S1-220133
Revision of S1-214101

Integrated Sensing and Communication

-Motivations, Use cases and Objectives

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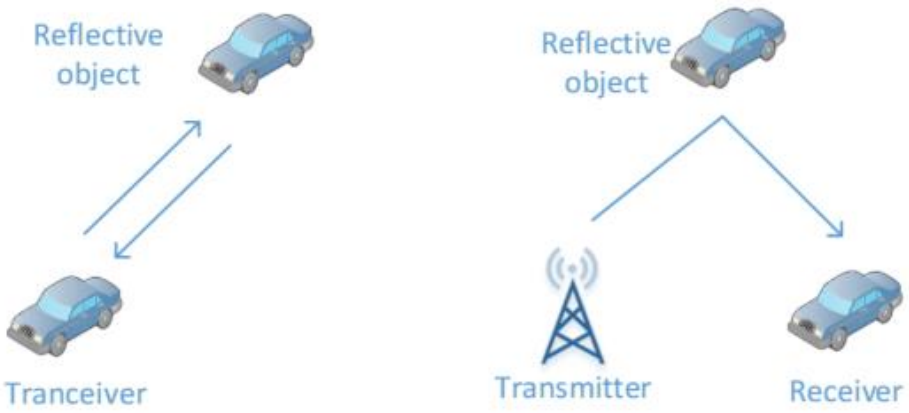
Integrated Sensing and Communication Service

- 3GPP based Integrated Sensing and Communication Service aims to enable 3GPP system to detect the target information (e.g., shape, size, speed, location, air quality, etc.) of an object who doesn't transmit signal

- Advantages:
  - Minimized interference, due to spectrum/Resource management by 3GPP system
  - Wide range sensing via the cellular network providing the sensing service in wider range
  - Easy integration with all kinds of sensing equipments such as time-of-flight (ToF) cameras, accelerometers, gyroscopes and Lidar
  - Native networking to enable communication among sensing devices
  - Easy exposure to service applications
  - Potential new business opportunities for operators to deploy the sensing services



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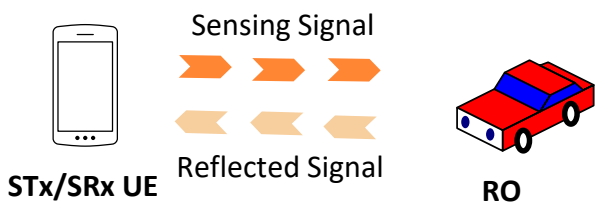
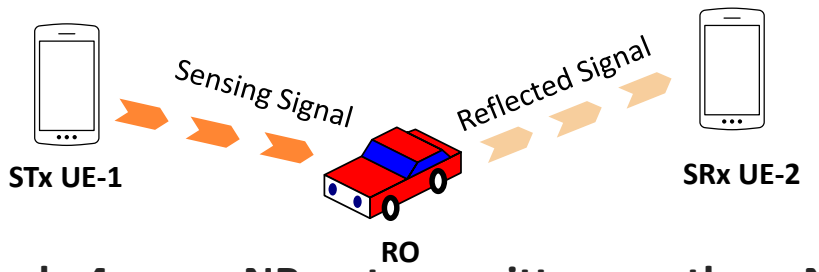
3GPP RF Sensing Service Mode Examples

