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3GPP TSG RAN Meeting #102 **RP-232980**
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Agenda Item:	**9.1.1.7**
Source:	**Spreadtrum Communications**
Title:	**Channel modeling for ISAC in Rel-19**
Document for:	**Discussion and decision**

Background

- **3GPP SA1 is working on the identification of use cases and KPIs for ISAC**
- **The identified use cases are captured in TR 22.837**

Index	Use Case	Index	Use Case
1	Intruder detection in smart home	17	Health monitoring at home
2	Pedestrian/animal intrusion detection on a highway	18	Service continuity of unobtrusive health monitoring
3	Rainfall monitoring	19	Sensor Groups
4	Transparent Sensing Use Case	20	Sensing for Parking Space Determination
5	Sensing for flooding in smart cities	21	Seamless XR streaming
6	Intruder detection in surroundings of smart home	22	UAVs/vehicles/pedestrians detection near Smart Grid equipment
7	Sensing for railway intrusion detection	23	AMR collision avoidance in smart factories
8	Sensing Assisted Automotive Maneuvering and Navigation	24	Roaming for sensing service of sports monitoring
9	AGV detection and tracking in factories	25	Immersive experience based on sensing
10	UAV flight trajectory tracing	26	Accurate sensing for automotive maneuvering and navigation service
11	Sensing at crossroads with/without obstacle	27	Public safety search and rescue or apprehend
12	Network assisted sensing to avoid UAV collision	28	Vehicles Sensing for ADAS
13	Sensing for UAV intrusion detection	29	Gesture Recognition for Application Navigation and Immersive Interaction
14	Sensing for tourist spot traffic management	30	Sensing for automotive maneuvering and navigation service when not served by RAN
15	Contactless sleep monitoring service	31	Blind spot detection
16	Protection of Sensing Information	32	Integrated sensing and positioning in factory hall

Typical use cases

- **Our preference on ISAC use cases for further study in RAN1 Rel-19**
  - ✓ UAV: sensing for flight trajectory tracing, collision avoidance, intrusion detection
  - ✓ Smart traffic: sensing in highway, railway, crossroads, parking space
  - ✓ Smart home: intruder detection, health monitoring

UAV

Smart traffic

Smart home

Target frequency ranges

- **Based on the Table 5.1-1 of TS 38.101-3, the frequency range of 7125 MHz - 24250 MHz doesn’t belong to FR1 or FR2.**
- **It is desired to support ISAC in the frequency range of 7125 MHz - 24250 MHz, i.e. FR3.**
  - Additional channel properties for FR3, e.g. near-field propagation, can be added in future release.

Table 5.1-1: Definition of frequency ranges

Frequency range designation		Corresponding frequency range
FR1		410 MHz – 7125 MHz
FR2	FR2-1	24250 MHz – 52600 MHz
	FR2-2	52600 MHz – 71000 MHz

Channel model for sensing

- **In order to evaluate sensing performance, it is essential to define channel model for sensing.**
- **TR 38.901 has modeled the multipath channel between gNB and UE without the modeling of sensing target(s).**
- **Radar Cross Section (RCS) of the sensing target is an important factor in channel modeling for sensing.**

$$\sigma = \frac{4\pi a^4}{\lambda^2} \qquad \sigma = \pi\left(\frac{d}{2}\right)^2 \qquad \sigma = \frac{\pi d h^2}{\lambda}$$

Typical RCS for simple shapes

Example of channel model for sensing

General objective

- **General objective**
  - ➢ Study on channel modeling for sensing based on TR 38.901 [RAN1]
    - ✓ Large scale fading including RCS of the sensing target
    - ✓ Small scale fading
      - ◆ Modeling of sensing path
      - ◆ Modeling of interference path from the environment
    - ✓ Study how to ensure spatial consistency
    - ✓ Strive to define a unified channel model for varies sensing modes

Appendix

- **Large scale fading**
  - Pathloss considering distance from transmitter to sensing target and distance from sensing target to receiver
    - ✓ Pathloss calculation can be based on TR 38.901
  - Radar Cross Section (RCS) of the target is modeled as additional large scale fading parameter
    - ✓ Randomly generated based on specific distribution, e.g. Uniform distribution, Gaussian distribution,…

Mono-static sensing

Bi-static sensing

Appendix

- **Small scale fading for single-hop assumption**
  - Step 1: Generate delay/power/angles of each cluster between **transmitter** and **receiver** according to TR 38.901.
    - ✓ For mono-static sensing: The angles are symmetrical.
  - Step 2: Calculate delay/power/angles of sensing cluster between **transmitter** and **sensing target** and between **sensing target** and **receiver** according to the location of sensing target.
  - Step 3: Replace one cluster with the sensing cluster.
  - Further steps are according to TR 38.901.

Mono-static sensing

Bi-static sensing

Appendix

- **Small scale fading for multi-hop assumption**
  - Step 1: Generate delay/power/angles of each cluster between **transmitter** and **sensing target** according to TR 38.901.
  - Step 2: Identify the locations of scatters according to departure angles and delays.
  - Step 3: Calculate delay/power/angles of each cluster between **sensing target** and **receiver** including clusters that passing through the identified scatters.
    - ✓ For mono-static sensing: The reflection clusters are the same as the forward clusters.
  - Step 4: Perform random coupling of the generated clusters and calculated clusters.
  - Further steps are according to TR 38.901.

Mono-static sensing

Bi-static sensing

Thanks

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