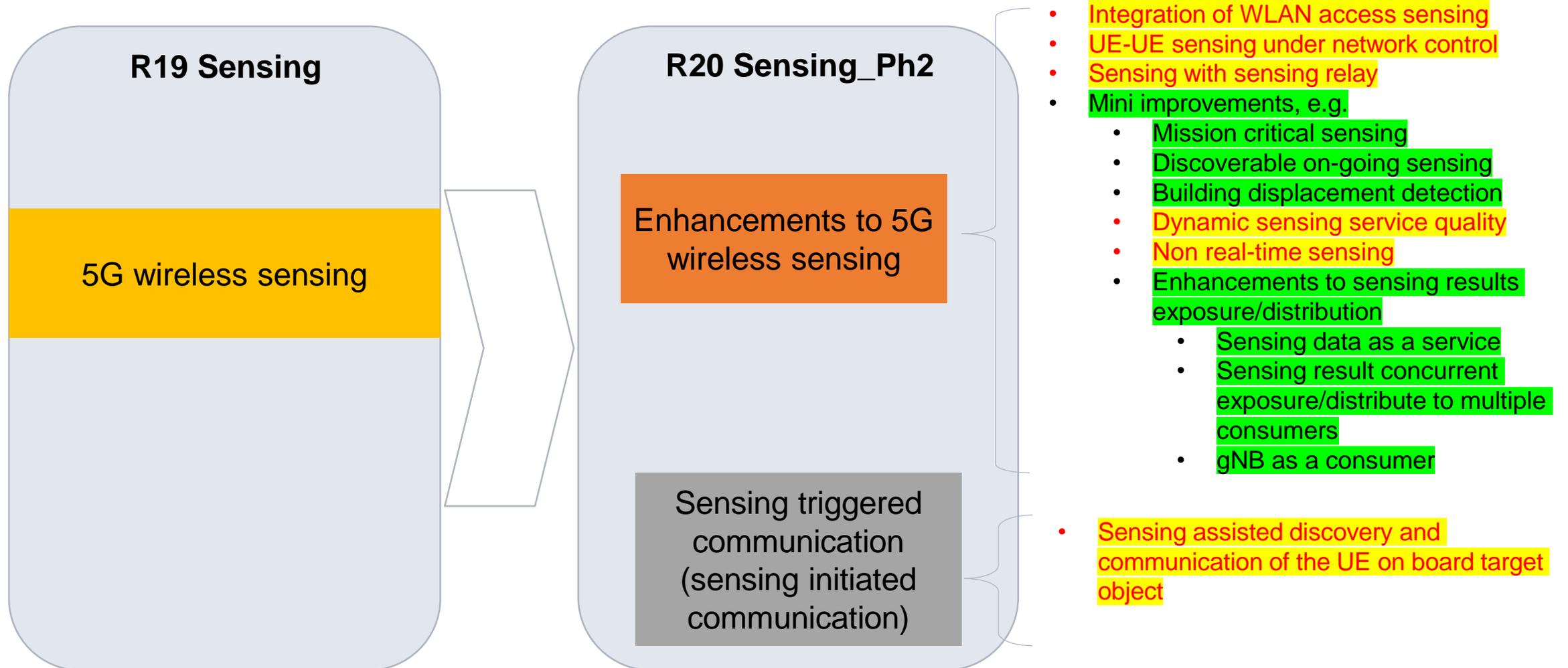


Integrated Sensing and Communication Phase2

Xiaomi

Motivations, Use cases and Proposed Objectives

Motivations



Limit to study those which have functional requirements and no higher/extra performance requirements

