**3GPP TSG RAN meeting #105 RP-241743**

**Melbourne, Australia, Sep 09-12, 2024**

## Status Report to TSG

**Agenda item:** **9.2.1**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **WI / SI Name** | Study on channel modelling enhancements for 7-24GHz for NR | | | | |
| included in this status report | Study Item:  Yes | Core part:  No | Performance part:  No | | Testing part:  No |
| **Acronym** | FS\_NR\_7\_24GHz\_CHmod | | | | |
| **Unique ID** | 1020081 | | | | |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-234018 | | | | |
| **Target Completion Date**  **(indicate if changed)** | Study Item:  06/2025 | Core part:  n/a | Performance part:  n/a | Testing part:  n/a | |
| **Overall Completion level** | Study Item:  35 % | Core part:  n/a | Performance Part:  n/a | Testing part:  n/a | |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |  |
| --- | --- | --- |
| **Leading WG** | | RAN1 |
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## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.  
 One time unit (TU) corresponds to ~ 2 hours in the meeting.  
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.  
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

**Conclusion**

* To provide measurement data, and/or simulation results, and/or available publications with measurement information for frequencies 7 to 24 GHz to validate/update the channel model.
* For frequency continuity of the channel models, Measurement information outside 7 to 24 GHz is also encouraged

**Agreement**

The following provides list of modelling parameters for 7 – 24 GHz frequencies that could be further studied for validation. The parameters listed are starting point for further discussions and does not imply the parameters require validation nor imply parameters require updates for 7 – 24 GHz frequencies.

* Antenna modelling parameters (e.g. radiation power patterns, directional gain values, etc.)
* Pathloss
* LOS probability
* O-to-I penetration loss
* Delay spread (mean, variance)
* AoD spread (mean, variance)
* AoA spread (mean, variance)
* ZoA spread (mean, variance)
* ZoD spread (mean, variance)
* ZoD offset
* Angle distribution characteristics (e.g. exponential, Gaussian, Laplacian distributions)
* Shadow fading
* K factor (mean, variance)
* LSP cross correlations
* Delay scaling parameter
* XPR
* Number of clusters
* Number of rays per cluster
* Cluster delay spread
* Cluster ASD
* Cluster ASA
* Cluster ZSD
* Cluster ZSA
* Per Cluster shadowing
* Correlation distances
* LSP correlation type (e.g. site-specific or all correlated)
* Oxygen absorption
* Correlation distance for spatial consistency
* Blockage region parameters/blocker parameters
* Spatial correlation for blockages
* Material properties for ground reflector model
* Spatial consistency model A/B

**Conclusion**

RAN1 to continue discussion on the need for new modelling parameters/scenarios and modelling procedure. The following modelling parameters/aspects for 7 – 24 GHz frequencies that are currently not available in TR38.901 have been identified by companies in RAN1#116bis. At least the following is for further study, but does not imply parameters/scenarios and modelling procedure are required for 7 – 24 GHz frequencies.

* Intra-cluster K factor
* Random power variability in each polarization
* Addition of SMa deployment scenario

**Conclusion**

* RAN1 to compile measurement/simulation descriptions from companies into a Tdoc to be added as reference to TR38.901.
  + Rapporteur to update the Tdoc in each meeting based on inputs from companies.
* Rapporteurs to provide a template for the measurement/simulation descriptions capture to RAN1 #117 for initial review and endorsement.

**Agreement**

To check and review the following results and measurement data provided in RAN1 #117 and RAN1#116bis for further discussion in next RAN1 meeting. R1-2405646 contains the list of data sources for the results and measurements provided in RAN1 #117.

* measurements for penetration loss for various materials, including drywall/wood, clear glass, IRR glass, and concrete
* measurements for pathloss for following scenarios: InH\_office LOS, InH-Office NLOS, InF LOS, InF NLOS, UMi LOS, UMi NLOS, UMa LOS, UMa NLOS, [Outdoor courtyard], RMa LOS, RMA NLOS, SMa NLOS
* measurements for polarization for UMa deployment scenario
* measurements for DS for following scenarios: InH-Office LOS, InH-Office NLOS, UMi LOS, UMI NLOS, UMa LOS, UMa NLOS, InF LOS, Inf NLOS.
* Measurements for angular distributions, such as ZOD, ZOA, AOD, AOA for following scenarios: InH, UMi, UMa
* Measurements for number of clusters for following scenarios: InH, UMi
* Simulations for LOS probability for SMa deployment scenario
* Measurement results regarding near-field model for following deployment scenarios: InH-Office LoS, UMa
* Measurement results regarding spatial non-stationarity for following deployment scenarios: UMa, [UE side]
* Simulation results regarding spatial non-stationarity for UMa deployment scenario

**Observation**

* Some companies provided information that sub-urban deployments cannot be represented by existing deployments in TR38.901 (such as UMi, UMa, RMa).

