

JCTVC-I0115

Implicit Weighted Prediction

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Weighted Prediction (recap)

Weighted Prediction (WP)

$$(1) \quad pred = ((predL_0 \times W_0 + (1 \ll shift - 1)) \gg shift) + O_0$$

$$(2) \quad pred = ((predL_0 \times W_0 + predL_1 \times W_1 + (1 \ll shift) + ((O_0 + O_1) \ll shift)) \gg (shift + 1))$$

■ Several WP algorithms:

- Default: default HEVC uni or bi prediction.
- Explicit: weighting factors transmitted explicitly in the slice header.
- Implicit: weighting factors for bi prediction are derived from the distance of the current POC with the POC of the ref. pictures (B_SLICE only):

$$W_0 = (2 - \alpha) \quad W_1 = \alpha \quad \text{where: } \alpha = 2 \times \frac{poc_{cur} - poc_0}{poc_1 - poc_0}, \quad O_i = 0$$

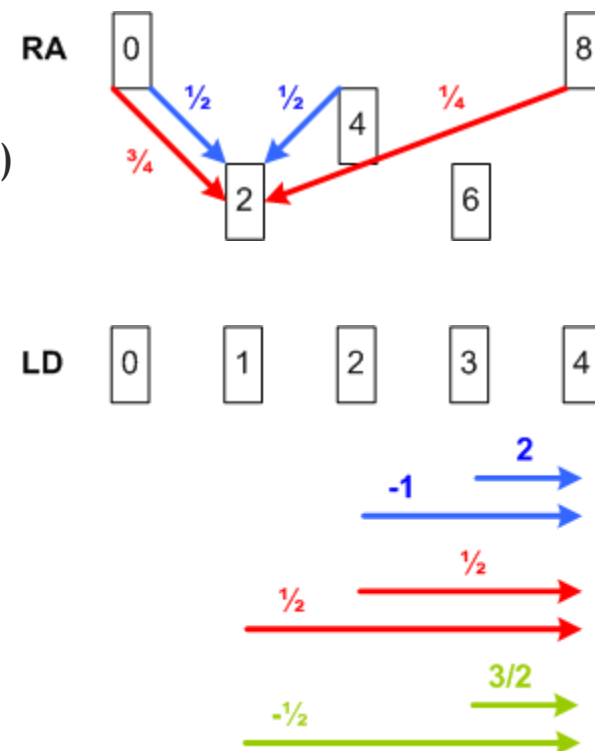
PPS	P_SLICE	
	Weighted_pred_flag	Weighting method
	0	Default
	1	Explicit

PPS	B_SLICE	
	Weighted_bipred_idc	Weighting method
	0	Default
	1	Explicit
	2	Implicit

Weighted Prediction (Implicit)

Implicit WP in HEVC

- RA cases:
 - Weights of closest references are $\frac{1}{2}$ (same as default)
- LD cases:
 - Weights may be negative
- LDB case:
 - Only B frames: Implicit WP only



Implicit WP in AVC

- Originally designed to manage IBBP GOPs:
 - Weights (0.33;0.66)
 - Combining of Explicit (P) and Implicit (B) WP

Implicit WP in HEVC & AVC

- Offsets are 0: Fades other than Fade to Black are disadvantaged
- Lack of flexibility: combining of (*Explicit*, *Implicit*, *Default*) is difficult (costly PPS duplication)

New Weighted Prediction (Implicit)

Principle

- Possibility to select *Explicit*, *Default* or *Implicit* WP regardless of slice type (P or B)
- Linear interpolation of previous *Explicit* (*e*), *Implicit* (*i*) or *Default* weights:

	Poc 0	Poc 1	Poc 2
Poc 0	$e(w_{00} ; o_{00})$		
Poc 1	$e(w_{10} ; o_{10})$	(1 ; 0)	
Poc 2	$i(w_{20} ; o_{20})?$		(1 ; 0)



$(w_{20} ; o_{20})$

$$W_{20} = W_{00} + (W_{10} - W_{00}) \times (poc_2 - poc_0) / (poc_1 - poc_0)$$
$$O_{20} = O_{00} + (O_{10} - O_{00}) \times (poc_2 - poc_0) / (poc_1 - poc_0)$$

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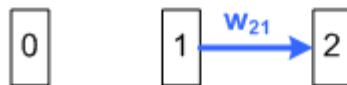


New Weighted Prediction (Implicit)

Principle

- Possibility to select *Explicit*, *Default* or *Implicit* WP regardless of slice type (P or B)
- Linear interpolation of previous *Explicit* (*e*), *Implicit* (*i*) or *Default* weights:

	Poc 0	Poc 1	Poc 2
Poc 0	$e(w_{00} ; o_{00})$		
Poc 1	$e(w_{10} ; o_{10})$	(1 ; 0)	
Poc 2	$i(w_{20} ; o_{20})$	$i(w_{21} ; o_{21}) ?$	(1 ; 0)



$$(w_{21} ; o_{21}) \quad \left\{ \begin{array}{l} I_1 = W_{10} \times I_0 + O_{10} \\ I_2 = W_{20} \times I_0 + O_{20} \end{array} \right.$$

$$\begin{array}{l} W_{21} = W_{20} / W_{10} \\ O_{21} = O_{20} - W_{21} \times O_{10} \end{array}$$

Modified Weighted Prediction syntax (proposal)

Proposed syntax

- PPS syntax: add mode **weighted_bipred_idc=3**

	Descriptor
pic_parameter_set_rbsp() {	
...	
weighted_pred_flag	u(1)
weighted_bipred_idc	u(2)
...	
}	

