**3GPP TSG RAN WG1 #120 *R1-250xxxx***

**Athens, Greece, February 17th – 21st, 2025**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Draft CR to introduce channel model for ISAC | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Xiaomi, AT&T | | | | | | | | | |
| ***Source to TSG:*** | R1 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_Sensing\_NR | | | | |  | ***Date:*** | | | 2025-2-17 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | B |  | | | | | ***Release:*** | | | Rel-19 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | In RAN #102, the study item for channel modelling for ISAC was agreed. The output of the study item was agreed to be incorporated into TR 38.901. This CR captures the agreements/conclusions of the study item for channel modelling for ISAC. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | New sections, i.e., 7.9 and [8.1] are added for the channel model for ISAC. The existing sections 1, 2, 4, […] are also updated to reflect the introduction of channel model for ISAC. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | The existing channel model for communications in TR 38.901 are not sufficient to address evaluation of sensing techniques for Integrated Sensing and Communications use cases. The existing models in TR38.901 are not designed for sensing, in particular they do not address target modelling and sensing, background environment modelling and differentiation from targets. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | Impact to all/most clauses expected | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

# 1 Scope

[Rapporteur’s note: To be updated if a necessary change is identified]

The present document captures the findings of the study item, "Study on channel model for frequency spectrum above 6 GHz" [2] and from further findings of the study item, "Study on New Radio Access Technology [22]", the study item "Study on Channel Modeling for Indoor Industrial Scenarios [23]" and the study item "Study on channel modelling for Integrated Sensing And Communication (ISAC) for NR [24]". The channel models in the present document address the frequency range 0.5-100 GHz. The purpose of this TR is to help TSG RAN WG1 to properly model and evaluate the performance of physical layer techniques using the appropriate channel model(s). Therefore, the TR will be kept up-to-date via CRs in the future.

This document relates to the 3GPP evaluation methodology and covers the modelling of the physical layer of both Mobile Equipment and Access Network of 3GPP systems.

This document is intended to capture the channel model(s) for frequencies from 0.5GHz up to 100GHz.

# 2 References

[Rapporteur’s note: To be updated if a necessary change is identified]

[24] 3GPP TD RP-242348: " Study on channel modelling for Integrated Sensing And Communication (ISAC) for NR ".

# 3 Definitions, symbols and abbreviations

[Rapporteur’s note: To be updated if a necessary change is identified]

# 4 Introduction

[Rapporteur’s note: To be updated if a necessary change is identified]

At TSG RAN #69 meeting the Study Item Description on "Study on channel model for frequency spectrum above 6 GHz" was approved [2]. This study item covers the identification of the status/expectation of existing information on high frequencies (e.g. spectrum allocation, scenarios of interest, measurements, etc), and the channel model(s) for frequencies up to 100 GHz. This technical report documents the channel model(s). The new channel model has to a large degree been aligned with earlier channel models for <6 GHz such as the 3D SCM model (TR 36.873) or IMT-Advanced (ITU-R M.2135). The new model supports comparisons across frequency bands over the range 0.5-100 GHz. The modelling methods defined in this technical report are generally applicable over the range 0.5-100 GHz, unless explicitly mentioned otherwise in this technical report for specific modelling method, involved parameters and/or scenario.

Subsequently, at the TSG RAN #81 meeting the Study Item Description "Study on Channel Modeling for Indoor Industrial Scenarios" was approved [23]. The findings from this study item is also captured in the present technical report. The Industrial channel model was developed by considering new measurements and information in the literature. An overview list of all such contributions and sources is available in tdoc R1-1909706.

At TSG RAN #102 meeting the Study Item Description “Study on channel modelling for Integrated Sensing And Communication (ISAC) for NR” was approved. The findings from this study item is captured in section 7.9.

The channel model is applicable for link and system level simulations in the following conditions:

- For system level simulations, supported scenarios are urban microcell street canyon, urban macrocell, indoor office, rural macrocell, and indoor factory.

- Bandwidth is supported up to 10% of the center frequency but no larger than 2GHz.

