Digital Video Broadcasting (DVB); Subtitling systems

Addition to EN 300743 v1.3.1 for Subtitles with Plano-Stereoscopic Content (3D)

DVB Document A156

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DVB
Digital Video
Broadcasting

- *Insert following text into section 7 of EN 300 743 v1.3.1*

7.2.7 Disparity Signalling Segment

The Disparity Signalling Segment (DSS) supports the subtitling of plano-stereoscopic (aka 3D) TV content by allowing disparity values to be ascribed to a region or to part of a region. Whilst regions cannot themselves share scan lines the DSS defines subregions which may be assigned different individual disparity values.

Absence of a DSS implies that the stream has been coded in accordance with EN 300 743 (v 1.3.1) to provide subtitles intended for 2D presentation. In such cases decoders capable of supporting 3D services shall apply an implicit disparity of zero.

Each region can contain one or more subregions referenced to that region. Subregions have the same height as their region and may not overlap horizontally (see figures 5 & 6 below).

There shall be no more than 4 subregions per region and no more than 4 subregions per display set.

A subregion shall enclose all the objects for which it conveys a particular disparity value and all objects shall be enclosed by one of the subregions of a region. All active subregions in a declared display set shall be signalled in the DSS.

A change to any data (e.g. disparity values) signalled in the DSS requires a change to the DSS version number but *does not* require a change to the version number of the RCSs nor the retransmission of the RCS if the relevant region definition itself remains unchanged.

Disparity is the difference between the horizontal positions of a pixel representing the same point in space in the right and left views of a plano-stereoscopic image. Positive disparity values move the subtitle objects enclosed by a subregion away from the viewer whilst negative values move them towards the viewer. A value of zero places the objects enclosed by that subregion in the plane of the display screen.

To ensure that subtitles are placed at the correct depth and horizontal location the disparity shift values signalled shall be applied symmetrically to each view of any subregion and by implication any object bounded by the subregion. A **positive** disparity shift value for example of +7 will result in a shift of 7 pixels to the left in the left subtitle subregion image and a shift of 7 pixels to the right in the right subtitle subregion image. A **negative** disparity shift value of 7 will result in a shift of 7 pixels to the **right** in the left subtitle subregion image and a shift of 7 pixels to the **left** in the right subtitle subregion image. Note that the actual disparity of the displayed subtitle is therefore double the value of the disparity shift values signalled in the disparity integer and/or fractional fields carried in the DSS .

Encoders shall assign a value of disparity to the default disparity (and its associated disparity_update_sequence if present) which would result in an appropriate placement of the subtitles were a decoder only able to apply the default disparity to the entire display set at that time. Decoders which can support only one value of disparity per page shall apply to each region the default disparity value.

Decoders which can attribute a separate disparity value to each region (or subregion) shall parse the region loop in the DSS syntax and implement the signalled disparity shift values for the declared regions or subregions.

Encoders shall ensure that the relative position and size of multiple subregions are managed so as to avoid horizontal overlap when the objects enclosed within those subregions have the relevant disparity values applied as a shift by the decoder**.** In the event, however, that a decoder is presented with subregions whose views do overlap, the decoder should manage occlusion appropriately (for example by presenting those subregions in depth-order of perceived proximity to the viewer i.e the foremost shown in its entirety).

Encoders that are generating streams which include a Disparity Signalling Segment shall encode the background of a region using the region fill mechanism ***only*** if the region contains a single subregion ***or*** if the region fill indexes a fully transparent CLUT entry.

A stream with a DSS shall include a Display Definition Segment and the display window parameters of that DDS shall be consistent with the application of the disparity values signalled in the DSS.

In transmission of a display set (new or updated) the DSS will normally follow the RCS. However, if the PCS has page_state = normal and if the only changes to be signalled are disparity values, these values may be updated by the simple transmission of a DDS, a DSS and an EDS.

