3GPP SA WG1 Meeting #97e S1-220144

Electronic Meeting, 14 Feb –24 Feb 2022 (revision of S1-21xxxx)

**Source: China Mobile,Xiaomi,Qualcomm**

**Title: New SID on Integrated Sensing and Communication**

**Document for: Approval**

**Agenda Item: 4**

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 Integrated Sensing and Communication

Document for: Approval

Acronym: FS\_ISC

Unique identifier:

Potential target Release: Rel-19

# 1 Impacts

{For Normative work, identify the anticipated impacts. For a Study, identify the scope of the study}

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Affects: | UICC apps | ME | AN | CN | Others (specify) |
| Yes |  | X | 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 …

|  |  |
| --- | --- |
|  | Feature |
|  | Building Block |
|  | *Work Task* |
| X | Study Item |

## 2.2 Parent Work Item

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

### 2.3 Other related Work Items and dependencies

|  |
| --- |
| Other related Work /Study Items (if any) |
| Unique ID | Title | Nature of relationship |
|  |  |  |
|  |  |  |

# 3 Justification

Wireless sensing technologies aim at acquiring information about a remote object and its characteristics without physically contacting it. The perception data of the object and its surrounding can be utilized for analysis, so that meaningful information about the object and its characteristics can be obtained.

Radar (radio detection and ranging) is a widely used wireless sensing technology that uses radio waves to determine the distance (range), angle, or instantaneous linear velocity of objects. There are other sensing technologies including non-RF sensors, which have been used in other areas, e.g., time-of-flight (ToF) cameras, accelerometers, gyroscopes and Lidar.

Integrated Sensing and Communication in a 3GPP 5G system means the sensing service is provided by the same NR wireless communication system and infrastructure as used for communication, and the sensing information could be derived from RF-based and/or non-RF based sensors. In general, it could involve scenarios of communication assisted sensing, e.g., where 5G communication system provides sensing services, or sensing assisted communication, e.g., when sensing information of the communication channel or environment is used to improve the communication performance of the system.

There are multiple market segments and verticals where 5G-based sensing services can be beneficial for intelligent transportation, aviation, enterprise, smart city, smart home, factories, consumer applications, XR, and public sector,.

Mobile operators can play an important role in providing 5GS-based Integrated Sensing and Communication to customers, including e.g.,the management and control of 5G-based sensing service. A recently published 5G-Automotive Association (5GAA) technical report ([5GAA\_White-Paper\_C-V2X-Use-Cases-Volume-II.pdf](https://5gaa.org/wp-content/uploads/2020/10/5GAA_White-Paper_C-V2X-Use-Cases-Volume-II.pdf)), illustrates some example of the roles operators can play to enhance V2X type of services, specifically for Infrastructure Assisted Environment Perception, Infrastructure-Based Tele-Operated Driving, High-Definition Map Collecting and Sharing and Tele-Operated Driving Support.

Other example use cases to study of 5GS to provide communication assisted sensing services are:

* Environment Real-time monitoring: Using wireless signals to reconstruct the environment map to further improve positioning accuracy and enable environment related applications, such as realizing an array of real-time monitoring related applications including dynamic 3D map for driving assistance, pedestrian flow statistics, intrusion detection, traffic detection and etc.
* Autonomous vehicles/UAV: Autonomous vehicles/UAV applications have some common functional requirements. For example, Autonomous vehicles/UAV shall support Detect and Avoid (DAA) to avoid obstacles. Meanwhile, Autonomous vehicles/UAV shall have the capability to monitor path information, like selecting routes, complying with traffic regulations.
* Weather or air pollution monitoring: The quality of the received wireless signal displays different attenuation characteristics with changes in air humidity, air particulate matter (PM) concentration, carrier frequency and etc, which can be used for weather or air quality detection.
* Indoor Health Care and Intrusion Detection. Respiration rate estimation, breathing depth estimation, apnoea detection, elders’ vital sign monitoring and indoor intrusion detection can be realized by wireless sensing.

