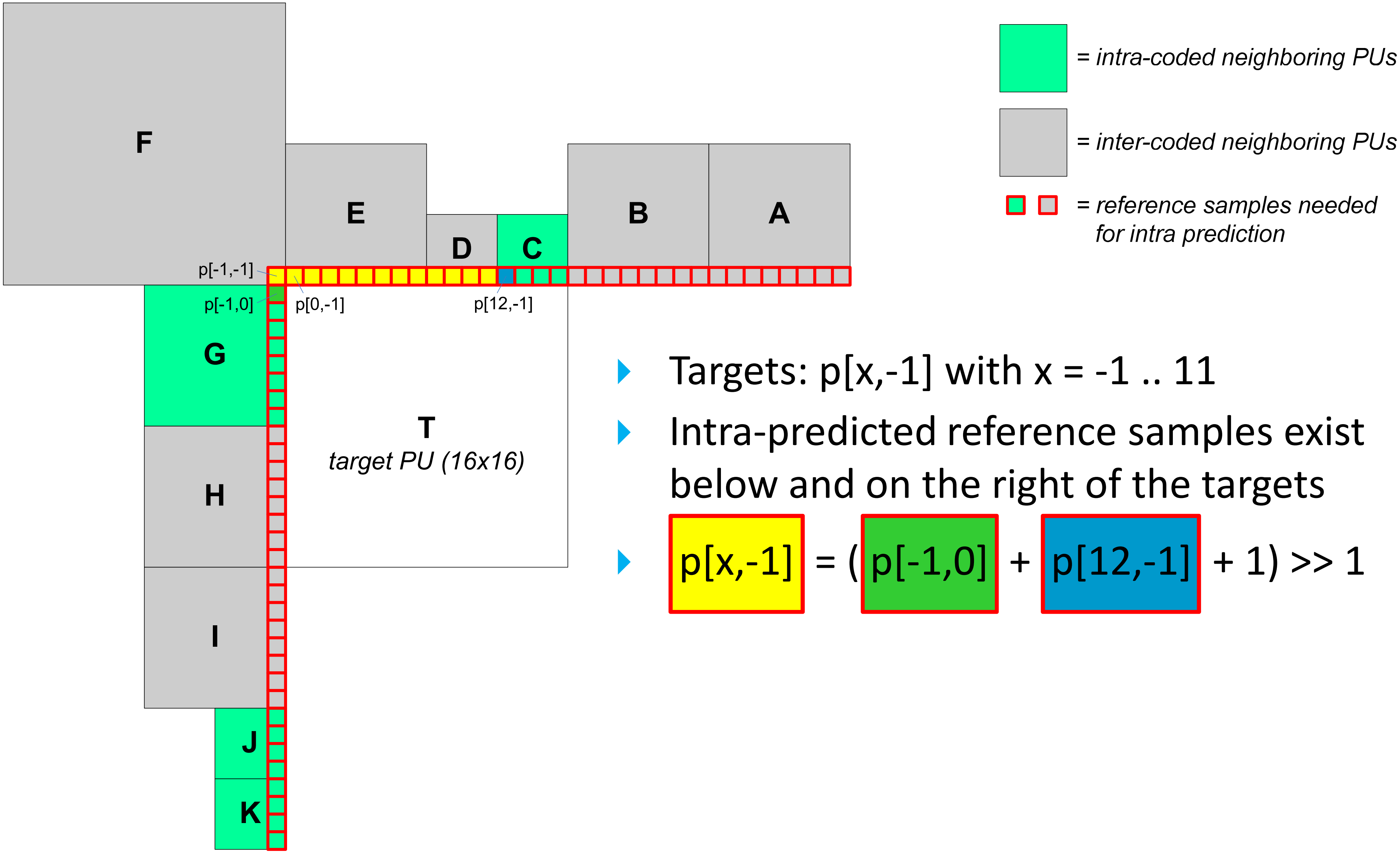
Proposed Constrained Intra Prediction Scheme