**Conclusion**

The following parameters are used as a starting point for aligning companies understanding of channel model parameters related to suburban use cases.

* BS height: [22.5] m
* Layout: Hexagonal grid, 19 Macro sites, 3 sectors per site, ISD = [1732] m
* Typical building heights: [Up to two floors for residential buildings, up to five floors for commercial buildings]
* UT height: [1.5 or 4.5 m for residential buildings], [1.5/4.5/7.5/10.5/13.5 m for commercial buildings]
* UT distribution: [Uniform horizontally, 70% indoor residential users are on ground floor, 30% are on upper floor]
* FFS: ratio between residential and commercial buildings
* Indoor/Outdoor: [80% indoor and 20% outdoor, FFS on in-car users]
* LOS/NLOS: LOS and NLOS
* Min BS - UT distance(2D): [25] m

**Conclusion**

* To provide information about motivation and reasons why changes to the channel model are essential.

**Agreement**

* Further study whether the following parameters for existing deployment scenarios is necessary to be updated:
  + Delay spread, pathloss, penetration loss, AoD/AoA/ZoA/Zod spreads, ZoD offset, Angle distribution characteristics (e.g. exponential, Gaussian, Laplacian distributions), XPR, number of clusters, number of rays per cluster, LSP correlations type (e.g. site-specific or all correlated), UE antenna modeling parameters, K factor (mean, variance)
* Study of updates to other parameters are not precluded and subject to further study.

**Agreement**

* Further study whether/how to reflect absolute delay between links, or whether/how correlation type of the delay needs to be changed from site-specific to all-correlated type in the model
  + Note: site-specific and all-correlated definitions are provided in TR38.901 Section 7.6.3.4.
  + FFS: impact of ISD on correlation type for the deployment scenario

**Agreement**

* Further study on correcting the scaling of the angles and other alternative to address angle scaling in TR38.901 Section 7.7.5 to enable accurate desired angle spread.

**Agreement**

* Further study of whether/how to model the variability of the co- and cross polar powers, in both diagonal and anti-diagonals of the polarization matrix, in the TR 38.901 model.
  + FFS: variability is applied for per ray or per cluster or per link
  + FFS: impact of antenna configurations
  + For example, variability may be random with an i.i.d. zero-mean Gaussian with some standard deviation, via changes to step 9 and eq (7.5-22) and (7.5-28) in clause 7.5 in TR 38.901.

**Agreement**

* Further study whether/how to model intra-cluster K factor to the TR38.901 models, such as power re-normalization among intra-cluster rays of a cluster so that first intra-cluster ray has K times more average power compared to rest of the intra-cluster rays.
  + FFS: whether same or different intra-cluster K factor is applied for each clusters
  + FFS: which applicable deployment scenarios

**Agreement**

* Further study whether/how following UE antenna modelling aspects should be considered in the modelling:
  + UE antenna placement, e.g. placement along edges of a rectangle reflecting UE form factor,
  + UE antenna orientation of individual antenna elements, e.g. randomize UE antenna element orientation,
  + Antenna radiation pattern, e.g. consider more realistic antenna patterns, including a phase component, potential reuse the parabolic pattern,
  + Antenna imbalance
* Note: this is only used for calibration.

**Agreement**

The antenna array is assumed for the near-field study.

**Agreement**

For the study of near-field channel modelling, at least following aspects should be considered:

* Whether/How to define the near-field region
* The parameters variation for each ray/cluster across different antenna element pairs

**Agreement**

The following scenarios defined in TR38.901 should be considered for the study/modelling of near-field.

* UMa,UMi, Indoor office and Indoor factory
* FFS: RMa and other new scenarios

**Agreement**

For the assumption on the aperture size of antenna array, the following is considered as reference for channel model study.

* up to [TBD] m, or [TBD] lambda for UMi
* up to [TBD] m, or [TBD] lambda for UMa
* up to [TBD] m, or [ TBD] lambda for Indoor office
* up to [TBD] m, or [TBD] lambda for Indoor factory

**Agreement**

For the near-field channel model:

* The impact of the assumption of wavefront is only considered from the perspective of antenna array.
* The near field for each element within the antenna array is not considered in this SI.

**Agreement**

For near-field channel model, RAN1 strives to design a unified model to explicitly reflect the new properties of near- and existing properties of far-field under the structure of existing stochastic model TR 38.901.

