

JVET-N0494

AHG17: Dependent random access point pictures in VVC

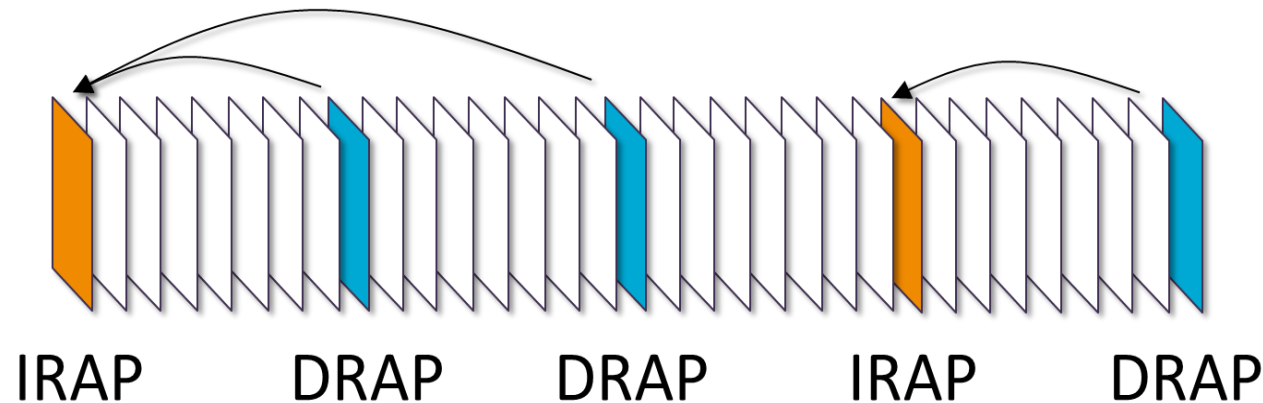


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Background



- HEVC specifies the dependent random access point (DRAP) indication SEI message that indicates the presence of a DRAP picture in the bitstream
 - A DRAP picture is a RAP picture that may use the previous IRAP picture in decoding order for temporal prediction to reduce bit cost
 - To perform a random access operation at a DRAP picture, the previous IRAP picture in the bitstream must be made available
 - After random access all pictures are decoded as normal



- DRAP pictures are supported in ISO/BMFF where it is specified with the DRAP sample and the related DRAP sample grouping

Proposal summary



- It is proposed to include DRAP pictures to the VVC draft, similar to the DRAP pictures in HEVC. In contrast to DRAP pictures in HEVC, the following is proposed for VVC:
 - To signal DRAP indication as a VCL NAL unit type in the NAL unit header
 - To signal a flag in SPS whether the CVS may contain DRAP pictures or not

Benefits of DRAP pictures



- DRAP pictures may, if the previous IRAP picture is available, be used to:
 - Decrease the overall bitrate by replacing some IRAP pictures with DRAP pictures
 - Increase the frequency of random access points (RAPs) without significantly increasing the required bitrate
- Why signal DRAP as a VCL NAL unit type instead of an SEI message?
 - **Reliable decoder support.** An encoder would know that an unknown decoder could support the DRAP functionality
 - **Improved compression efficiency.** When the encoder knows that DRAP is supported in the decoder, the frequency of IRAP pictures and potentially the bitrate can be reduced. An encoder may then replace some of the expensive IRAP pictures with less expensive DRAP pictures

Proposed changes to the VVC specification (1/2)



nal_unit_type	Name of nal_unit_type	Content of NAL unit and RBSP syntax structure	NAL unit type class
0	TRAIL_NUT	Coded tile group of a non- STSA trailing picture tile_group_layer_rbsp()	VCL
1	STSA_NUT	Coded tile group of an STSA picture tile_group_layer_rbsp()	VCL
2	RASL_NUT	Coded tile group of a RASL picture tile_group_layer_rbsp()	VCL
3	RADL_NUT	Coded tile group of a RADL picture tile_group_layer_rbsp()	VCL
4	DRAP_NUT	Coded tile group of a DRAP picture tile_group_layer_rbsp()	VCL
5..7	RSV_VCL_5.. RSV_VCL_7	Reserved non-IRAP VCL NAL unit types	VCL
...	...	...	...

The constraints on a DRAP picture with nal_unit_type equal to DRAP_NUT are as follows:

- The DRAP picture shall be a trailing picture with TemporalId equal to 0.
- The DRAP picture shall not include any pictures in its RPL except its associated IRAP picture.
- Any picture that follows the DRAP picture in both decoding order and output order shall not include, in its RPL, any picture that precedes the DRAP picture in decoding order or output order with the exception of the IRAP picture associated with the DRAP picture.