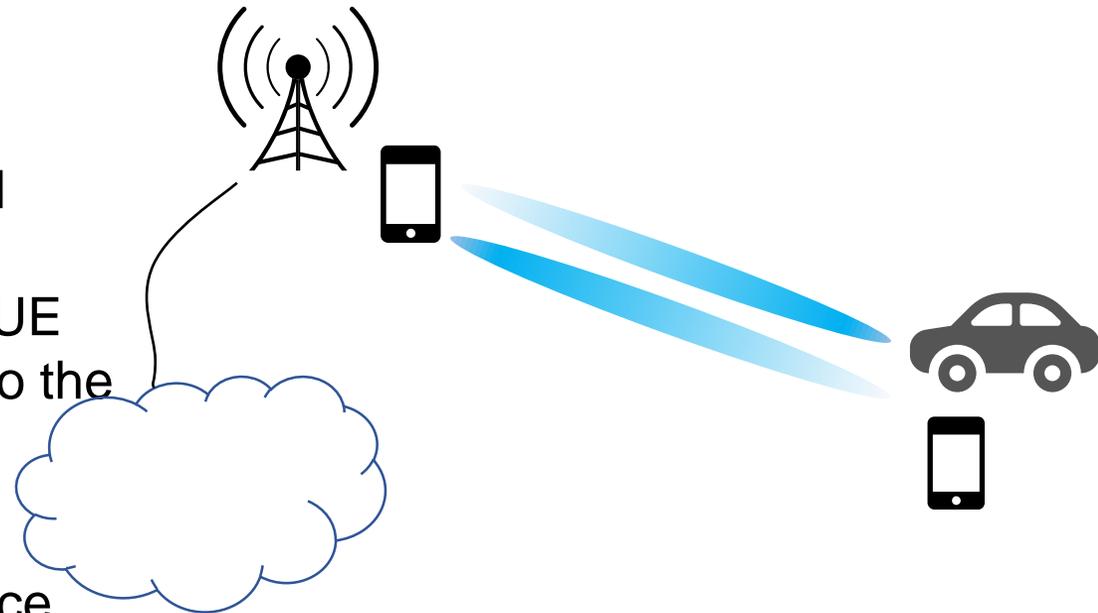
UE to UE sensing under network control (UE triggered)



- For sensing with UE transmitter/receiver, sensing is performed under network control (missing part):
 - Service triggered by UE
 - How UE form a sensing group and coordination among UEs in the sensing group
 - UE revoke sensing data from network/other UE
 - Sensing data processed by a UE /among UE(S)
 - How UE use sensing results from other(s)
- The network analyzes the sensing service request and network status, choose the optimal radio resource scheduling strategy and send the strategy to UE. The UE utilizes radio resources to perform sensing according to the received strategy.
- Based on sensing environment status, UE status and network status, etc., the network optimize radio resource scheduling and utilization.

Transmitter and receiver in R19 is only “part of a RAN node or a UE”

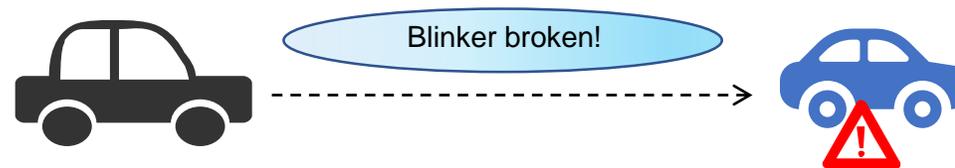
Transmitter/receiver cannot represent the whole UE!



Sensing triggered communication

□ Use Case: Reminder call

- In some cases, an object with specific characteristics (e.g. location, distance/direction, color, shape...) may be a UE on board target object which can be communicated. The characteristics can be sensed and then the UE on board target object can be discovered and communicated.
- A target object is communicated over Uu or PC5 when it matches with the sensed characteristics.
- For example, if the front car has some problems such as the blinker or brake light doesn't work, or door is not closed well, the driver of the rear car initiates communication with front car with characteristics of front car to give a reminder.



■ Procedure:

- 1) Black car sense the blue car 【Sensing Event 1】 and send the sensing results to NW
- 2) Network sense the blue car with UE ID in NW 【Sensing Event 2】 (New!)
- 3) Sensing Event 1 link to Sensing Event 2 due to sensing the same object (New!)
- 4) Communication build up between black car and blue car with the procedures above