Additionally, sensing of wireless communication channels and environment could further improve the performance of communication systems. Some examples of sensing assisted communication scenarios are:

* Sensing UE’s location and channel environment to narrow the beam sweeping range and shorten the beam training time.
* Sensing UE’s location, velocity, motion trajectory, and channel environment for beam prediction, and reducing the overhead of beam measurement and the delay of beam tracking.
* Sensing UE’s property and channel environment to improve the performance of channel estimation.

It is therefore proposed to perform an SA1 study, as per objectives listed in the next section.

The study should cover network-based sensing and UE-based sensing. For RF-based sensing, it could operate in both centralized and distributed mode, i.e. scenarios where the transmitter and receiver of the sensing signal can belong to the same entity (e.g. BS/UE, assisted network entity), different entities, or multiple transmitters/receivers can collaborate among them.

Note: For scenarios covering UE-based sensing, existing SA1 functionalities and requirements may apply, e.g., related to Rel-18 Ranging, and potential gaps or enhancements should be analysed.

# 4 Objective

The objective of this study item is to study use cases and requirements for 5G system to provide integrated sensing and communication services including network-centric, UE-centric (both in coverage and out of coverage) or a combination of both.

The objectives of the study include:

- Study use cases and potential requirements for enhancement of the 5G system to provide Integrated Communication and Sensing services addressing different target verticals/applications, e.g. autonomous/assisted driving, V2X, aviation/UAVs, 3D map reconstruction, smart city/factories, public sectors, healthcare, smart home, in-car sensing, infrastructure monitoring and crowd management, gaming, XR, public safety etc. Scenarios should cover both communication-assisted sensing and sensing-assisted communication.

NOTE1: For 5G RF based sensing, transmitter and receiver can be located in same or different sensing entities (UE, BS, assisted network entity etc.), and multiple transmitters*/*receivers cancollaborate together.

NOTE2: Non-5G type of sensors (RF or non-RF based, such as Radar, Lidar, cameras, motion sensors, etc.) could also be considered.

- Sensing and communication functional requirements applicable to the identified use cases:

* + Network control of sensing service management, e.g., discovery, authorization, provisioning and (de)activation/update of the sensing service.
	+ Configuration, collection and reporting of the sensing information, including different dimensions of sensing services (e.g., per UE/BS, object/area of interest), radio resources used for the sensing service (e.g.., licensed/unlicensed spectrum), etc.
	+ Exposure of the sensing and communication service to 3rd party.
	+ Sensing assisted optimization of communication management and operation, e.g., radio outage/blockage detection and prevention, interference mitigation, channel estimation, beam management, optimized mobility, , etc.

- Sensing and communication performance requirements pertaining to each of the identified use cases :

* + Sensing range, angle (e.g., incident angle), motion, velocity, sensing resolution, periodicity, latency, response time, accuracy/reliability, energy efficiency, etc.
	+ Communication QoS requirements for delivering the sensing data;

- Aspects related to security, privacy, regulatory requirements and charging.

- Gap analysis between the identified requirements and existing 5GS requirements or functionalities.

# 5 Expected Output and Time scale

|  |
| --- |
| New specifications {One line per specification. Create/delete lines as needed} |
| Type  | TS/TR number | Title | For info at TSG#  | For approval at TSG# | Rapporteur |
| “Internal TR” | 22.XXX | Study on Integrated Sensing and Communication | (Mar 2023) | (Jun 2023) |  |

|  |
| --- |
| Impacted existing TS/TR {One line per specification. Create/delete lines as needed} |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
|  |  |  |  |

# 6 Work item Rapporteur(s)

[TBD]

# 7 Work item leadership

SA1

# 8 Aspects that involve other WGs

None

# 9 Supporting Individual Members

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| --- |
| Supporting IM name |
| [China Mobile, Xiaomi, Qualcomm] |
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