**3GPP TSG SA WG4#127** **S4-240147rv1**

**Sophia-Antipolis, France, 29th Jan-2nd Feb, 2024**

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| *CR-Form-v12.2* | | | | | | | | |
| **PSEUDO CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** | **pseudo** | **rev** | **-** | **Current version:** |  |  |
|  | | | | | | | | |
| *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\_ARMRQoE] pCR on evaluations of ARMRQoE | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | China Unicom, Huawei | | | | | | | | | |
| ***Source to TSG:*** | S4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_ARMRQoE | | | | |  | ***Date:*** | | | 23-01-2024 |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***Release:*** | | | Rel-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-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | There are no other inputs from other 3GPP/non-3GPP specifications (e.g. MeCar) on Metrics Observation Points, evaluations on existing QoE metrics are presented to complete the SI. | | | | | | | | |
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| ***Summary of change:*** | | * Propose the evaluations for AR/MR QoE metrics. | | | | | | | | |
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| ***Consequences if not approved:*** | | AR/MR QoE SI is not completed. | | | | | | | | |
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| ***Clauses affected:*** | | 8 (new) | | | | | | | | |
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|  | | **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:*** | |  | | | | | | | | |

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| **1stChange** |

# 8 Evaluations on AR/MR QoE metrics

In clause 6.3, three types of QoE metrics are introduced, i.e. delay related metrics, Presentence and immersiveness related metrics and device related metrics. In order to make sure the QoE metrics are measurable with real impact to the user experience, the evaluations are proposed based on the existing implementable openXR APIs for the AR/MR QoE metrics specified in in the technical report.

- Delay related metrics

- Registration latency indicates the time from the application is started/activated until the 3D reconstructed map is obtained, which is defined as the during time from when the time application starts to call the *[xrEnumerateApiLayerProperties](https://registry.khronos.org/OpenXR/specs/1.0-khr/html/xrspec.html" \l "xrEnumerateApiLayerProperties)* function to obtain a list of available API layers, to the time when the application obtains the viewer pose and projection parameters with using *xrLocateViews* function defined in openXR [22].

- Scene startup latency and Interaction latency indicates the time from the application is started until the remote initial AR scene is displayed in the right place of the reconstructed 3D space, which is defined as the predicated display time of the rendered frame in the swapchain minus the time when the application starts to call the *[xrEnumerateApiLayerProperties](https://registry.khronos.org/OpenXR/specs/1.0-khr/html/xrspec.html" \l "xrEnumerateApiLayerProperties)* function to obtain a list of available API layers.

- One-way delay and RTT consists of the uplink one-way delay, the downlink one-way delay, or the RTT. This metric has been captured in the TS 26.119.

- Presence and immersiveness related metrics

- Tracking pose prediction error indicates the deviation of the relative pose in the real world and the predicted pose, which can be obtained by calculating the deviation of the predicated spaces locations and real space locations. The predicated spaces locations can be obtained with calling the *xrLocateSpace* function defined in openXR, while the actual location may not be known via the openXR API.

- Pose error and time error indicates the difference between the pose used for rendering and the pose at the actual display time and how much the predicted display time is off from the actual display time separately. Figure 6.3.5.3-1 shows this metric can be obtained with *xrLocateViews* and *xrWaitFrame* function defined in openXR.

- Pose correction error could be detected and measured by comparing the reprojected frame with reference rendered frame, while reprojected frame potentially captured at OP-1 and the rendered frame captured at OP-4. Implementability with openXR is not addressed in this study.

- Spatial Anchors and Trackables includes 3 QoE metrics, i.e. ACD, ADRP, and AUR.

1) ACD indicates the delay between the time of the spatial anchor creation request and the time when the related XR space is created. The ACD start time corresponds to the time that calling *xrCreateReferenceSpace, xrCreateActionSpace, xrCreateSpatialAnchorFB, xrCreateSpatialAnchorMSFT* function or *xrCreateSpatialAnchorFromPersistedNameMSFT* function. The ACD end time corresponds to the time when receiving a XR\_SUCCESS returned value.

2) ADRP indicates the delay between the time of the spatial anchor pose request leading to the detection of the trackable and the time when the virtual content is displayed in the user’s real environment. The ADRP start time corresponds to the time that calling *xrLocateSpace* function defined in the openXR. The ADRP end time corresponds to the actual display time for that frame.

3) AUR indicates the ratio between the number of frames where the trackable associated with the spatial anchor is not tracked and the total number of frames during the observation period in which no detection process is launched. The flags *XrSpaceLocationFlags* in the *XrSpaceLocation* structure returned by the *xrLocateSpace* function are used to know the tracked/untracked status of a trackable. Then AUR for that spatial ancho can be calculated by dividing the number of untracked in the observation period by the length in number of frames of the observation period in which no detection process is launched.

- Device related QoE metrics

- Resolution can be indicated by the camera information, which is derived from *XR\_OCULUS\_external\_camera* API defined in openXR.

- EyetrackingCapability can be indicated from *XrSystemEyeTrackingPropertiesFB* using *xrGetSystemProperties* function defined in openXR.

- HandtrackingCapability can be indicated from *XrSystemHandTrackingPropertiesEXT* using *xrGetSystemProperties* function defined in openXR.

- SpatialmappingCapability can be indicated from *XrSystemSpatialEntityPropertiesFB* using *xrGetSystemProperties* function defined in openXR.

According the analysis above, the following AR/MR QoE metrics are measurable based on the OpenXR implementation:

- Delay related metrics

- Registration latency

- Scene startup latency and Interaction latency

- One-way delay and RTT

- Presence and immersiveness related metrics

- Pose error and time error

- Spatial Anchors and Trackables

- Device related QoE metrics

- Resolution

- EyetrackingCapability

- HandtrackingCapability

- SpatialmappingCapability

Implementability with openXR of the following AR/MR QoE metrics are not or not fully addressed in this study:

- Presence and immersiveness related metrics

- Tracking pose prediction error

- Pose correction error

When considering the benefits of the above QoE metrics that are measurable based on the OpenXR implementation, some of them are easily observed to have impacts on users’ experience, which are listed as below:

- Delay related metrics

- Registration latency

- Scene startup latency and Interaction latency

- One-way delay and RTT

- Presence and immersiveness related metrics

- Pose error and time error

- Spatial Anchors and Trackables

- ACD

- ADRP

- Device related QoE metrics

- Resolution

- EyetrackingCapability

- HandtrackingCapability

- SpatialmappingCapability

The impacts of the AUR metric for user experience need to be further evaluated.

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| **END of 1st Change** |