- Mobility of either one end of the link or both ends of the link is supported

- For the stochastic model, spatial consistency is supported by correlation of LSPs and SSPs as well as LOS/NLOS state.

- Large array support is based on far field assumption and stationary channel over the size of the array.

- The sensing target is assumed in far field of sensing transmitter/receiver

# 5 Void

# 6 Status/expectation of existing information on high frequencies

[Rapporteur’s note: To be updated if a necessary change is identified]

# 7 Channel model(s) for 0.5-100 GHz

## 7.9 Channel model(s) for ISAC

[Rapporteur’s note: This clause is to capture the general principles on ISAC channel model]

The channel model for ISAC in this sub-section is designed based on the channel model in the previous sub-sections in section 7 taking into account the known properties, e.g., location, Radar Cross-Section (RCS), polarization and etc. of one or more physical objects. A physical object is categorized as a sensing target (ST) or an environment object (EO). The large scale and small scale parameters between any two from sensing transmitter (STX), ST and sensing receiver (SRX) in a sensing scenario are obtained from the TRs[X] for the same communication scenario unless updates on the parameter values are specially described. The ST is considered as a transmitter or receiver in the determination of a proper channel model of STX-ST link or ST-SRX link.

[Rapporteur’s note: In the following part, the exact referred TR for each combination of different TX/RX and targets will be provided, if adding reference to existing TRs can be agreed.]

### 7.9.1 Scenarios

[Rapporteur’s note: This clause is to capture the agreed scenarios for ISAC, which can be used for channel model calibration]

The detailed sensing scenario description in this clause can be used for channel model calibration.

### 7.9.2 Physical object model

[Rapporteur’s note: this clause is to capture the agreements on the model of a sensing target and [an environment object], e.g., single or multiple scattering points, RCS, etc.]

A physical object is categorized as a sensing target (ST) or an environment object (EO). A ST is an interested object for sensing. An EO is a non-target object with known location. An EO can be modelled same as a ST (type-1 EO). Further, An EO can be modelled differently from a ST (type-2 EO, 7.9.6.1).

In the following descriptions, only the related details on ST are described, which is also applicable to type-1 EO.

A ST is modelled with one or multiple scattering points. Each scattering point of a ST (SPST) is used to model the total scattering effects of some adjacent scattering centres at the ST. The impact of a SPST to the channel is modelled from two aspects, i.e., the RCS (Radar Cross Section, 7.9.2.1) and the polarization matrix (7.9.2.2). The RCS of the SPST is a scalar value and is defined as the hypothetical area required to intercept the incident power at the SPST such that if the total intercepted power were re-radiated [isotropically], the power density actually observed at the receiver would be produced. The polarization matrix of the SPST includes the impact of phase and amplitude in the two electric-field polarization components at the SPST. The polarization matrix of the SPST is separately modelled from other polarization effects introduced by stochastic clusters and/or EOs in the target channel.

#### 7.9.2.1 RCS of a sensing target

The RCS related coefficient of a SPST for a pair of incident/scattered rays is further composed of a first component which is included in the large-scale parameters, a second component and a third component which are included in the small-scale parameters, i.e., . Two RCS models are provided depending on whether is fixed to 1 or angular dependent.

In RCS model 1, is fixed to 1, is the mean of linear RCS values at the SPST, is modelled by a log-normal distribution with standard deviation . The mean of linear values equal to 1. is separately determined for each pair of incident/scattered angels at the SPST. [correlation]

In RCS model 2, is deterministically defined by the incident/scattered angles at the scattering point, …

[Rapporteur’s note: Bistatic RCS is necessary feature, further agreements are necessary before capturing it]

For UAV modelled with single scattering point, RCS model 1 and 2 are respectively defined for UAV size Option 1 and 2. [Rapporteur’s note: in the following part, exact details/values of will be provided. Further agreement is necessary]

For human modelled with single scattering point, RCS model 1 and 2 are provided.

[Rapporteur’s note: in the following part, exact details/values of will be provided. Further agreement is necessary]

For vehicle modelled with single scattering point, only RCS model 2 is provided.