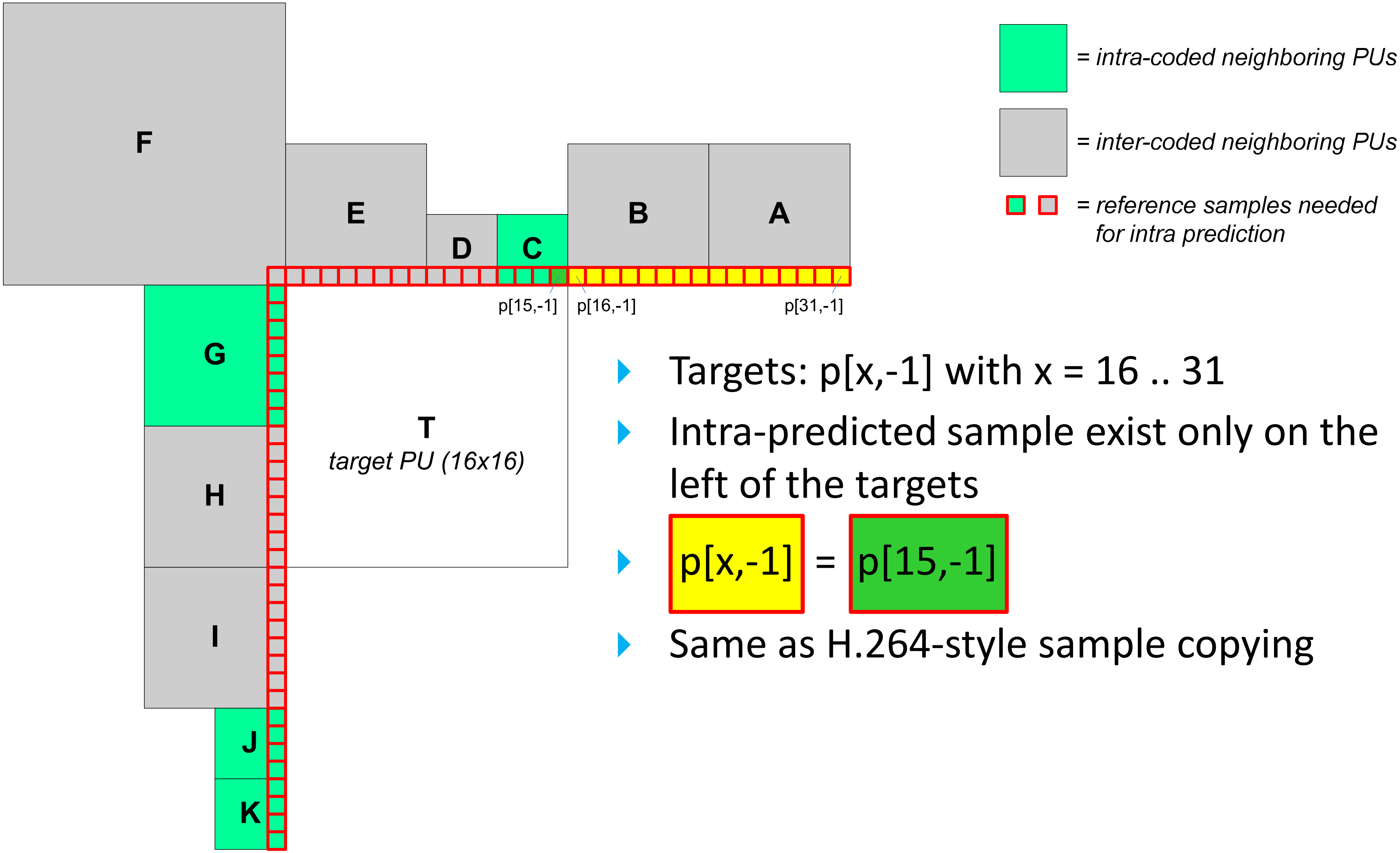
- Targets: p[-1,y] with y = 8 .. 23
- Intra-predicted reference samples exist below and above the targets
- p[-1,y] = (p[-1,24] + p[-1,7] + 1) >> 1

Proposed Constrained Intra Prediction Scheme



- Targets: p[x,-1] with x = -1 .. 11
- Intra-predicted reference samples exist below and on the right of the targets
- p[x,-1] = (p[-1,0] + p[12,-1] + 1) >> 1