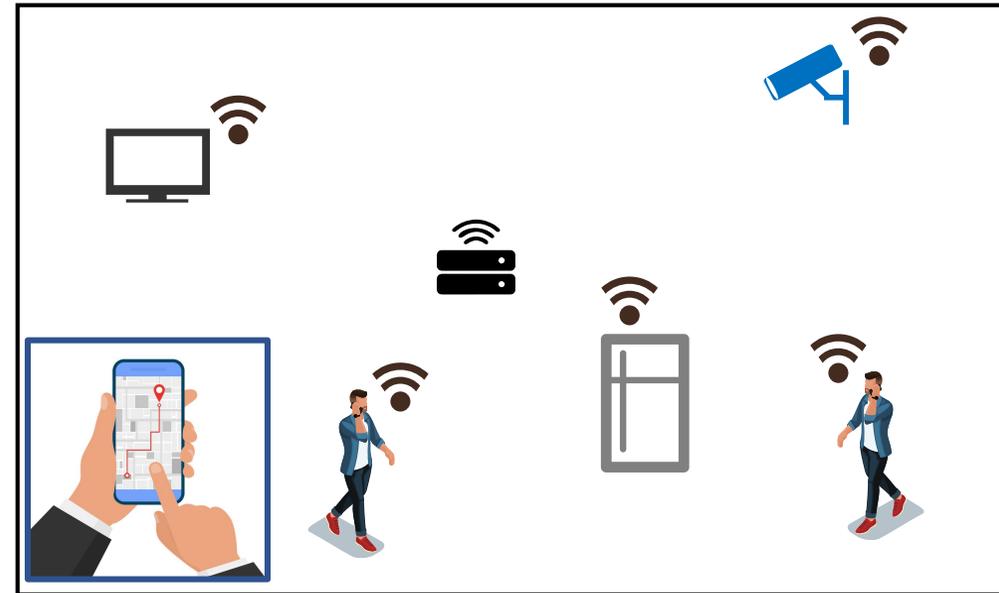
Proposed Objectives

- Study new use cases for:
 - Enhancements to Communication-Assisted Sensing, including
 - Integration of WLAN access sensing
 - UE-UE sensing under network control
 - Sensing with sensing relay
 - Mini improvements, e.g.
 - Mission critical sensing
 - Discoverable on-going sensing
 - Building displacement detection
 - Dynamic sensing service quality
 - Non real-time sensing
 - Enhancements to sensing results exposure/distribution
 - Sensing Data as a Service
 - Sensing result concurrent distribution to multiple consumers
 - gNB as a consumer
 - Sensing triggered communication, including
 - Sensing assisted discovery and communication of the UE on board target object
- Identify potential service requirements, KPIs and performance requirements.
- Aspects related to security, privacy, regulatory requirements and charging.
- Gap analysis between the identified potential requirements and existing 5GS requirements or functionalities.

Annex

Integration of WLAN access sensing

- Use Case: Indoor navigation with 3D map
 - WLAN devices are popularly deployed in public sites, especially the indoor environments where the cellular coverage is poor.
 - In large buildings, airports, shopping malls and other public sites, users can receive real-time 3D map which is generated by using WLAN access sensing, to navigate more easily and accurately.



Integration of WLAN access sensing

□ Use Case: Smart Home

- WLAN not only provides connections to the network as a radio access technology, but also enables security and home care services at home using sensing technology.
- WLAN has the ability to sense the external environment and the objects, and is the key to successfully realize interactions of "things-things" and "human-things" in smart home.
- WLAN devices (e.g. UE or WLAN AP, or WLAN AP mounted on UE) detect sensing data using wifi sensing, collect the sensing data, and send the collected data to the network for further processing. The sensing data collected over wifi sensing can be combined with the 3GPP sensing data to generate the sensing result.
- WLAN access sensing can support the detection of multiple sensing characteristics, such as motion detection, human activity detection and recognition, and vital sign detection. It makes home life more intelligent and efficient.

