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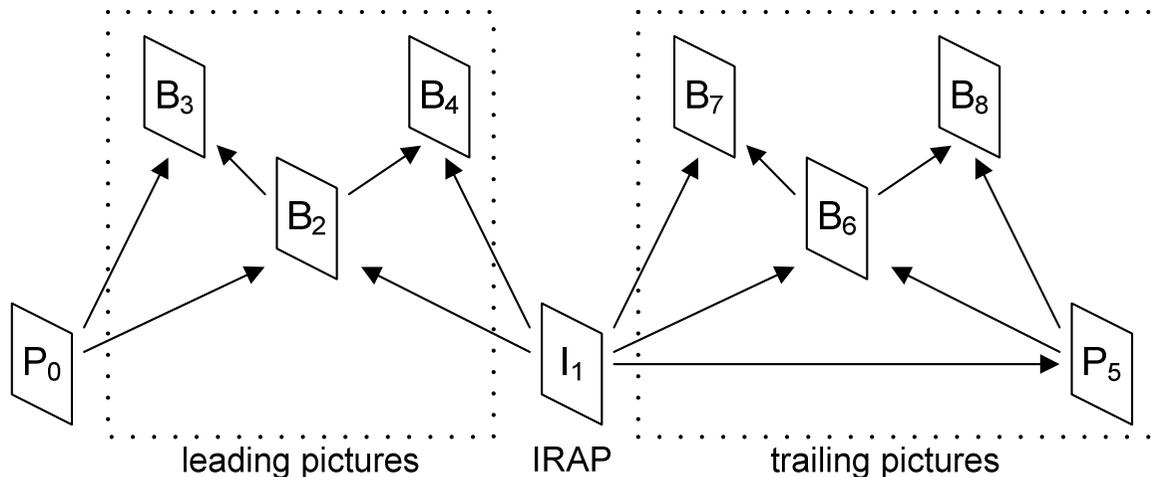
JCTVC-Q0116: REXT HLS: PICTURE REFERENCING ACROSS CRA PICTURES

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BACKGROUND



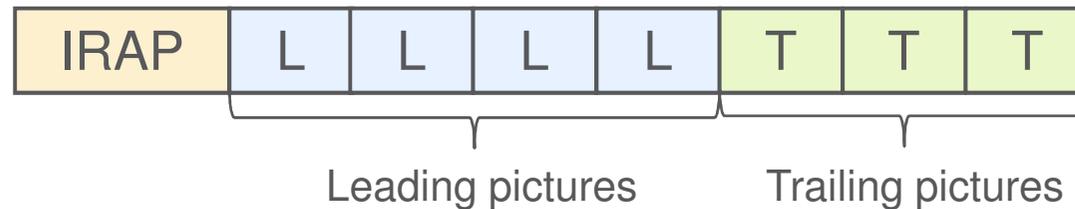
- › In HEVC, pictures can be categorized into three types:
 - IRAP pictures
 - › IDR, BLA, CRA pictures
 - › Provide random access points
 - Leading pictures
 - › Follows an (associated) IRAP in decoding order, precedes the IRAP in output order
 - Trailing pictures
 - › Follows an associated IRAP in both decoding and output order



