

# **G791 – Simplified reference samples padding for intra prediction**

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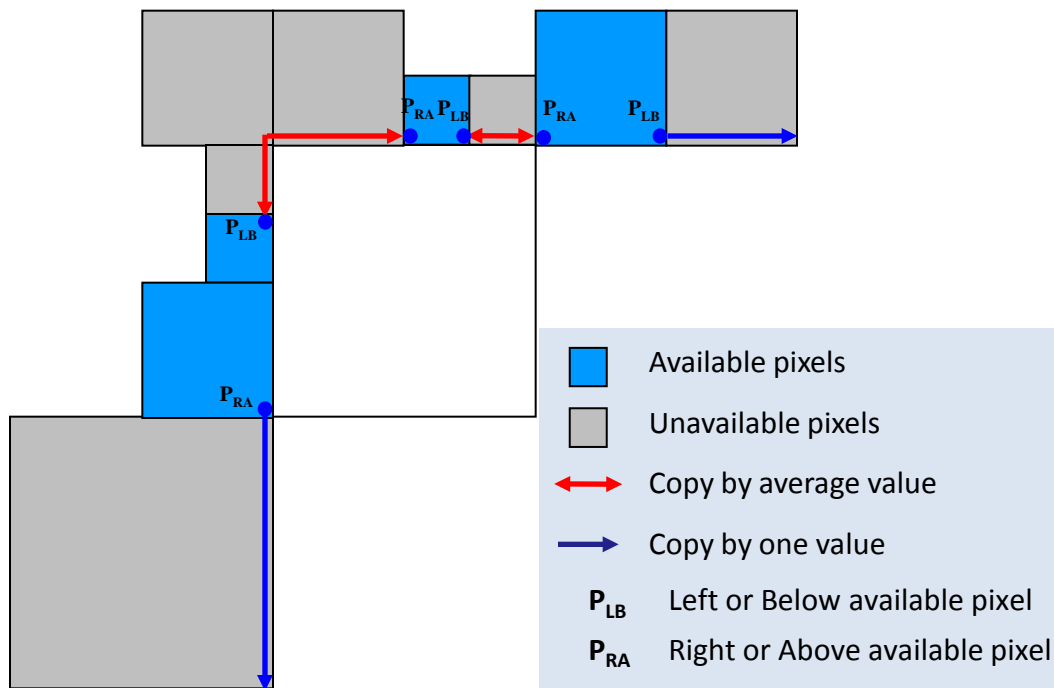
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# Introduction

## ❖ HM 4.0 reference samples padding for intra prediction

- When samples are not available, those are padded by available samples
  - Samples are not available when inter-coded in constraint intra prediction
  - Samples are not available when belong to other slice than the current slice in multiple slices coding in a picture
  - All directional intra prediction modes remain available to be used after padding
- Padding process



For  $P_T$  unavailable pixel to be padded,

- When samples on both sides are available:  

$$P_T = (P_{LB} + P_{RA} + 1) \gg 1$$
- When only one side is available:  