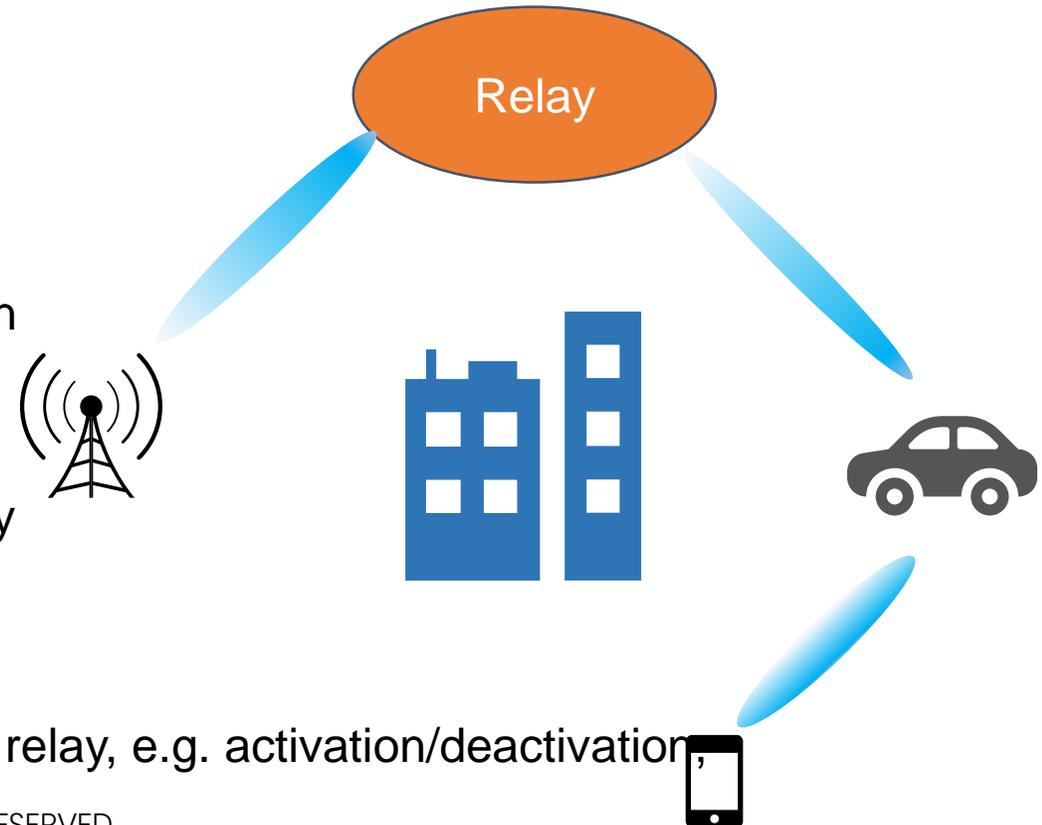


Sensing with sensing relays (as assistant to transmitter/receiver)

- Scenarios where sensing with LOS is not possible
 - The direct path between the transmitter, object and receiver is obstructed by obstacles such as buildings, trees, or terrain. NLOS conditions can significantly impact radio signal propagation, which ultimately affects the quality of sensing service and fails to meet service requirements.
 - The object to be sensed is out of the sensing area of the sensing entity (e.g. transmitter/receiver).

■ Sensing with Sensing Relay

- Sensing Relay: a network entity acting as a relay between sensing entities, providing a sensing RF link between sensing entities.
- The sensing RF signal is transmitted via the sensing relay over LOS path.



■ Requirements

- Configure, provision and control the operation of sensing relay, e.g. activation/deactivation, permitted location(s) or time of operation.

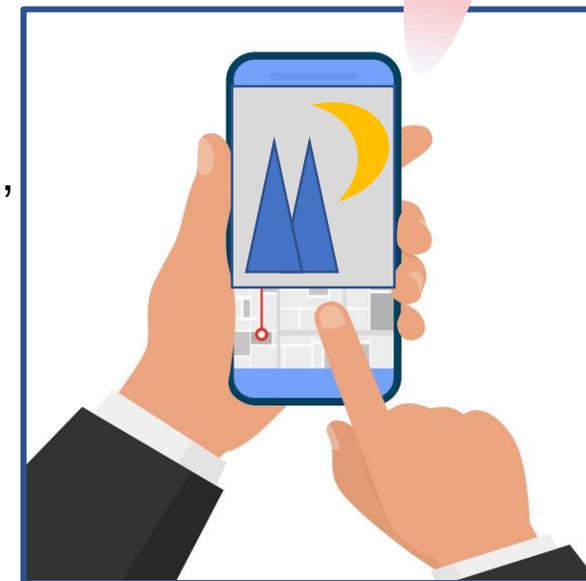
Mini improvements: e.g. Mission critical sensing

■ Use case:

Emergency sensing is used to deliver sensing information that is used to save lives. For instance, one human get hurt during climbing a mountain, he need to take a picture/info of the environment and send his/her hurtless to potential helpers (e.g., the police). The policeman can use the sensing result to help the hurt people by giving advice to deal with the hurtless and bring the right medicine by doctor afterwards to help him/her.