BACKGROUND



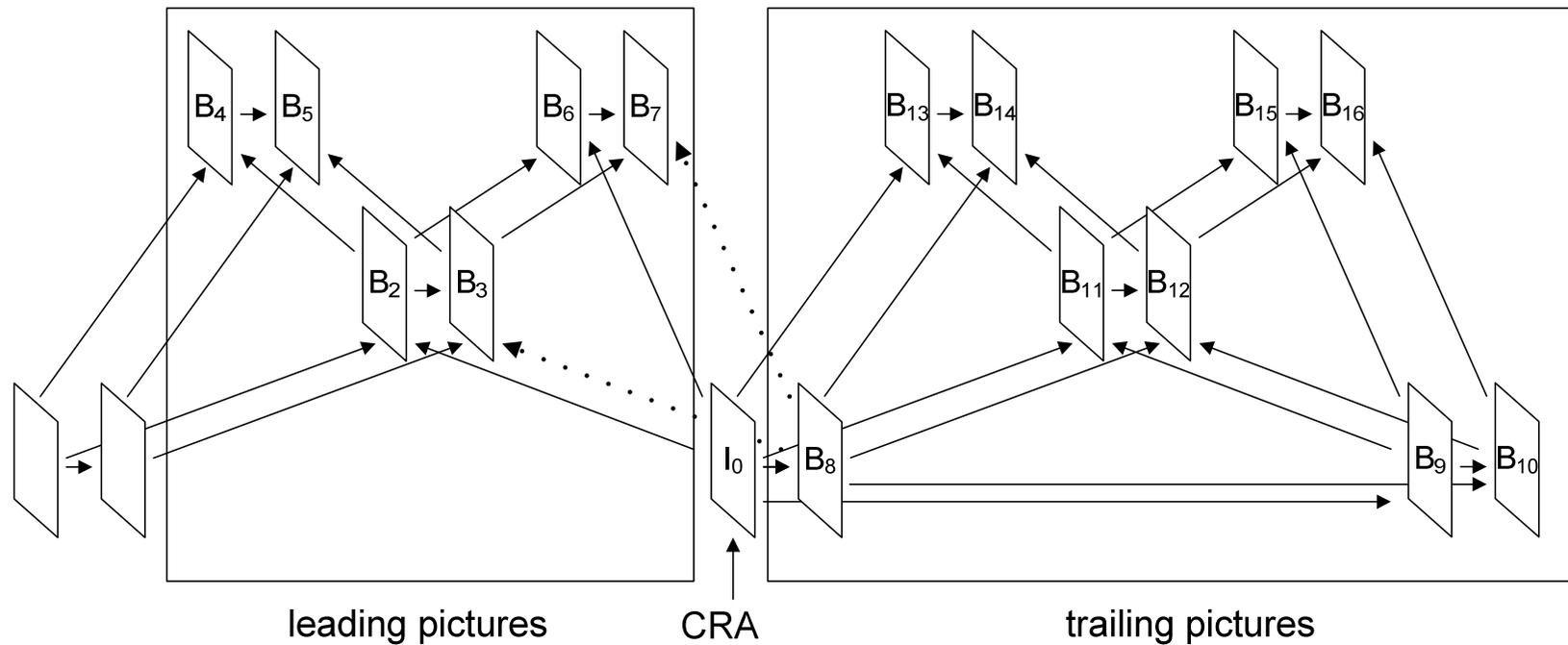
- › In HEVC, there are restrictions associated with IRAP pictures. One is:
 - When a picture is a leading picture, it shall precede, in decoding order, all trailing pictures that are associated with the same IRAP picture.
- › This means that the decoding order is always: IRAP, leading, trailing
- › The purpose of this rule is to enable a network node to easily discard the leading pictures in a stream
- › Without the rule, a leading picture may appear long after the IRAP picture in decoding order



PROBLEM



- › A problem with the rule is that some desirable picture structures are not allowed. For instance, the example the dotted predictions in the field coding structure below are not allowed



SIMULATION RESULTS



- › A compression efficiency test was done to see the impact of this restriction
 - HM-12.1+RExt-5.0rc1 was used as code base
 - All eight publically available sequences used within MPEG AHG were used
 - CRA picture every 32th field
 - Code patches available in contribution
 - Average bit-rate reduction by allowing full prediction is 1.7%.

