



3GPP TSG RAN Rel-19 workshop
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Views on Joint Communications and Sensing for Rel-19

Apple

Content

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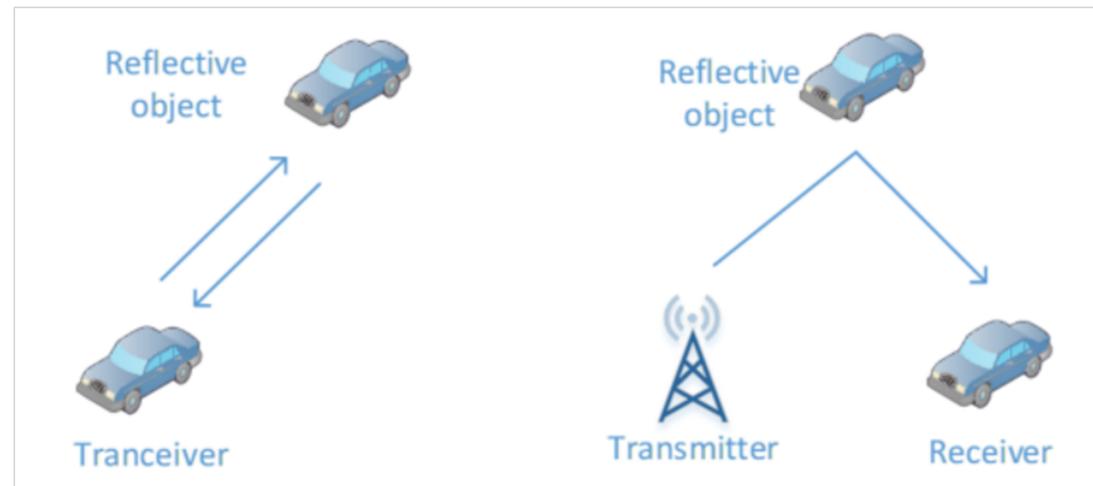


JSAC Overview | Joint Communications and Sensing (JSAC)

- Justification:
 - **New category of use-cases:** enable co-existence of sensing and communication in the same frequency band or hardware for new use cases identified in SA1 study
 - Both functions coexist by sharing the resources within the same band with a goal of minimizing the interference between each other and improving the coexistence efficiency.
 - **NR based signal sensing:** Enable 3GPP system (UE and RAN) to detect characteristics of the environment/object using NR RF signals where (a) target object does not transmit signal and/or (b) target object is not a 3GPP system entity
 - **Non-NR based signal sensing:** Enable 3GPP system to utilize non-NR based sensing within its framework
- **Proposal:** Phased approach in integrating sensing into existing 5G system
 - Release 19: NR Joint Communications and Sensing
 - Extension of Uu and sidelink positioning framework to sensing. Minimize any specification changes
 - Future releases: native integration of sensing into communication system.



JSAC Overview | NR based and non-NR based sensing

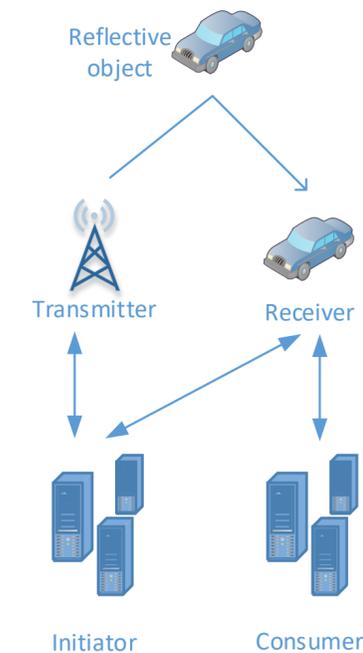


Existing technologies for sensing (**non-NR based sensing**)

- Radar, LiDAR, WiFi Sensing

Relies on **reflected radio waves** from a transmitter to detect information on target objects

