3GPP TSG RAN Rel-19 workshop
Taipei, June 15 - 16, 2023
Agenda: 5
RP-230419

# Study on Integrated Sensing and Communication in Rel-19

CMCC

# Scenarios and Requirements of ISAC

## Scenarios and Requirements

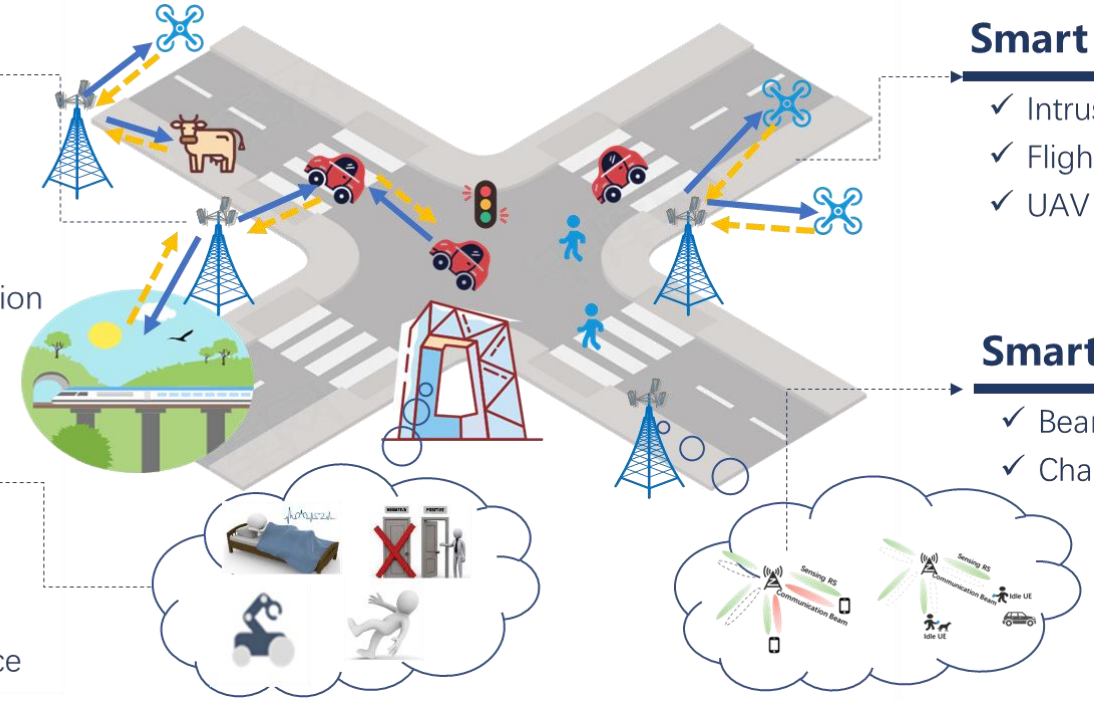
- **ISAC is expected to be a promising native feature in 6G**
  - Support low-cost, high-precision, seamless and ubiquitous sensing capability through joint design of new radio and network architecture, reuse of software and hardware equipment, and spectrum resource sharing.
- **32 use cases have been studied in SA and captured in TR 22.837. Based on the requirements from government and industries, the use cases with higher priority include:**
  - Transportation: Sensing at crossroads with/without obstacle, pedestrian/animal intrusion detection on a highway
  - UAV: intrusion detection
  - Indoor: intrusion detection

### Smart Transportation

- ✓ Assisted automotive maneuvering and navigation
- ✓ Intrusion Detection
- ✓ Traffic monitoring
- ✓ Tourist/sports hotspot detection
- ✓ Car parking

### Smart City

- ✓ Intrusion Detection
- ✓ Health monitoring
- ✓ Weather forecast
- ✓ AMR/AGV collision avoidance



### Smart UAV

- ✓ Intrusion Detection
- ✓ Flight trajectory tracing
- ✓ UAV collision avoidance

### Smart Communication

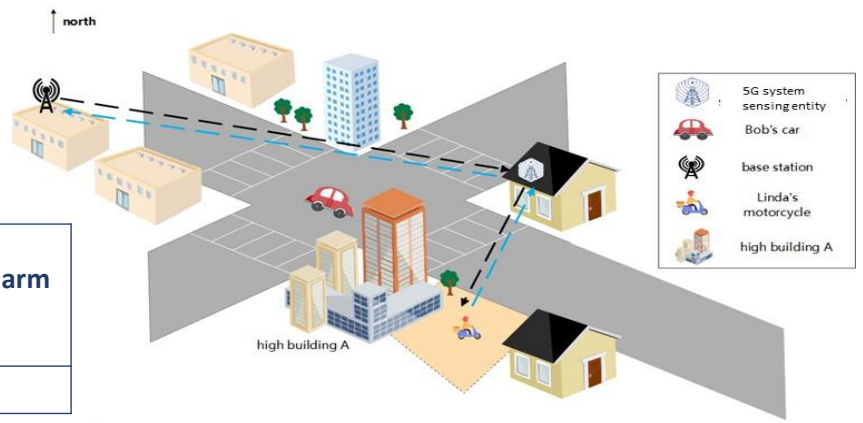
- ✓ Beam management
- ✓ Channel estimation