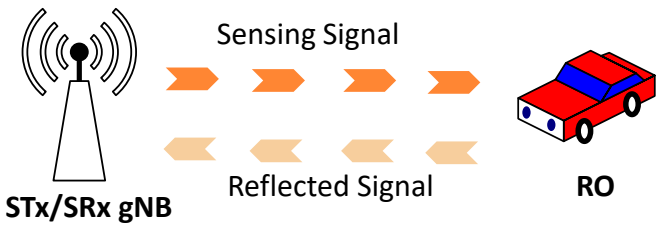
Mode 1: one UE as transmitter/Receiver



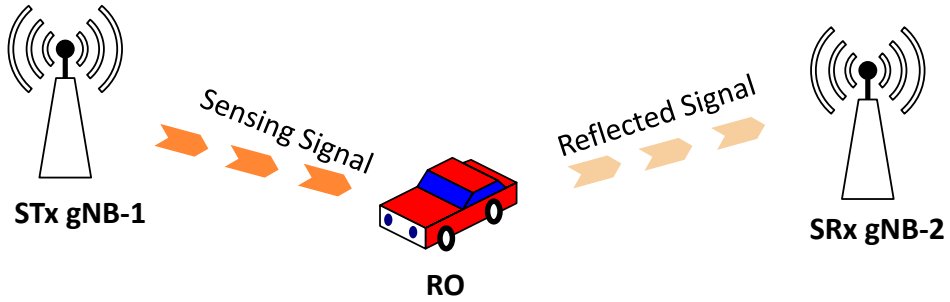
Mode 2: one UE as transmitter, another UE as Receiver



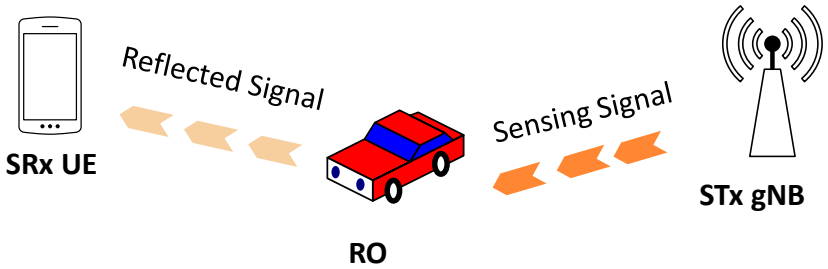
Mode 3: one gNB as transmitter and Receiver



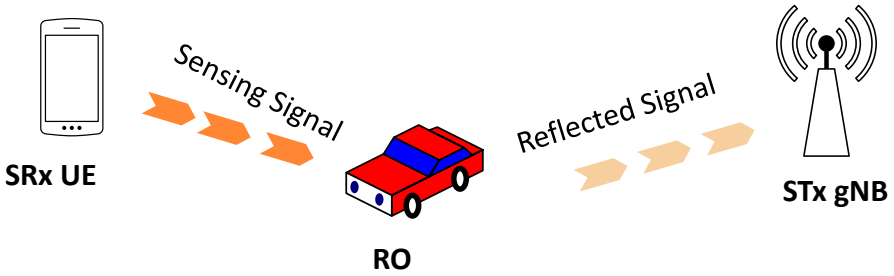
Mode 4: one gNB as transmitter, another gNB as Receiver