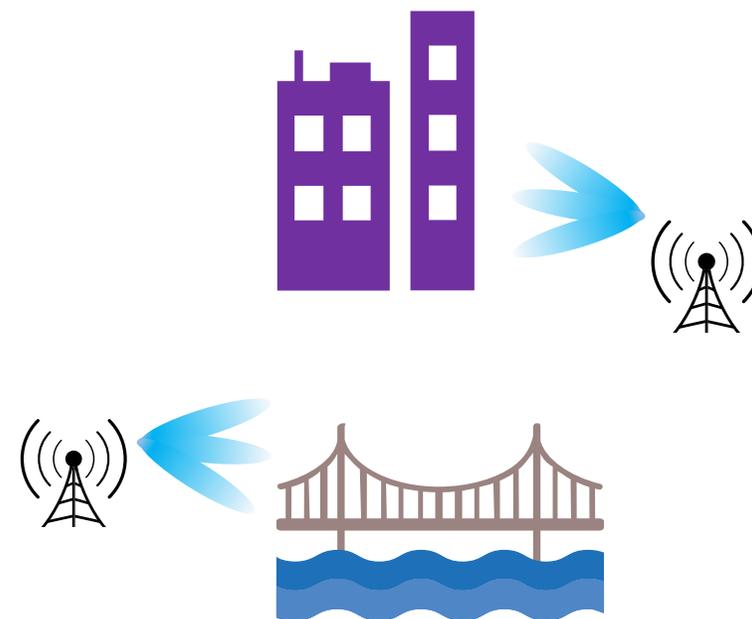
■ Mission critical sensing

- Humans can use UE/ME (i.e. the UE without the USIM or UE has no contract with the operator) to sense the situation and send the sensing data to the network (emergency center).
- To avoid abusing of emergency sensing, the network will only send the sensing result related to emergence sensing to the official helper side (e.g., the server deployed by the police station)
- The network will give high priority to the emergence sensing task.
- The network will omit the authorization, charging procedure to support the emergency sensing.



Building displacement detection

- Sensing service provides the network with the ability to detect object and/or its surrounding environment, which can predict and avoid potential safety hazards caused by displacement of object, e.g. buildings, bridges and other facilities, in advance, and then provides support for urban governance and infrastructure maintenance.
- For R19, the following characteristics can be detected:
 - shape, size, orientation, speed, location, distances or relative motion between objects, etc.
- For R20, it is expected that more characteristics (for sensing event) can be detected, for example, detect displacement of a building over a period of time



Discoverable on-going sensing

■ Scenarios

In sensing scenarios, humans occasionally run into the area that is running the sensing task. Then the human can be sensed by the UE/gNB in an unaware way. Sensing data can be used to derive sensitive information (e.g., heart rate). To avoid being sensed in an unaware manner, humans should be able to be notified of the area where sensing task is running on, so that humans may leave the sensing area on sensing.

■ Discoverable on-going sensing

- Humans can use their UE to obtain sensing task information run in a specific area from the network/the UE running the sensing tasks.



Dynamic Sensing service quality (KPIs)

