**3GPP TSG-SA WG4 Meeting #133-eS4-251410r01**

**Online, 18 – 25 July, 2025**

**Source: InterDigital Canada**

**Title: [FS\_ARSpatial] Pseudo-CR on Conclusions and Proposed Next Steps**

**Spec: 3GPP TR 26.819 v1.0.0**

**Agenda item: 9.7**

**Document for: Agreement**

**1. Introduction**

The Study on Spatial Computing for AR Services (FS\_ARSpatial) was approved during SA#104 meeting. The objectives of the study include identifying where spatial computing functions run and which media, metadata, and description formats are used for exchange between these elements based on the architecture defined in the TS 26.506, notably in split processing scenarios.

**2. Reason for Change**

Clause 7.1 on Conclusions needs to be updated based on the recent studies on the edge computing support (clause 6.5.1), on potential prerequisites for a spatial computing Media Service Enabler (MSE) (clause 6.5.2), and on potential mapping to Generalized IMS DC Architecture (clause 6.5.3).

Clause 7.2 on proposed next steps is currently empty.

This document provides an update for the conclusion and proposes potential next steps related to the Spatial Computing for AR Services.

**3. Proposal**

It is proposed to agree the following changes to 3GPP TR 26.819 v1.0.0.

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

## 7.1 Conclusions

Augmented reality (AR) composites virtual objects with reality. Knowledge of the real world is essential for the localization of the AR device and for a seamless insertion of virtual content into the user’s real environment. The generation of information about the real world from the processing of sensor data may be done on the UE or delegated to a server in some cases for a number of reasons (e.g., in the case of UE devices with limited computational capabilities or low battery levels, the need for a central network function in some multi-user applications, etc.).

To support such Spatial Computing services, the following aspects have been documented in this report:

- A set of relevant Spatial Computing functions have been identified in clause 4.1 based a number of AR use cases. For each Spatial Computing function, the input sensor data and the output Spatial Description are identified. Some examples of Spatial Description formats have also been documented.

- A number of existing Quality-of-Experience (QoE) metrics have been identified as relevant for Spatial Computing services and a mapping of these QoE metrics to the Spatial Computing functions has been documented in clause 4.2. In particular, the anchoring and re-localization functions are mapped to the relevant metrics, but no QoE metrics or delay requirements and constraints have been documented for other functions. Additional mappings and requirements may be further studied in the future.

- The related standardization works in 3GPP and other standardization bodies and the relevant of these works to Spatial Computing services in general, and the spatial computing functions identified in this report in particular, has been studied in clause 5, leading to the identification of some gaps:

- Some functions are not well addressed, in particular 3D model reconstruction, segmentation and labelling, light extraction, and collider generation, described in clause 4.2, as existing standardization works mainly address the world tracking (e.g., in ETSI ARF), re-localization, and anchoring functions (e.g., in ETSI ARF and TS 23.437).

- The UE device capabilities related to Spatial Computing is not defined in TS 26.119. This can include capabilities on the supported spatial computing functions, spatial description formats, and, based on the device capabilities, the format for requests and metadata for in-network support for spatial computing functions.

- The support of AR is not addressed in a split rendering architecture as specified in TS 26.565

- The mapping to 5G services:

 - A spatial computing architecture is provided in clause 6.3 based on the reference architecture for Media Delivery (clause 4.1.2.2 of TS 26.506). Call flows for spatial computing session set-up and operation involving a Spatial Computing client and the remote Spatial Computing functions located in a Media Application Server are also described in clause 6.4.

- In addition, an extension to this architecture for edge-enablement (defined in TS 23.558 and TS 26.501) and a potential mapping to the generalized IMS DC architecture are documented in clause 6.5.

- Guidance on the pre-requisites on the 5G system and device APIs to host and run spatial computing functions is also provided in clause 6.5.2.

## 7.2 Proposed next steps

Based on the details in the report, the following next steps are envisaged for defining a spatial computing Media Service Enabler (MSE):

* Identify a selected set of spatial compute functions that may benefit from off-device processing based on existing deployments and current industry practices.

- Add UE Spatial Computing capabilities to TS 26.119.

* For the identified set of spatial compute functions that may benefit from off-device processing:
	+ Specify the signaling and negotiation of exchanged media, sensor and control data.
	+ Select interoperable formats for the media, sensor and control data.
	+ Specify the configuration, and delivery of the media and sensor data, potentially identifying existing compression for that data.
	+ Specify procedures and APIs to access the spatial compute MSE.

