3GPP TSG-SA WG4 Meeting #132S4-250938

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**Source: Nokia, Philips, Interdigital, Deutsche Telekom, Fraunhofer HHI, KDDI, Samsung, Sony Group Corporation, Huawei**

**Title: pCR on using constant bitrate for evaluation of scenario 2**

**Spec: 3GPP TR 26.956 v0.4.0**

**Agenda item: 9.7**

**Document for: Agreement**

**1. Introduction**

This contribution provides the rationale for using fixed bitrate in scenario 2.

S4-250446 suggested using fixed bitrate for providing objective and subjective test results in scenario 2. In SA4#131-bis-e, this proposal has been challenged arguing that fixed bitrate is not realistic usage in market deployments, that it would only be an average fixed bitrate and that in TR 26.955 fixed QPs have been used for providing objective test results. As a result, the fixed bitrate text was left in square brackets in clause 7.3.9.2 of the TR. This contribution discusses the differences between 5G Video Codec Characteristics (TR 26.955) and Beyond2D (TR 26.956) studies and recommends removing the square brackets related to fixed bitrate.

**Reminder of 5G Video Codec characterization (TR 26.955)**

TR 26.955 describes 5 scenarios which rely basically on the same representation format, but with different image parameters or spatial / temporal characteristics. Anchors and potential future codecs support all 5 scenarios.

TR 26.955 documents performance characteristics per scenario of present and potential future video codecs in 5G services, where present video codecs H.264 and H.265 have been selected as anchors. All the codecs studied in this report are video codecs which are used to code basically the same representation format and a well-known framework for generating metrics has been followed:

Codec characterization follows basically the principles:

* Reference sequences are encoded with anchor video codecs using **constant QP** and metrics are calculated.
* Reference sequences are encoded with the new video codecs using **constant QP** and metrics are calculated. The RefSW for the video codecs is controlled by a single QP parameter, where a higher QP always provides a lower bitrate.
* Characterization is done by calculating BD rate gain of the potential future video codecs against the anchor video codecs and by plotting the rate quality curves and BD rate gain for different metrics.
* Subjective evaluation of anchors and of potential future codecs is not considered in this report. Subjective verification test reports engaged by the codec authoring organizations are referenced.

Summary of TR 26.955 testing:

* Anchors and potential future codecs all support the same representation format, enabling objective comparison.
* Characterization is done per scenario and purely objective with multiple metrics. As there are multiple codecs for the same representation format, rate quality curves can be overlaid in the same diagram for comparison. As curves are interpolated and can be overlaid, the use of fixed QPs works fine.
* No videos are provided for subjective viewing in the TR, but external subjective tests are referenced, which were done with test labs using MOS scores with interpolated curves where the use of fixed QPs works fine.

**Reminder of Beyond2D scenario 2 codec characterization (TR 26.956)**

TR 26.956 describes 3 scenarios which all have different representation formats, there can be multiple representation formats per scenario and for some representation formats no meaningful anchor can be provided. In the following we concentrate on scenario 2, which can be implemented by using dense dynamic point clouds or dynamic meshes as representation formats. For dense dynamic point clouds MPEG V-PCC is proposed as codec and there is no meaningful anchor for that format. Comparison of codecs for different representation formats (even within the same scenario) is not possible in a fair manner, as the reference changes due to format conversion.

Codec characterization of scenario 2 in S4-250446 and TR 26.956 V0.4.0 follows basically the principles:

* Reference sequences are encoded with MPEG V-PCC using **fixed bitrate** and objective metrics are calculated. The RefSW for V-PCC is controlled by 2 QPs (QP Geometry and QP Texture) and Occupancy Precision, so a triple of parameters. Obtaining fixed bitrates requires a search per test sequence, which takes time, but leads to meaningful bitrates. The fixed bitrate is an average over the sequence length, but as the length of the scene is 10s and there are no scene cuts, the average is meaningful. Using fixed QPs would require fixing the triple for all sequences of a rate point, which may lead to not useful bitrates (very low, very high, very close, …) for some of the sequences, and rate quality curves may not be monotonic.
* Characterization is done by plotting the rate quality curves. As there is no anchor, BD rate gain cannot be calculated. The results provided can be used as an anchor if at later point in time another dense dynamic point cloud codec would be characterized.
* Subjective evaluation is enabled by providing videos generated by following a camera path, for all 5 test sequences, for all 5 fixed rate points and for 3 rendering modes (cube, splat blend, splat blend + background). Videos produced with **fixed bitrate** encoding enable indicative comparison with a potential codec of another representation format (e.g. V-DMC) used at similar bitrates. Using fixed QPs would prevent such indicative comparison.

Summary of TR 26.956 V0.4.0 testing:

* Scenario 2 has dense dynamic point clouds and dynamic meshes as representation format and codec comparison is not possible in a fair manner, as the reference changes due to format conversion.
* Characterization of scenario 2 is done with objective metrics and subjectively by providing videos. Rate quality curves for V-PCC are plotted, but as there is no anchor, there is no overlay and BD rate gain cannot be calculated. Objective results can serve as an anchor for potential other dense dynamic point cloud codecs in future. Plotting the quality curves works with **fixed bitrate** and **fixed QP**.
* Videos are provided for subjective viewing during the study. Videos produced with **fixed bitrate** encoding enable indicative comparison with a potential codec of another representation format (e.g. V-DMC) used at similar bitrates. Using **fixed QPs** would prevent indicative comparison and testing using MOS scores would need to be engaged. Further subjective tests engaged by MPEG for V-PCC using fixed bitrates and lower resolution sequences are referenced in the TR.

**2. Reason for Change**

Decision on using fixed bitrate or fixed QP for scenario 2 is pending. Production and submission of objective and subjective test results for scenario 2 cannot move ahead without this decision.

**3. Conclusions**

Based on the analysis, it is recommended using **fixed bitrates** for scenario 2 tests in TR 26.956 and remove the square brackets in clause 7.3.9.2, as it enables an indicative subjective comparison of V-PCC with a codec supporting another potential representation format (e.g. V-DMC). It is noted that neither fixed bitrate nor fixed QP are used in market deployments, as typically rate control is used.

**4. Proposal**

It is proposed to agree the following changes to 3GPP TR 26.956.

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

### 7.3.9 Detailed test conditions

#### 7.3.9.2 Rate points and test conditions

In line with the V-PCC verification test [Vol-28], 5 rate points R1 to R5 for Random Access (RA) are used for each test sequence. Fixed rate points are used to enable an indicative subjective comparison of V-PCC with potential future other codecs for scenario 2, including codecs supporting another potential representation format (e.g. dynamic mesh with V-DMC).

For test sequences with 11-bit geometry precision (vox11) with approximately 2M points/frame the following target bitrates in kbps are used:

R1: 5000

R2: 10000

R3: 20000

R4: 30000

R5: 50000

Target bitrates are obtained by selecting values for the V-PCC codec parameters Occupancy Precision, QP Geometry and QP Texture. The values are selected per test sequence and are included in a JSON file that is used in the scripts for encoding. More information on encoding can be found in annex D.X. The values have been selected by doing encodes with varying value combinations and selecting those combinations which come close to the target bitrate and where a monotonic curve for objective metrics is obtained. There was no optimization in the sense of finding the closed bitrate match with the best objective and subjective performance.

In addition to the three codec parameters, a configuration file per test sequence is provided which is used by the encoding scripts.