Proposed Constrained Intra Prediction Scheme



- Targets: p[x,-1] with x = 16 .. 31
- Intra-predicted sample exist only on the left of the targets
- p[x,-1] = p[15,-1]
- Same as H.264-style sample copying

Experimental Results (Average)

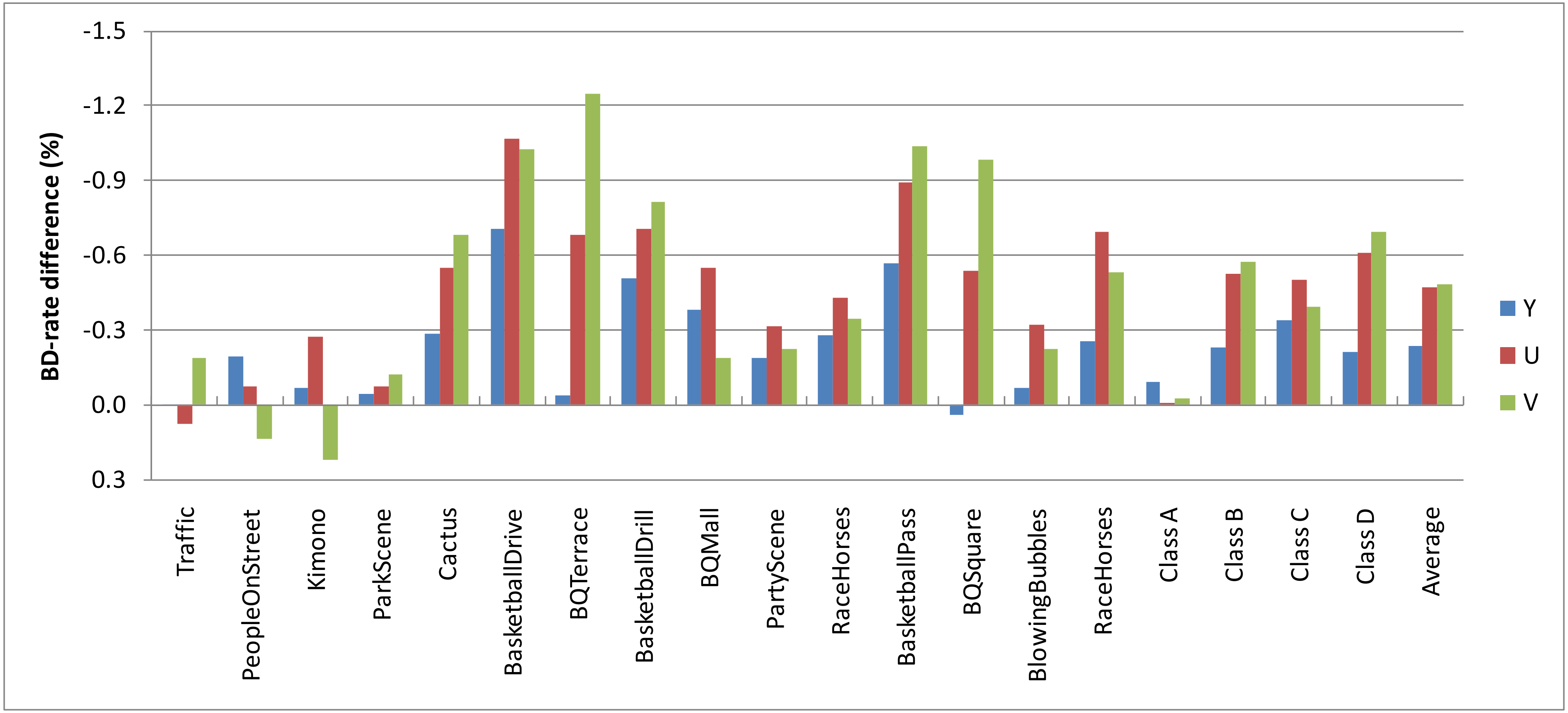
- Table shows results of proposed scheme with reference to H.264-style constrained intra prediction scheme (negative BD-rate difference indicates coding gain).
- Encoding and decoding time is virtually unchanged.