In a future release, a spatial computing enabler may be developed independently, or with support from some of the work done on the 3GPP Service Enabler Architecture Layer for Verticals (SEAL) on spatial map and spatial anchor management (TS 23.437).

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

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 26.928: "Extended Reality (XR) in 5G".

[3] 3GPP TR 26.998: "Support of 5G glass-type Augmented Reality / Mixed Reality (AR/MR) devices".

[4] ARCore SLAM, https://developers.google.com/ar/develop/fundamentals

[5] ARKit VIO, https://developer.apple.com/documentation/arkit/arkit\_in\_ios/configuration\_objects/understanding\_world\_tracking

[6] ARCore Cloud Anchor, <https://codelabs.developers.google.com/codelabs/arcore-cloud-anchors#0>

[7] ARKit World Map, <https://developer.apple.com/documentation/arkit/arworldmap>

[8] Meta Quest Spatial Anchor, <https://developer.oculus.com/documentation/unity/unity-spatial-anchors-overview/>

[9] HoloLens, https://learn.microsoft.com/en-us/windows/mixed-reality/design/spatial-mapping

[10] Meta Space Setup, <https://www.uploadvr.com/quest-v64-undocumented-features-furniture-recognition-multimodal/>

[11] Apple RoomPlan, <https://developer.apple.com/augmented-reality/roomplan/>

[12] Google Scene Semantics, <https://developers.google.com/ar/develop/scene-semantics>

[13] Unity Documentation - Collision, <https://docs.unity3d.com/2023.1/Documentation/Manual/collision-section.html>

[14] Blender Documentation – Collisions, https://docs.blender.org/manual/en/latest/physics/rigid\_body/properties/collisions.html

[15] Unity Documentation - Compound Colliders, <https://docs.unity3d.com/Manual/compound-colliders-introduction.html>

[16] Unity Documentation - Mesh Colliders, <https://docs.unity.cn/Manual/mesh-colliders-introduction.html>.

[17] ARCore Ligthing Estimation, <https://developers.google.com/ar/develop/lighting-estimation>

[18] Cast Shadow <https://ieeexplore.ieee.org/document/9018202>

[19] Macario Barros, A., Michel, M., Moline, Y., Corre, G., & Carrel, F. (2022). A comprehensive survey of visual slam algorithms. Robotics, 11(1), 24.

[20] Khronos OpenXR: https://registry.khronos.org/OpenXR/specs/1.0/html/xrspec.html

[21] ETSI Industry Specification Group AR Framework ([ISG ARF](https://www.etsi.org/committee/1420-arf)), <https://www.etsi.org/committee/1420-arf>

[22] ETSI GS ARF 004-2: “Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services - Part 2: World Storage and AR Authoring functions”.

[23] ETSI GS ARF 005: “Augmented Reality Framework (ARF); Open APIs for the Creation and Management of the World Representation”.

[24] ISO/IEC 23090-14, Text of ISO/IEC FDIS 23090-14 2nd edition Scene description, April 2024.

[25] 3GPP TS 26.119: “Media Capabilities for Augmented Reality”

[26] 3GPP TS 26.143: “Messaging Media Profiles”

[27] 3GPP TS 26.264: “IMS-based AR Real-Time Communication”

[28] 3GPP TR 26.812: “QoE metrics for AR/MR services”

[29] 3GPP TR 23.700-21: Study on Application architecture for enabling mobile metaverse applications.

[30] Open Geospatial Consortium: https://www.ogc.org/

[31] Open AR Cloud: <https://www.openarcloud.org/>

[32] ETSI GS ARF 004-4: “Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services - Part 4: World Analysis, World Storage and Scene Management functions”.

[33] OGC GeoPose 1.0 Data Exchange Draft Standard, https://docs.ogc.org/dis/21-056r10/21-056r10.html.

[34] OGC Points of Interest Conceptual Model Standard (draft document), <https://docs.ogc.org/DRAFTS/21-049.html>

[35] 3GPP TR 22.856: "Feasibility Study on Localized Mobile Metaverse Services".

[36] SIFT, <https://www.vlfeat.org/api/sift.html>

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[38] A. Alahi, R. Ortiz and P. Vandergheynst, "FREAK: Fast Retina Keypoint," 2012 IEEE Conference on Computer Vision and Pattern Recognition, Providence, RI, USA, 2012, pp. 510-517.

