**3GPP TSG-RAN WG1 Meeting #122bis**  **R1-2507956**

**Prague, Czech Republic, October 13 – 17, 2025**

**Agenda Item: 11.2**

**Source: Moderator (Huawei)**

**Title: FLS#4 on evaluation assumptions for 6GR air interface**

**Document for: Discussion and Decision**

# Introduction

Evaluation assumptions for 6GR air interface (in AI 11.2 from chair notes)

*Discussions on models, scenarios, parameters, and methodology, metrics/criteria, as well as traffic model that can be commonly used for evaluating technology proposals.*

[122bis-R20-6GR-Evaluation] Email discussion on Rel-20 6GR-Evaluation – Jinhuan (Huawei)

* To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc

As confirmed in the last RAN1 meeting, this agenda will continue discussing:

* The common evaluation assumptions including antenna modelling and system-level simulation assumptions for each TN scenario taking the collected companies views via post-122 email discussion as baseline.
* Traffic models;
* Link budget;

These issues will be discussed in each of subsequent sections. In addition, as agreed in the last meeting as well that the common evaluations assumptions for NTN will be separately provided and additional assumptions for TN can also be discussed in this agenda if any are identified. Based on a lot of inputs on NTN for this meeting, the discussions will be organized in another separate section in this summary, which will mainly start from the carrier frequency and a blank template preparation first.

Nevertheless, companies in their contributions additionally discussed the assumptions for other topics, e.g., power model for energy efficiency, performance metrics for different topics, MIMO specific assumptions, etc. The reasons why those proposals will have to be discussed in this agenda were not explained in the contributions nor clear to moderator per the moderator’s assessment. In any case, one section for identifying potential other common assumptions was created, so companies can share views/suggestions there if any.

Kinder Note for the discussions in this summary:

* Different rounds with proposals with label [FL1, FL2, …] of discussion may be created in this summary for proposal update based on the online/offline progress. It’s companies’ discretion to provide your comments to either round but just being reminded that the discussion is supposed to carry on the proposal in the latest round in principle.
* Please use the following convention for uploading your comments:
  + Filename\_v001\_Moderator
  + Filename\_v002\_Moderator\_CompanyA
  + Filename\_v003\_CompanyA\_CompanyB
  + Filename\_v004\_CompanyB\_CompanyC
  + Etc

# Antenna modeling for TN

## Collected views from RAN1#122

Companies’ views collected over post-122 email discussion are summarized in R1-2507292.

### Discussion

*Summary on the views:*

#### Around 700MHz

|  |  |
| --- | --- |
| **TXRU mapping** | **Mentioned by** |
| Option 1, a single TXRU is mapped per panel per subarray per polarization, Per panel reuse models in TR 36.897 | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T, MTK |
| Option 2, Fully connected TXRU mapping within a panel per polarization | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Samsung, Sony, Ofinno, Nokia, Futurewei, AT&T |
| Option 3, single TXRU is mapped per panel per polarization | DCM |

|  |  |  |
| --- | --- | --- |
| **Antenna configuration** | | **Mentioned by** |
| Number of antenna elements | 4 | Samsung |
| 8 | Samsung |
| 16 | Interdigital |
| 24 | Futurewei |
| 32 | Huawei, OPPO, CATT, Ericsson, ZTE, Nokia, AT&T |
| 64 | Huawei, CATT, vivo, Interdigital, Qualcomm, CMCC, DCM, MTK, Sony, Intel, Ofinno, Futurewei |
| Maximum antenna ports | 4 | Ericsson, Interdigital, Qualcomm, Futurewei |
| 8 | OPPO, CMCC |
| 16 | Huawei, vivo, OPPO, CATT, Interdigital, DCM, vivo, Sony, Intel, Ofinno, Nokia, Futurewei |
| 32 | ZTE |
| 64 | vivo |

|  |  |  |
| --- | --- | --- |
| **700 MHz BS Antenna configuration** | | **Mentioned by** |
| elements, ports |  |  |
| 4, 4 | (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 2, 1, 1, 2, 2); (dH, dV)=(0.5, 0.8)λ | Samsung |
| 8, 8 | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2), (dH, dV)=(0.5, 0.8)λ | Samsung |
| 16, 2 | (M, N, P, Mg, Ng; Mp, Np) = (4, 2, 2, 1, 1, 1, 1), (dH, dV)=(0.5, 0.8)λ | Qualcomm |
| 16, 4 | (M, N, P, Mg, Ng;Mp, Np) = (4, 2, 2, 1, 1;1, 2), (dH, dV)=(0.5, 0.8)λ | Interdigital, ZTE, Qualcomm |
| 16, 8 | (M, N, P, Mg, Ng, Mp, Np) = (4, 2, 2, 1, 1, 2, 2), (dH, dV)=(0.5, 0.5)λ | ZTE |
| 16, 8 | (M, N, P, Mg, Ng, Mp, Np) = (4, 2, 2, 1, 1, 2, 2), (dH, dV)=(0.5, 0.8)λ | ZTE |
| 24, 4 | (M, N, P, Mg, Ng; Mp, Np) = (6, 2, 2, 1, 1, 1, 2) | Futurewei |
| 32, 4 | (M, N, P, Mg, Ng;Mp, Np) = (8, 2, 2, 1, 1, 1, 2), (dH, dV)=(0.5, 0.5)λ | AT&T |
| 32, 4 | (M, N, P, Mg, Ng;Mp, Np) = (8, 2, 2, 1, 1, 1, 2), (dH, dV)=(0.5, 0.8)λ | AT&T |
| 32, 4 | (M, N, P, Mg, Ng;Mp, Np) = (8, 2, 2, 1, 1, 1, 2), (dH, dV)=(2.0 0.8)λ | Ericsson |
| 32, 8 | (M, N, P, Mg, Ng; Mp, Np)= (8, 2, 2, 1, 2, 2), (dH, dV) = (0.5, 0.8)λ | OPPO |
| 32, 16 | (M, N, P, Mg, Ng; Mp, Np)= (4, 4, 2, 1, 2, 4), (dH, dV) = (0.5, 0.8)λ | OPPO |
| 32, 16 | (M, N, P, Mg, Ng;Mp, Np) = (8, 2, 2, 1, 1, 4, 2), (dH, dV)=(0.5, 0.8)λ | Huawei, ZTE, Nokia |
| 32, 16 | (M, N, P, Mg, Ng;Mp, Np) = (8, 2, 2, 1, 1, 4, 2), (dH, dV)=(0.5, 0.5)λ | Huawei, ZTE |
| 32, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 2, 2, 1, 1, 8, 2), (dH, dV)=(0.5, 0.5)λ | ZTE |
| 32, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 2, 2, 1, 1, 8, 2), (dH, dV)=(0.5, 0.8)λ | ZTE |
| 64, nan | (M, N, P, Mg, Ng) = (8, 4, 2, 1, 1), (dH, dV) = (0.5, 0.5)λ | DCM |
| 64, 8 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1;1, 4), (dH, dV)=(0.5, 0.8)λ | CMCC |
| 64, 16 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.5)λ | Huawei, DCM, Futurewei |
| 64, 16 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.8)λ | Huawei, vivo, CATT, Interdigital, Sony, Intel, Ofinno. Futurewei |

|  |  |  |
| --- | --- | --- |
| **700 MHz BS Antenna configuration** | | **Mentioned by** |
| BS Polarized antenna modelling e.g., models in section 7.3.2 in TR38.901 | model1 901 | Huawei, ZTE, Ericsson, Qualcomm, CMCC |
| model2 901 | Huawei, vivo, OPPO, CATT, Ericsson, Interdigital, ZTE, Qualcomm |
| BS antenna element gain pattern | According to Table 7.3-1 in TR 38.901 | vivo, OPPO, CATT, Interdigital, ZTE, Qualcomm, CMCC, DCM, MTK, Intel Ofinno, Nokia, AT&T |

|  |  |  |
| --- | --- | --- |
| **700 MHz UT Antenna configuration** | | **Mentioned by** |
| Elements/ports | 2 | Intel, Nokia |
| 4 | Huawei, DCM, CATT, ZTE, Ofinno, Futurewei |
| General | 1T2R | OPPO, Interdigital, Spreadtrum |
| 2T2R | Interdigital |
| Handheld | 1Tx/2Rx | vivo, Ericsson, Qualcomm, Xiaomi |
| 1Tx/4Rx | Qualcomm |
| 2Tx/2Rx | Sony |
| low-end IoT UE/MTC | 1Tx/1Rx | Qualcomm, Xiaomi, Sony |
| 1Tx/2Rx | vivo |
| CPE/FMA | 1Tx/2Rx | Ericsson |
| 4Tx/4Rx | Sony |
| 4Tx/8Rx | vivo |
| 8Tx/8Rx | vivo, Qualcomm |
| Alt1 traditional model | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2),  (dH, dV)=(0.5, 0.5)λ | Huawei, DCM, CATT, ZTE, CMCC, Futurewei, AT&T (handheld), Xiaomi (IoT) |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 1, 1, 1, 1, 1, 1), (dH, dV)=(0.5, 0.5)λ | Spreadtrum, Sony (IoT) |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 1, 2, 1, 1, 1, 1) | Samsung, AT&T (handheld) |
| (1, 2, 1, 1, 1, 1, 2), (dH, dV)=(0.5, 0.5)λ | Spreadtrum, vivo, OPPO, Futurewei |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2), (dH, dV)=(0.5, 0.5)λ | Sony (CPE), Ofinno |
| Alt2 handheld model | (1, 3) | Sony (Smartphone/XR) |
| Two elements of (1, 3, 5, 7) | Intel |
| (1, 3, 5, 7) | Huawei, DCM, CATT, Futurewei |
| (2, 6) | Interdigital, Nokia |
| Also Support | Xiaomi (handheld, CPE/FMA), Samsung |

|  |  |  |
| --- | --- | --- |
| **700 MHz UT Antenna configuration** | | **Mentioned by** |
| UE Polarized antenna modelling,  e.g., models in section 7.3.2 in TR38.901 | Option 1, model-1 in section 7.3.2 in TR38.901 | CATT, ZTE, CMCC, DCM, Futurewei, Ofinno |
| Option 2, model-2 in section 7.3.2 in TR38.901 | vivo, OPPO, CATT, ZTE, DCM, MTK, Futurewei, Ofinno, Sony |
| Option 3, handheld UT model in section 7.3.2 in TR38.901 | CATT, DCM, Intel, Ofinno, Futurewei |
| UE antenna element gain pattern | Alt1: Omnidirectional | vivo, CATT, MTK |
| Alt2: According to Table 7.3-2 in TR 38.901 (radiation power pattern for handheld UT) | OPPO, CATT, Interdigital, ZTE, Qualcomm, DCM, Intel, Ofinno, Nokia, AT&T |

#### Around 2GHz

|  |  |  |
| --- | --- | --- |
| **2GHz TXRU mapping** | **Mentioned by** | |
| Indoor | outdoor |
| Option 1, a single TXRU is mapped per panel per subarray per polarization, Per panel reuse models in TR 36.897 | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T |
| Option 2, Fully connected TXRU mapping within a panel per polarization | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Sony, Ofinno, Nokia, Futurewei, AT&T | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Samsung, Sony, Ofinno, Nokia, Futurewei, AT&T |
| Option 3, Single TXRU is mapped per panel per polarization | DCM | DCM |

|  |  |  |  |
| --- | --- | --- | --- |
| **2GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| Number of antenna elements | 4 | Sony |  |
| 16 | Xiaomi |  |
| 32 | ZTE, CMCC, DCM |  |
| 64 |  | Interdigital, CMCC, Xiaomi |
| 128 | Huawei, OPPO, vivo, Intel, Ofinno Nokia, Futurewei | Huawei, OPPO, Interdigital, DCM, Intel, Ofinno, Nokia |
| 192 | Huawei | Huawei, Samsung, Futurewei |
| 256 | Qualcomm | vivo, Qualcomm, Sony |
| 288 |  | ZTE |
| Maximum antenna ports | 4 | DCM, Sony |  |
| 16 | Qualcomm | Interdigital, Qualcomm |
| 32 | OPPO, ZTE, Ofinno, Nokia | OPPO, DCM, Intel, Ofinno, Nokia |
| 64 | vivo, Intel, Futurewei | Huawei, vivo, Interdigital, Samsung, Sony, Futurewei |
| 96 |  | ZTE |

|  |  |  |  |
| --- | --- | --- | --- |
| **2GHz BS Antenna configuration** | | **Mentioned by** | |
| elements, ports |  | Indoor | outdoor |
| 4, 4 | (M, N, P, Mg, Ng, Mp, Np) = (2, 1, 2, 1, 1, 2, 1) (dH, dV) = (0.5, 0.5)λ | Sony |  |
| 32, 8 | (M, N, P, Mg, Ng, Mp, Np) = (4, 4, 2, 1, 1, 1, 4), (dH, dV) = (0.5, 0.8)λ |  | ZTE, Samsung |
| 32, 8 | (M, N, P, Mg, Ng, Mp, Np) = (4, 4, 2, 1, 1, 1, 4), (dH, dV) = (0.5, 0.5)λ | DCM |  |
| 32, 16 | (M, N, P, Mg, Ng; Mp, Np)= (4, 4, 2, 1, 2, 4), (dH, dV) = (0.5, 0.5)λ | Ericsson |  |
| 32, 16 | (M, N, P, Mg, Ng; Mp, Np)= (4, 4, 2, 1, 2, 4), (dH, dV) = (0.5, 0.8)λ |  | Samsung |
| 32, 16 | (M, N, P, Mg, Ng, Mp, Np) = (4, 4, 2, 1, 1, 2, 4), (dH, dV) = (0.5, 0.5)λ | Ericsson |  |
| 32, 32 | (M, N, P, Mg, Ng, Mp, Np) = (4, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.5)λ | CMCC, Xiaomi, ZTE |  |
| 64, 4 | (M, N, P, Mg, Ng; Mp, Np) = (8, 4, 2, 1, 1, 1, 2), (0.5, 0.5)λ | Qualcomm |  |
| 64, 8 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1;1, 4), (dH, dV)=(0.5, 0.5)λ | Qualcomm |  |
| 64, 16 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.8)λ |  | ZTE, Qualcomm, Interdigital |
| 64, 32 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 4, 4) |  | Ericsson, Futurewei |
| 128, 32 | (M, N, P, Mg, Ng; Mp, Np) = (16, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.5)λ |  | Huawei |
| 128, 32 | (M, N, P, Mg, Ng; Mp, Np) = (16, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.8)λ |  | Huawei, ZTE |
| 128, 32 | (M, N, P, Mg, Ng; Mp, Np) = (8, 8, 2, 1, 1, 4, 4) | Futurewei |  |
| 128, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.5)λ | Nokia |  |
| 128, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.8)λ | OPPO, Ofinno | OPPO, CMCC, DCM, Samsung, Ofinno, Nokia |
| 128, 64 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.5)λ | vivo, Intel |  |
| 128, 64 | (M, N, P, Mg, Ng, Mp, Np) = (4, 16, 2, 1, 1, 2, 16), (dH, dV) = (0.5, 0.8)λ |  | Samsung |
| 128, 64 | (M, N, P, Mg, Ng; Mp, Np) = (8, 8, 2, 1, 1;4, 8), (dH, dV)=(0.5, 0.8)λ |  | Interdigital |
| 128, 64 | (M, N, P, Mg, Ng; Mp, Np) = (8, 8, 2, 1, 1;8, 4), (dH, dV)=(0.5, 0.8)λ |  | Samsung |
| 128, 128 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.8)λ |  | Xiaomi |
| 192, 64 | (M, N, P, Mg, Ng, Mp, Np) = (12, 8, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.8)λ |  | Huawei, CMCC, Samsung, Futurewei |
| 256, 32 | (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2, 1, 1;2, 8), (dH, dV)=(0.5, 0.8)λ |  | CMCC, Sony |
| 256, 64 | (M, N, P, Mg, Ng;Mp, Np) = (16, 8, 2, 1, 1;4, 8), (dH, dV) = (0.5, 0.8)λ |  | vivo, ZTE, CMCC, Intel |
| 288, 96 | (M, N, P, Mg, Ng, Mp, Np) = (24, 6, 2, 1, 1, 8, 6), (dH, dV) = (0.5, 0.8)λ |  | ZTE |

|  |  |  |
| --- | --- | --- |
| **2GHz UT Antenna configuration** | | **Mentioned by** |
| Elements/ports | 4 | Huawei, ZTE, DCM, Intel, Ofinno Futurewei |
| General | 1T2R | Spreadtrum |
| 2T2R | OPPO |
| 2T4R | OPPO, Interdigital |
| Handheld | 1Tx/2Rx | Xiaomi, Samsung, vivo |
| 2Tx/2Rx | Sony |
| 2Tx/4Rx | Qualcomm, Nokia |
| 4Tx/4Rx | Ericsson |
| low-end IoT UE/MTC | 1Tx/1Rx | Ericsson, Qualcomm, Xiaomi, Sony |
| 1Tx/2Rx | Qualcomm |
| CPE/FMA | 4Tx/8Rx | Nokia |
| 8Tx/8Rx | Qualcomm, Ericsson (non-handheld/non-EMBB) |
| Alt1 traditional model | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2),  (dH, dV)=(0.5, 0.5)λ | Huawei, ZTE, CMCC, DCM, Ofinno, Futurewei, Xiaomi (IoT), Sony (FWA/CPE), Nokia (FWA/CPE), |
| 1T(1, 1, 1, 1, 1;1, 1) 2R(1, 2, 1, 1, 1;1, 1, 2) | Spreadtrum |
| 2Tx:  (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 1, 1, 1, 1, 2), (dH, dV) = (0.5, 0.5)λ  4Rx:  (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 1, 1, 1, 2, 2), (dH, dV) = (0.5, 0.5)λ | vivo, OPPO |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 1, 1, 1, 1, 1, 1), (dH, dV)=(0.5, 0.5)λ | Sony (IoT) |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 1, 2, 1, 1, 1, 1), (dH, dV)=(0.5, 0.5)λ | Samsung |
| (M, N, P, Mg, Ng, Mp, Np) = (2, 2, 2, 1, 1, 2, 2).(dH, dV) = (0.5, 0.5)λ | Nokia (FWA/CPE) |
| Alt2 handheld model | Supported by | ZTE, Xiaomi (handheld, CPE/FMA), Nokia(handheld) Sony, Samsung, |
| (1, 3, 5, 7) | Huawei, Interdigital, DCM, Sony (Smartphone/XR), Intel, Futurewei |
| Rx: (1, 3, 5, 7) Tx: (2, 6) | Nokia (handheld) |

|  |  |  |
| --- | --- | --- |
| **2GHz UT Antenna configuration** | | **Mentioned by** |
| UE Polarized antenna modelling,  e.g., models in section 7.3.2 in TR38.901 | Option 1, model-1 in section 7.3.2 in TR38.901 | ZTE, CMCC, DCM, Samsung, Ofinno |
| Option 2, model-2 in section 7.3.2 in TR38.901 | vivo, OPPO, ZTE, DCM, Xiaomi, Samsung, Ofinno |
| Option 3, handheld UT model in section 7.3.2 in TR38.901 | Interdigital, ZTE, DCM, Xiaomi, Samsung, Sony, Ofinno |
| UE antenna element gain pattern | Alt1: Omnidirectional | vivo, ZTE, Samsung, Nokia, Ofinno |
| Alt2: According to Table 7.3-2 in TR 38.901 (radiation power pattern for handheld UT) | OPPO, Interdigital, ZTE, Samsung, Intel, Ofinno (handheld), Nokia |

|  |  |  |  |
| --- | --- | --- | --- |
| **2GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| BS Polarized antenna modelling e.g., models in section 7.3.2 in TR38.901 | model 1 | CMCC, DCM, Samsung, Ofinno, Nokia, Futurewei, ZTE, Qualcomm, Samsung | Ericsson, ZTE, CMCC, DCM, Samsung, Ofinno, Nokia, Futurewei, ZTE, Qualcomm, Samsung |
| model 2 | vivo, OPPO, ZTE, Xiaomi, DCM, Samsung, Sony, intel, Ofinno, Nokia, Futurewei, ZTE, Qualcomm, Samsung | Vivo, OPPO, interdigital, ZTE, Xiaomi, DCM, Samsung, Sony, intel, Ofinno, Nokia, Futurewei, ZTE, Qualcomm, Samsung |
| BS antenna element gain pattern | Table 7.3-1 in TR 38.901 |  | vivo, OPPO, Interdigital, ZTE, Qualcomm, CMCC, DCM, Samsung, Sony, Intel, Ofinno, Nokia, ATT |
| Table A.2.1-7 in TR 38.802 | vivo, Intel |  |

#### Around 4GHz

|  |  |  |
| --- | --- | --- |
| **4GHz TXRU mapping** | **Mentioned by** | |
| Indoor | outdoor |
| Option 1, a single TXRU is mapped per panel per subarray per polarization, Per panel reuse models in TR 36.897 | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, Sony, MTK, Intel, Ofinno, Nokia, Futurewei | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, Sony, MTK, Intel, Ofinno, Nokia, Futurewei, Apple, AT&T, ETRI |
| Option 2, Fully connected TXRU mapping within a panel per polarization | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Samsung, Sony, Ofinno, Nokia | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Samsung, Sony, Ofinno, NOKIA, AT&T, ETRI |
| Option 3, Single TXRU is mapped per panel per polarization |  | DCM |

|  |  |  |  |
| --- | --- | --- | --- |
| **4GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| Number of antenna elements | 4 | Sony |  |
| 32 | Ericsson, ZTE, DCM, Xiaomi, Nokia |  |
| 64 | Samsung | Interdigital |
| 128 | Intel | Interdigital, DCM, Xiaomi, Samsung |
| 192 |  | Samsung, Nokia, Apple |
| 256 | vivo, OPPO, CATT, Qualcomm, Futurewei | OPPO, CATT, Ericsson, Qualcomm, Intel, ATT, NEC |
| 384 |  | Huawei |
| 512 | Huawei | Huawei, vivo, Sony, Futurewei, ETRI |
| 576 | Huawei, Ofinno | Huawei, ZTE, Ofinno |
| Maximum antenna ports | 4 | DCM, Sony |  |
| 16 | Ericsson | Interdigital |
| 32 | ZTE, Xiaomi, Nokia | DCM, Apple |
| 64 | OPPO, Qualcomm, Samsung, Intel, Futurewei | OPPO, Ericsson, Interdigital, Qualcomm, Intel, Nokia, AT&T |
| 128 | vivo, CATT | Huawei, vivo, CATT, ZTE, Xiaomi, Sony, Futurewei, ETRI, NEC |
| 144 | Ofinno | Huawei, Ofinno |

|  |  |  |  |
| --- | --- | --- | --- |
| **4GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| 16, 4 | (M, N, P, Mg, Ng;Mp, Np) = (4, 2, 2, 1, 1;1, 2), (dH, dV)=(0.5, 0.5)λ | Sony |  |
| 32, 4 | (M, N, P, Mg, Ng;Mp, Np) = (8, 2, 2, 1, 1, 1, 2), (dH, dV)=(0.5, 0.8)λ | DCM |  |
| 32, 16 | (M, N, P, Mg, Ng, Mp, Np) = (4, 4, 2, 1, 1, 2, 4), (dH, dV) = (0.5, 0.5)λ | Ericsson |  |
| 32, 32 | (M, N, P, Mg, Ng, Mp, Np) = (4, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.5)λ | ZTE, CMCC, Xiaomi, Nokia |  |
| 64, 16 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.5)λ | Qualcomm, Futurewei |  |
| 64, 16 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.8)λ | Futurewei | Interdigital |
| 64, 32 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 4, 4), (dH, dV)=(0.5, 0.5)λ | Qualcomm |  |
| 64, 64 | (M, N, P, Mg, Ng;Mp, Np) = (4, 8, 2, 1, 1, 4, 8), (dH, dV)=(0.5, 0.5)λ | Samsung |  |
| 96, 32 | (M, N, P, Mg, Ng, Mp, Np) = (12, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.8)λ |  | ZTE |
| 128, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.5)λ |  | Futurewei |
| 128, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.8)λ |  | CMCC, DCM, Futurewei |
| 128, 64 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.5)λ | Intel |  |
| 128, 64 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.8)λ |  | Interdigital, Samsung |
| 128, 64 | (M, N, P, Mg, Ng, Mp, Np) = (4, 16, 2, 1, 1, 2, 16), (dH, dV) = (0.5, 0.8)λ |  | Samsung |
| 128, 64 | (M, N, P, Mg, Ng, Mp, Np) = (16, 4, 2, 1, 1, 8, 4), (dH, dV) = (0.5, 0.8)λ |  | Samsung |
| 128, 128 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.8)λ |  | Xiaomi |
| 192, 32 | (M, N, P, Mg, Ng, Mp, Np) = (12, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.8)λ |  | Apple |
| 192, 64 | (M, N, P, Mg, Ng, Mp, Np) = (12, 8, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.8)λ |  | ZTE, Qualcomm, CMCC, Samsung, Nokia |
| 256, 32 | (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2, 1, 1;2, 8), (dH, dV)=(0.5, 0.8)λ |  | CMCC |
| 256, 64 | (M, N, P, Mg, Ng;Mp, Np) = (16, 8, 2, 1, 1;4, 8), (dH, dV) = (0.5, 0.5)λ | Futurewei | ATT |
| 256, 64 | (M, N, P, Mg, Ng;Mp, Np) = (16, 8, 2, 1, 1;4, 8), (dH, dV) = (0.5, 0.8)λ | OPPO, Futurewei | OPPO, Ericsson, CMCC, Intel, ATT |
| 256, 128 | (M, N, P, Mg, Ng;Mp, Np) = (16, 8, 2, 1, 1;8, 8), (dH, dV) = (0.5, 0.5)λ | vivo, CATT | CATT |
| 256, 128 | (M, N, P, Mg, Ng;Mp, Np) = (16, 8, 2, 1, 1;8, 8), (dH, dV) = (0.5, 0.8)λ | CATT | CATT |
| 384, 128 | (M, N, P, Mg, Ng;Mp, Np) = (24, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.8)λ |  | ZTE, Huawei |
| 384, 128 | (M, N, P, Mg, Ng;Mp, Np) = (24, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.5)λ |  | Huawei |
| 512, 128 | (M, N, P, Mg, Ng, Mp, Np) = (16, 16, 2, 1, 1, 4, 16), (dH, dV) = (0.5, 0.5)λ |  | Futurewei |
| 512, 128 | (M, N, P, Mg, Ng;Mp, Np) = (16, 16, 2, 1, 1;4, 16), (dH, dV) = (0.5, 0.8)λ |  | vivo, Sony, ETRI, Futurewei |

|  |  |  |
| --- | --- | --- |
| **4GHz UT Antenna configuration** | | **Mentioned by** |
| Elements/ports | 4 | ZTE, DCM, Intel, Futurewei |
| 8 | Ofinno, Futurewei |
| General | 2T4R | OPPO, Interdigital, MTK, Apple, ETRI |
| Handheld | 1TR | Qualcomm, Xiaomi |
| 1Tx/2Rx | Qualcomm, Xiaomi |
| 1T4R | Samsung |
| 2T8R | Qualcomm |
| 4Tx/4Rx | Ericsson |
| low-end IoT UE/MTC | 1Tx/1Rx | Sony, Ericsson |
| 1Tx/2Rx | vivo |
| CPE/FMA | 8Tx/8Rx | Ericsson, Qualcomm, Nokia |
| 8Tx/16Rx | Ericsson, Qualcomm, Nokia |
| Alt1 traditional model | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2), (dH, dV)=(0.5, 0.5)λ | CATT, ZTE, CMCC, Samsung, Futurewei, ETRI, Sony (FWA/CPE), |
| 2Tx: (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 1, 1, 1, 1, 2), (dH, dV) = (0.5, 0.5)λ 4Rx: (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 1, 1, 1, 2, 2), (dH, dV) = (0.5, 0.5)λ | vivo, OPPO |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 1, 1, 1, 1, 1, 1), (dH, dV)=(0.5, 0.5)λ | Sony (IOT) |
| (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 1, 1, 1, 2, 2), (dH, dV) = (0.5, 0.5)λ | ETRI |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 4, 2, 1, 1, 1, 4), (dH, dV)=(0.5, 0.5)λ | Futurewei |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 4, 2, 1, 1, 4, 2), (dH, dV)=(0.5, 0.5)λ | CATT |
| (M, N, P, Mg, Ng, Mp, Np) = (2, 2, 2, 1, 1, 2, 2).(dH, dV) = (0.5, 0.5)λ | Huawei, Ofinno, Nokia (FWA/CPE), Futurewei |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 2, 1, 2), (dH, dV)=(0.5, 0.5)λ | DCM, Sony (FWA/CPE), Nokia (FWA/CPE) |
| Also supported by | Xiaomi (IOT) |
| Alt2 handheld model | Support | ZTE, Xiaomi (handheld, CPE/FMA) |
| (1, 3, 5, 7) | CATT, Interdigital, DCM, Sony (Smartphone/XR), Intel, Futurewei |
| (1-8) | Huawei, Nokia (FWA/CPE) |
| Rx: (1, 3, 5, 7) Tx: (2, 6) | Nokia (handheld) |

|  |  |  |
| --- | --- | --- |
| **4GHz UT Antenna configuration** | | **Mentioned by** |
| UE Polarized antenna modelling,  e.g., models in section 7.3.2 in TR38.901 | Option 1, model-1 in section 7.3.2 in TR38.901 | CATT, ZTE, Qualcomm, CMCC, Samsung, DCM, Ofinno, Nokia, Futurewei |
| Option 2, model-2 in section 7.3.2 in TR38.901 | vivo, OPPO, CATT, ZTE, Qualcomm, DCM, Xiaomi, Samsung, MTK, Sony, Ofinno, Futurewei, Apple, ETRI |
| Option 3, handheld UT model in section 7.3.2 in TR38.901 | CATT, Interdigital, ZTE, Qualcomm, DCM, Xiaomi, Samsung, Sony, Intel, Ofinno, NOKIA, Futurewei |
| UE antenna element gain pattern | Alt1: Omnidirectional | Huawei, vivo, CATT, ZTE, Samsung, MTK, Sony, Nokia, Futurewei |
| Alt2: According to Table 7.3-2 in TR 38.901 (radiation power pattern for handheld UT) | Huawei, OPPO, CATT, Interdigital, ZTE, Qualcomm, DCM, Xiaomi, Samsung, Intel, Ofinno, Nokia, Futurewei, ETRI |

|  |  |  |  |
| --- | --- | --- | --- |
| **4GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | Indoor |
| BS Polarized antenna modelling e.g., models in section 7.3.2 in TR38.901 | model1 | ZTE, CMCC, Samsung, Ofinno, Nokia, Futurewei | Huawei, ZTE, CMCC, Samsung, Ofinno, NOKIA, Futurewei |
| model2 | vivo, OPPO, CATT, ZTE, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Futurewei | Huawei, vivo, OPPO, CATT, Interdigital, ZTE, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Futurewei, Apple, ETRI |
| BS antenna element gain pattern | According to Table 7.3-1 in TR 38.901 | CATT, Interdigital, ZTE, Qualcomm, CMCC, DCM, Xiaomi, MTK, Sony, Ofinno, Nokia, Futurewei | HW, vivo, OPPO, CATT, Interdigital, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, ETRI |
| Table A.2.1-7 in TR 38.80 | vivo, Intel |  |
| 5dBi | Samsung |  |

