

JCTVC-G166

AHG21: Explicit Reference Pictures Signaling with Output Latency Count Scheme

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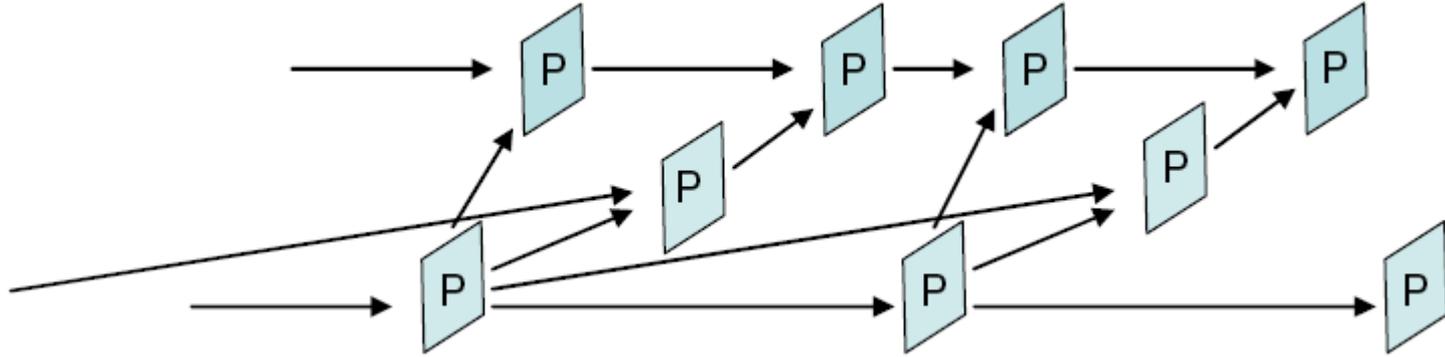
Proposal Item

- In Torino meeting, Explicit Reference Pictures Signaling (ERPS) was proposed
 - Explicitly signal list of reference pictures required by current pic and future pics
 - Signal in slice header / PPS
 - Basically, it signals all ref pics that should exist in DPB
 - Handle reference picture marking process & improve error resiliency
- Issues:
 - May not be efficient when some pictures should stay long in DPB (e.g., long-term ref pic)
 - Rigid. Tool to handle reference pic marking & error resiliency are tightly coupled
- Proposal
 - New ERPS design. Separate tool to handle reference pic marking & error resiliency
 - For error resiliency: explicitly signal list of ref pics required only by current picture
 - For reference pic marking: signal output latency count to tell decoder when a ref pic should be marked as “unused for reference”
 - Mechanism to handle long-term reference pictures (LTRP)
 - Can be harmonized with ERPS we propose or currently develop in AHG21

Proposed New ERPS Design

- For reference picture marking
 - Not signaling the list of active ref pics that must exist in DPB
 - Signal how long a pic should stay in DPB
 - Signal output latency count (OLC) in first slice header of each picture
 - OLC can be used with POC or with frame number
 - Mark a ref pic as “unused for reference” if:
 - $POC(\text{ref_pic}) + OLC(\text{ref_pic}) \leq POC(\text{curr_pic})$, or
 - $\text{Frame_num}(\text{ref_pic}) + OLC(\text{ref_pic}) \leq \text{frame_num}(\text{curr_pic})$
 - Robust against pic loss / temporal removal since information to handle a picture is carried in the slice header of that picture
- For error resiliency
 - Not signaling the list of active ref pics that must exist in DPB
 - Signal only list of active ref pics that are needed by current picture
 - Shorter & more compact list

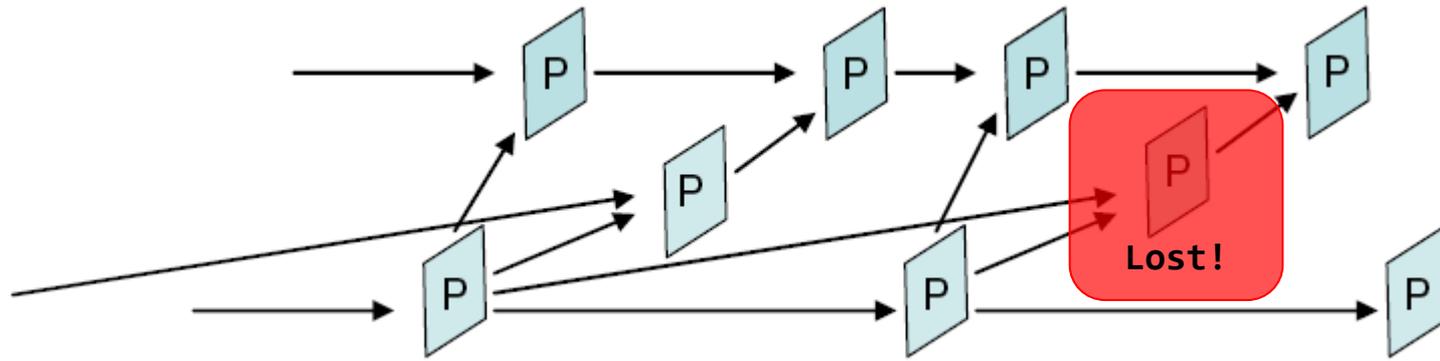
Example



POC	20	21	22	23	24	25	26	27	28
OLC	5	1	0	1	5	1	0	1	5
Ref pics set	16	20 19	20 16	22 21	20	24 23	24 20	26 25	24