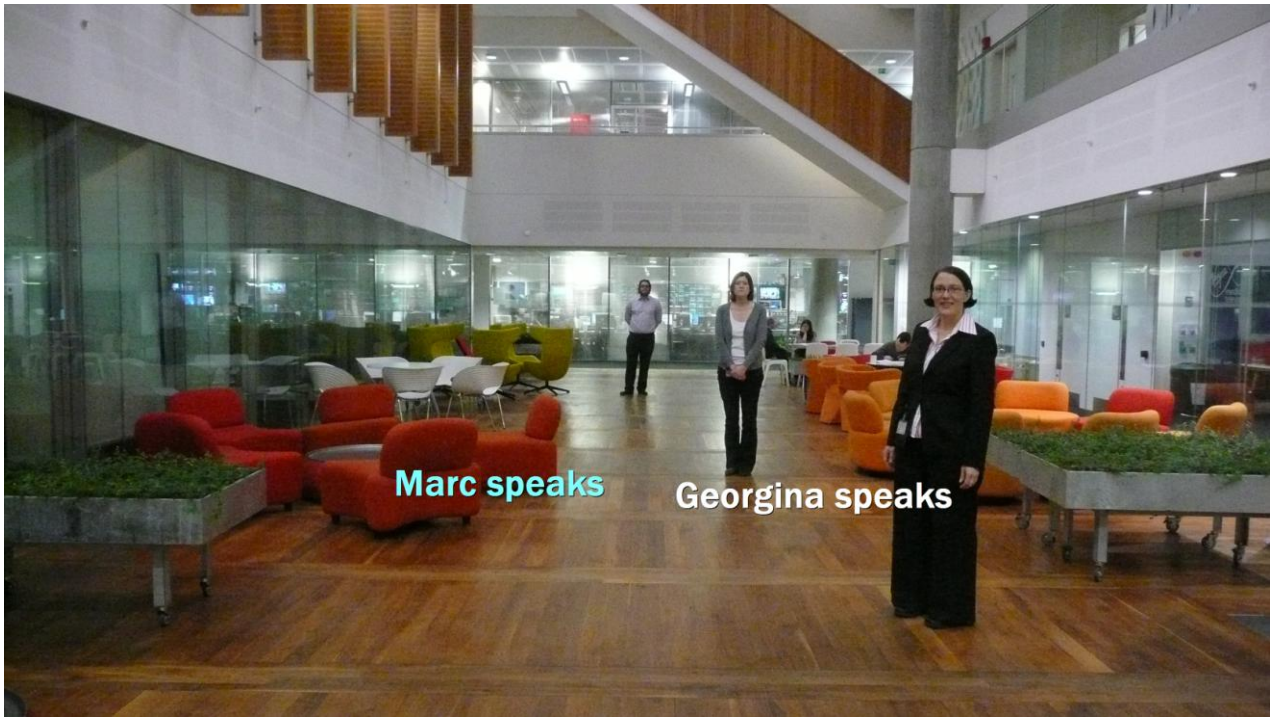


figure 5 Different subtitles sharing a region

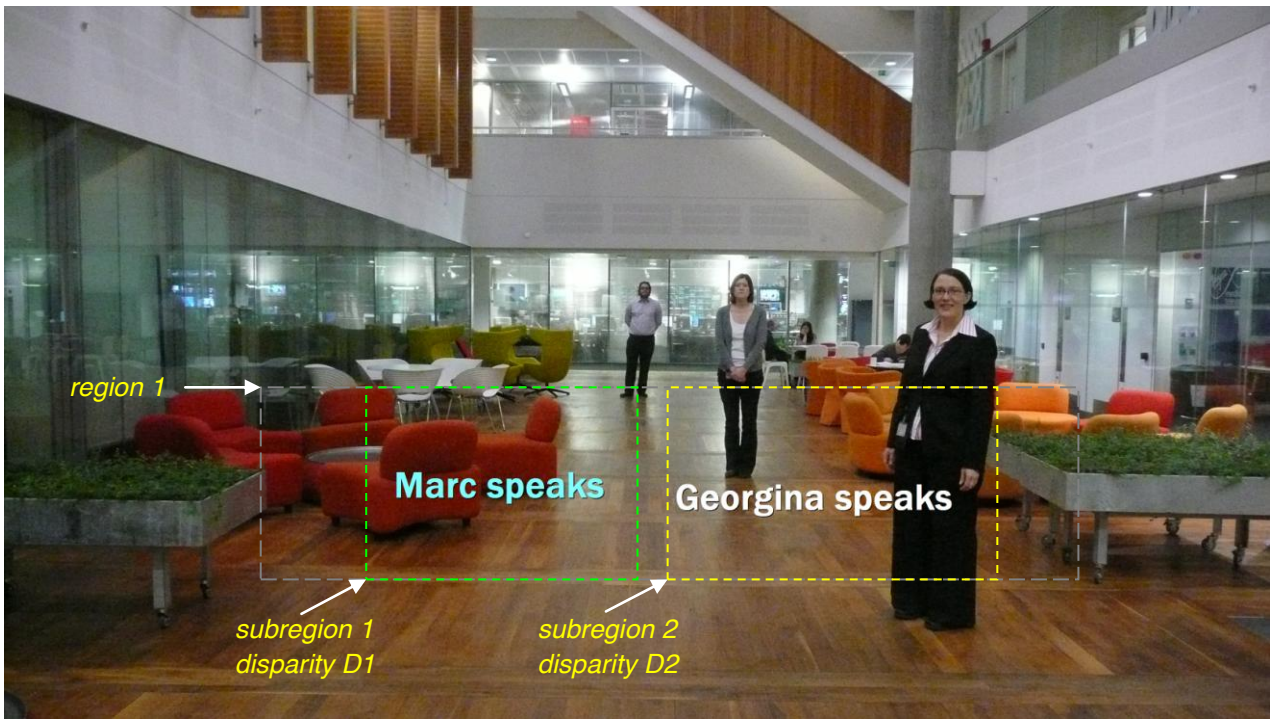


figure 6 Different subtitles assigned to different subregions within one region

Temporal updates to disparity values may be encoded by different strategies. One simple method is to transmit successive DSSs whose signalled values are timed to the PTS of their respective PES packets. Another potentially more bit-rate efficient method uses the DSS to signal a succession of disparity updates using the disparity_shift_update_sequence mechanism defined below [1].

The disparity shift update sequence mechanism is illustrated in figure 7 below and in Annex C. A succession of near-future disparity values are transmitted together, defined at intervals which can vary, and are applied at times which can easily be calculated from the PTS and the transmitted interval parameters. Intermediate disparity values may be interpolated by the decoder as appropriate (two possible interpolation approaches are indicated in figure 7 by hatched lines) within the capabilities of the decoder. Care should be take in interpolation to avoid "overshoot" in the calculated intermediate disparity values (particularly for positive values).

