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**3GPP TSG RAN Rel-19 workshop**

**Taipei, June 15th – 16th, 2023**

Source: NTT DOCOMO, INC.

Agenda item: 5

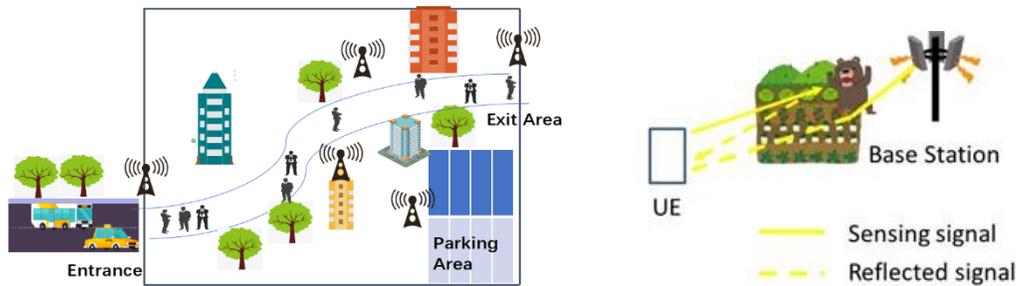
**RWS-230250**

# **Study on ISAC in Rel-19**

**NTT DOCOMO, INC.**

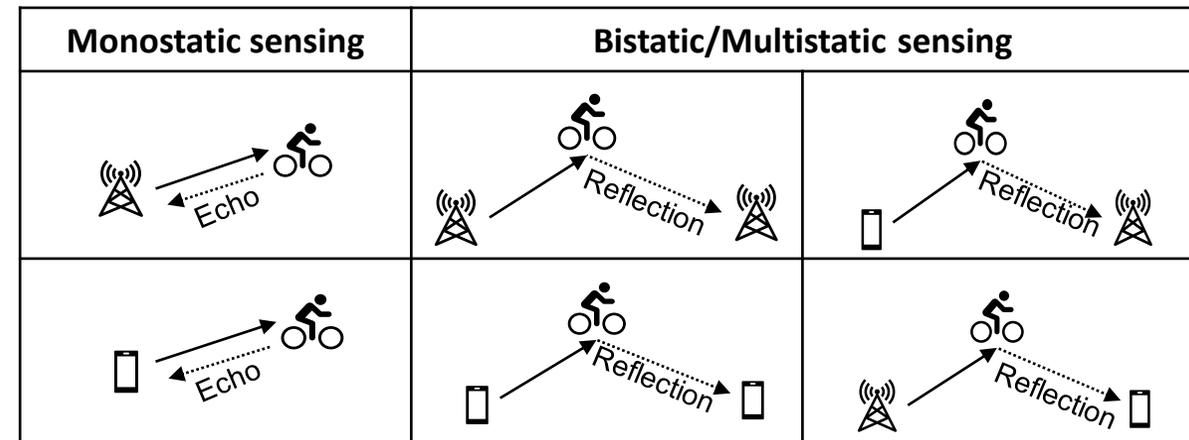
## ■ Time to start treating wireless sensing in 3GPP RAN

- Motivation:
  - » Good sensing performance by using various frequencies and cellular NW equipment
  - » Realizing new/enhanced services
  - » Optimizing NW parameters by analyzing real-time sensing data
- Background: SA1 study on ISAC (integrated sensing and communication) in Release 19
  - » Use cases and potential requirements for enhancement of the 3GPP system to provide sensing services addressing different target verticals/applications
  - » Some use cases could also include non-3GPP type sensors (e.g. Radar, camera)



Human/intruder/vehicle/obstacle detection/counting in indoor/outdoor scenario

### Use case examples



Architecture and sensing method examples

## ■ Start RAN discussion on ISAC in Rel-19

- **TSG-level: Study use cases and requirements, architectures and sensing methods**
  - » Clarify the categorization of use cases, requirements and architectures for wireless sensing based on the ISAC study in SA1, towards WG-level discussion.
  - » Note: No down-selection on use cases, requirements and sensing architectures from SA1 study is expected for TSG-level study scope.
- **WG-level: Study channel model and fundamental technical aspects**
  - » At least study channel modeling enhancements for ISAC.
    - Based on clarification in TSG-level study, the discussion scope for channel modeling would be identified.
  - » In addition, feasibility based on NR RS, measurement and report can be further studied if possible.
  - » Discussions are expected to be mainly in RAN1 but may be in RAN2/3/4 if required.

■ Basic functionalities of ISAC can be specified based on NR in Rel-20 or later.