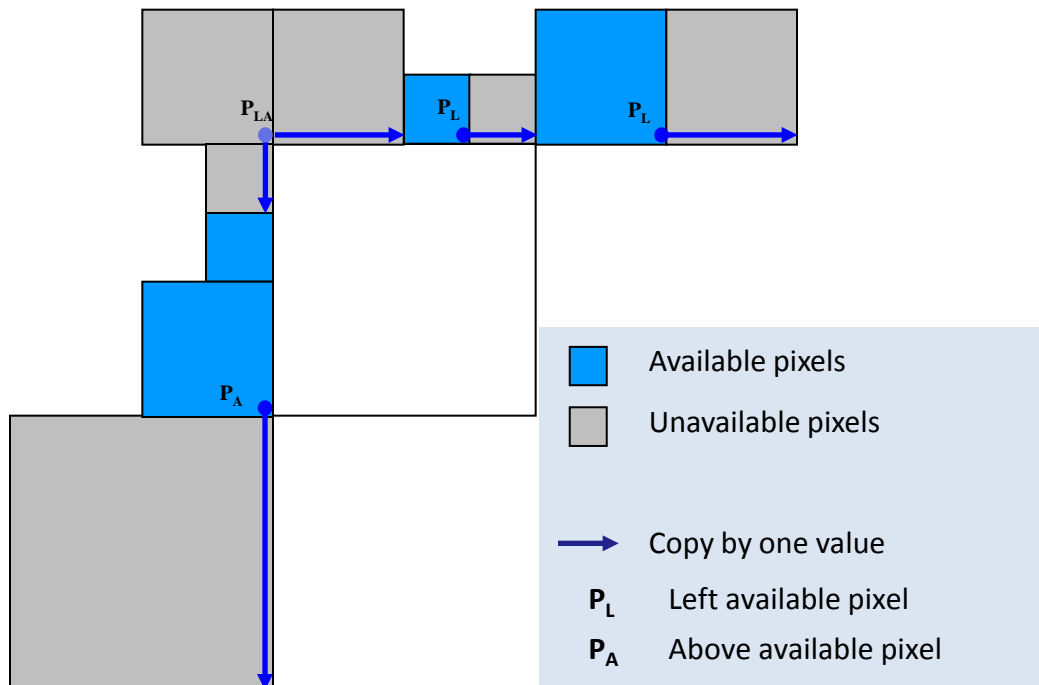
$$P_T = P_{LB} \text{ -OR- } P_T = P_{RA}$$
- Otherwise,  $P_T = (1 \ll (\text{BitDepth}_Y - 1))$
- This requires checking for two end points  $P_{LB}$  and  $P_{RA}$
- Padding process is changed according to the condition among averaging, copying from LB or copying from RA

# Simplified reference padding (1)

## ❖ Simplified reference samples padding for intra prediction

### ■ Padding process

- For unavailable samples on the above, copy from the left
- For unavailable samples on the left, copy from the Above
- If the left-top sample is not available, it is padded first



# Simplified reference padding (2)

❖ For the left-top pixel padding, the following two methods were tested

- Method1: Use the existing HM4.0 process

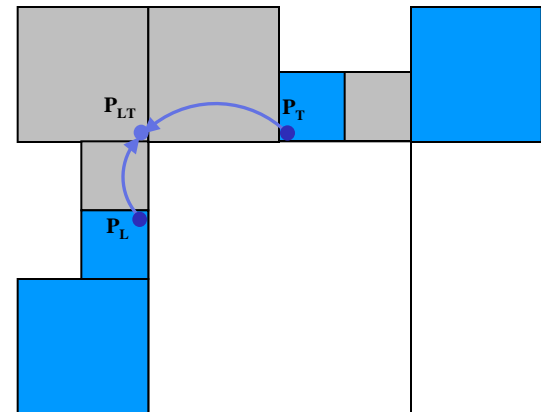
- When samples on both sides are available:

$$P_{LT} = (P_L + P_T + 1) \gg 1$$

- When only one side is available:

$$P_{LT} = P_L \text{ -OR- } P_{LT} = P_T$$

- Otherwise,  $P_T = (1 \ll (\text{BitDepth}_Y - 1))$



- Method2: Use the first available pixel to the left-top

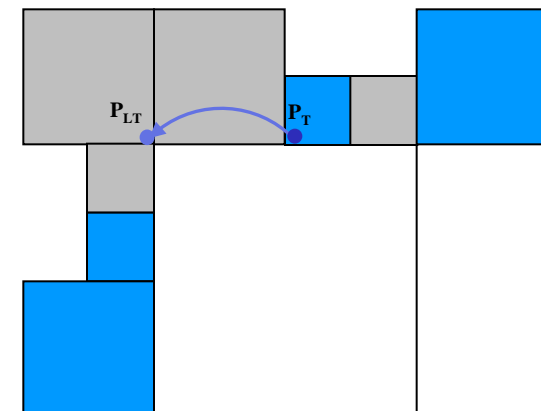
- If a sample on the above is available:

$$P_{LT} = P_T$$

- Else if a sample on the left is available:

