

# Motivation for Rel-19 Study on Channel Modeling design for Sensing Analysis

3GPP TSG RAN #98-e

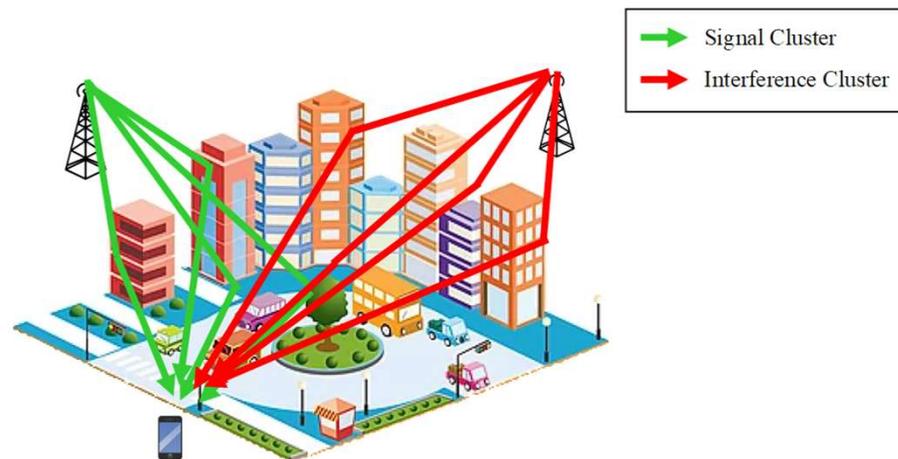
Electronic Meeting, December 12 – 16, 2022

Agenda: 9.1

RP-223119

# Background

- 3GPP SA1 is currently in the process of studying use cases and requirements for integrated sensing and communications in NR
- These use cases may offer promising opportunities for 3GPP with large scale, but currently 3GPP RAN lacks the tools to adequately assess the performance of possible solutions for these use cases
- The channel model specified by RAN1 in TR 38.901 is currently used to assess communication performance between gNB and UE but lacks relevant parameters for assessing a device capability to identify sensing targets and differentiate them from back clutter



Legacy 3GPP channel model

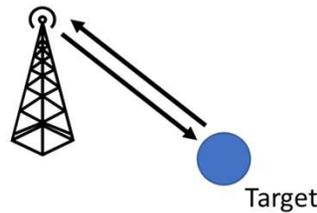
# Motivation

- 3GPP RAN1 needs a reliable framework for assessing the performance of communications and sensing solutions jointly
  - Models for sensing channels and communication channels should be spatially consistent and coherent
  - Models should reflect not only device mobility but sensing target mobility as well
- In order to fairly consider alternative solutions from multiple stakeholders the channel model must support a wide variety of sensing architectures and deployment scenarios
- To support forward-compatible analysis the channel model should be valid over a wide variety of evaluation assumptions not limited to range to target, sounding device height, sensing device height, band of operation, signal bandwidth, target RCS, and target mobility
- To provide fair analysis against the existing non-3GPP state-of-the-art the channel model should strive to achieve either empirical validation or validation against known industry standards

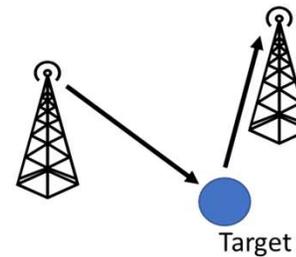
# Potential Sensing Architectures in 3GPP RAN

In 3GPP RAN a number of sensing architectures could be supporting by existing network infrastructure and UE deployments

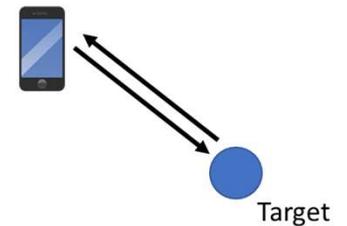
While relevant sensing architectures are use case-specific flexible support of all relevant architectures is necessary for reliable evaluation