# ISAC Enables Smart Transportation

## Sensing at crossroads with/without obstacle

- ✓ Pedestrians suddenly rush to the road from the invisible place.
- ✓ Sensing information to fill the blind points.

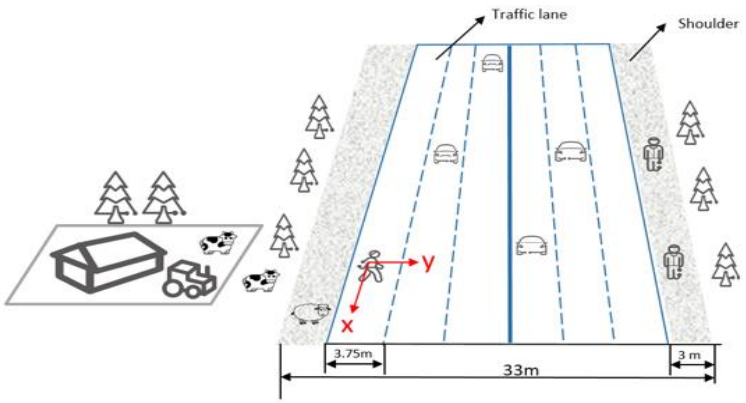
| Sensing service area | Confidence level [%] | Accuracy of positioning | | Max sensing service latency [ms] | Refreshing rate [s] | Missed detection [%] | False alarm [%] |
|---|---|---|---|---|---|---|---|
| | | Horizontal [m] | Vertical [m] | | | | |
| Outdoor | 95 | ≤1 | N/A | ≤100 | ≤ 0.1 | ≤5 | ≤5 |




## Intrusion detection

- ✓ Road safety, management of road traffic
- ✓ Low cost, all-day, wide area seamless coverage for intrusion detection.

| Sensing service area | Confidence level [%] | Accuracy of positioning | | Max sensing service latency [ms] | Refreshing rate [s] | Missed detection [%] | False alarm [%] |
|---|---|---|---|---|---|---|---|
| | | Horizontal [m] | Vertical [m] | | | | |
| Outdoor (Highway) | 95 | ≤1 | N/A | ≤5000 | ≤ 0.1 | ≤5 | ≤5 |

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# ISAC Enables Smart UAV and Smart City

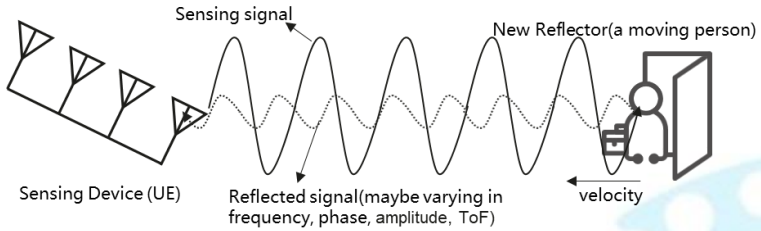
## UAV intrusion detection

- ✓ Non-cooperative UAVs intrude some no-fly zone
- ✓ Low cost, wide area seamless coverage for both supervision and non-cooperative UAV intrusion detection.

| | Sensing service area | Confidence level [%] | Accuracy of positioning | | Sensing resolution | | Max sensing service latency [ms] | Refreshing rate [s] | Missed detection [%] | False alarm [%] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Horizontal [m] | Vertical [m] | Range resolution [m] | Velocity resolution [m/s x m/s] | | | | |
| Level 1 | Outdoor | 95 | ≤10 | ≤10 | 10 | [5] | [≤1000] | [≤1] | ≤5 | ≤5 |
| Levle 2 | Outdoor | 95 | ≤5 | ≤5 | 10 | [5] | [≤1000] | [≤1] | ≤5 | ≤5 |