$$P_{LT} = P_L$$

- Otherwise,  $P_T = (1 \ll (\text{BitDepth}_Y - 1))$



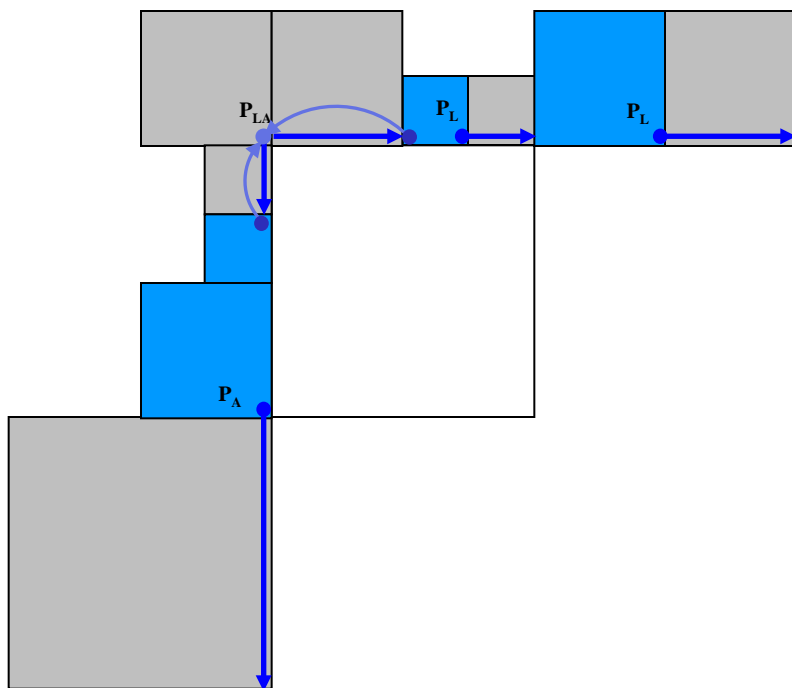
# Test Results on Method1

## ❖ Experiments on HM4.0

- Method1 is tested with constrained intra prediction
- Method1 has no performance change with multiple slices coding because the left-top padding is the same as HM4.0

**Method1 with CIP**

Test Config	Y	U	V	EncT	DecT
HE_RA	0.0%	0.0%	0.0%	99%	97%
LC_RA	0.0%	0.0%	-0.1%	99%	97%
HE_LD	0.0%	0.1%	0.1%	99%	97%
LC_LD	0.0%	0.0%	0.0%	99%	99%



# Test Results on Method2

## ❖ Experiments on HM4.0

- Method2 is tested with constrained intra prediction or/and 1500-byte slices

**Method2 with CIP**

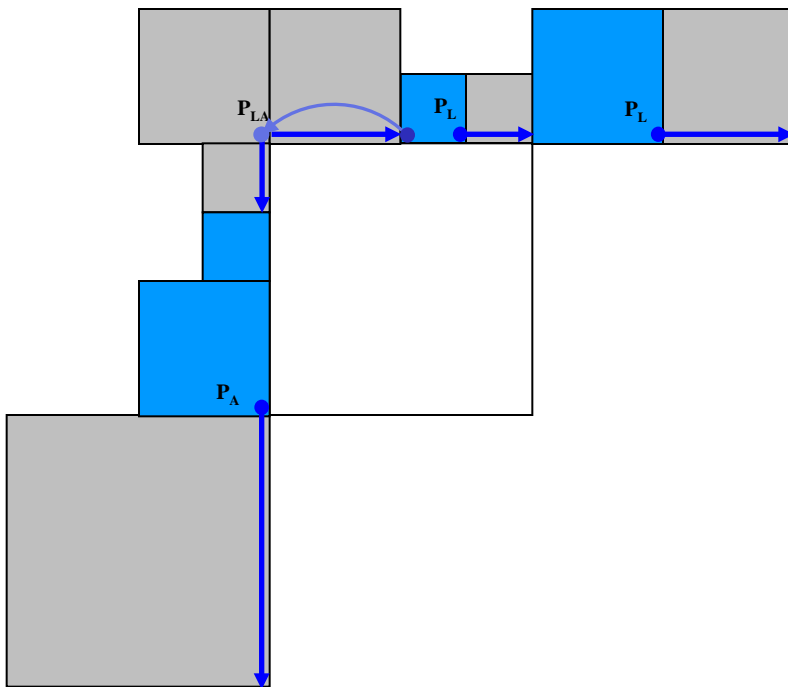
Test Config	Y	U	V	EncT	DecT
HE_RA	0.0%	0.1%	0.0%	99%	97%
LC_RA	0.0%	0.0%	0.0%	98%	97%
HE_LD	0.0%	0.0%	0.1%	99%	97%
LC_LD	0.0%	0.0%	0.0%	99%	99%