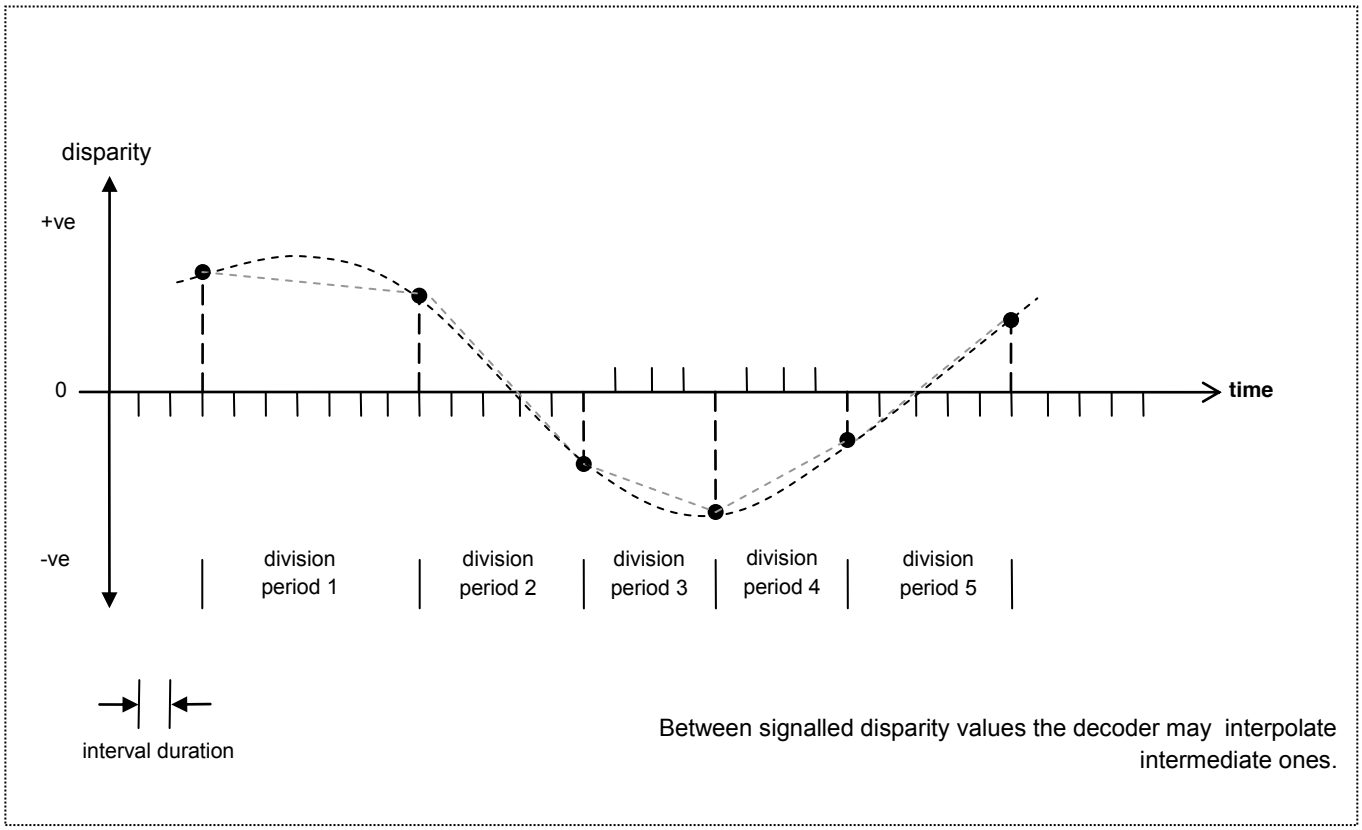


Figure 7 Disparity updates using the disparity_shift_update_sequence mechanism

[1] Note that a mixed approach is also possible in which, for example, a DSS which includes a disparity_shift_update_sequence is followed (and possibly overruled) by a DSS with a new disparity_shift_update_sequence or by a DSS which signals a new set of disparity values timed to the PTS.

Disparity signalling segment

Syntax	Size	Type
disparity_signalling_segment() {		
sync_byte	8	bslbf
segment_type	8	bslbf
page_id	16	bslbf
segment_length	16	uimsbf
dss_version_number	4	uimsbf
disparity_shift_update_sequence_page_flag	1	bslbf
reserved	3	bslbf
page_default_disparity_shift	8	tcimsbf
if (disparity_shift_update_sequence_page_flag ==1) {		
disparity_shift_update_sequence()		
}		
while (processed_length<segment_length) {		
region_id	8	uimsbf
disparity_shift_update_sequence_region_flag	1	bslbf
reserved	5	uimsbf
number_of_subregions_minus_1	2	uimsbf
for (n=0; n<= number_of_subregions_minus_1; n++) {		
if (number_of_subregions_minus_1 > 0) {		
subregion_horizontal_position	16	uimsbf
subregion_width	16	uimsbf
}		
subregion_disparity_shift_integer_part	8	tcimsbf
subregion_disparity_shift_fractional_part	4	uimsbf
reserved	4	uimsbf
if (disparity_shift_update_sequence_region_flag ==1) {		
disparity_shift_update_sequence()		
}		
}		
}		
}		

disparity_shift_update_sequence

Syntax	Size	Type
disparity_shift_update_sequence() {		
disparity_shift_update_sequence_length	8	bslbf
interval_duration[23..0]	24	uimsbf
division_period_count	8	uimsbf
for (i= 0; i< division_period_count; i ++) {		
interval_count	8	uimsbf
disparity_shift_update_integer_part	8	tcimsbf
}		
}		

Semantics :

dss_version_number : indicates the version of this disparity_signalling_segment. The version number is incremented (modulo 16) if ***any*** of the parameters for this particular disparity_signalling_segment are modified.

disparity_shift_update_sequence_page_flag : if '1' then the disparity_shift_update_sequence immediately following is to be applied to the page_default_disparity_shift. If '0' then a disparity_shift_update_sequence for page_default_disparity_shift is not included.

page_default_disparity_shift : specifies the default disparity value which should be applied to all regions within the page (and thus to all objects within those regions) in the event that the decoder cannot apply individual disparity values to each region. This disparity value is a signed integer and thus allows the default disparity to range between + 127 & -128 pixels.

