3GPP TSG-RAN WG1 Meeting #98 Tdoc R1-19xxxxx

Prague, CZ, Aug 26th –30th, 2019

Agenda Item: x.x.x

Source: Ericsson

Title: Meeting report from informal F2F meeting on indoor industrial channel model

Document for: Information

# 1 Introduction

An informal F2F meeting was conducted on July 1-2 in Berlin, Germany. The purpose of this meeting was to facilitate technical discussions and consensus building among channel model experts to support the SI on Indoor Industrial channel modeling. This tdoc contains a meeting report summarizing the discussions and views that were exchanged during the meeting.

# 2 Participation

The following participants attended the meeting:

1. **Raschkowski, Leszek, Fraunhofer HHI**
2. **Henrik Asplund, Ericsson**
3. **Rodriguez Larrad, Ignacio, Nokia**
4. **Koshiro Kitao, DOCOMO**
5. **Prasanth Karunakaran, Fraunhofer IIS**
6. **Schmieder, Mathis, Fraunhofer HHI**
7. **Jaeckel, Stephan, Fraunhiofer HHI**
8. **Tommi Jamsa, Huawei**
9. **Landmann, Markus, Fraunhofer IIS**
10. **Müller, Robert, Fraunhofer IIS**
11. **Guo Bolun, Huawei**

Remote participants:

1. **Piyush Gupta, Qualcomm**
2. **Raffaele D'Errico, CEA-LETI**
3. **Jianwu Dou, ZTE**
4. **Georg Wannemacher, Deutsche Telekom**
5. **Rakesh Tamrakar, Vivo**
6. **Xiaodong Sun, Vivo**
7. **Jian Lou(spelling?), Huawei**

# 3 Company input

Company input is available at <ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/>

# 4 Technical discussions

## 4.1 New measurements

Fraunhofer IIS presented the contribution [R1-XXXX-Single-band.docx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/R1-XXXX-Single-band.docx) containing new measurements in a high clutter density environment.

* Comments on how to take into account the very large relative bandwidth in the path loss analysis
* What percentage of floor area is covered by clutter? 3D scanner data available that can be processed
* Discussion on how this clutter density compares with some other available measurements
* Raw path loss data for 6 GHz has been shared
* 30 GHz may be added before RAN1#98

Fraunhofer HHI presented the contribution [2019-07-01 Industrial Indoor Measurements.pptx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/2019-07-01%20Industrial%20Indoor%20Measurements.pptx) containing new measurements in high clutter density environments.

* Can share path loss data points (5500 points in total)
* Angular spread is based on specular only (100 paths)
* Question on ratio between power of specular components and dense multipath. Has been analyzed…
* Which sub-scenario? 2 and 4: high clutter density, 3 m clutter height, BS height 2-8 m
* Fraunhofer have added their path loss and LSP results (possibly split into sub-scenarios) into [R1-19xxxxx Path loss model parameters\_v3\_CEA\_HHI.xlsx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/R1-19xxxxx%20Path%20loss%20model%20parameters_v3_CEA_HHI.xlsx), raw path loss data will be shared

## 4.2 Scenario description

Discussion on threshold between low and high clutter density:

* Nokia has estimated the clutter densities as above 50% for all high clutter density scenarios
* Fraunhofer IIS has calculated clutter density to 35% for a high clutter scenario
* Ask CMCC about clutter density in their low clutter scenario
* DOCOMO has estimated 29% in their scenario which is in between low and high clutter density, Huawei: DOCOMO path loss seems different compared to high density results

Outcome: High clutter density is above [35%] and low clutter density is below [35%]. Classify DOCOMO results as low clutter density

Discussion on clutter height:

* Ericsson proposes 1-10 m, Nokia proposes an open range with h\_clutter lower than ceiling height
* Nokia: open scenarios have higher ceiling height than high clutter density scenarios, suggest to couple ceiling height range with clutter density
* Nokia has compiled a complete scenario description table in [R1-xxxxxxxx\_scenario\_parametrization\_nokia\_v2.docx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/R1-xxxxxxxx_scenario_parametrization_nokia_v2.docx).
  + Discussion outcome: Use this scenario description with the following changes:
    - Change the ceiling height for sub-scenario 5 to [5-25] m
    - “Clutter height” -> “Effective clutter height”
    - Add “typical clutter size”: Big = 10 m, Small to medium = 2 m