- shape, size, speed, location, air quality



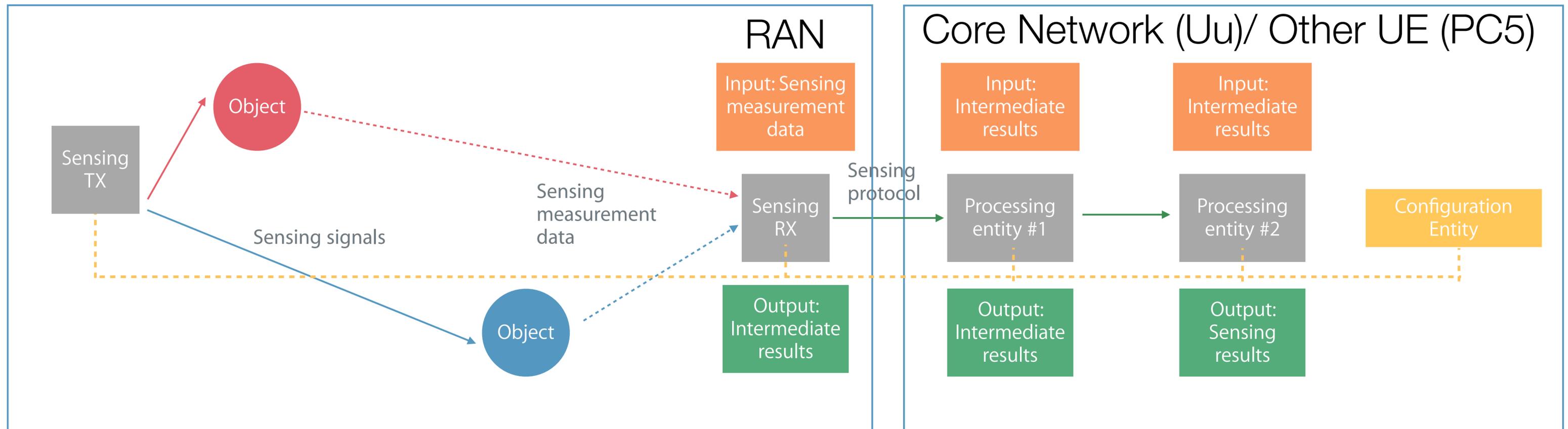
Proposal to enable 3GPP system (UE and RAN) to detect characteristics of the environment / object using NR RF signals:

- Target object does not transmit signal
- Target object is not a 3GPP system entity

Collect and report sensing data

Provide sensing data to 3rd parties e.g. via APIs

JSAC Overview | Sensing Concepts



■ Definitions:

- **Sensing transmitter:** entity that sends out the sensing signal.
- **Sensing receiver:** entity that receives the sensing signal
- **Sensing measurement data:** raw measurements
- **Intermediate results:** [interim] derived information from processing
- **Sensing results:** [final] derived information from processing

■ Modes:

- Mono-static: same transmitter and receiver
- Bi-static: different transmitter and receiver

■ Sensing Operations:

- Network-based sensing
- UE-based sensing
- UE-assisted sensing

Study Details (1/4) | Scenarios, Metrics, Requirements and Evaluation

- Identify use cases, scenarios and Positioning/Localization/Sensing requirements for JSAC in Rel-19 [RAN1].
 - Map **use cases** identified in SA to the following scenarios: **V2X, Public Safety, Commercial, IIoT**
 - Map **KPIs** identified in SA to the following metrics and accuracy requirements:

	Uu Positioning	Sidelink Positioning	NR Sensing
3GPP NR Release	Rel-16/Rel-17/Rel-18/Rel-19	Rel-18/Rel-19	Rel-19
Metrics	Absolute Horizontal Position Absolute Vertical Position Latency	Absolute Horizontal Position Absolute Vertical Position Latency Relative Horizontal Position Relative Vertical Position Local Coordinate System (LCS)/ Global Coordinate System (GCS) Angle	Absolute Horizontal Position Absolute Vertical Position Latency Relative Horizontal Position Relative Vertical Position LCS/GCS Angle Speed/Doppler target detection/discrimination pattern detection/discrimination
Accuracy Requirements	Absolute Positioning Accuracy (Horizontal or Vertical), latency	Ranging Accuracy, Relative/ Absolute Positioning Accuracy (Horizontal or Vertical), latency	Ranging Accuracy, Relative/ Absolute Positioning Accuracy (Horizontal or Vertical), latency, speed accuracy, target detection/discrimination accuracy, pattern detection/discrimination accuracy,

- Define a representative number of **evaluation scenarios** for indoor and outdoor
- Define **evaluation methodologies** considering the evaluation scenarios