Note : Any decoder which can apply separate disparity values to a region or subregion shall apply the relevant values to any subregions signalled in the region loop.

processed_length : the total number of bytes that have already been processed following the segment_length field.

region_id : identifies the region to which the following subregion data refers. Regions which have been declared in the display set but which are not referenced in the while-loop shall adopt the page_default_disparity and its associated disparity_update_sequence where present.

disparity_shift_update_sequence_region_flag : if '1' then a disparity_shift_update_sequence is included for all subregions of this region. If '0' then a disparity_shift_update_sequence for this region is not included.

number_of_subregions_minus_1 : the number of subregions minus one which apply to this region. If number_of_subregions_minus_1 = 0 then the region has only one subregion whose dimensions are the same as the region and the signalled disparity therefore applies to the whole region.

subregion_horizontal_position : specifies the left-hand most pixel position of this subregion. This value shall always fall within the declared extent of the region of which this is a subregion and shall therefore be in the range 1..4095.

subregion_width : specifies the horizontal width of this subregion expressed in pixels. The combination of subregion_horizontal_position and subregion_width shall always fall within the declared extent of the region to which this refers. The value of this field shall therefore be in the range 1..4095.

subregion_disparity_shift_integer_part : specifies the integer part of the disparity shift value which should be applied to all subtitle pixel data enclosed within this subregion. This allows the disparity to range between + 127 & -128 pixels.

subregion_disparity_shift_fractional_part : specifies the fractional part of the disparity shift value which should be applied to all subtitle pixel data enclosed within this subregion. When used as an extension of the integer part, this allows the signalled disparity shift to be defined to $^{1}/_{16}$ pixel accuracy. Note that this fractional part is unsigned (0b0001 represents $^{1}/_{16}$ pixel and 0b1111 represents $^{15}/_{16}$ pixel) and should be combined with the integer part according to the sign of the integer part.

