3GPP TSG-SA WG1 Meeting #97-e

E-meeting, Feb 14-24th 2022

Discussion on Network based Sensing Service

S1-220029

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High level concept for Sensing

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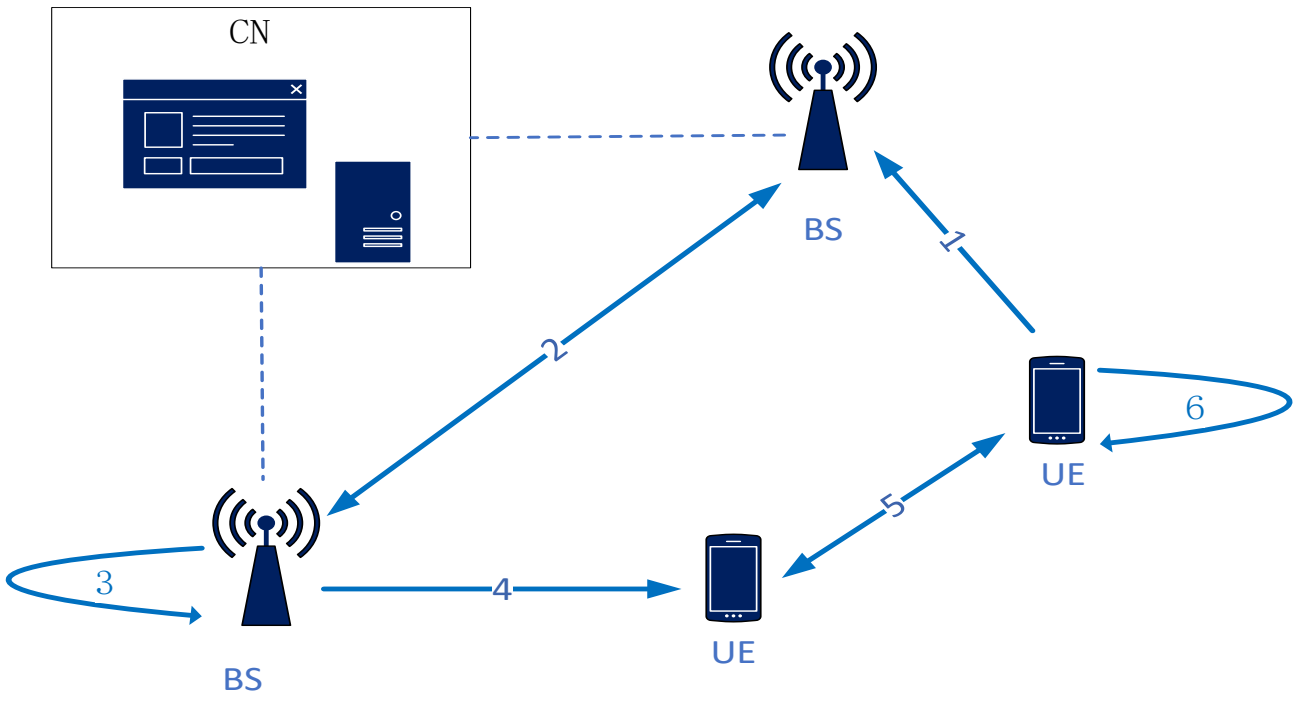
- In wireless communication network, electromagnetic waves propagation transmits signals and carries environmental information at the same time, which can be captured for sensing use.

Category of comm. sensing	Sensing contents	Potential scenarios
Macro information sensing	Information of weather, air quality, etc.	Meteorology, agriculture, life services
	Target tracking, ranging, speed measurement, shape measurement, etc.	Application scenarios of radar
	Statistics of the traffic flow at the intersection, personnel flow (including intrusion detection)	Intelligent transportation, business services
	3D environment construction (including reflector detecting)	Intelligent driving and navigation (car/UAV), smart city (3D map), network planning and optimization
Short distance refined information sensing	Heartbeat and breathing monitoring	Health care, medical care
	Imaging, material detection, etc.	Security check, industry, etc.