- Pic 20 is marked as “unused for reference” when pic 27 is received
- Pic 21 is marked as “unused for reference” when pic 24 is received
- Pic 22 is marked as “unused for reference” when pic 24 is received
- Pic 23 is marked as “unused for reference” when pic 26 is received
- Pic 24 is marked as “unused for reference” when pic 31 is received
- Pic 25 is marked as “unused for reference” when pic 28 is received
- ...

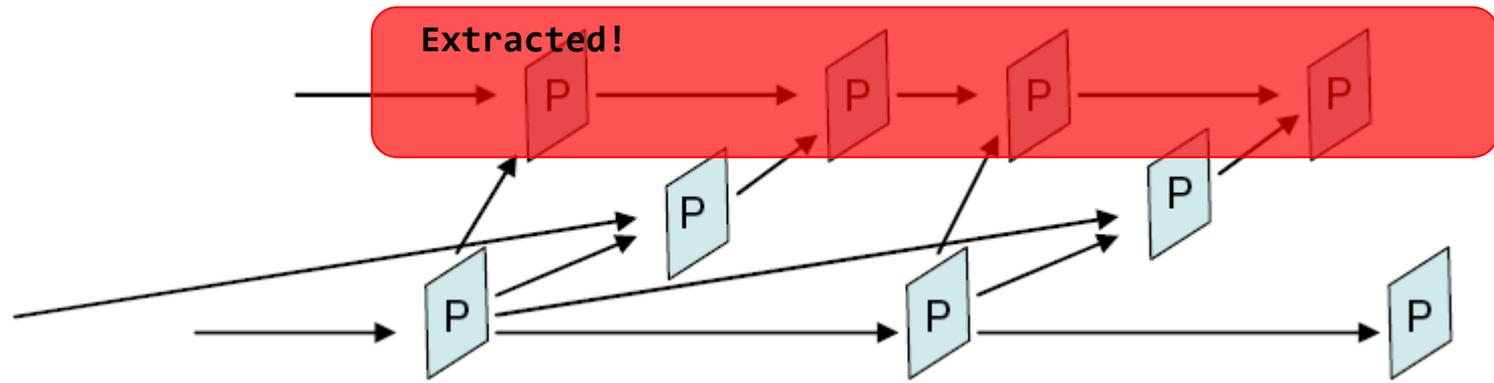
Example – OLC against picture loss



POC	20	21	22	23	24	25	26	27	28
OLC	5	1	0	1	5	1	0	1	5
Ref pics set	16	20 19	20 16	22 21	20 23	24	24 20	26 25	24

- Pic 20 is marked as “unused for reference” when pic 27 is received
- Pic 21 is marked as “unused for reference” when pic 24 is received
- Pic 22 is marked as “unused for reference” when pic 24 is received
- Pic 23 is marked as “unused for reference” when pic 26 is received
 - **But since 26 will never be received, do that in pic 27 instead**
- Pic 24 is marked as “unused for reference” when pic 31 is received
- Pic 25 is marked as “unused for reference” when pic 28 is received
- ...

Example – OLC against temporal layer removal



POC	20	21	22	23	24	25	26	27	28
OLC	5	1	0	1	5	1	0	1	5
Ref pics set	16	20 19	20 16	22 21	20 23	24 23	24 20	26 25	24

- Pic 20 is marked as “unused for reference” when pic 27 is received
 - **But since 27 will never be received, do that in pic 28 instead**
- Pic 22 is marked as “unused for reference” when pic 24 is received
- Pic 24 is marked as “unused for reference” when pic 31 is received
 - **But since 31 will never be received, do that in pic 32 instead**
- Pic 26 is marked as “unused for reference” when pic 28 is received
- ...

