RP-233690

KEYSIGHT

Keysight Views on 3GPP Release 19

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Keysight Technologies

Keysight Views on Release 19

Keysight has shared our inputs for the following listed 3GPP Release 19 topics to assist with the development of SIDs/WIDs for these topics

1. Exploring Study in New Spectrum (7-24GHz) and ISAC
2. NTN for NR
3. AI/ML for NG-RAN

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3GPP Release 19 - Exploring Study in New Spectrum (7-24GHz) & ISAC

1. OVERVIEW

- In RP-231540, one of the potential RAN1-led Rel-19 work packages was identified as ISAC / Exploring study in new spectrum (7-24 GHz), indicating that, for the new spectrum, focus should be on channel modeling only, while for ISAC, it could be further discussed if channel modeling only or additionally techniques should be in scope.
- Radio frequencies between 7 and 24 GHz look promising for Rel-19 systems
- TR 38.901 channel models cover 0.5 – 100 GHz
  - Models were originally developed for below 6 GHz and later extended up to 100 GHz with small modifications
  - Models were generated mainly for communication scenarios
- “New” frequency range, new use cases, and new antenna systems bring a need for channel model updates
- The sensing part of ISAC contains a multitude of use cases not supported by TR 38.901
  - Current channel models are for point-to-point and only weakly for point-to-multipoint communication scenarios

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3GPP Release 19 - Exploring Study in New Spectrum (7-24GHz) & ISAC

2. SYSTEMS FOR RADIO FREQUENCIES AT 7-24 GHZ AND ISAC

Aspects affecting channel modelling

- **Extremely large antenna arrays are potentially used at 7-24 GHz frequency range**
  - Very high angular resolution
  - Precise beamforming
- **Wide bandwidths are potentially available at 7-24 GHz frequency range**
  - Beamforming becomes sensitive to BW effects (e.g. beam squinting)
- **Integrated Sensing and Communication (ISAC) has a bigger role -> many new use cases in different frequency ranges**
  - Localization of UEs
  - Radar type of applications for other targets than UE
  - Mapping of environments
  - Sensing of micro motion and diverse set of other events

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3. COMMUNICATIONS CHANNEL MODELS FOR FREQUENCY RANGE 7-24 GHZ

Aspects to be considered

- **The amplitude fading might not be Rayleigh distributed on many paths**
  - In TR 38.901 only the LOS path has Rician and all others have Rayleigh distribution (~40 dB fading)
  - -> possibly a need to introduce a specular component and Rice distribution for NLOS paths
    - measurements & analysis of scattering patterns and amplitude distributions
- **Clusters, i.e., groups of propagation paths are not necessarily properly modelled for high resolution antenna arrays**
  - In TR 38.901 there are 20 equal gain sub-paths -> large array might resolve sub-paths and provide over optimistic high spatial degrees of freedom
  - -> the cluster structure must be studied and possibly revised for FR3
    - measurements & analysis of intra-cluster structure
- **Truly dynamic channel models are needed for evaluation of beam tracking and similar operations**
  - TR 38.901 does not contain dynamic models
  - -> develop modification for good spatial consistency and smoothly time evolving channel conditions
    - consider the alternative hybrid model of TR 38.901 as the starting point of this study
    - no need for measurements, just update the mathematical framework

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4. ISAC CHANNEL MODELS

Aspects to be considered

- **Mono-static and bi/multi-static radar require strong spatial consistency**
- **Evaluation of localization applications is not meaningful if the environment is not defined**
- **Motion of transceivers or radar objects requires dynamic/spatially consistent modelling of channels**
  - Time variant absolute propagation delays and arrival/departure angles, LOS/NLOS transitions, …
- **Back scattering and radar cross section modelling**
  - theoretical model components can be found from literature, possibly new measurements & analysis is needed
- -> current Geometry Based Stochastic Modelling (GSCM) requires enhancements
  - Support for back scattering, moving objects, specular reflections, environment clutter model parameterization
- -> using map-based or other ray tracing type of models might require major updates
  - consider the alternative hybrid model of TR 38.901 as the starting point
- **Diverse sensing use cases may require very specific modelling of radio propagation**
  - -> define and study use cases one by one, check suitability of existing modelling frameworks and develop new models if necessary

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5. SUMMARY / PROPOSAL

- Existing channel model framework and parameterization specified in TR 38.901 must be re-evaluated and necessary updates and modifications must be done
- For some ISAC use cases new model components and updates to GSCM framework must be specified