Network based sensing supported in 3GPP (between RAN(s) , or between RAN and UE(Uu))



Sensing modes

Sensing mode	Mode No.	Transmitter	Receiver
Network based sensing	1	UE	BS
	2	BS A	BS B
	3	BS A	BS A
	4	BS	UE
UE based sensing	5	UE A	UE B
	6	UE A	UE A

Note: UE based sensing is UE implementation and out of 3GPP scope

Prioritize sensing mode 1~4 for Network Based Sensing：

Mode 1: UL reference signals for measurements executed by BS (Uu UL sensing)

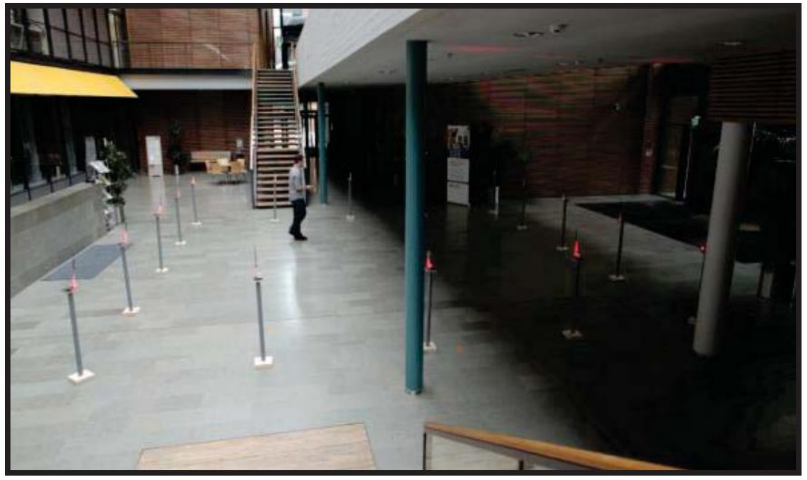
Mode 2: Existing or new measurements between BSs

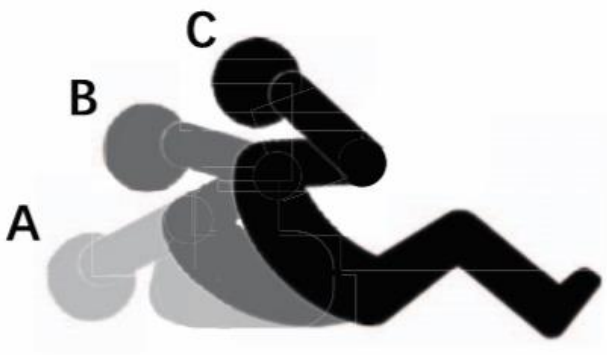
Mode 3: Existing or new measurements based on BS echo

Mode 4: DL reference signals for measurements executed by UE (Uu DL sensing)

Use cases for UE involved sensing (Uu interface sensing)

Reuse existing communication signals (e.g., SRS, CSI-RS) or new designed reference signals to support sensing.





Case1:
Respiration monitoring [1]

Requirement 1:
Acquire the target respiration rate of a person.

Case2:
Indoor intrusion detection [2]

Requirement 2:
Detect the intrusion of a person walking inside the monitored area and track his movements.

Case3:
Bodyweight exercises [3]

Requirement 3:
Count and recognize different typical bodyweight exercises.

Source[1]: Youwei Zeng et. al., "Farsense: Pushing the range limit of wifi-based respiration sensing with csi ratio of two antennas"
Source[2]: O. Kaltiokallio and M. Bocca, "Real-Time Intrusion Detection and Tracking in Indoor Environment through Distributed RSSI Processing"
Source[3]: S. Li, X. Li, Q. Lv, G. Tian and D. Zhang, "WiFit: Ubiquitous Bodyweight Exercise Monitoring with Commodity Wi-Fi Devices"

Use cases for UE involved sensing (Uu interface sensing)

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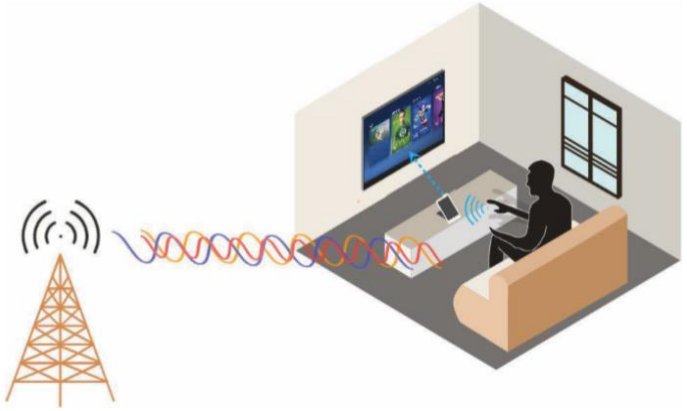