Mode 5: gNB as Transmitter, UE as Receiver

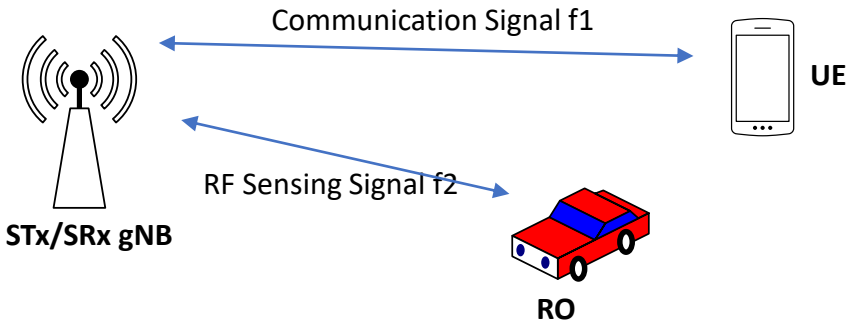


Model 6: UE as Transmitter, gNB as Receiver

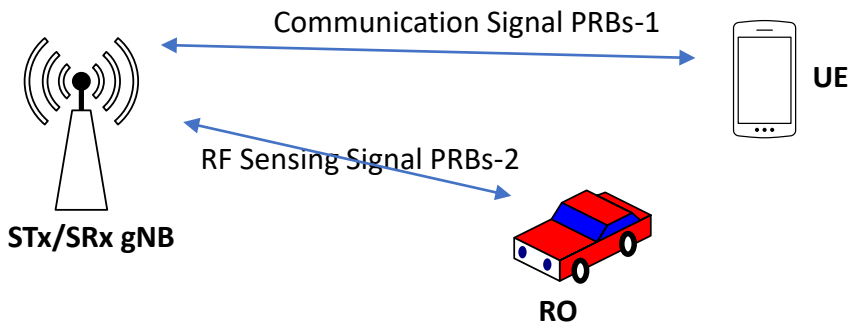


Integration of Sensing and Communication

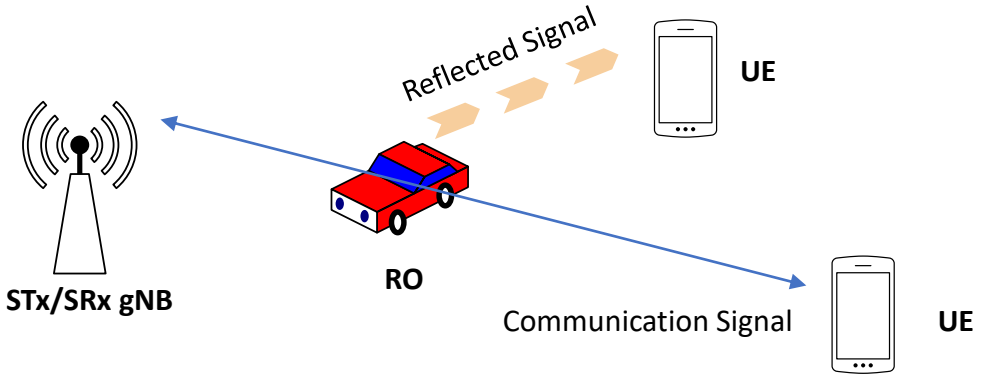
Example 1: Use the different frequency



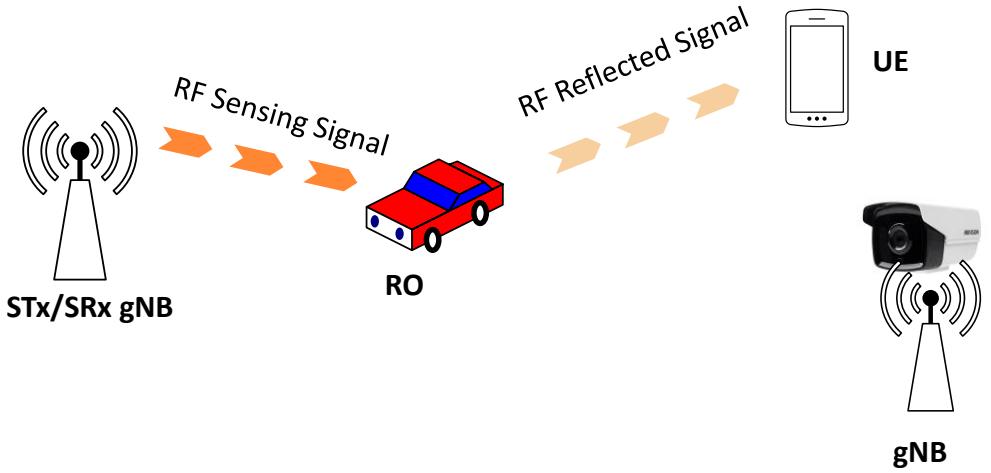
Example 2: Use the same frequency, but different PRBs



