3GPP TSG WG4 Meeting #128 S4-241119

Jeju, Korea, 20th – 24th May 2024 revision of S4-241101

**Source: InterDigital Canada, Orange, B-COM, Nokia Corporation**

**Title: New SID on Real-time Spatial Computing for AR**

**Document for: Approval**

**Agenda Item: 6**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

Title: Study on Spatial Computing for Real-time AR

Acronym: FS\_Spatial

Unique identifier:

{A number to be provided by MCC at the plenary}

Potential target Release: Rel-19

# 1 Impacts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Affects: | UICC apps | ME | AN | CN | Others (specify) |
| Yes |  | x |  | x |  |
| No |  |  |  |  |  |
| Don't know | x |  | x |  |  |

# 2 Classification of the Work Item and linked work items

## 2.1 Primary classification

### This work item is a …

|  |  |
| --- | --- |
| x | Study  |
|  | Normative – Stage 1 |
|  | Normative – Stage 2 |
|  | Normative – Stage 3 |
|  | Normative – Other\* |

## 2.2 Parent Work Item

For a brand-new topic, use “N/A” in the table below. Otherwise indicate the parent Work Item.

|  |
| --- |
| Parent Work / Study Items  |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
| N/A |  |  |  |

### 2.3 Other related Work Items and dependencies

|  |
| --- |
| Other related Work /Study Items (if any) |
| Unique ID | Title | Nature of relationship |
| 880011 | FS\_5GSTAR | Initial study that contains relevant information and definitions for spatial computing. |
| 950015 | MeCAR | Defines AR anchoring capabilities. |
| 960044 | GA4RTAR | Generic architecture for real-time and AR/XR media communications that may be extended to support spatial computing. |
| 960046 | 5G\_RTP | RTP related functions may be handled as part of future extensions to the 5G\_RTP work.  |
| 960042 | IBACS | Defines split rendering call flows for AR.  |
| 960045 | SR\_MSE | New profile for AR services and interactions between split rendering and spatial computing. |
| 1030003 | SR\_IMS | IMS-based split rendering. |
| 950011 | FS\_AI4Media | Interactions with FS\_AI4Media architecture. |

# 3 Justification

Augmented reality (AR) composites virtual objects with reality. The compositing is a combination of light from real world and light presented on display to make them visible together to a user's eyes. 3GPP SA4 has conducted studies on support for XR services (TR 26.928) in general and AR services (TR 26.998) in particular.

When virtual objects are placed in the user’s geometry in AR applications, these objects are anchored to a part of the real-world geometry. As documented in TR 26.928 and TR 26.998, the 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. Such knowledge about the real world includes the location of trackables and anchors, in order to correctly place virtual content, and also the 3D representation of the surrounding environment (point cloud, mesh, semantics) in order to ensure proper interactions between virtual and real content (occlusion, physics). For example, point cloud data are exchanged between Meta Quest HMDs to enable a variety of features, such as local multiplayer experiences, or defining local boundaries [1] and are used as an intermediate format for environmental analysis by ARKit [2].

While anchors and trackables have been defined in TS 26.119, capabilities related to these concepts, which are essential to supporting AR services, are still missing from the specification. Moreover, TR 26.998 has also identified defining a split rendering media service enabler with an AR profile in the set of potential new works that would follow that study. While this was partially addressed in TS 26.565, that specification does not include an AR profile and currently only supports basic split rendering scenarios that do not address AR service requirements. Further, AR extensions can enable content adaptation based on various condition (e.g., network, device type, etc.).

The set of AR functions which process sensor data to generate information about the world 3D space surrounding the AR user are often collectively referred to as *spatial computing*. Spatial computing includes functions such as tracking (to estimate the movement of the AR device at a high frequency), relocalization (to estimate the pose of the AR device), mapping (to reconstruct the surrounding space), and semantic perception (to process the captured information into semantical concepts). The resulting output of spatial computing is a set of spatial mapping information that is organized in a data structure called the XR Spatial Description for storing and exchanging the information.

The 3GPP SA1 TR 22.856 has defined several use cases which require the handling of XR Spatial Descriptions. For example, the technical report includes use cases for a localized mobile metaverse service enabler, a spatial anchor enabler, and a spatial mapping and localization service enabler. Spatial computing and spatial descriptions have also been briefly studied in 3GPP SA4 TR 26.998. The potential work identified by that study included 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. Some of these have been addressed in Rel-18 worked items. For example, SA4 has worked on defining a general architecture for real-time media communications and AR/XR experiences in TS 26.506 with a media service enabler for split rendering functions defined in TS 26.565.