Syntaxes

- No separation for positive & negative delta POC
 - Only signal sign bit

	Descriptor
ref_pic_set(idx) {	
num_ref_pics	ue(v)
for(i = 0; i < num_ref_pics; i++) {	
sign_bit_of_ref_pic[i]	ue(v)
delta_poc_minus1[i]	u(1)
}	
}	

- Different flags for OLC & ERPS
- Can use OLC with frame number if necessary

	Descriptor
seq_parameter_set_rbsp() {	
...	
olc_flag	f(1)
if(olc_flag) {	
use_frame_num_flag	f(1)
if(use_frame_num_flag)	
log2_max_frame_num_minus4	ue(v)
}	
erps_flag	f(1)
if(erps_flag) {	
num_ref_pic_sets	ue(v)
for(idx = 0; idx < num_ref_pic_sets; idx++)	
ref_pic_set(idx)	ue(v)
}	
}	
...	
}	

Syntaxes

	Descriptor
slice_header () {	
...	
if (nal_ref_flag == 1 && olc_flag) {	
if (use_frame_num_flag) {	
frame_num	u(v)
}	
olc_minus2	ue(v)
}	
If ((slice_type == P slice_type == B) && erps_flag == 1) {	
ref_pic_set_idx_plus1	ue(v)
if (ref_pic_set_idx_plus1 > 0) { //not using RPS in SPS	
ref_pic_set(idx - 1)	ue(v)
}	
}	
...	
}	

- OLC is signaled only for picture that are used for reference
- Frame number is signaled only if used

Performance -- Overhead bits

- Anchor: HM-4.0 with common test condition
- Cross-check by Samsung – JCTVC-G832

Signal ERPS + OLC + frame number

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class C	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Class D	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Class E						
Overall	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Enc Time[%]	100%			100%		
Dec Time[%]	93%			94%		

Overhead bit is comparable to that of ERPS in AHG21

Signal ERPS + OLC

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class C	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Class D	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Class E						
Overall	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Enc Time[%]	100%			100%		
Dec Time[%]	96%			99%		

Signal OLC only

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class E	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Overall	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time [%]	100%			100%		
Dec Time [%]	94%			100%		

Overhead bit is slightly better than that of ERPS in AHG21

Handling Long-Term Reference Pictures

- Using similar concept to ERPS design for short-term reference pictures (STRP), but with some modifications
- Use OLC to signal how long the LTRP shall stay in DPB
 - But the value of OLC can be big → many bits required
 - Divide OLC into two terms (MSB & LSB)
 - `log2_olc_msb_minus4`
 - `olc_cnt`
- Assign LTRP_Id for pictures that are assigned as LTRP
- Do not use delta POC to refer to LTRP but use LTRP_Id instead
 - Delta POC between current picture & LTRP can be big

Syntaxes

	Descriptor
seq_parameter_set_rbsp() {	
...	
use_long_term_reference_flag	f(1)
...	
}	

- Signal if LTRP is used
 - Similar flag proposed in G788

	Descriptor
slice_header () {	
...	
if (nal_ref_flag == 1 && use_long_term_reference_flag) {	
LTRP_flag	f(1)
If (LTRP_flag == 1) {	
LTRP_Id	ue(v)
log2_olc_msb_minus4	ue(v)
olc_cnt	u(v)
}	
}	
...	
}	

- e.g., a LTRP must stay in DPB / available as reference for 300 more pictures, thus intended OLC is 300
 - $\text{log2_olc_msb_minus4} = 4$ (i.e., shall be computed as $256 - 2^{(4+4)}$)
 - $\text{olc_cnt} = 44$

ERPS for STRP & LTRP – With new ERPS design

	Descriptor
slice_header () {	
...	
If ((slice_type == P slice_type == B) && erps_flag == 1) {	
ref_pic_set_idx_plus1	ue(v)
if (ref_pic_set_idx_plus1 > 0) { //not using RPS in SPS	
ref_pic_set(idx - 1)	
}	
}	
If (use_long_term_reference_flag == 1) {	
num_used_long_term_pics	ue(v)
If (num_used_long_term_pics > 0) {	
for (i = 0; i < num_used_long_term_pics; i++) {	
LTRP_Id	ue(v)
}	
}	
}	
}	
}	
...	
}	

ERPS for STRP & LTRP – With AHG21 ERPS design

	Descriptor
slice_header() {	
...	
if(IdrPicFlag) {	
idr_pic_id	ue(v)
no_output_of_prior_pics_flag	u(1)
}	
else {	
pic_order_cnt_lsb	u(v)
short_term_ref_pic_set_pps_flag	u(1)
if(!short_term_ref_pic_set_pps_flag)	
short_term_ref_pic_set(num_short_term_ref_pic_sets)	
else	
short_term_ref_pic_set_idx	u(v)
if(long_term_ref_pics_present_flag) {	
num_used_long_term_pics	ue(v)
for(i = 0; i < num_used_long_term_pics; i++) {	
LTRP_Id	ue(v)
}	
}	
}	
...	
}	

Conclusion

- Propose items:
 - New design for ERPS
 - Mechanism to handle long-term reference picture
 - Integration with proposed ERPS
 - Integration with existing ERPS in AHG21
- Thank you to Samsung for doing the cross-check
- Recommend JCTVC group to review and adopt the proposed schemes