3GPP TSG RAN WG1 Meeting #119 **R1-2500414**
Athens, Greek, February 17th – 21st, 2025

Agenda Item: 9.7.2

Source: EURECOM

Title: Discussion on ISAC channel modeling

Document for: Discussion and decision

1. Introduction

According to the SI for Release 19 [1], the objective of this SI is as follows:

> The study should aim at a common modelling framework capable of detecting and/or tracking the following example objects and to enable them to be distinguished from unintended objects:
> - UAVs
> - Humans indoors and outdoors
> - Automotive vehicles (at least outdoors)
> - Automated guided vehicles (e.g. in indoor factories)
> - Objects creating hazards on roads/railways, with a minimum size dependent on frequency
>
> All six sensing modes should be considered (i.e. TRP-TRP bistatic, TRP monostatic, TRP-UE bistatic, UE-TRP bistatic, UE-UE bistatic, UE monostatic).
>
> Frequencies from 0.5 to 52.6 GHz are the primary focus, with the assumption that the modelling approach should scale to 100 GHz. (If significant problems are identified with scaling above 52.6 GHz, the range above 52.6 GHz can be deprioritized.)
>
> For the above use cases, sensing modes and frequencies:
> - Identify details of the deployment scenarios corresponding to the above use cases.
> - Define channel modelling details for sensing using 38.901 as a starting point, and taking into account relevant measurements, including:
>   a) modelling of sensing targets and background environment, including, for example (if needed by the above use cases), radar cross-section (RCS), mobility and clutter/scattering patterns;
>   b) spatial consistency.

The following agreements were made in RAN1#116:

> **Agreement**
>
> The common framework for ISAC channel model is composed of a component of target channel and a component of background channel,
>
> $$H_{ISAC} = H_{target} + H_{background}$$
>
> - Target channel H_{target} includes all [multipath] components impacted by the sensing target(s).
>   - FFS details of the target channel
> - Background channel $H_{background}$ includes other [multipath] components not belonging to target channel
>   - FFS details of the background channel

- FFS whether/how to model environment object(s), i.e., object(s) with known location, other than sensing target(s)
  - FFS whether/how to model propagation path(s) between the target(s) and the environment object(s)
- FFS whether/how to model propagation path(s) between the target(s) and the stochastic clutter(s)
- Note: the notation HISAC can be revised later if needed

The following agreements were made in RAN1#116b:

Agreement

The following cases of radio propagation in the target channel are considered for the study

Case	Tx-target	Target-Rx
1	LOS condition	LOS condition
2	LOS condition	NLOS condition
3	NLOS condition	LOS condition
4	NLOS condition	NLOS condition

- Case 1/2/3/4 can be considered for bistatic sensing mode
- At least Case 1/4 can be considered for monostatic sensing mode
- Note: It doesn't imply the channel response for each link is separately generated then concatenated
- FFS how to determine LOS condition and NLOS condition, e.g., based on LOS probability, or determined based on geometrical locations of environment object (EO).
- In LOS condition, line of sight ray(s) are present between Tx/Rx and target, and there may or may not exist non-line of sight ray(s) between Tx/Rx and target too
- In NLOS condition, there only exist non-line of sight ray(s) between Tx/Rx and target.

Agreement

- In the target channel between Tx and Rx, scattering of a sensing target can be modelled as single scattering point or multiple scattering points
- FFS one or multiple incoming/output rays corresponding to a scattering point
- FFS how to select single or multiple scattering points for the target, e.g. depending on the distance between target and Tx/Rx, size/shape of target, etc.
- Note: the sensing target can be assumed in far field of sensing Tx/Rx.
- FFS details to model the single or multiple scattering points.

Agreement

RCS of a physical object shows dependency to at least the following factors:

- Type of the object
  - The size of the object

- The material of the object
  - The shape of the object
- Orientation of the object
- FFS: Distance between Tx/Rx and the object
- The incident angle and scatter angle
- The carrier frequency
- polarization of the transmitter and receiver
- FFS Temporal or spatial consistency
- FFS antenna pattern
- FFS whether/how to model the above factors in the CR, e.g. with an RCS model with a scattering point

Agreement

EO is a non-target object with known location.

- FFS other known parameters of the EO
- FFS details on EO modeling

The following options for EO modeling are considered for further study

- Option 1: EO is modelled different from a sensing target
  - Applicable at least for an EO having extremely large size (referred as EO type-2 for discussion purpose)
  - FFS modeled similar to section 7.6.8 ground reflection in TR 38.901
  - FFS EO modeling impacts the target channel and/or the background channel
- Option 2: EO is modeled same/similar as a sensing target
  - Applicable for an EO having comparable physical characteristics as a sensing target, (referred as EO type-1 for discussion purpose)
  - FFS Applicable for EO type-2
  - FFS EO modeling impacts the target channel and/or the background channel
- Option 3: EO is modeled and its location is determined from a stochastic clutter generated following the cluster generation in TR 38.901
  - FFS details
- Option 4: EO is not modelled
- Other options are not precluded
- Note: it is not precluded that multiple options can be supported in the channel modelling

Agreement

The following options are considered for further study to model the target channel for a target

- Option 1: modelled by concatenation of path(s) from Tx to target and from target to Rx
- Option 2: modelled by Tx-to-Rx path(s) satisfying Tx-target-Rx geometry
- Option 3: combination of Option 1 and Option 2

Agreement

If a target is modelled with single scattering point, the following options to model RCS of the target are considered for further study.

- Option 1: Random RCS value generated by a statistical distribution, depending on the factor(s) having impacts on the RCS modelling.
  - FFS the distribution.
  - FFS the factor(s)

- Option 2: Deterministic RCS value is defined by a function and/or a table, depending on the factor(s) having impacts on the RCS modelling
    - Note: Constant RCS for a target type can be a special case of Option 2
    - FFS the factor(s)
    - FFS details of function and/or table
- Option 3: combination of Option 1 & 2, e.g., RCS value is generated by combining a deterministic component and a randomly generated component.
- FFS application of each option to large scale fading and/or small scale fading
- FFS target with multiple scattering points

Agreement

- Interested companies are encouraged to submit validation results together with their proposal for ISAC channel modeling
- Up to each company to select the way for validation
    - Option 1: Experimental results
    - Option 2: Experimental results to validate a ray-tracing model, then the ray-tracing based results to validate the ISAC channel model
        - Note: the layout of the scenario used for validation is up to company choice

Agreement

ISAC channel model for link level simulation is to be discussed after the system level channel model is sufficiently stable with basic functionalities.