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[41] PLY, <http://gamma.cs.unc.edu/POWERPLANT/papers/ply.pdf>

[42] FBX, <https://www.autodesk.com/products/fbx/overview>

[43] STL, <https://docs.fileformat.com/cad/stl/>

[44] glTF, https://registry.khronos.org/glTF/specs/2.0/glTF-2.0.pdf

[45] USD, <https://openusd.org/dev/api/class_usd_object.html>

[46] Unity, <https://docs.unity3d.com/Manual/mesh-colliders-introduction.html>

[47] ISO/IEC 23090-14, Text of ISO/IEC FDIS 23090-14 2nd edition Scene description, April 2024.

[48] FAST, <http://www.edwardrosten.com/work/rosten_2006_machine.pdf>

[49] Herbert Bay, Andreas Ess, Tinne Tuytelaars, Luc Van Gool, Speeded-Up Robust Features (SURF), Computer Vision and Image Understanding, Vol. 110, Issue 3, 2008, pp. 346-359.

[50] 3GPP TS 23.558: “Architecture for enabling Edge Applications”

[51] 3GPP TS 26.501: “5G Media Streaming (5GMS); General description and architecture”

[52] 3GPP TS 23.548: “5G System Enhancements for Edge Computing; Stage 2”

[53] 3GPP TS 23.501: “System architecture for the 5G System (5GS)”

[54] W3C WebXR Device API: <https://immersive-web.github.io/webxr>

[55] 3GPP TS 23.503: “Policy and charging control framework for the 5G System (5GS); Stage 2”

[56] Niantic Visual Positioning System: https://www.nianticspatial.com/products/visual-positioning-system

[57] Niantic Lightship VPS: <https://lightship.dev/docs/ardk/features/lightship_vps/>

[58] Augmented City: [Augmented City API](https://developer.augmented.city/doc/v2)

[59] Google Geosptial API: <https://developers.google.com/ar/develop/geospatial>

[60] bcom<>\*Overview\*: <https://b-com.com/en/overview>

[61] Niantic Lighship Localizing with VPS: <https://www.lightship.games/docs/ardk/vps/vps_localization.html>

[62] Magic Leap AR Cloud: <http://magicleap.care/hc/en-us/articles/9312806819597-AR-Cloud>

[63] 3GPP TS 23.228: “IP Multimedia Subsystem (IMS); Stage 2”.

[64] 3GPP TS 23.501: “System architecture for the 5G System (5GS)”.

[65] 3GPP TS 26.506: “5G Real-time Media Communication Architecture (Stage 2)”

[66] 3GPP TS 23.437: “Service Enabler Architecture Layer for Verticals (SEAL); Spatial map and Spatial anchors”

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

# 5 Related standardization work

## 5.1 3GPP

The Feasibility Study on Localized Mobile Metaverse Services (TR 22.856) [35] investigates specific use cases and service requirements for 5GS support of enhanced XR-based services as well as potentially other functionality, to offer shared and interactive user experience of local content and services, accessed either by users in the proximity or remotely. The technical report documents several use cases which require the handling of XR Spatial Descriptions, including: a localized mobile metaverse service enabler, a spatial anchor enabler, and a spatial mapping and localization service enabler.

3GPP has also conducted studies on support for XR services (TR 26.928) [2] in general and AR services (TR 26.998) [3] in particular with documented use cases where he knowledge of the real world is essential for the localization of the AR device and for a seamless insertion of virtual content into the user’s real environment. The potential work identified by TR 26.998 includes specifying support for AR relevant functionalities such split-rendering or spatial computing on top of a 5G System based on a generic architecture for real-time media delivery.

In Release 18, support for AR anchoring has been defined in TS 26.119 [25] and TS 26.143 [26] based on the MPEG\_anchor glTF extension. A visualization space format defining a volume free of obstacles to insert virtual content into the user’s environment is defined in TS 26.119 [25] and TS 26.264 [27]. Quality-of-Experience (QoE) metrics related to AR anchoring are defined in the TR 26.812 [28].

3GPP has also been working on a study on an application enablement architecture for mobile metaverse services. The technical report of this study, TR 23.700-21 [29], documents a spatial mapping service enabler which includes procedures to produce, update, and delete spatial maps, to subscribe to event related to spatial maps, to get localization service, to register spatial map service provided by 3rd party application server, and to augment VAL UEs into spatial maps. A detailed definition of a service enabler based on the outcome of the study is defined in TS 23.437 [66].

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