Note : Any processing (either at the encoder or the decoder) which needs to implement only integer values of disparity shift shall ensure values are rounded “towards the viewer” (i.e. that positive values of disparity are rounded down and negative values rounded up).

disparity_shift_update_sequence_length : specifies the number of bytes contained in the disparity_shift_update_sequence which follows this field.

interval_duration : specifies the unit of interval used to calculate the PTS for the disparity update as a 24-bit field (in 90 kHz STC increments). The value of interval_duration shall correspond to an exact multiple (≥1) of frame periods and its maximum value is therefore just over 186 seconds.

division_period_count : specifies the number of unique disparity values (≥ 1) and hence the number of time intervals within the following disparity_shift_update_sequence ‘for’ loop.

interval_count : specifies the multiplier used to calculate the PTS for this disparity update from the initial PTS value. The calculation for the PTS for this update is $PTS_{new} = PTS_{previous}$ + (interval_duration * interval_count) where interval count ≥ 1, where PTS_{new} increases with every iteration of the loop and where the initial value of $PTS_{previous}$ is the PTS signalled in the PES header.

disparity_shift_update_integer_part : specifies the integer part of the disparity update value which should be applied to all subtitle pixel data enclosed within this page or this subregion. This allows the disparity to excurse + 127 to -128 pixels.

- *Add to abbreviations in 3.2 a definition for “tcimsbf”*
- *Append to the second paragraph of section 5.1.2 the sentence :*

  Subtitling segments should not be fragmented across PES boundaries.
- *Include a reference to DSS in assignment of segment_type values (table 2) using value of 0x15*
- *Replace in existing semantics of PCS, and CDS and place in semantics of RCS a corrected definition of processed_length as per above viz. :*

  processed_length : the total number of bytes that have already been processed following the segment_length field.
- *Renumber present figure 5 as figure 8*
- *Add new Annex - see below*
- *Rename present Annex C as Annex D*

Annex C

Illustration of the application of the disparity_shift_update_sequence mechanism for 3D content

This example shows two regions (region1 & region2) each of which has a single subregion equal in size to the region itself.

