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Integrated Sensing And Communications (ISAC); Use Cases and Deployment Scenarios

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Integrated Sensing And Communications (ISAC).

Modal verbs terminology

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Executive summary

The present document identifies 18 advanced use cases relying on Integrated Sensing And Communications (ISAC) and their technological benefits. Described use cases bring societal benefits in various fields such as healthcare, public safety, transportation, robotics, smart factories or smart cities.

Described use cases are analysed to highlight consolidated requirements and KPIs that future 6G communications systems need to ensure to support these advanced use cases. The present document formulates considerations on deployment scenarios, suitable frequency bands, sensing modes, and integration levels. The present document also gives an overview of challenges associated with the described use cases.

Finally, the present document draws conclusions and formulates recommendations in terms of needed future work on ISAC channel modelling, measurements, evaluation methodology, system and radio access network architectures, security, privacy, trustworthiness, and sustainability for ISAC.

Introduction

There is currently an increased interest for ISAC from the whole research ecosystem (including worldwide standardization bodies, industrial individual members and stakeholder associations, academia, strategic national and regional collaborative projects, etc.). In this context, the present document proposes new use cases to be potentially supported by future 6G systems.

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1 Scope

The scope of the present document is to:

- Define 6G use cases for integrated sensing and communications.
- Identify and describe the corresponding deployment scenarios and the potentially suitable frequency bands.
- Define, characterize and evaluate the relevance of different sensing types and integration levels, and their mapping to the selected use cases/deployments.
- Identify requirements and define key performance/value indicators for the identified use cases.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

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3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3 rd Generation Partnership Project
6GS	6 th Generation System
ADAS	Advanced Driver Assistance Systems
ADS-B	Automatic Dependent Surveillance-Broadcast
AGV	Automated Guided Vehicles
AI	Artificial Intelligence

AMR	Autonomous Mobile Robots
ANSP	Air Navigation Service Provider
AP	Antenna Pannel
API	Application Programming Interface
AV	Aerial Vehicles
AWGN	Additive White Gaussian Noise
BLE	Bluetooth® Low Energy
BPS	Body Proximity Sensor
BS	Base Station
BVLoS	Beyond Visual Line of Sight
CIS	Common Information Services
C-ITS	Cooperative Intelligent Transport Systems
CLSK	Commando Luchtstrijdkrachten
CN	Core Network
CPE	Customer Premises Equipment
CPR	Consolidated Potential functional Requirements
CPS	Cyber-Physical System
CR	Cooperative Robot
CRLB	Cramer-Rao lower bound
CSI	Channel State Information
CTR	Controlled Traffic Regions
DT	Digital Twin
DUT	Device Under Test
EIRP	Effective Isotropic Radiated Power
FCC	Federal Communications Commission
FWA	Fixed Wireless Access
GDPR	General Data Protection Regulation
gNB	3GPP Radio Access Point (gNodeB)
GNSS	Global navigation satellite system
GPU	Graphic processing unit
HAPS	High-Altitude Platform Station
HD	High Definition
I2O	Indoor to Ourdoor
IC	In Coverage
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IoT	Internet of Things
ISAC	Integrated Sensing And Communications
KPI	Key Performance Indicator
LAPS	Low-Altitude Platform Station
LIDAR	Light Detection and Ranging
LoS	Line of Sight
LVNL	Luchtverkeersleiding Nederland
MaaS	Mobility as a Service
ML	Machine Learning
MNO	Mobile Network Operator
MPE	Maximum Permissible Exposure
MPR	Maximum Power Reduction
NB-IoT	Narrow Band Internet of Things
NCR	Network Controlled Repeater
NL	Netherlands
NLoS	Non Line of Sight
NTN	Non-Terrestrial Networks
O2I	Outdoor to Indoor
OoC	Out of Coverage
OPEX	Operating Expenses
PD	Power Density
PR	Potential Requirement
PRS	Positioning Reference Signal
QoS	Quality of Service
RAN	Radio Access Network
R-CPS	Realtime Cyber-Physical System
RCS	Radar Cross-Section