Example 3: Bi-use communication signal for sensing

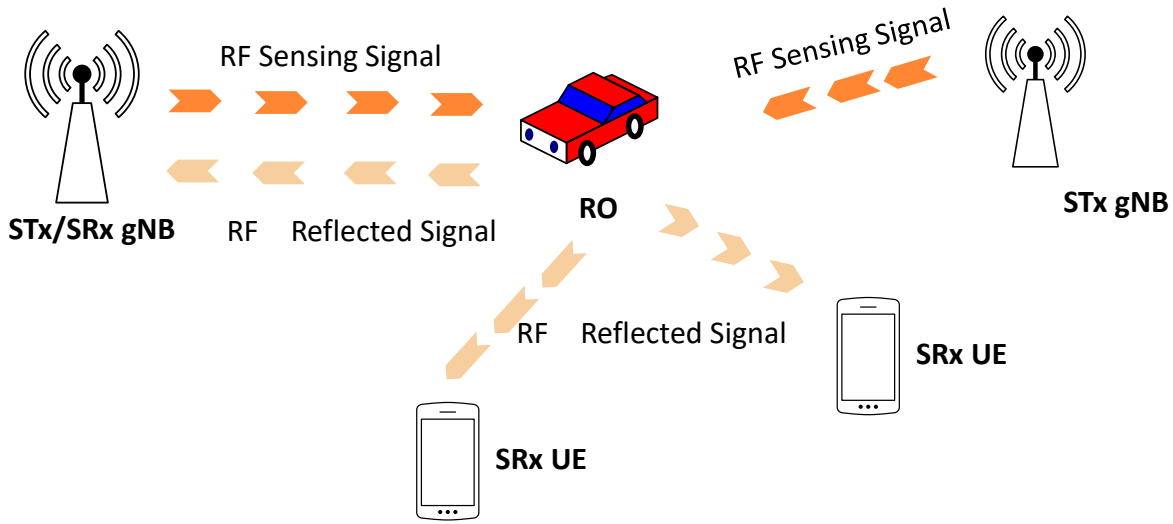


Example 4: Different type of sensors, sensing data transfer to processing center

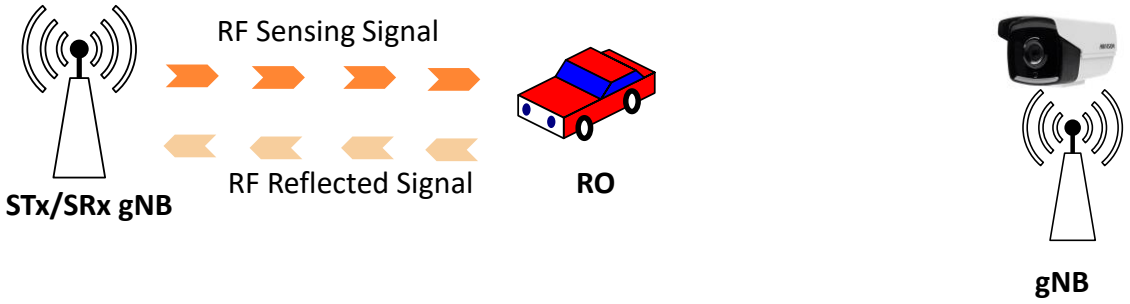


Benefits/advantages by the Integration

- Space of Sensing diversity & integration
  - Sensing from 360°



- Sensing methods & equipment diversity & integration
  - RF or non-RF based Radar
    - Lidar, cameras, motion sensors, etc.



Annex

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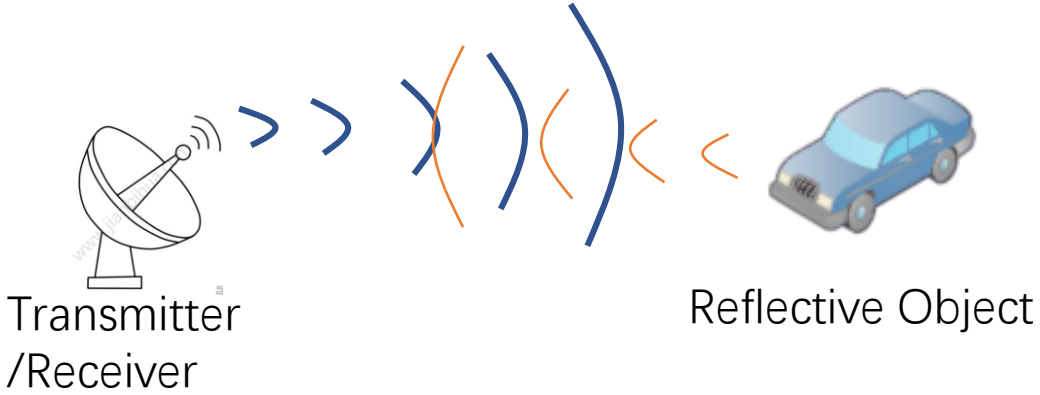
Traditional Wireless Sensing Technology

- Traditional wireless sensing technology, in which reflected radio wave from transmitter is used to detect the target objects information, such as shape, size, speed, location, air quality, etc., has been wildly applied in **Radar, Lidar, WiFi Sensing** and so on.
- Issues of the traditional wireless sensing technology
  - Interference among devices using same spectrum
  - Limitation of sensing range, i.e. distance and angles
  - High Cost for dedicated components e.g., Radar/LiDAR device
  - Operators can only provide connectivity for sensing data transmission from UE
  - Dedicated system for various service applications