#### Around 7GHz

|  |  |  |
| --- | --- | --- |
| **7GHz TXRU mapping** | **Mentioned by** | |
| **Indoor** | **outdoor** |
| Option 1, a single TXRU is mapped per panel per subarray per polarization, Per panel reuse models in TR 36.897 | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, ETRI |
| Option 2, Fully connected TXRU mapping within a panel per polarization | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Samsung, Sony, Nokia, Futurewei | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Samsung, Sony, Nokia, Futurewei, ETRI |
| Option 3, Single TXRU is mapped per panel per polarization | DCM | DCM |

|  |  |  |  |
| --- | --- | --- | --- |
| **7GHz BS Antenna configuration** | | **Mentioned by** | |
| **Indoor** | **outdoor** |
| Number of antenna elements | 64 | Ericsson, ZTE, DCM, Sony |  |
| 96 |  | ZTE |
| 128 | Nokia, DCM, Samsung | Interdigital |
| 256 | Samsung, Intel | Ericsson |
| 512 | Futurewei, vivo, OPPO | OPPO, Ericsson, DCM, Intel |
| 768 |  | Apple, Nokia |
| 960 |  | ZTE, CMCC |
| 1024 | NEC, CATT, Qualcomm | NEC, ETRI, CATT, Ericsson, Interdigital, ZTE, Qualcomm, Samsung, Intel |
| 1536 | Huawei | Huawei |
| 2048 | Huawei, Xiaomi | Huawei, Futurewei, vivo, ZTE, Xiaomi, MTK, Sony |
| 2304 | Huawei, Xiaomi, Ofinno | Huawei, Xiaomi, Ofinno |
| Maximum antenna ports | 4 | Sony |  |
| 32 | Ericsson, ZTE, DCM | ZTE |
| 64 | Intel | Ericsson, Interdigital |
| 128 | Futurewei, Nokia, OPPO, Samsung | OPPO, CATT, Ericsson, ZTE, DCM, Samsung, Intel |
| 256 | NEC, Qualcomm, Samsung | NEC, ETRI, Apple, Futurewei, Nokia, Huawei, Ericsson, Interdigital, Qualcomm, CMCC, Samsung, Intel |
| 384 |  | ZTE |
| 512 | vivo, Xiaomi | Huawei, vivo, ZTE, Xiaomi, Sony |
| 576 |  | Huawei |
| 2304 | Ofinno | Ofinno |

|  |  |  |  |
| --- | --- | --- | --- |
| **7GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| 32, 32 | (M, N, P, Mg, Ng, Mp, Np) = (4, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.5)λ | ZTE |  |
| 32, 32 | (M, N, P, Mg, Ng; Mp, Np) = (8, 8, 2, 1, 1;2, 8), (dH, dV)=(0.5, 0.8)λ |  | CMCC |
| 64, 2 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 2, 1), (dH, dV)=(0.5, 0.5)λ | Sony |  |
| 64, 32 | (M, N, P Mg, Ng, Mp, Np) = (4, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.5)λ | Ericsson |  |
| 96, 32 | (M, N, P, Mg, Ng, Mp, Np) = (12, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.8)λ |  | ZTE |
| 128, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.5)λ |  | DCM |
| 128, 64 | (M, N, P, Mg, Ng; Mp, Np) = (8, 8, 2, 1, 1;4, 8), (dH, dV)=(0.5, 0.8)λ |  | Interdigital |
| 128, 128 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.5)λ | Nokia |  |
| 192, 64 | (M, N, P, Mg, Ng, Mp, Np) = (12, 8, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.8)λ |  | CMCC |
| 256, 16 | (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2, 1, 1, 1, 8), (dH, dV) = (0.5, 0.5)λ | Qualcomm |  |
| 256, 32 | (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2, 1, 1;2, 8), (dH, dV)=(0.5, 0.8)λ |  | CMCC |
| 256, 32 | (M, N, P, Mg, Ng; Mp, Np) = (8, 16, 2, 1, 1, 1, 16), (dH, dV) = (0.5, 0.5)λ | Qualcomm |  |
| 256, 64 | (M, N, P, Mg, Ng, Mp, Np) = (8, 16, 2, 1, 1, 2, 16), (dH, dV) = (0.5, 0.8 )λ |  | Ericsson |
| 256, 64 | (M, N, P, Mg, Ng;Mp, Np) = (16, 8, 2, 1, 1;4, 8), (dH, dV) = (0.5, 0.5)λ | Intel |  |
| 256, 64 | (M, N, P, Mg, Ng;Mp, Np) = (16, 8, 2, 1, 1;4, 8), (dH, dV) = (0.5, 0.8)λ |  | CMCC |
| 256, 128 | (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.8)λ |  | Qualcomm |
| 384, 128 | (M, N, P, Mg, Ng;Mp, Np) = (12, 16, 2, 1, 1, 4, 16), (dH, dV) = (0.5, 0.8)λ |  | CMCC |
| 512, 128 | (M, N, P, Mg, Ng, Mp, Np) = (16, 16, 2, 1, 1, 4, 16), (dH, dV) = (0.5, 0.5)λ | OPPO | OPPO |
| 512, 128 | (M, N, P, Mg, Ng;Mp, Np) = (16, 16, 2, 1, 1;4, 16), (dH, dV) = (0.5, 0.8)λ |  | DCM, Ericsson, Intel |
| 512, 128 | (M, N, P, Mg, Ng;Mp, Np) = (32, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.5)λ | Futurewei |  |
| 512, 128 | (M, N, P, Mg, Ng;Mp, Np) = (32, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.8)λ | Futurewei |  |
| 512, 512 | (M, N, P, Mg, Ng) = (16, 16, 2, 1, 1, 16, 16), (dH, dV) = (0.5, 0.5)λ | vivo |  |
| 768, 2 | (M, N, P, Mg, Ng; Mp, Np) = (24, 16, 2, 1, 1; 1, 1), (dH, dV) = (0.5, 0.8)λ |  |  |
| 768, 256 | (M, N, P, Mg, Ng; Mp, Np) = (24, 16, 2, 1, 1, 8, 16), (dH, dV) = (0.5, 0.8)λ |  | Qualcomm, CMCC |
| 768, 256 | (M, N, P, Mg, Ng; Mp, Np) = (8, 6, 16, 2, 1, 8, 16), (dH, dV) = (0.5, 0.8)λ |  | Apple |
| 768, 256 | (M, N, P, Mg, Ng; Mp, Np) = (12, 32, 2, 1, 1, 4, 32), (dH, dV) = (0.5, 0.8)λ |  | Nokia |
| 960, 240 | (M, N, P, Mg, Ng, Mp, Np) = (24, 20, 2, 1, 1, 6, 20), (dH, dV) = (0.5, 0.8)λ |  | ZTE |
| 1024, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 16, 2, 1, 1, 4, 8), (0.5, 0.5)λ |  | Futurewei |
| 1024, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 16, 2, 1, 1, 4, 8), (0.5, 0.8)λ |  | Futurewei |
| 1024, 128 | (M, N, P, Mg, Ng, Mp, Np) = (32, 16, 2, 1, 1, 4, 16), (dH, dV) = (0.5, 0.5)λ |  | CATT |
| 1024, 128 | (M, N, P, Mg, Ng, Mp, Np) = (32, 16, 2, 1, 1, 4, 16), (dH, dV) = (0.5, 0.8)λ |  | ZTE, CATT |
| 1024, 256 | (M, N, P, Mg, Ng, Mp, Np) = (32, 16, 2, 1, 1, 8, 16), (dH, dV) = (0.5, 0.8 )λ |  | Ericsson, Interdigital, ETRI |
| 1024, 256 | (M, N, P, Mg, Ng; Mp, Np) = (16, 32, 2, 1, 1, 4, 32) (dH, dV)=(0.5, 0.8)λ |  | Intel |
| 1536, 256 | (M, N, P, Mg, Ng; Mp, Np) = (48, 16, 2, 1, 1, 8, 16), (dH, dV)=(0.5, 0.5)λ |  | Huawei |
| 1536, 256 | (M, N, P, Mg, Ng, Mp, Np) = (48, 16, 2, 1, 1, 8, 16), (dH, dV) = (0.5, 0.8)λ |  | ZTE, Huawei |
| 2048, 256 | (M, N, P, Mg, Ng;Mp, Np) = (32, 32, 2, 1, 1, 8, 16), (dH, dV)=(0.5, 0.5)λ |  | Futurewei |
| 2048, 256 | (M, N, P, Mg, Ng, Mp, Np) = (32, 32, 2, 1, 1, 8, 16), (dH, dV) = (0.5, 0.8)λ |  | Futurewei |
| 2048, 512 | (M, N, P, Mg, Ng;Mp, Np) = (64, 16, 2, 1, 1; 16, 16), (dH, dV) = (0.5, 0.5)λ | Xiaomi |  |
| 2048, 512 | (M, N, P, Mg, Ng, Mp, Np) = (64, 16, 2, 1, 1, 16, 16), (dH, dV) = (0.5, 0.8)λ |  | ZTE, Xiaomi, Huawei |
| 2048, 512 | (M, N, P, Mg, Ng; Mp, Np) = (64, 16, 2, 1, 1, 16, 16), (dH, dV)=(0.5, 0.5)λ |  | Huawei |
| 2048, 512 | (M, N, P, Mg, Ng, Mp, Np) = (32, 32, 2, 1, 1, 8, 32), (dH, dV) = (0.5, 0.8)λ |  | vivo, Sony |
| 2048, 512 | (M, N, P, Mg, Ng;Mp, Np) = (32, 32, 2, 1, 1; 8, 32), (dH, dV)=(0.5, 0.5)λ | Xiaomi |  |
| 2304, 384 | (M, N, P, Mg, Ng;Mp, Np) = (48, 24, 2, 1, 1; 8, 24), (dH, dV)=(0.5, 0.5)λ | Xiaomi |  |
| 2304, 384 | (M, N, P, Mg, Ng;Mp, Np) = (48, 24, 2, 1, 1; 8, 24), (dH, dV)=(0.5, 0.8)λ |  | ZTE, Xiaomi |
| 2304, 468 | (M, N, P, Mg, Ng; Mp, Np)=(72, 16, 2, 1, 1, 18, 16);(dH, dV)=(0.5, 0.5)λ | Ofinno | Ofinno, Huawei |
| 2304, 576 | (M, N, P, Mg, Ng; Mp, Np) = (72, 16, 2, 1, 1, 18, 16), (dH, dV)=(0.5, 0.8)λ |  | Huawei |

|  |  |  |
| --- | --- | --- |
| **7GHz UT Antenna configuration** | | **Mentioned by** |
| Elements/ports | 4, 4 | DCM, Intel, Futurewei |
| 8, 8 | ZTE, Ofinno |
| General | 2T4R | OPPO, MTK, Spreadtrum, NEC |
| 4T8R | Interdigital, MTK |
| Handheld | 1T4R | Samsung |
| 2Tx/4Rx | Xiaomi, Sony |
| 4Tx/4Rx | NOKIA |
| 3Tx/6Rx | Xiaomi |
| 4Tx/6Rx | Xiaomi |
| 4Tx/8Rx | Nokia, Ericsson, Qualcomm |
| low-end IoT UE/MTC | 1Tx/1Rx | Sony, Ericsson, Qualcomm |
| 1Tx/2Rx | vivo, Qualcomm |
| CPE/FMA | 8Tx/8Rx | Ericsson, Qualcomm, LGE |
| 8Tx/16Rx | Qualcomm |
| 16T16R | Nokia |
| Alt1 traditional model | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2),  (dH, dV)=(0.5, 0.5)λ | ZTE, CMCC, Samsung, Futurewei, CATT, Sony (FWA/CPE), |
| 2Tx: (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 1, 1, 1, 1, 2), (dH, dV) = (0.5, 0.5)λ 4Rx: (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 1, 1, 1, 2, 2), (dH, dV) = (0.5, 0.5)λ | vivo, OPPO, ETRI, Spreadtrum |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 1, 1, 1, 1, 1, 1), (dH, dV)=(0.5, 0.5)λ | Sony (IOT) |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 4, 2, 1, 1, 4, 2), (dH, dV)=(0.5, 0.5)λ | CATT |
| (M, N, P, Mg, Ng, Mp, Np) = (2, 2, 2, 1, 1, 2, 2).(dH, dV) = (0.5, 0.5)λ | ZTE |
| (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 2, 1, 2), (dH, dV)=(0.5, 0.5)λ | CATT |
| (M, N, P, Mg, Ng; Mp, Np) = ((2, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.5)λ | Huawei, Ofinno, Futurewei |
| (M, N, P, Mg, Ng, Mp, Np) = (4, 2, 2, 1, 1, 4, 2), (dH, dV) = (0.5, 0.5)λ | Nokia (FWA/CPE) |
| Alt2 handheld model | Support | Qualcomm, Xiaomi (handheld), NEC |
| (1, 3) | Huawei |
| (1, 3, 5, 7) | DCM, Intel, Sony (Smartphone/XR), Nokia |
| (1-8) | Interdigital |
| Rx: (1-8) Tx: (1, 3, 5, 7) | Nokia (handheld) |

|  |  |  |
| --- | --- | --- |
| **7GHz UT Antenna configuration** | | **Mentioned by** |
| UE Polarized antenna modelling,  e.g., models in section 7.3.2 in TR38.901 | Option 1, model-1 in section 7.3.2 in TR38.901 | Huawei, ZTE, CMCC, DCM, Samsung, Ofinno, Nokia, Futurewei |
| Option 2, model-2 in section 7.3.2 in TR38.901 | Huawei, vivo, OPPO, ZTE, DCM, Xiaomi, Samsung, MTK, Sony, Ofinno, Futurewei, Apple, ETRI |
| Option 3, handheld UT model in section 7.3.2 in TR38.901 | Huawei, Interdigital, ZTE, DCM, Xiaomi, Samsung, Sony, Intel, Ofinno, Nokia, Futurewei |
| UE antenna element gain pattern | Alt1: Omnidirectional | Huawei, vivo, ZTE, Samsung, MTK, Nokia, Futurewei |
| Alt2: According to Table 7.3-2 in TR 38.901 (radiation power pattern for handheld UT) | Huawei, OPPO, Interdigital, ZTE, DCM, Xiaomi, Samsung, Sony, Intel, Ofinno, Nokia, Futurewei, ETRI |

|  |  |  |  |
| --- | --- | --- | --- |
| **7GHz BS Antenna configuration** | | **Mentioned by** | |
| **Indoor** | **Outdoor** |
| BS Polarized antenna modelling e.g., models in section 7.3.2 in TR38.901 | model1 | Ericsson, ZTE, CMCC, DCM, Samsung, Nokia, Futurewei | Huawei, Ericsson, ZTE, CMCC, DCM, Samsung, Ofinno, Nokia, Futurewei |
| model2 | vivo, OPPO, Ericsson, ZTE, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Futurewei | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Futurewei, Apple, ETRI |
| BS antenna element gain pattern | Table 7.3-1 in TR 38.901 | OPPO, Ericsson, Interdigital, ZTE, CMCC, DCM, Xiaomi, MTK, Sony, Nokia, Futurewei | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, CMCC, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, ETRI |
| Table A.2.1-7 in TR 38.802 | vivo, Intel |  |
| 5dBi | Samsung |  |

#### Around 15GHz

|  |  |  |
| --- | --- | --- |
| **15GHz TXRU mapping** | **Mentioned by** | |
| Indoor | outdoor |
| Option 1, a single TXRU is mapped per panel per subarray per polarization, Per panel reuse models in TR 36.897 | Huawei, ZTE, DCM, Samsung, Intel, Nokia, Futurewei | Huawei, ZTE, DCM, Samsung, Intel, Nokia, Futurewei |
| Option 2, Fully connected TXRU mapping within a panel per polarization | ZTE, DCM, Samsung, Nokia | ZTE, DCM, Samsung, Nokia |
| Option 3, Single TXRU is mapped per panel per polarization | DCM | DCM |

|  |  |  |  |
| --- | --- | --- | --- |
| **15GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| Number of antenna elements | 128 | ZTE, DCM |  |
| 256 | Samsung |  |
| 512 | Nokia | DCM |
| 768 |  | Nokia |
| 1024 | Futurewei |  |
| 2048 |  | Intel |
| 2304 | Huawei | Huawei, ZTE, Futurewei |
| 4096 |  | Samsung |
| Maximum antenna ports | 32 | DCM |  |
| 128 | ZTE, Futurewei | DCM |
| 144 | Samsung, Nokia | Samsung, Nokia, Futurewei |
| 256 |  | ZTE, Intel |
| 512 |  | ZTE, Intel |
| 576 |  | Huawei |

|  |  |  |  |
| --- | --- | --- | --- |
| **15GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| 96, 32 | (M, N, P, Mg, Ng, Mp, Np) = (12, 4, 2, 1, 1, 4, 4), (dH, dV) = (0.5, 0.8)λ |  | ZTE |
| 128, 16 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 4), (dH, dV) = (0.5, 0.5)λ | Futurewei |  |
| 128, 16 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 4), (dH, dV) = (0.5, 0.8)λ | Futurewei |  |
| 128, 32 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 8), (dH, dV) = (0.5, 0.5)λ | DCM |  |
| 128, 128 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.5)λ | ZTE |  |
| 256, 256 | (M, N, P, Mg, Ng, Mp, Np) = (8, 16, 2, 1, 1, 8, 16); (dH, dV)=(0.5, 0.5)λ | Samsung |  |
| 512, 128 | (M, N, P, Mg, Ng;Mp, Np) = (16, 16, 2, 1, 1;4, 16), (dH, dV) = (0.5, 0.8)λ |  | DCM |
| 512, 256 | (M, N, P, Mg, Ng, Mp, Np) = (16, 16, 2, 1, 1, 8, 16), (dH, dV) = (0.5, 0.5)λ | Nokia |  |
| 768, 256 | (M, N, P, Mg, Ng; Mp, Np) = (12, 32, 2, 1, 1, 4, 32), (dH, dV) = (0.5, 0.8)λ |  | Nokia |
| 960, 240 | (M, N, P, Mg, Ng, Mp, Np) = (24, 20, 2, 1, 1, 6, 20), (dH, dV) = (0.5, 0.8)λ |  | ZTE |
| 1024, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 16, 2, 1, 1, 4, 8), (0.5, 0.5)λ |  | Futurewei |
| 1024, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 16, 2, 1, 1, 4, 8), (0.5, 0.8)λ |  | Futurewei |
| 1024, 128 | (M, N, P, Mg, Ng, Mp, Np) = (32, 16, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.5)λ | Futurewei |  |
| 1024, 128 | (M, N, P, Mg, Ng, Mp, Np) = (32, 16, 2, 1, 1, 8, 8), (dH, dV) = (0.5, 0.8)λ | Futurewei | ZTE |
| 1536, 256 | (M, N, P, Mg, Ng; Mp, Np) = (48, 16, 2, 1, 1, 8, 16), (dH, dV)=(0.5, 0.5)λ |  | ZTE, Samsung |
| 2048, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 32, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.5)λ |  | Futurewei |
| 2048, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 32, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.8)λ |  | Futurewei |
| 2048, 512 | (M, N, P, Mg, Ng;Mp, Np) = (64, 16, 2, 1, 1; 16, 16), (dH, dV) = (0.5, 0.5)λ |  | Huawei |
| 2048, 512 | (M, N, P, Mg, Ng, Mp, Np) = (64, 16, 2, 1, 1, 16, 16), (dH, dV) = (0.5, 0.8)λ |  | ZTE, Intel, Huawei |
| 2304, 384 | (M, N, P, Mg, Ng;Mp, Np) = (48, 24, 2, 1, 1; 8, 24), (dH, dV)=(0.5, 0.8)λ |  | ZTE |
| 2304, 256 | (M, N, P, Mg, Ng; Mp, Np) = (48, 24, 2, 1, 1, 8, 16), (dH, dV) = (0.5, 0.5)λ |  | Futurewei |
| 2304, 256 | (M, N, P, Mg, Ng; Mp, Np) = (48, 24, 2, 1, 1, 8, 16), (dH, dV) = (0.5, 0.8)λ |  | Futurewei |
| 2304, 576 | (M, N, P, Mg, Ng; Mp, Np) = (72, 16, 2, 1, 1, 18, 16), (dH, dV)=(0.5, 0.8)λ |  | Huawei |
| 2304, 576 | (M, N, P, Mg, Ng; Mp, Np) = (72, 16, 2, 1, 1, 18, 16), (dH, dV)=(0.5, 0.5)λ |  | Huawei |

|  |  |  |
| --- | --- | --- |
| **15 GHz UT Antenna configuration** | | **Mentioned by** |
| Elements/ports | 4, 4 | Intel, Futurewei (Typical) |
| 8, 8 | ZTE, DCM |
| 16, 16 | Huawei, Futurewei (Max) |
| General | 4T8R | Spreadtrum |
| Handheld | 1T4R | Samsung |
| 4Tx/4Rx | Nokia |
| 4Tx/8Rx | Nokia |
| CPE/FMA | 16 Tx/Rx: | Nokia |
| Alt1 traditional model | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2),  (dH, dV) =(0.5, 0.5)λ | Samsung, Futurewei, ZTE |
| 4T(2, 2, 1, 1, 1;1, 2, 2) 8R(2, 4, 1, 1, 1;1, 2, 4) | Spreadtrum |
| (M, N, P, Mg, Ng, Mp, Np) = (2, 2, 2, 1, 1, 2, 2).(dH, dV) = (0.5, 0.5)λ | ZTE |
| (M, N, P, Mg, Ng; Mp, Np) = ((2, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.5)λ | Huawei, Futurewei |
| (M, N, P, Mg, Ng, Mp, Np) = (4, 2, 2, 1, 1, 4, 2), (dH, dV) = (0.5, 0.5)λ | Nokia (FWA/CPE) |
| Alt2 handheld model | Support | Samsung |
| (1, 3, 5, 7) | ZTE, DCM, Intel, Nokia |
| (1-8) | Huawei, Spreadtrum |
| Rx: (1-8) Tx: (1, 3, 5, 7) | Nokia |

|  |  |  |
| --- | --- | --- |
| **15 GHz UT Antenna configuration** | | **Mentioned by** |
| UE Polarized antenna modelling,  e.g., models in section 7.3.2 in TR38.901 | Option 1, model-1 in section 7.3.2 in TR38.901 | Huawei, ZTE, DCM, Samsung, Futurewei, Nokia |
| Option 2, model-2 in section 7.3.2 in TR38.901 | Huawei, ZTE, DCM, Samsung, Futurewei |
| Option 3, handheld UT model in section 7.3.2 in TR38.901 | Huawei, ZTE, DCM, Samsung, Futurewei, Nokia, Intel |
| UE antenna element gain pattern | Alt1: Omnidirectional | Huawei, ZTE, Nokia, Futurewei, Samsung |
| Alt2: According to Table 7.3-2 in TR 38.901 (radiation power pattern for handheld UT) | Huawei, ZTE, Nokia, Intel, DCM, Samsung, Futurewei |

|  |  |  |  |
| --- | --- | --- | --- |
| **15 GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| BS Polarized antenna modelling e.g., models in section 7.3.2 in TR38.901 | model1 | ZTE, DCM, Samsung, Nokia, Futurewei (optionally) | Huawei, ZTE, DCM, Samsung, Nokia, Futurewei (optionally) |
| model2 | ZTE, DCM, Samsung, Intel, Futurewei | Huawei, ZTE, DCM, Samsung, Intel, Futurewei |
| BS antenna element gain pattern | Table 7.3-1 in TR38.901 | ZTE, Nokia, DCM, Futurewei | Huawei, ZTE, Nokia, Intel, DCM, Samsung, Futurewei |
| Table A.2.1-7 in TR38.802 | Intel |  |
| 5dBi | Samsung |  |

#### Around 30GHz

|  |  |  |
| --- | --- | --- |
| **30 GHz TXRU mapping** | **Mentioned by** | |
| Indoor | outdoor |
| Option 1, a single TXRU is mapped per panel per subarray per polarization, Per panel reuse models in TR 36.897 | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Ofinno, Futurewei | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Ofinno, Futurewei |
| Option 2, Fully connected TXRU mapping within a panel per polarization | vivo, OPPO, ZTE, CMCC, DCM, Ofinno | vivo, OPPO, ZTE, CMCC, DCM, Ofinno |
| Option 3, Single TXRU is mapped per panel per polarization | Ericsson, DCM, Samsung | Ericsson, DCM, Samsung |

|  |  |  |  |
| --- | --- | --- | --- |
| **30GHz BS Antenna configuration** | | **Mentioned by** | |
| **Indoor** | **outdoor** |
| Number of antenna elements | 64 | Ericsson, CMCC, DCM | Interdigital |
| 128 | ZTE, Qualcomm |  |
| 256 |  | DCM, CMCC |
| 512 | vivo | Qualcomm |
| 1024 | OPPO, Samsung | OPPO, Ericsson, Samsung |
| 2048 | Futurewei |  |
| 4096 | Huawei, Ofinno | Huawei, vivo, ZTE, Ofinno, Futurewei |
| Maximum antenna ports | 2 | Qualcomm | Qualcomm |
| 4 | Samsung | Interdigital, Samsung |
| 8 | OPPO, ZTE | OPPO, CMCC |
| 16 | DCM |  |
| 32 | CMCC | ZTE |
| 64 | Futurewei | DCM, Futurewei |
| 256 | vivo, Ofinno | vivo, Ofinno |
| 512 | vivo, Ofinno | vivo, Ofinno |

|  |  |  |  |
| --- | --- | --- | --- |
| **30 GHz BS Antenna configuration** | | **Mentioned by** | |
| **Indoor** | **outdoor** |
| 64, N/A | (M, N, P, Mg, Ng) = (4, 8, 2, 1, 1), (dH, dV) = (0.5, 0.5)λ | Ericsson |  |
| 64, 4 | (M, N, P, Mg, Ng; Mp, Np) = (4, 8, 2, 1, 1; 1, 2), (dH, dV)=(0.5, 0.5)λ |  | Interdigital |
| 64, 8 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1;1, 4), (dH, dV)=(0.5, 0.5)λ | CMCC |  |
| 64, 16 | (M, N, P, Mg, Ng;Mp, Np) = (4, 8, 2, 1, 1, 1, 8), (dH, dV)=(0.5, 0.5)λ | DCM |  |
| 64, 32 | (M, N, P, Mg, Ng;Mp, Np) = (8, 4, 2, 1, 1, 4, 4), (dH, dV)=(0.5, 0.5)λ | CMCC |  |
| 128, 2 | (M, N, P, Mg, Ng; Mp, Np) = (8, 8, 2, 1, 1, 1, 1), (dH, dV) = (0.5, 0.5)λ | Qualcomm |  |
| 128, 8 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 2), (dH, dV) = (0.5, 0.5)λ | ZTE |  |
| 128, 16 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 4), (dH, dV) = (0.5, 0.5)λ | Futurewei |  |
| 128, 16 | (M, N, P, Mg, Ng, Mp, Np) = (8, 8, 2, 1, 1, 2, 4), (dH, dV) = (0.5, 0.8)λ | Futurewei |  |
| 256, 8 | (M, N, P, Mg, Ng; Mp, Np) = (4, 8, 2, 2, 2; 1, 1), (dH, dV)=(0.5, 0.5)λ, (dg, H, dg, V) = (4.0, 2.0)λ |  | CMCC |
| 256, 64 | (M, N, P, Mg, Ng, Mp, Np) = (4, 8, 2, 2, 2, 1, 8), (dH, dV) = (0.5, 0.5)λ, (dg, H, dg, V) = (4.0, 2.0)λ |  | DCM |
| 512, 512 | (M, N, P, Mg, Ng) = (16, 16, 2, 1, 1, 16, 16), (dH, dV) = (0.5, 0.5)λ | vivo |  |
| 768, 2 | (M, N, P, Mg, Ng; Mp, Np) = (24, 16, 2, 1, 1; 1, 1), (dH, dV) = (0.5, 0.8)λ | Samsung | Samsung |
| 1024, N/A | (M, N, P, Mg, Ng) = (32, 16, 2, 1, 1), (dH, dV) = (0.5, 0.5)λ |  | Ericsson |
| 1024, 4 | (M, N, P, Mg, Ng; Mp, Np) = (16, 16, 2, 2, 1; 1, 1), (dH, dV) = (0.5, 0.5)λ | Samsung | Samsung |
| 1024, 8 | (M, N, P, Mg, Ng, Mp, Np) = (16, 8, 2, 2, 2, 1, 1), (dV, dH) = (0.5, 0.5)λ, (dg, V, dg, H) = (2.0, 4.0)λ |  | OPPO |
| 1024, 8 | (M, N, P, Mg, Ng, Mp, Np) = (8, 16, 2, 2, 2, 1, 1) |  | ZTE |
| 2048, 8 | (M, N, P, Mg, Ng; Mp, Np) = (8, 32, 2, 2, 2, 1, 1), (dH, dV) = (0.5, 0.5)λ, (dg, H, dg, V) = (4.0, 2.0)λ |  | Qualcomm |
| 2048, 16 | (M, N, P, Mg, Ng, Mp, Np) = (8, 16, 2, 4, 2, 1, 1) |  | ZTE |
| 2048, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 32, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.5)λ | Futurewei |  |
| 2048, 64 | (M, N, P, Mg, Ng; Mp, Np) = (32, 32, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.8)λ | Futurewei |  |
| 4096, 64 | (M, N, P, Mg, Ng; Mp, Np) = (64, 32, 2, 1, 1, 4, 8), (dH, dV) = (0.5, 0.5)λ or (0.5, 0.8)λ |  | Futurewei |
| 4096, 512 | (M, N, P, Mg, Ng, Mp, Np) = (32, 16, 2, 2, 2, 8, 8), (dHg, dVg) = (8, 16)λ, (dH, dV) = (0.5, 0.5)λ |  | vivo |

|  |  |  |
| --- | --- | --- |
| **30 GHz UT Antenna configuration** | | **Mentioned by** |
| Elements, ports | 4, 4 | Futurewei (Typical) |
| 8, 2 | Samsung |
| 8, 8 | DCM |
| 16, 4 | OPPO, Interdigital |
| 16, 16 | Huawei, Futurewei (Max) |
| 32, 4 | CMCC ZTE |
| 32, 8 | CMCC |
| 32, 32 | vivo, Ofinno |
| 128, 2 | Samsung |
| General | 8T8R | Spreadtrum |
| 32T32R | Qualcomm |
| Alt1 traditional model | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1, 1, 2),  (dH, dV)=(0.5, 0.5)λ | Futurewei |
| (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 1, 2, 2, 1, 1), (dH, dV) = (0.5, 0.5)λ,  (dg, V, dg, H) = (0, 0)λ | OPPO |
| (M, N, P, Mg, Ng; Mp, Np) = ((2, 4, 2, 1, 1, 2, 4), (dH, dV)=(0.5, 0.5)λ | Futurewei, vivo |
| (M, N, P, Mg, Ng; Mp, Np) = (2, 4, 2, 1, 2; 1, 1) (dH, dV) = (0.5, 0.5)λ, (dg, H, dg, V) = (0, 0)λ | CMCC |
| (M, N, P, Mg, Ng; Mp, Np) = (2, 4, 2, 1, 2; 1, 2) (dH, dV) = (0.5, 0.5)λ, (dg, H, dg, V) = (0, 0)λ | Interdigital, CMCC |
| (M, N, P, Mg, Ng; Mp, Np) = (4, 1, 2, 1, 1, 1, 1, ), (dH, dV)=(0.5, 0.5)λ | Samsung |
| (M, N, P, Mg, Ng; Mp, Np) = (8, 8, 2, 1, 1, 1, 1), (dH, dV)=(0.5, 0.5)λ | Samsung |
| Alt2 handheld model | Support | Intel |
| (1, 3, 5, 7) | DCM |

|  |  |  |
| --- | --- | --- |
| **30 GHz UT Antenna configuration** | | **Mentioned by** |
| UE Polarized antenna modelling,  e.g., models in section 7.3.2 in TR38.901 | Option 1, model-1 in section 7.3.2 in TR38.901 | ZTE, CMCC, DCM, Samsung, Ofinno, Futurewei |
| Option 2, model-2 in section 7.3.2 in TR38.901 | vivo, OPPO, ZTE, DCM, Samsung, Ofinno, Futurewei |
| Option 3, handheld UT model in section 7.3.2 in TR38.901 | Interdigital, ZTE, DCM, Samsung, Ofinno, Ericsson, Qualcomm, Intel |
| UE antenna element gain pattern | Alt1: Omnidirectional |  |
| Alt2: According to Table 7.3-2 in TR 38.901 (radiation power pattern for handheld UT) | Intel, Interdigital, OPPO, Ofinno, Ericsson, Samsung |
| Table A.2.1-8 in the TR 38.80 | vivo, ZTE, Qualcomm, DCM |

|  |  |  |  |
| --- | --- | --- | --- |
| **30 GHz BS Antenna configuration** | | **Mentioned by** | |
| Indoor | outdoor |
| BS Polarized antenna modelling e.g., models in section 7.3.2 in TR38.901 | model1 | Ericsson, Qualcomm, DCM, ZTE, CMCC, Samsung, Ofinno, Futurewei(optionally) | Ericsson, Qualcomm, DCM, ZTE, CMCC, Samsung, Ofinno, Futurewei(optionally) |
| model2 | Ericsson, Qualcomm, DCM, vivo, OPPO, ZTE, Samsung, Intel, Ofinno, Futurewei | Ericsson, Qualcomm, DCM, vivo, OPPO, Interdigital, ZTE, Samsung, Intel, Ofinno, Futurewei |
| BS antenna element gain pattern | Table 7.3-1 in TR38.901 | Ericsson, ZTE, CMCC, Interdigital, OPPO, Ofinno, Futurewei | Ericsson, vivo, ZTE, Qualcomm, CMCC, Intel, Interdigital, Samsung, OPPO, Ofinno, Futurewei |
| Table A.2.1-7 in TR38.802 | DCM, vivo, Qualcomm, DCM, Intel | Qualcomm, DCM |