The following agreements were made in RAN1#117:

Agreement

- Multiple sensing targets can be modelled in the ISAC channel of a pair of sensing Tx and sensing Rx
    - FFS whether to model a propagation path from Tx to Rx interacting with more than one sensing target
- The same sensing target can be modelled in the ISAC channels of multiple pairs of sensing Tx and Rx

Agreement

- For discussion purpose, the propagation paths in the target channel are classified
    - The direct path, i.e., LOS ray from Tx to target + LOS ray from target to Rx
    - The indirect paths, i.e., any propagation path other than the direct path, including
        - LOS ray from Tx to target + NLOS ray from target to Rx
        - NLOS ray from Tx to target + LOS ray from target to Rx
        - NLOS ray from Tx to target + NLOS ray from target to Rx
- For radio propagation Case 1,
    - For a direct path, the following parameters are [deterministically] generated at least based on the geometry location of Tx, target and Rx
        - AoA/ZoA at Rx
        - AoD/ZoD at Tx
        - AoA/ZoA/AoD/ZoD at target
        - delay
        - FFS initial phase
        - Doppler
        - FFS power/polarization including the impact of RCS
        - FFS the number of direct path(s) for a target
    - FFS on detailed modelling of indirect path(s)

- FFS on details of modelling of indirect paths in radio propagation Case 2/3/4
- To generate the channel coefficients of direct/indirect path(s) in the target channel, the channel coefficient generation function in step 11 in section 7.5 of TR 38.901 (e.g., formula 7.5-22) is used as the start point
    - Note: modification to step 11 is deemed necessary
    - FFS adding impact of small scale RCS
    - FFS Doppler

Agreement

- Spatial consistency should be supported for ISAC channel
- Spatial consistency should be supported based on movement of sensing Tx, sensing target and/or sensing Rx
    - FFS EO handling

Agreement

When the stochastic cluster is used to generate the indirect paths in the target channel of a target

- The stochastic cluster generation in section 7, TR 38.901 is used as starting point.
    - FFS a stochastic cluster is generated between Tx and Rx satisfying Tx-target-Rx geometry, or between Tx/Rx and target
        - FFS modification to stochastic cluster generation in section 7, TR 38.901
        - FFS use of sub-cluster to model the indirect paths

Note: RAN1 continues studying using EO to generate the indirect paths in the target channel of a target

Agreement

When the stochastic cluster is used to model indirect path in the target channel

- For bistatic, the LOS condition from Tx to target and from target to Rx is determined separately for a target
    - FFS: The correlation of LOS condition of Tx-target and Rx-target links of a target
- For monostatic, a same LOS condition is determined for Tx to target and target to Rx
- The LOS condition from Tx to target and/or from target to Rx is determined with the LOS probability
    - The probability schemes in existing 3GPP TRs, e.g., TR 38.901. TR 36.777, TR 37.885, etc. are considered as start point
    - FFS: How to consider the impacts of target height on LOS probability.

Agreement

When stochastic cluster is used to model indirect path in the target channel, down-select between the following options

- Option 1: modelled by concatenation of path(s) from Tx to target and from target to Rx
    - For each of the Tx-target link and target-Rx link,
        - The parameters delay, power, angle, [initial phase], [Doppler] of NLOS ray(s) in the link Tx-to-Target or Target to RX are generated
            - FFS following cluster generation in section 7, 38.901
        - The target channel is generated by concatenating the parameters of the Tx-target link and target-Rx link.
            - FFS on Convolutional or 1-by-1 coupling or 1-to-many coupling
    - FFS how to combine the clusters in target channel and the clusters in background channel
- Option 2: modelled by Tx-to-Rx path(s) satisfying Tx-target-Rx geometry of the direct path

- The parameters delay, power, angle, initial phase of a stochastic (sub-)cluster between Tx and Rx are generated following cluster generation in section 7, 38.901
    - The parameters [delay], [power], [angle], [Doppler] of the (sub-)cluster are updated by the target property
- FFS how to combine the clusters in target channel and the clusters in background channel

The following agreements were made in RAN1#118:

Agreement

If RCS related coefficient of a scattering point is included in small scale, the RCS related coefficients are separately determined for different pairs of incident/scattered ray(s) at the scattering point.

Agreement

For radio propagation Case 1, for modelling the target channel of a target with single scattering point,

- To model a direct path, a single LOS ray from Tx to target and a single LOS ray from target to Rx are generated
    - AoA/ZoA of the direct path at Rx, AoD/ZoD of the direct path at target are generated at least based on the 3D location of target and Rx in the global coordinate system
    - AoD/ZoD of the direct path at Tx, AoA/ZoA of the direct path at target are generated at least based on the 3D location of Tx and target in the global coordinate system
    - The Delay of the direct path = (d3D_tx_target + d3D_target_rx)/c
    - The Doppler of the direct path is generated by spherical unit vectors by AoD/ZoD at Tx, by spherical unit vectors by AoA/ZoA at Rx, and velocity of Tx, target and Rx
    - The power of the direct path is generated as the product of the power of the LOS ray from Tx to target, the power of the LOS ray from target to Rx, and the effect of RCS
    - FFS initial phase
    - FFS how to model RCS, polarization of target
- FFS number of direct paths
- FFS on detailed modelling of indirect path(s)
- FFS applicability of direct path generation to each scattering point when the target is modelled as multiple scattering points

Agreement

For the target channel of a target with single scattering point, when stochastic cluster is used to model an indirect path in the target channel,

- An indirect path in small scale is modelled by concatenation of path(s) from Tx to target and from target to Rx, i.e., Option 1 in the agreement of RAN1 #117
    - AoD/ZoD/AoA/ZoA from Tx to target or from target to Rx are
        - generated for a LOS ray at least based on the 3D location of Tx/Rx and target in the global coordinate system
        - stochastically generated for a NLOS ray using section 7, 38.901 as starting point
    - Delay is sum of delay of LOS/NLOS ray from Tx to target and the LOS/NLOS ray from target to Rx
    - Doppler is generated by spherical unit vector by AoD/ZoD at Tx and velocity of Tx, by spherical unit vector by AoA/ZoA at Rx and velocity of Rx, and by spherical unit vectors by AoA/ZoA/AoD/ZoD at target and velocity of target
        - FFS The mobility of stochastic clutter

- The power of the indirect path is generated as the product of the power of the LOS/NLOS ray from Tx to target, the power of the LOS/NLOS ray from target to Rx and the effect of RCS
- FFS initial phase
- FFS how to model effect of RCS at target
- FFS whether/how to model polarization at target
- FFS How to reduce complexity
- FFS applicability of the indirect path generation to each/a single scattering point when the target is modelled as multiple scattering points