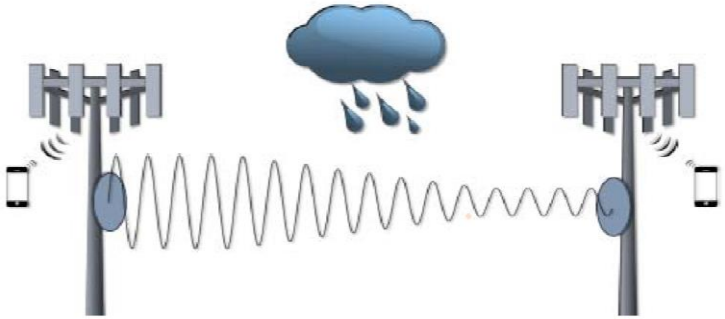

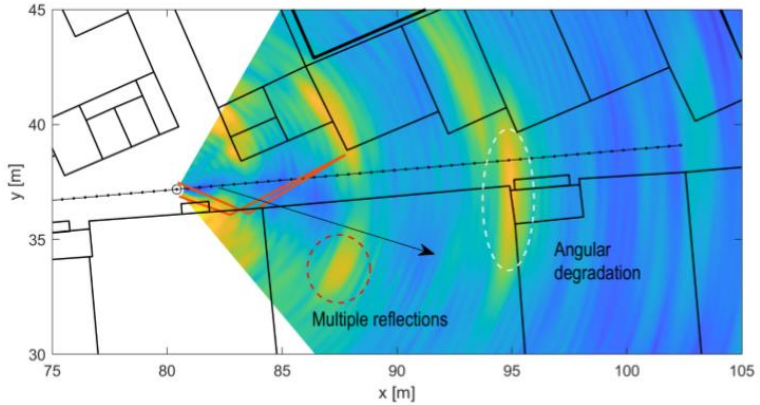

Case4:
Hand gesture recognition [1]

Requirement 4:
Recognize dynamic hand gestures for human-computer interaction.

Case5:
Weather Monitoring [2]

Requirement 5:
Use Communication links for real-time rainfall monitoring.

Case6:
Environment Mapping [3]

Requirement 6:
Exploit the multipath component information for simultaneous localization and mapping.

Source[1]: W. Chen et al., "Robust Dynamic Hand Gesture Interaction using LTE Terminals"
Source[2]: Messer H , Gazit L ., "From cellular networks to the garden hose: Advances in rainfall monitoring via cellular power measurements"
Source[3]: C. B. Barneto, E. Rastorgueva-Foi et al., "Millimeter-wave Mobile Sensing and Environment Mapping: Models, Algorithms and Validation"

Uu interface sensing(BS -> UE & UE -> BS) complements BS echo detecting sensing

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Table 1: Comparison between BS echo detecting and Uu based sensing

	Transmitter BS A, receiver BS A (echo detecting)	BS -> UE & UE -> BS (Uu based sensing)
Sensing range	BS position is fixed; The number of BS is much smaller than the number of UE; The sensed area/objects is restricted	UE is widely distributed in the cell and the number of UE is larger than the number of BS. The sensed area/objects is greatly extended.
Sensing use cases	Rader-like sensing use cases including range/velocity/angle measurements	More use cases are supported (See Table 2).
Hardware implementation	In order to support echo detecting, BS need to support full duplex/pulse signal	No new hardware requirements.

Table 2: Example of measurements and use cases for Uu based sensing

Measurements		DL/UL	Use cases
Existing measurements	RSRP	BS -> UE & UE -> BS	Information of weather; air quality; traffic/personnel flow
	RSRP, angle	BS -> UE & UE -> BS	3D environment construction
New measurement	CSI (amplitude and phase of frequency domain channel response)	BS -> UE & UE -> BS	Heartbeat and breathing monitoring
	…	…	…

SA1 Rel-19 Proposal

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vivo supports Network based Sensing study work in rel19, especially Uu interface sensing.

- **Our High-level Objectives:**

✓ Identify use cases, service requirements and KPI requirements for Network based Sensing service supported by 5GS in 3GPP, including BS(s) echo sensing and Uu based sensing.

- **Objectives include:**

✓ Identify Network based Sensing use cases , including the ones for BS(s) echo sensing and the ones for Uu based sensing;

✓ Identify potential requirements for 5GS to support Network based Sensing, including:

  ✓ Service requirements for sensing, such as requirements on sensing resolution, error of sensing, update freshness for sensing and latency for sensing, and other sensing specific KPIs.

  ✓ Related communication KPI requirements for sensing service, such as PDB, GFBR, PER… for sensing data transmission.

  ✓ Requirements on registration, authentication, entities discovery and service control for sensing service

  ✓ Other requirements about privacy, security and charging.

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THANK YOU.

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