## 4.3 Path loss

Huawei presented a first attempt at producing merged path loss models in [IIot Path Loss measured data expressions and curves\_v1.3.xlsx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/IIot%20Path%20Loss%20measured%20data%20expressions%20and%20curves_v1.3.xlsx) based on (a sub-set of) the available raw path loss data. The following improvements were discussed:

* Classify/re-classify sub-scenario association
* Include missing raw data, e.g. Huawei/CEA-LETI/Fraunhofer (AP: Huawei)
* Include random raw data generated from contributed path loss parameters (AP: Huawei, Nokia)
  + How many data points? If not specified, check the reference if there is some information. Otherwise, handle later.
* How to apply weights to the data from different sources (low vs high number of samples in different data sets)
  + No additional weighting as a starting point. Revisit later.

Nokia: will provide random path loss data based on the v3 email discussion summary by end of Monday 1 July. Huawei has updated to v1.4 to include “all LOS” and “all NLOS”. Huawei will update the excel file with CMCC, CEA-LETI, Fraunhofer HHI raw data and random raw data by Tuesday afternoon.

Discussion on embedded devices:

* Qualcomm may do new measurements on other aspects than path loss, trying to complete before August meeting
* Wait with further discussion until August, Qualcomm encouraged to provide a complete model proposal

## 4.4 LOS probability

Discussion on LOS probability:

* Agreement from Reno:
* Two proposals: empirical or analytical as captured in ZTEs contribution [ZTE\_LOS probability.docx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/ZTE_LOS%20probability.docx).

Discussion outcome: As a starting point for calibration, use proposal 2 from ZTE:

***Proposal 2***: For analytical LOS probability model, use following formula to calculate , where r is the effective clutter density after removing the clutters no higher than UE, represents the clutter size, {,,} are the heights of clutter, base station and terminal, respectively.

* and are FFS.

Discussion outcome: use the following values as starting point and for calibration:

* For elevated and high clutter density: d\_subsce=[1], p\_subsce=[0.6]
* For all other cases, d\_subsce=[0], p\_subsce=[1]

Discussion on LOS autocorrelation:

* Two proposals: 18/20 m or equal to
* Nokia: Related to , to make it different for different sub-scenarios
* Huawei: 18/20 m is seen as too long, perhaps use a smaller distance such as 10/20?
* Ericsson: good to have short correlation distance to get better statistical significance of simulation of a limited area
* Fraunhofer HHI: prefer single number
* Outcome of discussion: Use [10 m] for calibration

## 4.5 Fast fading modelling

Discussion on how to merge LSP proposals

* Ericsson provided an updated plot of DS vs hall volume to include new results that were not part of the tdoc in Reno in [Delay spread vs hall volume\_v3.pptx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/Delay%20spread%20vs%20hall%20volume_v3.pptx). Discussion:
  + “Raw data” available in the ppt and in R1-1905202. Further possible analysis to look at reverberation theory using surface area and volume [Fraunhofer IIS, this week]
* Huawei has provided updated LSP proposals in [R1-19xxxxx LSP parameter proposals\_v3\_CEA\_HW2.xlsx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/R1-19xxxxx%20LSP%20parameter%20proposals_v3_CEA_HW2.xlsx)
* Fraunhofer has provided updated LSP proposals in [R1-19xxxxx LSP parameter proposals\_v3\_CEA\_HW\_HHI.xlsx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/R1-19xxxxx%20LSP%20parameter%20proposals_v3_CEA_HW_HHI.xlsx)
* These two need to be merged [Huawei, by Tuesday afternoon]
* Possible merging principles: Revisit after the table is updated
  + Treat DS separately
  + Treat K-factor separately
  + Averaging all other LSP proposals

Discussion on dense multipath

* The experience from Fraunhofer IIS is that up to 80-90% of indoor power is captured in the dense multipath, more dense multipath in sub-6 GHz than at mmw
* Different views on the spatial properties of the DMC, white or not?
* How to capture dense multipath? Proposals:
  1. Optional model: Consider if 38.901 sec 7.6.2 approach can be used to emulate DMC using more rays
  2. Optional model: Colored noise process to model the transfer function (of frequency and tx/rx antenna elements), using frequency correlation function and angular correlation functions. Few analysis available on the correlation properties of the DMC in f and antenna dimensions
  3. Baseline model: Change (increase) the number of clusters and rays in the baseline model
  4. Room electromagnetics for DMC (Univ of Ghent): 30% of the power in the DMC
  5. Do nothing
* Conclusion: encourage companies to analyze DMC in their measurements and if necessary propose models and parameterizations until Prague. If no such proposals, don’t do anything.