■ Discussion points and Study/work schedule

- 1) Use cases and requirements
- 2) Architecture and sensing methods
- 3) Channel model
- 4) Detailed technical aspects
  - 4-1) For Basic use cases and architecture
    - a. fundamental part (RS/ measurement/report) **based on NR waveform/frame structure**
  - 4-2) For Advanced use cases and architecture
    - a. fundamental part (waveform/frame structure/RS/ measurement/report) **based on new design**
    - b. enhanced part (AI/etc.) based on new design

Option	R19 TSG/WG-level SI	R20 WG-level SI	R20 WI	R21 or later WG-level SI	R21 or later WI
1	1) 2) 3)	4-1)4-2)			4-1)4-2)
2	1) 2) 3)	4-1)	4-1)	4-2)	4-2)
3	1) 2) 3) 4-1)		4-1)	4-2)	4-2)
4	1) 2) 3) 4-1)	4-2)	4-1)		4-2)

## ■ Basic use cases/architectures of ISAC

- Use cases and requirements:
  - » Prioritize use cases with similar or easier functions with NR positioning, e.g., detection, positioning and tracking type use cases
- Architecture and Sensing methods:
  - » At least 2 bistatic sensing methods, including gNB1-to-gNB2 bistatic sensing, UE-to-gNB bistatic sensing due to no hardware implementation efforts and limited spec. impacts.
  - » gNB-to-UE bistatic sensing can be included if UE complexity and spec impact can be minimized
- Solutions
  - » NR-based architectures and techniques with minor enhancements, based on existing NR frame structure/waveform/RS/etc.
- Channel modeling and Sensing metric
  - » At least stochastic channel modeling should be studied.
  - » Distance/angle/velocity estimation accuracy (e.g., mean square error), detection probability, false alarm probability, etc.

## ■ Advanced use cases/architectures of ISAC

- Use cases and requirements:
  - » All the potential ISAC use cases.
- Architecture and Sensing methods:
  - » All the sensing methods, including gNB/UE monostatic sensing, gNB-to-UE bistatic sensing, UE1-to-UE2 bistatic sensing.
- Solutions
  - » Fully new designs are acceptable for the fundamental part (new waveform/frame structure/RS/measurement/report) and/or enhancement part (AI/RIS/full duplex/massive MIMO/etc.)
- Channel modeling and Sensing metric
  - » All the channel modeling of stochastic, deterministic or hybrid channel modeling should be studied
  - » Sensing/imaging resolution, target/posture/gesture recognition accuracy, etc.

Architecture and Sensing method					
Basic architecture and sensing method			Advanced architecture and sensing method		
<b>Baseline: UE-to-gNB Bistatic/Multi-static sensing</b> 	<b>gNB1-to-gNB2 Bistatic/Multi-static sensing</b> 	<b>gNB-to-UE Bistatic/Multi-static sensing</b> 	<b>UE1-to-UE2 Bistatic/Multi-static sensing</b> 	<b>gNB Monostatic sensing</b> 	<b>UE Monostatic sensing</b> 

# Appendix - Analysis on sensing methods

	Sensing method	Suitable scenario	Capability requirement	Sensing performance
Monostatic sensing	<b>gNB Monostatic sensing</b> 	<ul style="list-style-type: none"> <li>Sensing target near to sensing BS/UE                             <ul style="list-style-type: none"> <li>High or medium SNR of the echo signal</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Full duplex at BS or UE (High requirement)</li> </ul>	<ul style="list-style-type: none"> <li>[gNB sensing] High precision due to no quantization</li> <li>[UE sensing] Medium precision due to quantization of the feedback values</li> <li>The precision is related to the SNR of echo signal</li> <li>Short latency</li> </ul>
	<b>UE Monostatic sensing</b> 			
Bistatic/Multi-static sensing	<b>gNB1-to-gNB2 sensing</b> 	<ul style="list-style-type: none"> <li>Extremely tight synchronization among BSs</li> </ul>	<ul style="list-style-type: none"> <li>Half duplex (Low requirement)</li> <li>Synchronization among BSs (High requirement)</li> </ul>	<ul style="list-style-type: none"> <li>High precision due to no quantization</li> <li>The precision is related to the synchronization error</li> <li>Medium latency</li> </ul>
	<b>UE-to-gNB sensing</b> 			
	<b>gNB-to-UE sensing</b> 	<ul style="list-style-type: none"> <li>Half duplex (Low requirement)</li> <li>UE with high computation resources/ detection of reflection signal (High requirement)</li> <li>High UE positioning accuracy</li> </ul>		
	<b>UE1-to-UE2 sensing</b> 			

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