NOTE 5 - These constraints enables a decoder to properly decode the DRAP picture and the pictures that follow it in both decoding order and output order without needing to decode any other pictures except the associated IRAP picture.

Proposed changes to the VVC specification (2/2)



3 Definitions

...

3.34 dependent random access point (DRAP) access unit: An *access unit* in which the *coded picture* is a *DRAP picture*.

3.35 dependent random access point (DRAP) picture: A *coded picture* for which each *VCL NAL unit* has *nal_unit_type* equal to DRAP_NUT.

NOTE – A DRAP picture does not refer to any pictures other than its associated IRAP picture for inter prediction in its decoding process. Provided the necessary parameter sets are available when they need to be activated and that the associated IRAP picture is available, the DRAP picture and all subsequent pictures in decoding order can be correctly decoded without performing the decoding process of any pictures that precede the DRAP picture in decoding order, other than the associated IRAP picture.

general_constraint_info() {	Descriptor
general_progressive_source_flag	u(1)
general_interlaced_source_flag	u(1)
general_non_packed_constraint_flag	u(1)
general_frame_only_constraint_flag	u(1)
intra_only_constraint_flag	u(1)
max_bitdepth_constraint_idc	u(4)
max_chroma_format_constraint_idc	u(2)
frame_only_constraint_flag	u(1)
no_dependent_random_access_point_flag	u(1)
no_qtbt_dual_tree_intra_constraint_flag	u(1)
no_sao_constraint_flag	u(1)
no_alf_constraint_flag	u(1)
no_pcm_constraint_flag	u(1)
...	
}	

no_dependent_random_access_point_flag equal to 1 specifies that it is a requirement of bitstream conformance that no access unit in the CVS shall have *nal_unit_type* equal to DRAP_NUT. **no_dependent_random_access_point_flag** equal to 0 does not impose a constraint.

Example use cases for DRAP

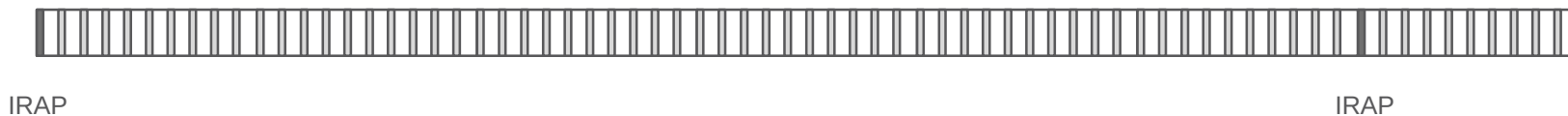


- Searching in static video content
- Fast channel switching for broadcasted services
- Fast channel switching for IPTV broadcasted services
- Random access in MPEG-DASH
- Server-controlled streaming
- Massive video conference

Use case 1: Searching in static video content



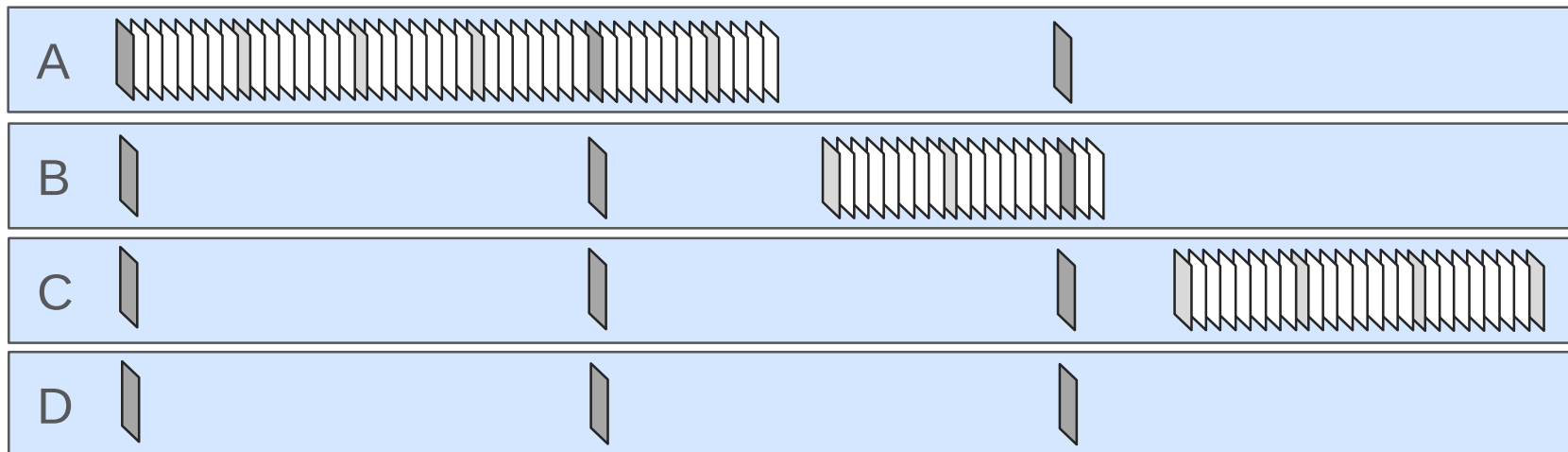
- Video services that typically have very static content include:
 - Surveillance video
 - Screen sharing (as communication tool or for monitoring of other computers, e.g. servers)
- For these services it may be useful to store the video material where the stored material preferably should be easy to navigate and search
- For static video content IRAP pictures may be very expensive to encode compared to inter pictures
- By using DRAP pictures for most of the RAPs, compression efficiency is improved and the material is still easily navigated
 - Example: Use DRAP pictures every second and IRAP pictures every 60 seconds