**Round-1 discussions:**

(FL1) Proposal in Attachment1

**Please check the ‘moderator’s proposal’ as attached for the antenna modelling for each of carrier frequencies.**

*Any comments/suggestions, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Futurewei | We thank the FL for the great effort. Overall the proposals are very reasonable. We have a couple of comments:   1. For TXRU mapping Option2: Fully connected TXRU mapping within a panel per polarization, we are not sure if it is feasible when the number of antenna elements and number of ports are very high, for, e.g., ~4 GHz and higher.   For example, at ~4 GHz, the proposed BS has baseline 512 antenna elements and max 128 antenna ports. Since most companies consider 1 panel, each polarization has 256 elements and max 64 ports, which leads to 256 x 64 x 2 = 32k connections. This number gets even higher for higher frequencies.  Is such a huge number of connections practical? Or maybe we missed something? Our understanding is based on 38.802 and 36.897; see below figure. Maybe companies can share their understanding of the full-connection model and the practicality of the number of connections to make sure we are all on the same page.    Figure 5.2.2-2: TXRU virtualization model option-2: full-connection model (36.897)  Regarding the baseline values and optional values, e.g., “Baseline: 256 Optional: 128, 64, 32”, we feel the baseline should be a smaller number, and the optional can be much larger, such as “Baseline: 128, 64, 32 Optional: 256”. |
| ZTE | Thanks for FL’s comprehensive summary, it’s indeed a huge amount of work. We have following comments  Considering that the 7 GHz frequency band poses significant challenges in terms of both coverage performance and hardware design, we suggest the following:   * Different antenna configuration assumptions should be taken into consideration, e.g., 960 AEs with (24, 20, 2, 1, 1, 6, 20) * At least 8 Rx at the UE side should be considered, especially as foldable phones become increasingly popular. |
| Vivo | For 4GHz and 7GHz UE antenna numbers, it seems more companies support to use maximum 4 antennas. Further, most of the UE vendors think 2T4R is the baseline for evaluation. The baseline should be 4 antennas, and 8 should be optional. The numbers of Tx and Rx antennas should also be specified to avoid confusion for UL simulations. Hence we think the baseline should be 2T4R considering UE vendors’ views.  For UE antenna model, the so-called “handheld model” specified in Rel-19 is only for calibration as captured in TR38.901 i.e., “This subclause captures the antenna array structures considered in this SI for calibration”. The intention of having this model is to make it more practical to real UE implementations. However, whether this model is really practical is questionable. The location to put antennas is a very complex issue in real UE design. There are many aspects to be considered beyond communications. The 8 candidate locations specified in the TR are still too ideal. Hence given the so-called “practical” locations are not really practical, why don’t we use the simpler legacy model and control the antenna correlation based on antenna spacing? |
| Nokia | **For 700 MHz:**  The proposed default parameterization both for gNB and UE antenna numbers are too large.  The wavelength at 7 GHz is around 0.43 m. Hence, the panel width becomes 1.72 m by 1.4 m what is very large. On the UE side, supporting 4 antennas faces the same problem.  Hence, be default, 32 antenna elements should be considred at the BS side and 2 at the UE.  **For below 7 GHz:**  We should not consider more that 8 AEs for CPE at these bands.  **For 2-7 GHz**:  8 antenna elements at the Handgeld UE side should not be considred by default.  **General proposals:**  Having multiple default options will considerably increase the simulation burden. We should strive for a single default option, that is close to the practical values.  We propose to assume directional UE antennas by default.  Fow UE directional antennas, the default candidate location should be listed, e.g., (4, 8) for 700Mhz, (1,3,5,7) for 4 antennas.  Polarization Model-1 should be considred by default, at least for UE modelling, if omnidirectional antennas are considred. |
| Interdigital | **UE polarization model**  It seems all polarization models are simply stated as supported. We think Model-1 or Model-2 should only apply for non-handheld UT model, and when handheld UT model is used the polarization model for handheld should apply. Also for the non-handheld antenna model, (similar to Nokia) Model-1 should be the default for consideration. While there has been presentation and data that Model-2 could apply to BS antenna, we are not aware of any data that hints that model-2 for UE is appropriate. |
| Xiaomi | For 700MHz UE antenna number, more companies support 2Rx antennas, and UE vendors generally prefer 2Rx. Then, the baseline should be 2Rx, and 4Rx can be optional.  For 2GHz, we also think 2Rx can be the baseline and 4Rx should be optional at least for handheld UEs. For companies that support 4Rx, we would like to further inquire: whether 4Rx is supported for all UEs, or if 4Rx is the maximum value while 2Rx can be supported for handheld UEs?  For 4GHz and 7GHz, we share the similar comments as vivo, i.e., the baseline should be 4 antennas, and 8 should be optional. |
| Sony | Thanks for FL’s summary. The FL’s proposals generally look fine, except for the number of UE antenna for IoT device.  We think 1 as baseline and 2 as optional for the number of UE antenna for IoT device. If it would be agreed that 2 UE antennas for IoT is baseline, basic coverage would be determined assuming 2 UE antennas, which have a risk for scalable 6GR design with minimum capability device that implements 1 UE antenna only to fail meet the 6G requirement. |
| Ericsson1 | Thanks for sharing the draft. Some initial comments below. We will provide additional comments in next update.  **For base station antenna assumptions**  **700 MHz:** 32 antenna elements should be baseline for base station antenna elements. 64 elements options correspond to a very large array which may not be practical in several cases. It can be optional for special case scenarios, such as dedicated air to ground coverage. Also 4 antenna ports should be used as baseline. Gains from higher number of ports need to be further evaluated in different deployment scenarios. 16 ports can be optional. For (M,N,P,Mg,Ng; Mp, Np) Proposal is Baseline: (8, 2, 2, 1, 1; 1, 2) and Optional: (8, 2, 2, 1, 1; 4, 2). Four columns corresponds to a very wide array which may not be practical in several cases.  **4 GHz:** 64 ports should be the baseline. 128 can be optional  **7 GHz:** For indoor 64 or 128 number of antenna elements should be used as baseline. 512 might correspond to too large form factor for indoor. |
| Samsung | Some proposed numbers of AEs and ports seem unrealistic, especially for UE side, as commented by other companies. The baseline assumptions should consider practical implementation to most extent. In particular, the followings are suggested considering key implementation aspects in reality:  For handheld UE, 1TXRU should be considered as the baseline for Non-FR2 bands   * For around 700 MHz and 2 GHz, 1T2R should be the baseline. * For around 4 GHz and 7 GHz, 1T2R should be the baseline. 2 TX needs to be further discussed as optional.   For around 700 MHz BS, up to 8 AEs and up to 8 ports due to constraint of form factor in typical deployment.  For around 30 GHz:   * Up to 2 ports and up to 8 AEs for handheld UE, the proposed 32 ports is unaffordable. 4 AEs for each port can be the baseline. * Up to 1024 AE and up to 4 ports for BS. 768 AEs and 2 ports can be the baseline. |
| DOCOMO | [BS antenna configuration – Antenna element]  Regarding the number of antenna element in ATMT1, the definition of “baseline” and “optional” seems to be unclear. Therefore, we need to specify what kind of numbers should be used as baseline.  From our perspective, the value similar to NR can be used as baseline, since we believe baseline should be configured to show technical benefit from NR, not from increasing antenna element.  In addition to that, we propose to clarify number of maximum antenna elements is up to TR38.914 to limit other value which is up to company report.  [TXRU mapping]  We think analog beamforming i.e., Option3 in FR2 can also be included to FR3 band, considering its large number of antenna elements. |
| Qualcomm | **On UE antenna assumptions**  For 700MHz, we think 8 antenna elements for CPE is too much. If we follow the CPE antenna layout agreed by R19 channel modeling, the 8 antenna requires a CPE size of 40cm x 40cm, which is different from R19 assumption. Otherwise, the antenna spacing will be reduced to 1/4 lambda instead of 1/2 lambda if we stick to 20cm x 20cm size constraint. We think 4 elements for 700MHz will be reasonable.  Also, there is only the maximum number of antenna ports assumption. We suggest to have separate parameter for tx and rx ports on UE side.  For UE antenna configuration, multiple companies propose to consider a realistic UE antenna modeling and the legacy omnidirectional antenna does not reflect the actual UE antenna design. As shown in our contribution, the omnidirectional antenna assumption at UE side is too optimistic in terms of achievable capacity and rank of the channel leading to overestimated performance. |

**Round-2 discussions:**

The BS antenna modelling for 700MHz carrier frequency was agreed as follows:

|  |
| --- |
| *Agreement*  *For around 700MHz, for TXRU mapping at base station, it is adopted as mandatory option for simulation campaign that a single TXRU is mapped per panel per subarray per polarization.*  *Note: Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.*  *Agreement*   * *For around 700MHz, 32 for total number of antenna element at base station, 4 for total number of TXRU at base station, (8, 2, 2, 1, 1; 1, 2) for (M,N,P,Mg,Ng; Mp, Np), and (0.5, 0.5)λ for (dH,dV) are assumed as the baseline combination.* * *For around 700MHz, 64 for total number of antenna element at base station, 8 for total number of TXRU at base station, (8, 4, 2, 1, 1; x, y) for (M,N,P,Mg,Ng; Mp, Np), and (0.5, 0.5)λ for (dH,dV) are assumed as the optional combination.*   *Note: Other values/combinations are up to company to report* |

The moderator’s proposal regarding BS antenna modelling for other carrier frequencies are proposed for the follow-up discussions.

(FL2) Proposal for BS antenna modelling

**For around 2GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg , Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 32 | 32 | (4, 4, 2, 1, 1; 4, 4) | (0.5, 0.5)λ |
| Combination 2 | 128 | 64 | (8, 8, 2, 1, 1; 4, 8) | (0.5, 0.5)λ |
|  |  |  |  |  |
| **Outdoor** | | | | |
| Combination 1 | 128 | 32 | (8, 8, 2, 1, 1; 2, 8) | (0.5, 0.8)λ |
| Combination 2 | 192 | 64 | (12, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Combination 3 | 256 | 64 | (16, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 4GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 32 | 32 | (4, 4, 2, 1, 1; 4, 4) | (0.5, 0.5)λ |
| Combination 2 | 128 | 64 | (8, 8, 2, 1, 1; 4, 8) | (0.5, 0.5)λ |
| Combination 3 | 256 | 128 | (16, 8, 2, 1, 1; 8, 8) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 192 | 64 | (12, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Combination 2 | 256 | 64 | (16, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Combination 3 | 512 | 128 | (16, 16, 2, 1, 1; 4, 16) | (0.5, 0.8)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 7GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 64 | 32 | (4, 8, 2, 1, 1; 2, 8) | (0.5, 0.5)λ |
| Combination 2 | 256 | 32 | (8, 16, 2, 1, 1; 1, 16) | (0.5, 0.5)λ |
| Combination 3 | 512 | 128 | (32, 8, 2, 1, 1; 8, 8) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 1024 | 256 | (32, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 2 | 1536 | 256 | (48, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 3 | 2048 | 512 | (64, 16, 2, 1, 1; 16, 16) | (0.5, 0.8)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 15GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 128 | 32 | (8, 8, 2, 1, 1; 2, 8) | (0.5, 0.5)λ |
| Combination 2 | 256 | 256 | (8, 16, 2, 1, 1; 8, 16) | (0.5, 0.5)λ |
| Combination 3 | 512 | 256 | (16, 16, 2, 1, 1; 8, 16) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 1536 | 256 | (48, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 2 | 2048 | 512 | (64, 16, 2, 1, 1; 16, 16) | (0.5, 0.8)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 30GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 64 | 8 | (8, 4, 2, 1, 1; 1, 4) | (0.5, 0.5)λ |
| Combination 2 | 128 | 8 | (8, 8, 2, 1, 1; 2, 2) | (0.5, 0.5)λ |
| Combination 3 | 1024 | 4 | (16, 16, 2, 1, 1; 1, 1) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 1024 | 8 | (16, 8, 2, 2, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 2 | 2048 | 16 | (8, 16, 2, 4, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 3 | 4096 | 64 | (64, 32, 2, 1, 1; 4, 8) | (0.5, 0.5)λ |
| Note1: A single TXRU is mapped per panel per polarization as mandatory option. Companies can provide results optionally, assuming a single TXRU is mapped per panel per subarray per polarization as mandatory option.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

*Any comments/suggestions, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | For antenna elements, we propose to consider the number of “up to xx antenna elements for BS” from the conclusion from RAN#109 per carrier frequency. There may be defined more than one evaluation configuration according to the different views on the floor, but the potential maximum elements should be considered for further 6G technology evaluation, in order to develop better 6G system than 5G.  **- around 2GHz**: Up to 288 Tx and Rx antenna elements  **- around 4GHz**: Up to 2304 Tx and Rx antenna elements  **- around 7GHz**: Up to 2304 Tx and Rx antenna elements  **- around 15GHz**: Up to 2304 Tx and Rx antenna elements  **- around 30GHz**: Up to 4096 Tx and Rx antenna elements  Further, regarding the candidate BS antenna ports in outdoor case:  **- around 2GHz**: 64 ports  **- around 4GHz**: 144 ports, 128 ports, 64 ports  **- around 7GHz**: 576 ports, 512 ports, 256 ports  **- around 15GHz**: 576 ports, 512 ports, 256 ports  Besider, considering the UE element in TR 38.913 already supported up to 8Tx/Rx, the candidate maximum UE antenna ports in 6G:  **- For IOT device**: 2 ports, such 2, 1  **- For non-IOT device**:  **- around 700MHz, and around 2GHz:**  8 ports, such as 8, 4  **- around 4GHz, around 7GHz and around 15GHz:**  16 ports, such as 16, 8 |
| Nokia1 | Thank you for the summary. Generally, looks OK for us, except for 7GHz, we think that for Outdoor Combination 1 765, i.e., (12, 32, 2, 1, 1,4,32) will provide more direct comparison to 4 MHz 192 AE outdoor combination. |
| ZTE | Thanks for FL’s great summary, and we have following comments:   * For 2GHz, we recommend adding **Combination 4** for **outdoor scenario** with 288 AEs and 96 TXRUs, i.e., (M, N, P, Mg, Ng, Mp, Np) = (24,6,2,1,1,8,6), as 288 AE config is listed in TR 914. * For 4GHz, we recommend adding **Combination 4** for **outdoor scenario** with 576 AEs and 96 TXRUs, i.e., (M, N, P, Mg, Ng, Mp, Np) = (36,8,2,1,1,6,8), as 576 AE config. is listed in TR 914. * For 7GHz, we recommend adding following Combination for outdoor scenario:   + 960 AEs, 240 ports: (M, N, P, Mg, Ng, Mp, Np) = (24,20,2,1,1,6,20)   + 2304 AEs, 384 ports: (M, N, P, Mg, Ng, Mp, Np) = (48,24,2,1,1,8,24)   Considering that 7 GHz is a very important frequency band and the implementation faces many uncertainties, we should keep several evaluation options open.   * For 30 GHz, considering the different implementation strategies across companies, we suggest specifying only the combinations of candidate AE numbers and TXRU numbers, while whether to use single or multiple panels should be reported by each company. |
| Qualcomm | For each scenario, there are more than one combination. We would like to clarify whether the purpose is to support all combinations for evaluation or just down-select only one?  For 2GHz, since it is FDD band and in previous NR evaluation the same # of TXRUs, e.g., 4 are assumed for both 700MHz and 2GHz. In field deployment, not all FDD supports massive MIMO. For 6G evaluation, we prefer to follow the same principle in the previous NR evaluation and include at least 4Tx for evaluation. Therefore, we propose to support the combination (8,2,2,1,1,1,2) for 2GHz.  For 4GHz, combination 1 is aligned with existing NR assumption and is okay for us.  For 7GHz, if we assume the same array size for both 4GHz and 7GHz, the number of antenna elements per dimension will be scaled by 2. Based on it, we think 256 antenna elements for indoor and 1024 antenna elements for outdoor will be reasonable. The number of TXRUs can be 32 for indoor and 256 for outdoor. Therefore, combination 2 for indoor and combination 1 for outdoor can be considered for 7GHz evaluation.  For 15GHz, in the last RAN#109 meeting, the same value for the maximum number of BS antenna elements was assumed for both around 7 GHz and around 15 GHz. Therefore, the same antenna configuration as 7GHz may be assumed for 15GHz  For 30GHz, we think the number of TXRUs should be two since massive MIMO is not possible for FR2. The number of antenna elements could be 128 for indoor and 512 for outdoor. In addition, we think multiple panels should be also considered, e.g., 1, 2 or 4 panels. |
| NTT DOCOMO | As shown in Note2, this combination is not mandatory, and other combinations could be open. So, we propose changing the word “Combination" into “Candidate combination” |
| Samsung | Thank you for great efforts on 6G evaluation.  For 2, 4, 7, 15 GHz indoor, we support 1 to 1 mapping between antenna element and TXRU. And for some combinations, too many antennas are captured. We need to reduce the number of antenna elements and ports for indoor scenarios.  Considering real field deployments for 30GHz, we suggest to support (16,16,2,2,1; 1, 1); (0.5, 0.5)λ for 4 ports and  (24,16,2,1,1; 1, 1); (0.5, 0.8)λ for 2 ports. And we should not consider ‘Combination 3’ for 30 GHz (both Indoor and Outdoor) because the number of TXRU is unaffordable. |

(FL3) Proposal for UE antenna modelling

**For around 700MHz carrier frequency:**

|  |  |  |  |
| --- | --- | --- | --- |
| UE antenna modelling for evaluation | Total number of antenna elements | Total number of TXRU | Alt 1: (M,N,P,Mg,Ng; Mp, Np), (dH,dV), (dg,H,dg,V) if any, or  Alt 2: handheld device antenna model using candidate antenna locations as described in section 7.3 in TR38.901 |
| Combination 1 | 1 | 1T1R | (M, N, P, Mg, Ng; Mp, Np) = (1,1,1,1,1;1,1) , (dH,dV)= (0.5, 0.5)λ |
| Combination 2 | 2 | 1T2R | **1T2R,**  Alt 1: (dH,dV)= (0.5, 0.5)λ   * 1T: (M, N, P, Mg, Ng; Mp, Np) = (1,1,1,1,1;1,1) * 2R: (M, N, P, Mg, Ng; Mp, Np)=(1,2,1,1,1;1,2) |
| Combination 3 | 4 | 2T4R  4T4R | **2T4R,**  Alt 1: (dH,dV)= (0.5, 0.5)λ   * 2T: (M, N, P, Mg, Ng; Mp, Np)=(1, 2, 1, 1, 1; 1, 2) * 4R: (M, N, P, Mg, Ng; Mp, Np)=(1, 2, 2, 1, 1; 1, 2)   Alt 2:   * 2T: (2, 6) as described in section 7.3 in TR 38.901 * 4R: (2, 4, 6, 8) as described in section 7.3 in TR 38.901   **4T4R,**  Alt 1: (M, N, P, Mg, Ng; Mp, Np)= (1, 2, 2, 1, 1; 1, 2), (dH,dV)= (0.5, 0.5)λ  Alt 2: (1, 3, 5, 7) as described in section 7.3 in TR38.901 |
| Combination 4 | 8 | 4T8R  8T8R | **4T8R,**  Alt 1: (dH,dV)= (0.5, 0.5)λ   * 4T: (M, N, P, Mg, Ng; Mp, Np)= (1, 2, 2, 1, 1; 1, 2) * 8R: (M, N, P, Mg, Ng; Mp, Np)= (1, 4, 2, 1, 1; 1, 4)   Alt 2:   * 4T: (1, 3, 5, 7) as described in section 7.3 in TR38.901 * 8R: (1, 2, 3, 4, 5, 6, 7, 8) as described in section 7.3 in TR38.901   **8T8R,**  Alt 1: (M, N, P, Mg, Ng; Mp, Np)= (1, 4, 2, 1, 1; 1, 4), (dH,dV)= (0.5, 0.5)λ  Alt 2: (1, 2, 3, 4, 5, 6, 7, 8) as described in section 7.3 in TR38.901 |

*Any comments/suggestions, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | Thank you for FL summary and proposals for UE antenna modeling.  First of all, it is too early to select the number of UE’s antenna elements more than 5G for 6GR evaluation because RAN plenary is discussing and have not made agreement. For the time being, we suggest 1 TXRU as baseline regarding the UE antenna modelling for evaluation, considering the reality. |
| Qualcomm | Regarding Alt. 1 and Alt. 2, multiple companies propose to consider a realistic UE antenna modeling and the legacy omnidirectional antenna does not reflect the actual UE antenna design. As shown in our contribution, the omnidirectional antenna assumption at UE side is too optimistic in terms of achievable capacity and rank of the channel leading to overestimated performance. Therefore, we propose to make Alt 2 as the baseline and Alt 1 is optional. This also helps to reduce simulation efforts  For 2T4R and 4T8R, Alt 1 assumes a different array structure for Tx and Rx. It may not be possible. We suggest having a single array for both Tx and Rx and not specifying Tx antenna selection (up to company report). |

#### Agreement

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Agreement*   * *For around 700MHz, 32 for total number of antenna element at base station, 4 for total number of TXRU at base station, (8, 2, 2, 1, 1; 1, 2) for (M,N,P,Mg,Ng; Mp, Np), and (0.5, 0.5)λ for (dH,dV) are assumed as the baseline combination.* * *For around 700MHz, 64 for total number of antenna element at base station, 8 for total number of TXRU at base station, (8, 4, 2, 1, 1; x, y) for (M,N,P,Mg,Ng; Mp, Np), and (0.5, 0.5)λ for (dH,dV) are assumed as the optional combination.*   *Note: Other values/combinations are up to company to report*  *Agreement*  *For around 2GHz carrier frequency, for BS antenna modelling*   |  |  |  |  |  | | --- | --- | --- | --- | --- | | *BS antenna modelling* | *Total number of antenna elements* | *Total number of TXRU* | *(M, N, P, Mg , Ng; Mp, Np)* | *(dH,dV)* | | *Indoor* | | | | | | *Combination 1(Optional)* | *8* | *4* | *(2, 2, 2, 1, 1; 1, 2)* | *(0.5, 0.5)λ* | | *Combination 2 (Baseline)* | *32* | *8* | *(4, 4, 2, 1, 1; 1, 4)* | *(0.5, 0.5)λ* | |  |  |  |  |  | | *Outdoor* | | | | | | *Combination 1(Optional)* | *32* | *4* |  | *(0.5, 0.8)λ* | | *Combination 2 (Baseline)* | *192* | *64* | *(12, 8, 2, 1, 1; 4, 8)* | *(0.5, 0.5)λ* | | *Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.*  *Note2: Other combinations used in the simulation results are up to company to report.* | | | | | |

#### (FL4) Proposal for BS atenna modelling for 4/7/15/30GHz – Afteroffline

**For around 4GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 32 | 32 | (4, 4, 2, 1, 1; 4, 4) | (0.5, 0.5)λ |
| Combination 2 | 128 | **32** | **(8, 8, 2, 1, 1; 2, 8)** | (0.5, 0.5)λ |
| ~~Combination 3 (optional)~~ | ~~256~~ | **~~64~~** | **~~(16, 8, 2, 1, 1;4, 8)~~** | ~~(0.5, 0.5)λ~~ |
| **Outdoor** | | | | |
| Combination 1 (optional) | 192 | 64 | (12, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Combination 2 (baseline) | 256 | 64 | (16, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Combination 3 (optional) | 512 | 128 | (16, 16, 2, 1, 1; 4, 16) | (0.5, 0.5)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 7GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 64 | 32 | (4, 8, 2, 1, 1; 2, 8) | (0.5, 0.5)λ |
| Combination 2 | 256 | **64** | (16, 8, 2, 1, 1; 4, 8) | (0.5, 0.5)λ |
| Combination 3 | 512 | 128 | (32, 8, 2, 1, 1; 8, 8) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 768 | 128 | **(24, 16, 2, 1, 1; 4, 16)** | (0.5, 0.8)λ |
| Combination 2 | 1024 | 256 | (32, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 3 | 1536 | 256 | (48, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 4 | 2048 | 256 | (32, 32, 2, 1, 1, 8, 16) | (0.5, 0.5)λ |
| Combination 5 | 2048 | 512 | (64, 16, 2, 1, 1; 16, 16) | (0.5, 0.5)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 15GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 128 | 32 | (8, 8, 2, 1, 1; 2, 8) | (0.5, 0.5)λ |
| Combination 2 | 256 | 256 | (8, 16, 2, 1, 1; 8, 16) | (0.5, 0.5)λ |
| Combination 3 | 512 | 256 | (16, 16, 2, 1, 1; 8, 16) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 1536 | 256 | (48, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 2 | 2048 | 512 | (64, 16, 2, 1, 1; 16, 16) | (0.5, 0.8)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 30GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 128 | 8 | (8, 8, 2, 1, 1; 2, 2) | (0.5, 0.5)λ |
| Combination 2 | 512 | 8 | (8, 8, 2, 2, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 3 | 1024 | 8 | (16, 8, 2, 2, 2; 1, 1) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 1024 | 8 | (16, 8, 2, 2, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 2 | 2048 | 16 | (16, 8, 2, 4, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 3 | 4096 | 64 | (16, 8, 2, 4, 2; 2, 2) | (0.5, 0.5)λ |
| Note1: A single TXRU is mapped per panel per polarization as mandatory option. Companies can provide results optionally, assuming a single TXRU is mapped per panel per subarray per polarization as mandatory option.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

*Any strong concerns, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | For 4GHz:  There is a typo in ‘Total number of TXRU column of outdoor combination 2. It should be 64 instead of 6464.  Remove combination 3 of Indoor and one of combination 2 for outdoor.  For 7 GHz:  Remove combination 3 for indoor.  Remove combination 3 for outdoor as the vertical array size is > 2m.  For 15 GHz:  We are wondering if companies can be given more time for this (e.g., decide in RAN1#123 or email discusssion) since this was agreed only very recently by RAN.  For 30 GHz:  Remove combination 3 for outdoor. |
| AT&T | For 4GHz:  Take Combination 1 as baseline. |
| Nokia2 | An additional comment from our side on 7 and 15 GHz. In the current proposals for outdoors the vertical aggregation is 6:1 (e.g., 48 AE rows-->8 TRX rows for Config. 2), which might be too high for a full digital array (too narrow a vertical beamwidth for the TXRUs). A lot of the other cases have vertical aggregation of 4:1 which is more reasonable.  For 15 Ghz, we noticed that all options have 16 AEs horizontally (i.e., 16 columns), but it is also 16 for 7 GHz. To keep the antenna size we should consider: (32,32,2; 1,1; 8,32). |

## Other views in TDoc

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *Proposed to study energy consumption* *by different antenna models/architectures.*  *Proposed to study mixed antenna architectures (with additional fully-digital 1-bit ADC receiver at the base station) for mmWave FR2.* |

# SLS assumptions for TN

## Collected views from RAN1#122

### Discussions

*Controversial views are summarized here:*

#### Indoor Hotspot

|  |  |
| --- | --- |
| **Carrier frequency** | **Mentioned by** |
| Around 2GHz | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Samsung, Sony, Intel, Ofinno |
| Around 4GHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 7GHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 15GHz | Huawei, OPPO, Ericsson, DCM, Samsung, Intel, Ofinno |
| Around 30GHz | Huawei, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Samsung, Intel, Ofinno |
| Around 4GHz + Around 7GHz | ZTE |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Aggregated system bandwidth** | **Mentioned by** |
| Around 2GHz | Up to 200MHz (DL+UL) | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, |
| Around 4GHz | Up to 300MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, Nokia, |
| Up to 200MHz (DL+UL) | ZTE, MTK, Futurewei |
| Around 7GHz | Up to 400MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Sony, Intel, Ofinno, Nokia, Futurewei |
| Up to 200MHz (DL+UL) | MTK |
| Around 15GHz | Up to 400MHz (DL+UL) | Huawei, OPPO, Ericsson, DCM, Sony, Intel, Ofinno, |
| Around 30GHz | Up to 1GHz (DL+UL) | Huawei, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Simulation bandwidth** | **Mentioned by** |
| Around 2GHz | 200MHz per CC | Huawei, DCM, Sony, Ofinno, |
| 100MHz per CC | CMCC, Samsung, Intel, |
| 20MHz per CC | OPPO, Ericsson, ZTE, Qualcomm, Samsung, |
| 10MHz per CC | Samsung, |
| Around 4GHz | 300MHz per CC | Huawei, Sony, Ofinno, |
| 200MHz per CC | DCM, Intel, Futurewei |
| 100MHz per CC | vivo, Ericsson, CMCC, Samsung, Nokia, |
| 20MHz per CC | OPPO, CATT, ZTE, Qualcomm, Samsung, MTK, |
| 10MHz per CC | Samsung, |
| Around 7GHz | 400MHz per CC | Huawei, vivo, Ericsson, CMCC, Sony, Ofinno, Futurewei, |
| 200MHz per CC | vivo, CMCC, DCM, Xiaomi, Samsung, Intel, Nokia |
| 100MHz per CC | Qualcomm, Samsung, |
| 80MHz per CC | ZTE, |
| 20MHz per CC | OPPO, CATT, Samsung, MTK |
| Around 15GHz | 400MHz per CC | Huawei, Samsung, Intel, Ofinno, |
| 200MHz per CC | DCM, Samsung, |
| 100MHz per CC | Samsung, |
| 80MHz per CC | OPPO, Ericsson, |
| 20MHz per CC | Samsung, |
| Around 30GHz | 1GHz per CC | Ofinno, |
| 800MHz per CC | Samsung, Intel, |
| 400MHz per CC | Ericsson, DCM, Samsung, |
| 200MHz per CC | Samsung, |
| 100MHz per CC | Qualcomm, Samsung, |
| 80MHz per CC | OPPO, ZTE |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Total transmit power per BS** | **Mentioned by** |
| Around 2GHz | 24dBm/20MHz | Huawei, OPPO, CATT, Ericsson, ZTE, Qualcomm, DCM, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 4GHz | 24dBm/20MHz | Huawei, OPPO, CATT, Ericsson, ZTE, Qualcomm, DCM, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 7GHz | 24dBm/20MHz | Huawei, OPPO, CATT, ZTE, Qualcomm, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 23dBm/80MHz | Ericsson |
| Around 15GHz | 23dBm/20MHz, EIRP not exceed 58dBm | Huawei, ZTE, DCM, Intel, Nokia |
| 24dBm/20MHz | Samsung, |
| 23dBm/80MHz | Ericsson |
| Around 30GHz | 23dBm/20MHz, EIRP not exceed 58dBm | Huawei, ZTE, Qualcomm, DCM, Intel, Nokia |
| 26.6dBm/100MHz | Samsung, |
| 23dBm/80MHz | Ericsson |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE power class** | **Mentioned by** |
| Around 7GHz and below | 23dBm (FDD and TDD) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, DCM, Samsung, MTK, Sony, Intel, Nokia, Futurewei |
| 26dBm (TDD) | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, Samsung, MTK, Intel, Ofinno, Nokia, Futurewei |
| 29dBm (TDD) | Huawei, Qualcomm, Nokia, Futurewei |
| 31dBm (CPE/FWA) | ZTE, |
| Around 15GHz and above | 23dBm, EIRP not exceed 43dBm | Huawei, OPPO, Ericsson, DCM, Samsung, Intel, |
| 29dBm | Nokia, |
| 26dBm | Samsung, Nokia, |
| 12dBm | Qualcomm, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE noise figure** | **Mentioned by** |
| Around 7GHz and below | 7dB | Xiaomi, Samsung, |
| 8dB | Huawei, |
| 9dB | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 15GHz | 10dB | Huawei, OPPO, Ericsson, ZTE, DCM, Samsung, |
| 13dB | Huawei, OPPO, Ericsson, ZTE, Intel, |
| Around 30GHz | 10dB | Huawei, OPPO, Ericsson, ZTE, DCM, Samsung, |
| 13dB | Huawei, OPPO, Ericsson, ZTE, Qualcomm, Samsung, Intel, Nokia, |

|  |  |
| --- | --- |
| **Traffic model** | **Mentioned by** |
| Full buffer | Huawei, CATT, Qualcomm, CMCC, DCM, Xiaomi, MTK, Ofinno, Nokia, |
| FTP1 | CATT, ZTE, Qualcomm, Xiaomi, Samsung, |
| FTP2 |  |
| FTP3 | Huawei, vivo, CATT, ZTE, Qualcomm, CMCC, DCM, Samsung, MTK, Sony, Ofinno, Nokia, Futurewei |
| XR | vivo, ZTE, Ericsson, CMCC, DCM, Sony, Nokia, Futurewei |
| VoIP | Ericsson, Samsung, |
| IM | Samsung, |
| FTP3 variant with packet delay budget requirement | Huawei, |
| a mixed/variable packet size and the associated time domain behaviors | Ericsson, Ofinno, |
| AI/ML services | Huawei, Ofinno, |
| Immersive communication services | Huawei, Ericsson, Sony, Futurewei |
| Other/Feature-dependent | OPPO, ZTE, Intel, Interdigital |

