**3GPP TSG RAN WG1 #94 R1-180xxxx**

**Augest 20th – Augest 24th, 2018**

**Gothenburg, Sweden**

**Agenda item:** **7.6.1**

**Source: Qualcomm Incorporated**

**Title: Email discussion on NR-U outdoor sub7 GHz simulation calibration**

**Document for:** **Discussion and Decision**

# Background

In RAN1 #93, the following agreements were reached:

Agreement:

* For sub7 GHz outdoor scenario, adopting the following
	+ Macro deployment with ISD=200×A meters
	+ Each operator randomly drops 1 micro-layer TRP within each macro cell sector with minimum distance between micro-layer TRPs equals 57.9×A meters
	+ Independent dropping between two operators
		- Use 10 meters as the inter-operator micro-layer TRP minimum distance
		- For the inter-operator micro-layer TRP maximum distance
			* Outdoor scenario 1: 30
			* Outdoor scenario 2: No limit as long as the TRP is within the macro cell
	+ UE randomly dropped within macro cell sector with a minimum serving cell RSSI of -82dBm
	+ All UEs dropped outdoor
	+ Try A>=1 and find the A that satisfies serving cell received power distribution satisfies (10+X)% to (15+X)%] UEs below -72dBm
	+ Other parameters follow the table below

|  |  |
| --- | --- |
| Parameters | Outdoor Sub-7GHz |
| Carrier Frequency | 5GHz |
| Carrier Channel Bandwidth | 20MHz baseline , 80MHz optional |
| Number of carriers | 1 |
| Number of users per operator | 5 per gNB per 20MHz |
| SCS | To be reported together simulation results |
| Channel Model | NR UMi street canyon |
| BS/AP Tx Power | 23dBm (total across all TX antennas) |
| UE/STA Tx Power | 18dBm (total across all TX antennas) |
| BS/AP Antenna gain | 0 dBi  |
| UE/STA Antenna gain | 0 dBi |
| BS/AP Noise Figure | 5dB |
| UE/STA Receiver Noise Figure | 9dB |
| Minimum received power from serving cell for UE dropping | -82dBm |
| UE receiver | MMSE-IRC as the baseline receiver |
| BS/AP antenna Array configuration | (M, N, P, Mg, Ng) = (1, 2, 2, 1, 1), dH = dV = 0.5 λ |
| UE/STA antenna Array configuration | Baseline Tx/Rx: (M, N, P, Mg, Ng) = (1, 1, 2, 1, 1), dH = dV = 0.5 λOptional Tx/Rx: (M, N, P, Mg, Ng) = (1, 2, 2, 1, 1), dH = dV = 0.5 λ |
| Traffic model | Use 36.889 Table A.1.1. Note: Results based on the mixed traffic models can be used to determine the design. |
| UE/STA to UE/STA link pathloss model | Directly use UMi street canyon pathloss model with proper d\_3D with UMi street canyon LOS probability |
| gNB to gNB link pathloss model | Directly use UMi street canyon pathloss model with proper d\_3D with UMi street canyon LOS probability |

An email discussion was assigned to further fine tune the parameters (A and X) on the layout of the simulation, targeting Augest 2nd for a decision. The email discussion is organized into two steps:

* Step 1: Generating the necessary cdfs
	+ Target a deadline of 6/15/18
	+ Companies to provide serving cell received power cdf for a sweep of A parameters for each sub-scenario
	+ We will send out a word document and excel sheet in a few days like what we did for the indoor calibration.
* Step 2: Further discussion on agreeing on the X value and selecting an A parameter
	+ Target an agreement on 8/2/18

This paper summarizes the email discussion Discussions. A companion spreadsheet contains the raw data for the cdf curves provided by different companies.

# Step 1 calibration

Following the agreed parameters as below, we sweep A=1, 1.2, 1.4, 1.6, 1.8, and 2. In these simulations, UE redropping with -82dBm is applied as well.