* FFS: whether the same or different implementations, e.g., procedures/equations, are used for near- and far-field channel realization

**Agreement**

The near- or far-field condition should be studied for the direct path and non-direct paths between BS and UE.

* The near-/far-field condition for the direct path may be assessed by using the 3D BS-UE distance.
  + FFS: The determination of near-/far-field condition for the non-direct paths
* Note: The direct path is referring to the LoS ray in the TR 38.901 in principle.
* Note: The non-direct paths are referring to the cluster/ray(s) without including LoS ray in the TR 38.901.

**Agreement**

For near-field channel, if necessary, to model the following antenna element-wise channel parameters of direct path between TRP and UE,

* Angular domain parameters (i.e., AoA, AoD, ZoA, ZoD), Delay, initial phase, Doppler shift, Amplitude
* FFS: Impacts on the polarization

The following options are considered:

* Option-1: Determined by the locations of both TRP and UE.
* Option-2: Determined by the antenna element locations of both TRP and UE

**Agreement**

The following scenarios defined in TR38.901 should be considered for studying/modelling of spatial non-stationarity

* UMi, UMa, Indoor office and Indoor factory
* FFS: RMa and other new scenarios

**Agreement**

For the modelling of spatial non-stationarity, at least the following options can be studied to identify the impacted ray/cluster and element-pair link:

* Option 1: Introducing per ray/cluster the visible probability, or visibility region for set of antenna element
* Option 2: Introducing the physical blocker to emulate the blockage impact on the link for each element-pair
* Note: The consistency across antenna elements and across clusters should be guaranteed.

**Agreement**

For the assumption on the aperture size of antenna array, the following is considered for near-field and spatial non-stationarity channel model study, e.g., simulation/measurement and calibration:

* Up to 1.5 m for UMa with maximum antenna elements in the array is [5k] for single Polarization.
* Up to 1 m for UMi with maximum antenna elements in the array is [2.22k] for single Polarization.
* Up to [0.71] m for Indoor factory with maximum antenna elements in the array is [1.12k] for single Polarization.
* Up to [0.25 (for rectangular antenna array), 0.5 (for linear antenna array)] m for Indoor office with maximum antenna elements in the array is [138, 24] for single Polarization, respectively.

**Working Assumption**

For the near-field channel modeling, no changes are expected on both value and parameter generation procedure of at least following large-scale parameters in existing TR 38.901:

* Pathloss model, SF, LOS probability
* FFS:DS, ASA, ASD, ZSA, ZSD, K factor

**Agreement**

For near-field channel, if necessary, to model the following antenna element-wise channel parameters of direct path between TRP and UE,

* Phase

with Option-2 “Determined by the antenna element locations of both TRP and UE”.

**Agreement**

For near-field channel, if necessary, to model the following antenna element-wise channel parameters of non-direct path between TRP and UE,

* Angular domain parameters (i.e., AoA, AoD, ZoA, ZoD), Delay, phase, Doppler shift, Amplitude
* FFS: Impacts on the polarization

The following options are considered:

* Option-1: The cluster location-based approach, wherein the cluster location is obtained with following alternatives:
  + Alt-1: cluster location is derived based on at least the distance between the BS/UE and clusters.
  + FFS: How to obtain the distance.
  + FFS: Other parameters.
  + Alt-2: cluster location is directly dropped and generated.
* Option-2: The parameter-based approach with following detailed alternatives:
  + Alt-1: Introduce the model of variation rate of parameter over antenna elements.
  + Alt-2: Modelling the variation by taking the existing spatial consistency procedure of TR 38.901 as baseline.
* Option-3: The curvature-based approach.

**Agreement**

For the modelling of spatial non-stationarity, if necessary, the variation (e.g., reduction) of power for the impacted ray/cluster within the element-pair link should be modelled.

* FFS: The value for power variation
* FFS: Impacts on the phase

**Agreement**

For the modelling of spatial non-stationarity, if necessary, if visible probability (VP) or visibility region (VR) is adopted, at least the following aspects should be considered for definition of VR/VP:

* Granularity of visible probability or visibility region (e.g., per cluster or per ray)
* Determination of visible probability (e.g., distribution) or visibility region (e.g., size, location)

**Agreement**

For the modelling of spatial non-stationarity, if necessary, if physical blocker-based approach is adopted, the following aspects should be considered for definition of blocker:

* Blocker size/type:
  + FFS: Additional blocker size/type compared to the Table 7.6.4.2-5 in TR 38.901.
  + FFS: Different blocker sizes/types are considered to emulate the antenna element-wise blockage effect at the BS and UE side
* Blocker location, e.g. distribution of the blocker, relative distance between blocker and BS or UE
* FFS: Number of physical blockers to be considered.