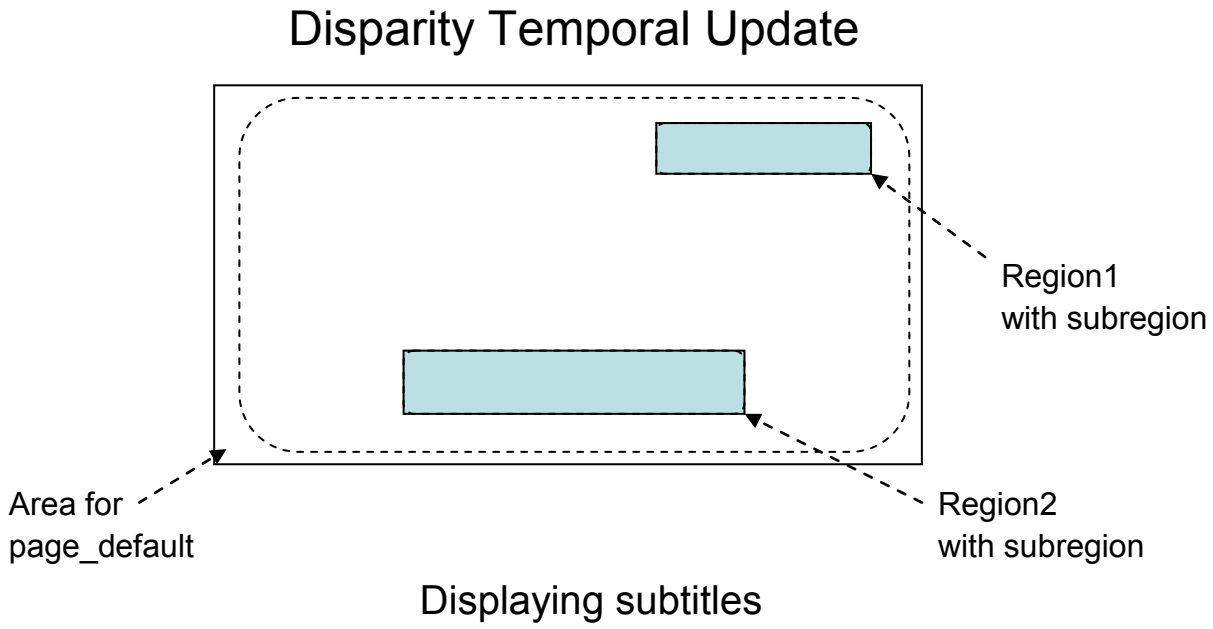
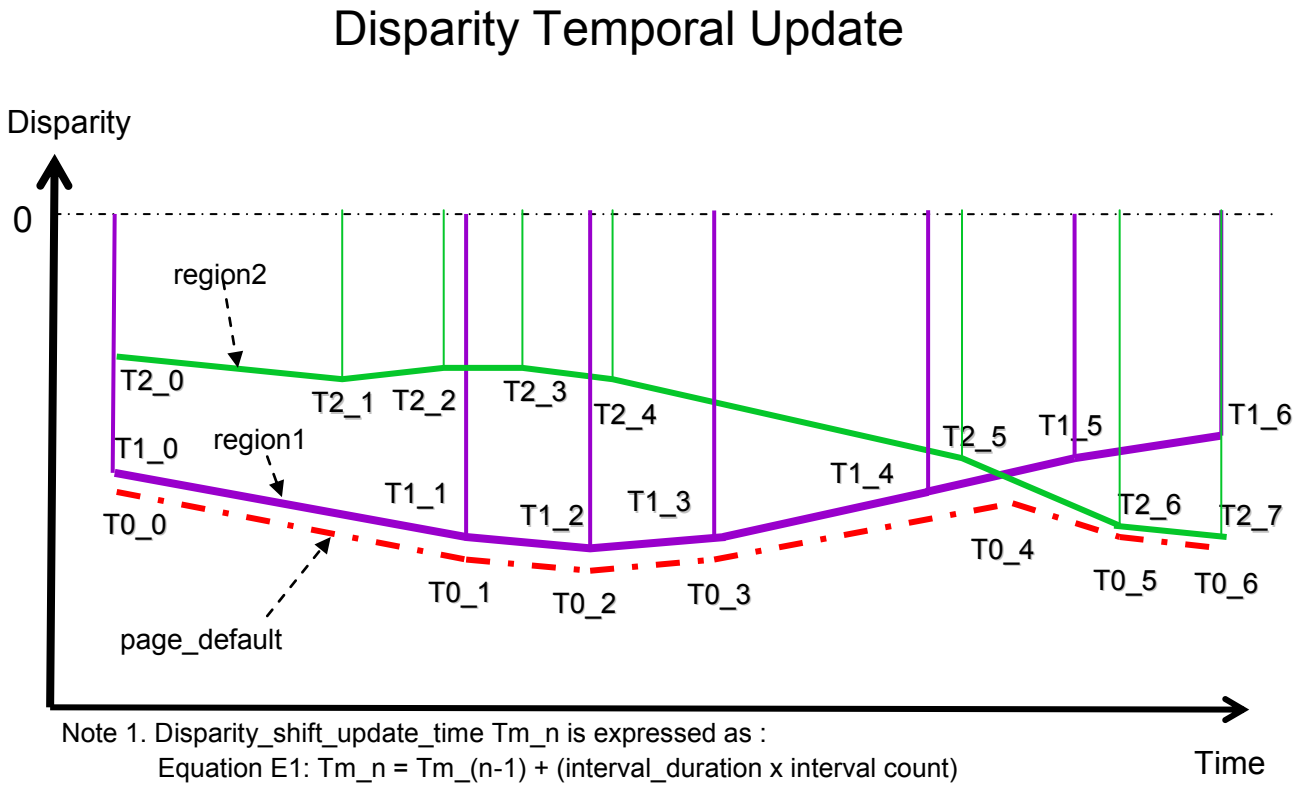


Fig.C1 Example of disparity update applying to the page default and to 2 regions



Note 1. Disparity_shift_update_time Tm_n is expressed as :
Equation E1: Tm_n = Tm_(n-1) + (interval_duration x interval count)
where Tm_0 = PTS in PES header

Note 2. In (T1_n-1, T1_n), the intermediate values between the vertices are generated by decoder interpolation

Note 3. The signalled page default disparity values are calculated by the encoder.

Fig. C2 Disparity shift update values applied to example

From equation E1 in figure C2 above, each disparity update timing Tm_n is calculated by multiplying the interval_duration by the interval_count and adding it to the previous update timing Tm_(n-1). The period between Tm_(n-1) and Tm_n is interpolated by the decoder.

The update timing Tm_n of each region may be independent and is set by the encoder. The example shown in Fig C2 has two regions and a page default disparity update sequence. Region 1's disparity shift update sequence starts from T1_0 with successive updates for T1_1, T1_2 .. T1_6. Region 2's disparity shift update sequence starts from T2_0 with successive updates for T2_1, T2_2 .. T2_7. The page default disparity shift update sequence starts from T0_0 with successive updates for T0_1, T0_2 .. T0_6.