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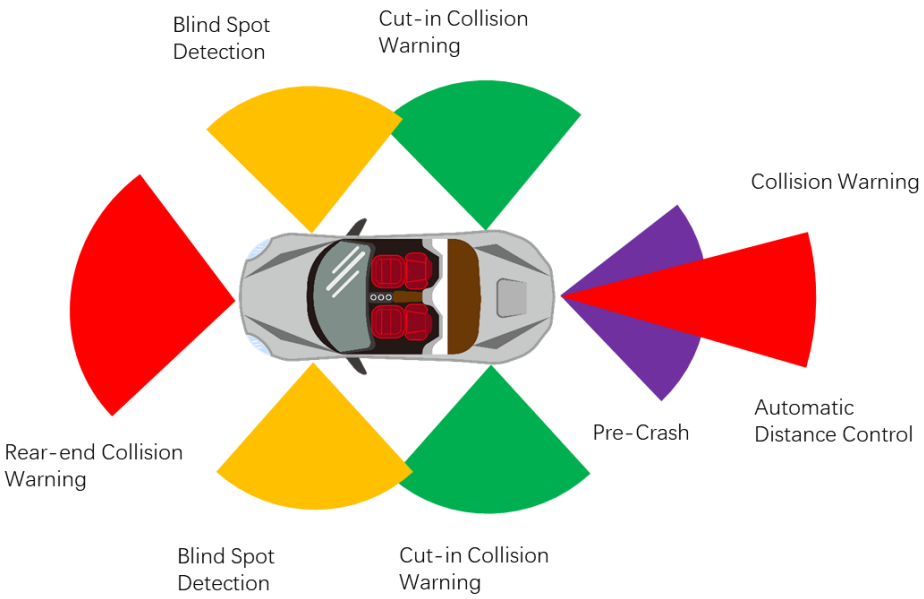
Use cases (1): Auto Driving

- A UE on board car for motion detection, e.g.,
  - Blind Spot Detection
  - Collision Warning
  - Automatic Distance Control



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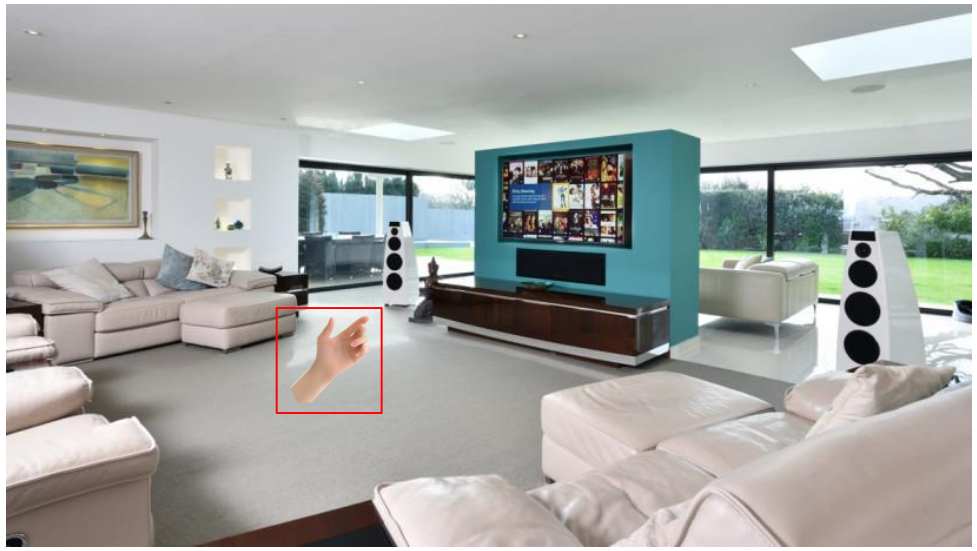
Use cases (2): Smart Home and Live

- Home devices controlled by gestures, e.g.,
  - Switch on/off TV, switch channels
  - Turn on/off, adjust lights
  - Intruder detection



- Sensing based AR/VR gaming, e.g.,
  - Detecting players movement without any wearable device