Spatial computing functions involve computationally expensive operations that can quickly drain a device’s battery power. While some more powerful UE devices may be capable of handling such operations for simple applications involving a small number of users, many devices may have limited resources and poor XR Spatial Description computation capabilities. Edge computing can significantly facilitate AR in general, and multi-user AR in particular, by alleviating the burden of these computationally expensive tracking and 3D mapping operations. In the case of multi-user applications, an edge server can also serve as a central location to facilitate information sharing between AR devices on the current state of an AR task and helps compensate for the heterogeneous compute capabilities of different AR devices. While some AR service’s (e.g., Google’s ARCore Cloud Anchors [3]) may rely on cloud endpoints for sharing spatial maps in basic multi-user applications, measurement studies have shown that the resulting latencies over mobile networks are significant and that using edge computing results in improved performance [4]. This is especially the case in applications which require constructing large spatial maps by merging the local maps of participating devices. It is therefore important to study how such functionalities could be delegated to an edge server, either in full or in part.

Spatial computing can leverage processing resources in a network function as well as the processing resources in the UE. As an example, the ETSI Industry Specification Group AR Framework (ISG ARF) has proposed an AR reference architecture that includes the concept of World Storage (with associated communication methods) that could be considered to be part of a network function for spatial description. The adaptation of processing operations for scene rendering based on UE capabilities is also considered in 3GPP studies into XR services, for example, TR 23.700-77 clause 5.8.1, TR 23.700-87 clause 6.9.3.

This feasibility study proposes to identify the gaps in existing XR-related specifications (TS 26.119, TS 26.506, and TS 26.565) for supporting AR services and evaluating the use of XR Spatial Description formats, semantic annotation of spaces or objects, their correlation with scene description formats and the support of spatial computing functionality on top of the 5G architecture defined in TS 26.506 for both split and non-split scenarios.

[1] https://www.meta.com/help/quest/articles/in-vr-experiences/oculus-features/point-cloud/.

[2] https://developer.apple.com/documentation/arkit/arpointcloud

[3] https://developers.google.com/ar/develop/cloud-anchors

[4] Moinak Ghoshal, Pranab Dash, Zhaoning Kong, Qiang Xu,Y. Charlie Hu, Dimitrios Koutsonikolas, and Yuanjie Li. “Can 5G mmWave support Multi-User AR?” In Passive and Active Measurement (PAM), 2022.

# 4 Objective

The study has the following objectives:

1. AR extensions:
	1. Identify gaps in TS 26.119, TS 26.264, and TS 26.565 for supporting AR services.
	2. Study capabilities and requirements for supporting more advanced real-time AR use cases (e.g., overlaying multiple virtual objects in the user’s environment).
	3. Study and document relevant procedures, flows, configurations, and transport protocols to support the placement and anchoring of virtual objects in an AR scene based on the architecture in TS 26.506 and identified gaps in (1.a) and (1.b).
	4. Study and document procedures for the measurement and collection of relevant QoE metrics, taking into consideration the metrics defined in TR 26.812.
2. Spatial computing:
	1. Study relevant use cases from 3GPP SA1 TR 22.856 and SA4 TR 26.998 that require XR Spatial Description handling.
	2. Collect and document the different formats for spatial descriptions as well as interoperability requirements for such descriptions.
	3. Study potential architectural enhancements and flows for supporting spatial computing based on the architecture defined in the TS 26.506.
	4. Identify where spatial computing functions run and which media, metadata, and description formats are used for exchange between these elements of the described architecture in split processing scenarios.
	5. Study the interactions and cross-operation between a spatial computing service and other media service enablers and architectures, such as split rendering, as well as potential interactions with AI/ML architectures in TR 26.927.
3. Identify and recommend potential areas for normative work as the next phase and communicate/align with other potential 3GPP WGs and external organizations on relevant aspects related to the study.

# 5 Expected Output and Time scale

***{If this WID covers both stage 2 and stage 3, clearly indicate the different completion dates.}***

|  |
| --- |
| New specifications |
| Type  | TS/TR number | Title | For info at TSG#  | For approval at TSG# | Rapporteur |
| TR | 26.xxx | Spatial Computing for Real-time AR | SA#107 (11 - 14 March 2025, Korea) | SA#108 (10 - 13 June 2025, China) | Hamza, Ahmed, InterDigital Canada, <Ahmed.Hamza@InterDigital.com> |
|  |  |  |  |  |  |

{Note 1: Only TSs may contain normative provisions. Study Items shall create or impact only TRs.
"Internal TR" is intended for 3GPP internal use only whereas "External TR" may be transposed by OPs.}

{Note 2: The first listed Rapporteur is the specification primary Rapporteur. Secondary Rapporteur(s) are possible for particular aspect(s) of the TS/TR. In this case, their responsibility has to be provided as "Remarks".}

|  |
| --- |
| Impacted existing TS/TR |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
|  |  |  |  |

# 6 Work item Rapporteur(s)

Hamza, Ahmed, InterDigital Canada, <Ahemd.Hamza@InterDigital.com>

# 7 Work item leadership

SA4

# 8 Aspects that involve other WGs

SA2 may need to be involved for architectural aspects.

# 9 Supporting Individual Members

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| --- |
| Supporting IM name |
| InterDigital Canada |
| Orange |
| B-COM |
| Nokia Corporation |
| ??? |
|  |