#### Dense Urban

|  |  |  |
| --- | --- | --- |
| **Network layer** | **Carrier frequency** | **Mentioned by** |
| Macro or micro layer | Around 700MHz | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Intel, Ofinno, AT&T, |
| Around 2GHz | Huawei, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T, |
| Around 4GHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, AT&T, ETRI |
| Around 7GHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, AT&T, ETRI |
| Around 15GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, Futurewei, AT&T, |
| Around 2GHz + Around 4GHz | Huawei, OPPO, CMCC, DCM, Intel, Ofinno, AT&T, |
| Around 4GHz + Around 7GHz | Huawei, OPPO, ZTE, CMCC, DCM, Intel, Ofinno, Nokia, AT&T, ETRI |
| Around 7GHz + Around 4GHz + Around 2GHz + Around 700MHz | Huawei, OPPO, CMCC, DCM, Intel, Ofinno, AT&T, |
| Micro layer | Around 7GHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Sony, Intel, Ofinno, Futurewei, Apple, AT&T, |
| Around 15GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, Futurewei, AT&T, |
| Around 30GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, Futurewei, AT&T, |
| Macro+Micro | Around 4GHz + Around 30GHz | Huawei, vivo, OPPO, ZTE, CMCC, DCM, Intel, Ofinno, Nokia, AT&T, |
| Around 7GHz + Around 30GHz | Huawei, vivo, OPPO, ZTE, CMCC, DCM, Intel, Ofinno, AT&T, |
| Around 4/7GHz + Around 4/7GHz | DCM |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Aggregated system bandwidth** | **Mentioned by** |
| Around 700MHz | Up to 60MHz (DL+UL) | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, Nokia, AT&T |
| Around 2GHz | Up to 200MHz (DL+UL) | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, AT&T |
| Up to 120MHz (DL+UL) | ZTE, Nokia, |
| Up to 60MHz (DL+UL) | Futurewei, |
| Around 4GHz | Up to 300MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, CMCC, DCM, Sony, Intel, Ofinno, AT&T, ETRI |
| Up to 200MHz (DL+UL) | ZTE, Qualcomm, MTK, Nokia, Futurewei, |
| Around 7GHz | Up to 400MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T, ETRI |
| Up to 200MHz (DL+UL) | MTK, |
| Around 15GHz | Up to 400MHz (DL+UL) | Huawei, OPPO, Ericsson, DCM, Sony, Intel, Ofinno, Futurewei, AT&T |
| Around 30GHz | Up to 1GHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Sony, Intel, Ofinno, Nokia, AT&T |
| Up to 400MHz (DL+UL) | Futurewei |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Simulation bandwidth** | **Mentioned by** |
| Around 700MHz | 60MHz per CC | Huawei, CMCC, Ofinno, |
| 20MHz per CC | OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, Samsung, |
| 10 MHz per CC | Samsung, |
| Around 2GHz | 200MHz per CC | Huawei, DCM, Sony, Ofinno, |
| 100MHz per CC | CMCC, Intel, Nokia, |
| 60 MHz per CC | Futurewei, |
| 40 MHz per CC | Samsung, |
| 20MHz per CC | OPPO, Ericsson, Interdigital, ZTE, Qualcomm, |
| 10MHz per CC | Samsung, |
| Around 4GHz | 300MHz per CC | Huawei, Sony, Ofinno, |
| 200MHz per CC | DCM, Intel, Futurewei |
| 100MHz per CC | vivo, Ericsson, Interdigital, CMCC, Samsung, Nokia, |
| 20MHz per CC | OPPO, CATT, ZTE, Qualcomm, Samsung, MTK, Apple, ETRI |
| 10MHz per CC | Samsung, |
| Around 7GHz | 400MHz per CC | Huawei, vivo, Ericsson, Interdigital, CMCC, Sony, Ofinno, Futurewei |
| 200MHz per CC | vivo, CMCC, DCM, Samsung, Intel, Nokia, |
| 100MHz per CC | Qualcomm, Samsung, |
| 80MHz per CC | ZTE, |
| 20MHz per CC | OPPO, CATT, Samsung, MTK, Apple, ETRI |
| Around 15GHz | 400MHz per CC | Huawei, Samsung, Intel, Ofinno, Futurewei, |
| 200MHz per CC | DCM, Samsung, |
| 100MHz per CC | Samsung, |
| 80MHz per CC | OPPO, |
| 20MHz per CC | Samsung, |
| Around 30GHz | 1GHz per CC | Ofinno, |
| 800MHz per CC | Samsung, |
| 400MHz per CC | CMCC, DCM, Samsung, Intel, Futurewei, |
| 200MHz per CC | Samsung, Nokia, |
| 100MHz per CC | Samsung, |
| 80MHz per CC | OPPO, ZTE, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Total transmit power per BS** | **Mentioned by** |
| Around 700MHz | 44dBm/20MHz | Huawei, vivo, OPPO, CATT, Interdigital, ZTE, DCM, Samsung, Intel, Ofinno, Futurewei, ETRI |
| 33dBm/20MHz (micro layer) | Huawei, OPPO, Interdigital, ZTE, DCM, Intel, Ofinno, Nokia, Futurewei, |
| 46dBm/20MHz | Apple |
| 49dBm/20MHz | Qualcomm, |
| 52dBm/20MHz | Ericsson, Nokia, |
| Around 2GHz | 44dBm/20MHz | Huawei, vivo, OPPO, CATT, Interdigital, ZTE, DCM, Samsung, Sony, Intel, Ofinno, Futurewei, ETRI |
| 33dBm/20MHz (micro layer) | Huawei, OPPO, Interdigital, ZTE, DCM, Sony, Intel, Ofinno, Nokia, Futurewei, |
| 46dBm/20MHz | Apple |
| 49dBm/20MHz | Ericsson, Qualcomm, Nokia, |
| 52dBm/20MHz | Ericsson, |
| Around 4GHz | 44dBm/20MHz | Huawei, vivo, OPPO, CATT, Interdigital, ZTE, DCM, Samsung, MTK, Sony, Intel, Ofinno, Futurewei, ETRI |
| 33dBm/20MHz (micro layer) | Huawei, OPPO, Interdigital, ZTE, DCM, Sony, Intel, Ofinno, Nokia, Futurewei, |
| 46dBm/20MHz | Qualcomm, Apple, |
| 49dBm/20MHz | Ericsson, |
| 52 dBm/20MHz | Nokia, |
| Around 7GHz | 44dBm/20MHz | Huawei, vivo, OPPO, CATT, Interdigital, DCM, Samsung, MTK, Sony, Intel, Ofinno, Futurewei, ETRI |
| 33dBm/20MHz (micro layer) | Huawei, OPPO, Interdigital, ZTE, DCM, Sony, Intel, Ofinno, Nokia, Futurewei, |
| 46dBm/20MHz | Qualcomm, Apple |
| 46.2dBm/20MHz | Nokia, |
| 49dBm/20MHz | Ericsson, |
| 56dBm | ZTE |
| Around 15GHz | 40dBm/20MHz, EIRP not exceed 73dBm | Huawei, OPPO, Futurewei, |
| 33dBm/20MHz, EIRP not exceed 68dBm (micro layer) | Huawei, OPPO, Nokia, Futurewei, |
| 23dBm/20MHz, EIRP not exceed 58dBm | Intel, |
| 44dBm/20MHz | Samsung, |
| 46.2dBm/20MHz | Nokia, |
| Around 30GHz | 40dBm/20MHz, EIRP not exceed 73dBm | Huawei, OPPO, ZTE, Futurewei, |
| 33dBm/20MHz, EIRP not exceed 68dBm (micro layer) | Huawei, OPPO, ZTE, Nokia, Futurewei, |
| 34dBm/20MHz | vivo, Ericsson, |
| 26.6dBm/100MHz | Samsung, |
| 32.6dBm/800MHz | Samsung, |
| 23dBm/20MHz, EIRP not exceed 58dBm | Intel, |
| 35dBm/20MHz | Nokia, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE power class** | **Mentioned by** |
| Around 7GHz and below | 23dBm (FDD and TDD) | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, Samsung, MTK, Sony, Intel, Nokia, Futurewei, Apple, ETRI |
| 26dBm (TDD) | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, Samsung, MTK, Intel, Ofinno, Nokia, Futurewei, Apple |
| 29dBm (TDD) | Huawei, Qualcomm, Nokia, Futurewei |
| 31dBm (CPE/FWA) | ZTE, Nokia |
| Around 15GHz and above | 23dBm, EIRP not exceed 43dBm | Huawei, vivo, OPPO, Ericsson, DCM, Samsung, Intel, Futurewei |
| 29dBm | Nokia, |
| 26dBm | Samsung, Nokia, |
| 12dBm | Qualcomm, |
| 35dBm (CPE/FWA) | Samsung |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE noise figure** | **Mentioned by** |
| Around 7GHz and below | 7dB | Interdigital, Samsung, Apple |
| 8dB | Huawei, |
| 9dB | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, ETRI |
| Around 15GHz | 10dB | Huawei, OPPO, Ericsson, ZTE, DCM, Samsung, |
| 13dB | Huawei, OPPO, Ericsson, ZTE, Intel, |
| Around 30GHz | 10dB | Huawei, OPPO, Ericsson, ZTE, DCM, Samsung, |
| 13dB | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, Samsung, Intel, Nokia, |

|  |  |
| --- | --- |
| **Traffic model** | **Mentioned by** |
| Full buffer | Huawei, CATT, Qualcomm, CMCC, DCM, Xiaomi, MTK, Ofinno, Nokia, |
| FTP1 | CATT, ZTE, Qualcomm, Samsung, |
| FTP2 |  |
| FTP3 | Huawei, vivo, CATT, ZTE, Qualcomm, CMCC, DCM, Samsung, MTK, Sony, Ofinno, Nokia, Futurewei, AT&T, ETRI |
| XR | vivo, ZTE, Ericsson, CMCC, DCM, Sony, Nokia, Futurewei, AT&T, |
| VoIP | Ericsson, Samsung, |
| IM | Samsung, |
| FTP3 variant with packet delay budget requirement | Huawei, |
| a mixed/variable packet size and the associated time domain behaviors | Ericsson, Ofinno, |
| AI/ML services | Huawei, Ofinno, |
| Immersive communication services | Huawei, Ericsson, Sony, Futurewei |
| Other/Feature-dependent | OPPO, ZTE, Intel, Interdigital, AT&T, |

|  |  |  |
| --- | --- | --- |
| **UE distribution and speed** | | **Mentioned by** |
| UE number per TRxP | 10 | Huawei, vivo, OPPO, CATT, Ericsson, Interdigital (10/20), CMCC, DCM, MTK, Intel, Ofinno, Nokia, Futurewei, AT&T, ETRI |
| 30 | Huawei, Sony, Nokia (10/30/50), Futurewei, |
| UE location & speed | 20% outdoor incar 30km/h  80% indoor 3km/h | vivo (outdoor 30,60,120km/h), OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Intel, Ofinno, Futurewei, Apple, AT&T, ETRI |
|  | 20% outdoor incar 30km/h  60% outdoor 3km/h  20% indoor 3km/h | Ericsson, |
| O2I penetration loss | 20% high-loss  80% low-loss | Huawei, vivo, OPPO, CATT, Ericsson, Interdigital, ZTE, CMCC, DCM, Samsung, MTK, Sony, Ofinno, Nokia, Futurewei, Apple, ETRI |
| 50% high-loss  50% low-loss | Huawei, vivo, OPPO, ZTE, DCM, Nokia, |

|  |  |  |
| --- | --- | --- |
| **BS array downtilt** | | **Mentioned by** |
| BS mechanic tilt | 90° | Huawei, vivo, OPPO, CATT, Interdigital, Qualcomm, CMCC, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| According to scenario/ Need optimization | Ericsson, Apple |
| BS electronic tilt | 105° | Huawei, vivo, MTK, Sony, Futurewei, |
| 102° | CATT, Interdigital, ZTE, Intel, Futurewei, |
| 90° | Nokia |
| According to scenario/ Need optimization | Ericsson, Qualcomm, Apple |

#### Rural

|  |  |  |
| --- | --- | --- |
| **Network layer** | **Carrier frequency** | **Mentioned by** |
| Macro layer | Around 700MHz (for ISD 1 or ISD 2) | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 4GHz (for ISD 1) | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, CMCC, DCM, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 7GHz (ISD 1) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, {Tejas Networks, CEWiT, IIT Madras}, MTK, Intel, Ofinno, Nokia, |
| Around 700MHz + Around 2GHz (for ISD 2) | Huawei, OPPO, Ericsson, ZTE, CMCC, DCM, Intel, Ofinno, Nokia, |
| Around 700MHz + Around 7GHz (for ISD 1) | Huawei, OPPO, Ericsson, ZTE, CMCC, DCM, Intel, Ofinno, Nokia, |
| Around 2GHz | Sony, Futurewei |
| Around 600/700MHz (ISD2) | {Tejas Networks, CEWiT, IIT Madras} |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Aggregated system bandwidth** | **Mentioned by** |
| Around 700MHz | Up to 60MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| Around 2GHz | Up to 200MHz (DL+UL) | Huawei, OPPO, Ericsson, CMCC, DCM, Sony, Intel, Ofinno, Futurewei |
| Up to 120MHz (DL+UL) | ZTE, Nokia, |
| Around 4GHz | Up to 300MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, CMCC, DCM, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Ofinno, |
| Up to 200MHz (DL+UL) | ZTE, Qualcomm, Nokia, |
| Up to 400MHz (DL+UL) | Futurewei |
| Around 7GHz | Up to 400MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Ofinno, Nokia, |
| Around 600/700MHz | Up to 40MHz (DL+UL) | {Tejas Networks, CEWiT, IIT Madras} |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Simulation bandwidth** | **Mentioned by** |
| Around 700MHz | 60MHz per CC | Huawei, vivo, CMCC, {Tejas Networks, CEWiT, IIT Madras}, Sony, Ofinno, Nokia, |
| 20MHz per CC | OPPO, CATT, Ericsson, Interdigital, ZTE, Qualcomm, DCM, Samsung, MTK, Futurewei |
| 10MHz per CC | Samsung, |
| 100MHz per CC | Intel |
| Around 2GHz | 200MHz per CC | Huawei, DCM, {Tejas Networks, CEWiT, IIT Madras}, Sony, Ofinno, Futurewei |
| 100MHz per CC | CMCC, Samsung, Intel, Nokia, |
| 60MHz per CC |  |
| 40 MHz per CC | Samsung, |
| 20MHz per CC | OPPO, Ericsson, Interdigital, ZTE, Samsung, |
| 10MHz per CC | Samsung, |
| Around 4GHz | 300MHz per CC | Huawei, {Tejas Networks, CEWiT, IIT Madras}, Sony, Ofinno, |
| 200MHz per CC | DCM, Intel, Futurewei |
| 100MHz per CC | vivo, Ericsson, Interdigital, CMCC, Samsung, Nokia, |
| 20MHz per CC | OPPO, CATT, ZTE, Qualcomm, Samsung, MTK, |
| 10MHz per CC | Samsung, |
| Around 7GHz | 400MHz per CC | Huawei, vivo, Ericsson, Interdigital, CMCC, {Tejas Networks, CEWiT, IIT Madras}, Ofinno, |
| 200MHz per CC | vivo, CMCC, DCM, Samsung, Intel, Nokia, |
| 100MHz per CC | Qualcomm, Samsung, |
| 80MHz per CC | ZTE, |
| 20MHz per CC | OPPO, Samsung, MTK, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Total transmit power per BS** | **Mentioned by** |
| Around 700MHz | 49dBm/20MHz | Huawei, vivo, OPPO, CATT, Interdigital, ZTE, Qualcomm, DCM, Samsung, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 52dBm/20MHz | Ericsson, |
| Around 2GHz | 49dBm/20MHz | Huawei, OPPO, Ericsson, Interdigital, ZTE, DCM, Samsung, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 52dBm/20MHz | Ericsson, |
| Around 4GHz | 49dBm/20MHz | Huawei, vivo, OPPO, CATT, Ericsson, Interdigital, ZTE, DCM, Samsung, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 46dBm/20MHz | Qualcomm, |
| Around 7GHz | 49dBm/20MHz | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, DCM, Samsung, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 56dBm/20MHz | ZTE, |
| 53dBm/100MHz | Qualcomm, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE power class** | **Mentioned by** |
| Around 7GHz and below | 23dBm (FDD and TDD) | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, Samsung, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Nokia, Futurewei |
| 26dBm (TDD) | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, Samsung, {Tejas Networks, CEWiT, IIT Madras}, MTK, Intel, Ofinno, Nokia, Futurewei |
| 29dBm (TDD) | Huawei, Qualcomm, Nokia, Futurewei |
| 31dBm (CPE/FWA) | ZTE, Nokia |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE noise figure** | **Mentioned by** |
| Around 7GHz and below | 7dB | Interdigital, Samsung, {Tejas Networks, CEWiT, IIT Madras} |
| 8dB | Huawei, |
| 9dB | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |

|  |  |
| --- | --- |
| **Traffic model** | **Mentioned by** |
| Full buffer | Huawei, CATT, Qualcomm, CMCC, DCM, Ofinno, Nokia, |
| FTP1 | CATT, ZTE, Qualcomm, Samsung, |
| FTP2 |  |
| FTP3 | Huawei, vivo, CATT, ZTE, Qualcomm, CMCC, DCM, Samsung, MTK, Sony, Ofinno, Nokia, Futurewei |
| XR | vivo, ZTE, Ericsson, DCM, MTK, Sony |
| VoIP | Ericsson, Samsung, |
| IM | Samsung, |
| FTP3 variant with packet delay budget requirement | Huawei, |
| a mixed/variable packet size and the associated time domain behaviors | Ericsson, Ofinno, |
| AI/ML services | Huawei, Ofinno, |
| Immersive communication services | Huawei, Ericsson |
| Other/Feature-dependent | OPPO, ZTE, Intel, Interdigital, {Tejas Networks, CEWiT, IIT Madras} |

|  |  |  |
| --- | --- | --- |
| **UE distribution and speed** | | **Mentioned by** |
| UE number per TRxP | 10 | Huawei, vivo, OPPO, CATT, Ericsson, Interdigital, CMCC, DCM, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 30 | Huawei, Nokia (optional 10/30/50), |
| UE location & speed | 50% outdoor incar 120km/h  50% indoor 3km/h | Huawei, vivo, OPPO, CATT, Ericsson, Interdigital, ZTE, Qualcomm, CMCC, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 15% outdoor incar 120km/h  15% outdoor 3km/h  70% indoor 3km/h | Ericsson, DCM, Ofinno, Nokia, |
| 40% Outdoor pedestrian 3km/h  20% Outdoor incar 30km/h or 60km/h  40% Indoor 0-3km/h | {Tejas Networks, CEWiT, IIT Madras} |
| 100% outdoor 0km/h | {Tejas Networks, CEWiT, IIT Madras} |
| O2I penetration loss | 100% low-loss | vivo, Ericsson, Interdigital, CMCC, DCM, {Tejas Networks, CEWiT, IIT Madras}, MTK, Sony, Ofinno, Nokia |
| 20% high-loss  80% low-loss | Futurewei, ZTE |
| 50% high-loss  50% low-loss | ZTE, |

|  |  |  |
| --- | --- | --- |
| **BS array downtilt** | | **Mentioned by** |
| BS mechanic tilt | 90° | Huawei, vivo, OPPO, CATT, Qualcomm, CMCC, MTK, Sony, Intel, Ofinno, Nokia, Futurewei |
| 91.5° | Samsung, |
| 92° | ZTE, |
| 95° | Interdigital, |
| 100° | {Tejas Networks, CEWiT, IIT Madras} |
| According to scenario/ Need optimization | Ericsson, |
| BS electronic tilt | 92° | Nokia |
| 94° | Intel, |
| 96°for ISD=1732m  100°otherwise | Huawei, vivo, OPPO, MTK, Sony, Futurewei |
| 100°for ISD=1732m | CATT |
| According to scenario/ Need optimization | Ericsson, |

#### UMa

|  |  |  |
| --- | --- | --- |
| **Network layer** | **Carrier frequency** | **Mentioned by** |
| Macro or micro layer | Around 700MHz | Huawei, OPPO, Ericsson, Qualcomm, DCM, Sony, Intel, Ofinno, AT&T |
| Around 2GHz | Huawei, OPPO, Ericsson, ZTE, Qualcomm, DCM, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T |
| Around 4GHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, AT&T |
| Around 7GHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, DCM, Xiaomi, Sony, Intel, Ofinno, Nokia, Futurewei, Apple, AT&T |
| Around 15GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, Futurewei, AT&T |
| Around 2GHz + Around 4GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, AT&T |
| Around 2GHz + Around 7GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, AT&T |
| Around 4GHz + Around 7GHz | Huawei, OPPO, Ericsson, ZTE, DCM, Intel, Ofinno, Nokia, AT&T |
| Around 2GHz + Around 4GHz + Around 7GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, AT&T |
| Around 7GHz + Around 4GHz + Around 2GHz + Around 700MHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, AT&T |
| Micro layer | Around 7GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, Futurewei, Apple, AT&T |
| Around 15GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, Futurewei, AT&T |
| Around 30GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, Futurewei, AT&T |
| Macro+Micro | Around 2GHz + Around 30GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, AT&T |
| Around 4GHz + Around 30GHz | Huawei, vivo, OPPO, Ericsson, ZTE, DCM, Intel, Ofinno, Nokia, AT&T |
| Around 7GHz + Around 30GHz | Huawei, vivo, OPPO, Ericsson, ZTE, DCM, Intel, Ofinno, AT&T |
| Around 4/7GHz + Around 4/7GHz | DCM |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Aggregated system bandwidth** | **Mentioned by** |
| Around 700MHz | Up to 60MHz (DL+UL) | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, Nokia, AT&T |
| Around 2GHz | Up to 200MHz (DL+UL) | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Sony, Intel, Ofinno, AT&T |
| Up to 120MHz (DL+UL) | ZTE, Nokia, |
| Up to 60MHz (DL+UL) | Futurewei |
| Around 4GHz | Up to 300MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, CMCC, DCM, Sony, Intel, Ofinno, AT&T |
| Up to 200MHz (DL+UL) | ZTE, Qualcomm, MTK, Nokia, Futurewei |
| Around 7GHz | Up to 400MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T |
| Around 15GHz | Up to 400MHz (DL+UL) | Huawei, OPPO, Ericsson, DCM, Sony, Intel, Ofinno, Futurewei, AT&T |
| Around 30GHz | Up to 1GHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, CMCC, DCM, Sony, Intel, Ofinno, AT&T |
| Up to 400MHz (DL+UL) | Futurewei, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Simulation bandwidth** | **Mentioned by** |
| Around 700MHz | 60MHz per CC | Huawei, CMCC, Sony, Ofinno, |
| 20MHz per CC | OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, |
| 10 MHz per CC |  |
| Around 2GHz | 200MHz per CC | Huawei, DCM, Sony, Intel, Ofinno, Futurewei |
| 100MHz per CC | CMCC, Samsung, Nokia, |
| 60 MHz per CC |  |
| 40 MHz per CC | Samsung, |
| 20MHz per CC | OPPO, Ericsson, Interdigital, ZTE, Qualcomm, Samsung, |
| 10MHz per CC | Samsung, |
| Around 4GHz | 300MHz per CC | Huawei, Sony, Ofinno, |
| 200MHz per CC | DCM, Intel, Futurewei |
| 100MHz per CC | vivo, Ericsson, Interdigital, CMCC, Samsung, Nokia, |
| 20MHz per CC | OPPO, CATT, ZTE, Qualcomm, Samsung, MTK, Apple, |
| 10MHz per CC | Samsung, |
| Around 7GHz | 400MHz per CC | Huawei, vivo, Ericsson, Interdigital, CMCC, Sony, Ofinno, Futurewei |
| 200MHz per CC | vivo, CMCC, DCM, Xiaomi, Samsung, Intel, Nokia, |
| 100MHz per CC | Qualcomm, Samsung, |
| 80MHz per CC | ZTE, |
| 20MHz per CC | OPPO, CATT, Samsung, Apple |
| Around 15GHz | 400MHz per CC | Huawei, Samsung, Intel, Ofinno, Futurewei |
| 200MHz per CC | DCM, Samsung, |
| 100MHz per CC | Samsung, |
| 80MHz per CC | OPPO, |
| 20MHz per CC | Samsung, |
| Around 30GHz | 1GHz per CC | Ofinno, |
| 800MHz per CC | Samsung, |
| 400MHz per CC | vivo, CMCC, DCM, Samsung, Futurewei |
| 200MHz per CC | Samsung, Nokia, |
| 100MHz per CC | Samsung, |
| 80MHz per CC | OPPO, ZTE, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Total transmit power per BS** | **Mentioned by** |
| Around 7GHz and below | 56dBm | ZTE |
| 52dBm/20MHz | Ericsson, Nokia, |
| 49dBm/20MHz | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, DCM, Xiaomi, MTK, Sony, Ofinno, Nokia, Futurewei, |
| 46dBm/20MHz | Huawei, Qualcomm, Nokia, Apple |
| 44dBm/20MHz | Interdigital, Samsung, Intel, |
| 33dBm/20MHz (micro layer) | Huawei, Sony, Ofinno, Nokia, |
| Around 15GHz and above | 43dBm/20MHz, EIRP not exceed 78dBm | Huawei, vivo, OPPO, ZTE, DCM, Futurewei, |
| 33dBm/20MHz, EIRP not exceed 68dBm (micro layer) | Huawei, |
| 34dBm/20MHz | Ericsson, |
| 44dBm/20MHz | Samsung |
| 23dBm/20MHz | Intel |
| Around 30GHz | 26.6dBm/100MHz | Samsung |
| 32.6dBm/800MHz | Samsung |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE power class** | **Mentioned by** |
| Around 7GHz and below | 23dBm (FDD and TDD) | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, Xiaomi, Samsung, MTK, Sony, Intel, Nokia, Futurewei, Apple |
| 26dBm (TDD) | Huawei, vivo, OPPO, CATT, Ericsson, ZTE, Qualcomm, Samsung, MTK, Intel, Ofinno, Nokia, Futurewei, Apple |
| 29dBm (TDD) | Huawei, Qualcomm, Nokia, Futurewei, |
| 31dBm (CPE/FWA) | ZTE, Nokia, |
| Around 15GHz and above | 23dBm, EIRP not exceed 43dBm | Huawei, vivo, OPPO, Ericsson, DCM, Samsung, Intel, Futurewei, |
| 26dBm | Samsung, Nokia, |
| 29dBm | Nokia, |
| 35dBm (CPE/FWA) | Samsung, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE noise figure** | **Mentioned by** |
| Around 7GHz and below | 7dB | Interdigital, Xiaomi, Apple |
| 8dB | Huawei, |
| 9dB | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, DCM, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, Apple |
| Around 15GHz | 10dB | Huawei, OPPO, Ericsson, DCM, |
| 13dB | Huawei, OPPO, Ericsson, Intel, Nokia, |
| Around 30GHz | 10dB | OPPO, Ericsson, ZTE, DCM, |
| 13dB | vivo, OPPO, Ericsson, ZTE, Qualcomm, Intel, Nokia, |

|  |  |
| --- | --- |
| **Traffic model** | **Mentioned by** |
| Full buffer | Huawei, CATT, Qualcomm, CMCC, DCM, Xiaomi, MTK, Ofinno, Nokia, |
| FTP1 | CATT, ZTE, Qualcomm, Xiaomi, Samsung, |
| FTP2 |  |
| FTP3 | Huawei, vivo, CATT, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, MTK, Sony, Ofinno, Nokia, Futurewei, AT&T |
| XR | vivo, ZTE, Ericsson, DCM, Sony, Nokia, Futurewei, AT&T, |
| VoIP | Ericsson, Samsung, |
| IM | Samsung, |
| FTP3 variant with packet delay budget requirement | Huawei, |
| a mixed/variable packet size and the associated time domain behaviors | Ericsson, Ofinno, |
| AI/ML services | Huawei, Ofinno, |
| Immersive communication services | Huawei, Ericsson, Sony |
| Other/Feature-dependent | OPPO, ZTE, Intel, Interdigital, AT&T, |

|  |  |  |
| --- | --- | --- |
| **UE distribution and speed** | | **Mentioned by** |
| UE number per TRxP | 10 | Huawei, vivo, OPPO, Interdigital, CMCC, DCM, Xiaomi, MTK, Sony, Intel, Ofinno, Nokia, Futurewei, AT&T |
| 30 | Huawei, Nokia (10/30/50 per TRxP), |
| UE location & speed | 20% outdoor incar 30km/h  80% indoor 3km/h | Huawei, vivo (incar 30,60,120km/h), OPPO, Ericsson, Interdigital, ZTE, Qualcomm, CMCC, Xiaomi, MTK, Sony, Intel, Nokia, Futurewei, Apple |
| O2I penetration loss | 20% high-loss  80% low-loss | Huawei, vivo, CATT, Ericsson, Interdigital, ZTE, CMCC, DCM, Xiaomi, MTK, Sony, Ofinno, Nokia, Futurewei, Apple |
| 50% high-loss  50% low-loss | Huawei, vivo, CATT, ZTE, DCM, Intel, Ofinno, Nokia, Futurewei |

|  |  |  |
| --- | --- | --- |
| **BS array downtilt** | | **Mentioned by** |
| BS mechanic tilt | 90° | Huawei, vivo, OPPO, CATT, Interdigital, Qualcomm, CMCC, DCM, Xiaomi, MTK, Sony, Ofinno, Nokia, Futurewei, |
| 102° | Samsung, |
| According to scenario/ Need optimization | Ericsson, Apple |
| BS electronic tilt | 96° | Nokia |
| 98° | Huawei, Sony, |
| 102° | vivo, OPPO, CATT, Interdigital, ZTE, Xiaomi, MTK, Intel, Futurewei |
| According to scenario/ Need optimization | Ericsson, Apple, Qualcomm, |