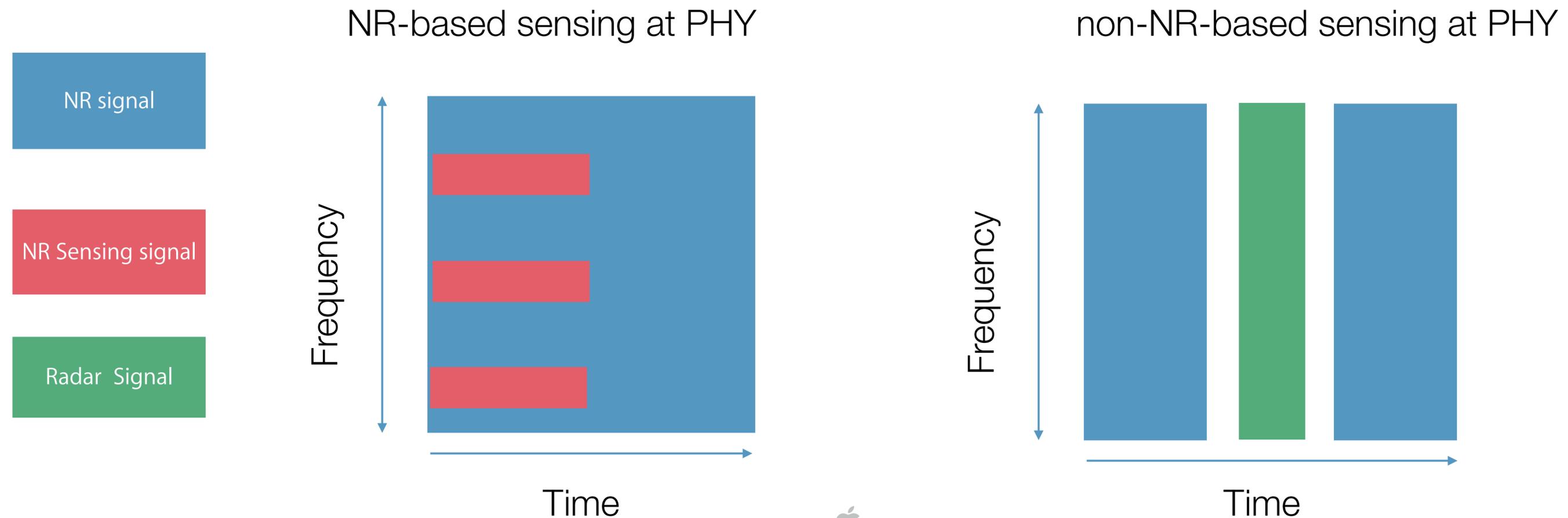


Study Details (2/4) | JSAC Modes, Channel Modeling, Architecture

- Study the relationship between the **use cases/scenarios** and the **JSAC modes** and identify representative JSAC modes for evaluation [RAN1, RAN2]:
 - For NR-based sensing, supporting **mono-static** sensing mode maybe quite challenging and **only the bi-static mode would be feasible** due to lack of support for full duplex transmission.
 - For non-NR based sensing, **both mono-static and bi-static** modes are possible
- Study and define a statistical **channel model** for both **sensing and communications** based on TR 38.901
 - For active sensing (where sensing entity uses reflected signal), need to **model echo propagation** between transmitter and scatterers
 - For passive sensing (where sensing entity uses signal from another transmitter), sensing and communication channels can be modeled in the same way.
- Consider the regulatory aspects related to spectrum access for non-communication use (such as ranging and detection) [RAN]
- Study the **sensing architecture** for sensing services, functional interfaces, protocols, and procedures to support NR based sensing technologies [RAN2, RAN3, SA]
 - A Sensing Management Function (SensMF) with an associated sensing protocol similar to or merged with the Location Management Function (LMF) and LPP/NRPPa can be used as a starting point.
 - Solutions should consider the **privacy** and **security** implications of sensing (+RAN1)

Study Details (3/4) | Potential Solutions (1/2)

- Study and evaluate **potential solutions** of sensing technologies based on the identified requirements, evaluation scenarios and methodologies [RAN1, RAN2, RAN3]
 - Study NR-based sensing, non-NR based sensing and Hybrid Schemes [RAN1,RAN2]
 - **NR-based sensing** uses the existing NR architecture with NR signals, channels, and higher layer signaling to perform sensing
 - **non-NR based sensing** uses other technologies (e.g. radar) within the existing NR framework to perform sensing (similar to RAT-independent positioning)
 - Study at what layer the non-NR based sensing is incorporated into the NR network.



Study Details (4/4) | Potential Solutions (2/2)

- The solutions should include at least **NR-based sensing** to operate in **both FR1 and FR2** whereas other sensing technologies are not precluded.
- The solutions should consider the use of existing or new (if needed) **signals** and existing or new (if needed) **measurements, measurement data** and **reporting** to support JSAC.
 - Overhead of any new sensing signal (if needed) or increase in overhead of existing signals for sensing (if any) should be considered
- The solutions should consider the **interaction** between communications capacity and sensing accuracy
 - Example: for immersive experience applications, we require high reliability and low latency type **communications** while supporting high **positioning** accuracy, velocity accuracy, and range resolution with low latencies and refreshing rates