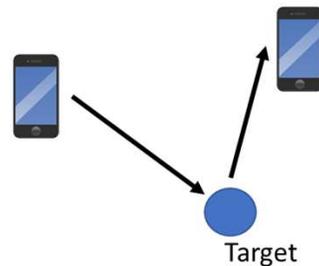
**a.) Mono-static Network-Based:**  
Single gNB acts as sounder and sensor



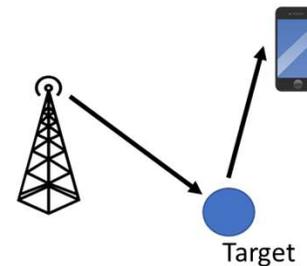
**b.) Bi-/Multi-static Network-Based:**  
One gNB acts as sounder and other gNB(s) act as sensor



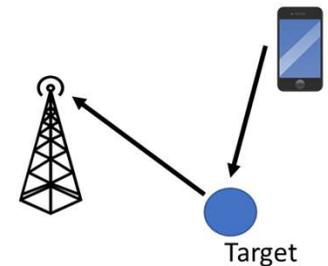
**c.) Mono-static UE-based:**  
Single UE acts as sounder and sensor



**d.) Bi-/Multi-static UE-Based:**  
One UE acts as sounder and other UE(s) act as sensor



**e.) DL-Based Collaborative:**  
One gNB acts as sounder and UE(s) act as sensor



**f.) UL-Based Collaborative:**  
One UE acts as sounder and gNB(s) act as sensor

# Channel Modeling with Novel Sensing Architectures



Channel model for mono-static network-based sensing



Channel model for bi-/multi-static network-based sensing

- Channel modeling for sensing channels is dependent on sensing architectures as identified previously
- For fair analysis it is necessary to ensure that channel models under different sensing architecture assumption are consistent not only with each other, but also with communications channels as well
- In addition to capturing device mobility channel models should capture target mobility including relative mobility between target and background

# RCS Characterization

- A significant fact in target sensing channel modeling is characterization of the reflectivity of the target being sensed
- Typically characterized as radar cross section (RCS)
- RCS defines the ratio of energy received by the sensing device from the target relative to the energy transmitted by the sounding device
  - RCS is generally a function of multiple parameters including:
    - Target size
    - Target shape and orientation
    - Material properties of the target
    - Frequency of the sounding signal used for the sensing operation
- Sensing analysis will require accurate representation of likely sensing target RCS over the range of potential use cases (e.g., pedestrian, automobile, UAV, etc.)
- Parameterized model of target RCS would allow for flexible integration of various targets with existing channel models

# Appendix A: SID Evaluation Scenarios and Assumptions

- The study on channel modeling design for integrated sensing and communication analysis should focus on the following scenarios and assumptions:
  - Channel model specified in TR 38.901 is a baseline model for characterization and enhancements should focus on providing necessary functionality to perform joint evaluation of sensing and communications solution
  - Relevant channels for sensing and communication evaluation should be spatially consistent and coherent.
  - To support flexibility the new channel model should be considered valid over a large range of key parameters including, but not limited to target range, sounding device height, sensing device height, band of operation, signal bandwidth, target RCS, and target mobility.

# Appendix B: SID Objectives

- Define the relevant channels for each of the potentially supported sensing architectures in NR [RAN1]
  - Characterize channel parameters for environmental clutter including overall power, distribution among clusters, number of clusters, cluster AOA/AOD/arrival time, and other statistics.
  - Characterize target channel parameters including number of clusters, cluster AOA/AOD/arrival time and other statistics.
  - Characterize inter-cluster mobility for both target and environment, and spatial relation for each channel
- Develop parameterized model for target RCS [RAN1]
  - Relevant parameters include target classification (i.e., pedestrian, automobile, UAV, etc.), object size and orientation, and sensing band of operation
- Identify range of parameters for valid modeling of sensing operations including target range, sounding device height, sensing device height, band of operation, signal bandwidth, target RCS, and target mobility. [RAN1]

**NOKIA**