[Rapporteur’s note: in the following part, exact details/values of will be provided. Further agreement is necessary]

For vehicle modelled with multiple scattering points, the recommended five scattering points are located in front, left, back, right and roof side of the vehicle. RCS values for each scattering point are respectively provided based on RCS model 2.

[Rapporteur’s note: in the following part, exact details/values of will be provided. Further agreement is necessary]

[Rapporteur’s note: in the following part, RCS model for other target types will be provided. Further agreement is necessary]

#### 7.9.2.2 Cross-polarization of a sensing target

The cross-polarization matrix of a SPST for a pair of incident/scattered angles is modelled by and initial random phases , i.e., . is separately determined for each pair of incident/scattered angels at the SPST.

[7.9.3 Required updates to existing channel models when used for ISAC channel modeling] [Rapporteur’s note: this clause is to capture the agreements on slow fading model for ISAC. Specifically, necessary extension on slow fading model for the supported ISAC sensing modes is captured here.]

### 7.9.4 Fast fading model

[Rapporteur’s note: this clause is to capture the agreements on fast fading model for the target channel and the background channel for bistatic and monostatic sensing mode, including model of mobility of Tx/target/Rx.]

The common framework for ISAC channel between a pair of STX and SRX is composed of a component of target channel and a component of background channel. A pair of STX and SRX can sense one or multiple STs. 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. The target channel of ST *k* includes all [multipath] components impacted by ST *k,* , where *K* is the number of STs. Such [multipath] components may interact with stochastic cluster(s) in either or both the STX-ST link and ST-SRX link. The background channel includes other [multipath] components not belonging to the target channel.

A stepwise procedure illustrated in Figure 7.9.4-1 is used to generated the channel model for ISAC referring to the procedure in section 7.5 with parameters derived by Table 7.9-2 and 7.9-3. The step 1 is commonly executed, followed by the respective steps for target channel (7.9.4.1) and background channel (7.9.4.2). Finally, the target channel and background channel are combined to form the final channel model for ISAC (7.9.4.3).



Figure 7.9.4-1 Channel coefficient generation procedure

Step 1: Set environment, network layout, and antenna array parameters

a) Choose one of the sensing scenarios (e.g. UMa, UMi-Street Canyon, RMa, InH-Office, Urban grid, Highway, or InF). Choose a global coordinate system and define zenith angle *θ*, azimuth angle *ϕ*, and spherical basis vectors , as shown in Figure 7.5-2. Note: Scenario RMa is for up to 7GHz while others are for up to 100GHz.

b) Give number of STX, ST and SRX. [Give the number of the SPST(s) of each ST].

c) Give 3D locations of STX and SRX, give number and 3D locations of SPST of each ST, and determine LOS AOD (*ϕLOS,AOD*), LOS ZOD (*θLOS,ZOD*), LOS AOA (*ϕLOS,AOA*), and LOS ZOA (*θLOS,ZOA*) of each pair of STX and SPST, of each pair of SPST and SRX in the global coordinate system

d) Give STX and SRX antenna field patterns *Frx* and *Ftx* in the global coordinate system and array geometries.

e) Give STX and SRX array orientations with respect to the global coordinate system. STX array orientation is defined by three angles Ω*STX,α* (STX bearing angle), Ω*STX,β* (STX downtilt angle) and Ω*STX,γ* (STX slant angle). SRX array orientation is defined by three angles Ω*SRX,α* (SRX bearing angle), Ω*SRX,β* (SRX downtilt angle) and Ω*SRX,γ* (SRX slant angle). Give the orientation of ST in the global coordinate system. ST orientation is defined by three angles Ω*ST,α* (ST bearing angle), Ω*ST,β* (ST downtilt angle) and Ω*ST,γ* (ST slant angle).

f) Give speed and direction of motion of STX, ST and SRX in the global coordinate system

g) Specify system centre frequency and bandwidth

Note: In case wrapping is used, each wrapping copy of a STX or SRX should be treated as a separate STX/SRX considering channel generation.