Agreement

The RCS related coefficient of a scattering point can be modelled with two components, i.e., linear value

RCS = A*B

- A first RCS component A (m^2) is included in large scale
  - FFS the first RCS component is deterministic or stochastic
  - FFS The first component is dependent on incident and scattered directions at target
- A second RCS component B (unit ratio) is included in small scale
  - FFS The second component is dependent on incident and scattered directions at target
  - FFS the second RCS component is deterministic or stochastic or combination
- Note: RCS component A or B can be disabled by setting its linear value to 1
  - Whether to disable a component can be discussed per target type
- FFS how to determine A and B for each target
- FFS whether/how to model polarization impact at target
- FFS whether/how to normalize power accounting for target channel and background channel

Agreement

The impact of a scattering point of the target in the target channel is modelled by a scalar RCS value RCS times a complex-valued 2x2 polarization matrix CPM_{sp}, i.e., $\sqrt{RCS} \cdot CPM_{sp}$

- FFS whether CPM_{sp} is angular/ray-dependent or independent.
- FFS whether polarization matrix CPM_{sp} is modelled assuming specular reflection or random coefficient for diffraction or scattering.
- FFS whether polarization matrix CPM_{sp} is explicitly modelled or merged with other polarization matrixes from Tx to target and/or from target to Rx.

Agreement

For modeling stochastic cluster in background channel, in order to define the background channel for TRP-UE and UE-TRP bistatic sensing mode,

- The large scale and small scale parameters defined in TR 38.901, TR 37.885, TR 36.777 are used as start point

In order to define the background channel for TRP-TRP and UE-UE bistatic sensing mode,

- RAN1 to study how to model background channel
  - Option 1: The large scale and small scale parameters defined in TR 38.901, TR 38.858, 37.885, 38.859 are used as start point.
  - Option 2: New channel model based on measurement results or ray-tracing model validated by experimental results.

FFS whether/how to do power normalization between target channel and background channel.

Agreement

In order to define the background channel for TRP and UE mono-static sensing mode,

- RAN1 to study how to model the background channel
  - Option 1: randomly drop at least one virtual Rx, and then the background channel is generated based on the channel generated as TR 38.901 between the real Tx and each virtual Rx for a scenario.
    - FFS EO is modelled in the background channel.
  - Option 2: New channel model based on measurement results or ray-tracing model validated by experimental results or radar literatures.
    - FFS EO is modelled in the background channel.
  - Option 3: the locations of clusters in the target channel are deterministically generated, then the background channel is generated using the clusters with the determined locations.
  - Other options are not precluded.

Agreement

When EO type-2 is modelled, specular reflection is considered to model EO type-2 using section 7.6.8 of TR 38.901 as reference

- As starting point, the effect of type-2 EO (i.e., in the path node1-EO-node2) is modelled as $b\begin{bmatrix} R_{\parallel}^{specular} & 0 \\ 0 & -R_{\perp}^{specular} \end{bmatrix}$, b is a scaling factor (e.g., c equals to $\frac{d_{3D}}{d_{GR}}$ relative to LOS ray in section 7.6.8 in TR 38.901)
  - FFS any update to $b, R_{\parallel}^{specular}, R_{\perp}^{specular}$
  - FFS any update taking EO orientation into account
- FFS any changes based on section 7.6.8 of TR 38.901 if EO type-2 has finite size
- FFS whether diffraction and scattering can be considered in addition to specular reflection
- EO type-2 is an optional modelling component if supported in a sensing scenario
  - FFS which deployment scenario(s) EO type-2 will apply

The following agreements were made in RAN1#118b:

Agreement

RAN1 strives to define a single option per target per monostatic/bistatic sensing mode from the following two options to generate RCS values/patterns for a scattering point of a target.

- Option 2: The RCS=A*B of a scattering point can be generated by
  - The component A is commonly applied to any incident/scattered angles at the scattering point
    - A is [mean] RCS value. FFS value(s) A
      - Note: Mean RCS value is defined as the mean value of the distribution of RCS
  - The component B
    - B is generated by [log-normal] distribution, the related [log-normal] distribution has mean μ=1 and variance V, FFS σ^2

            - B is separately generated for each direct/indirect path at the scattering point. FFS correlation dependent on the incident/scattered angles of the direct/indirect paths
    - FFS whether/how power of all generated direct/indirect paths need to be normalized considering impact of RCS
- Option 3: The RCS=A*B=A*B1*B2 of a scattering point can be generated by
    - The component A is commonly applied to any incident/scattered angles at the scattering point
        - FFS: A = 1 m^2 or [mean] RCS value
            - Note: Mean RCS value is defined as the mean value of the distribution of RCS
    - The component B is further split into B1, B2, i.e., B=B1*B2
        - B1 is deterministic based on incident/scattered angles
            - FFS: B1 is defined by a function or by a table
        - B2 is generated by [log-normal] distribution, the related [log-normal] distribution has mean μ=1 and variance V, FFS σ^2
            - B2 is separately generated for each direct/indirect path at the scattering point. FFS correlation dependent on the incident/scattered angles of the direct/indirect paths
    - FFS whether/how power of all generated direct/indirect paths need to be normalized considering impact of RCS

Agreement

RCS Option 3 is selected to model RCS of UAV with single scattering point for monostatic

- B2 of UAV is modelled using log-normal distribution for monostatic
- Different mean RCS values can be supported for UAV due to different size, shape, frequency, etc.
- For UAV of small size (option 2 for UAV size in UAV parameters table)
    - B1=1
    - A is mean RCS value
- For UAV of large size (option 1 for UAV size in UAV parameters table)
    - B1 have dependency on incident/scattered angles
    - A is mean RCS value

Agreement

To model the effect of polarization for each direct/indirect path:

- Polarization of a direct/indirect path is product of polarization matrix of Tx-target link, the target, and the target-Rx link
    - Total polarization of a direct/indirect path is $CPM_{tx,sp,rx} = CPM_{sp,rx} \cdot CPM_{sp} \cdot CPM_{tx,sp}$
        - For a LOS ray from Tx to target or from target to Rx, $CPM = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$ for $CPM_{tx,sp}$ or $CPM_{sp,rx}$
        - For a NLOS ray generated by a stochastic cluster from Tx to target or from target to Rx, $CPM_{tx,sp}$ or $CPM_{sp,rx}$ CPMis generated by XPR ratio □ and initial random phases referring to TR 38.901 as start point
        - FFS how to normalize on $CPM_{tx,sp,rx}$ CPM~~tx,sp,rx~~
        - FFS CPM_{sp} CPM~~sp~~ of a scattering point of the target
- FFS: how to model the effect of polarization when EO type-2 is present

Agreement

A single direct path is modeled for a scattering point of target

- In each of the Tx-target and target RX links, the first NLOS cluster is generated with same delay as the LOS ray (when the absolute delay modelling of $\Delta\tau$ as in section 7.6.9, TR 38.901 is not applied) and with the same direction as the LOS ray.
    - FFS how to generate NLOS cluster when $\Delta\tau$ is applied.