**Agreement**

To align the understanding of the terminology for channel model study, the following figures are considered as the reference:

* For non-direct path:

*A diagram of a mathematical equation

Description automatically generated with medium confidence*

* For direct path:

*A diagram of a diagram of a number of equations

Description automatically generated with medium confidence*

**Conclusion**

For near-field channel, no changes are expected on the following parameters for direct path.

* Amplitude, polarization matrix

**Agreement**

To check and review the following results and measurement data provided in RAN1 #118 for further discussion in next RAN1 meeting. R1-2407251 contains the list of data sources for the results and measurements provided in RAN1 #118, RAN1 #117, and RAN1 #116-bis.

**Agreement**

* Enable necessary model to support “sub-urban macro deployments”. Scenario of interest can be implemented when necessary by one of the following options:
  + Option-1: Define alternate parameters for UMa based on different assumption on building density/heights and corresponding BS and UE height/distributions, ISD, other aspects related to sub-urban macro deployments.
  + Option-2: Define a new scenario, e.g., SMa.
  + FFS parameter commonality and differences between Uma and scenario of interest
  + FFS whether and how to enable frequency continuity beyond 7-24 GHz for scenario of interest

**Agreement**

* At least for calibration purposes, introduce new UE antenna model that potentially provides updates to following parameters:
  + UE antenna placement
    - E.g. placement along edges of a rectangle reflecting UE form factor.
  + UE antenna orientation
    - E.g. randomize UE antenna orientation
  + Antenna radiation pattern
    - E.g. consider more realistic antenna patterns, including a phase component
    - Consider reusing the parabolic pattern
* Note: not all parameters are necessarily updated from current calibration antenna model.

**Agreement**

* At least for calibration purposes, for a new UE antenna model, additionally
  + FFS: Antenna imbalance

**Observation**

* ‘standard’ Glass penetration loss model in TR38.901 seems to be aligned well with measurements in 7-24 GHz conducted by companies.
* Some exceptional cases are wood, concrete and IRR glass penetration losses. It should be noted that assumption of at least material thickness has impact to penetration loss and further alignment of at least material thickness is useful for further validation.
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue.

**Conclusion**

* Continue study on penetration loss at least for the wood, concrete and IRR glass penetration loss and provide details of experimental setup used for penetration loss measurements.

**Observation**

* Preliminary study shows pathloss updates may not be needed at least for the following scenarios:
  + InH-Office LOS/NLOS, UMi Street Canyon LOS/NLOS, InF LOS/NLOS, RMa LOS/NLOS
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue.

**Conclusion**

* Continue study on at least pathloss for the following applicable scenarios, UMa LOS/NLOS.

**Observation**

* Preliminary study shows delay spread updates may not be needed at least for the following scenarios:
  + InH-Office NLOS
* Preliminary study shows delay spread updates may be needed at least for the following scenarios:
  + UMi LOS/NLOS
* Preliminary study shows different conclusions from different sources on whether delay spread updates are needed at least for following scenarios and further study and validation is needed.
  + InH-Office LOS
  + UMa LOS/NLOS/O2I
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue.

**Conclusion**

* Continue study on at least delay spread for applicable scenarios, including any frequency dependency analysis of delay spread.
* Companies are encouraged to provide methodology of frequency dependence analysis of delay spread, if performed

**Observation**

* Preliminary study shows some updates may be needed for azimuth and zenith angular spread for at least following scenarios:
  + InH LOS/NLOS, UMi LOS/NLOS, UMa LOS/NLOS
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue, including frequency continuity aspects.

**Conclusion**

* Continue study on angular spread for applicable scenarios. The following are preliminary examples for identified scenarios:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | | **InH @10 GHz** | | **UMi @10 GHz** | | **UMa @13 GHz** | |
| **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** |
| ASD  lgASD=log10(ASD/1°) | lgASD | 1.21 | 1.27 | 1.04 | 1.14 | 1.08 | 1.25 |
| lgASD | 0.18 | 0.14 | 0.2 | 0.07 | 0.21 | 0.3 |
| ASA  lgASA=log10(ASA/1°) | lgASA | 1.29 | 1.5 | 1.19 | 1.37 | ~~-~~ | ~~-~~ |
| lgASA | 0.13 | 0.23 | 0.13 | 0.08 | ~~-~~ | ~~-~~ |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | | **InH @10.1 GHz** | | **UMi @10.1 GHz** | | **UMi @ 10GHz** | |
| **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** |
| ASD | lgASD | 8.3 | 24.0 | 16.6 | 22.8 | 36.7 | 17.4 |
| lgASD | 4.8 | 13.7 | 15.8 | 19.3 | 20.4 | 24.0 |
| ASA | lgASA | 28.4 | 47.6 | 32.8 | 60.2 | 19.2 | 31.7 |
| lgASA | 7.3 | 20.6 | 16.0 | 12.6 | 11.0 | 9.3 |
| ZSD | lgASD | 10.5 | 6.6 | 6.8 | 7.9 | ~~-~~ | ~~-~~ |
| lgASD | 8.6 | 10.5 | 2.8 | 1.3 | ~~-~~ | ~~-~~ |
| ZSA | lgASA | 4.4 | 8.3 | 13.5 | 12.6 | ~~-~~ | ~~-~~ |
| lgASA | 1.8 | 6.2 | 3.2 | 3.8 | ~~-~~ | ~~-~~ |