#### SMa

|  |  |  |
| --- | --- | --- |
| **Network layer** | **Carrier frequency** | **Mentioned by** |
| Macro layer | Around 700MHz | Huawei, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Intel, Ofinno, Nokia, AT&T |
| Around 2GHz | Huawei, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Intel, Ofinno, Nokia, Futurewei, AT&T |
| Around 4GHz | Huawei, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, MTK, Intel, Ofinno, Nokia, Futurewei, Apple, AT&T |
| Around 7GHz | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, DCM, MTK, Intel, Ofinno, Nokia, Futurewei, Apple, AT&T |
| Around 15GHz | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, AT&T |
| Around 700MHz + Around 7GHz | Huawei, OPPO, Ericsson, CMCC, DCM, Intel, Ofinno, AT&T |
| Around 4GHz + Around 7GHz | Huawei, OPPO, Ericsson, ZTE, CMCC, DCM, Intel, Ofinno, Nokia, AT&T |
| Around 2GHz + Around 7GHz + Around 30GHz | Huawei, OPPO, Ericsson, CMCC, DCM, Intel, Ofinno, AT&T |
| Around 2GHz + Around 700MHz | Huawei, OPPO, Ericsson, ZTE, CMCC, DCM, Intel, Ofinno, Nokia, AT&T |
| Around 7GHz + Around 4GHz + Around 2GHz + Around 700MHz | Huawei, OPPO, Ericsson, CMCC, DCM, Intel, Ofinno, AT&T |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Aggregated system bandwidth** | **Mentioned by** |
| Around 700MHz | Up to 60MHz (DL+UL) | Huawei, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Intel, Ofinno, Nokia, AT&T |
| Up to 40MHz (DL+UL) | MTK, |
| Around 2GHz | Up to 200MHz (DL+UL) | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Intel, Ofinno, AT&T |
| Up to 120MHz (DL+UL) | ZTE, Nokia, |
| Up to 60MHz (DL+UL) | Futurewei |
| Around 4GHz | Up to 300MHz (DL+UL) | Huawei, OPPO, Ericsson, Qualcomm, CMCC, DCM, Intel, Ofinno, AT&T |
| Up to 200MHz (DL+UL) | ZTE, MTK, Nokia, Futurewei |
| Up to 400MHz (DL+UL) |  |
| Around 7GHz | Up to 400MHz (DL+UL) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, CMCC, DCM, Intel, Ofinno, Nokia, Futurewei, AT&T |
| Up to 200MHz (DL+UL) | MTK, |
| Around 15GHz | Up to 400MHz (DL+UL) | Huawei, OPPO, Ericsson, DCM, Intel, Ofinno, AT&T |
| Around 30GHz | Up to 1GHz (DL+UL) | Huawei, OPPO, Ericsson, CMCC, DCM, Intel, Ofinno, AT&T |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Simulation bandwidth** | **Mentioned by** |
| Around 700MHz | 60MHz per CC | Huawei, CMCC, Intel, Ofinno, Nokia, |
| 20MHz per CC | OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, Samsung, MTK, |
| 10MHz per CC | Samsung, |
| Around 2GHz | 200MHz per CC | Huawei, DCM, Intel, Ofinno, Futurewei |
| 100MHz per CC | CMCC, Samsung, Nokia, |
| 60MHz per CC |  |
| 40 MHz per CC | Samsung, |
| 20MHz per CC | OPPO, Ericsson, Interdigital, ZTE, Qualcomm, Samsung, |
| 10MHz per CC | Samsung, |
| Around 4GHz | 300MHz per CC | Huawei, Ofinno, |
| 200MHz per CC | DCM, Intel, Futurewei |
| 100MHz per CC | Ericsson, Interdigital, CMCC, Samsung, Nokia, |
| 20MHz per CC | OPPO, ZTE, Qualcomm, Samsung, MTK, Apple |
| 10MHz per CC | Samsung, |
| Around 7GHz | 400MHz per CC | Huawei, vivo, Ericsson, Interdigital, CMCC, Ofinno, Futurewei |
| 200MHz per CC | vivo, CMCC, DCM, Samsung, Intel, Nokia, |
| 100MHz per CC | Qualcomm, Samsung, |
| 80MHz per CC | ZTE, |
| 20MHz per CC | OPPO, Samsung, MTK, Apple |
| Around 15GHz | 400MHz per CC | Huawei, Samsung, Intel, Ofinno, |
| 200MHz per CC | DCM, Samsung, |
| 100MHz per CC | Samsung, |
| 80MHz per CC | OPPO, |
| 20MHz per CC | Samsung, |
| Around 30GHz | 1GHz per CC | Huawei, |
| 400MHz per CC | CMCC, DCM |
| 80MHz per CC | OPPO, ZTE, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Total transmit power per BS** | **Mentioned by** |
| Around 7GHz and below | 56dBm | ZTE |
| 52dBm/20MHz | Ericsson, Nokia, |
| 49dBm/20MHz | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, MTK, Ofinno, Nokia, Futurewei, Apple |
| 46dBm/20MHz | Qualcomm, Nokia, |
| 44dBm/20MHz | Samsung, Intel, |
| Around 15GHz and above | 49dBm/20MHz | DCM, |
| 44dBm/20MHz | Samsung, |
| 23dBm/20MHz | Intel, |
| Around 30GHz | 34dBm/20MHz | Ericsson, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE power class** | **Mentioned by** |
| Around 7GHz and below | 23dBm (FDD and TDD) | Huawei, vivo, OPPO, Ericsson, Interdigital, ZTE, Qualcomm, DCM, Samsung, MTK, Intel, Nokia, Futurewei, Apple |
| 26dBm (TDD) | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, Samsung, MTK, Intel, Ofinno, Nokia, Futurewei, Apple |
| 29dBm (TDD) | Huawei, Qualcomm, Nokia, Futurewei, |
| 31dBm (CPE/FWA) | ZTE, Nokia |
| Around 15GHz and above | 23dBm, EIRP not exceed 43dBm | Huawei, OPPO, Ericsson, DCM, Nokia, |
| 26dBm (TDD) | Samsung, Nokia, |

|  |  |  |
| --- | --- | --- |
| **Frequency** | **UE noise figure** | **Mentioned by** |
| Around 7GHz and below | 7dB | Interdigital, Samsung, Apple |
| 8dB | Huawei, |
| 9dB | Huawei, vivo, OPPO, Ericsson, ZTE, Qualcomm, DCM, MTK, Intel, Ofinno, Nokia, Futurewei, Apple |
| Around 15GHz and above | 10dB | Huawei, OPPO, Ericsson, ZTE, DCM, Samsung, |
| 13dB | Huawei, OPPO, Ericsson, ZTE, Qualcomm, |

|  |  |
| --- | --- |
| **Traffic model** | **Mentioned by** |
| Full buffer | Huawei, CATT, Qualcomm, CMCC, DCM, MTK, Ofinno, Nokia, |
| FTP1 | CATT, ZTE, Qualcomm, Samsung, MTK, |
| FTP2 |  |
| FTP3 | Huawei, vivo, CATT, ZTE, Qualcomm, CMCC, DCM, Xiaomi, Samsung, MTK, Sony, Ofinno, Nokia, Futurewei, AT&T |
| XR | vivo, ZTE, Ericsson, DCM, Sony, Nokia, Futurewei, AT&T, |
| VoIP | Ericsson, Samsung, |
| IM | Samsung, |
| FTP3 variant with packet delay budget requirement | Huawei, |
| a mixed/variable packet size and the associated time domain behaviors | Ericsson, Ofinno, |
| AI/ML services | Huawei, Ofinno, |
| Immersive communication services | Huawei, Ericsson, Sony |
| Other/Feature-dependent | OPPO, ZTE, Intel, Interdigital, AT&T, |

|  |  |  |
| --- | --- | --- |
| **UE distribution and speed** | | **Mentioned by** |
| UE number per TRxP | 10 | Huawei, vivo, OPPO, Ericsson, Interdigital, CMCC, DCM, MTK, Ofinno, Nokia, Futurewei, Apple, AT&T |
| 30 | Huawei, Nokia (optional 30/50), Futurewei, |
| UE location & speed | 10% outdoor pedestrian 3km/h  10% outdoor incar 40km/h  80% indoor 3km/h | Huawei, vivo (incar 40,60,120km/h), Ericsson, ZTE, Qualcomm, DCM, MTK, AT&T |
| 20% outdoor 40km/h  80% indoor 3km/h | OPPO, Interdigital, Intel, Ofinno, Nokia, Apple, |
| O2I penetration loss | 100% low-loss | Huawei, vivo, CMCC, DCM, Ofinno, |
| 20% low-loss  80% low-loss A | Ericsson, |
| 100% low-loss A | Interdigital, Intel, Nokia |
| 5% high-loss  20% low-loss  75% low-loss A | Ericsson, |
| 20% high-loss  80% low-loss | ZTE, MTK, Futurewei, Apple |
| 50% high-loss  50% low-loss | ZTE, Futurewei, |

|  |  |  |
| --- | --- | --- |
| **BS array downtilt** | | **Mentioned by** |
| BS mechanic tilt | ISD=1299m: 95°  ISD=1732m: 92° | Huawei, OPPO, ZTE, Intel, Ofinno, Nokia, Futurewei, |
| 90° | vivo, Qualcomm, CMCC, MTK, |
| 95° | Interdigital |
| According to scenario/ Need optimization | Ericsson, Apple |
| BS electronic tilt | 90° | Huawei, Interdigital, Intel, |
| 102° | OPPO, Futurewei |
| ISD=1299m: 99°  ISD=1732m: 96° | vivo, |
| ISD=1299m: 95°  ISD=1732m: 92° | MTK, |
| According to scenario/ Need optimization | Qualcomm, |

(FL1) Proposal in Attachment2

**Please check the ‘moderator’s proposal’ as attached for the SLS assumptions for TN for the first 5 scenarios based on the majority inputs.**

*Any comments/suggestions, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Points for further discussion based on review of the attached moderator proposal:   * For the UE density, our understanding a fixed 10 UE/cell could be applicable to a limited set of evaluation e.g. DL full buffer. We’d like to discuss more dependency of the UE density from the traffic model and scenario * Particular traffic models are listed there (full buffer, FTP 3, and XR). It seems premature to put those since we have a separate discussion on traffic model. * Scheduling is set to PF currently. We believe if QoS and latency are considered, some modification to PF is required. For now we can leave this row out and discuss it per scenario. * BS receiver assumption. We notice only UE receiver assumption is mentioned, while BS receiver assumption is also important to quantify UL performance. |
| Futurewei | Regarding the proposal on backhaul/sync such as “Baseline: ideal backhaul/sync Optional: non-ideal backhaul/sync”, we feel ideal backhaul/sync generally is only feasible if 1) M-TRP is for co-site sectors or 2) the TRPs are not too far away from each other. For example, for Rural of ISD = 1732m, we do not think it is very practical to have ideal backhaul/sync across multiple sites. Thus, we suggest the following update for any scenario if ISD > 200 m:  *Baseline: ideal backhaul/sync for co-site sectors, and non-ideal backhaul/sync across different sites* |
| ZTE | We have following comments:   * For dense urban and Uma scenarios, we share the same view as DCM, i.e., co-channel deployment where macro and micro cells share the same carrier frequency should be considered. This reflects the most realistic commercial deployment strategy and allows for more efficient spectrum utilization. In addition, co-channel deployment introduces more complex interference conditions, which makes it even more necessary to be properly evaluated. Given the importance of dense urban scenarios, it's critical that RAN1 identifies the possible frequency combinations as soon as possible. If this discussion is deferred to the plenary, it would likely mean no conclusion until the end of the year. * For the traffic model, we suggest first discussing the possible model options, and then considering which traffic models are suitable for each scenario. |
| vivo | We have three comment for the general SLS parameter as following:   1. In the Urban macro scenario, the parameter of simulation bandwidth for 2GHz and 4GHz is confusing since the baseline of 2GHz is 200MHz, which is larger than that of 4GHz. It is better that the baseline of 2G and 4GHz is equal or the baseline of 4GHz is larger than 2GHz. All of them equal to 100MHz seems more desirable. 2. In the Rural scenario, the channel model is “TR 38.901 v19.1.0 UMa (for macro layer) and UMi-street canyon (for micro layler)”. We think it is a mistake, it should be “TR 38.901 v19.1.0 RMa”. 3. In the Sub-Urban scenario, regarding the mechanic tilt that “95 degrees for ISD = 1299m and 92 degrees for ISD = 1732m”, it comes from the TR 38.901. However, the mechanic tilt that “95 degrees for ISD = 1299m and 92 degrees for ISD = 1732m” is only for channel calibration, it does not imply the further evaluation should reuse the configuration. Moreover, in the Rural scenario with the same ISD of 1732m, the mechanic tilt is 90 degrees in GCS. Therefore, the mechanic tilt with 90 degrees in GCS is better as baseline. 4. For UE speed in scenarios involving outdoor UEs, given ITU requirements specifically mention support of high mobility UEs (e.g., up to 500km/h), higher speed for outdoor UEs needs to be included, e.g., 60 km/h and 120km/h. |
| Interdigital | **Mechanical & Electrical downtilt**  For Indoor, it is stated electrical downtilt of 90 degrees in LCS. However, given that we are using mechanical 180 degree downtilt, using a 90 degree LCS doesn’t seem to make sense. It should be 0 degrees in LCS paired with mechanical 180 degrees.  For many deployments, the electrical tilt is stated to be reported by the company. It would be ideal if we could define a default value for the electrical downlink as well. Having various values reported by companies could make the evaluations defer company to company quite significantly as it strongly impacts UE association and interference levels.  **UE attachment**  It is stated that RSRP is used for UE attachment. We should further clarify that it should be based on port 0 RSRP. |
| Ericsson1 | Thanks for sharing the draft. Some initial comments below. We will provide additional comments in next update.  Replace ‘Electronic tilt’ with ‘Electrical tilt’ in all scenarios.  For traffic models, prefer to avoid parallel discussion in this spreadsheet as the details are being discussed in other proposals.  For base station Tx power: For 700MHz, higher Tx power of 52 dBm for 20 MHz (160W) should be used. For 2GHz, at least 49 dBm should be used. For FR2, we propose 34 dBm for 20MHz with 41 dBm as max power  For UE distribution, we suggest to add additonal option that reflects more outdoor UEs (e.g., Alt. 60% outdoor (3km/h), 20% outdoor in cars (30km/h), 20% indoor (3km/h)). Typically, such dense urban grids are targeting areas with high outdoor UEs, such as avenues, plazas. By utilizing a different mix, DU differentiates more from Urban.  For SMa, 30Ghz should be added to carrier frequency list for baseline.  For SMA and O2I penetration, suggest to add 20% low loss and 80% low loss A model to reflect a mix of house types.  For rural propagation model – “TR 38.901 v19.1.0 UMa (for macro layer) and UMi-street canyon (for micro layler)” seems incorrect since no micro layer. |
| Samsung | Simulation BW needs to be clarified, per CC? For 7GHz, it is quite controversial to consider 400 MHz BW for a single CC.  For total transmit power per BS at around 30GHz band, the calculation of 58dBm EIRP limit should be clarified, as typically we can have much more than that number for typical FR2 channel BW. It is better not to define the TRP based on 20MHz BW for FR2 as proposed by FL, instead typical channel BW should be used, says 100MHz or 400MHz. |
| DOCOMO | [Carrier frequency] We think carrier frequencies should follow TR 38.914, and all carrier frequencies listed in TR 38.914 should not be excluded. The current moderator's proposal omits the 15 GHz band in the SMa scenario. We propose changing the expression as follows.  (Moderator’s proposal for carrier frequency in SMa)  Baseline: Around 700MHz, Around 2GHz, Around 4 GHz, Around 7 GHz  Optional: Other carrier frequency combinations as TR 38.914  (Our proposal)  Baseline: Around 700MHz, Around 2GHz, Around 4 GHz, Around 7 GHz  Optional: Other carrier **frequencies and their** combinations as TR 38.914. |
| Qualcomm | We think the current simulation BW is too large. The simulation bandwidth is introduced to reduce the simulation effort while still capturing representation system performance. For example, in previous NR evaluation, a 20MHz simulation BW is assumed for 100MHz system bandwidth. We could follow the same principle for 6G evaluation. For FR3 with larger system bandwidth such as 400MHz, we think a 100MHz simulation bandwidth would be good.  Regarding UE receiver, the advanced RML receiver should be used as the baseline considering it has been widely available in the real-world UE devices. The MMSE receiver could be used for calibration purpose.  For multi-TRP operation, we think the non-ideal assumption on the backhaul and synchronization across TRPs should be the baseline. The ideal backhaul assumption won’t be the case in the real-world since even with UE feedback there will also be some residual error after the calibration/compensation that cannot be ignored. |
| Huawei | [Carrier frequency] We think carrier frequencies should follow the guidance in TR 38.914, but TR 38.914 left one note as “Note: Regarding the various carrier frequency configurations and options listed in the tables below, only a **sub-set of** them will be required to be evaluated for ITU IMT-2030 self-evaluation and 3GPP internal evaluation, others may be optionally used for specific RAN features or requirements evaluation.” So, we prefer to select typic carrier frequencies to do evaluation, instead of all. We propose to prioritize single layer deployment evaluation. The performance of most technologies should be evaluated in one carrier frequency firstly to check whether it is good enough, because the one carrier frequency is widely deployed assumption, especially for around 7 GHz and below.  Base on the above consideration. around 700MHz, around 2GHz, around 4 GHz, and around 7 GHz should be prioritized to be evaluated.  [Simulation bandwidth] We think the lowest bandwidth (e.g. 20MHz) is not suitable to all evaluation scenarios. In 5G, we define the 20MHz mainly considering the 20MHz is typically configuration per CC in LTE-A. In NR, for all R15 NR device already support 100MHz per CC. So, we propose to consider more than 100MHz bandwidth for 6G evaluation, such as 200MHz, 400MHz. Of course, it does not mean all features have to use largest bandwidth to simulation. It also depends on the topic evaluation requirement.  Base on the above consideration. At least 200MHz, 400MHz should be considered as the simulation bandwidth to be used in the 6G evaluation.  [UE power class] 23dBm, 26dBm and 29dBm could be considered for handheld device, the 29dBm and 31dBm can be considered for large size device  [BS power class] propose to reuse the power class as TR37.910, 44dBm per 20MHz for dense Urban, 49dBm per 20MHz for Urban Marco. And the BS power can be scaling up with increasing the bandwidth. Whether or not define the maximum BS power in around 7GHz and below per scenario could be FFS. |
| Nokia1 | We think that a basic **BW** of 100 MHz should be supported by default at all Carriers, except for 700 MHz for the possibility of direct comparison between carriers.  Additionally, the **Max Tx power** levels should be accurately checked not to violate max EIRP requirements when antenna configurations are agreed.  While there is justification for many suggested settings of bandwidth, traffic models, deployments, etc., in our view, it is important to agree on a limited set of default assumptions that companies use to ensure we can compare results. In particular, we propose the following default assumptions:  • Deployments: Default deployments are Urban Macro (UMa), Dense Urbna (DU), and RMa/SMa. Nokia is also supporting to have, e.g., UMa with FWA deployments as one of the default configurations. |

#### (FL4) Proposal 3.1.1-1 on carrier frequency and bandwidth – Afteroffline

**The following configurations for system-level simulations could be used for 6GR evaluation:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Indoor Hotspot** | **Dense Urban** | **Rural** | **Urban Macro** | **Sub-urban macro** |
| Carrier frequency | Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz |
| Aggregated BW | Follow system bandwidth per carrier frequency in TR 38.914 as 1) Around 700 MHz: Up to 60 MHz 2) Around 2GHz: Up to 200 MHz 3) Around 4GHz: Up to 300 MHz  4) Around 7GHz: Up to 400MHz 5) Around 15GHz: Up to 400MHz  6) Around 30GHz: Up to 1GHz | | | | |
| Simulation BW | Around 700 MHz: 20MHz, 60MHz | | | | |
| Around 2 GHz: 20MHz, 100MHz, 200MHz | | | | |
| Around 4 GHz: 20MHz, 100MHz, 200MHz, 300MHz | | | | |
| Around 7 GHz: 20MHz, 100MHz, 200MHz, 400MHz | | | | |
| Around 15 GHz: 20MHz, 100MHz, 200MHz, 400MHz | | | | |
| Around 30GHz: 100MHz, 400MHz, 800MHz | | | | |
| Note: other simulation BW could be considered. | | | | |
| **Note: The layout for each scenario will be separately discussed, including the carrier frequency combination for single layer and/or two layers.** | | | | | |

*Any strong concerns, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | Suggest to add 30GHz in the suburban scenario to cover services like FWA.  For simplification, suggest to remove the 700 MHz option from the dense urban scenario. The rationale is that the grid ISD is very low so contiguous eMBB coverage could be achieved with 2 GHz.  For simulation bandwidth, suggest to remove the 300MHz option for frequency around 4GHz, since it seems to exceed any of current typical allocations. |

#### (FL4) Proposal 3.1.1-2 on BS Tx power - Afteroffline

**The following total transmit power per BS for system-level simulations can be used for 6GR evaluation:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Indoor Hotspot** | **Dense Urban** | **Rural** | **Urban Macro** | **Sub-urban macro** |
| **Around 700MHz** | **NA** | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 2GHz** | 24 dBm per 20 MHz | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 4GHz** | 24 dBm per 20 MHz | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 7GHz** | 24 dBm per 20 MHz | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 15GHz** | BS transmit power is 23 dBm per 20 MHz, EIRP not exceed 58dBm | Macro BS: BS transmit power is 40 dBm per 20 MHz, EIRP not exceed 73dBm  Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm |  | Macro BS: BS transmit power is 43 dBm per 20 MHz, EIRP not exceed 78dBm  Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm | BS transmit power is 43 dBm per 20 MHz, EIRP not exceed 78dBm |
| **Around 30GHz** | BS transmit power is 23 dBm per 100 MHz, EIRP not exceed 58dBm | Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm |  | Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm |  |
| **Note:** BS Tx power scales up with bandwidth proportionally.  **Note**: The maximum BS Tx power for each scanrio will be defined. FFS values. | | | | | |

*Any strong concerns, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | Assumptions based on carrier frequency (i.e., independent of scenario other than indoor/outdoor) is the framework used for antenna array size assumptions. We suggest to use similar approach also for BS Tx power. Also, assumptions should capture cap on total transmit power in addition to power per MHz. 700MHz: use 52 dBm per 20 MHz of simulated bandwidth.   * 2GHz Macro layer: use two values depending on if a classic or AAS solution is used. In case of classic radio solution, use 52 dBm per 20 MHz. For AAS we support the current proposal of 49 dBm per 20 MHz. In order to avoid excessive transmit power levels as bandwidth scales, cap on total transmit power to 56 dBm (400 W) should be captured in the assumptions. * 4GHz and 7GHz Macro layer: use 49 dBm per 20 MHz. cap on total transmit power to 56 dBm (400 W) should be captured in the assumptions. * 30GHz outdoor: remove the Micro characterization of the BS, thus allowing the proposed values to be used in both Macro and Micro layers. For transmit power, use 34 dBm per 20 MHz with 70 dBm max EIRP.   OK to have the max power values in brackets or have them as TBD if more time needed to align. |

## Other views in TDoc

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *Proposed to study multi-cell / multi-TRP deployments with nonideal backhaul or imperfect network synchronization.* |
| *vivo* | *Discussed in details and proposed to support the urban grid scenarios for 6GR evaluations.* |
| *ZTE* | *Discussed the co-frequency networking for two-layer deployment and multi-layer heterogenous network with assisting node.*  *Proposed to consider multi-TRP operation with CJT (targeting for FR1/around-7GHz) and NCJT transmission (targeting FR2/around 30GHz under ideal/non-ideal backhaul and ideal/non-ideal sync (in terms of frequency-domain and time-domain)*  *Proposed sensing related scenarios, e.g., indoor-factory, highway.* |
| *Huawei* | *Discussed and proposed to add the urban grid scenario for sensing and communication.* |
| *LGE* | *Discussed and proposed urban grid and highway should be studied so need to remove the brackets.* |
| *Sony* | *Proposed that High-density of cells in indoor hotspot (e.g. 12/36 TRPs) and dense urban (e.g. 6 or 9 micro TRPs per macro TRP) should be considered for the evaluation of spectrum efficiency and user-experienced data rates.* |
| *Tejas* | *Proposed to study Isolated Macro cell with cluster UE drop as one of the deployment scenarios for Rural in 6G. Proposed to add indoor-factor as one of scenarios.* |

# Traffic models

## Existing models

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *It should be sufficient to* ***prioritize*** ***FTP Model 3 and XR traffic models*** *as they enable the study of user experience and generally cover other models and can be easily extended for new traffic types.* |
| *Nokia* | *Proposal 9: RAN1 to* ***adopt full buffer traffic model*** *for some 6G evaluation simulations,* ***at least for calibration purposes.***  *Proposal 11: RAN1 to* ***adopt FTP-3 as the default model for time-variant best effort traffic*** *in 6G evaluation simulations.*  *Proposal 12: RAN1 to consider the parametrization of the FTP-3 traffic model with a default file size of 0.5 MB, while varying the file arrival rate to result in Low, Medium, Large offered loads per cell that corresponds to average PRB utilization of approximately 10%, 30% and 60%.*  *Proposal 14: RAN1 to* ***adopt the single-stream packet-based XR traffic model for real-time video*** *from TR 38.838* ***with default settings of 45 Mbps for DL and 10 Mbps for UL, assuming 60 fps****.*  *Proposal 15: RAN1 to* ***adopt for the 6GR study the model of XR UL control information feedback from 38.838*** *that needs to be transmitted together with DL traffic.* |
| *vivo* | *Throughout the entire NR phase, the full buffer traffic model was* ***rarely used*** *for system level simulation, except for the IMT spectrum efficiency submissions.*  *Proposal 2:* ***Do not support using the full buffer traffic model*** *for 6G technology evaluation.* |
| *xiaomi* | *Proposal 9:* ***Support both full buffer and non-full buffer traffic models*** *in 6GR.* |
| *CMCC* | *Proposal 3: For the basic traffic models for 6GR evaluation, RAN1 at least consider the following:*  ***• Full buffer***  ***• FTP Model 3 (in TR 36.872)***  ***• XR Traffic models (in TR 38.838)*** |
| *ZTE* | *Proposal 4-1-1: 6GR evaluation should* ***consider utilizing full-buffer traffic model****, particularly for*   * ***assessing system capacity limits and scheduling algorithm performance****.* * ***enabling comparison with IMT-Advanced baseline values***   *Proposal 4-1-2: 6GR evaluation should* ***prioritize the use of FTP model 1/3 and deprioritize FTP model 2****. Model parameters should be determined based on actual service characteristics.*  *Proposal 4-1-3: 6GR evaluation should* ***consider using XR traffic model****, particularly for periodic arrival and delay-sensitive services.*  *Proposal 4-1-4: 6GR evaluation should* ***deprioritize the VoIP model*** *and address potential evaluation requirements through an extended FTP model.* |
| *Huawei* | *Proposal 7:* ***Full buffer and FTP3 model could be considered*** *for 6GR evaluation.* |
| *CATT* | *Proposal 7:* ***Support the full buffer model, the FTP model 1 and the FTP model 3*** *for 6G evaluations.*  *Proposal 8: For the metric for evaluation,* ***at least average spectral efficiency and the 5th percentile user spectral efficiency should be considered for full buffer traffic****. Average user perceived throughput and the 5th percentile user perceived throughput are suggested for FTP models in 6GR.*  *Proposal 9:* ***Whether to support FTP2 model or other existing models depends on the evaluation methodology adopted for each KPI****.*  *Proposal 10: The discussion on new traffic models should be postponed until the discussion of the common evaluation assumptions is completed.* |
| *OPPO* | *Proposal 7: The selection of traffic models for different topics/evaluations can be decided under each individual agenda.* |
| *Samsung* | *Proposal #5:*   * ***Use conventional traffic models (FTP1, FTP3,*** [***FTP3-IM***](ftp://FTP3-IM)***, and VOIP) as baseline*** *for 6GR evaluations* |
| *Ofinno* | *Proposal 12:* ***The full buffer traffic model is used for RAN1 evaluations*** *(e.g., related to system capacity evaluations).*  *Proposal 13:* ***FTP Model 3 defined in TR 36.814 is used*** *for RAN1 evaluations of UE power saving and network energy saving related use cases.* |
| *Sony* | *Proposal 1: RAN1 should define at least the following traffic model for 6G system level simulation assumption:*   * ***FTP model 3*** *for mobile broadband and IoT, with scale of data rate* * ***Periodic traffic with 60/120 fps for XR devices*** * *Immersive communication services such as UL-heavy* |
| *Intel* | *Proposal 8*  *•* ***Full buffer is applicable to 6GR scenarios to evaluate user experienced throughput, 5th percentile user spectral efficiency, average SE, area traffic capacity KPIs*** |
| *AT&T* | *Proposal 3:* ***Full Buffer, FTP Model 2, FTP Model 3, VoIP and XR traffic models*** *are reused for 6G evaluations*  *Proposal 4:* ***FTP Model 3 is considered as the main bursty traffic model*** *for general evaluations.* ***FTP Model 2 is only considered as a web browsing proxy*** *and for regression until a dedicated HTTP model is available.*  *Proposal 5: When applicable,* ***full buffer traffic model can be used*** *in addition to a bursty traffic model for performance evaluations.*  *Note: Full buffer traffic model is not exclusively used to make observations/decisions on performance evaluations*  *Proposal 6:* ***The XR traffic model is used as a baseline for latency/jitter sensitive workloads in general evaluations****, including evaluation of HARQ timing and K1 selection.* |
| *DOCOMO* | *Proposal 2*   * *Support to base following traffic models for 6GR evaluation:*   + ***Full buffer***   + ***FTP1***   + ***FTP2***   + ***FTP3***   + ***FTP3-IM***   + ***XR***   + ***VoIP*** * *Whether to replace/update the existing traffic model should be decided including how to model/update.* |

### Discussions

The definitions of the exiting traffic models are copy-pasted in the appendix.

Companies all agree to keep FTP-3 and XR traffic models. Some specific parameters setting is suggested for XR model.

*Whether to use full buffer traffic model:*

- Most companies mentioned full buffer can be reused to evaluate user experienced throughput, 5th percentile user spectral efficiency, average SE, area traffic capacity KPIs, etc, though one company proposed not to consider it.

*Proposed being deprioritized by a couple of companies: FTP-2, VOIP.*

- However, a couple of companies also proposed to have them as ones of baseline traffic models or the usage of them may depend on the evaluation methodology.

It seems no consensus to preclude any one of the existing traffic models for 6GR evaluation at this moment.