* Macro deployment with ISD=200×A meters
* Each operator randomly drops 1 micro-layer TRP within each macro cell sector with minimum distance between micro-layer TRPs equals 57.9×A meters
* Independent dropping between two operators
	+ Use 10 meters as the inter-operator micro-layer TRP minimum distance
	+ For the inter-operator micro-layer TRP maximum distance
		- Outdoor scenario 1: 30
		- Outdoor scenario 2: No limit as long as the TRP is within the macro cell
* UE randomly dropped within macro cell sector with a minimum serving cell RSSI of -82dBm
* All UEs dropped outdoor

The following figures show the cdf of UE received signal power from serving cell for scenario 1 and scenario 2. Note that for the UE serving cell received power cdf, the difference between scenario 1 and scenario 2 is not obvious.

Figure 1. UE serving cell received power cdf, A=1

Figure 2. UE serving cell received power cdf, A=1.2

Figure 3. UE serving cell received power cdf, A=1.4

Figure 4. UE serving cell received power cdf, A=1.6

Figure 5. UE serving cell received power cdf, A=1.8

Figure 6. UE serving cell received power cdf, A=2

The percentile at -72dBm for each layout options are summarized in the next table.

Table 1. Percentile of -72dBm point for UE serving cell received power for scenario 1/scenario 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **A=1.0** | **A=1.2** | **A=1.4** | **A=1.6** | **A=1.8** | **A=2.0** | **A=3.0** |
| Qualcomm | 5.4%/6.1% | 12.7%/13.1% | 19.2%/18.9% | 25.6%/24.3% | 30.2%/28.6% | 34.8%/36.2% |  |
| Intel | 3.4%/4.4% | 10.8%/9.4% | 17.2%/17.4% | 25.7%/25.4% | 30.3%/32.1% | 37.0%/36.7% | 47.9%/50.8% |
| LG | 5.8%/5.8% | 12.6%/12.7% | 20.3%/19.9% | 27.5%/27.3% | 33.3%/33.1% | 37.7%/37.3% |  |
| InterDigital  | 4.4%/3.8% | 9.4%/9.8% | 18%/18.1% | 24.5%/24.4% | 32.7%/32.3% | 35.9%/35.4% |  |
| Ericsson | 3.3%/3.6% | 9.5%/9.3% | 16.9%/16.7% | 24.7%/24.6% | 32%/32.2% | 36.3%/36.3% |  |
| MediaTek | 4.2%/2.9% | 12.0%/9.4% | 17.2%/18.6% | 24.7%/25.0% | 31.7%/30.3% | 36.5%/39.1% |  |
| ZTE | 4.2%/4.6% | 10.3%/9.5% | 17.8%/18.2% | 26.6%/25.4% | 32.5%/30.5% | 36.3%/36.9% |  |
| Samsung | 5.8%/5.7% | 12.5%/11.8% | 19.1%/19.1% | 25.4%/25.3% | 31.1%/30.9% | 36.8%/37.7% |  |
| Nokia | 7.0%/7.4% | 14.8%/14.6% | 21.2%/21.3 | 27.9/28.2% | 33.2%/32.8% | 38.2%/37.9 |  |
| Broadcom | 8.1%/8.4% | 13.5%/13.1% | 17.9%/18.5% | 22.3%/23.2% | 27.4%/26.5% | 30.8%/29.5% |  |

Between scenario 1 and scenario 2, due to different ways to drop gNBs between the operators, the max AP2AP received power cdf will be different. For different A values, the cdf are shown in the next set of figures.

Figure 6. Max AP2AP received power cdf, A=1.0

Figure 6. Max AP2AP received power cdf, A=1.2

Figure 6. Max AP2AP received power cdf, A=1.4

Figure 6. Max AP2AP received power cdf, A=1.6

Figure 6. Max AP2AP received power cdf, A=1.8

Figure 6. Max AP2AP received power cdf, A=2.0

Table 1. Percentile of -72dBm point for Max AP2AP received power for scenario 1/scenario 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **A=1.0** | **A=1.2** | **A=1.4** | **A=1.6** | **A=1.8** | **A=2.0** |
| Qualcomm | 0%/0.8% | 0.1%/2.7% | 0.1%/7.3% | 0.4%/16.5% | 0.6%/23% | 0.8%/32% |
| LG | 0%/1.1% | 0.1%/3.8% | 0.2%/9.7% | 0.3%/16.8% | 0.2%/25.7% | 0.4%/33.7% |
| InterDigital | 0%/0.4% | 0.1%/1.5% | 0%/5.9% | 0%/13% | 0.5%/21.3 | 0.2%/30.5% |
| Nokia | 0%/2.5% | 0.1%/6.3% | 0.1%/12.7% | 0.3%/21.8 | 0.3%/29.6 | 0.4%/37.2 |
| Broadcom | 0%/0.2% | 0%/2% | 0%/6.6% | 0.2%/13.6% | 0.4%/21.4% | 0.4%/29.8% |
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Table 1. Observations