Table 5.7.4-1: Standardized 5QI to QoS characteristics mapping : TS 23.501

5QI Value	Default Priority Level	Packet Delay Budget (NOTE 3)	Packet Error Rate	Example Services
80	68	10 ms	10 ⁻⁶	Low Latency eMBB applications Augmented Reality

Communications characteristics for AR

Scenario	Sensing service area	Confidence level [%]	Accuracy of positioning estimate		Accuracy of velocity estimate		Sensing resolution		Max sensing service latency[ms]	Refreshing rate [s]	Missed detection [%]	False alarm [%]
Immersive experience	Indoor	95	0.5	0.5	0.1	N/A	0.5	N/A	250	0.25	5	5

Sensing Characteristics for Immersive Experience, e.g. AR (agreed SA1 KPI)



Appendix

FS_Sensing | Use cases

<p>intruder detection in smart home or surroundings</p>	<p>sensing for highway/railway intrusion detection</p>	<p>sensing for V2X</p>	<p>health monitoring</p>	<p>sensing for UAV</p>
<p>intruder detection in smart home</p>	<p>pedestrian/animal intrusion detection on a highway</p>	<p>sensing Assisted Automotive Maneuvering and Navigation</p>	<p>health monitoring at home</p>	<p>UAV flight trajectory tracing,</p>
<p>intruder detection in surroundings of smart home</p>	<p>sensing for railway intrusion detection</p>	<p>sensing for tourist spot traffic management</p>	<p>service continuity of unobtrusive health monitoring</p>	<p>network assisted sensing to avoid UAV collision</p>

rainfall monitoring , sensing for flooding in smart cities

AGV detection and tracking in factories



FS_Sensing | KPIs Agreed to in SA1

Scenario	Sensing service area	Confidence level [%]	Accuracy of positioning estimate		Accuracy of velocity estimate		Sensing resolution		Max sensing service latency[ms]	Refreshing rate [s]	Missed detection [%]	False alarm [%]
			Horizontal [m]	Vertical [m]	Horizontal [m/s]	Vertical [m/s]	Range resolution [m]	Velocity resolution [m/s]				
Intruder detection in smart home	Indoor	95	≤10	≤10	N/A	N/A	N/A	N/A	<1000	< 1	< 5	< 2
Pedestrian/animal intrusion detection on a highway	Outdoor (Highway)	95	≤1	N/A	N/A	N/A	N/A	N/A	≤5000	≤ 0.1	≤5	≤5
Rainfall monitoring	outdoor	95	N/A	N/A	N/A	N/A	N/A	N/A	1 min	10min	5	5
Intrusion detection on a railway	Outdoor (Along railway)	95	≤1.5	N/A	N/A	N/A	N/A	N/A	<1500	≤ 0.1	≤0.1	≤0.1
UAV flight trajectory tracing	Outdoor	N/A	N/A	N/A	N/A	N/A	1m x 1m ~10m x 10m	1m/s x 1m/s ~ 10m/s x 10m/s	5~50	0.3~5Hz	5	5
sensing at crossroads with/without obstacle	Outdoor	95	≤1	N/A	N/A	N/A	N/A	N/A	≤100	≤ 0.1	≤5	≤5
Network assisted sensing to avoid UAV collision	Outdoor	[99]	1	N/A	1	N/A	<1	1	500	0.5	N/A	N/A
UAV intrusion detection	Outdoor	95	Level 1 ,≤10 Level 2 ,≤5	Level 1 ,≤10 Level 2 ,≤5	N/A	N/A	10	[5]	[≤1000]	[≤1]	≤5	≤5
Tourist spot traffic management	Outdoor	95	[≤2]	N/A	N/A	N/A	[1]	[1]	[≤5000]	[≤0.2]	[≤5]	[≤5]
Sleep monitoring	Outdoor (bedroom)	95	N/A	N/A	N/A	N/A	N/A	N/A	60s	60	5	5
Parking space determination	Indoor/ outdoor	95	0.5	0.5	0.1	N/A	2.5m / 5m	N/A	1000	1	1	5
Sensing for the use case in Smart Grid	Outdoor	95	≤0.7	N/A	UAV: ≤25; Vehicle: ≤15	N/A	N/A	N/A	≤5s	≥10Hz	[≤5]	[≤5]
AMR collision avoidance in smart factories	100m	99	≤1	N/A	1	N/A	1	10	<500	≥20Hz	N/A	5
Sports monitoring	Indoor (living room)	95	N/A	N/A	N/A	N/A	N/A	N/A	60s	1min	N/A	N/A
Immersive experience	Indoor	95	0.5	0.5	0.1	N/A	0.5	N/A	250	0.25	5	5