Agreement

In order to generate each of the Tx-target link and target-Rx link in the target channel, the large scale and small scale parameters defined in existing 3GPP TRs, e.g., TR 38.901. TR 36.777, TR 37.885, TR 38.858, TR 38.859, TR 38.802, TR 38.854, etc. are used as starting point.

Agreement

On the background channel for TRP-TRP and UE-UE bistatic sensing mode, the large scale and small scale parameters defined in TR 38.901, TR 38.858, 37.885, 38.859 are used as starting point.

- Update on values of the LSP/SSP parameters can be discussed based on validation data acquired by measurement or ray-tracing model.
    - FFS The power threshold for removing clusters in step 6, i.e., -25 dB is revised to X<-25 dB. FFS X.
- FFS whether/how to resolve the inconsistency between TRP-TRP channel according to TR 38.858 and the TRP-target (UAV) channel according to TR 36.777 when UAV and TRP are set to same height.

Agreement

3D spatial consistency needs to be studied for at least UAV scenario.

Agreement

In LOS condition between sensing Tx/Rx and target, the power of LOS ray is generated following power of LOS ray in TR 38.901.

Agreement

The following options are to be studied for the concatenation of Tx-target and target-Rx link in the target channel

- Direct path (if present) is always kept
- Indirect paths of LOS+NLOS, NLOS+LOS (if present) are generated
- On other indirect paths of NLOS + NLOS
    - Option 0: ray level full convolution between Tx-target link and target-Rx link for radio propagation Case 1/2/3/4
    - Option 0A: ray level full convolution between Tx-target link and target-Rx link only for radio propagation Case 4
    - Option 1: cluster level full convolution between Tx-target link and target-Rx link, then 1-by-1 coupling rays within each pair of clusters for radio propagation Case 1/2/3/4
    - Option 1A: cluster level full convolution between Tx-target link and target-Rx link, then 1-by-1 coupling rays within each pair of clusters only for radio propagation Case 4
    - Option 2: cluster level 1-by-1 coupling between Tx-target link and target-Rx link, then 1-by-1 coupling rays within each pair of clusters for radio propagation Case 1/2/3/4
    - Option 2A: cluster level 1-by-1 coupling between Tx-target link and target-Rx link, then 1-by-1 coupling rays within each pair of clusters only for radio propagation Case 4

- Option 3: ray level 1-by-1 coupling between Tx-target link and target-Rx link for radio propagation Case 1/2/3/4
    - Option 3A: ray level 1-by-1 coupling between Tx-target link and target-Rx link only for radio propagation Case 4
- Note: reducing the number of rays per cluster and/or reducing the number of clusters can be considered for the options above
- Any indirect path with power metric less than [threshold] is dropped
    - the power metric of a path is the product of power of a ray in Tx-target link, power of a ray in target-Rx link and RCS of the pair of rays
    - FFS power normalization of target channel after path dropping
    - FFS the set of remaining indirect paths can be updated during movement of Tx, target or Rx

The following agreements were made in RAN1#119:

Agreement

- To generate indirect paths of NLOS ray + NLOS ray in the target channel
    - Option 0 is recommended, i.e., ray level full convolution between Tx-target link and target-Rx link for radio propagation Case 1/2/3/4
    - Option 3 to generate a reduced number of indirect paths of NLOS ray + NLOS ray is recommended, i.e., ray level 1-by-1 random coupling between Tx-target link and target-Rx link is supported for radio propagation Case 1/2/3/4
        - If number of rays in the two links are different, e.g., M1, M2 respectively for link 1 and link 2,
            - If M1<M2, randomly M1 rays are selected in link 2, otherwise randomly M2 rays are selected in link 1
    - Other methods are up to company choice for complexity reduction
    - Both option 0 and 3 will be calibrated independently. Company should report which option is used in calibration
- The power threshold for path dropping is X=[-25] dB
    - X is relative to the strongest indirect path in the target channel
- FFS: further power normalization of target channel is performed after path dropping,
- Note: power normalization when target channel and background channel are combined can be discussed separately
- FFS The set of remaining indirect paths can be updated during movement of Tx, target or Rx

Agreement

The following RCS models are supported when human is modelled with single scattering point for monostatic, where different RCS values and/or models can be supported for human due to different size, shape, frequency, etc.

- Model 1
    - B1=0 dB
    - A is mean RCS value
    - B2 is modelled using log-normal distribution
- Model 2
    - B1 have dependency on incident/scattered angles, with further down-selection among the alternatives below:
        - Alt 1: formulated similar as the antenna radiation power pattern in 38.901
        - Alt 2: a function
        - Alt 3: Lookup table
    - B2 is modelled using log-normal distribution
    - FFS RCS component A
- FFS: conditions for using which model

Agreement

The following RCS model is supported when vehicle is modelled with single scattering point for monostatic, where different RCS values can be supported for vehicle due to different size, shape, frequency, etc.

- B1 have dependency on incident/scattered angles, with further down-selection among the alternatives below:
  - Alt 1: formulated similar as the antenna radiation power pattern in 38.901
  - Alt 2: a function
  - Alt 3: Lookup table
- B2 is modelled using log-normal distribution
- FFS RCS component A

Agreement

When vehicle is modelled with multiple scattering points for monostatic, where different RCS values can be supported for vehicle due to different size, shape, frequency, etc.

- the recommended five scattering points are located in front, left, back, right and roof side of the vehicle
- the following RCS model is supported for each scattering point
  - B1 have dependency on incident/scattered angles, with further down-selection among the alternatives below:
    - Alt 1: formulated similar as the antenna radiation power pattern in 38.901
    - Alt 2: a function
    - Alt 3: Lookup table
  - B2 is modelled using log-normal distribution
  - FFS RCS component A

Agreement

EO type-1 (when modelled) is modelled in the same way as a sensing target in the ISAC channel model.

Agreement

- If blockage/forward scattering between sensing targets is not considered, a propagation path from Tx to Rx interacting with more than one sensing targets is not modelled.
- FFS whether/how blockage/forward scattering can be modelled in the target channel.