Luma BD-rate performance for QP 22,27,32,37

Sequence	BDR	Bit-rate range
MusicHD1_1088_300	-2.28%	4-47 Mbps
CheersHD2_1088_300	-0.36%	5-52 Mbps
CheersHD4_1088_300	-0.56%	9-103 Mbps
MadHD1_1088_300	-2.80%	1.5-14 Mbps
Tennis_1920x1088_420_60i_8bit	-4.68%	2-31 Mbps
Basketball_1920x1088_420_60i_8bit	-1.68%	4-67 Mbps
CattleDogs_1920x1088_420_60i_8bit	-0.68%	1-18 Mbps
WaveRocks_1920x1088_420_60i_8bit	-0.42%	2-36 Mbps
Average	-1,68%	

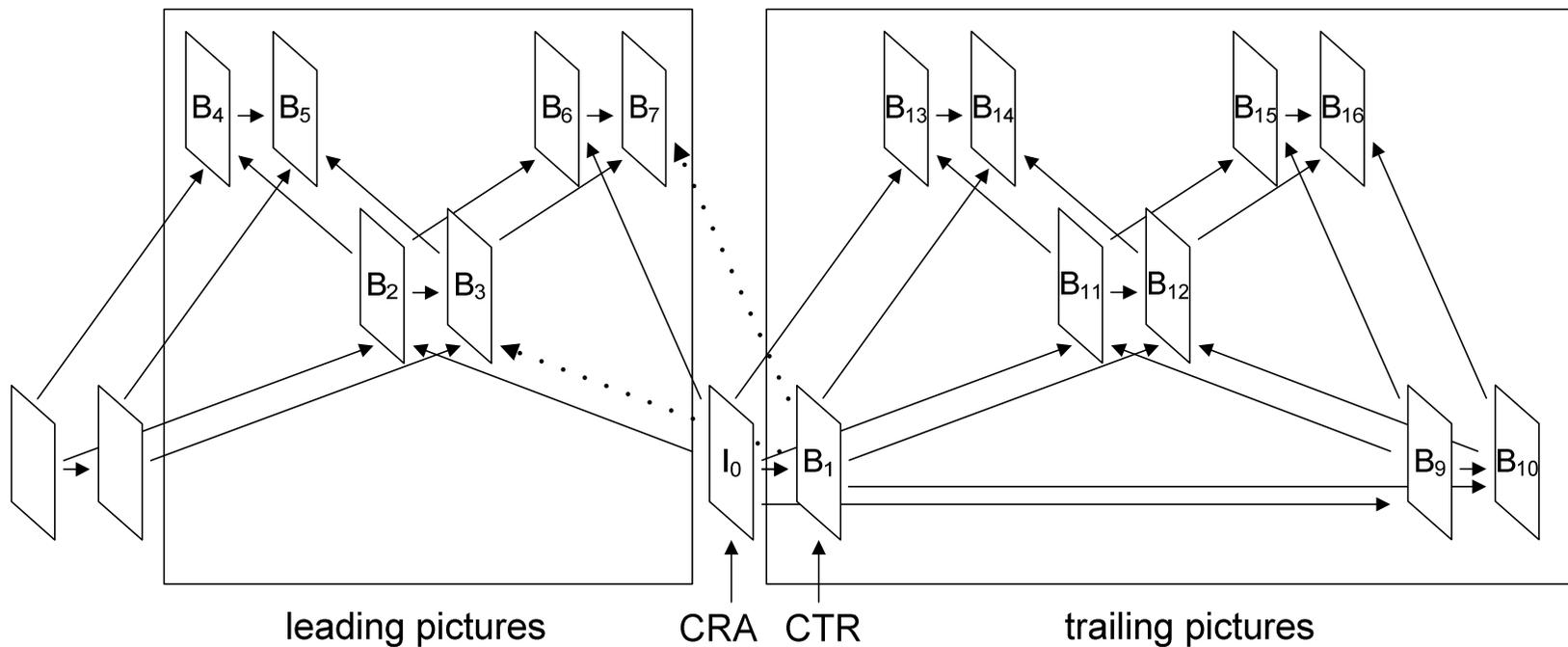
Luma BD-rate performance for QP 17,22,27,32