RF	Radiofrequency
RGB	Red Green Blue
RIS	Reconfigurable Intelligent Surfaces
RMa	Rural Macro
SAR	Specific Absorption Rate
SBA	Service-Based Architecture
SDO	Standard Development Organization
SNR	Signal to Noise Ratio
STA	Station
TPU	Tensor Processing Unit
TR	Technical Report
TRP	Transmission Point
TS	Technical Specification
UAV	Unmanned Aerial Vehicle
UE	User Equipment
UMa	Urban Macro
UMi	Urban Micro
USSP	UTM-Space Service Provider
UTM	Unmanned Aircraft System Traffic Management
UWB	Ultra-WideBand
V2V	Vehicle to Vehicle
V2X	Vehicle to Everything
VRU	Vulnerable Road User
WBPMF	Walking, (e-)Biking, Public transport, Mobility as a service and Private car
WG	Working Group
WI	Work Item
XR	eXtended Reality

iTech Standards

<https://standards.iteh.ai/catalog/standards/etsi/44843083-977b-45b3-b5ec-c5da34deb423/etsi-gr-isc-001-v1-1-1-2025-03>

4 Foundations of integrated sensing and communications

4.1 Sensing modes

The term "sensing mode" describes the topology consisting of one or more sensing nodes and their role. Sensing nodes may be User Equipment's (UEs) or Transmission Points (TRPs) that may act as a sensing transmitter and/or sensing receiver.

There are six unique sensing modes:

- TRP-TRP bistatic;
- TRP monostatic;
- TRP-UE bistatic;
- UE-TRP bistatic;
- UE-UE bistatic; and
- UE monostatic.

These basic modes may be extended to multi-static variants by adding additional UE(s) or TRP(s) to any of the six basic modes as sensing transmitter(s) and/or receiver(s).

4.2 Integration levels

The term "integration level" describes how communication and sensing functionalities are combined in one system. It is commonly categorized in multiple levels, reaching from loose integration to tight integration with variable granularity [i.41].

Loose integration refers to the case where the two functionalities are realized rather on a standalone basis with some level of coordination, e.g. on application level, or by combining dedicated sensors and communication hardware on a site.

Tight integration refers to a joint waveform or joint signal design that is suitable for both tasks.

Intermediate integration may refer to anything in between.

4.3 System terminology for sensing-enabled 6G systems

For the purposes of the present document, the following terms apply:

- **Sensing Signal** is a transmitted signal from a Sensing Transmitter for the purpose of sensing. The signal can be 6G or non-6G.
- A **Sensing Transmitter** is a 6G or non-6G entity that transmits a Sensing Signal.
- A **Sensing Receiver** is a 6G or non-6G entity that receives a Sensing Signal and produces Sensing Data. A Sensing Receiver can be co-located with a Sensing Transmitter.
- **Sensing Data** is the 6G or non-6G data produced for sensing purposes.
- A **Sensing Service** is a feature of the 6GS that is offered to service consumers. A Sensing Service provides Sensing Results based on communicated requirements and KPIs.
- A **Sensing Task** consists of activities to perform sensing, including the configuration of the required Sensing Transmitter(s) and Sensing Receiver(s) (if applicable), the collection of Sensing Data, the processing of the Sensing Data and the exposure of the Sensing Results. Each Sensing Task fulfils a Sensing Service request.
- A **Target Sensing Service Area** as defined in clause 3.1 of 3GPP TS 22.137 [i.2].
- The **Sensing Results** may include characteristics of objects (e.g. type, distance, velocity, trajectory, size, shape, material), or other contextual information (e.g. time of generation, environmental information) about objects in the Target Sensing Service Area.

NOTE: It is not precluded that the sensing result exposed to an entity within 6GS or to a third party may in some cases consist of the sensing data itself.

- **Fusion** refers to a process to join two or more streams of Sensing Data or Sensing Results together to form one or more Sensing Data or Sensing Result stream(s). Fusion can take place at the origin of the sensing data, along the system entities of a 6GS. The fusion of Sensing Results can also take place along all 6GS system entities. Fusion can also take place in non-6GS entities.

Figure 1 uses the terminology defined above and illustrates the described information flow.