Agreement

- Doppler for a target including both macro-Doppler and micro-Doppler can be modeled using a unified formula,

$$\frac{\hat{r}_{rx,n',m'}^{T}(t).\bar{v}_{rx}(t)+\hat{r}_{p,n',m'}^{T}(t)\cdot\bar{v}_{sp}(t)+\hat{r}_{tx,n,m}^{T}(t).\bar{v}_{tx}(t)+\hat{r}_{p,n,m}^{T}(t)\cdot\bar{v}_{sp}(t)}{\lambda_0}+f(t)$$

Where,

  - $\hat{r}_{rx,n',m'}^{T}$ is the spherical unit vector at receiver for the link from Rx to the scattering point
  - $\hat{r}_{tx,n,m}^{T}$ is the spherical unit vector at transmitter for the link from Tx to the scattering point

- $\hat{r}^{T}_{p,n',m'}$ is the spherical unit vector at the scattering point for the link from the scattering point to Rx
- $\hat{r}^{T}_{p,n,m}$ is the spherical unit vector at the scattering point for the link from the scattering point to Tx

- Dual mobility model in 7.6.10, TR 38.901 is used as start point to model Doppler effect $f(t)$ due to movement of stochastic clusters, i.e., $\frac{2\alpha_{n,m}D_{n,m}}{\lambda_0}$
  - $f(t)$ is only applicable for indirect path
  - Support one term of $\frac{2\alpha_{n,m}D_{n,m}}{\lambda_0}$ for indirect path of LOS ray+NLOS ray, NLOS ray+LOS ray
  - Support two terms of $\frac{2\alpha_{n,m}D_{n,m}}{\lambda_0}$ for indirect path of NLOS ray+NLOS ray
- Doppler is separately determined for each of the multiple scattering points of a target
- $\overline{v}_{sp}(t)$ can include macro-Doppler and/or micro-Doppler motion,

$$\overline{v}_{sp}(t) = \bar{v}_{\text{macro}}(t) + \bar{v}_{\text{micro,p}}(t)$$

- FFS: maximum speed of moving scatterers
- FFS: ratio of moving scatterers among all scatterers

Agreement

- The following options are supported to generate the combined ISAC channel
  - Option 1: The ISAC channel of a pair of sensing Tx/Rx is obtained by summing the target channel(s) and background channel, i.e., power normalization is not performed.
  - Option 2: As an additional modelling component, power normalization is performed when summing the target channel(s) and background channel, to keep the same/similar channel power as the background channel without target. Down select between
    - Alt 1: Power normalization on both target channel and background channel
    - Alt 2: Power normalization on background channel only
    - Alt 3: the target channel of a target will replace one cluster in the background channel
- FFS Blockage is modelled for the background channel due to sensing target and/or EO type-2
- FFS condition to select option, e.g. depending on scenario, sensing mode, number of target/EO type-2

Agreement

To model the polarization matrix of a direct/indirect path at a scattering point of an object other than EO type-2, the polarization matrix of the scattering point, i.e., $CPM_{sp,i}$ is modelled by $\alpha_{i,1}, \alpha_{i,2}, \beta_{i,1}, \beta_{i,2}$, and initial random phases $\{\Phi^{\theta\theta}_{sp,i}, \Phi^{\theta\phi}_{sp,i}, \Phi^{\phi\theta}_{sp,i}, \Phi^{\phi\phi}_{sp,i}\}$, i.e., $CPM_{sp,i} = \begin{bmatrix} \alpha_{i,1}exp(j\Phi^{\theta\theta}_{sp,i}) & \beta_{i,1}exp(j\Phi^{\theta\phi}_{sp,i}) \\ \beta_{i,2}exp(j\Phi^{\phi\theta}_{sp,i}) & \alpha_{i,2}exp(j\Phi^{\phi\phi}_{sp,i}) \end{bmatrix}$

- The initial random phase $\{\Phi^{\theta\theta}_{sp,i}, \Phi^{\theta\phi}_{sp,i}, \Phi^{\phi\theta}_{sp,i}, \Phi^{\phi\phi}_{sp,i}\}$ is [uniformly distributed within $(-\pi, \pi)$]
- FFS correlation between $\alpha_{i,1}, \alpha_{i,2}, \beta_{i,1}, \beta_{i,2}$
- FFS specular reflection
- FFS: CPM normalization

The following options are considered for further study, down select one option from the following

- Option 1: $\alpha_{i,1} = \alpha_{i,2} = 1$, $\beta_{i,1} = \beta_{i,2} = \sqrt{\kappa_{sp,i}}^{-1}$ is generated for path i, where $\kappa_{sp,i}$ is XPR ratio
  - $\kappa_{sp,i}$ is randomly generated by log-normal distribution. FFS mean/variance of the distribution
- Option 2: $\alpha_{i,1} = 1$, $\alpha_{i,2}, \beta_{i,1}, \beta_{i,2}$ are variables generated for path i
- Option 3: $\alpha_{i,1}, \alpha_{i,2}, \beta_{i,1}, \beta_{i,2}$ are variables generated for path i
  - $CPM_{sp,i}$ defined in LCS

- Option 4: $\alpha_{i,1} = \alpha_{i,2} = 1$, $\beta_{i,1} = \beta_{i,2} = 0$ is generated for path i

Agreement

The finite size of the EO type-2 affects identification of specular reflection point. In the target channel, EO type-2 is modelled only if the specular reflection point is in the area of the EO type-2.

Agreement

Component B2 of RCS is upper bounded by kσ dB for the log-normal distribution, where σ is the standard deviation of B2 in dB. FFS the value of k.

Agreement

When the EO type-2 is modelled in the target channel, down select between the following options to determine the LOS condition of the Tx-target link and target-Rx link

- Option A: If type-2 EO is in the LOS ray of one link, the link is determined as NLOS condition, and otherwise use the LOS probability equation to determine the LOS/NLOS condition
    - FFS changes to the LOS probability defined in existing TRs
    - FFS details on blockage by EO type-2
- Option B: Use the LOS probability equation to determine the LOS/NLOS condition of one link, and then the impacts of type-2 EO is modeled by a blockage model.

In this contribution, we discuss some viewpoints of ISAC channel modeling.