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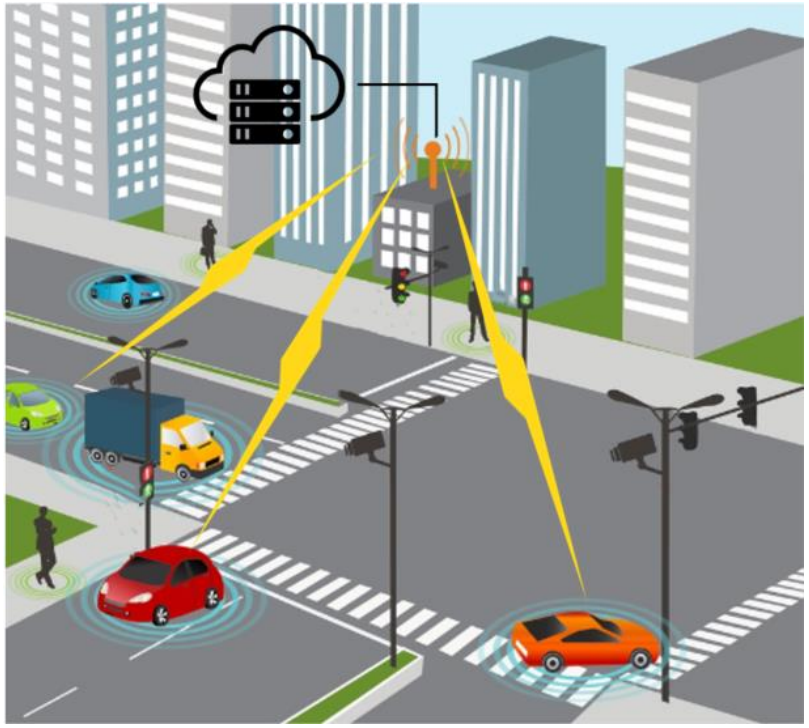
Use case (3): Smart Transport & Dynamic 3D maps

- The UEs on board car and the base stations can detect the sensing information of the surrounding cars, e.g. distance and velocity, to report to the traffic center for further processing, e.g. to build up the traffic map, to predict traffic, to enable traffic management, and to notify the cars



- With the coordination of multiple UEs/gNBs to perform sensing on one and multiple objects, either static or dynamic, a dynamic 3D map can be built up based on the aggregated sensing information of the objects in a specific area or a city