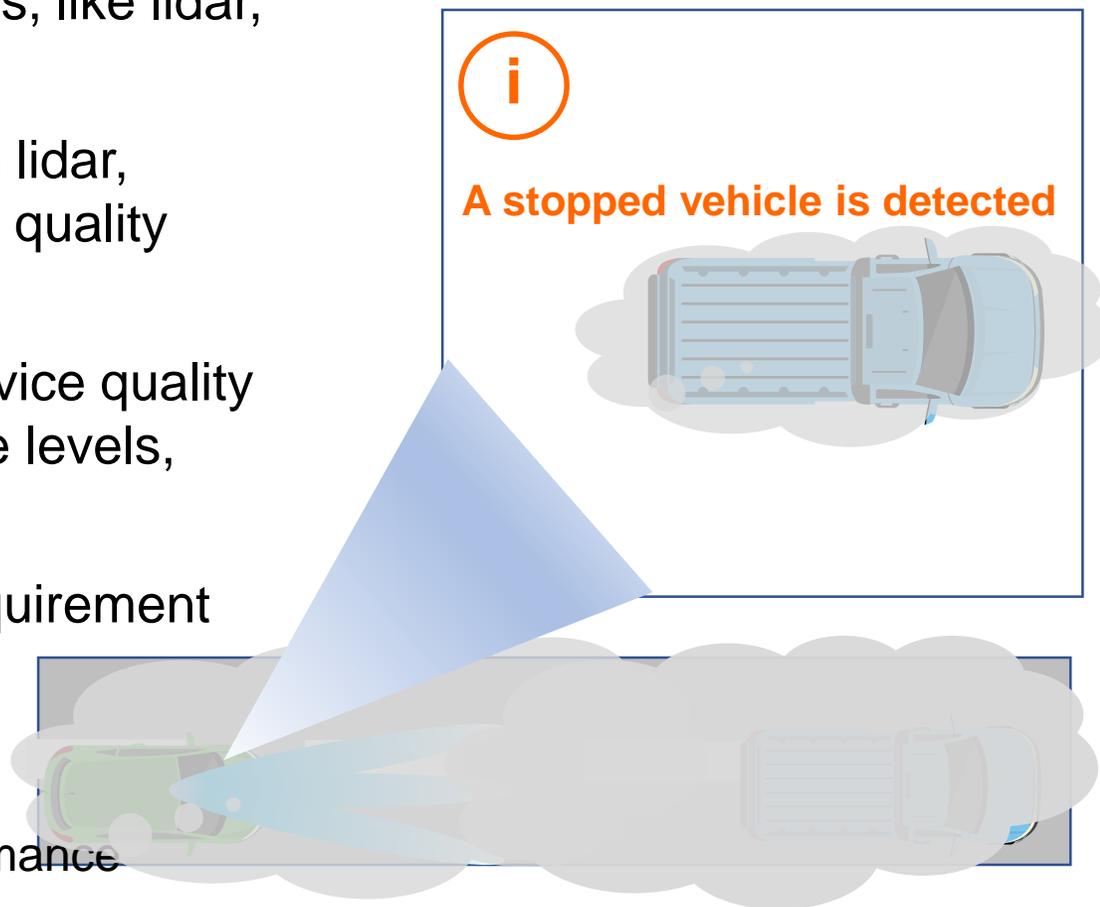
■ Scenarios

- Vehicle drive under bad weather conditions (e.g., snow, fog, rain, sand storms, dense smoke) equipped sensors, like lidar, camera, ultrasonic radar and 3GPP sensing.
- 3GPP sensing has much better performance than lidar, camera, ultrasonic radar, but cannot reach service quality requirement for normal weather condition.
- 3GPP sensing results with decreased sensing service quality is still valuable since autonomous driving have five levels, from L1 to L5
- 3GPP sensing provide required service quality requirement after car return to normal weather conditions

■ Potential requirements

- 3GPP sensing should be able to handle multiple performance requirements in a single sensing service request.

(Even best effort is acceptable in some cases)



Non real time sensing

- Scenarios have the common sensing characteristic
 - No signal coverage.
 - Sensing object is static or sensing results for a period of time is enough and valuable
- The transmitter/receiver can perform sensing service in a no-signal coverage environment by collecting and saving sensing data locally. Once they move back into the signal coverage area, they can forward stored sensing data to the 5G network and get the non-real-time sensing result.



UE explore sensing in Cave

Sensing object is static
(no change during a period of time)



UE rescue sensing on UAV in earthquake --no signal coverage



Wild Rainfall Sensing



Wildlife Migration Sensing

Sensing results for a period of time
is enough and valuable

Static Sensing Result Exposure

■ Scenario

It is assumed that sensing data of a specific sensing area are static, i.e. real-time/on-demand detection is not necessary, thus can be stored for future use. One example is the 3D map of an area.