2. Sensing channel

New parameters for sensing channel are generated after the general parameters such as LOS probability, root mean square delay spread, root mean angular spread, power, delay, arrival and departure angles are generated as in the current 3GPP model. Similar to communication channel with communication clusters, there are sensing clusters in the sensing channel. The size and type of scatters determine the distribution of multipath components. Pathloss and shadowing fading are calculated for each sensing cluster then applied to each ray in the cluster. Based on the below parameters and applying cross polarization power ratios as the communication channel, channel coefficient for the sensing cluster in time domain are generated with the field patterns of the receiving and transmitting antennas (the azimuth angle of departure, zenith angle of departure, azimuth angle of arrival and zenith angle of arrival) for each ray in each cluster. The procedure is shown in Figure 1 where the highlighted squares show the modification in the procedure compared to the current procedure in TR39.901 to generate the coefficients for the sensing channel. The channel is developed based on Geometry-based stochastic channel model TR 38.901. The parameters need to be updated for the channel model of TRP-TRP link and UE-UE link.

Proposal 1: The channel is developed based on Geometry-based stochastic channel model TR 38.901. The parameters need to be updated for the channel model of TRP-TRP link and UE-UE link.

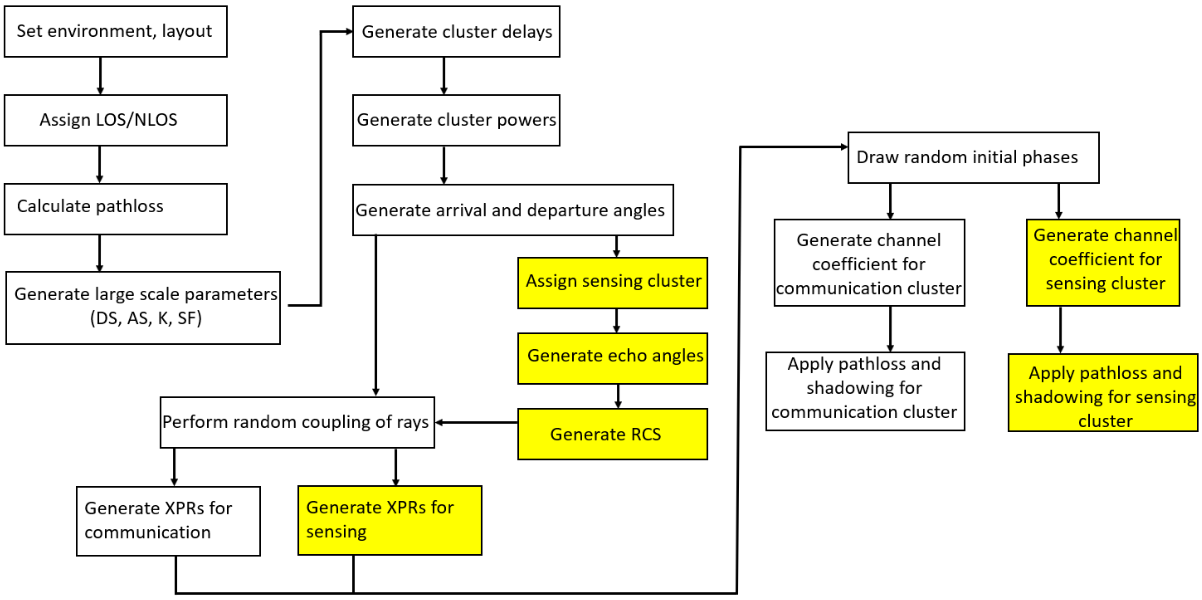

Figure 1. Channel coefficients generation procedure for communication and sensing channels.

2.1. Echo angle

Echo angle is the arrival angle of the echo signal at the sensing antenna. Echo spread angle can be used to represent the characters of the scatter such as shape, type, size. Echo angle is generated for each ray of each sensing cluster.

2.2. Radio cross-section (RCS)

RCS represents the radio wave scattering characteristic of an object. RCS of the sensing target affects the echo signal from the target to the transmitter. RCS of the objects varies with the size, shape and material of the objects, the orientation of the objects, the arriving angle of the signal, polarization of the transmitter and receiver, and also with the frequency of the signal. RCS is used to calculate reflection coefficient that is used to calculate the received echo signal.

The simplest model is to use a single point model. A point on the sensing target is used as an ideal scattering point to represent the sensing target and the amplitude and position of the scattering point are modelled as constants. For big targets in fast fading channel, multiple points can be used to model RCS where all the points have the same RCS value or each point has its own value. The size of the targets, type of channel as well the distance between the sensing target and Tx/Rx determine the use of multiple scattering points and the number of the points used to model RCS. The number of scattering points is determined at the beginning and does not change in the whole process. Each scattering point in the multiple scattering points is modelled independently as if a single scattering point is modelled on the sensing target so RCS value of each scattering point on the sensing target in the multiple scattering points is determined independently. No ray is scattered from one point to another point of the same target.

For RCS of UAV, for small UAV, RCS is independent to incident/scattered angles so B1 is 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = \frac{-ln(10)}{20}\sigma_{B2}^2$. For big UAV, RCS is dependent of incident/scattered angles modelled with B1 different to 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = 0$.

RCS option 3 is used to model RCS of AGV with single scattering point for monostatic. A is mean RCS value. B2 is modelled using log-normal distribution. For small AGV, B1 is equal to 1. For large AGV, B1 has dependency on incident/scattered angles so B1 is different to 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = 0$.

For RCS of animals, it is independent to incident/scattered angles so RCS option 2 or RCS option 3 with B1 equal to 1 is used. In both options, A is mean RCS value. If Option 2 is used, B is modelled using log-normal distribution. If Option 3 is used, B2 is modelled using log-normal distribution.

RCS of the same object might also be different in monostatic and bistatic modes that requires the measurements to determine RCS in different modes.

Proposal 2: The number of scattering points depend on the size of the targets, type of channel as well the distance between the sensing target. The number of scattering points is determined at the beginning and does not change in the whole process.

Proposal 3: Each scattering point in the multiple scattering points is modelled independently as if a single scattering point is modelled on the sensing target.

Proposal 4: RCS value of each scattering point on the sensing target in the multiple scattering points is determined independently.

Proposal 5: No ray is scattered from one point to another point of the same target.

Proposal 6: For RCS of UAV, for small UAV, RCS is independent to incident/scattered angles so B1 is 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = \frac{-ln(10)}{20}\sigma_{B2}^2$. For big UAV, RCS is dependent of incident/scattered angles modelled with B1 different to 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = 0$.

Proposal 7: RCS option 3 is used to model RCS of AGV with single scattering point for monostatic. A is mean RCS value. B2 is modelled using log-normal distribution. For small AGV, B1 is equal to 1. For large AGV, B1 has dependency on incident/scattered angles so B1 is different to 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = 0$.