The number of updates differs between the page default, region1 and region2 but the timing of the end of the sequence is the same. The page default disparity shift value would typically be created by taking the minimum value at the corresponding time stamp of all the regions. Fig. C3 below shows the hierarchy of the disparity update data structure within the disparity_shift_update_sequence.

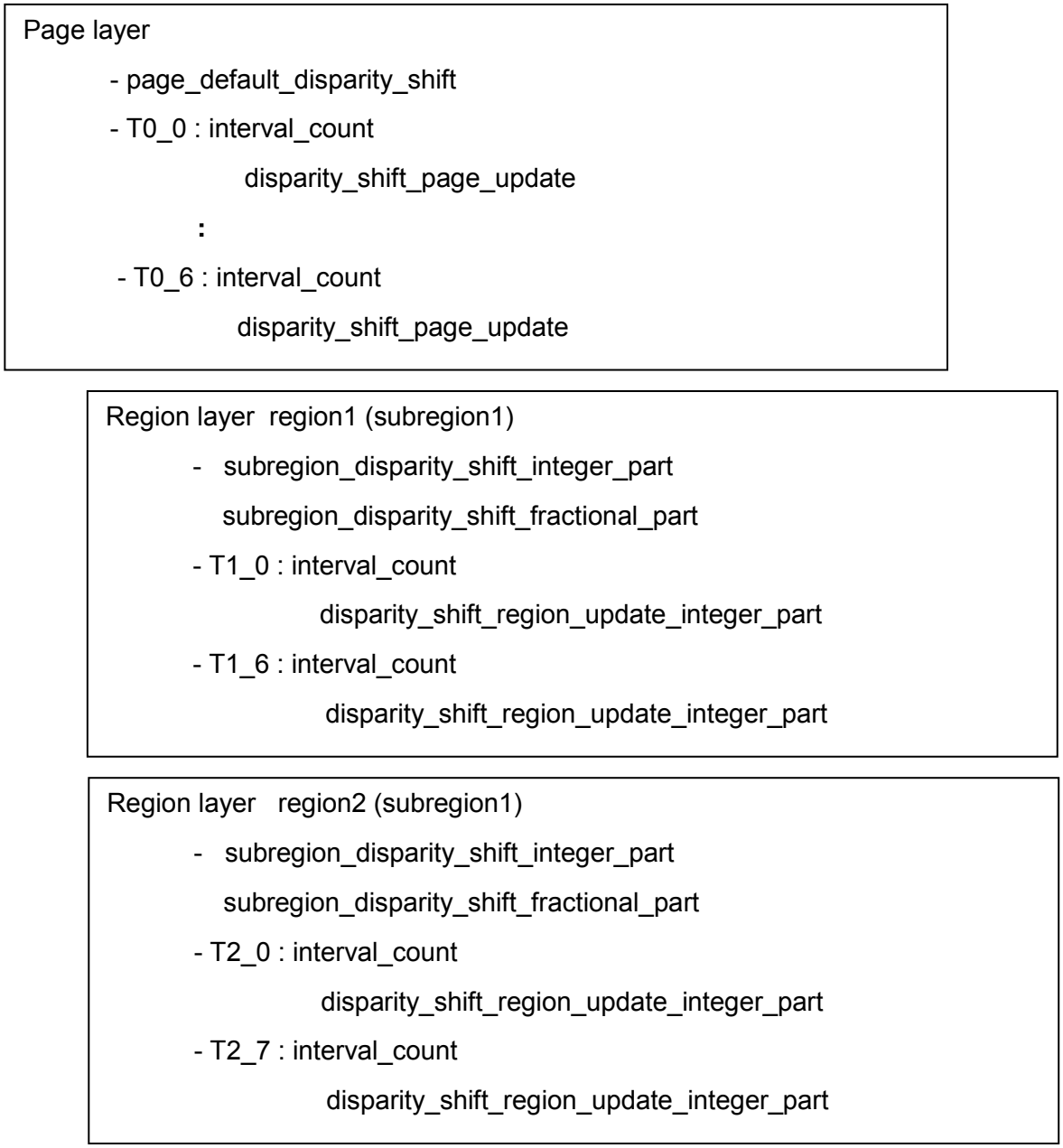


Fig. C3 Overview of the structure of a disparity_shift_update_sequence

Timing Constraints

1 Every disparity_shift_update_sequence shall be received in the decoder's compressed buffer prior to the presentation time of the corresponding subtitle display set.

2 The time interval between the successive disparity updates shall be greater than or equal to 33msec, which corresponds to a frame rate of 30Hz or less, or greater than or equal to 40 ms for 25Hz systems.

