

JCTVC-G166

# AHG21: Explicit Reference Pictures Signaling with Output Latency Count Scheme

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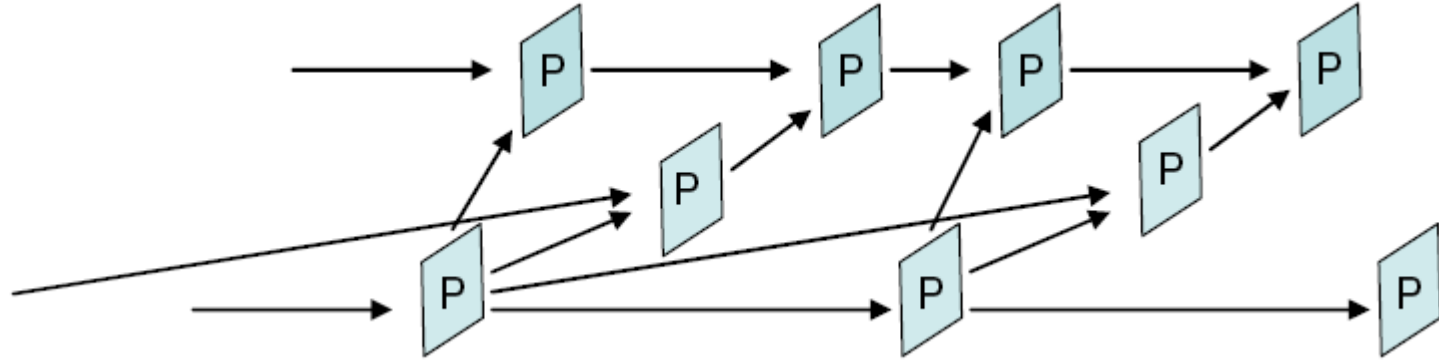
# Proposal Item

- 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:
      - $\text{POC}(\text{ref\_pic}) + \text{OLC}(\text{ref\_pic}) \leq \text{POC}(\text{curr\_pic})$ , or
      - $\text{Frame\_num}(\text{ref\_pic}) + \text{OLC}(\text{ref\_pic}) \leq \text{frame\_num}(\text{curr\_pic})$
  - 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

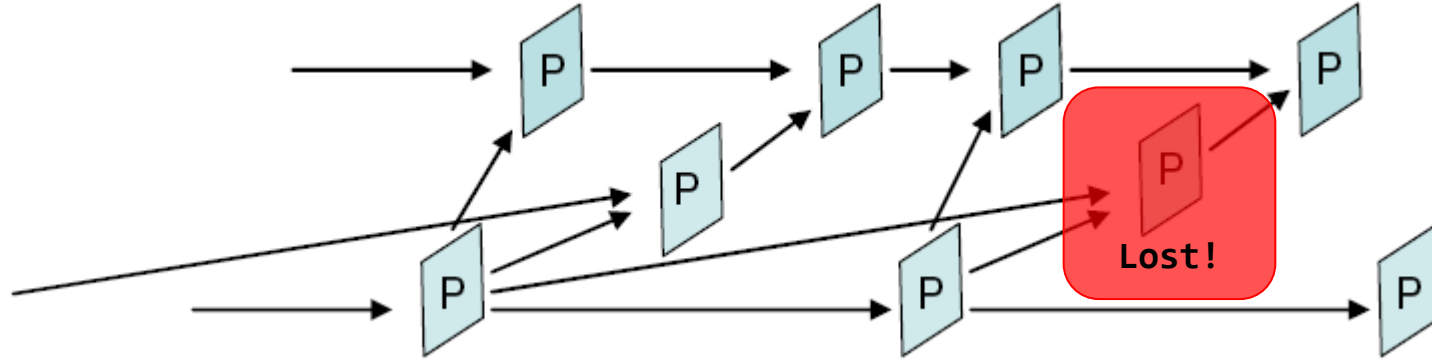
# Example



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 23	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
- ...