Proposal 8: RCS option 2 or RCS option 3 with B1 equal to 1 is used to model RCS of animals. In both options, A is mean RCS value. If Option 2 is used, B is modelled using log-normal distribution. If Option 3 is used, B2 is modelled using log-normal distribution.

Proposal 9: The small-scale parameters for the sensing channel such as RCS, echo angles, cross power ratio are generated after the general parameters are generated. Subsequently, channel coefficient for the sensing channel is generated then pathloss is calculated for each sensing cluster.

Proposal 10: RCS of an object in the bistatic mode is obtained by measurement or ray-tracing.

2.3. Target channel model

For the target channel containing target, environment objects (EOs) and stochastic clutter, the small-scale parameters of the rays in the Tx-target link and the target-Rx link are coupled in 1-1 mapping for radio propagation Case 1/2/3/4 then the coupled small-scale parameters are used to generate channel coefficient for the Tx-Rx link. There are one LOS ray and several NLOS rays due to EOs and stochastic clutters in the Tx-Rx link.

The power of the signal weakens after each bounce. After two bounces, the power of the signal is weak for target detection. Taking the signal into account with more than two bounces between Tx and Rx is not necessary and increases the complexity. Therefore, there are maximum 2 bounces between Tx and Rx. Moreover, the indirect paths between Tx and Rx with power less than 25 dB power of the strongest path are removed.

The target channel is modelled with Tx - target - Rx rays, Tx - target - EO type2/stochastic clutter - Rx rays, Tx - EO type 2/stochastic clutter - target - Rx rays. The deterministic paths include: Tx - target - Rx, Tx - target - EO type2 - Rx, Tx - EO type2 - target – Rx rays. The stochastic paths include: Tx - target - stochastic clutter - Rx, Tx - stochastic clutter - target – Rx rays. When an EO type 2 blocks a LOS path in a one link, that link is considered as a NLOS path. LOS probability is calculated as in TR 38.901, 37.885. Because of weak interaction between target and EO type 1, a propagation path between Tx and Rx interacting with target and EO type 1 is not modelled. For similar reason, a propagation path between Tx and Rx with more than one sensing target is not modelled.

The number of clusters between the Tx and the Rx is the same as number of clusters in TR 38.901. The clusters are divided in two types: LOS cluster and NLOS cluster where each NLOS cluster includes 20 rays as in TR 38.901. The number of rays in a cluster is the same as in the current TR.

RCS attributes to pathloss where a higher RCS makes more power reflected so pathloss is smaller. The pathloss can be calculated as:

$$PL(d) = PL(d_1) + PL(d_2) + 10\log_{10}\frac{c^2}{4\pi f^2} - 10\log_{10}\sigma_{RCS} + SF \quad (dB)$$

where PL(d_1): pathloss in the Tx-target link

d_1: distance between Tx and the sensing target in meter

PL(d_2): pathloss in the target-Rx link

d_2: distance between the sensing target and Rx in meter

f: carrier frequency

σ_{RCS}: the RCS of the sensing target

SF: the shadowing of the target

Proposal 11: Both NLOS and LOS rays are generated for the Tx-target and target-Rx links if LOS condition is determined.

Proposal 12: There are maximum two bounces between Tx and Rx.

Proposal 13: EO type 1 is not modelled in the propagation path Tx-target-Rx.

Proposal 14: A propagation path with more than one sensing target is not modelled.

Proposal 15: When an EO type 2 blocks a LOS path in a one link, that link is considered as NLOS path. Otherwise, LOS probability is calculated as in TR 38.901, 37.885.

Proposal 16: The target channel is modelled with Tx-target-Rx rays, Tx-target- EO type2/stochastic clutter-Rx rays, Tx- EO type 2/stochastic clutter- target -Rx rays.

Proposal 17: The number of clusters between the Tx and the Rx is the same as number of clusters in TR 38.901. The clusters are divided in two types LOS cluster and NLOS cluster where each NLOS cluster includes 20 rays as in TR 38.901. The number of rays in a cluster is the same as in the current TR.

Proposal 18: RCS attributes to pathloss where a higher RCS makes more power reflected so pathloss is smaller. The pathloss can be calculated as:

$$PL(d) = PL(d_1) + PL(d_2) + 10\log_{10}\frac{c^2}{4\pi f^2} - 10\log_{10}\sigma_{RCS} + \mathrm{SF} \quad (dB)$$

where PL(d_1): pathloss in the Tx-target link

d_1: distance between Tx and the sensing target in meter

PL(d_2): pathloss in the target-Rx link

d_2: distance between the sensing target and Rx in meter

f: carrier frequency

σ_{RCS}: the RCS of the sensing target.

SF: the shadowing factor of the target

2.4. Background channel

The background channel model with pathloss, LOS probability is based on the current model in TR38.901. Both environment objects (EOs) and stochastic clutters are modelled in the background channel model so we have the Tx-EO-Rx ray and the Tx-stochastic cluster-Rx ray. There is one LOS path Tx-Rx. The deterministic path includes Tx-EO-Rx ray. The stochastic paths include Tx-Rx, Tx-stochastic cluster-Rx rays.

Proposal 19: Background channel with pathloss, LOS probability modelled with both EOs and stochastic clutters is generated from the channel model in TR 38.901.

For background channel in monostatic sensing mode, a virtual Rx is generated then the stochastic mechanism in TR 38.901 between the real Tx and the virtual Rx is used.

Proposal 20: For background channel in monostatic sensing mode, a virtual Rx is generated then the stochastic mechanism in TR 38.901 between the real Tx and the virtual Rx is used.

LOS and NLOS rays in the background channel are generated as in TR 38.901.

2.5. Combined channel

Power normalization is carried out on both target channel and background channel when target channel and background channel are combined to keep the same channel power as background channel without target. There are N targets with power P_1, P_2, ..., P_N. The power of background channel is $P_{background}$. The normalized power of a target is:

$$P_{n\_normalization} = \frac{P_n}{\sum_{n=1}^{N} P_n + P_{background}} \quad (1)$$

The normalized power of background channel is:

$$P_{background\_normalization} = \frac{P_{background}}{\sum_{n=1}^{N} P_n + P_{background}} \quad (2)$$

Proposal 21: Power normalization is carried out on both target channel and background channel with equations (1) and (2) when target channel and background channel are combined to keep the same channel power as background channel without target.

2.6. Mobility model

For TRP monostatic mode and TRP-TRP bistatic mode, the mobility model in TR 38.901 is used. For TRP-UE bistatic, UE-TRP bistatic, UE-UE bistatic, UE monostatic, if the UE is static when it is the Tx or Rx, the mobility model in TR 38.901 is used. If the UE moves then both nodes are mobile in the channel between the UE and the target, the mobility model must be studied further because Section 7.5 TR38.901 defines a channel between two nodes, only one is mobile.