	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	-0.1	0.0	0.0	-0.1	-0.2	-0.1
Class B	-0.2	-0.5	-0.6	-0.2	-0.3	-0.4
Class C	-0.3	-0.5	-0.4	-0.3	-0.4	-0.4
Class D	-0.2	-0.6	-0.7	-0.2	-0.4	-0.3
Class E						
All	-0.2	-0.5	-0.5	-0.2	-0.3	-0.3
Enc Time[%]	92%			93%		
Dec Time[%]	101%			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	-0.1	-0.2	0.3	0.0	0.0	-0.2
Class C	-0.1	-0.2	0.0	-0.1	-0.1	0.0
Class D	0.0	-0.2	0.0	-0.1	-0.1	-0.2
Class E	-0.1	-0.1	0.2	-0.1	-0.4	-0.3
All	-0.1	-0.2	0.1	-0.1	-0.1	-0.2
Enc Time[%]	99%			99%		
Dec Time[%]	103%			98%		

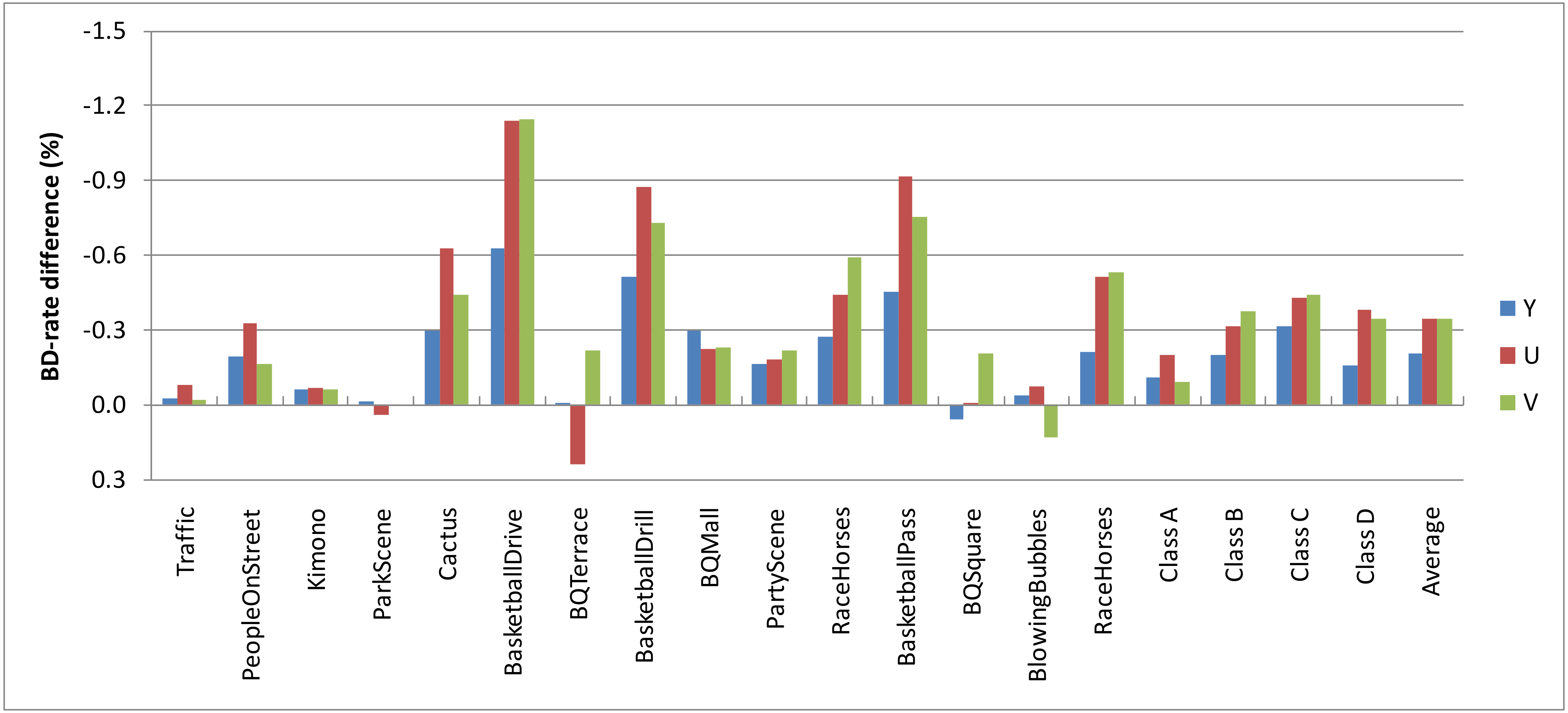
Experimental Results (Per Sequence)