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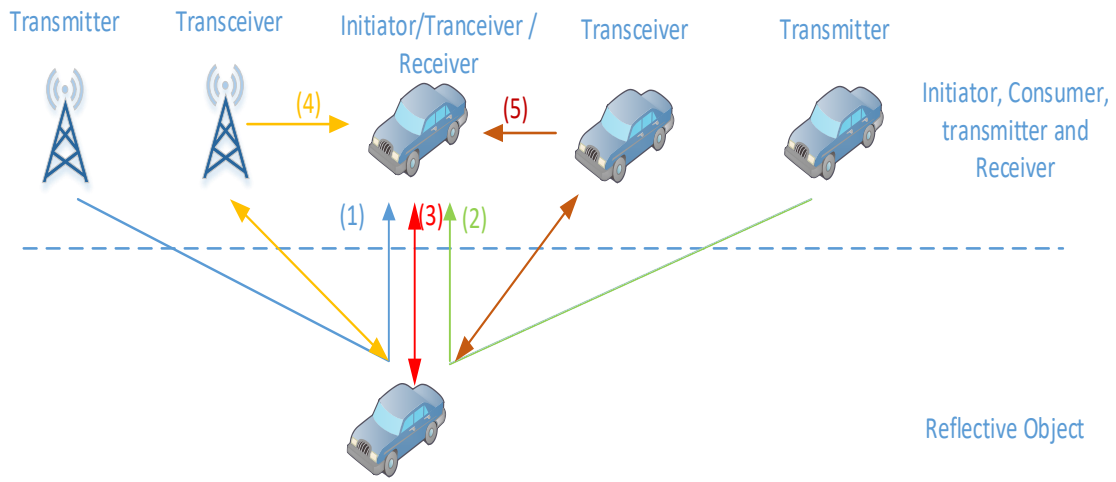
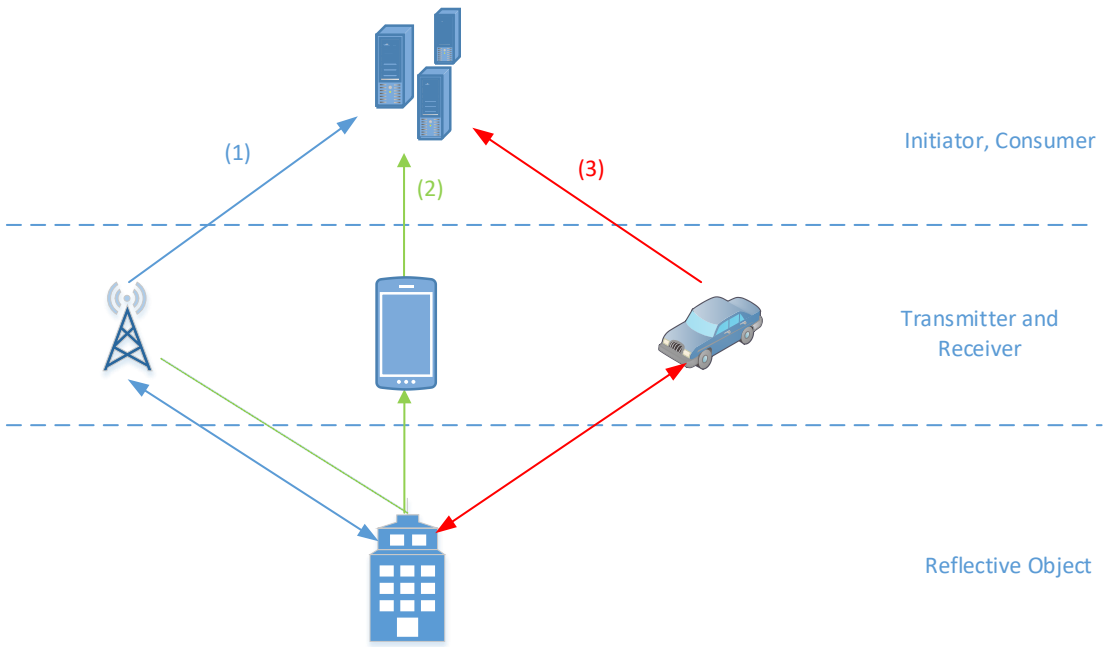
Sensing Data Collection

Sensing information can be derived at UE or network side， based on sensing data collected from multiple sources



Sensing information aggregation & processing at UE



Sensing information aggregation & processing at network

Objectives and Requirements

The objective of this study item is to study use cases and requirements for 3GPP system to provide integrated sensing and communication services including network-centric, UE-centric or both modes. The objectives of the study include:

- Study use cases, traffic scenarios and potential requirements for enhancement of the 3GPP 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, infrastructure monitoring and crowd management, gaming, XR, public safety etc. Scenarios should cover both communication-assisted sensing and sensing-assisted communication.

  NOTE1: For 3GPP RF based sensing, transmitter and receiver can be located in same or different sensing entities (UE or BS), and multiple transmitters/receivers can collaborate together.

  NOTE2: Non-3GPP based sensors (RF or non-RF based, such as Radar, Lidar, cameras, motion sensors, etc.) could also be considered.

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Objectives and Requirements

- Integrated sensing and communication functional requirements applicable to the identified use cases:
  - Network control of integrated sensing and communication, 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 integrated sensing and communication service (e.g.., radio frequencies in licensed/unlicensed spectrum), etc.
  - Exposure of the system capability for integrated sensing and communication service to 3rd party.
  - Communication resource management for the integrated sensing and communication service, e.g., radio outage/blockage detection and prevention, interference mitigation, channel estimation, beam management, optimized mobility, etc.

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Objectives and Requirements

- Integrated sensing and communication performance requirements pertaining to each of the identified use cases/traffic scenarios:
    - 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;

- Security, privacy, regulatory and charging requirements related to sensing including aspect relating to e.g.,:
    - Stakeholder model (e.g., PLMN, SNPN, 3rd party service provider, vertical/user)
    - Location privacy requirements and lawful intercept requirements related to sensing

- Application enablement layer requirements

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

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Thank You

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