#### 7.9.4.1 Target channel

Following Step 1 in section 7.9.4, the target channels for the one or multiple STs between a pair of STX and SRX is generated using the following procedure with parameters derived by Table 7.9-2. It assumes a ST *k* consists of *P* scattering points, .

**Large scale parameters:**

Step 2: Assign propagation condition (LOS/NLOS) for each pair of STX and ST, and each pair of ST and SRX according to Table 7.4.2-1 updated as necessary in section 7.9.3.2. The propagation conditions for different STX-ST links and ST-SRX links are [TBD: uncorrelated, or subjected to spatial consistency in section 7.9.5].

Step 3: Calculate pathloss with formulas in Table 7.4.1-1 updated as necessary in section 7.9.3.1 [for each STX-SPST link and each SPST-SRX link].

Step 4: For each STX-SPST link and SPST-SRX link, generate large scale parameters, e.g. delay spread (DS), angular spreads (ASA, ASD, ZSA, ZSD), Ricean K factor (K) and shadow fading (SF) taking into account cross correlation according to Table 7.5-6 and using the procedure described in clause 3.3.1 of [14] with the square root matrix being generated using the Cholesky decomposition and the following order of the large scale parameter vector: **s***M* = [*sSF, sK, sDS, sASD, sASA, sZSD, sZSA*]*T*.

These LSPs for different STX-SPST links and SPST-SRX links are [TBD: uncorrelated, or subjected subjected to spatial consistency in section 7.9.5], but the LSPs for links from co-sited sectors to a STX/SPST/SRX are the same. In addition, these LSPs for the links of STX/SPST/SRX on different floors are uncorrelated.

Limit random RMS azimuth arrival and azimuth departure spread values to 104 degrees, i.e., ASA= min(ASA, 104°), ASD= min(ASD, 104°). Limit random RMS zenith arrival and zenith departure spread values to 52 degrees, i.e., ZSA= min(ZSA, 52°), ZSD= min(ZSD, 52°).

**Small scale parameters:**

Step 5: Generate cluster delays

The cluster delays of cluster n in a STX-SPST link are generated using Step 5 in section 7.5, i.e.,.

The cluster delays of cluster in a SPST-SRX link are generated using Step 5 in section 7.5 by replacing subscript *n* with *n’*, i.e., .

Step 6: Generate cluster powers.

The cluster power of cluster n in a STX-SPST link are generated using Step 6 in section 7.5, i.e., .

The cluster power of cluster in a SPST-SRX link are generated using Step 6 in section 7.5 by replacing subscript *n* with *n’*, i.e., .

Step 7: Generate arrival angles and departure angles for both azimuth and elevation.

The arrival angles and departure angles for both azimuth and elevation of a cluster *n* in a STX-SPST link are generated using Step 7 in section 7.5, i.e., , , , .

The arrival angles and departure angles for both azimuth and elevation of a cluster *n’* in a SPST-SRX link are generated using Step 7 in section 7.5 by replacing subscript *n, m* with *n’, m’*, i.e.,, , , .

Step 8: Coupling of rays within a cluster for both azimuth and elevation.

The rays within a cluster *n* for both azimuth and elevation in a STX-ST link are coupled using Step 8 in section 7.5.

The rays within a cluster *n’* for both azimuth and elevation in a ST-SRX link are coupled using Step 8 in section 7.5 by replacing subscript *n, m* with *n’, m’*.

Step 9: Coupling of rays for a STX-SPST link and the corresponding SPST-SRX link.

A ray in STX-SPST link coupled with a ray in the corresponding SPST-SRX link is named a path.

* In the STX-SPST link, a LOS ray is represented by , a NLOS ray *m* of a stochastic cluster *n* is represented by .
* In the SPST-SRX link, a LOS ray is represented by a NLOS ray *m’* of a stochastic cluster *n’* is represented by .

The following paths are generated, subjected to path dropping in Step 10.