**Round-1 discussion:**

(FL1) Proposal 4.1.2

The following existing traffic models could be used for 6GR performance evaluations, e.g.,

* Full buffer
* FTP Model 1 (in TR 36.814)
* FTP Model 2 (in TR 36.814)
* FTP Model 3 (in TR 36.872)
* XR Traffic models (in TR 38.838)
* VoIP model (as in TR 36.814)
* Instant message (as in TR 38.840)
* Note that which model(s) will be used can be further decided when performing simulations.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | We are not sure how to correlate this proposal with the draft moderator proposal for general assumptions which only mentions full buffer, FTP 3, and XR.  Further, when mentioning FTP model 3, we believe that it should not be used as is based on TR 36.872, but should have an associated PDB as a baseline, as was discussed in our tdoc. |
| ZTE | Our views are listed as follows:   * We suggest prioritizing the Full Buffer traffic model for assessing system capacity limits and enabling comparison with IMT-Advanced baseline values. * We suggest prioritizing the FTP1/FTP3 traffic models, as they capture the characteristics of random data arrivals. * We suggest prioritizing the XR traffic model, as it represents the characteristics of periodic data arrivals.   In the 6GR evaluation, the model parameters should not be fixed to specific values, but rather adjusted according to the characteristics of each traffic type. |
| CMCC | Generally support this proposal.  Full buffer is needed at least for IMT-Advanced submission, FTP model 3 can be used for specific technology evaluation, and XR traffic model can be used for immersive communication evaluation. |
| vivo | 1. We still have concern on full buffer. If we want to include full buffer, it is better to specify the use case, e.g., for calibration or for potential IMT-2030 submission. We don’t think it is a practical model for evaluation technical proposals. Previous discussion happened in MIMO or other topics has verified this. 2. In the recent studies of 5G NR, it seems FTP model 3 was typically used in practice, FTP model 1 and 2 were seldomly used. Suggest we focus on FTP model 3 to avoid unnecessary simulation work. 3. For RedCap studies in TR38.875, a heartbeat traffic model was introduced (see table 6.2-2 of TR38.875, also copied as below), which can also be used. |
| Nokia | We acknowledge that the various mentioned traffic models all have their justification for different use cases. However, as we cannot expect every company to deliver exhaustive 6G system-level simulation (SLS) results for all traffic models, we find it important to agree on a limited set of default traffic models. This is important to ensure we can compare results between companies for at least these default configurations. In particular, we propose the following default assumptions:   * Full buffer only used initial calibration of results. * FTP-3 is the default bursty traffic model, potentially extended to include variable file-size bursts. * Finally, real-time Video XR models with 45 Mbps (DL) and 10Mbps (UL) are considered. |
| Ericsson1 | If FTP 1 or FTP3 are extended (e.g., to incorporate multiple size packets), the existing model descriptions (e.g., using same packet size for all UEs) can become special cases. Also, if modifications are agreed to XR models then the updated models with modifications should perhaps be used. Full buffer results may be used for calibration, but conclusions exclusively based on full buffer results should be avoided. Considering this, we propose following updates to the proposal   * The following existing traffic models could be used for 6GR performance evaluations, e.g.,   + Full buffer     - Note: Full buffer results may be used for calibration and should not be exclusively used for RAN1 conclusions on system performance   + FTP Model 1 with potential modifications     - FFS modifications to incorporate multiple packet sizes and packet delay budget constraints   + FTP Model 2 (in TR 36.814)   + FTP Model 3 with potential modifications     - FFS modifications to incorporate multiple packet sizes and packet delay budget constraints   + XR Traffic models (in TR 38.838) are used as starting point with potential modifications     - FFS modifications to better reflect immersive communications requirements   + VoIP model (as in TR 36.814)   + Instant message (as in TR 38.840)   Note that which model(s) will be used can be further decided when performing simulations. |
| Samsung | Generally fine with FL’s proposal. All existing traffic models in the list can be used considering various evaluation purposes. Prioritizing some traffic models can be further discussed per evaluation scenario or purpose |
| OPPO | We are fine with the proposal. |
| DOCOMO | We support the Proposal. |
| Google | Support. |
| Qualcomm | We are okay with the proposal. But we want to clarify for the FTP models whether the proposal implies the same parameters used for NR evaluation will be reused for 6G evaluation. If possible, we prefer to list these FTP model parameters, e.g., packet size and the arrival rate etc. |

**Round-2 discussion:**

(FL2) Proposal 4.1.2-r1

The following existing traffic models could be used for 6GR performance evaluations, e.g.,

* Full buffer
* FTP Model 1 (in TR 36.814)
* FTP Model 2 (in TR 36.814)
* FTP Model 3 (in TR 36.872)
* XR Traffic models (in TR 38.838)
* VoIP model (as in TR 36.814)
* Instant message (as in TR 38.840)
* Note that which model(s) will be used can be further decided when performing simulations in each individual topic.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | We are ok to FL proposals |
| Nokia1 | We believe that additional guidance on the use of the basic traffic models will be beneficial:   * + Full buffer is only used initial calibration of results.   + even load scenario with such UE spatial placement that ensures equal number of connected UEs per cell should be considred.   + FTP-3 is the default bursty traffic model   + Real-time Video XR models with 45 Mbps (DL) and 10Mbps (UL) are considered. |
| OPPO | We are fine with the proposal. |
| NTT DOCOMO | We support the proposal. |
| Google | Support. |
| Samsung | We are fine with FL proposal. |
| Ericsson2 | As commented in earlier round, If FTP 1 or FTP3 are extended (e.g., to incorporate multiple size packets), the existing model descriptions (e.g., using same packet size for all UEs) can become special cases. Also, if modifications are agreed to XR models then the updated models with modifications should perhaps be used. Full buffer results may be used for calibration, but conclusions exclusively based on full buffer results should be avoided. Considering this, we propose following updates to the proposal.   * The following existing traffic models could be used for 6GR performance evaluations, e.g.,   + Full buffer     - Note: Full buffer results may be used for calibration and should not be exclusively used for RAN1 conclusions on system performance   + FTP Model 1 with potential modifications     - FFS modifications to incorporate multiple packet sizes and packet delay budget constraints   + FTP Model 2 (in TR 36.814)   + FTP Model 3 with potential modifications     - FFS modifications to incorporate multiple packet sizes and packet delay budget constraints   + XR Traffic models (in TR 38.838) are used as starting point with potential modifications     - FFS modifications to better reflect immersive communications requirements   + VoIP model (as in TR 36.814)   + Instant message (as in TR 38.840) Note that which model(s) will be used can be further decided when performing simulations. |
| vivo2 | Listing/supporting all the traffic models may not be help for future study. We suggest clarifying the potential use case of each traffic model, and the reasons for the modification. For example, we don’t see the need to use full buffer model for specific technology evaluation, while we are open to using it for IMT-2030 self-evaluation or calibration. |

#### Conclusion

|  |
| --- |
| Conclusion  The following existing traffic models could be used for 6GR performance evaluations,   * Full buffer * FTP Model 1 (in TR 36.814) * FTP Model 3 (in TR 36.872) * XR Traffic models (in TR 38.838) * VoIP model (as in TR 36.814) * Instant message (as in TR 38.840) * Note that which model(s) will be used can be further decided when performing simulations in each individual topic. |

## New model 1- AI/ML services

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *For AI/ML services,* ***it can be further discussed after relevant decisions are made in AI/ML agenda items****.* |
| *Nokia* | *Proposal 17: RAN1* ***to send an LS to SA4 to trigger the study of traffic modeling for AI/ML applications, e.g. tokenized traffic,*** *before agreeing on its use for performance evaluation.* |
| *CMCC* | *Proposal 5: For traffic model for new use cases or services,* ***RAN1 can consider token communication as the new AI service and further discuss the detailed characteristics of token transmission.*** |
| *ZTE* | ***Proposal 4-2-3:*** *Adopt the traffic model in Table 4-2-3 for* ***generative AI application (NW for AI)*** *in 6GR evaluation.*  **Table 4-2-3** Traffic model **for generative AI application**   |  |  |  |  | | --- | --- | --- | --- | | Parameter | **Image based GenAI app** | **Video based GenAI app** | **Chatbot** | | Packet size | [~400] KB | [~20] MB | [~0.5] KB | | Arrival time | Poisson process with [~2 - 20] packets per second | Poisson process with [~0.1 - 1] packets per second | Poisson process with [~1000] packets per second | | Latency requirement | < [~400] ms | < [~2] s | < [~10] ms | | Reliability requirement | > [99%] | > [99%] | > [99%] |   ***Proposal 4-2-4****: Study* ***traffic models for AI/ML model training/inference in 6GR evaluation (AI for NW):***   * *Consider the traffic characteristics of the following processes separately:*   + ***Training data collection***   + ***Inference result transmission***   + ***Model download*** * ***Adopt traffic model in Table 4-2-4 for AI/ML model training/inference****.*   **Table 4-2-4** Traffic model for **model training/inference**   |  |  |  |  | | --- | --- | --- | --- | | Parameter | Model download | Training data collection | Inference result transmission | | Packet size | [~100] MB | [~500] KB | [~10] KB | | Arrival time | Poisson process with [~0.01 - 0.1] packets per second | Poisson process with [~2 - 20] packets per second | Poisson process with [~100 - 1000] packets per second | | Latency requirement | < [~5] s | < [~500] ms | < [~10] ms | | Reliability requirement | > [99%] | > [99%] | > [99%] | |
| *Huawei* | *Proposal 9: The traffic model of token communications includes the parameters with regards to* ***token arrival rate, token size, token success rate requirement, and token delay budget****.*  Table 8: Examples for the traffic model of token communications.   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | **Token arrival rate (Note 0)** | **Token size** | **Token success rate (Note 1)** | **Token Delay budget** | | Human-agent communication with text/visual tokens [26] | 30K~100K tokens/second (Note 2) | [small: 10~20, large: ~400] bits/token (Note 5) | [80~99] % for image/video/audio (Note 3) | 0.1~1 s (Note 4) | | Robot-agent communication with visual tokens [27] | 30K~60K tokens/second (Note 10) | [small: 10~20, large: ~400] bits/token (Note 5) | [80~99] % | 10~15 ms (Note 6) | | Agent-agent communication [28] | up to 30K tokens/second (Note 7) | ~20 bits/token (Note 8) | [90~99] % for image/video/audio | [1~15] ms (Note 9) | |
| *OPPO* | *Proposal 8：****A new traffic model for AI service (e.g., Token communication) should be introduced in 6G****, at least including following aspects:*   * + ***Introduce Token transmission as a new traffic type*** *for RAN1 evaluation*   + ***Introduce Token size, Token packet size, Token packet arrival, Assumptions on Token Importance***   + ***Introduce success rate requirement for token transmission***   + ***Service requirement for token transmission***   *Proposal 9：Regarding* ***the successful ratio requirement*** *for token transmission, at least following aspects should be introduced:*   * + ***Requirements for Tokens Transmission*** *(e.g., for Token Error Rate)*   + ***Methodology for Token error identification***   *Proposal 10：Regarding the service requirement for token transmission, at least following aspects should be introduced:*   * *Assumptions on downstream service* * *Downstream service requirement* * *Transmission requirement to guarantee the service requirement*   *Proposal 11: A* ***typical Token communication traffic model*** *for RAN1 evaluation should be considered and introduced, shown as Table 1:*  ***Table 1: A typical Token communication traffic model for RAN1 evaluation.***   |  |  |  | | --- | --- | --- | | ***New traffic type*** | | ***Token communication, e.g., tokenized image*** | | *Token based Packet (Tokenized image)* | *Original source data size (image)* | *256\*256\*3\*8 bit* | | *Tokenized source data size (tokenized image)* | *256\*12 bit* | | *Number of Token per image* | *256* | | *Number of bits per token* | *12* | | *Tokenizer and Detokenizer model* | *Up to implementation, [e.g., by AI models like One-D-Piece]* | | *Packet size*  *Tokens to be transmitted in one packet* | *N image, N\*256 tokens to be transmitted,*  *i.e., N\*256\*12/8 Bytes*  *FFS the value of N* | | *Packet arrival* | *Case1: Packet arrival in Poisson distribution*  *Case2: Packet arrival in Periodic distribution* | | *Packet delay budget* | *The value of Packet delay budget may vary for different services.* | | *Assumptions on Token Importance* | *Case 1: tokens are treated without different importance*  *Case 2: tokens are treated with different importance,*  *e.g., with assumptions as below:*   * *256 Tokens can be numbered from 0 to 255 in descending order of importance;* * *a lower number indicates higher criticality for information expression, while a higher number corresponds to detail information.* | | *Success rate requirement for token transmission* | *Requirements for Token Transmission* | *Consider the error tolerance characteristics for token communication, follow token transmission requirement should be evaluated:*  *Case1: All tokens are transmitted with different token error rate (TER) requirements,*  *e.g., TER=10%,20%,50%*  *Case2: Partial tokens with high importance are transmitted, TER=0 for the selected and transmitted high importance tokens, e.g., 10%,20%,50% tokens with high importance are selected and transmitted*  *Case3: Partial tokens with high importance are transmitted, TER=0 for the selected and transmitted high importance tokens, 10%,20%,50% tokens with high importance are selected and transmitted; and the rest tokens are transmitted with different token error rate requirements, e.g., TER=10%,20%,50%*  *Note: The value of Success rate requirement for token transmission (based on TER) may vary for different services.*  *Note: Error tolerance characteristics are discussed in [3].* | | *Methodology for Token error identification* | *Methods for Token level error identification are needed*  *Note: error tolerance characteristics are discussed in [3]* | | *Service requirement for token transmission* | *Assumptions on downstream service* | *Case 1: a classification task, [ e.g., ImageNet dataset, with N images, belonging to M categories, FFS N, M, e.g., N=3000, M=1000]*   * *FFS whether/how to define an aligned source data set* * *FFS whether/how to define an aligned classification algorithm/model*   *Case 2: FFS others* | | *Downstream service requirement* | *Top-5 accuracy > 90%* | | *Transmission requirement to guarantee the service requirement* | *X TER (token error rate) / BER (bit error rate) / BLER (block error rate) that could guarantee corresponded service requirement. FFS the value of X, e.g., 20% TER, or 5% BER.*  *Y important tokens are selected for transmission that guarantee corresponded service requirement. FFS the value of Y, e.g., 25% tokens are selected based on their importance.* | |
| *NEC* | *Proposal 5: For AI services,* ***adopt a flexible traffic model that differentiates between bursty and streaming uplink prompts****, defined by the following parameters:*   * *Uplink Traffic Profile, configured as either:*   + *For bursty inputs (e.g., text, images): An Uplink Prompt Size.*   + *For streaming inputs (e.g., real-time video): An Uplink Service Data Rate with periodic packet generation.* * ***Token Generation Rate (downlink).*** * ***Token Size****.* * ***Token Success Rate****.* * ***E2E Delay Budget****.* |
| *NVIDIA* | *Proposal 2:* ***Study traffic models for performance evaluation during 6GR study taking into consideration the unique characteristics of UL-heavy immersive and AI applications related traffic****.* |
| *Ofinno* | *Proposal 16:* ***New traffic model to evaluate AI/ML related use cases is needed****.*  *Proposal 17: New traffic model for AI/ML related use cases is studied under agenda item 11.6.* |
| *Google* | *Proposal 1:* ***Adopt the token-streamlined traffic model as the baseline for evaluating AI-specific use cases****.*  *Proposal 2:* ***GenAI traffic properties as agreed in SA1/TR 22.870 can be used as baseline for token-streamlined traffic model in RAN1****.*  *Proposal 3: Support 1% target BLER for CQI reporting in evaluations for AI traffic.*  *Proposal 4:* ***Support a max allowed latency for a burst (e.g., 20 ms) as key target metric for AI traffic****.* |
| *Qualcomm* | *Proposal 8:* ***For 6GR evaluation of the new use cases or services, e.g., AI/ML services, immersive communication services, study whether it can be based on extending the existing FTP or XR traffic models****.* |
| *Intel* | *- We are* ***open to consideration*** *of new traffic models to cover new use cases.* |
| *AT&T* | *Proposal 7: For 6G evaluations,* ***introduce a new traffic model for AI/ML traffic****.*  *Note: Thrive to minimize modeling complexity for the new traffic model.* |

### Discussions

13 companies discussed the traffic model for AI/ML services. With the reference to the SA1 study report in TR22.870 for 6G use cases and service requirements for AI/ML and based on the contributions for this meeting, it seems consensus that the existing traffic models do not reflect the traffic characteristics of the AI/ML services and new traffic model is needed.

**The different views among the companies lie in**:

- *What AL/ML services are concerned about*: 7 companies (Nokia, CMCC, Huawei, OPPO, NEC, Google, AT&T) explicitly mentioned the traffic model for token communication; 2 companies (ZTE, NEC) discussed the traffic models for non-tokenized generative AI application and for model training/inference or mentioned uplink prompts. 5 companies (Futurewei, NVIDIA, Ofinno, Qualcomm, Intel) just mentioned the model for AI/ML generally.

- *What level of details on the token traffic model*: 5 companies (CMCC, Huawei, OPPO, NEC, Google) are generally supportive for defining a token traffic model. 4 companies (Huawei, OPPO, NEC, Google) mentioned the token traffic model are characterized by some parameters (e.g., token size, token arrival rate, token success rate, delay budget, etc). 2 companies (Huawei, OPPO) elaborated the detailed values for the parameterized token traffic model. 1 company (ZTE) provided detailed parameterized traffic model for non-tokenized generative AI application and for model training/inference.

- *Whether other WG should be involved/consulted for defining the traffic model*: 1 company (Nokia) mentioned SA4 should be triggered for the study of the traffic model before agreeing on its use for evaluation.

- *Which agenda (11.2 or 11.6) the traffic model for AI/ML should be discussed:* 2 companies (Futurewei, Ofinno) mentioned the model can be further discussed after relevant decision is made in AI 11.6 or the model is studied under AI 11.6.

**Other suggestions from companies:**

- Some company proposed to make the token-streamlined traffic model the baseline for evaluating AI-specific use cases.

- Some companies mentioned TR22.870 documented the use cases and the requirements so can be used to derive the traffic model.

- Some companies considered to extend the existing FTP-3 or XR traffic model for simplicity regarding how to model.

- Some company argued that there are no standardized ways for compression and transport of tokens, especially considering that different tokenized traffic behaviors heavily depend on the application-level coding, encapsulation, formats etc. In addition, SA4 has studied AI/ML for media applications (AI4Media) in Rel-19 and concluded that further study is needed for traffic characteristics of AI/ML data (conclusions in TR 26.927) so SA4 should be consulted before defining the traffic model in RAN1. *[Moderator’s note: SA4’s further study is on the data defined in the TR which comprise of AI/ML model data, Intermediate data, Inference input/output data, training input/out data, etc, nothing to do with token?]*

With that and assuming agenda 11.2 will continue discussing the model, RAN1 discussions can start from the following aspects:

- *Whether the new traffic model is needed for AI/ML services:* The answer should be positive based on the above summary*.*

- *How many traffic models are needed for AI/ML services*, *e.g., one for tokenized and the other for non-tokenized for GenAI services? One traffic model for AI/ML model training/inference?*

*- Whether RAN1 can define the traffic model(s)? For instance, start from deriving the necessary parameters based on the services requirements in TR22.870?*

**Round-1 Discussion:**

The new traffic model(s) for AI/ML will be needed. The questions are how many models are needed and how to set the models.

(FL1) Question 1:

*How many traffic models are needed for AI/ML services*, *e.g., one for tokenized and the other for non-tokenized for GenAI services? One traffic model for AI/ML model training/inference? For example, study to define traffic model(s) that could be used for 6GR AI/ML services performance evaluations,*

* *For GenAI services:*
  + *Model-1: Token traffic model*
  + *Model-2: FTP-3 variant type1 (i.e., non-tokenized model)*
* *For AI/ML model training/inference*
  + *Model-3: FTP-3 variant type2*

(FL1) Question 2:

*Start from deriving the necessary parameters based on the services requirements in TR22.870? For example,* *study to define traffic model(s) that could be used for 6GR AI/ML services performance evaluations,*

*- For GenAI services:*

* + *Model-1: Token traffic model*
    - ***Parameterized by: Token size, Token arrival, Token success rate, Token delay budget.*** 
      * ***FFS on values.***
      * ***FFS on whether defining other parameters.***
  + *Model-2: FTP-3 variant type1 (i.e., non-tokenized model)*
    - ***Parameterized by: Same as FTP-3 with different values.*** 
      * ***FFS on values***
* *For AI/ML model training/inference*
  + *Model-3: FTP-3 variant type2*
    - ***Parameterized by: Same as FTP-3 with different values.*** 
      * ***FFS on values***

*Moderator’s proposals will be based on the collected views to the above two questions.*

*Please share your views to the above questions here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | We would like to emphasize that although most generative AI services are indeed token-based, the tokens are generated at the application layer. After passing through the PDCP, RLC, and MAC layers, these tokens are ultimately transmitted over the air interface as TB, just like other types of services.  Since the current discussion focuses on RAN1 simulations, attention should be paid to the characteristics of physical layer packets. An appropriate approach could be to map the actual token characteristics (e.g., packet size and latency) to physical layer packets for the simulation. |
| CMCC | For Q1: the traffic model of AI/ML model training/inference, we can wait for more progress in 11.6.  For Q2:  AI/ML model inference, the traffic characteristic is much related to the specific use case, some even not related with any traffic model. For example, for AI/ML based CSI use cases, the model input/output is simply CSI measurement and UCI transmission, which is not related with any traffic.  For AI/ML model training, if it refers to NW/UE side training data collection, we haven’t decided on the details of data collection mechanism, for example, whether it is via UP or CP or specific data plane. For model transfer/deliver, we haven’t decided whether it is feasible or not, whether it is via OTA signalling or non-OTA signalling. |
| vivo | Before discussing AI-related service, we need to clarify the types of GenAI service, rather than simply dividing them into token and non-token. AI-related service includes things like   * Text-Generative AI * Image-Generative AI * Audio-Generative AI * Video-Generative AI * Multimodal-Generative AI   Different types of services have distinct traffic characteristics, so we need to discuss them case by case basis.  In addition, we haven’t studied AI-related traffic flows yet, it is premature to say that we will use FTP-3 model for modeling. |
| Nokia | RAN1 does not have the competence to develop new traffic models for AI use cases. RAN1 shall therefore send an LS to SA4, requesting that SA4 provides guidance on what are the most realistic traffic models for AI uses cases such as e.g. GenAI, AI inference/training, etc. |
| Interdigital | It is difficult to directly convert token sizes and arrival rates into traffic, as the AI modeling/interference data goes through different protocol stack layers. Even if AI models can tolerate higher token loss, if the underlying protocol stack is TCP/IP, then the transport layer will try to reduce packet loss and failures from retransmissions.  As Nokia mentioned given that expertise on traffic is in SA4, we think feedback from SA4 would be useful before defining a traffic profile for AI. |
| Ericsson1 | On “*Whether other WG should be involved/consulted for defining the traffic model*”, there is also a RAN2 study on transmission characteristics of mobile AI traffic in Rel20 XR Phase 4 WI. Details in RP-251866 (some excerpts copied below). Considering this, before discussing traffic model details in RAN1, it is perhaps better to check with RAN2 (and SA4 as suggested by Nokia) to better understand the traffic characteristics of the related applications. |
| OPPO | As a starting point, we could identify at least one traffic model to kick off the study and evaluation on NW for AI/ML services (e.g., token based communications). Two traffic models, one for token based source and another for non-tokenized source, are also OK to us. Regarding the LS to SA4(RAN2), we don’t think it would help for traffic modeling in RAN1. As mentioned by modulator, SA4’s current study is not related to token communication. Furthermore, if we wait for reply from another group, we would miss the window to define a new traffic model (which could be important at least for some companies), considering only two meetings left for EVM. We can at least agree on the proposal first, and whether LS on the detailed parameters/characteristics is needed can be further studied. |
| DOCOMO | We are generally fine to discuss the traffic model for AI/ML service.  Considering each new traffic model can be modeled by changing word from packet to token and related values, impact would be small. Then, we think all models can be discussed based on the services requirements. |
| Google | Q1: We propose to adopt a single new model, the token-streamlined traffic model, as the baseline for evaluating AI-specific use cases. We also support more coordination with SA4 as done in XR in 5G.  Q2: Yes, we support using the GenAI traffic properties agreed in SA1/TR 22.870 as the baseline/starting-point for the token-streamlined traffic model in RAN1 |
| Qualcomm | It may be too early to discuss how many traffic models are needed for the AIML services. Before answering this question, we should study whether the existing or extension of the existing traffic models can be reused for evaluating the AIML services. We also need to know what the traffic characteristics of the considered AIML services/use cases. Since these questions are out of the scope of RAN1, we prefer to get some input from other WGs before RAN1 starts to discuss the traffic models for the AIML services. |

**Round-2 Discussion:**

**Based on the offline discussion, assuming the traffic model for token communication is decided to be discussed in this agenda, RAN1 can continue the study to define the traffic models and consider to agree on some high-level guidance for the next step study. Meanwhile, it was also suggested consulting other WG (i.e., SA4) for helpful instruction if any.**

(FL1) Proposal 4.2.2

Study in RAN1 to define traffic model(s) that could be used for 6GR AI/ML services performance evaluations:

* Model-1: AI/ML traffic model
  + - The representative AI/ML service is the generative AI, e.g., Image based GenAI app, Video based GenAI app, or Chatbot as defined in TR22.870.
    - Model-1a: The model is characterized by at least Token size, Token arrival rate, Token success rate, and Token delay budget.
      * FFS values for these parameters in RAN1 evaluation.
      * FFS how to reflect the variable importance of tokens.
      * FFS whether other parameters are additionally needed when tokens are encapsulated together into a packet, e.g., Token packet arrival rate, Token packet success rate, and Token packet delay.
    - FFS other models.
* FFS other models need to be defined for other AI/ML services.
* Send LS to SA4 requesting SA4 for helpful instruction if any, RAN1 continues the study on the traffic models before SA4 potential response.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| NVIDIA | Supports proposal 4.2.2 as the starting point for Ai/ML services performance evaluation. Sending LS to other WG is okay as long as it doesn’t hinder progress in RAN1. |
| Huawei | Support proposal 4.2.2 to study Model-1a for AI/ML service. We should take token-based generative AI as a representative one, because each GenAI app will generate token during the service. The new traffic model can be used for evaluation for non-AI/ML based solutions, hence don’t need to wait for the progress of 11.6. As there is no discussion about AI/ML service traffic in SA4, RAN1 can start the study first. |
| Nokia1 | We propose a few changes to the FL proposal:   1. Study in RAN1 **whether** to define **new** traffic model(s) that could be used for 6GR AI/ML services performance evaluations:   Model-1 change to Option 1: AI/ML **application** traffic model. Model 1a- > Option 1a. |
| ZTE | We agree with studying AI/ML traffic model. However, since the token is created in application layer, and focus of this agenda should be PHY layer, we suggest extending FTP mode to model token characteristic.  We think the final model should be represented in terms of packet characteristics, but the parameter values should be determined by the token characteristics. The proposal can be modified as  **Proposla (Modified)**  Study in RAN1 to define traffic model(s) that could be used for 6GR AI/ML services performance evaluations:   * Model-1: AI/ML traffic model   + - The representative AI/ML service is the generative AI, e.g., Image based GenAI app, Video based GenAI app, or Chatbot as defined in TR22.870.     - Model-1a: The model is characterized by at least Token size, Token arrival rate, Token success rate, and Token delay budget.       * FFS values for these parameters in RAN1 evaluation.       * FFS how to reflect the variable importance of tokens.       * FFS whether other parameters are additionally needed when tokens are encapsulated together into a packet, e.g., Token packet arrival rate, Token packet success rate, and Token packet delay.     - Model-1b: The model is characterized by the parameters of PHY layer packet, including packet size, arrival rates, latency requirement, reliability requirement, etc.       * FFS: relationship between tokens and packets at the PHY layer.       * FFS: values of above model parameters.       * FFS: whether existing traffic model (e.g. FTP 3) can be used.     - FFS other models. * FFS other models need to be defined for other AI/ML services. * Send LS to SA4 requesting SA4 for helpful instruction if any, RAN1 continues the study on the traffic models before SA4 potential response. |
| OPPO | We are generally fine with FL’s proposal. Token communication is an important AI/ML service type in 6G (NET for AI). As we know, token communication is totally different from the current service type (e.g. in packet definition, success rate definition, etc) and a new traffic model is needed. The details can be found in our contribution (**R1-2507176**). Without this traffic model, it would be difficult for further performance evaluation on token-based communication.  Regarding the LS, we agree that it should not impact the study process in RAN1. However, in our understanding, SA2 is more appropriate group to send the LS to rather than SA4. If further information is needed by SA2, they can send the LS to SA4. |
| CAICT | Token-based communication is important for AI/ML service type and Fine with FL’s proposal. |
| Qualcomm | We support to study traffic models for 6G AI/ML services but am not sure whether new traffic model will be defined or it can be based extension of the existing traffic models. At this stage it is too early to say to define new traffic model.  Secondly, it is not clear to us why the traffic model is based on Token. In our view, Token is application layer term and not relevant to RAN1. If the model is characterized by Token size, Token arrival rate, Token success rate and delay budget, we want to know the difference to the existing FTP model. Note extension of FTP model to include delay budget have been also proposed by multiple companies. **As such, the characteristic of the new model is very similar to the FTP model extended by PDB, and why we need to define a new model here**.  As commented offline, when defining a new model for AI/ML services, we need to know the traffic characteristics of the services and how it is different from the existing traffic model. We cannot define an arbitrary model without knowing the traffic pattern details. We suggest asking other WG input regarding the traffic pattern for the 6G AI/ML services.  To move forward, we suggest the following modifications.  Study in RAN1 to define traffic model(s) for 6G AI/ML services:   * The representative AI/ML service is at least the generative AI, e.g., Image based GenAI app, Video based GenAI app, or Chatbot as defined in TR22.870. * **FFS on whether to define a new model or extend the existing traffic model, and the model details.** * Send LS to SA4 requesting SA4 for helpful instruction if any, RAN1 continues the study on the traffic models before SA4 potential response. |
| NTT DOCOMO | We support the proposal. |
| Google | Support the Proposal in general.  Some minor modifications below:   * "Study... to define" to "Study... **whether to define a new model or extend an existing model**." * Add FFS to investigate the mapping and relationship between token characteristics and packet characteristics   LS to **SA4 and SA2** |
| Samsung | Thank FL for the new proposals.  We think RAN1 itself is lack of competence to define the traffic model for AI/ML services. If the need to incorporate a new model in RAN1 for generative AI services is justified, consulting with other working groups, e.g. SA4 mentioned by other companies, may be a way to go. On the other hand, studying the possibility of **reusing existing traffic model or an extension for generative AI services should be considered with higher priority, e.g. XR model**. |
| Intel | Suggest modification to the main bullet “Study in RAN1 **whether/how** to define…”  Suggest adding “FFS if the traffic model can be approximated by FTP model 3 or enhanced FTP model 3 with specific parameters”  Suggest removing Model-1 and Model-1a labeling for now. There is implicit assumption that we need more than one model, but once we reach conclusions that there are multiple models, we can introduce labels.  Remove “variable importance of tokens” which seem to be undefined. |
| Ericsson2 | We prefer the approach suggested by Qualcomm/Intel with below updates  For the study in RAN1 ~~to define~~ on traffic model(s) for 6G AI/ML services,:   * The representative AI/ML service is at least the generative AI, e.g., Image based GenAI app, Video based GenAI app, or Chatbot as defined in TR22.870. * FFS on whether to define a new model or extend the existing traffic model, and the model details.   Send LS to SA4 (cc RAN2) requesting ~~SA4 for helpful instruction~~ input if any on traffic characteristics for AI/ML services, RAN1 can continue~~s~~ the study ~~on the traffic models~~ before SA4 potential response. |
| Xiaomi | 1. For the AI/ML service, we consider it deserves further study. This proposal is a good starting point. 2. For the second subbullet(Model-1a), we think RAN1 need more time to check whether the Token size, Token arrival rate, ... should be included in the model characterization. We suggest the following updated wording “As a starting point, model characterization may consider Token size, Token arrival rate, Token success rate and Token delay budget” |
| vivo2 | We agree with Qualcomm/Intel/Ericsson’s direction to make our discussion more general. If we want to send an LS to SA4, we prefer to involve the haptics service as well. The modification we suggest are as follows:  For the study in RAN1 ~~to define~~ on traffic model(s) for 6GR ~~AI/ML~~ services,   * AI/ML services: The representative AI/ML service is at least the generative AI, e.g., Image based GenAI app, Video based GenAI app, or Chatbot as defined in TR22.870. * Haptic services as defined in TR 26.854. * FFS on whether to define a new model or extend the existing traffic model, and the model details.   Send LS to SA4 (cc RAN2) requesting ~~SA4 for helpful instruction~~ input if any on traffic characteristics ~~for AI/ML services~~, RAN1 can continue~~s~~ the study ~~on the traffic models~~ before SA4 potential response. |

**Round-3 Discussions:**

The proposal is updated based on the comments received during round-2.

(FL2) Proposal 4.2.2-r1

For the study in RAN1 on traffic model(s) for 6GR AI/ML services:

* Model-1: AI/ML traffic model
  + - The representative AI/ML service is the generative AI, e.g., Image based GenAI app, Video based GenAI app, or Chatbot as defined in TR22.870.
    - Option-1a: The model is parameterized by at least Token size, Token arrival rate, Token success rate, and Token delay budget.
      * FFS values for these parameters in RAN1 evaluation.
      * FFS how to reflect the variable importance of tokens.
      * FFS whether other parameters are additionally needed when tokens are encapsulated together into a packet, e.g., Token packet arrival rate, Token packet success rate, and Token packet delay.
    - Option-1b: The model is characterized by the parameters of PHY layer packet, including packet size, arrival rates, latency requirement, reliability requirement, etc.
      * FFS: relationship between tokens and packets at the PHY layer.
      * FFS: values of above model parameters.
      * FFS: whether existing traffic model (e.g. FTP 3) can be used.
    - FFS other options, e.g., reusing or extending the FTP-3/XR traffic model.
* FFS other models need to be defined for other AI/ML services.
* Send LS to SA2/SA4 (cc RAN2) requesting input if any on traffic characteristics for AI/ML services, RAN1 can continue the study before SA2/SA4 potential response.

#### Agreement

|  |
| --- |
| Agreement  For the study traffic model(s) for 6GR AI/ML services:   * + A representative AI/ML service is the generative AI, e.g., as defined in TR22.870.   Send LS to SA1/SA2/SA4 (cc RAN2) requesting input if any on traffic characteristics for AI/ML services.  Note: RAN1 is discussing the following options for the model:   * + Option-1a: The model is parameterized by Token, e.g., Token size, Token arrival rate, and Token delay budget.     - Token is the minimum unit of data generated in the application layer.     - How to associate Tokens to PHY layer packets.     - How to reflect the variable importance of tokens.     - Whether other parameters are additionally needed when tokens are encapsulated together into a packet, e.g., packet arrival rate, packet success rate, and packet delay.   + Option-1b: The model is characterized by the parameters of PHY layer packet, including e.g., packet size, arrival rates, latency requirement, reliability requirement, etc.   + Option-1c: reusing or extending the FTP-3/XR traffic model.   + FFS other models/options need to be defined for other AI/ML services. |

## New model 2-Immersive comm.

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *For* *immersive communication services, it is likely that they can be viewed as further* ***extensions of XR services****, and generalizations of XR traffic models can be discussed and adopted.* |
| *vivo* | *Proposal 3: Support to introduce* ***haptic traffic model for immersive communication service evaluation****, and further study,*  *- The distribution of packet size*  *- The distribution of packet arrival time*  *- Packet delay budget*  *- Packet error rate*  *- Jitter*  *- The number of channels*  *- The density*  *Proposal 4: Support to* ***evaluate hybrid traffic flows (e.g., audio, video, haptics) for immersive communication service****, taking into account synchronization requirements among different flows.* |
| *Huawei* | *Proposal 10: The traffic model of immersive communications should* ***take the XR traffic model as the baseline but with the modifications on packet size******related*** *as in Table 9.*  *Table 9: Modifications of traffic model based on XR for emerging immersive services*   |  |  |  |  | | --- | --- | --- | --- | | *Parameter* | *unit* | *XR traffic model (TR38.838)* | *6GR immersive communication traffic model* | | *Mean: M* | *Byte* | *R×1e6 / F / 8* | *R×1e6 / F / 8* | | *Data rate: R* | *Mbps* | *DL: 30/45/60*  *UL: 10/20* | *DL: 100/300/500*  *UL: 20/60/100* | | *Frame generation rate: F* | *fps or Hz* | *DL: 60*  *UL: 60* | *DL: 90/120*  *UL: 15/30* | | *STD* | *Byte* | *10.5% of M* | *25% of M* | | *Max* | *Byte* | *150% of M* | *300% of M* | | *Min* | *Byte* | *50% of M* | *25% of M* | |
| *NVIDIA* | *Proposal 2: Study traffic models for performance evaluation during 6GR study taking into consideration the unique characteristics of* ***UL-heavy immersiv****e and AI applications related traffic.* |
| *Ofinno* | *Proposal 15:* ***The XR related traffic models defined in TR 38.838 are used for RAN1 evaluations related to immersive communications including XR****.* |
| *Sony* | *Proposal: RAN1 should define at least the following traffic model for 6G system level simulation assumption:*   * *FTP model 3 for mobile broadband and IoT, with scale of data rate* * *Periodic traffic with 60/120 fps for XR devices* * ***Immersive communication services such as UL-heavy*** |
| *Intel* | *We are open to consideration of new traffic models to cover new use cases.* |
| *Qualcomm* | *Proposal 8: For 6GR evaluation of the new use cases or services, e.g., AI/ML services, immersive communication services, study whether it can be based on extending the existing FTP or XR traffic models.* |

### Discussions

First off, immersive Communication has been described as follows by ITU-R: "This usage scenario extends the enhanced Mobile Broadband (eMBB) of IMT-2020 and covers use cases which provide a rich and interactive video (immersive) experience to users, including the interactions with machine interfaces.".