## Intruder detection in home/factory/office

- ✓ Ensure people at home/factory/office feel comfortable and secure
- ✓ Monitor locations without line-of-sight and to monitor wider areas




| Sensing service area | Confidence level [%] | Accuracy of positioning | | Max sensing service latency [ms] | Refreshing rate [s] | Missed detection [%] | False alarm [%] |
|---|---|---|---|---|---|---|---|
| | | Horizontal [m] | Vertical [m] | | | | |
| Indoor | 95 | ≤10 | ≤10 | <1000 | <1 | <5 | <2 |

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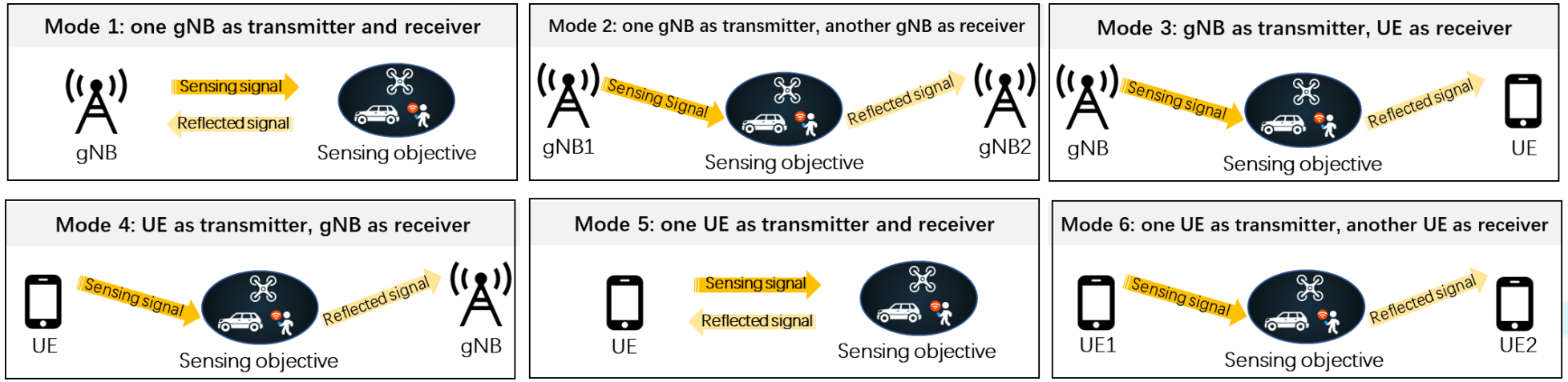
# Diversity Modes to Enable Variable Scenarios

## Diversity Modes

- **Six modes have been discussed for ISAC, Mode 1 and Mode 2 are more suitable for V2X, UAV and indoor intrusion detection use cases, to provide low cost, all-day, wide area seamless coverage sensing, and enable higher sensing accuracy with high transmission power and large antenna array.**
  - Mode 1: one gNB as transmitter and receiver. Mode 2: one gNB as transmitter and another gNB as receiver.
    - Pros: high transmission power and large antenna array to enable high sensing accuracy.
    - Cons: isolation between transmitter and receiver for Mode 1, synchronization between gNB for Mode 2.
  - Mode 3: gNB as transmitter and UE as receiver. Mode 4: UE as transmitter and gNB as receiver.
    - Pros: compatibility with 5G system.
    - Cons: sensing of non-cooperative UE.
  - Mode 5: one UE as transmitter and receiver. Mode 6: one UE as transmitter and another UE as receiver.
    - Pros: scenarios without LOS from gNB or even out of coverage of gNB.
    - Cons: isolation between transmitter and receiver, low transmission power and small antenna array of UE.



# Integrated Sensing and Communication

## Motivations

- To enable ISAC for V2X, UAV and indoor intrusion detection use case with higher requirements from government and industries, potential enhancement may include signal design, resource allocation, measurements based on existing waveform and reference RS, and sensing architecture for supporting sensing application.
  - The detailed design of potential solutions require a reliable and comprehensive understanding of sensing channel. **Adequate channel model representing the multipath of sensing signal is very important for performance evaluation for different sensing modes and different scenarios.**
  - Based on sensing signal, it is important to **process the sensing measurements at RAN side to satisfy low latency requirement of the use cases, such as ≤100ms for V2X.**

## Potential Objectives

- **Identify prioritized use cases and corresponding requirements from TR 22.837 [RAN1]**
- **Study the channel modeling for integrated sensing and communication for both FR1 and FR2 [RAN1]**
  - Taking into account sensing signal and reflected signal modeling, sensing related parameter, such as RCS
- **Study of RAN side sensing architecture, including functional interfaces, protocol, and procedures, e.g. measurement processing is within RAN node, or measurement data is directly delivered from RAN node to non-3GPP entity [RAN3]**

# THANK YOU !