* Case 1: The LOS ray in STX-SPST link is coupled with the LOS ray in SPST-SRX link.
* Case 2: The LOS ray in STX-SPST link is coupled with any NLOS ray in SPST-SRX link.
* Case 3: Any NLOS ray in STX-SPST link is coupled with the LOS ray in SPST-SRX link.
* Case 4: Two Options coupling NLOS rays in STX-SPST link and SPST-SRX link are recommended.
  + Option 1: Any NLOS ray in STX-SPST link is coupled with any NLOS ray in SPST-SRX link.
  + Option 2: The NLOS rays in STX-SPST link are 1-by-1 randomly coupled with the NLOS rays in ST-SRX link. If the number of rays in the two links M1, M2 are not equal, min(M1, M2) rays are randomly selected in the link with larger number of rays in the coupling operation.

Step 10: Obtain the second component of RCS and the third component of RCS at SPST *p* for all paths generated in Step 9, and dropping paths with lower power.

at the SPST *p* for a path are derived by the incident angle, i.e., AOA (), ZOA () of the ray in the STX-SPST link and the scattered angle, i.e., AOD (), ZOD () of the ray in the SPST-SRX link, referring to the RCS model defined in section 7.9.2 for the SPST.

A path of Case 1 in Step 9, if present, is never dropped. The paths of Case 2-4 in Step 9 with power metric less than [threshold] compared to the maximum power metric among all paths of Case 2-4 in Step 9 are dropped. The power metric of a path is defined as

(7.9-xx)

where,

* If the STX-SPST link is in LOS condition,
  + for a LOS ray, is the Ricean K-factor of the STX-SPST link.
  + for a NLOS ray *m* of a stochastic cluster *n,*  , M is number of rays per cluster
* If the STX-SPST link is not in LOS condition,
  + for a NLOS ray *m* of a stochastic cluster *n*, , M is number of rays per cluster
* If the SPST-SRX link is in LOS condition,
  + for a LOS ray, , is the Ricean K-factor of the SPST-SRX link.
  + for a NLOS ray *m’* of a stochastic cluster *n’*,
* If the SPST-SRX link is not in LOS condition,
  + for a NLOS ray *m’* of a stochastic cluster *n’*,

The set of paths () after path dropping is denoted as set *R*.

Step 11: Generate the cross polarization power ratios for paths in set *R*.

The cross polarization power ratios for each ray *m* of a cluster *n* in a STX-SPST link is generated using Step 9 in section 7.5, i.e., =.

The cross polarization power ratios for each ray *m’* of a cluster *n’* in a ST-SRX link is generated using Step 9 in section 7.5 by replacing subscript *n, m* with *n’, m’*, i.e., .

The cross polarization power ratios for each path at SPST *p* is [TBA].

The outcome of Steps 1-11 shall be identical for all the links from co-sited sectors to a STX/ST/SRX.

**Coefficient generation:**

Step 12: Draw initial random phases for paths in set *R*.

The random initial phases for each ray *m* of a cluster *n* in a STX-ST link is generated using Step 9 in section 7.5, i.e.,

The random initial phases for each ray *m’* of a cluster *n’* in a ST-SRX link is generated using Step 9 in section 7.5 by replacing subscript *n, m* with *n’, m’*, i.e., .

Draw random initial phases for each path at SPST and for four different polarisation combinations (θθ, θϕ, ϕθ, ϕϕ). The distribution for initial phases is [uniform within (*-π, π*)].

Step 13: Generate channel coefficients for paths in set *R* for each receiver and transmitter element pair *u, s*.