■ Service flows

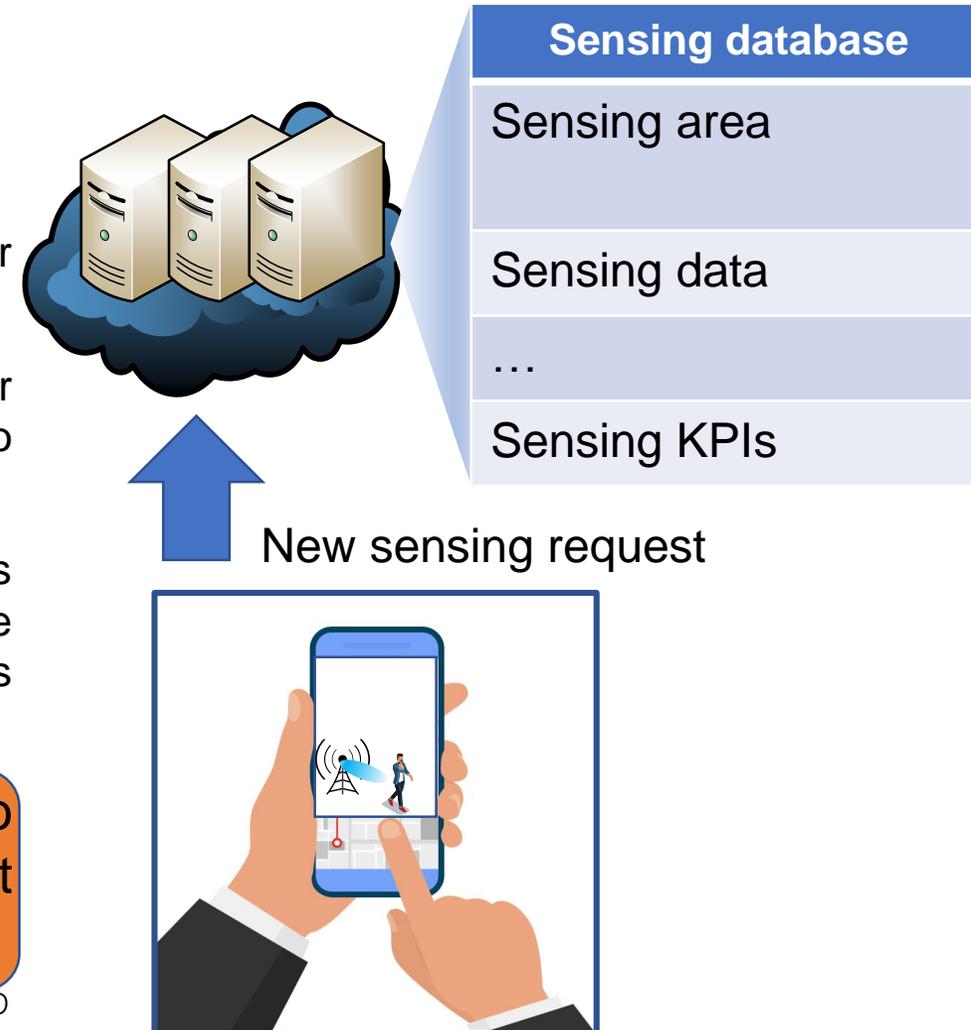
At Time A, Alice triggers sensing service request related to Area X from her UE. The network triggers sensing detection based on the request.

The detected sensing data is then transmitted to the sensing data processor for processing and the sensing result is provided to Alice's UE and also stored in the network.

At Time B, Bob triggers sensing service request related to Area X from his UE. The network checks from the stored sensing information matching the service request and finds available sensing data, and the sensing result is provided to Bob's UE.

Sensing Result as a Service enables the 3GPP operators to provide sensing result based on the stored sensing result matching to the service requirement.

i Core network checks the sensing database.



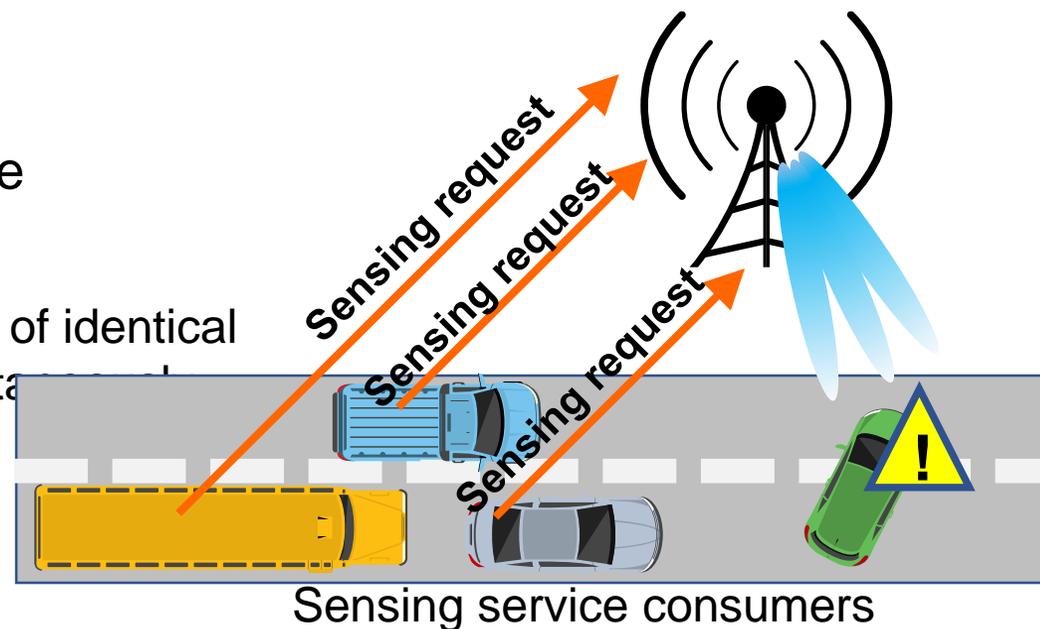
Sensing results concurrent exposure/distribute to multiple consumers