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| --- | --- |
| Company | Comments |
| Qualcomm | As expected, with larger A, the UE RSSI will be lower. For both scenarios, with A=1.2, we can achieve below -72dBm within 10~15%, and with A=1.5, we can achieve below -72dBm within 20~25%. Between secnarios, the max AP2AP received power distribution is different. For scenario 1, as the APs are dropped within the hopspot, the max AP2AP is always high, and almost 0% max AP2AP links are below -72dBm. For scenario 2, the max AP2AP is lower. |
| Intel | Both scenario 1 and scenario 2 provide very similar results in terms of the serving link RSRP distribution with negligible differences for each value of A. While A=2.0 achieves about 35-40% of serving link RSRP to be below -72dBm, we have also provided results for A=3.0 in consideration of the measured RSRP value range provided in R1-1807327 for an outdoor Wi-Fi network. The AP2AP RSRP statistics are not provided as they are out of the scope for this email discussion.  |
| LG | For A = 1, it is observed that the percentile of UE’s received power below -72 dBm is smaller than 10% (i.e., about 6%) in both scenarios. As expected, we can observe as the value of A increases, the percentile of UEs below -72 dBm also increases. Especially for A=1.2 and 1.6, it is observed that the percentile of UE’s received power below -72 dBm is about 12% and 27%, respectively. |
| InterDigital | Results for both scenarios are provided which indicate increasing percentage of RSSI<-72dBm with increasing value of A. A value of 1.2<A<1.4 would give the desired percentage of %10-%15. |
| Ericsson | It is observed that the results for both scenarios are quite similar in terms of serving link RSSI for different A values. With larger A value, weak UE RSSI ratio becomes higher as expected: with A=1.3-1.4, RSSI below -72dBm may achieve 10%-15%; with A=1.5-1.6, RSSI below -72dBm may achieve 20%-25%. The AP2AP RSRP statistics are not provided as they are out of the scope for this email discussion.  |
| MediaTek | First, the distributions of serving cell received power in scenario 1 and scenario 2 are similar for each value of A. Second, with A= 1, the ratio of UEs with serving cell received power below -72dBm is smaller than 10%. Thus, the value of A should be increased. With A = 1.2, it has 10%~15% UEs with serving cell received power below -72dBm. With A = 1.4, it has 15%~20% UEs with serving cell received power below -72dBm. With A = 1.6, it has 20%~25% UEs with serving cell received power below -72dBm. Third, we did not provide the results of AP2AP links since it is out of scope in this email discussion. |
| ZTE | As observed, for both scenarios we can achieve (10+X)% to (15+X)%   of serving link RSRP below -72dBm, when A is greater than 1.2, assuming X is positive. Especially for A=1.4,we can achieve below -72dBm within 15~20%, and for A=2.0, we can achieve below -72dBm within 35~40%. |
| Samsung | The serving link received power distribution is very similar for both scenarios with only minor differences. It can be observed that 10% to 15% of serving link received power below -72 dBm can be achieced with A = 1.2 for both scenarios. In addition, more fraction of serving links below -72 dBm will be observed with higher value of A.  |
| Nokia | As also observed by other companies, for gNB-UE serving cell RSSI, there is no significant difference between the scenarios. A=1.2 appear to be a good choise for scaling factor. |
| Broadcom | As expected Scenario1 and Scenario2 have the same serving gNB-UE RSSI cdfs and very different AP2AP RSSI cdfs. In Scenario1, the AP2AP cdf is not correlated to the serving gNB-UE cdf; for example the AP2AP RSSI remains high even when the serving gNB-UE cdf is progressively made lower with increasing values of A. In Scenario2, the AP2AP cdf is correlated to the serving gNB-UE cdf.  |

# Step 2 Calibration

# Conclusion

TBA.