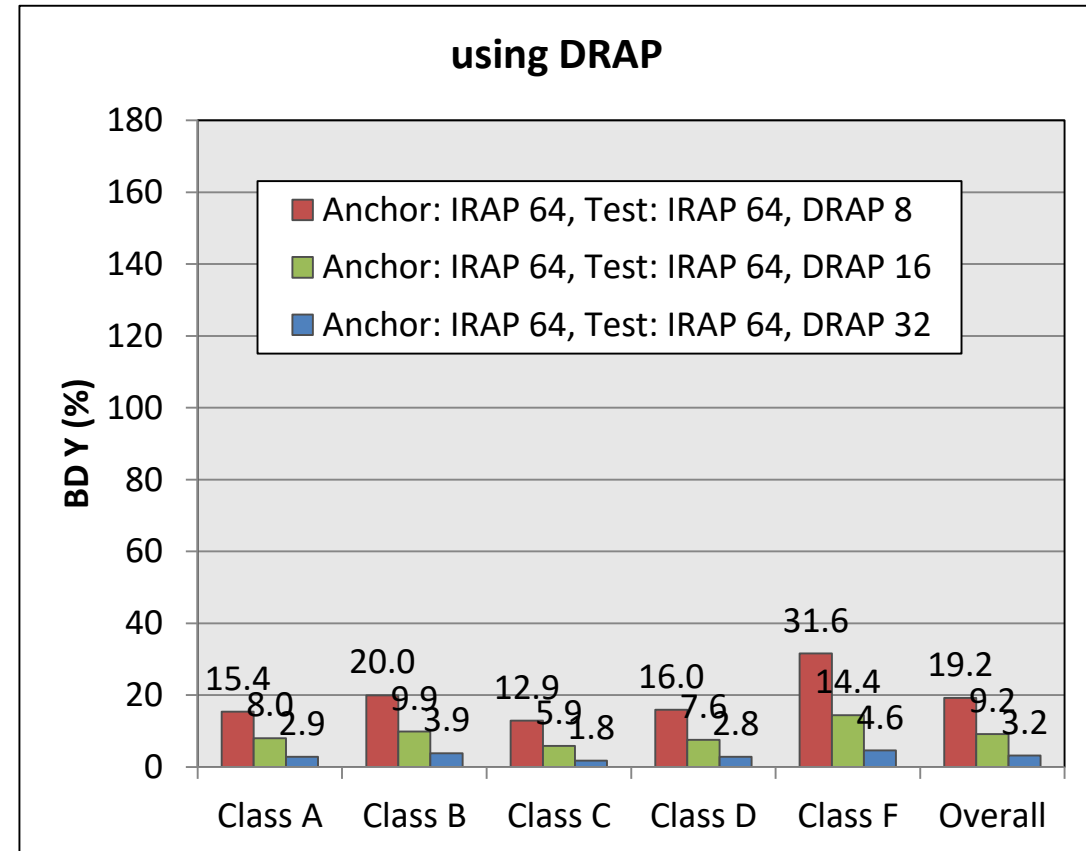
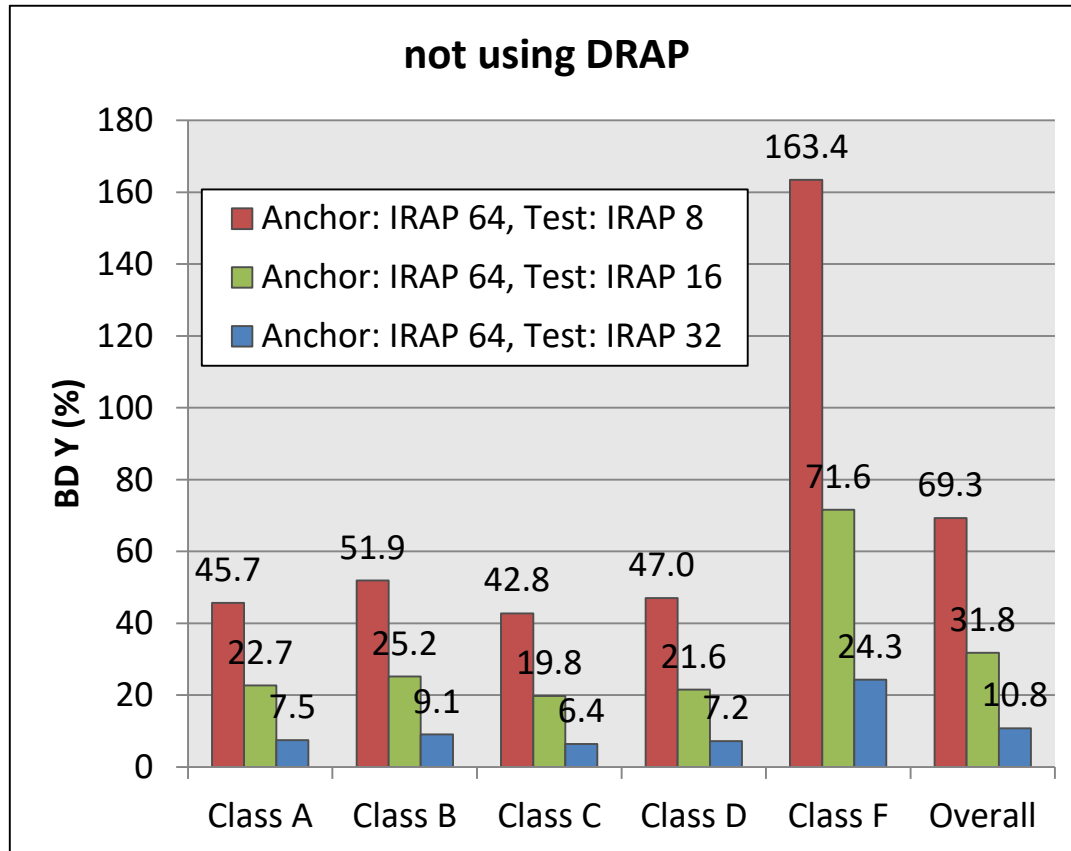
Use case 2: Faster channel switching for broadcasted services