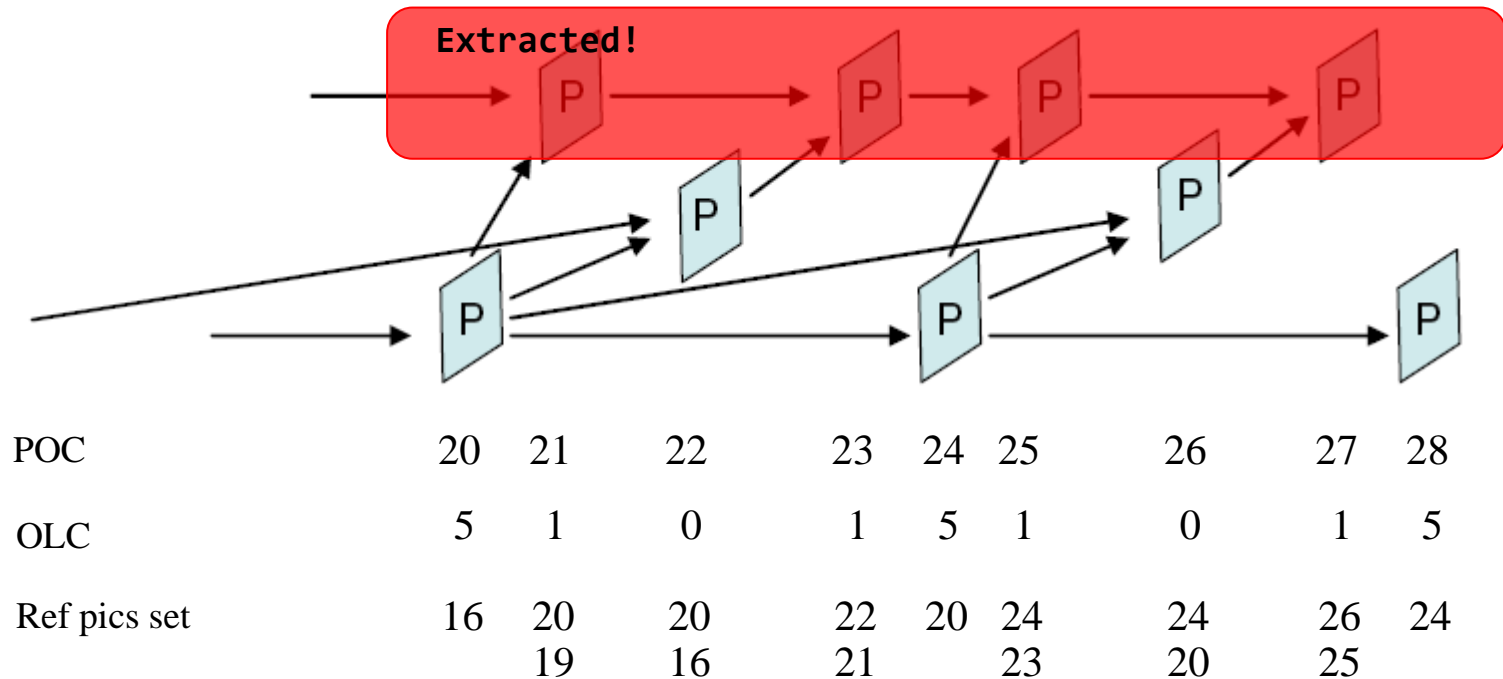
# Example – OLC against picture loss



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



- 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 ) {	
<b>num_ref_pics</b>	ue(v)
for( i = 0; i < num_ref_pics; i++ ) {	
<b>sign_bit_of_ref_pic[ i ]</b>	ue(v)
<b>delta_poc_minus1[ i ]</b>	u(1)
}	
}	

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

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

# Syntaxes

slice_header ( ) {	Descriptor
...	
if (nal_ref_flag == 1 && olc_flag) {	
if (use_frame_num_flag) {	
<b>frame_num</b>	u(v)
}	
<b>olc_minus2</b>	ue(v)
}	
If ((slice_type == P    slice_type == B) && erps_flag == 1) {	
<b>ref_pic_set_idx_plus1</b>	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						
<b>Overall</b>	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 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%
<b>Overall</b>	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%		

*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						
<b>Overall</b>	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%		

*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

seq_parameter_set_rbsp() {	<b>Descriptor</b>
...	
<b>use_long_term_reference_flag</b>	f(1)
...	
}	

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

slice_header () {	<b>Descriptor</b>
...	
if (nal_ref_flag == 1 && use_long_term_reference_flag) {	
<b>LTRP_flag</b>	f(1)
If (LTRP_flag == 1) {	
<b>LTRP_Id</b>	ue(v)
<b>log2_olc_msb_minus4</b>	ue(v)
<b>olc_cnt</b>	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

slice_header ( ) {	Descriptor
...	
If ((slice_type == P    slice_type == B) && erps_flag == 1) {	
<b>ref_pic_set_idx_plus1</b>	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) {	
<b>num_used_long_term_pics</b>	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

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

# Conclusion

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- 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