Proposal 22: if the Tx and Rx are static, the mobility model in TR 38.901 is used.

According to the supported use cases, a micro-Doppler model is not necessary to model the frequency shift due to the micro-motion such as arm swing of human body, respiration, etc.

Proposal 23: a micro-Doppler model is not necessary to model the frequency shift.

2.7. Spatial consistency

Spatial consistency is considered in all 6 sensing modes. For TRP monostatic mode and TRP-TRP bistatic mode, the spatial consistent procedures in TR 38.901 is used for the Tx-target and the target-Rx links where the sensing targets are considered as the user terminals in the legacy procedures. For TRP-UE bistatic, UE-TRP bistatic, UE-UE bistatic, UE monostatic, if the UE is static when it is the Tx or Rx, new spatial consistent procedures need to be studied because the spatial consistent procedures in TR 38.901 do not consider the link between two user terminals.

Proposal 24: For TRP monostatic mode and TRP-TRP bistatic mode, the spatial consistent procedures in TR 38.901 is used for the Tx-target and the target-Rx links where the sensing targets are considered as the user terminals in the legacy procedures.

Proposal 25: For TRP-UE bistatic, UE-TRP bistatic, UE-UE bistatic, UE monostatic, if the UE is static when it is the Tx or Rx, new spatial consistent procedures need to be studied.

The current spatial consistent procedures are for 2D configuration. For UAV use cases, the spatial procedures are need to be extended to 3D configuration.

Proposal 26: Extends the 2D spatial consistent procedures to support 3D spatial consistency in some scenarios such as UAV.

3. Conclusions

In this contribution, the following proposals are put forward:

Proposal 1: The channel is developed based on Geometry-based stochastic channel model TR 38.901. The parameters need to be updated for the channel model of TRP-TRP link and UE-UE link.

Proposal 2: The number of scattering points depend on the size of the targets, type of channel as well the distance between the sensing target. The number of scattering points is determined at the beginning and does not change in the whole process.

Proposal 3: Each scattering point in the multiple scattering points is modelled independently as if a single scattering point is modelled on the sensing target.

Proposal 4: RCS value of each scattering point on the sensing target in the multiple scattering points is determined independently.

Proposal 5: No ray is scattered from one point to another point of the same target.

Proposal 6: For RCS of UAV, for small UAV, RCS is independent to incident/scattered angles so B1 is 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = \frac{-ln(10)}{20}\sigma_{B2}^2$. For big UAV, RCS is dependent of incident/scattered angles modelled with B1 different to 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = \mathbf{0}$.

Proposal 7: RCS option 3 is used to model RCS of AGV with single scattering point for monostatic. A is mean RCS value. B2 is modelled using log-normal distribution. For small AGV, B1 is equal to 1. For large AGV, B1 has dependency on incident/scattered angles so B1 is different to 0 dB. B2 is modelled by a Gaussian distribution (μ_{B2}, σ_{B2}^2) with $\mu_{B2} = 0$.

Proposal 8: RCS option 2 or RCS option 3 with B1 equal to 1 is used to model RCS of animals. In both options, A is mean RCS value. If Option 2 is used, B is modelled using log-normal distribution. If Option 3 is used, B2 is modelled using log-normal distribution.

Proposal 9: The small-scale parameters for the sensing channel such as RCS, echo angles, cross power ratio are generated after the general parameters are generated. Subsequently, channel coefficient for the sensing channel is generated then pathloss is calculated for each sensing cluster.

Proposal 10: RCS of an object in the bistatic mode is obtained by measurement or ray-tracing.

Proposal 11: Both NLOS and LOS rays are generated for the Tx-target and target-Rx links if LOS condition is determined.

Proposal 12: There are maximum two bounces between Tx and Rx.

Proposal 13: EO type 1 is not modelled in the propagation path Tx-target-Rx.

Proposal 14: A propagation path with more than one sensing target is not modelled.

Proposal 15: When an EO type 2 blocks a LOS path in a one link, that link is considered as NLOS path. Otherwise, LOS probability is calculated as in TR 38.901, 37.885.

Proposal 16: The target channel is modelled with Tx-target-Rx rays, Tx-target- EO type2/stochastic clutter-Rx rays, Tx- EO type 2/stochastic clutter- target -Rx rays.

Proposal 17: The number of clusters between the Tx and the Rx is the same as number of clusters in TR 38.901. The clusters are divided in two types LOS cluster and NLOS cluster where each NLOS cluster includes 20 rays as in TR 38.901. The number of rays in a cluster is the same as in the current TR.

Proposal 18: RCS attributes to pathloss where a higher RCS makes more power reflected so pathloss is smaller. The pathloss can be calculated as:

$$PL(d) = PL(d_1) + PL(d_2) + 10\log_{10}\frac{c^2}{4\pi f^2} - 10\log_{10}\sigma_{RCS} + \mathrm{SF} \quad (dB)$$

where PL(d_1): pathloss in the Tx-target link

d_1: distance between Tx and the sensing target in meter

PL(d_2): pathloss in the target-Rx link

d_2: distance between the sensing target and Rx in meter

f: carrier frequency

σ_{RCS}: the RCS of the sensing target.

SF: the shadowing factor of the target

Proposal 19: Background channel with pathloss, LOS probability modelled with both EOs and stochastic clutters is generated from the channel model in TR 38.901.

Proposal 20: For background channel in monostatic sensing mode, a virtual Rx is generated then the stochastic mechanism in TR 38.901 between the real Tx and the virtual Rx is used.

Proposal 21: Power normalization is carried out on both target channel and background channel with equations (1) and (2) when target channel and background channel are combined to keep the same channel power as background channel without target.

Proposal 22: if the Tx and Rx are static, the mobility model in TR 38.901 is used.

Proposal 23: a micro-Doppler model is not necessary to model the frequency shift.

Proposal 24: For TRP monostatic mode and TRP-TRP bistatic mode, the spatial consistent procedures in TR 38.901 is used for the Tx-target and the target-Rx links where the sensing targets are considered as the user terminals in the legacy procedures.

Proposal 25: For TRP-UE bistatic, UE-TRP bistatic, UE-UE bistatic, UE monostatic, if the UE is static when it is the Tx or Rx, new spatial consistent procedures need to be studied.

Proposal 26: Extends the 2D spatial consistent procedures to support 3D spatial consistency in some scenarios such as UAV.

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