## 4.6 Additional modelling components

Presentation on new measurements and modeling of additional delay by Fraunhofer IIS and Huawei in [Berlin\_Meeting\_NLOS\_Relative\_Delay\_Results\_v2.pptx](ftp://ftp.3gpp.org/Email_Discussions/RAN1/RAN1_IIChM_July19/Docs/Berlin_Meeting_NLOS_Relative_Delay_Results_v2.pptx). Discussion:

* New results show clear dependence on distance
* Lower bound at shorter distances may be due to obstructed LOS (diffraction). Suggestion to use lower bound for  that is larger than 0
* Can the distance trend be extrapolated beyond 40 m? Will give >700 ns DS for 280 m…
* Perhaps fitting against log(distance) instead?
* Select strongest or first peak? The first peak within -5 dB of the strongest one
* 6 and 60 GHz data may be available later, also analysis with different thresholds

Discussion on absolute delay modeling

* How to select from the different proposals (including the new one from H/IIS)?
* Outcome: Encourage companies to share data: (f,d,) samples and report the used detection threshold
  + Analyze based on merging of data from multiple sources [Huawei volunteers]
  + Further discussion on upper bound and cross-correlations over email

## 4.7 Channel model calibration

* Table 7.8-2: Simulation assumptions for large scale calibration for the indoor industrial scenario

|  |  |
| --- | --- |
| Parameter | Values |
| Scenario | Indoor industrial – sub-scenarios 1-4 |
| Room size | 100x100 m |
| Room height | 10 m |
| Sectorization | None |
| BS antenna configurations | 1 element (vertically polarized), Isotropic antenna gain pattern |
| UT antenna configurations | 1 element (vertically polarized), Isotropic antenna gain pattern |
| Handover margin (for calibration) | 0dB |
| BS deployment | Rectangular grid with ISD = 20 m, FFS on exact grid and number  BS height = [1.5] m or 8 m |
| UT distribution | uniform dropping for indoor with minimum distance ([2D or 3D]) of [1] m  UT height = 1.5 m |
| UT attachment | Based on pathloss |

* Outcome of discussion: Use the following simulation assumptions for calibration of the indoor industrial scenario:
  + Hall sizes: sub-scenario 1: 60x120 m, 2: 300x150 m, 300x150 m, 4: 60x120 m
  + Use a minimum 2D dropping distance of 1 m
  + BS height is 1.5 m for the clutter-embedded scenarios
  + BS tx power: 30 dBm
  + BS deployment: in rectangular grid with 20 m spacing and 10 m from the walls for the small halls, and in rectangular grid with 50 m spacing and 25 m from the walls for the big halls
  + UT noise figure: 9 dB
  + Carrier frequency: 3.5 GHz, 28 GHz
  + Bandwidth: 100 MHz
* Outcome of discussion: The following metrics are proposed for the channel model calibration:
  + 1) Coupling loss – serving cell
  + 2) Geometry with and without noise
  + 3) CDF of delay and angle spread (ASD, ZSD, ASA, ZSA) according to definition in Annex A.1 of TR 38.901
  + 4) CDF of first path excess delay for serving cell

Discussion outcome: Use the following parameters for calibration:

|  |  |  |
| --- | --- | --- |
|  | Low clutter density | High clutter density |
| Clutter density: r | 20% | 60% |
| Clutter height: | 2 m | 6 m |
| Clutter size: | 10 m | 2 m |

# References

1. RP-182138, SID on Channel Modeling for Indoor Industrial Scenarios, Ericsson, 3GPP TSG-RAN Meeting #81, Gold Coast, Australia, September 10th – 13th 2018.
2. R1-1907920, List of agreements, Ericsson, RAN1#97, Reno, USA, May 13-17, 2019.
3. R1-1907940, Addition of indoor industrial channel model, Ericsson, RAN1#97, Reno, USA, May 13-17, 2019.
4. R1-1907405, Summary of email discussion on path loss, Ericsson, RAN1#97, Reno, USA, May 13-17, 2019.
5. R1-1907407, Summary of email discussion on fast fading, Ericsson, RAN1#97, Reno, USA, May 13-17, 2019.