In addition, what immersive communication services are discussed in 3GPP can refer to SA1 study report in TR22.870 for 6G use cases and service requirements, where such use cases are documented, e.g., immersive gaming, wearable devices with immersive applications which require much computing capability for processing application data, holographic telepresence in healthcare, personalized interactive immersive guided tour service of a city, etc.

**In particular, companies discussed the traffic model for immersive comm. are referring to the use cases:**

- cloud gaming with higher display resolution such as 8K/12K predicts a larger downlink data rate. In addition, with variable bit rate (VBR) coding emerging, a larger fluctuation range on packet size compared with the traditional constant bit rate coding is implied. *(Discussed by Huawei).*

- AI wearable and intelligent eldercare on embodied AI robots implies an UL-heavy traffic packet data rate. *(Discussed by Huawei, NVDIA, Sony)*

- haptics service with traffic characteristics studied by SA4 in Rel-19 and documented in TR26.854. Haptics refers to the sense of touch, and encompasses the generation, manipulation, and perception of tactile sensations, forces, and motions. Three parameters, namely the number of channels, the media format, and the density, affect the traffic data rate. When researching immersive service, hybrid video, audio and haptics flows, along with their synchronization requirements of the arrival sequence, should be considered. *(Discussed by vivo)*

**Ideas on how to model from companies**

- Some other companies mentioned to use/extend XR traffic model to cover the use cases for immersive comm. *(Mentioned by Futurewei, Huawei, Ofinno, Qualcomm)*

- Same parameters (packet size, arrival time, delay budget and error rate, jitter) as XR traffic model will be used for haptic traffic model. In addition, consider the number of channels and the density. *(Mentioned by vivo)*

With these summarized, it can be concluded that a traffic model is needed for performance evaluations with regards to immersive communication services and the traffic model could be based on the XR traffic model with modification. The discussion points can start from:

*- How many traffic models will be defined for this purpose, e.g., haptic traffic model and others with the same parameters with different values?*

(FL1) Proposal 4.3.2

Study to define a traffic model that will be used for performance evaluations with regards to immersive communication services, the XR traffic model with modifications will be the starting point.

* FFS how many models need to be defined and the corresponding representative use cases.
* FFS the detailed modifications to the XR traffic model.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree, at least between FTP-3 and XR modifications, we believe XR is more appropriately approximating the immersive communication services. |
| ZTE | We support FL’s proposal here. |
| CMCC | Support.  XR traffic model, including the definition of jitter, packet size, arrival time, delay budget and error rate, can be reused. |
| vivo | Haptics refers to the sense of touch, and encompasses the generation, manipulation, and perception of tactile sensations, forces, and motions. SA4 has already well studied haptic service in Rel-19.  In XR services, the presence of haptics media plays a significant role in improving the sense of presence and immersion. Real-time tactile feedback in response to user interactions with virtual objects make the user feel as they are genuinely touching and manipulating the virtual elements. Moreover, users with visual or auditory impairments can engage with virtual content through haptic feedback.  Supporting immersive services is one of the most important goals for 6G, and haptic services play the most crucial role in enhancing the user experience. Therefore, we recommend conducting haptic service study. |
| Nokia | In our view, the XR traffic models in 3GPP TR 38.838. From that TR, we could select the **real-time Video cases with 4K upscaled quality at 45 Mbps (DL) and 10 Mbps (UL) as the default configurations**. Models for e.g. haptic feedback also appear in this TR, referred to as **Pose information feedback**.  As 3GPP has not yet agreed **on XR models for 8K/12K Video quality**, **RAN1 may ask SA4 for advice on such models**. Asking what is the relevance of such cases, and if considered relevant, what is the recommended model. |
| Interdigital | **SA4 has conducted a study on haptics traffic in TR26.854**. Given that there are numerous differences compares to XR traffic and SA4 has taken significant effort to perform the study, we think it would be worthwhile for RAN1 to further consider haptics services and discuss further how this could be leveraged for evaluations in 6G.  It would be preferrable to explicitly list this (haptics traffic) as part of the study. |
| Ericsson1 | Existing XR models can be used as starting point and we are open to studying modifications. Suggest reformulating the proposal as below.   * XR traffic models (in TR 38.838) are considered as starting point for evaluations related to immersive communications.   + FFS any modifications to the models in 38.838. |
| DOCOMO | We are generally fine with the FL proposal. |
| Google | Yes we support the proposal. |
| Qualcomm | We support to use the existing XR models for evaluating the immersive communications. We are also open to possible modifications to better support the immersive communications evaluation. |
| NVIDIA | Fine with FL proposal. Start with existing XR models as the baseline and then enhance/modify as needed to better reflect UL heavy traffic. |
| Huawei | we support the proposal. |
| Interdigital | As mentioned, one of the key aspects of immersive communication that should be considered is haptics services. As such, we believe it would be preferable to note this aspect in the proposal.  **Proposal:**  Study to define a traffic model that will be used for performance evaluations with regards to immersive communication services including but not limited to XR and haptics services,   * Consider XR traffic model as a starting point. * FFS how many models need to be defined and the corresponding representative use cases. * FFS how to incorporate haptics traffic (TR26.854) * FFS the detailed modifications to the XR traffic model. |
| Apple | Okay |

(FL2) Proposal 4.3.2-r1

Study to define a traffic model for evaluations related to immersive communication services including but not limited to XR and haptics services,

* XR traffic models (in TR 38.838) with modification are considered as starting point.
* FFS how many models need to be defined and the corresponding representative use cases.
* FFS how to incorporate haptics traffic (TR26.854).
* FFS the detailed modifications to the XR traffic model.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |

#### (FL4) Proposals 4.3.2-r3 - Afteroffline

Study traffic modelling for evaluations related to immersive communication services including but not limited to advanced XR [TR22.870, section 9] and haptics services,

* XR traffic models (in TR 38.838) are considered as starting point.
  + FFS the detailed modifications on the parameters to the XR traffic model, e.g., higher packet size, higher packet arrival rate, higher packet size deviation, PDB, etc.
* FFS how many models need to be defined and the corresponding representative use cases.
* FFS how to incorporate haptics traffic (TR26.854).

Send LS to SA4 requesting input if any on the relevant traffic characteristics, RAN1 can continue the study before SA4 potential response.

***Any strong concerns****, please leave them here.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | Ok with proposal part. On the notes related to LS, suggest to add RAN2 in cc and remove “RAN1 can continue the study before SA4 potential response”. |

## New model 3 – FTP-3+PDB

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *we suggest* ***introducing packet delay budget for FTP-3 Model****.* |
| *Nokia* | *Proposal 13: We propose* ***not to introduce a new FTP-3 traffic model with a with packet delay budget (PDB) requirement****. Instead, we suggest* ***using the existing FTP-3 model and defining a Capacity measure/KPI as the maximum offered cell load*** *that can be supported while UEs meet a minimum PDB threshold allowing for 5%-ile outage.* |
| *ZTE* | *Proposal 4-2-2:* ***Adopt the extended FTP traffic model in Table 4-2-2 for 6GR evaluation****.*  *FFS:* ***Using single FTP file download to simulate burst transmission and how to configure PDB values*** |
| *Huawei* | *Proposal 8:* ***FTP model 3 with different packet sizes, mean inter-arrival time and packet delay budget can be used to model some typical traffic****, and the Table 7 can be the starting point for this kind of traffic model.*  *Table 7: Example for parameters about the traffic model of FPT3 plus packet delay budget*   |  |  | | --- | --- | | *Items* | *Notes/Values* | | *FTP Model* | *FTP model 3* | | *Packet size* | *e.g. 0.05Mbytes, 0.25Mbytes, 0.5Mbytes, 1 Mbytes or other value, which is used to achieve different RUs, assuming fixed UE number per cell* | | *Mean inter-arrival time* | *e.g. 200 ms, 30ms or other value, which is also used to achieve different RUs* | | *Packet delay budget (PDB) within RAN* | *e.g. 50ms, 200ms or other value, which is used for modelling*  *different PDBs, where 98% of the packets shall not experience a delay exceeding the PDB in section 5.7.3.4 in TS 23.501* | |
| *NEC* | *Proposal 4: For MBB evaluations,* ***adopt FTP Model 3 with an added PDB requirement****. The model is defined as follows:*   * *Packets are generated according to the FTP Model 3 process (e.g., 0.5 Mbytes packet size, 200 ms mean inter-arrival time).* * *Each packet is assigned a PDB (e.g., 50 ms or 200 ms) to reflect QoS requirements.* * *The evaluation metric shall be the QoS satisfaction rate (the percentage of packets successfully delivered within their PDB) in addition to average UPT.* |
| *Ofinno* | *Proposal 14: S****tudy new traffic model generating mixed/variable packet size*** *for RAN1 evaluations related to* ***UE/network power saving and new/other use cases****.* |
| *Intel* | *Proposal 9*  *•* ***FTP Model 3 is updated to always have an associated PDB***  *•* ***A packet exceeding PDB during the transfer is dropped***  *• The number / ratio of dropped packets is reported*  *• UE packet throughput accounts all three types of packets,*  *o Successfully transferred during the simulation time,*  *o Dropped during the simulation time,*  *o Unfinished during the simulation time.* |

### Discussions

It is the fact that the FTP traffic models do not allow for the required latency for the delivery, which essentially only reflect the traffic with random packet arrival and fixed packet size for all the UEs.

*Whether the FTP-3 with packet delay budget (PDB) considered is needed:*

- With increasing number of 6G services have latency requirement, the existing FTP traffic models are not appropriate, especially considering when the RU is high, some packets stuck in the queue will have to be discarded and flagged as failure to deliver. *(mentioned by ZTE, Futurewei, NEC, Huawei, Intel)*

- There are many services (based on the standardized 5QI to QoS characteristics mapping from Table 5.7.4-1 in TS 23.501) that need both data rate and latency at the same time, such as real time gaming, video (Live Streaming), interactive gaming and etc. However, it is worth noting also that such model is not the same as XR traffic, because its each packet size keeps the same and its latency budget is around 50-280ms. *(mentioned by Huawei)*

*How to reflect PDB for the FTP-3:*

*-* Most companies view to add PDB parameter into the FTP-3 model, with some values suggested or TBD. *(Mentioned by Futurewei, ZTE, Huawei, NEC, Intel)*

*-* One company views that PDB does not need to be considered as a part of the traffic model. Instead, we can define **a capacity KPI for FTP-3 that factors in experienced packet delays** We define Capacity as maximum offered load per cell that the system can tolerate while the 5%-ile outage UE experienced PDB is above a certain threshold. This threshold may e.g. be set to equal 100 ms correct reception of a file. So essentially defining the Capacity subject to a certain minimum cell-edge UE outage performance**.**  *(Mentioned by Nokia)*

With that, companies discussed the model seem to converge that the FTP-3 model with PDB considered for the evaluations is needed. Moreover, except one company all other companies view that just adding PDB into the FTP-3 model will suffice.

(FL1) Proposal 4.4.2

Study to define a traffic model that could be used for 6GR evaluations, a.k.a. FTP-3a, by adding the parameter of packet delay budget (PDB) into the existing FTP-3 traffic model.

* A packet exceeding PDB during the transfer is dropped.
* FFS exact values for the PDB to be added.
* FFS other values for packet size, mean inter-arrival time will be added.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | It is suggested to considered FTP-3a as a baseline version of FTP-3. We believe some PDB should always be modelled when the packet arrival process allows the packets to overlap in UE buffer. |
| ZTE | We agree with FL’s view. By the way, the PDB value should be chosen very carefully to avoid introducing excessive additional efforts in the simulation just to meet latency requirements, especially since the vast majority of real-world services can easily satisfy latency requirements. |
| CMCC | Support to add PDB into FTP 3 model.  If we make a rule that a packet exceeding PDB during the transfer is dropped, then the corresponding KPI, like the packet loss rate should also be defined when we use this traffic model in specific technology evaluation, like what we did in Rel-18 Duplex evaluation. |
| vivo | In our view, for FTP traffic, **the required PDB would be significantly different across different use cases,** e.g. different PDBs for different packet sizes and inter-arrival time, or different PDBs even for same packet size and inter-arrival time.  We are open to study but not sure we will commit to define the PDB so far.  Suggest revision: Study whether and how to define XXX |
| Nokia | It shall **not** be the traffic model that drops packets. In 5G NR specifications, packet dropping is based on the packet discard mechanism at the PDCP layer (i.e. DiscardTimer based). The Packet Discard mechanisms are the responsibility of RAN2, RAN1 needs to consult RAN2 to make sure that RAN1 takes realistic assumptions when it comes to such behaviors. |
| Ericsson1 | From our perspective, any updates to FTP Model 1/FTP Model 3 can be taken together as ‘unified extension’ to the corresponding models to avoid overlapping discussions (e.g., with next proposal). |
| DOCOMO | We support the proposal. |
| Qualcomm | We have the same view as Nokia that the modeling of the packeting dropping exceeding PDB is not needed. Following the same principle in XR model, if the delay is larger than a given PDB for the packet, then, the packet is said to violate PDB, otherwise the packet is said to be successfully delivered. Secondly, the PDB value will vary from different applications and traffic types. It is not possible to have a single PDB value. |
| Huawei | We support the proposal. Almost all traffic in the current network have the latency requirements, because it will impact on the user experience in the 6G network. So, it is valuable to explore how to reflect this in the further 6G evaluation. |
| Apple | Agree with Ericsson, this can be jointly considered with the next proposal.  If we understand Huawei’s point correctly, for XR, the user experience can be quantified by “user satisfaction” as in the XR TR. |

#### Merged into section 4.5

## New model 4- mixed/variable packet size

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *we* ***suggest introducing a FTP-3 variant (i.e., extending the current FTP-3*** ***Model) with mixed/variable packet sizes****, or* ***even with mixed packet size distributions****, and the associated time domain behaviors, which can be used to model mixed traffic profiles, e.g., mixed delivery of large files and voice packets.* |
| *CMCC* | *Proposal 4: For enhancement on FTP3-wise traffic model, RAN1* ***take the traffic model in ETSI TS 103 786 as the starting point*** *and* ***further discuss whether there is modification/enhancement*** *on top of it.* |
| *Huawei* | *Proposal 11: The* ***services*** *corresponding to the traffic of mixed/variable packet size and the associated time domain behaviours* ***should be identified and justified before discussing how to model it****.* |
| *OPPO* | *Proposal 6:* ***A new traffic model with a mixed/variable packet size or a mix of multiple traffic models can be supported*** *in 6G without significant increase on evaluation complexity.* |
| *Samsung* | *Observation:*   * ***Packets with variable sizes are observed from real traffic logs****, with small and medium packets occurring much more frequently than larger ones*   *Proposal #6:*   * *In addition to conventional traffic models,* ***consider optional*** *6GR evaluation with non-full buffer traffic models* ***supporting variable packet sizes using FTP modeling framework***   *Proposal #7:*   * *For traffic model supporting variable packet sizes,* ***define three reference packet sizes*** *corresponding to small, medium and large packet sizes along with associated packet arrival rates*    + ***The proportion of the packet arrival rates*** *should be maintained to ensure that smaller packets are occurring much more frequently than larger ones*   *Proposal #8:*   * *For traffic model supporting variable packet sizes, consider scheduling aspects to determine reference packet sizes*   *Proposal #9:*   * *For traffic model supporting variable packet sizes, consider the following options of packet assignment to the UE for joint SLS evaluation with different packet sizes:* * *Each UE can receive the packet of only one size from the reference packet sizes* * *Each UE can receive packet of different sizes from reference packet sizes* |
| *Apple* | *For more realistic traffic modeling and suiting the need for new service/new use cases,* ***consider traffic flows with different packet size distribution/inter-arrival time/latency bound****.*  *- Consider packet size variation and inter-arrival time variation in traffic flow modeling*  *- Consider latency & reliability requirements for specific evaluations*  *-* ***Traffic flow mixture can be per UE or across UEs considering simulation time span and simulation goal****.*  *- For KPI, consider*  *- 5th percentile user spectral efficiency & average spectral efficiency*  *- UE satisfaction for new traffic model(s)* |
| *Qualcomm* | *Regarding the new traffic model considering a mixed or variable packet size, we think* ***it has been already supported by the existing XR traffic model used in 5G NR evaluation.*** *XR models inherently involve mixed traffic characteristics. Therefore, introducing a new mixed traffic model for 6G would be redundant. Instead,* ***XR model parameters can be tuned or extended*** *to match the specific traffic profiles with mixed or variable packet size.* |
| *Intel* | *- The mix of traffic types may be used to evaluate efficiency of supporting a mix of services in the system with diverse QoS requirements. In 5G, such mixed scenarios were evaluated as part of eMBB and URLLC multiplexing studies. It is expected that study on 6GR may* ***also introduce mixed traffic scenarios based on 6G use cases****, such as Immersive Communication and HRLLC.* |
| *AT&T* | *Proposal 8: For 6G evaluations,* ***introduce a new traffic model considering mixed traffic****.*  *Proposal 9: Consider enhancements on the mixed traffic model in TR36.899 to include representations of traffic characteristics of AI/ML, video streaming, web browsing, VoIP and XR traffic.* |
| *Ericsson* | *Observations*   * *Without accurate traffic models, the behavior of many mechanisms such as frequency domain scheduling, MU-MIMO, hybrid beamforming, can be misunderstood and incorrect conclusions drawn on the merit of design alternatives.* * *Existing bursty traffic models in RAN1 may not adequately reflect aspects such as mixed/variable packet size and time domain behaviors (e.g., time between packets and packet arrivals in a burst).*   *Proposal 4-1*   * *Support following traffic models for 6GR Evaluations* * *Extension of FTP Model 1 to enable multiple packet sizes*   + *UEs arrive according to Poisson process. Arrival rate of UEs is λ*     - *Each UE has one burst. A UE of class c has Sc bits per burst*       * *There are Nc packets per burst (UE). Each packet contains Sc/Nc bits*       * *Each subsequent packet is separated by time Tc from its previous packet*         + *FFS: if Tc is random or is a fixed value*   + *Each UE class c consumes a fraction αc of the total traffic, where*   + *At least two UE classes are defined*   + *FFS: the number of UE classes ‘c’ to define and corresponding values of , Tc, and Sc.* * *Extension of FTP Model 3 to enable multiple packet sizes*   + *Packets of a UE arrive according to Poisson process.*      - *Arrival rate of packets for UE of class c is λc (mean inter-arrival time between packets is 1/ λc)*   + *UEs of class c have Sc bits per packet*   + *Each UE class c consumes a fraction of the total traffic, where*   + *At least two UE classes are defined*   + *FFS: the number of UE classes ‘c’ to define and corresponding values of , Sc and λc* |

### Discussions

*Companies’ observations from the live networks:*

- Some companies mentioned packets (e.g., smartphone traffic) with variable sizes are observed from real traffic logs, with small and medium packets occurring much more frequently than larger ones. *(mentioned by Samsung, Ericsson)*

*Whether a new traffic model with mixed/variable packet size with time domain:*

- Several companies mentioned the new traffic model can be defined, given FTP1 and FTP3 assume perfectly homogenous traffic: only a single packet size is supported. *(mentioned by Futurewei, CMCC, OPPO, Apple, Intel, AT&T)*

- However, one company (*Qualcomm*) mentioned that XR inherently involves mixed traffic characteristics and extending XR model can also be considered if necessary. One company (*Huawei*) suggests clarifying the targeting service first before discussing how to model it.

*How to define the model considering the mixed/variable packet sizes and the associated time-domain behaviour, consider*

- Take the traffic model in ETSI TS 103 786 as the starting point. *(CMCC)*

- Define three reference packet sizes corresponding to small, medium and large packet sizes along with associated packet arrival rates .Two sub-options can be considered: per-UE fixed packet size: Each UE is assigned packets of a single size, but different UEs may have different packet sizes; or per-UE variable packet size: Each UE may receive packets of varying sizes over time: *(Samsung)*

- Traffic flow mixture can be per UE or across UEs considering simulation time span and simulation goal. *(Apple)*

- Extension of FTP Model 1 to enable multiple packet sizes and extension of FTP Model 3 to enable multiple packet sizes. *(Ericsson). [Moderator’s note: whether either one suffices.]*

With that, among companies discussed the model, most of them view that a new model is needed because the targeting services (i.e., smartphone traffic as mentioned by Ericsson) may have quite different traffic characteristics from XR services, so modifying the XR traffic model might be more complex than defining a new traffic model. However, how to define the model companies’ views are quite divergent.

(FL1) Proposal 4.5.2

Study to define a traffic model that could be used for 6GR evaluations, considering mixed/variable packet size and associated time-domain behaviors, FFS which of following approach will be pursued:

* Take the traffic model in ETSI TS 103 786 as the starting point.
* Define three reference packet sizes corresponding to small, medium and large packet sizes along with associated packet arrival rates .
* Extension of FTP Model 1 to enable multiple packet sizes and/or extension of FTP Model 3 to enable multiple packet sizes.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Agree on the main bullet, however all the sub-bullets require clarifications.   * ETSI TS 103 786 looks to be based on FTP model 2 structure. * The second sub-bullet does not mention which model it is based on * The third sub-bullet seems overlapping with the 2nd and lacks of details   Some work on the sub-bullets and details is needed |
| ZTE | We support the traffic model with mixed packet sizes mentioned by Samsung and Ericsson, and our tdoc also proposes a similar model. Moreover, we suggest giving priority to the FTP-1 model, as it can further simplify the simulation assumptions compared to FTP-3.  The main difference between the ETSI model and the mixed packet size model lies in whether each UE transmits files of the same size. We propose using “each UE is assigned packets of a single size” as the baseline, and “each UE may receive packets of varying sizes” (i.e., the ETSI model) as an optional configuration. |
| CMCC | We are generally fine with the main sentence.  Regarding the three bullets, we think that there are somehow not orthogonal. Therefore, instead of down-selection, we suggest to discuss the following issues:   * How to model the traffic flow of mixed/variable packet size, i.e. with multiple-individual traffic flows associated with each packet size or integrated multiple packet sizes into a single traffic flow. * How to model the arrival time between two packets, i.e. uniform distribution, exponential distribution (according to Poisson process). |
| Nokia | We are fine with considering extension of the FTP-3 model to have variable file-sizes. Considering the options with where one traffic flow essentially consists of a superposition of two to three FTP-3 models, having different file-sizes and arrival rates could be a feasible approach. But, we will then need to agree on the settings, as the eFTP-3 model than starts to have two to three times more parameters as the default FTP3 model, and it is important to ensure that companies use same settings so 6G SLS results can be compared. |
| Ericsson1 | In our understanding, the proposals for this area (including any of the sub bullets) can be formulated as extensions of FTP Model 1/FTP Model 3. XR traffic models follow specialized assumption related to video (e.g., traffic is quasi-periodic) so reusing XR framework may not be suitable. Considering this, we suggest following reformulation of the proposal.   * Study extensions to FTP Model 1/FTP Model 3 to incorporate multiple packet sizes and associated time-domain behaviors   + FFS number packet sizes (e.g., 2 or 3)   + FFS: packet size and arrival rate characteristics   + FFS packet delay budget (PDB) related parameters to drop packets exceeding the budget. |
| OPPO | We support the traffic model with mixed packet size and arrival rates. In our understating, approach 2 and 3 don’t collide with each other. For example, we can apply approach 2 as extension of FTP Model 1/3. |
| DOCOMO | We are generally fine with the FL proposal. |
| Qualcomm | We support extension of FTP model for mixed packet size and packet arrival rates. **But we want to clarify whether the mixed packet size is on per-UE or per-cell basis.** Specially, for FTP model 3, is it possible that multiple packets by the same UE at different time have a different packet size? Or different packet sizes are assumed for different UEs but each UE has a single packet size. For modeling of the mixed packet sizes, we need also to define the probability for packet sizes. We prefer to add these aspects for study in the proposal. |
| Huawei | We are generally fine with the proposal, but we prefer to use FTP Model 3 as Nokia mentioned. For easily simulation, the component number that included in one traffic flow should be no more than two FTP-3 models. |
| Apple | For the point raised by CMCC, we believe the inter-arrival time can demonstrate different behaviors depending on time scale. |
| Samsung | In principle, we support to study the extension of FTP model for mixed/variable packet size and arrival rates. |

(FL2) Proposal 4.5.2-r1

Study extensions to FTP Model 1/FTP Model 3 to incorporate multiple packet sizes and associated time-domain behaviors

* FFS number packet sizes (e.g., 2 or 3)
* FFS: packet size and arrival rate characteristics
* FFS packet delay budget (PDB) related parameters to drop packets exceeding the budget.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

#### (FL4) Proposal 4.5.2-r2 - Afteroffline

Study extensions to FTP Model 1/FTP Model 3 to incorporate the following:

* Multiple packet sizes and associated time-domain behaviors (e.g., inter arrival time)
  + FFS number of packet sizes (e.g., 2 or 3).
  + FFS whether to have fixed or variable packet size and packet arrival rate for a given UE.
  + ~~FFS whether packet size(s) and arrival rate are identical or different for different UEs.~~
  + FFS applicability of multiple packet sizes to only one or both of FTP Model 1/FTP Model 3.
  + FFS packet size and arrival rate characteristics.
* Packet delay budget (PDB) related parameters
  + FFS PDB applicability to packets (e.g., one PDB parameter for only one traffic flow or different PDB parameters for different traffic flows).
  + FFS how to consider the PDB, e.g., whether to drop packets when exceeding the budget, PDB aware metric.
* Note consider the following for PDB:
  + Applicability to the extension to FTP Model 1/ FTP Model 3 with one packet size.
  + Applicability or not to the extension to FTP Model 1/ FTP Model 3 with multiple packet sizes.

***Any strong concerns****, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Interdigital | We do not have concerns on the proposal and are supportive of the proposal.  However, we would like to ask to add an FFS under 1st bullet.   * Multiple packet sizes and associated time-domain behaviors (e.g., inter arrival time)   + FFS number packet sizes (e.g., 2 or 3)   + FFS: Whether the packets size for a given UE is the same or different.   + FFS: whether packet size(s) and arrival rate are identical or different for different UEs   + FFS: applicability of multiple packet sizes to only one or both of FTP Model 1/FTP Model 3   + FFS: packet size and arrival rate characteristics   The main motivation for the FSS, is due to the fact that TCP/IP traffic is congestion controlled, meaning the rate is adapted to the link quality. This may mean the offered traffic load for UEs with good channel conditions and could potentially sustain higher peak datarate will be different for UEs with bad channel conditions (e.g. coverage limited). We believe this aspect to should studied together. |

## New model 5-bidirectional traffic

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *In our view, with the above models and enhancements to model variable packet arrival rates, packet sizes, and time-domain behaviors, the general impact of bidirectional traffic flows is already taken into account. To avoid further complicating the system-level simulators and simulation result comparison,* ***we suggest that the impact of*** ***bidirectional traffic flows being incorporated into enhanced FTP-3/XR models as much as possible****, rather than* ***introducing new/additional approaches for this purpose****. In any case, bidirectional traffic flows can be further discussed if justified.* |
| *Nokia* | *Observation 6: Closed-loop (bi-directional) traffic model* ***facilitates realistic studies of RAN recovery loops*** *at different layers such as HARQ, RLC, PDCP and inter-play with TCP CUBIC, where the dependency between the DL and UL is explicitly modelled.*  *Proposal 16: RAN1 to* ***add at least one closed-loop (bi-directional) traffic model into the 6GR study****, e.g.,* ***can be based on the existing XR model with TCP ACK feedback****.* |
| *CMCC* | *Proposal 6: For traffic model on bidirectional traffic flow,* ***RAN1 first discuss and clarify how to embed such procedure within the existing traffic model*** *(e.g. how to consider the latency on RAN MAC/RRC/core network layer/etc., and how to model the impact on ACK/NAK for TCP layer).* |
| *ZTE* | *Proposal 4-2-5: Whether to model the TCP slow start mechanism in traffic models still* ***requires sufficient justification****.* |
| *Huawei* | *Proposal 12: The* ***transport layer traffic should not be modelled*** *before 3GPP well studied the up-to-date transport layer models.* |
| *Apple* | *-* ***Be prudent in making assumptions regarding high layer protocols****, and assess evaluation complexity carefully.*  *- DL and UL traffic is separately evaluated.* |
| *DOCOMO* | *Proposal 3*   * *New/additional approaches that can reflect the impact of bidirectional traffic flows on performance metrics (e.g., impact of UL TCP ACK latency on DL throughput/latency) should be deprioritized.* |
| *Ericsson* | *Proposal 4-2*   * *6G system simulation methodology should include realistic modelling of bidirectional traffic flows by considering impact of TCP slow start and TCP ACK latency on throughput.* * *In DL system simulations the UL TCP ACK delay can be modeled by combining the two components below*   + *Component 1: Fixed delay (e.g., 5-10ms) to reflect Core/transport/internet network delays*   + *Component 2: SR+ UL grant+UL transmission delay.*      - *Suitable values can be chosen based on HARQ RTT, SR availability and TTI length for the corresponding evaluation*     - *Ideal transmission of UL TCP ACK can be assumed instead of explicitly simulating UL.* |

### Discussions

*What’s the bidirectional traffic to be considered:*

The bidirectional traffic discussed the last meeting was mainly talking about the TCP protocol from transport layer and its impact on the wireless network performance. The TCP protocol has a slow start mechanism and is used to prevent network congestion.

Specifically, as explained in a couple of companies’ contributions *(ZTE, Ericsson)* as well, when the TCP connection starts, the congestion window (cwnd) is set to a small initial value, typically measured in units of maximum segment size (MSS). For each ACK received, the congestion window increases by one MSS, which implies cwnd size increases exponentially. During the slow start process, the performance is latency limited. Only when the cwnd size stabilizes can the UE's data rate reach its maximum. This means that a packet transported using TCP consists of a sequence of data chunks, where the separation between packets is determined by the latency of the acknowledgment in the opposite link direction.

Since DL throughput depends on packet size divided by the total transmission time, the DL throughput will be affected by the UL latency. With the high data rates to be supported, the intervals between data chunks will be comparable to the time it takes to transmit the bits. This is the motivation from the proponent to consider the bidirectional traffic flow impact on wireless network performance.

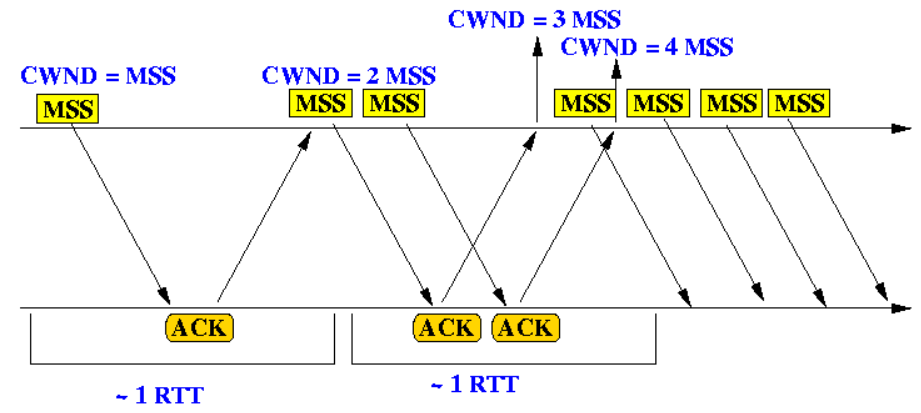


Illustration of slow start mechanism of TCP protocol

*Companies’ view on* ***whether*** *to consider this bidirectional traffic flow impact:*

- Most companies *(Futurewei, CMCC, ZTE, Huawei, Apple, DOCOMO)* view that it should be well justified or clarified first and be **prudent** in assuming a higher layer protocol to be considered for evaluating wireless network performance.