- Slice header syntax

	Descriptor
slice_header() {	
...	
if(slice_type != I && weighted bipred_idc == 3)	
wp_implicit_flag	u(1)
if((weighted_pred_flag && slice_type == P) (weighted_bipred_idc == 1 && slice_type == B) (slice_type != I && weighted bipred_idc == 3 && !wp_implicit_flag))	
pred_weight_table()	
...	
}	

Flexible Explicit/Implicit
WP selection

Results

Fade to Black

Fade to White

Random Access, MP Random Access, HE10

	Y	U	V	Y	U	V
Anchor Expl.	-16,9%	-19,6%	-19,2%	-17,2%	-19,6%	-19,4%
Anchor Impl.	-0,2%	-0,3%	-0,6%	-0,2%	-0,1%	-0,1%
Proposed (EP=2)	-17,5%	-19,4%	-18,8%	-17,4%	-19,2%	-18,9%
Proposed (EP=4)	-17,9%	-19,4%	-18,6%	-17,7%	-18,4%	-18,2%
Proposed (EP=8)	-17,4%	-19,1%	-17,9%	-17,0%	-16,5%	-16,3%
Proposed (EP=16)	-16,7%	-17,2%	-15,6%	-16,4%	-13,9%	-14,6%

Random Access, MP Random Access, HE10

	Y	U	V	Y	U	V
Anchor Expl.	-20,3%	-23,4%	-23,0%	-20,5%	-22,9%	-23,1%
Anchor Impl.	-0,3%	-0,5%	-0,6%	-0,2%	-0,1%	-0,2%
Proposed (EP=2)	-20,5%	-23,0%	-22,5%	-20,7%	-22,7%	-23,0%
Proposed (EP=4)	-20,6%	-22,8%	-22,5%	-20,8%	-21,7%	-22,0%
Proposed (EP=8)	-19,7%	-22,3%	-21,3%	-19,6%	-19,6%	-20,0%
Proposed (EP=16)	-18,4%	-19,9%	-19,0%	-18,4%	-16,9%	-17,7%

Low Delay, MP Low Delay, HE10

	Y	U	V	Y	U	V
Anchor Expl.	-32,3%	-40,5%	-39,3%	-32,0%	-43,2%	-41,2%
Anchor Impl.	1,4%	3,1%	2,2%	1,9%	2,6%	2,4%
Proposed (EP=2)	-32,0%	-36,1%	-33,6%	-31,4%	-37,1%	-34,2%
Proposed (EP=4)	-31,5%	-37,3%	-32,9%	-30,9%	-35,8%	-32,6%
Proposed (EP=8)	-27,6%	-31,7%	-27,2%	-27,2%	-29,3%	-24,8%
Proposed (EP=16)	-15,7%	-19,8%	-9,6%	-15,8%	-12,8%	-1,7%

Low Delay, MP Low Delay, HE10

	Y	U	V	Y	U	V
Anchor Expl.	-34,2%	-42,3%	-41,4%	-33,6%	-44,3%	-42,8%
Anchor Impl.	1,5%	2,5%	2,8%	2,0%	3,2%	2,7%
Proposed (EP=2)	-34,2%	-40,3%	-37,0%	-33,9%	-39,6%	-37,4%
Proposed (EP=4)	-33,3%	-39,1%	-35,0%	-32,7%	-37,7%	-35,4%
Proposed (EP=8)	-29,2%	-33,8%	-29,0%	-28,7%	-30,9%	-27,5%
Proposed (EP=16)	-17,3%	-22,1%	-12,3%	-17,0%	-13,9%	-4,9%

Low Delay P, MP Low Delay P, HE10

	Y	U	V	Y	U	V
Anchor Expl.	-32,0%	-39,5%	-38,3%	-31,3%	-42,7%	-41,3%
Anchor Impl.	NA	NA	NA	NA	NA	NA
Proposed (EP=2)	-32,0%	-36,1%	-33,6%	-31,4%	-37,1%	-34,2%
Proposed (EP=4)	-30,7%	-35,3%	-31,3%	-30,0%	-34,7%	-31,2%
Proposed (EP=8)	-26,6%	-31,7%	-29,0%	-25,9%	-30,3%	-28,6%
Proposed (EP=16)	-17,3%	-25,6%	-22,6%	-16,6%	-21,5%	-20,8%

Low Delay P, MP Low Delay P, HE10

	Y	U	V	Y	U	V
Anchor Expl.	-33,8%	-40,7%	-39,7%	-33,1%	-44,2%	-42,4%
Anchor Impl.	NA	NA	NA	NA	NA	NA
Proposed (EP=2)	-33,7%	-37,8%	-34,5%	-33,2%	-39,1%	-35,8%
Proposed (EP=4)	-32,0%	-36,2%	-31,8%	-31,3%	-35,9%	-32,0%
Proposed (EP=8)	-26,9%	-32,0%	-29,4%	-26,3%	-30,8%	-28,4%
Proposed (EP=16)	-17,2%	-25,9%	-22,4%	-16,7%	-22,1%	-20,5%

EP = Explicit WP frame period

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Conclusion

Proposal of Higher flexibility in Explicit/Implicit WP mode signaling

- wp_implicit_flag

Proposal of new Implicit WP mode

- Complement to existing Implicit WP
- Enhance performance of Explicit WP in general:
 - Gains superior or equivalent to Explicit for RA

Keep benefits of Implicit WP

- Lightweight signaling of WP weights
- Reduce complexity at encoder (WP parameters estimation)
- WP management with Temporal scalability is straightforward