The channel coefficient for a path in set *R* is generated by

(7.9-xx)

With the Doppler frequency defined as

(7.9-xx)

Where,

* The parameter is the polarization matrix of the SPST *p* as defined in 7.9.2.2.
* The parameters are dependent on whether stochastic clusters is modelled in the SPST-SRX link.
  + for the LOS ray, if present,
  + for NLOS ray generated by stochastic cluster,

(7.9-xx)

* The parameters are dependent on whether stochastic clusters is modelled in the STX-SPST link.
  + for the LOS ray, if present,
  + for NLOS ray generated by stochastic cluster,

(7.9-xx)

* is the spherical unit vector at receiver for the link from SRX to SPST *p* of ST *k*, given by

(7.9-xx)

* is the spherical unit vector at transmitter for the link from STX to SPST *p* of ST *k*, given by

(7.9-xx)

* is the spherical unit vector at the scattering point for the link from SPST *p* of ST *k* to SRX, given by

(7.9-xx)

* is the spherical unit vector at the scattering point for the link from SPST *p* of ST *k* to STX, given by

(7.9-xx)

* are respectively the velocity of SRX, STX
* is the velocity of SPST *p* of ST *k*, , where is the velocity of the ST *k*, is velocity due to micro motion of SPST *p* of ST *k*
* denotes a reference point in time that defines the initial phase, e.g. .

The channel impulse response of SPST *p* of ST *k* is given by

(7.9-xx)

Where, for the LOS ray, if present in STX-SPST link, . For the LOS ray, if present in SPST-SRX link, . is the 3D distance between STX and SPST *p*. is the 3D distance between SPST *p* and SRX.

Step 14: Apply pathloss,shadowing, the first component of RCS for the channel coefficients.

[Rapporteur’s note: further agreement is necessary regarding how to apply pathloss, SF, etc. to the channel coefficient]

The target channel for ST *k*, is formed by summing the channel coefficients of the *P* SPST respectively scaled by the pathloss, shadowing and the first component of RCS of the *P* SPST*.*

(7.9-xx)

Where,

* is the pathloss of the STX-SPST link
* is the pathloss of the SPST-SRX link
* is the shadow fading of the STX-SPST link
* is the shadow fading of the SPST-SRX link
* is the first component of RCS for the SPST *p* of ST *k*, referring to the RCS model defined in section 7.9.2,
* , P is the total number of SPST of the ST *k*.

#### 7.9.4.2 Background channel

Following Step 1 in section 7.9.4, the background channel between a pair of STX and SRX is generated differently for bistatic sensing mode and monostatic sensing mode.

For TRP-TRP, TRP-UE, UE-TRP and UE-UE bistatic sensing mode, the background channel is generated using Step 2-12 in section 7.5 in [38.901] with parameters derived by Table 7.9-3. The resulting channel is denoted as .

[Rapporteur’s note: need further agreements on background channel for monostatic]

#### 7.9.4.3 Combining target channel and background channel

The channel model for ISAC for a pair of STX and STX is the sum of the target channel(s) and the background channel generated in section 7.9.4.1 and 7.9.4.2, i.e.,

. (7.9-xx)

### 7.9.5 Spatial consistency

[Rapporteur’s note: this clause is to capture the agreements on spatial consistency for ISAC.]

### 7.9.6 Additional modelling components

[Rapporteur’s note: this clause is to capture the agreements on additional modelling components for ISAC.]

#### 7.9.6.1 Type-2 environment object

A type-2 EO can be ground, wall, ceiling, etc. The specular reflection at the type-2 EO is considered in the link between STX and SPST or between SPST and SRX. A ray specularly reflected by an type-2 EO is modelled if a specular reflection point can be found within the surface of the type-2 EO.

When Type-2 EO is present in STX-ST link and/or ST-SRX link, the following modification to the ISAC channel generation in section 7.9.4, 7.9.4.1 and 7.9.4.2 can be used.

1. In Step 1 in section 7.9.4,

b) Give number of type-2 EO

c) Give 3D locations of type-2 EO in the global coordinate system

e) Give the orientation of type-2 EO in the global coordinate system. The type-2 EO orientation is defined by three angles Ω*EO,α* (type-2 EO bearing angle), Ω*EO,β* (type-2 EO downtilt angle) and Ω*EO,γ* (type-2 EO slant angle).

Note: In case wrapping is used, each wrapping copy of a type-2 EO should be treated as a separate type-2EO considering channel generation.

1. In Step 2 in section 7.9.4.1,

[Rapporteur’s note: Further agreement necessary regarding LOS condition when Type-2 EO is present.]