**Method2 with SliceBytes**

Test Config	Y	U	V	EncT	DecT
HE_AI	0.0%	0.0%	0.0%	98%	96%
LC_AI	0.0%	0.0%	0.0%	97%	95%
HE_RA	0.0%	0.0%	0.0%	99%	96%
LC_RA	0.0%	0.0%	0.0%	99%	98%
HE_LD	0.0%	0.1%	0.0%	99%	97%
LC_LD	0.0%	-0.1%	-0.2%	98%	96%

**Method2 with CIP + SliceBytes**

Test Config	Y	U	V	EncT	DecT
HE_RA	0.0%	0.0%	0.0%	100%	99%
LC_RA	0.0%	0.1%	0.0%	100%	99%
HE_LD	0.0%	0.0%	0.3%	99%	99%
LC_LD	0.0%	0.1%	0.0%	100%	102%



# Summary

- ❖ By only one-directional copying allowed to pad unavailable pixels,
  - Performance has no loss
  - No need to check bi-directional possibility
  - No need to average pixels
- ❖ For the left-top pixel padding,  
either averaging (Method1) or taking one value (Method2) has no loss
  - Taking one value (Method2) requires the smaller complexity
  - Averaging (Method1) may provide better prediction quality

\* Thank HiSilicon for taking heavy cross-checking!

# Supplementary data

❖ For the left-top pixel padding, the following method was also tested

- By checking the adjacent two pixels to the left-top pixel

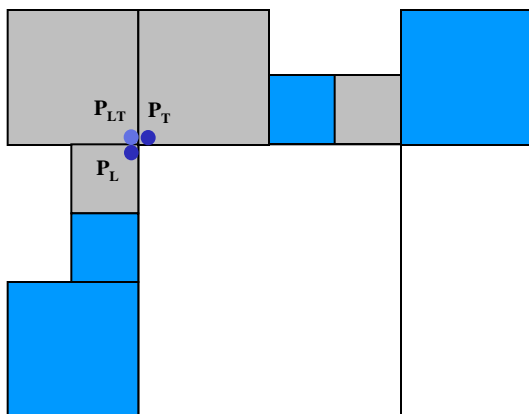
- If a sample on the above is available:

$$P_{LT} = P_T$$

- Else if a sample on the left is available:

$$P_{LT} = P_L$$

- Otherwise,  $P_T = (1 \ll (\text{BitDepth}_Y - 1))$



**Method2\* with CIP**

Test Config	Y	U	V	EncT	DecT
HE_RA	0.1%	0.2%	0.1%	99%	98%
LC_RA	0.1%	0.1%	0.2%	98%	97%
HE_LD	0.0%	0.0%	0.0%	99%	98%
LC_LD	0.0%	0.0%	-0.1%	99%	100%

**Method2\* with SliceBytes**

Test Config	Y	U	V	EncT	DecT
HE_AI	0.0%	0.0%	0.0%	98%	98%
LC_AI	0.0%	0.0%	0.0%	97%	97%
HE_RA	0.0%	0.0%	0.0%	100%	99%
LC_RA	0.0%	0.0%	0.0%	100%	100%
HE_LD	0.0%	-0.1%	-0.2%	100%	99%
LC_LD	0.0%	-0.1%	0.1%	99%	99%

**Method2\* with CIP + SliceBytes**

Test Config	Y	U	V	EncT	DecT
HE_RA	0.1%	0.1%	0.1%	100%	100%
LC_RA	0.1%	0.1%	0.1%	100%	99%
HE_LD	0.0%	0.0%	0.2%	100%	100%
LC_LD	0.0%	0.0%	-0.2%	100%	101%



Thank you !