3 Disparity update mechanism

Division_Period_n = interval_duration * (variable value)

In the interval (T1_n-1, T1_n), the intermediate values may be generated through interpolation.

Note1. Disparity_shift_update_time Tm_n is expressed as :-

Tm_n = Tm_(n-1) + (interval_duration * interval_count)

where Tm_0 = PTS in PES header

Concurrently, the initial disparity value in the disparity shift update sequence is encoded with the interval_count being set to 0.

Compliant decoder

4 All decoders shall decode the disparity shift update sequence if the disparity_shift_update_sequence_page_flag is set to "1". In this case the decoder should ignore the page_default_disparity_shift and apply to the page the disparity values signalled in the relevant disparity_shift_update_sequence.

5 High performance decoders shall decode the disparity shift update sequence if the disparity_shift_update_sequence_region_flag is set to "1". In this case the decoder should ignore the subregion_disparity_shift values and apply to each subregion the disparity values signalled in the relevant disparity_shift_update_sequence.

Other

6 A disparity update trajectory is created in the decoder from the successive disparity values contained within a display_shift_update_sequence. Interpolation may be applied to generate intermediate disparity values as illustrated by the dotted line in fig C4. Such interpolation is beneficial but is optional.

7 If the cumulative disparity sequence duration is shorter than the subtitle display set lifetime the decoder should use the last signalled values of disparity until the end of presentation of the display set.

If the cumulative disparity sequence duration is longer than the subtitle display set lifetime the decoder should ignore those signalled disparity values.which would apply beyond the lifetime of the display set.

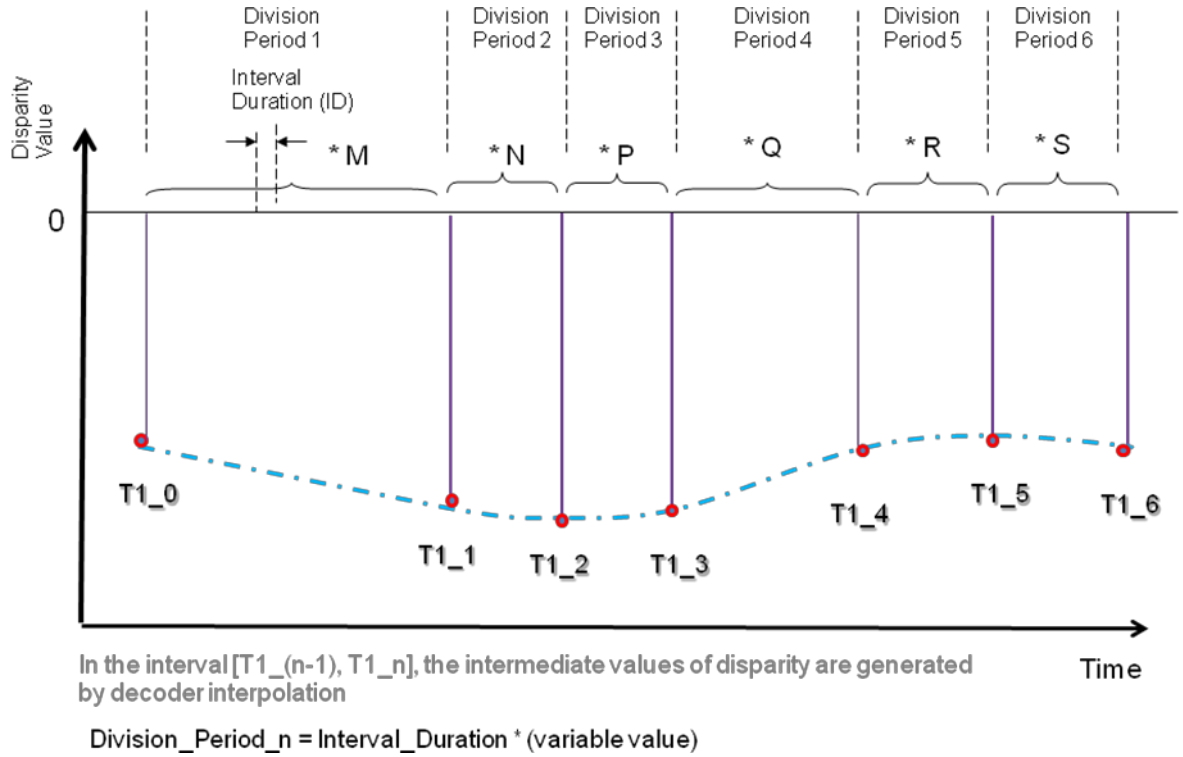


Fig. C4 Disparity update sequence showing interpolation