Sequence	BDR	Bit-rate range
MusicHD1_1088_300	-2.02%	8-122 Mbps
CheersHD2_1088_300	-0.33%	10-114 Mbps
CheersHD4_1088_300	-0.51%	21-207 Mbps
MadHD1_1088_300	-2.97%	3-38 Mbps
Tennis_1920x1088_420_60i_8bit	-3.56%	4-80 Mbps
Basketball_1920x1088_420_60i_8bit	-0.92%	8-173 Mbps
CattleDogs_1920x1088_420_60i_8bit	-1.10%	2-59 Mbps
WaveRocks_1920x1088_420_60i_8bit	-0.50%	5-85 Mbps
Average	-1.49%	

PROPOSAL



- › New NAL unit type for upcoming profiles, CRA trailing reference (CTR_NUT)
- › The CTR_NUT is allowed to precede the leading pictures in decoding order



PROPOSAL



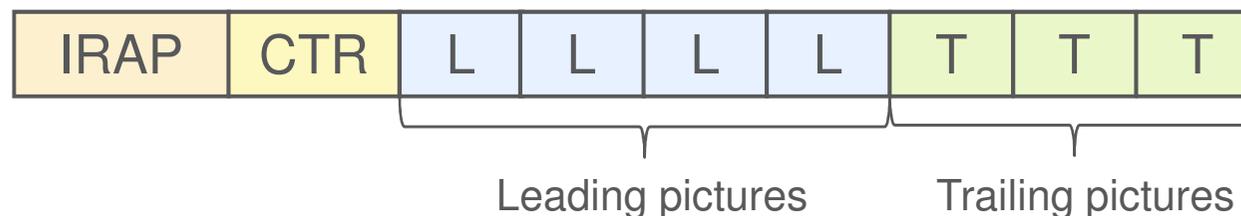
- › New NAL unit type for upcoming profiles, CRA trailing reference (CTR_NUT)

nal_unit_type	Name of nal_unit_type	Content of NAL unit and RBSP syntax structure	NAL unit type class
11	CTR_NUT	Coded slice segment of a CTR picture slice_segment_layer_rbsp()	VCL
11 13 15	RSV_VCL_R11 RSV_VCL_R13 RSV_VCL_R15	Reserved non-IRAP sub-layer reference VCL NAL unit types	VCL

When a picture is a leading picture, it shall precede, in decoding order, all trailing pictures **with nal_unit_type not equal to CTR_NUT** that are associated with the same IRAP picture.

A CTR picture associated with an IRAP picture shall directly follow the associated IRAP picture in decoding order.

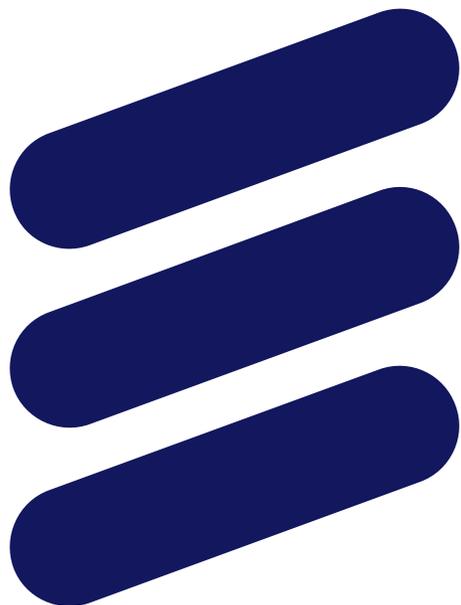
An IRAP picture shall not have more than one associated CTR picture.



ALTERNATIVE SOLUTION



- › Use recovery point SEI messages with all pictures being TRAIL pictures. Then no IRAP restrictions would apply.
 - But a solution that enables use of the IRAP NAL unit types is strongly preferable in order to perform random-access-point detection at NAL unit header level and make use of the features associated with IRAP pictures such as alternative HRD parameters.