| Scenarios | | UMa @ 3.5 GHz, 13 GHz, 28 GHz | | |
| --- | --- | --- | --- | --- |
| LOS | NLOS | O2I |
| ASD  lgASD=log10(ASD/1°) | *µ*lgASD | 0.39 + 0.1114 log10(*fc*) | 0.83 - 0.1144 log10(*fc*) | 0.58 |
| *σ*lgASD | 0.4 | 0.7 | 0.7 |
| Cluster *ASD* () in [deg] | | 1.5 | 1.5 | 1.5 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | | **InH @15 GHz** | |
| **LOS** | **NLOS** |
| ASA  lgASA=log10(ASA/1°) | lgASA | 1.57 | 1.78 |
| lgASA | 0.15 | 0.15 |
| ZSA  lgASA=log10(ZSA/1°) | lgASA | 0.94 | 0.94 |
| lgASA | 0.05 | 0.06 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | | **UMa @6.5 GHz** | |
| **LOS** | **NLOS** |
| ASD  lgASD=log10(ASD/1°) | lgASD | 0.82 | 1.26 |
| lgASD | 0.28 | 0.27 |
| AOA spread (ASA)  lgASA=log10(ASA/1°) | lgASA | 1.67 | 1.72 |
| lgASA | 0.19 | 0.15 |

**Observation**

* Preliminary study shows some updates may be needed for number of cluster and/or the threshold for removing lower powered clusters in the channel model for at least following scenarios:
  + InH LOS/NLOS, UMi LOS/NLOS, UMa LOS/NLOS
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue, including frequency continuity aspects.

**Conclusion**

* Continue study on handling of number of clusters for applicable scenarios.
* The following are preliminary examples for identified scenarios:
  + InH LOS/NLOS number of clusters
    - LOS @ 10 GHz, 500 MHz measurement BW: 15 ⇒ 10
    - LOS @ 10.1 GHz, 500 MHz measurement BW: 15 ⇒ 6
    - NLOS @ 10 GHz, 500 MHz measurement BW: 19 ⇒ 11
  + UMi LOS/NLOS number of clusters
    - LOS @ 10 GHz, 500 MHz measurement BW: 12 ⇒ 5
    - LOS @ 10.1 GHz, 500 MHz measurement BW: 12 ⇒ 8
    - NLOS @ 10 GHz, 500 MHz measurement BW: 19 ⇒ 7
    - NLOS @ 10.1 GHz, 500 MHz measurement BW: 19 ⇒ 10
  + UMa LOS/NLOS number of clusters
    - LOS @ 13 GHz, 400 MHz measurement BW: 12 ⇒ 9
    - NLOS @ 13 GHz, 400 MHz measurement BW: 20 ⇒ 14
* Companies are encouraged to disclose measurement methodology and conditions for determining number of clusters, such as measurement noise floor, capture dynamic range, measurement bandwidth, angular/spatial resolution, etc.

**Observation**

* 1 source observed existence of dominant angle for each cluster angular power distribution in 13 GHz UMa NLOS scenario. The source noted that dominant angle representation of the channel may be done by introducing an intra-cluster power factor.
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue, including frequency continuity aspects.
* The following is an example of potential changes:

where ICP is the intra cluster power ratio.

**Conclusion**

* To potentially reflect the channel angular domain sparsity, continue study of unequal intra-cluster power distribution for applicable scenarios.

**Observation**

* Preliminary study shows LOS probability do not need to be updated for the frequency range of interest for all existing scenarios. Further study is needed on LOS probability if existing scenario building/node deployment statistics are updated or if new deployment scenario(s) are adopted.
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue, including frequency continuity aspects.