- **Random Access, High Efficiency** (reference: H.264-style scheme)



Experimental Results (Per Sequence)

- **Random Access, Low Complexity** (reference: H.264-style scheme)



Experimental Results (Per Sequence)

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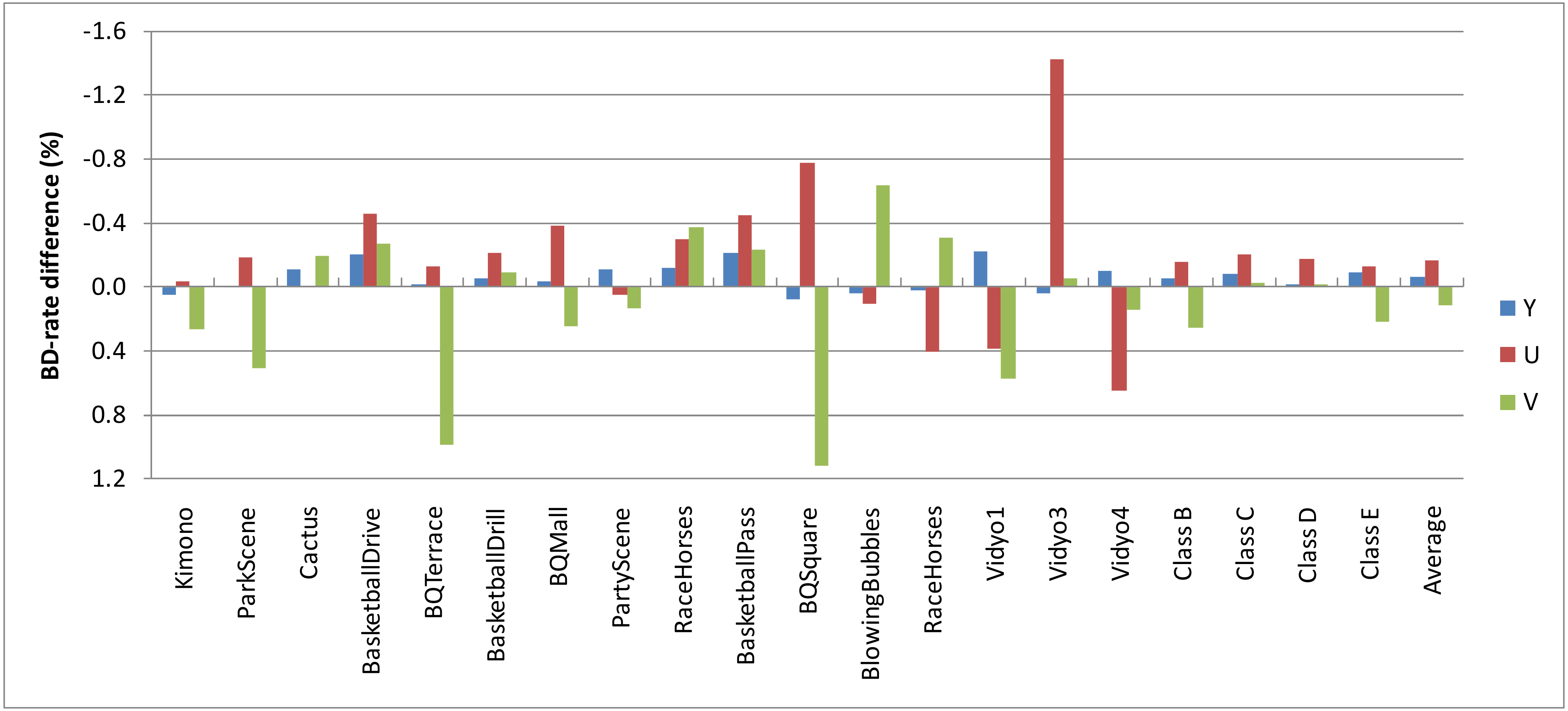
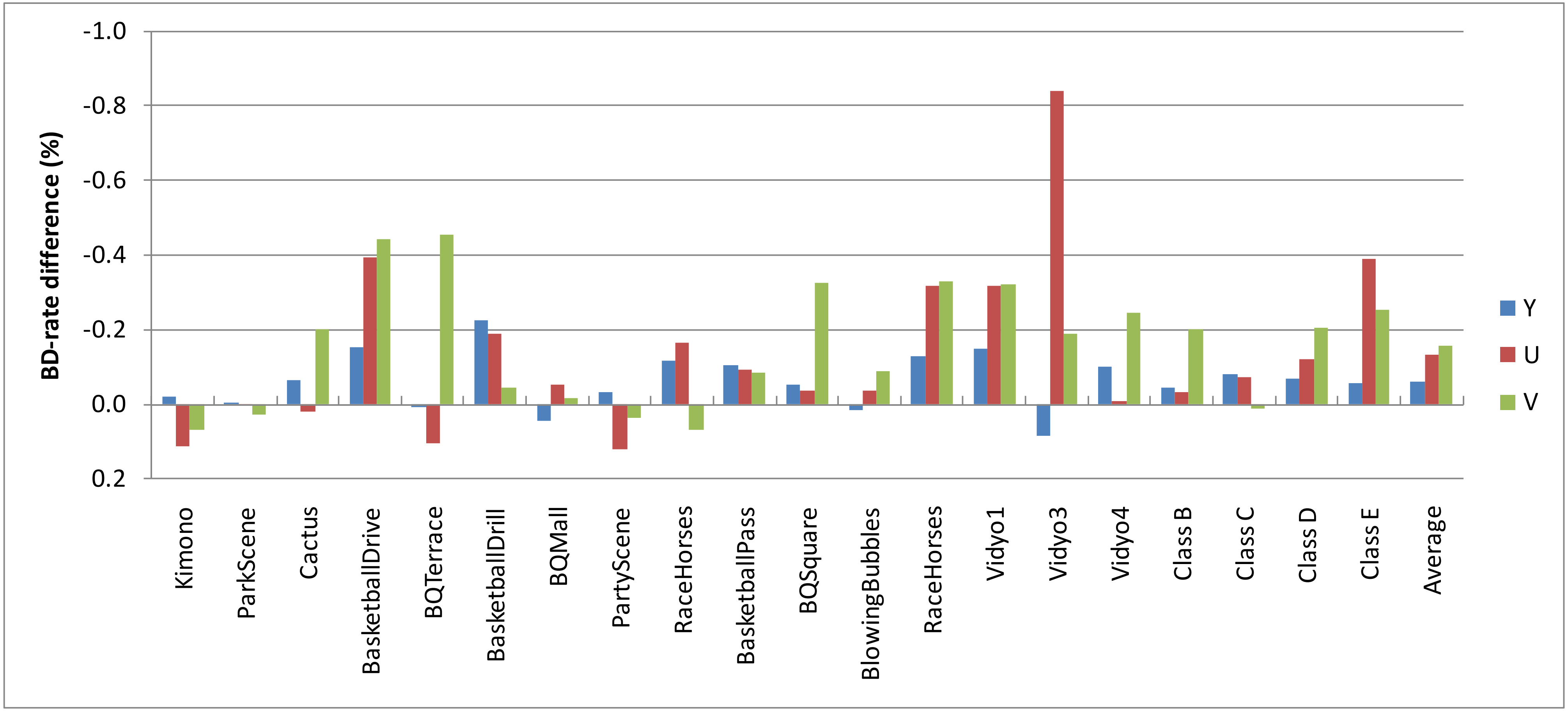


Experimental Results (Per Sequence)

- **Low Delay, Low Complexity** (reference: H.264-style scheme)



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Conclusions

- Constrained intra prediction is beneficial for controlling spatial error propagation, as reported in JCTVC-D086.
- However, some coding efficiency loss is reported when H.264-style constrained intra prediction is used.
- This contribution shows that the loss can be reduced by considering HEVC characteristics (in particular flexible-sized PU) in the design of constrained intra prediction scheme.
- We recommend JCT-VC to:
  - Include constrained intra prediction into HEVC;
  - Further investigate possible improvements such as the current proposed technique.

Thank you