■ Scenarios

In vehicular scenarios, multiple vehicles may request the core network to sense the same target, which leads to the core network generating a large number of identical sensing results. Moreover, the sensing result can be the point cloud with a large data size. To improve distribution efficiency, the core network distribute large amounts of identical sensing results to multiple vehicles simultaneously.

■ Sensing result concurrent exposure/distribute to multiple consumers

The core network should be able to distribute large amounts of identical sensing results to multiple sensing service consumers simultaneously.



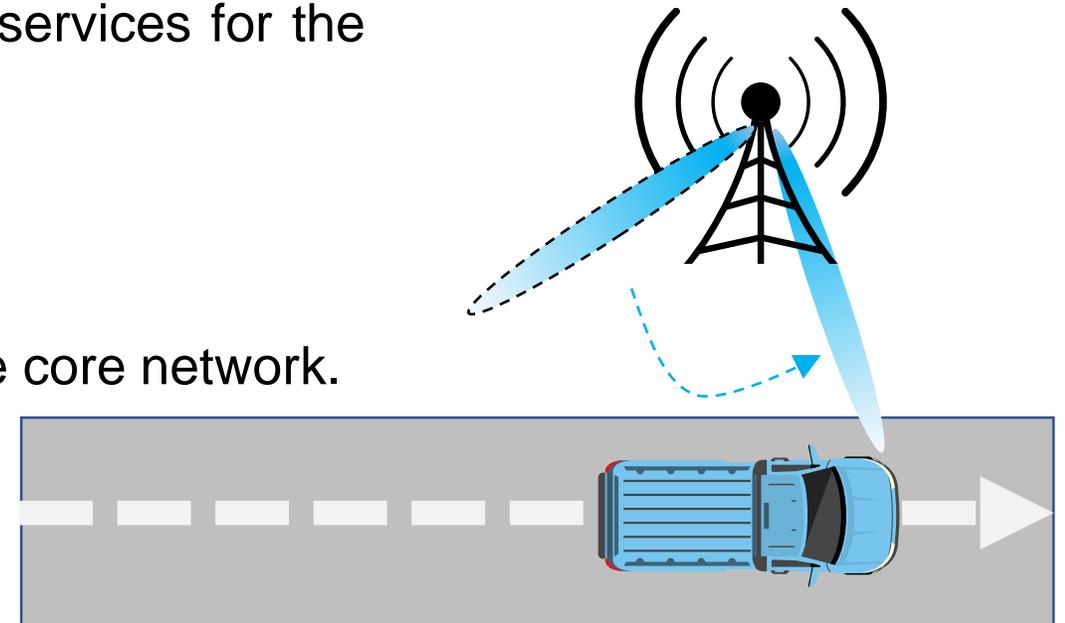
gNB as the sensing service consumer

- Scenarios where gNB serves as the sensing service consumer.

A UE onboard vehicle can be a subscriber of the 5G network. The gNB can request the sensing result of a UE onboard vehicle from the core network. Once the sensing result (e.g., positioning/velocity estimate by sensing) is obtained, the gNB can leverage the beamforming to provide high quality communication services for the moving vehicle.

- gNB as the sensing service consumer

gNB should be able to request sensing result from the core network.



Use case: Sensing triggered communication

□ Case: Autonomous Driving Cars Info Exchange

- Autonomous driving cars benefit from exchanging information in between to improve efficiency of the autonomous driving algorithms, which further guarantees the security, e.g.
 - Accident avoidance
 - To front car: Can you drive a little faster?
 - To rear car: Can you drive a little slower?
- Sensing triggered communication enables the one-one communication between UE onboard vehicles.
- Improvement: One-One communication by sensing triggered communication compared to One-Many communication for V2X with Prose.



Thanks