**3GPP TSG-SA WG4 Meeting #127S4-240171**

**Sophia-Antipolis, France, 29 January - 2 February 2024**

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| *CR-Form-v12.0* | | | | | | | | |
| **PSEUDO CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **26**.**966** | **CR** | **-** | **rev** | **-** | **Current version:** | **1.0.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

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| ***Title:*** | **[FS\_HEVC\_Profiles] On frame-packing** | | | | | | | | | |
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| ***Source to WG:*** | Apple Inc. | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | **FS\_HEVC\_Profiles** | | | | |  | ***Date:*** | | | 15/01/2024 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | 18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | There is an editor's note in clause 6.2.3.2 that analysis of frame packing is to be provided; this contribution provides this analysis. | | | | | | | | |
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| ***Summary of change:*** | | An analysis based on the solution of frame packing is provided. | | | | | | | | |
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| ***Consequences if not approved:*** | | Editor's note on frame packing will remain | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 5.1.2, 6.0, 6.x (New), 6.2.3.2 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | * Added mapping of solutions to scenarios * Removed text on multi-track solutions | | | | | | | | |

\* \* \* First Change \* \* \* \*

5.1.2 Review of previous work

Evaluation of AVC based stereoscopic 3D coding techniques has been done in TR 26.905 [3] and its normative support has been added for 3GPP DASH in TS 26.247 [3], the 3GPP file format in TS 26.244 [5], IMS in TS 26.114 [6], VR profiles in TS 26.118 [7], and MBMS in TS 26.347 [8]. The work done in TR 26.905 [3] for Rel-11 focused mostly on stereoscopic viewing on TVs, while today's applications have grown far beyond these, given especially advancements in AR devices. Also, today's requirements on quality are much higher owing to higher quality displays and the available channel capacities.

Simulcast and frame packed HEVC video operating points are specified in TS 26.118 for VR streaming scenarios. With the established support for MV-AVC, simulcast and frame packed HEVC in 3GPP SA4 specifications, an assessment needs to be done to upgrade the support for multiview coding using MV-HEVC with its superior coding performance.

\* \* \* First Change \* \* \* \*

6.0 Mapping of Solutions to Scenarios

**Table 6.0-1: Mapping of Solutions to Scenarios**

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| --- | --- | --- |
| **Solution #** | **Solution Title** | **Scenario(s)** |
| **#1.1** | HEVC simulcast | #1.1, #1.2 |
| **#1.2** | HEVC Frame packing | #1.1, #1.2 |
| **#1.3** | Multiview HEVC coding | #1.1, #1.2 |
| **#2.1** | HEVC 4:2:0 coding | #2 |
| **#2.2** | HEVC 4:2:2 coding | #2 |
| **#2.3** | Native 4:4:4 coding - HEVC Main 4:4:4 profiles | #2 |
| **#2.4** | Derived 4:4:4 coding - Layered use of HEVC 4:2:0 profiles | #2 |
| **#3.1** | Scalable HEVC coding | #3 |
| **#4.1** | MV-HEVC with auxiliary depth/alpha channels | #4 |

\* \* \* Next Change \* \* \* \*

6.x Solution #1.x: HEVC frame packing

6.x.1 Introduction

HEVC frame packing is considered a solution that addresses Scenario#1.

6.x.2 High-level Description

6.x.2.1 Overview HEVC frame packing

Frame packing can be used as one of the options to deliver multiview (stereoscopic) video content. This solution is focused on reusing existing decoding HW and SW to deliver stereoscopic content and utilizes SEI messages to indicate how the content should be interpreted for viewing. For example, the frame packing arrangement SEI message is specified in the Advanced Video Coding (AVC) and High Efficiency Video Coding (HEVC) [3] cl D.3.16. specifications and could allow indicating a variety of frame packing arrangements, including spatial arrangements such as side-by-side or top-bottom, or temporal interleaving.

6.x.2.2 Transport of HEVC frame packing

The scheme for stereoscopic video arrangements ([23] cl 13.5.4) for restricted media tracks is one example of signalling that allows indicating the frame packing arrangement for a stereo pair.

6.x.3 Evaluation

6.x.3.1 Assessment/discussion of hardware impact

The use of frame packing allows the reuse of existing decoding HW and SW for the compression and delivery of stereoscopic content. SEI messages that identify the frame packing arrangement format used can be indicated in the bitstream to assist the decoding or display process to properly interpret, post-process, and/or display the decoded video data. However, frame packing can have an significant impact on the quality of the representation if full resolution is not used. If full resolution is used, the level requirements of a decoder may need to be increased. Such impact is noted in the following section. The increased sample rate needed for full resolution frame packing maybe the same as that for MV-HEVC.6.x.3.2 Codec performance evaluation based on existing results

Though existing evaluations between simulcast, MVC, and MV-HEVC are available, as documented in clause 6.2.3.2, evaluations between frame packed HEVC and MV-HEVC are not.

Except for full-resolution spatial packing and temporal interleaving, retaining the same resolution for spatial frame packing with the same decoding level for the decoder would result in reduced video resolution for the views. This can have a considerable impact in visual quality. On the other hand, full resolution frame packing typically require higher level capability HEVC decoders, while also potentially being less efficient than MV-HEVC since it does not permit efficient exploitation of inter-layer redundancies. Spatial frame packing could also result in seam artifacts at the boundaries between two views.

Temporal interleaving would also require supporting double the frame rate and hence may increase the level requirements of the decoder. Although inter-layer prediction can be partially exploited, such is not supported for non-reference pictures in the base-layer, while constraints in the reference buffer specified by HEVC can negatively impact inter prediction.

In conclusion, compared to MV-HEVC, frame packed video:

* video commonly has reduced quality or increased bitrate requirements
* When stereoscopic MV-HEVC based content is used on a non-3D capable device, the content can be played back using only the base view for a 2D presentation. Frame-packed content require the interpretation of the frame packing arrangement SEI message, or analysis of the content to determine whether and, if yes, how the content would need to be processed (e.g. cropped) to extract and display a 2D representation from the decoded pictures.

\* \* \* Next Change \* \* \* \*

6.2.3.2 Codec performance evaluation based on existing results

The objective and subjective performance results comparing MVC and Simulcast HEVC (each view coded independently) with MV-HEVC are documented in [12]. The test sequences used for this evaluation are 1080p 8-bit 4:2:0 content either at 25 or 30 Hz. IPP encoding was used to generate the results. The objective results demonstrate significant performance improvements achieved by MV-HEVC against both MVC and simulcast HEVC, demonstrated by the Bjøntegaard Delta (BD) bitrates table reproduced here:

|  |  |  |
| --- | --- | --- |
| Test Sequence | BD-rate reduction of MV-HEVC [%] relative to | |
| MVC | Simulcast HEVC |
| S03: Undo\_Dancer | -45.7 | -38.7 |
| S04: GT\_Fly | -52.9 | -41.0 |
| S13: Band06 | -43.3 | -31.7 |
| S14: BMX | -60.6 | -25.6 |
| Average | -50.6 | -34.2 |

Hence at least 30% performance gains were observed against simulcast HEVC. The corresponding subjective tests using the “Expert Viewing Protocol” (EVP) verified the objective gains via MOS for all the sequences above.

Although no formal evaluation exists for the Multiview Main 10 profile of MV-HEVC, considering the large gains achieved as noted above, it is expected that its performance should be similar to what is demonstrated for 8-bit content.

Editor's note: Potentially reproduce some EVP results, FFS.

\* \* \* End of Changes \* \* \* \*