**Observation**

* 3 source observed variability in power between co-polarized and cross-polarized antennas.
  + Among the 3 sources, 1 source observed ground reflection model in 38.901 may be used to introduce the polarization variability.
* 1 source observed variability in power between co-polarized and cross-polarized antennas for fix antenna setup. The source noted that UE relative polarization is not fixed in practice and questioned the applicability of the measurements for deployments of interest.
* 1 source observed that power ratio for co-polarization and cross-polarization is influenced by the depolarization effects of the environment and the antenna assumptions. Furthermore, under ±45° antenna slant assumption, the ratios of cross-polarization received power to co-polarization received power have a consistent mean value and therefore existing polarization modeling in TR 38.901 is sufficient.

**Conclusion**

* Continue study on handling of polarization for applicable scenarios.

**Observation**

* Preliminary study shows inconclusive results on whether updates may be needed for shadow fading for pathloss parameters of the channel model.
  + 1 source observed shadow fading values, are frequency-independent based on measurements at 6.75, 16.95, 28, and 73 GHz for InH-Office scenario. The discrepancies in shadow fading values are less than 0.3 dB for LOS and less than 2 dB for NLOS channel conditions across the entire frequency range of 0.5-100 GHz.
  + 1 sourced observed frequency dependency of the shadow fading in UMa LOS/NLOS scenario in 7-24 GHz, which the current channel modeling does not have.
* Preliminary study shows inconclusive results on whether updates may be needed for shadow fading per cluster parameters of the channel model.
  + 1 source observed 3dB reduced per cluster shadowing standard deviation for UMi LOS scenario, 1 dB reduced per cluster shadowing standard deviation for InH LOS scenario.
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue.

**Conclusion**

* Continue study on handling of shadow fading parameters for applicable scenarios.

**Observation:**

* Preliminary study shows some updates may be needed for K-Factor parameters of the channel model for at least following scenarios:
  + InH LOS, UMi LOS
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue, including frequency continuity aspects.

**Conclusion**

* Continue study on handling of K-factor parameters for applicable scenarios. The following are preliminary examples for identified scenarios:
  + InH LOS K-factor
    - Mean 9, std-dev 5 ⇒ Mean 5.1, std-dev 3.2
  + UMi LOS K-factor
    - Mean 7, std-dev 4 ⇒ Mean 8.5, std-dev 3.5

**Observation:**

* Inconclusive on whether CDL model angle calculation update is needed.
* Note that these are initial observations from RAN1 #118 and does not represent conclusive observations for the SI. RAN1 study and validation is expected to continue, including frequency continuity aspects.

**Conclusion**

* Continue study on handling of other channel modeling aspects. The following are examples of suggested changes for angle calculation for CDL model by sources:
  + Example 1)
    - * (7.7-5)
      * where
      * ,
      * and
  + Example 2)
    - * , and
      * where s is a scale factor to achieve desired angular spread.

**Conclusion**

* Continue study on handling of channel delays between different UE-TRP links. The following are examples of how absolute delays between different UE-TRP link may be applied in 38.901 provided by companies.
  + Example 1) introduce a new correlation type called “physically consistent” that takes the individual UE-TRP distances into account when generating the link-specific delays.
  + Example 2) Reuse absolute delay modelling in section 7.6.9 in TR 38.901 with extension for other scenarios as follows:

**Table 7.6.9-1: Parameters for the absolute time of arrival model**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scenarios** | | **InF-SL, InF-DL** | **InF-SH, InF-DH** | **UMi** | **UMa** |
|  |  | -7.5 | -7.5 | -7 | -6.8 |
|  | 0.4 | 0.4 | 0.4 | 0.6 |
| Correlation distance in the horizontal plane [m] | | 6 | 11 | 15 | 50 |

**Agreement**

The following assumptions are modeling parameters related to suburban use case. For aspects with multiple options, FFS which option(s) to support.

* BS height:
  + Option 1: 22.5 m
  + Option 2: 20 m – 25 m
  + Option 3: 15 m
  + Option 4: 35 m
  + Option 5: 25 m
* Layout: Hexagonal grid, 19 Macro sites, 3 sectors per site,
  + Option 1: ISD = 1732 m
  + Option 2: ISD = 500 m
  + Option 3: ISD <= 1000 m
  + Option 4: 500 ~ 1000 m
  + Option 5: 1299 m
  + Option 6: ISD < 500 m
* Building density
  + Option: [373, 440, others] buildings/km2
* UT height: 1.5 or 4.5 m for residential buildings, 1.5/4.5/7.5/10.5/13.5 m for commercial buildings
  + Typical building heights: Up to two floors for residential buildings, up to five floors for commercial buildings
* UT distribution:
  + Option 1: Uniform horizontally, 70% indoor residential users are on ground floor, 30% are on upper floor
  + Option 2: 0.5 m for outdoor; 1.5+3(-1) m for indoor, where is the floor and is uniform (1, 2) for residential buildings or is uniform (1, 5) for commercial buildings. (framework in 36.873 for UMa with changes to distribution of (number of floors).)
* Indoor/Outdoor:
  + Option 1: 80% indoor and 20% outdoor,
    - FFS: ratio between residential and commercial buildings
    - FFS on in-car users
  + Option 2: 40% indoor in residential buildings, 40% indoor in commercial buildings, and 20% outdoor
* LOS/NLOS: LOS and NLOS
* Min BS - UT distance (2D):
  + Option 1: 25 m
  + Option 2: 10 m
  + Option 3: 35 m
* FFS: Penetration model: low-loss penetration model
* FFS: clutter height parameter, e.g. foliage