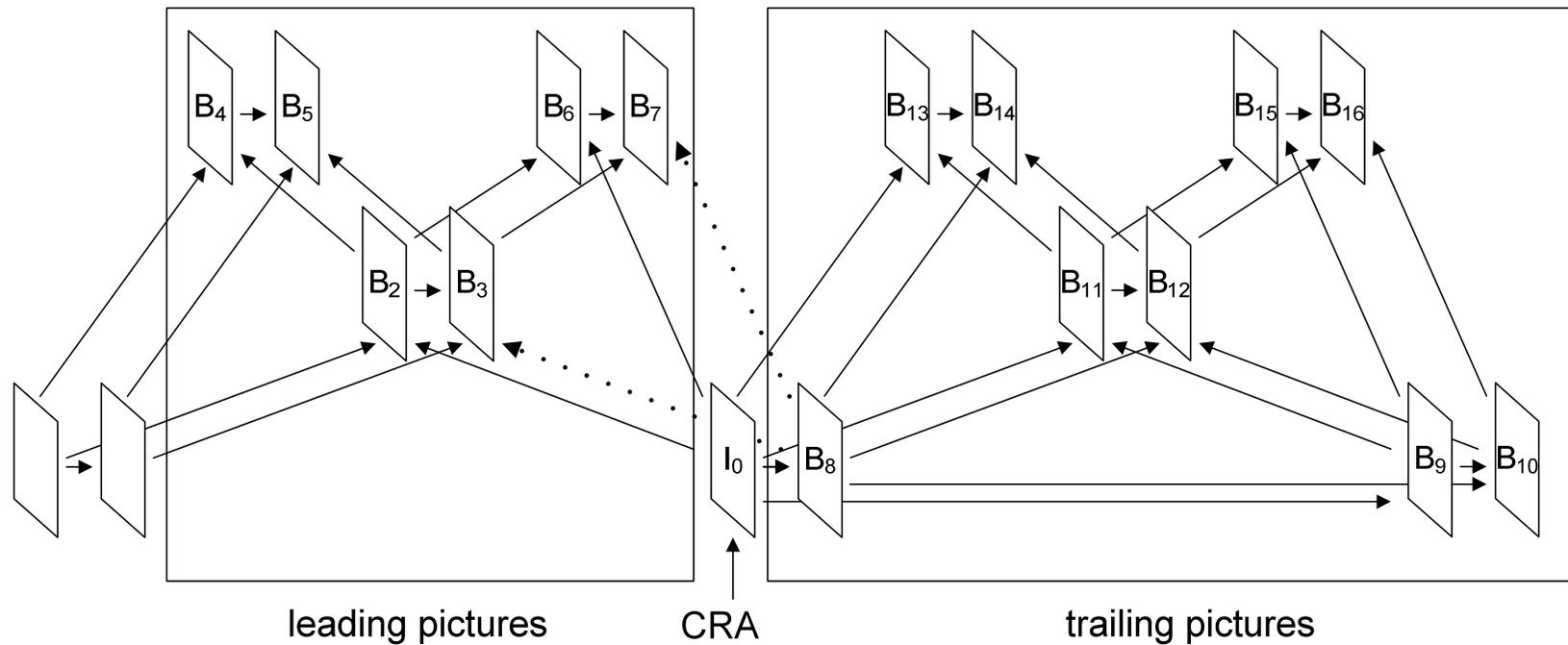
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FIELD CODING ORDER



Clause 7.4.2.1:

”When a picture is a leading picture, it shall precede, in decoding order, all trailing pictures that are associated with the same IRAP picture.”



SWAPPING FIELD CODING ORDER



Clause 8.3.2:

”When the current picture is a trailing picture, there shall be no picture in the RPS that precedes the associated IRAP picture in output order or decoding order.”