- **Proposal:**
  - Initiate one combined study item or two separate study items for Rel-19 to research and specify necessary channel model updates to 7-24GHz frequency range and ISAC channel models (text proposals for the justification and objectives of this/these study item(s) can be found in the “Detailed inputs” section of this contribution)

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3GPP Release 19 - NTN for NR

- In Rel-18, work item NR NTN enhancement work item (RP-232669) is adding Ka band as spectrum available for NR Non-Terrestrial communications and initial requirements defined as priority 1 are radiated requirements.
- Additionally, in Rel-19 new frequency bands (as Ku band) could be added to NR NTN spectrum.
- However, OTA test methodologies framework has not been defined for the frequency range between 7 and 24 GHz. This work is usually triggered by RAN4.
- **Proposal:**
  - Define RAN4 Study item to carry out analysis required on OTA test methodologies for frequencies between 7 and 24 GHz (or at least Ka and Ku bands) on top of the assigned work for other features to be added to NR NTN domain.

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3GPP Release 19 - AI/ML for NG-RAN

PROPOSAL FOR STUDY ON AI/ML TEST AND EVALUATION FRAMEWORK

Motivation

- In 3GPP Release 18, WI (RP-231159) (NR_AIML_NGRAN-Core) "Artificial Intelligence (AI)/Machine Learning (ML) for NG-RAN" is planned to be completed by RAN#102 for three AI/ML-based use cases on Network Energy Saving, Load Balancing and Mobility Optimization.
- In additional, SI (RP-230566) (FS_Netw_Energy_NR) "Study on network energy savings for NR" has been completed in Release 18 with a technical report delivered.
- One of the key challenges with deploying AI/ML models in commercial networks is the need to test and evaluate the gain vs complexity / cost for AI/ML enabled optimization. To date, 3GPP has not develop a standardized test methodology and framework to help overcome this challenge.

Proposal

1. **Study in Rel-19, a standardized test methodology and framework for each of the prioritized AI/ML for NG-RAN use cases (RAN4)**
   a) Evaluation of gain vs complexity / cost for AI/ML enabled optimization
   b) Testing the features which can have potential impacts on RF regulations (among others such as UEs and network performances including energy consumption and efficiency, user experiences etc.)
2. **Consider cross domains metrics - UE, Network, AI/ML models, user experiences and correlation between them**
   a) UE and Network performances including energy consumption and efficiency (among others)
   b) Models drift measuring changes between distributions over time from training, validation, even production network data
3. **RAN3 can lead** (supported by RAN4 and additional groups)

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Detailed Inputs for 3GPP Release 19 - Exploring Study in New Spectrum (7-24GHz) & ISAC

3GPP Release 19 - Exploring Study in New Spectrum (7-24GHz) & ISAC

JUSTIFICATION RELATED TO FREQUENCY RANGE BETWEEN 7 AND 24 GHZ

Proposal

Radio frequencies between 7 and 24 GHz are seen promising for Release 19 systems. This document aims at identifying needs for radio channel modelling at the mentioned frequency range for Rel-19. Not only a “new” radio spectrum, but also new deployment and use cases may require new or updated channel models. Models specified in TR 38.901 [1] were originally developed for frequencies below 6 GHz but later for Rel-15 they were extended to cover frequencies up to 100 GHz. Moreover, those models were primarily developed for evaluation of communication links. It means, the channel models specified in TR 38.901 have been originally targeted for evaluation of communication links with relatively small delay and angular resolutions.

Extremely large antenna arrays, potentially used at frequency range between 7 and 24 GHz, enable very high angular resolution and may also lead to such long Fraunhofer distance that the near field condition becomes possible. Substantially enhanced angular resolution might make the sub-paths of 38.901 type channel models resolvable and hence necessitate re-designing the intra cluster structure of such channel models. Wide bandwidth together with very large arrays may make frequency dependent array modelling important to capture effects such as, e.g., beam squinting.

The amplitude fading of resolvable paths might not be Rayleigh distributed in all cases. In TR 38.901 only the LOS path has Rice and all others have Rayleigh probability distribution, where the latter has approximately 40 dB of range of amplitude fluctuation. In addition, TR 38.901 contains an optional ground reflection model that contains specular reflection component. Inclusion of dominant (specular) path component on all or at least many paths must be investigated. The inclusion of dominant component might be needed due to the importance of specular reflection among other propagation mechanisms in frequency range between 7 and 24 GHz and due to the increased resolution of in delay and angle domains. There are many ways to investigate this by propagation measurements. One is measurements and analysis of scattering patterns of individual interactions. Another is continuous measurements in various environments, path identification and tracking, and analysis of their amplitude distributions.