- A receiver with multiple tuners, decodes one channel
- At the same time the receiver stores the last IRAP pictures for some other channels, e.g. “up” and “down”
- When a user determines to switch channel the stored IRAP picture for that channel is decoded and used to decode the next DRAP picture followed by the other pictures in the stream



Results: Additional bitrate cost when decreasing RAP distance compared to IRAP 64

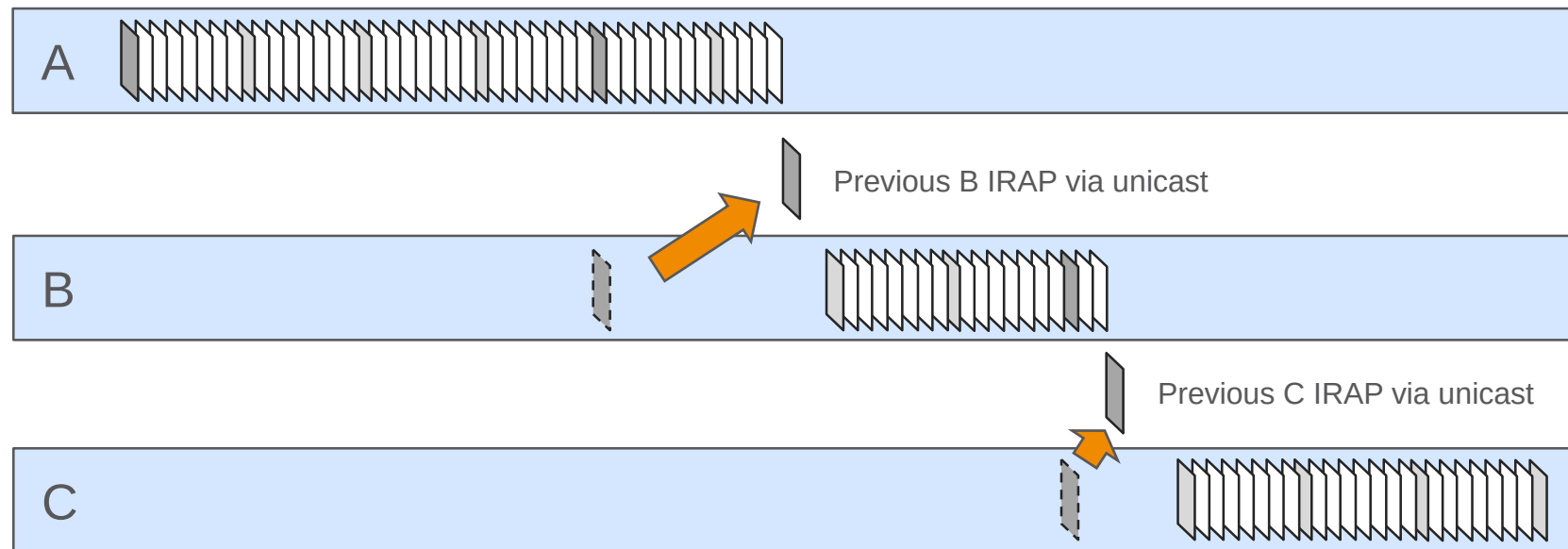


Results for RA Main using HEVC CTC for HM16.2. DRAP implementation on top of HM16.2

Use case 3: Fast channel switching for IPTV broadcasted services



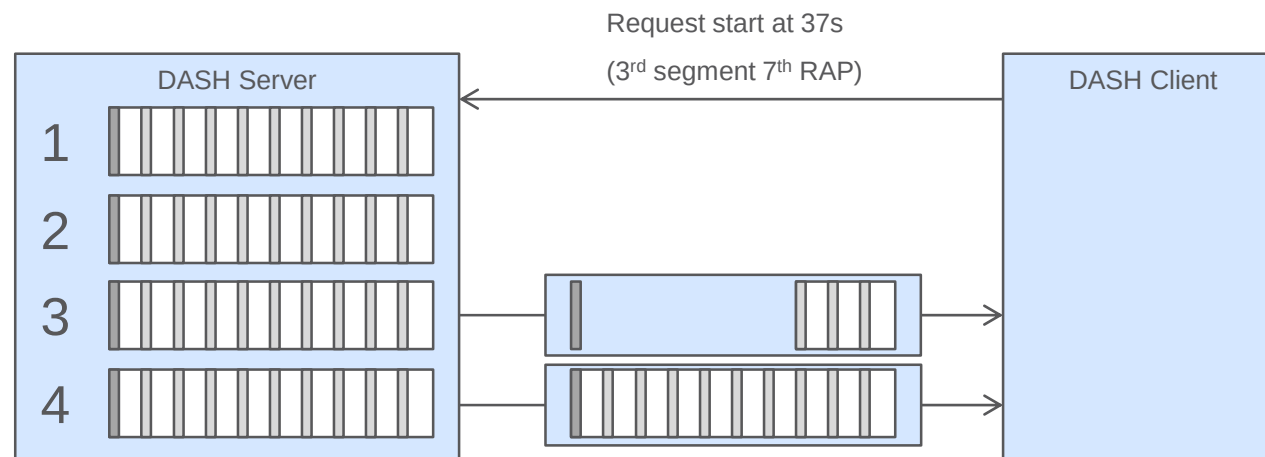
- When a user determines to switch channel the previous IRAP for the new channel is sent to the user via very fast unicast
- The received IRAP picture is decoded and used to decode the next DRAP picture followed by the other pictures in the stream
- This may enable more frequent RAP points and faster channel switch