1. In Step 3 in section 7.9.4.1,

[Rapporteur’s note: Further agreement necessary regarding pathloss when Type-2 EO is present.]

1. Between Step 8 and 9 in section 7.9.4.1, insert one more step to generate NLOS rays of type-2 EO.

In each STX-SPST link, a NLOS ray specularly reflected by a type-2 EO is modelled if a specular reflection point can be found within the surface of the type-2 EO.

In each SPST-SRX link, a NLOS ray specularly reflected by a type-2 EO is modelled if a specular reflection point can be found within the surface of the type-2 EO.

[Rapporteur’s note: Further agreement necessary to calculate the reflection point, delay/polarization matrix of reflection ray.]

1. In Step 9 in section 7.9.4.1,

In the STX-SPST link, a NLOS ray of EO type-2, if present, is represented by . In the SPST-SRX link, a NLOS ray of EO type-2, if present, is represented by .

1. In Step 10 in section 7.9.4.1,

[Rapporteur’s note: Further agreement necessary regarding power of NLOS ray of Type-2 EO.]

1. After Step 11 in section 7.9.4.1, the outcome of Steps 1-11 shall be identical for all the links from co-sited sectors to a STX/ST/EO/SRX.
2. In Step 13 in section 7.9.4.1,

In the generation of channel coefficient for a path interacting with type-2 EO in set *R*

* If EO type-2 is present in the SPST-SRX link, is defined as
* If EO type-2 is present in the STX-SPST link, is defined as

1. In the channel impulse response of SPST *p* of ST *k*, , for NLOS ray generated by EO type-2, if present in STX-SPST link, . for NLOS ray generated by EO type-2, if present in SPST-SRX link,.

[Rapporteur’s note: Further agreement necessary regarding Type-2 EO in background channel.]

#### 7.9.6.2 Power normalization across target channel and background channel

[Rapporteur’s note: further agreements are necessary on model B with power normalization]

In combining the target channel and the background channel, an alternative combining scheme with power normalization may be used depending on the scenario, use case, sensing mode and/or number of ST/EO.

#### 7.9.6.3 Doppler of mobile scatters

To support scatterer mobility, the Doppler frequency component in the channel coefficient generation in step 13 in clause 7.9.4.1 should be updated as follows.

(7.9-xx)

Where,

* is a random variable from to , and is the maximum speed of the clutter. is a random variable of Bernoulli distribution with mean if , otherwise . Parameter determines the proportion of mobile scatterers and can thus be selected to appropriately model statistically larger number of mobile scatterers (higher ) or statistically smaller number of mobile scatterers (e.g. in case of a completely static environment: =0 results in all scatteres having zero speed). A typical value of is 0.2.
* is a random variable from to , and is the maximum speed of the clutter. is a random variable of Bernoulli distribution with mean *p* if , otherwise . Parameter *p* determines the proportion of mobile scatterers and can thus be selected to appropriately model statistically larger number of mobile scatterers (higher *p*) or statistically smaller number of mobile scatterers (e.g. in case of a completely static environment: p=0 results in all scatteres having zero speed). A typical value of *p* is 0.2.

#### 7.9.6.4 [Blockage]

[Rapporteur’s note: this clause is to capture future agreements if any on details of blockage.]

#### 7.9.6.5 [Micro-Doppler]

[Rapporteur’s note: this clause is to capture future agreements if any on details of micro-Doppler, e.g. function to modle micro motion/speed.]

### 7.9.7 Channel models for link-level evaluations

[Rapporteur’s note: this clause is to capture the agreements on LLS channel model for ISAC.]

### 7.9.8 Channel model calibration

[Rapporteur’s note: this clause is to capture the calibration assumptions/results on the channel model for ISAC.]

# 8 Map-based hybrid channel model (Alternative channel model methodology)

# [8.1 Map-based hybrid channel model (Alternative channel model methodology) for ISAC]

[rapporteur’s note: if agreed, this clause is to capture the agreements on map-based hybrid channel model for ISAC.]