The composition of cluster by sub-paths (rays) in TR38.901 is an aspect highly related to the amplitude distributions and how they are observable by a radio system. Clusters, i.e., groups of propagation sub-paths are not necessarily properly modelled for high resolution antenna arrays. Currently there are 20 equal gain sub-paths and a large array might be able to resolve sub-paths and provide over optimistic high spatial degrees of freedom. Also the delay dispersion of a single cluster must be re-considered. Measurements and analysis are needed to revise the intra cluster structure for frequency range between 7 and 24 GHz channel models.

Primary channel models of TR 38.901 are wide sense stationary, i.e., multipath parameters are static over time. Truly dynamic channel models would be needed for many purposes, e.g., for evaluation of beam tracking and similar operations. In the literature there are already methods for extending geometry based stochastic models to support for dynamic evolution of propagation parameters. The alternative hybrid model of TR 38.901 may also serve as a good starting point for specifying dynamic models.

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3GPP Release 19 - Exploring Study in New Spectrum (7-24GHz) & ISAC

OBJECTIVES FOR CHANNEL MODELS FOR FREQUENCY RANGE BETWEEN 7 AND 24 GHZ

Proposal

1. Research intra cluster structure and its implications on the performance of FR3 7-24 GHz communication links and compare to measurements. Revise the structure in existing models of TR 38.901 if found necessary.
    a) Research scattering patterns and fading distributions and introduce a dominant path component into clusters in existing models of TR 38.901 if found necessary
2. Develop modifications for existing models of TR 38.901 to achieve good spatial consistency and smoothly time evolving channel conditions to support for motion of transceivers or the environment.

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3GPP Release 19 - Exploring Study in New Spectrum (7-24GHz) & ISAC

JUSTIFICATION RELATED TO CHANNEL MODELS FOR ISAC

Proposal

The rising interest towards Integrated Sensing and Communication (ISAC) is an expected direction in Rel-19. The sensing component is different to the traditional communications link between separated transmitter and receiver units. Foreseen versatile use cases of sensing functions introduce atypical radio links and hence require revisiting the existing channel modelling methods that are originally aimed at evaluation of wireless communication links. Current channel models are made mainly for point-to-point links and support only weakly point-to-multipoint communication scenarios and practically not at all, e.g., mono-static radar functions. Overall, the sensing part of ISAC will be containing a multitude of use cases not supported by TR 38.901. Those may be related to, e.g., the following categories: localization of UEs, radar type of applications for other targets than UE, mapping of environments, and sensing of micro motion and diverse set of other events.

Primary channel models of TR 38.901 are wide sense stationary, i.e., multipath parameters are static over time. Truly dynamic channel models would be needed for many purposes, e.g., for evaluation of beam tracking and similar operations. In the literature there are already methods for extending geometry based stochastic models to support for dynamic evolution of propagation parameters. The alternative hybrid model of TR 38.901 may also serve as a good starting point for specifying dynamic models.

There are numerous sensing use cases discussed in the research literature and it is difficult to predict which of those become important for Release-19. Use cases may be related to, e.g., the following categories: localization of UEs, radar type of applications for other targets than UE, mapping of environments, and sensing of micro motion and diverse set of other events. Different uses of radio waves set new demands for channel models and require modelling different aspects of channels as compared to the traditional point-to-point communication.

For example, evaluation of mono-static and bi/multi-static radar require strong spatial consistency from the model. Motion of transceivers or radar objects requires dynamic and spatially consistent modelling of channels, and inclusion of back scattering and radar cross section models. The interacting objects within environment become more important, while currently they are modelled in TR 38.901 only by random static path parameters.

Overall, evaluation of localization applications may not be meaningful if the environment is not defined. Hence, the existing geometry based stochastic approach must be elaborated and possibly even replaced by more environment/layout specific models. For that purpose, the alternative hybrid model of TR 38.901 may serve as a good starting point. Some other simple deterministic (ray tracing based) model may serve as well.

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OBJECTIVES FOR CHANNEL MODELS FOR ISAC

Proposal

Define and study ISAC use cases one by one, check suitability of existing modelling frameworks and develop new models if necessary. Consider modifications to the GSCM approach or use the alternative hybrid model of TR 38.901 as the starting point.

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