Use case 4: Random access in MPEG-DASH



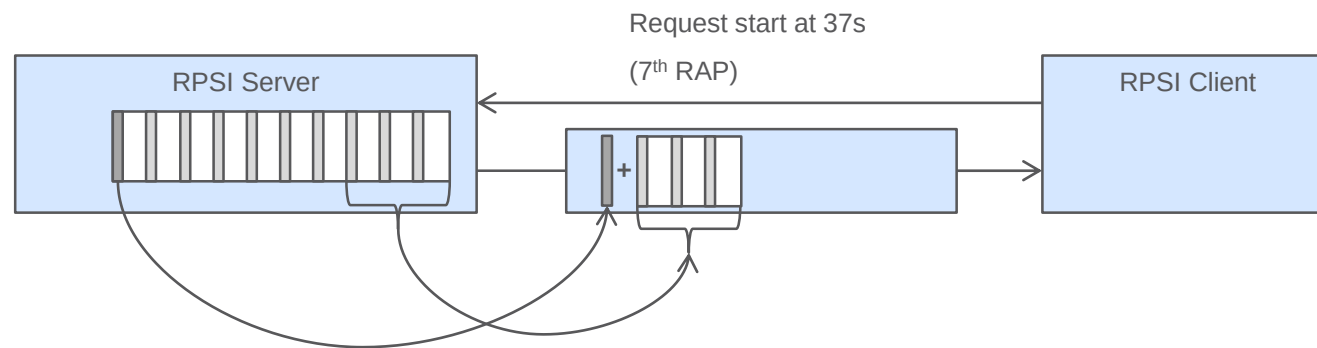
- MPEG-DASH segments may be 10 seconds long with IRAP pictures every second to allow random access
- To save bits all IRAP pictures in a segment except the first one may instead be coded as DRAP pictures
- When the client requests to start in the middle of a segment only the DRAP at the specified position and its associated IRAP picture needs to be transmitted, followed by the remaining pictures



Use case 5: Server-controlled streaming



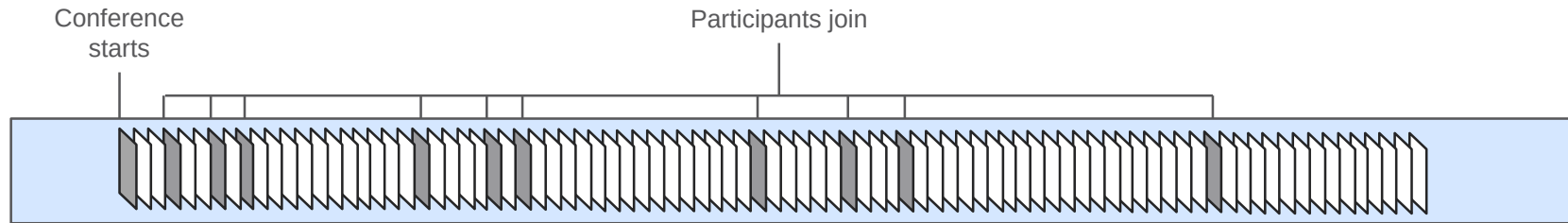
- In this example the client requests a specific position in a stream to be delivered from the server (e.g. by using the PLAY request with a range value in RTSP).
- The server will on-the-fly construct the stream to be delivered by concatenating the previous IRAP picture with the DRAP picture that corresponds to the start of the requested range.



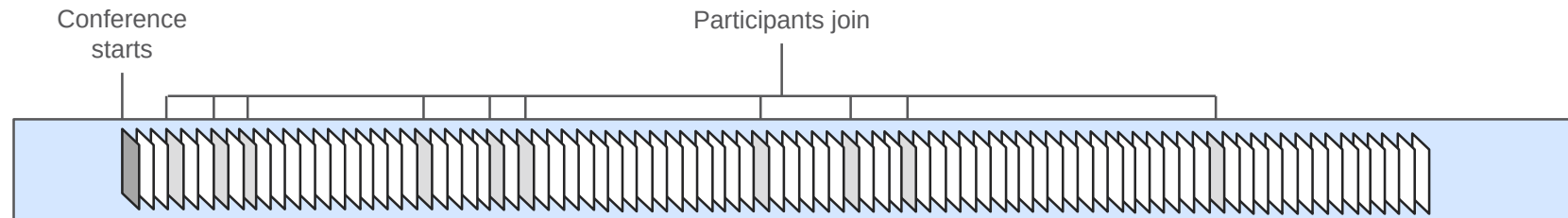
Use case 6: Massive video conference



- Massive video conference (one to many) without DRAP
 - Each time a new participant joins, the conference server request an expensive IRAP from the sender



- Massive video conference (one to many) with DRAP
 - When a new participant joins, the conference server sends the previous IRAP by unicast to that participant.
 - The conference server then request an inexpensive DRAP from the sender



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