**Conclusion**

Study at least the following channel modelling aspects of suburban use case. The sub-bullets describing the detailed equations of the modelling aspect are examples for consideration:

* Pathloss
  + NLOS:
  + LOS: Reuse pathloss model of UMa scenario in TR 38.901
  + LOS:
  + For LOS and NLOS, reuse Winner II

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Description automatically generated

* LOS probability
* ASD

| Scenarios | | SMa | | |
| --- | --- | --- | --- | --- |
| LOS | NLOS | O2I |
| AOD spread (ASD)  lgASD=log10(ASD/1°) | *µ*lgASD | 0.55 | 0.55 | 0.55 |
| *σ*lgASD | 0.25 | 0.25 | 0.25 |
| Cluster *ASD* () in [deg] | | 1.5 | 1.5 | 1.5 |

* ZSD

| Scenarios | | SMa | | |
| --- | --- | --- | --- | --- |
| LOS | NLOS | O2I |
| ZOD spread (ZSD)  lgZSD=log10(ZSD/1°) | *µ*lgZSD | 0.55 | 0.55 | 0.55 |
| *σ*lgZSD | 0.25 | 0.25 | 0.25 |

**Agreement**

Previous agreement made in RAN1#117 is updated as:

For the assumption on the aperture size of antenna array, the following is considered for near-field and spatial non-stationarity channel model study, e.g., simulation/measurement and calibration:

* Up to 1.5 m for UMa with maximum antenna elements in the array is 5k for single Polarization.
* Up to 1 m for UMi with maximum antenna elements in the array is 2.22k for single Polarization.
* Up to 0.71 m for Indoor factory with maximum antenna elements in the array is 1.12k for single Polarization.
* Up to 0.25 (for rectangular antenna array), 0.5 (for linear antenna array) m for Indoor office with maximum antenna elements in the array is 256, 80 for single Polarization, respectively.

**Agreement**

Confirm the following working assumption made in RAN1#117.

* **Working Assumption**
  + For the near-field channel modeling, no changes are expected on both value and parameter generation procedure of at least following large-scale parameters in existing TR 38.901:
  + Pathloss model, SF, LOS probability
  + FFS:DS, ASA, ASD, ZSA, ZSD, K factor

**Agreement**

For the near-field channel modeling, no changes are expected on both value and parameter generation procedure of at least following large-scale parameters in existing TR 38.901:

* DS, ASA, ASD, ZSA, ZSD, K factor

**Agreement**

The spatial non-stationarity characteristics, i.e., the antenna element-wise power variation at least at BS side, is supported in the channel modelling.

* FFS: the antenna element-wise power variation at UE side
* FFS: the causes and details of methodology for modelling the spatial non-stationarity characteristics

**Agreement**

For near-field channel, no changes are expected on following parameters of the non-direct path between TRP and UE:

* Polarization matrix
* FFS: Amplitude

**Agreement**

For near-field channel, the following formula is adopted to model the phase of direct path between TRP and UE as antenna element-wise channel parameter:

,

where the refers to the vector determined by the location of antenna element u and s. The refers to the 3D distance between reference antenna at TRP and UE side.

**Agreement**

For near-field channel, if necessary, the following parameters of the non-direct path between TRP and UE should be modeled as antenna element-wise parameter.

* Phase
* FFS: Doppler shift, Angular domain parameters, delay

**Observation**

According to the inputs from multiple sources, partial blockage effect may cause the spatial non-stationarity.

**Agreement**

For the modelling of spatial non-stationarity, the variation (e.g., reduction) of power for the impacted ray/cluster within the element-pair link should be modelled as:

* If visible probability (VP) or visibility region (VR) is adopted,
* A power attenuation factor within [0 1] is introduced.
* FFS: Details on how to determine the exact value for each cluster
* If physical blocker-based approach is adopted:
* Adopt the existing knife edge attenuation model in TR 38.901 in blockage Model-B to model the power attenuation per element with following update as:
* For each ray/cluster, rotating the blocker to ensure the arrival/departure direction at each Receive/Transmit antenna element is always perpendicular to the screen, respectively.
* FFS: applicability and details for blockage Model-A

**Agreement**

For the modelling of spatial non-stationarity, if physical blocker-based approach is adopted, the following additional blocker type can be considered for blockage model B:

* Building edge for outdoor scenario
* Small object, e.g., billboard, street lamp, pillar, for either indoor or outdoor scenario
* FFS: UE-side (self-blockage) blocker for both indoor and outdoor scenario
* Details, e.g., blocker types such as Single hand grip, dual-hand grip, and head with one hand grip.

FFS: the number and the location of the blocker between BS and one specific UE.

FFS: applicability and details for blockage Model-A

**Agreement**

For near-field channel, if necessary, the antenna element-wise channel parameters of non-direct path between TRP and UE can be determined by one of the following candidate options:

* Option-1: The antenna element-wise channel parameters are derived based on at least the distance between the BS/UE and a point associated with cluster.
  + FFS: How to obtain the distance.
  + FFS: Other parameters.
  + FFS: association between a point and a cluster
* Option-2: The antenna element-wise channel parameters are determined based on the existing spatial consistency procedure of TR 38.901 with updates.
  + FFS: Details to obtain the antenna element-wise parameters.

Note: Companies are encouraged to check the Option-3 including the similarity/difference with Option-1.

**Agreement**

For the modelling of spatial non-stationarity, if visible probability or visibility region is adopted,

* Visible probability or visibility region is modelled per cluster
* FFS Ratio of UEs and clusters that have SNS impact
* Rectangle can be considered as starting point for shape of VR with following alternatives to define the size:
* Alt 1: VR size is defined as number of elements generated by a distribution
* FFS distribution
* Alt 2: VR size is derived based on distance between antenna array of BS and UE/cluster
* Note: Cluster location is required in this alternative
* Alt 3: VR size is randomly generated with a minimum size limit

#### 2.1.2 Remaining Open issues

Validate using measurements the channel model of TR38.901 at least for 7-24 GHz.

Adapt/extend as necessary the channel model of TR38.901 at least for 7-24 GHz, including at least the following aspects for applicable scenarios:

* Near-field propagation (with consideration being given to consistency between near-field and far-field)
* Spatial non-stationarity

## 2.2 RAN2

#### 2.2.1 Agreements

#### 2.2.2 Remaining Open issues

## 2.3 RAN3

#### 2.3.1 Agreements

#### 2.3.2 Remaining Open issues

## 2.4 RAN4

#### 2.4.1 Agreements

#### 2.4.2 Remaining Open issues

## 2.5 RAN5

#### 2.5.1 Agreements

#### 2.5.2 Remaining Open issues

#### 2.5.3 Remaining Open issues with cross-WG dependencies

## 2.6 RAN6

#### 2.6.1 Agreements

#### 2.6.2 Remaining Open issues

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

## 3.1 SAx/CTs

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

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27.10.2022 minor adaptations for RAN #98e

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12.05.2019 minor adaptations for RAN #84

27.02.2019 minor adaptations for RAN #83

21.11.2018 completion levels with colours added (for RAN #82)

v04.81 31.07.2018 simplification of template and addition of cross-TSG aspects (for RAN #81)

v04.80 21.05.2018 minor adaptations for RAN #80

v04.79 26.02.2018 minor adaptations for RAN #79

v04.78 18.11.2017 minor adaptations for RAN #78

v04.77 06.08.2017 minor adaptations for RAN #77

v04.76 15.05.2017 minor adaptations for RAN #76

v04.75 31.01.2017 minor adaptations for RAN #75

v04.74 28.10.2016 minor adaptations for RAN #74

v04.73 01.09.2016 adaptations for RAN #73 (time units in extra Excel table, RAN6 reporting included)

v04.72 26.05.2016 adaptations for RAN #72 (introduction of NR & GERAN TUs)

v04.71 10.02.2016 minor adaptations for RAN #71

v04.70 30.10.2015 minor adaptations for RAN #70

v04.69 12.08.2015 minor adaptations for RAN #69

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v04.64 22.05.2014 minor adaptations for RAN #64

v04.63 24.01.2014 restructuring for RAN #63 to cover Core & Perf. in one doc file

v03.62 11.11.2013 section 1.2.3 adapted for RAN #62

v03 11.08.2013 section 1.2.3 added on time budget

v02 07.05.2010 history added, some spelling corrections

v01 13.11.2009 First version of the template