- Specific concerns mentioned in companies’ contributions:

* Transport layer protocol is out of 3GPP and has been evolving as well in another standard origination. For instance, as mentioned that the TCP protocol nowadays allows a larger initial congestion window size, which can mitigate significantly the performance bottleneck caused by latency-limited slow start phases. *(ZTE, Huawei)*
* It is unclear and should be clarified how to consider the latency on RAN MAC/RRC/core network layer/etc., and how to model the impact on ACK/NAK for TCP layer. *(CMCC)*

*Companies’ view on* ***how*** *to consider this bidirectional traffic flow impact:*

- A couple of companies (Futurewei, Nokia) mentioned it can be based on the existing XR model or FTP-3 with modification, if the necessity is well justified.

- The proponent (Ericsson) also considered the implementation complexity and suggested a simplified approach. Also mentioned that the DL system simulations with the TCP modelling methodology has been discussed/considered for LTE Rel-14 latency reduction evaluations (see Table A2-1 of TR 36.881). In the simulations, the delay caused due to TCP ACKs (i.e., for the TCP segments in the other direction) can be reflected without explicitly modelling the TCP ACK transmissions. This approach was used by several companies in previous evaluations (see Annex B of TR 36.881for some example contributions).

With proponent’s concretely simplified approach suggested, RAN1 can discuss whether this approach can be agreeable.

- The delay due to TCP ACKs can be modeled as Component 1: Core/transport/internet network delay which could be a fixed number (e.g., 5-10ms) and Component 2: SR+ UL grant+UL transmission delay. Suitable values for Component 2 can be chosen based on HARQ RTT, SR availability and TTI length for the corresponding evaluation (ideal TCP ACK transmission can be assumed instead of explicitly simulating the ACKs).

(FL1) Question

Whether to define a bidirectional traffic flow modelling with simplified modelling as follows:

* *In DL system simulations the UL TCP ACK delay can be modeled by combining the two components below*
  + *Component 1: Fixed delay (e.g., 5-10ms) to reflect Core/transport/internet network delays*
  + *Component 2: SR+ UL grant+UL transmission delay.* 
    - *Suitable values can be chosen based on HARQ RTT, SR availability and TTI length for the corresponding evaluation*
    - *Ideal transmission of UL TCP ACK can be assumed instead of explicitly simulating UL.*

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Before discussing how to model this, it is better to fully justify whether this issue has a significant impact on system performance. For example, the existing protocols already support a relatively large congestion window. |
| CMCC | We are generally fine with component 2.  For component 1, we are not sure whether a fixed delay with 5-10ms is proper. Normally, the delay within core network and/or internet is much larger than the delay in access network. It is recommended to have some further discussion on this. |
| vivo | From the perspective of capacity and energy efficiency evaluation, bidirectional traffic can better reflect actual condition than unidirectional traffic. Good performance in one direction does not necessarily mean the system is functioning optimally. Therefore, it is essential to support the evaluation of bidirectional traffic in certain use cases, where UE and NW sides need to be considered jointly.  If companies have doubts about the first component, at least the second component should be taken into account in the future simulation. |
| Samsung | The justification to have the proposed simplified modelling is not clear to us for now. |
| DOCOMO | We can accept simplified modeling as in Ericsson proposal. |
| Google | We should be prudent in making assumptions regarding higher layer protocols. The impact of evolving transport layer protocols is complex, and we should focus on Layer 1/2 aspects within RAN1 scope |
| Qualcomm | It is not clear to us whether the component 2 value is fixed or dynamic during the evaluation. If it is dynamic, how is the value decided.. |
| Huawei | Agree with ZTE proposals. We should justify this issue firstly when the existing protocols already support a relatively large congestion window. |
| Nokia1 | We support having a case defined where the core network (CN) delay is fixed to a certain value (e.g. 10 ms), including effects of TCP flow-control and potential other retransmission mechanisms such as RLC AM, and of course HARQ. We further furthermore assume that RAN processing times (e.g. for HARQ, Scheduling) are explicitly modelled in SLS, including aspects such that ACK/NACKs in UL are sent only during slots with UL transmissions, as well as the same for CSI reports, SRS, TCP ACK, RLC Status Report.  In this respect, we think that term Simplified should be removed at this stage, and other options than just a single value at Stage 2 can be considred. |
| Apple | We have concerns on the proposal. TCP is not the only relevant transport layer protocol. |

## Other traffic model

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Ericsson* | *Proposal 4-3*   * *Based on RAN#109 agreement to support massive communication in 6G, include traffic model(s) suitable for massive communications for 6G evaluations.* * *Include the following massive communication (IoT) traffic types for 6G evaluations:*   + *Triggered/polled reporting*   + *Autonomous reporting (event-driven or periodic)*   + *Remote actuation*   + *Firmware/software update*   + *FFS the values for traffic characteristics (e.g., packet size, inter-arrival time, number of users, mobility pattern) considering 6G massive communication use cases* |

### Discussions

One company *(Ericsson)* proposed a new traffic model is needed for IOT traffic types.

*What traffic models were used in the past*

- In TR 37.910 (“Study on self-evaluation towards IMT-2020 submission”), mMTC uses a traffic model with layer 2 PDU (Protocol Data Unit) message size of 32 bytes and 1 message/day/device or 1 message/2 hours/device, where the packet arrival follows Poisson arrival process for non-full buffer system-level simulation.

- In TR 36.888 (“Machine-Type Communications (MTC) User Equipments (UEs) based on LTE”), the following traffic types have been considered for mMTC (Annex A and Annex A.1):

* Triggered reporting (command-response traffic)
* Autonomous reporting (exception/event-driven reports or periodic reports)

- In TR 45.820 (“Cellular system support for ultra-low complexity and low throughput Internet of Things”), the following traffic types have been considered (Annex E.2):

* Autonomous reporting (exception reports or periodic reports)
* Network command
* Software update

*Why a new model is needed?*

- Although the traffic types described in the above TRs may still be relevant for 6G massive communication, the traffic characteristics (e.g., packet size, inter-arrival time) may not be representative of what is expected for 6G massive communication or what has been observed in real deployments of legacy massive IoT solutions.

*What the new aspect needs to be considered for the new traffic model for IOT*

The following traffic models can be considered as representative of the applications expected for 6G massive communications for evaluation purposes:

* Network triggered/polled reporting
  + Application layer in the network triggering an UL application payload from the device, e.g., for sensor reading.
* Device autonomous reporting (event-driven or periodic)
  + Event-driven: An UL application payload triggered by an event in the device delivered (within a certain latency target) and a DL application ACK, e.g., for outage notifications from sensors.
  + Periodic: Periodic UL reporting from a device and a DL application ACK, e.g., for regular sensor reading.
* Remote actuation
  + An application server generates an application layer command to the device to perform an action (in the physical world) with an UL application ACK received (within a certain latency target), e.g., for disconnecting devices or triggering an emergency shutoff.
* Firmware/software update
  + All 6G massive communication devices are expected to require occasional firmware and/or software updates (e.g., every few months). Although updates are expected rather occasionally, file sizes are expected to be relatively large (e.g., for new version release) and certain updates (e.g., security patches) may need to be delivered to selected UE groups withing a certain update campaign timeframe (e.g. within a few days or weeks). Based on the above discussion, we have the following proposals.

(FL1) Question

Whether need to study a new traffic model for 6GR IoT performance evaluation, considering the following factors:

* *Triggered/polled reporting*
* *Autonomous reporting (event-driven or periodic)*
* *Remote actuation*
* *Firmware/software update*
* *FFS the values for traffic characteristics (e.g., packet size, inter-arrival time, number of users, mobility pattern) considering 6G massive communication use cases*

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | The different processes above clearly exhibit distinct traffic characteristics. We suggest describing them using either an extended FTP model (for random arrivals) or an XR model (for periodic arrivals). The discussion may only need to focus on the specific value of model parameters. |
| Ericsson1 | Since RAN#109 decided to support Massive Communication (IoT) for FR1, corresponding traffic models should be considered. We think the factors in the list (triggered/polled reporting, event-driven or periodic autonomous reporting, remote actuation, and firmware/software update) cover the most important aspects. |

# Link budget

## General consideration for 6GR coverage

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *Proposal 12: Evaluate coverage for 6GR upper mid-band in* ***at least around 7 GHz based on existing 5G mid-band site grid, based on link budget analysis.***   * *At least maximum path loss (MPL) is used as a metric for coverage performance.* |
| *Nokia* | *Proposal 18: RAN1 needs to agree first on the default system-level evaluation parameters in various deployment scenarios before starting link-budget evaluation.*  *Observation 7: Link budget calculation can be initially based on modified Shannon Bound (MSB) but should be refined based on the results of LLS and SLS. Besides PUSCH and PDSCH the link budgets would need to account for PDCCH and PUCCH, PRACH, CQI and ACK/NACK formats for different UE form factors and other multiple propagation factors.*  *Proposal 19:* ***Link budget evaluations should consider not only data channels but also PDCCH, PUCCH, PRACH****.*  *Proposal 20: For the data channels (PDSCH, PUSCH), the link budget evaluation should provide supported data rate for a given gNB-UE distance as one of the metrics.* |
| *CMCC* | *Proposal 7:* ***Compared with 5G, similar or better coverage performance can be considered for 6G design****.*  *Proposal 8: Both urban macro and rural scenarios can be considered for coverage performance evaluation. And urban macro scenario has higher priority.*  *Proposal 9：Both requirements of wideband traffic with high data rate and VoIP, LPWA traffic should be considered for the coverage performance evaluations.*  *Proposal 10: 7GHz can be considered as main operation frequency for the coverage evaluations.*  *Proposal 11: Both uplink and downlink channels in the idle mode and connected mode should be considered for the coverage evaluations.* |
| *CATT* | *Proposal 12: Separate LLS simulation assumptions should be adopted for MBB UE and IoT devices respectively, and at least data rate, number of UE Rx chains and system bandwidth should be studied.*  *Proposal 13: gNB antenna gain from RF chains in LLS to actual TxRUs can be reflected in link budget template similar as NR.* |
| *Apple* | *Deployment scenarios*  *- Site sharing for 7 GHz and 4GHz/(2.6 GHz?)*  *- Target data rates for eMBB performance evaluation for FR3*  *- Urban scenario: DL 10Mbps, UL 1Mbps*  *- Rural scenario (?): DL 1Mbps, UL 100kbps*  *- LPWA (10dB extension compared with eMBB)*  *Evaluated channels*  *- PUSCH for eMBB (same or different UL/DL pattern with NR), PUSCH for VoIP, PUCCH, SSB, PDCCH (broadcast and unicast), PDSCH for eMBB*  *- Random access channels (Msg1 to Msg5, PUCCH with HARQ-ACK for Msg.4 )* |
| *Qualcomm* | *Proposal 4: Study how 7GHz co-site deployment with 4GHz can be effectively supported.*  *This may involve modeling of channel estimation error in system-level simulations.* |
| *DOCOMO* | *Proposal 1*  *• Support to evaluate 5%-tile UPT for evaluation of coverage, in addition to link budget.* |

### Discussions

One of the study objectives is to target the comparable coverage to 5G mid-band for reusing 5G mid-band (~3.5GHz) site grid for 6G deployments in at least around 7 GHz. Moreover, 6GR physical layer structure study will evaluate coverage compared to 5G NR.

Last RAN1 and plenary meetings discussed coverage aspect and it was clarified that the coverage target is to be decided by the RAN plenary meeting.

For this RAN1 meeting, companies discussed some points such as

- The different requirements of data rate regarding different traffic types, e.g., wideband traffic, LPWA traffic, or for different scenarios, e.g., Uma or Rural, should be considered;

- Coverage analysis should consider data channel and other channels, e.g., control channels, PRACH;

- Coverage analysis should consider both uplink and downlink channels;

- Diverse device types should be considered;

- The concerned scenarios and carrier frequency for coverage evaluations, i.e., Uma and rural, 7GHz carrier frequency

- 5%-tile UPT should also be evaluated for coverage in addition to link budget.

As RAN plenary decided to make the decision for the coverage target, it seems premature for RAN1 WG to move further step than discussing the evaluation methodology first. Whether further aspects need to be discussed in this agenda can be TBD.

(FL1) Moderator’s suggestion:

Evaluation methodology for coverage analysis can be discussed first. Whether further aspects need to be discussed in this agenda can be TBD.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | We think it is acceptable to first use a link budget approach for coverage evaluation, for example, to identify potential coverage bottlenecks. However, for key issues such as the coverage comparison between 3.5 GHz and 7 GHz, the final conclusion should still rely on link-level or system-level simulations. |
| CMCC | In this agenda, evaluation methodology can be link budget. For detailed coverage performance comparison, simulation can be considered in dedicated agendas. |
| DOCOMO | We are fine with the FL suggestion. |
| Huawei | We are ok with FL suggestion |
| Ericsson2 | The context for “Evaluation methodology for coverage analysis” should be clarified.  Following was agreed in RAN#109 and the methodology for link budget to set the RAN requirement for coverage target has to be discussed.  **Proposal 4: For 3GPP internal study, link budget is used as the evaluation methodology for coverage when applicable**  **Proposal 5: For 3GPP internal study, the target for coverage is to be determined by RAN.**  **- FFS: Exact coverage target value(s).**  **- FFS: Additional details considering control/data channel**  RAN1 may also later perform additional coverage evaluations when designing different physical channels and signals and the methodology for such potential evaluations would be another separate discussion. They may need link/system level simulations or link budget analysis and the decision can be made later on a case by case basis.  In our view, the methodology for link budget to set the RAN requirement for coverage target should be the focus of discussion in this meeting. |

## Metric for 6GR coverage analysis

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Futurewei* | *Proposal 12: Evaluate coverage for 6GR upper midband in at least around 7 GHz based on existing 5G mid-band site grid, based on link budget analysis.*   * ***At least maximum path loss (MPL)*** *is used as a metric for coverage performance.* |
| *CMCC* | *Proposal 13:*  *It is proposed that* ***considering the pathloss, penetration loss and shadow fading in total as propagation loss for the coverage performance metric****.*  *Proposal 14:*  ***MCL with modification based on Rel-16 definition can be considered as the coverage performance metric****.*  *Proposal 15:*  *The definition of MCL is proposed,*  ***Definition of MCL:***  ***- MCL = Total transmit power – Receiver sensitivity + gNB antenna gain (considering all elements in one polarization).*** |
| *ZTE* | *Proposal 3-1:* ***Adopt MCL as the standardized link budget metric*** *for 6GR evaluation as 5G NR.* |
| *Huawei* | *Proposal 13: Table 11 (Link budget template in TR38.830) as the starting point is used for 6G Link budget template,* ***where the MPL should be used as the basic performance metric for coverage analysis****.* |
| *Apple* | *-* ***Coverage bottleneck channel(s) identification is performed using MIL or MCL or MPL*** |
| *Ericsson* | *Proposal 5*   * ***MCL as defined by Table 7.10.1-1 of TR 38.913 is used by RAN1 to quantify the RAN coverage targets for 6G****.* * *Methodologies for evaluating the coverage of each physical channel/signal are further discussed.* |

### Discussions

The evaluation methodology for coverage analysis, based on Rel-17 coverage enhancement study report in TR 38.380, includes the performance metrics and link budget template.

It was documented in TR 38.830 that for LLS based methodology, coverage bottleneck(s) identification is performed using at least MIL or MCL (assuming the set of simulation assumptions). Even when SLS is used to obtain some components of MIL or MCL, it is categorized as LLS based methodology. MCL values can also be used to identify the coverage bottleneck(s). MPL can be used as supplemental information for coverage bottleneck(s) identification.

The correlations among MCL, MIL, and MPL are

- MCL = Total transmit power – Receiver sensitivity + gNB antenna gain (component 2).

- MIL = Total transmit power – Receiver sensitivity – Tx loss – Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain.

- MPL = MIL – Shadow fading margin + BS selection/macro-diversity gain – Penetration margin + Other gains.

The gNB antenna gain with components 2, 3, and 4 are defined in TR 38.830:

|  |
| --- |
| *For link level simulation, two options for TDL channel model are considered:*  *- TDL channel model option 1: 2 or 4 gNB RF chains in LLS*  *- TDL channel model option 2 (optional): number of gNB RF chains in LLS = number of TXRUs*  *For TDL channel model option 1, the complexity of link level simulation can be simplified, while the practical gNB architecture can be reflected in TDL channel model option 2.*  *Figure 4.1-1 and Figure 4.1-2 depict gNB antenna gain modelling for TDL channel model option 1, and TDL channel model option 2 and CDL channel model respectively. M is the number of antenna elements, N is the number of TXRUs, k is the number of RF chains considered in LLS. For TDL channel model option 1, gNB antenna gains include 4 components, i.e., antenna gain component 1/2/3/4. For TDL channel model option 2 and CDL channel model, gNB antenna gains include 3 components, i.e., antenna gain component 1/3/4. The antenna gain component 1 is included in LLS, while the antenna gain component 2/3/4 are included in link budget template.*    Figure 4.1-1: gNB antenna gain modelling for TDL channel model option 1    Figure 4.1-2: gNB antenna gain modelling for TDL channel model option 2 and CDL channel model |

**However, it was noted by companies in contributions that**

- Cons of MCL: MCL does not consider some important factors that should be considered for a more realistic coverage footprint identification for 6GR and comparison between 5G NR coverage and 6GR coverage when co-site deployed, though it is simpler and straightforward.

- Cons of MPL: The shadow fading and the penetration loss vary in different deployment scenarios. It is not fair that RAN1 or RAN assume a fixed shadow fading and penetration loss and only provide the pathloss for the deployments.

- **Challenging for MIL/MPL**: when determining MIL and MPL, a value of antenna array gain must be determined, and this depends on a wide variety of factors, such as the tilt in a fixed antenna system, the beamwidth in an adaptive antenna system for a particular physical channel, and the angle spread of the channel relative to the beamwidth. These effects were discussed at length in the Rel-17 NR coverage enhancement item, which concluded with companies proposing widely different values for effective beamforming gain.

- MCL counts gNB antenna gain (component 2) should be updated to contain all the component 2+3+4.

**Suggestions from companies:**

- If companies are interested in the MIL/MPL, they can further study based on their appropriate hardware implementation assumption, on the top of 3GPP outcome of MCL evaluation.

- MIL and MPL are suited to specific tasks. MIL may be motivated where antenna gains differ among physical channels and may provide insight on ‘bottleneck’ channels that result from these differences. MPL can be used as a rough check of supported cell size.

- It is most important to first have a simple link budget approach like the MCL calculation above that can be consistently used across companies for discussions on coverage targets (e.g., in RAN). More detailed methodologies for evaluating the coverage of each physical channel/signal, including any additional link budget metrics can be considered later according to the feature being designed. To be clear, link budget metrics like MCL/MIL/MPL etc. will not on their own accurately determine the physical size of a cell. The evaluation methodology should reflect basic link design aspects like power, modulation, coding, diversity, etc. which are used by most or all 6G services.

(FL1) Proposal 5.2.2

To target the comparable coverage to 5G mid-band for reusing 5G mid-band (~3.5GHz) site grid for 6G deployments in at least around 7 GHz, the performance metrics of MCL/MIL/MPL could be used with definitions referring to TR38.830:

* MCL can be used for carrier frequency independent coverage comparison.
* MIL can be used for comparing different channels where antenna gains differ among physical channels
* MPL can be used as for the supported cell size (i.e., ISD) conversion.
* FFS: For MCL definition, whether the gNB antenna gain comprising component 2 should be updated to include components 2+3+4.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | We think using MCL for a preliminary evaluation is sufficient, because MPL involves too many parameters, making it difficult for different companies to align, and the final evaluation results would be useless. For a more detailed coverage evaluation, system-level or link-level simulations can be used. |
| CMCC3 | In general, we support to the main sentence in FL’s proposal to begin to discuss the performance metric based on the definition from TR38.830. It should clarify the definition of MCL, MPL and MIL first. Then we can discuss how to use those performance matric to make any decision. Since the situation and the targets may be slightly different between Rel-17 CE and the overall coverage enhancements in 6GR, the definition of MCL/MIL/MPL can be further discussed and updated.  As discussed in our paper, 3.5GHz/2.6GHz and around 7GHz NW would adopt different number of antenna elements. 2.6GHz BS is using 192 elements. And in the last RAN plenary meeting, it was concluded that   * Around 7 GHz: Up to 2304 Tx and Rx antenna elements   Since different frequency bands will assume different antenna elements, our thinking is to take it into account in the definition of MCL. |
| DOCOMO | We are generally fine with the FL proposal. |
| Huawei | MCL defined in TR 38.830 should not be used here for the following reasons   * MCL is only a subset of MIL. It is much less accurate than MIL in coverage analysis because UE antenna gains, Tx loss and Rx loss are ignored and BS antenna gains are not fully included. * Since Rel-17 coverage enhancement, MCL is abandoned and MIL is used to identify bottle neck channels for coverage analysis. * Among additional parameters compared to MCL,   + Parameters Tx loss and Rx loss of MIL were stable in Rel-16 self-evaluation and Rel-17 Coverage and RedCap SI’s, whose sum values are 4 dB (e.g. refers to column 8 and column 12 in the linkbudge template of TR 37.910 and simply cannot be ignored.   + The additional parameters to have the full BS antenna gains are necessary for better coverage accuracy and have been discussed anyway in this evaluation agenda.   MIL can be also used for the case with the same antenna gains among different channels. It is not good enough to compare coverages at different frequency bands  MPL should be prioritized for the coverage evaluation of co-site deployments between two frequency bands, e.g. 3.5 GHz and 7GHz because it is the only coverage metric to evaluate whether the same ISD can be achieved between two bands.  Suggested revisions to FL proposal: (FL1) Proposal 5.2.2-rev To target the comparable coverage to 5G mid-band for reusing 5G mid-band (~3.5GHz) site grid for 6G deployments in at least around 7 GHz, the performance metrics of ~~MCL/MIL/~~MPL could be used with definitions referring to TR38.830:   * ~~MCL can be used for carrier frequency independent coverage comparison.~~ * ~~MIL can be used for comparing different channels where antenna gains differ among physical channels~~   MPL can be used for comparing different channels at the same frequency band and used as for the supported cell size (i.e., ISD) conversion. |
| Ericsson2 | For the link budget, below calculation of MCL (from Table 7.10.1-1 of TR 38.913) should be used at this stage. This framework enables a consistent methodology to be used across companies for discussions on coverage targets.    With other link budget approaches (such as those used in TR 38.830 that rely on antenna gains) it is difficult to produce consistent results across companies, especially when adaptive antenna systems are used (based on experience from Rel-17 NR Cov Enh and later WI/SIs). Antenna gains depend on a wide variety of factors, such as the tilts, beamwidth to assume for a particular physical channel (e.g., dedicated vs. common channels) and can depend on UE position in the cell, and the angle spread of the channel relative to the beamwidth. Considering all these aspects, it is better to avoid incorporating antenna assumptions into the link budget methodology at this stage of discussions where coverage requirements are being set in RAN. Antenna assumptions would of course be part of link/system level simulations or later link budget analysis involved with designing different physical channels/signals. |

#### (FL4) Proposal 5.2.2 - Afteroffline

To target the comparable coverage to 5G mid-band for reusing 5G mid-band (~3.5GHz) site grid for 6G deployments in at least around 7 GHz, the performance metrics of MCL/MIL/MPL could be considered for 6GR coverage analysis with definitions referring to TR38.830:

* MCL can be used for carrier frequency independent coverage comparison.
* MIL can be used for comparing different channels where antenna gains differ among physical channels
* MPL can be used as for the supported cell size (i.e., ISD) conversion.
* FFS: For MCL definition, whether the gNB antenna gain comprising component 2 should be updated to include components 2+3+4.
* FFS which one is used for coverage target setting.

***Any strong concerns****, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | Following was agreed in Wednesday 11.1 online session and the methodology to set the RAN requirement for coverage target should be discussed first (other more elaborate coverage evaluation assumptions can be later considered).    As we commented earlier, for the link budget, below calculation of MCL (from Table 7.10.1-1 of TR 38.913) should be used at this stage (i.e., for RAN requirements discussion). This framework enables a consistent methodology to be used across companies for discussions on coverage targets.    With other link budget approaches (such as those used in TR 38.830 that rely on antenna gains) it is difficult to produce consistent results across companies, especially when adaptive antenna systems are used (based on experience from Rel-17 NR Cov Enh and later WI/SIs). Antenna gains depend on a wide variety of factors, such as the tilts, beamwidth to assume for a particular physical channel (e.g., dedicated vs. common channels) and can depend on UE position in the cell, and the angle spread of the channel relative to the beamwidth. Considering all these aspects, it is better to avoid incorporating antenna assumptions into the link budget methodology at this stage of discussions where coverage requirements are being set in RAN. Antenna assumptions would of course be part of link/system level simulations or later link budget analysis involved with designing different physical channels/signals. |

## Link budget template for 6GR

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *CMCC* | *Proposal 12: Link level simulation can be carried out to evaluate the SINR requirements for the specific channel and traffic. Link budget template from Rel-16 CE and IMT-2020 self-evaluations can be considered as a starting point.*  *Proposal 16:*  ***The link budget template from TR 38.830 (as in section A.3)*** *is proposed as a starting point for the coverage evaluations.* |
| *ZTE* | *Proposal 3-2:* ***Adopt method in TR 38.830 as the starting point*** *for link budget analysis in 6GR evaluation.*   * *When determining target SINR values, advanced hardware capabilities and algorithmic improvements should be taken into consideration.* |
| *Huawei* | *Proposal 13:* ***Table 11 (Link budget template in TR38.830) as the starting point*** *is used for 6G Link budget template, where the MPL should be used as the basic performance metric for coverage analysis.* |
| *CATT* | *Proposal 11:* ***Link budget template in TR38.830*** *can be a starting point for 6G coverage evaluation.*  *Proposal 14: Penetration margin in the link budget template can be separately determined for O2I scenarios at around 4GHz and around 7GHz based on the latest O2I penetration model in TR 38.901.* |
| *OPPO* | *Proposal 5****: Link budget template and performance metrics from Rel-17 NR coverage enhancement in TR 38.830*** *can be used as a starting point.* |
| *Apple* | *The basic evaluation methodology is based on link-level simulation*  *- Obtain the required SINR for the physical channels under target scenarios and service/reliability requirements*  *- Obtain the baseline performance based on required SINR and the link budget template* |

### Discussions

With reference of TR38.830, companies all suggested the link budget template from this TR can be used as a starting point.

#### (FL4) Proposal 5.3.2

Reusing the link budget template from TR38.830 (with the deletion highlighted) for 6GR coverage evaluation, i.e., the following table with notes as follows:

* The values of the parameters are TBD.
* The row (22bis) of MCL may be updated based on the performance metric discussion.

|  |  |
| --- | --- |
| System configuration | |
| Channel for evaluation |  |
| Scenarios and Carrier frequency (GHz) |  |
| BS antenna heights (m) |  |
| UT antenna heights (m) |  |
| Cell area reliability (%) |  |
| Lognormal shadow fading std deviation (dB) |  |
| Tx Diversity |  |
| Number of SSB |  |
| Transmitter | |
| (1) Number of transmit antenna elements |  |
| (2) Number of transmit TxRUsNote: this row is void (left empty) for uplink |  |
| (2a) Number of transmit chains modelled in LLS |  |
| (3) Total transmit power (dBm) Note: total transmit power for system bandwidth |  |
| (3a) System bandwidth for downlink, or occupied bandwidth for uplink (Hz) |  |
| (3b) Power Spectrum Density = (3) - 10 log( (3a) / 1000000 ) (dBm/MHz)  ~~Note: For FR1 downlink, (3b) should satisfy the following:   For 4GHz frequency, 24 and 33  For 2.6 GHz frequency, 33  For 700MH and 2GHz frequency, 36 Note: For FR2 downlink, the following should be satisfied:  40 dBm for 100 MHz Urban scenario,  23 dBm for 100 MHz Indoor scenario.~~ Note: no PSD constraint for uplink |  |
| (3c) Bandwidth used for the evaluated channel (Hz) Note: (3c) is identical to the number of PRBs assigned to the channel evaluated. For uplink, (3a) = (3c) |  |
| (3bis) Total transmit power for occupied bandwidth = (3b) + 10 log ((3c) /1000000) (dBm) |  |
| (4) Total antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4a) – (4b) (dB) |  |
| (4a) Antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4c) + 10 log ((1) / (2)) (dB) for downlink, and = (4c) + 10 log ((1) / (2a)) (dB) for uplink |  |
| (4b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of transmitter (dB) |  |
| (4c) Gain of antenna element (dBi) |  |
| (5) Total antenna gain at antenna gain component 2 of transmitter = (5a) - (5b) (dB) Note: zero for uplink |  |
| (5a) Antenna gain at antenna gain component 2 of transmitter = 10 log((2)/(2a)) (dB) Note: zero for uplink |  |
| (5b) Antenna gain correction factor at antenna gain component 2 of transmitter (dB) Note: zero for uplink |  |
| (8) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for downlink) |  |
| (9) EIRP = (3bis) + (4) + (5) – (8) dBm |  |
| Receiver | |
| (10) Number of receive antenna elements |  |
| (10a) Number of receive TxRUs Note: this row is void (empty) for downlink |  |
| (10b) Number of receive chains modelled in LLS |  |
| (11) Total antenna gain at antenna gain component 3 & antenna gain component 4 of receiver = (11a) - (11b) (dB) |  |
| (11a) Antenna gain at antenna gain component 3 & antenna gain component 4 of receiver  = (11c) + 10 log ((10)/(10a)) (dB) for uplink  = (11c) + 10 log ((10)/(10b)) (dB) for downlink |  |
| (11b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of receiver (dB) |  |
| (11c) Gain of antenna element (dBi) |  |
| (11bis) Total antenna gain at antenna gain component 2 of receiver = (11bis-a) - (11bis-b) (dB) Note: zero for downlink |  |
| (11bis-a) Antenna gain at antenna gain component 2 of receiver = 10 log((10a)/(10b)) (dB) Note: zero for downlink |  |
| (11bis-b) Antenna gain correction factor at antenna gain component 2 of receiver (dB) Note: zero for downlink |  |
| (12) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for uplink) |  |
| (13) Receiver noise figure (dB) |  |
| (14) Thermal noise density (dBm/Hz) |  |
| (15) Receiver interference density (dBm/Hz) |  |
| (16) Total noise plus interference density = 10 log (10^(( (13) + (14))/10) + 10^((15)/10)) (dBm/Hz) |  |
| (18) Effective noise power = (16) + 10 log ((3c)) (dBm) |  |
| (19) Required SNR (dB) |  |
| (20) Receiver implementation margin (dB) |  |
| (21) H-ARQ gain (dB) Note: Only applicable if HARQ is not considered in LLS |  |
| (22) Receiver sensitivity = (18) + (19) + (20) – (21) (dBm) |  |
| (22bis) MCL = (3bis) – (22) + (5) + (11bis) (dB) |  |
| (23) Hardware link budget, a.k.a. MIL = (9) + (11) + (11bis) − (12) − (22) (dB) Note: MIL can also be derived by (22bis) + (4) – (8) + (11) − (12) |  |
| Calculation of available pathloss | |
| (25) Shadow fading margin (function of the cell area reliability and lognormal shadow fading std deviation) (dB) |  |
| (26) BS selection/macro-diversity gain (dB) |  |
| (27) Penetration margin (dB) |  |
| (28) Other gains (dB) (if any please specify) |  |
| (29) Available path loss = (23) – (25) + (26) – (27) + (28) (dB) |  |
| Range/coverage efficiency calculation | |
| (30) Maximum range (based on (29) and according to the system configuration section of the link budget) (m) |  |

***Any strong concerns****, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | Following was agreed in Wednesday 11.1 online session and the methodology to set the RAN requirement for coverage target should discussed first (other more elaborate coverage evaluation assumptions can be later considered).    For such discussions, the template below (from Table 7.10.1-1 of TR 38.913) is sufficient. Other more complex templates such as in FL proposal can be discussed later for other coverage evaluations (that may also include link/system level simulations). |

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | It is too early to finalize the template at this stage. We should first clarify the evaluation metrics for the link budget. If MCL is to be used, the parameters in the current template, such as (25) and (26), would no longer be needed. |
| CMCC | General fine with the proposal. The table can be used as starting point for further refinement. |
| DOCOMO | We support the proposal. |
| Sharp | We are OK with the FL proposal. |
| Huawei | We are ok for FL proposal, because the link budget table in TR38.830 is comprehensive to any metric |
| Ericsson2 | For purpose of current discussions below template (from Table 7.10.1-1 of TR 38.913) is sufficient in our view. Other more complex templates such as in FL proposal can be discussed for evaluations (that may also include link/system level simulations). |

# Additional assumptions for NTN

## Carrier frequency for NTN

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Nokia* | *Proposal 8: Frequency band assumptions for 6GR system evaluations should be based on existing FR1-NTN and FR2-NTN. That is, FDD operation, and 2 GHz for FR1-NTN and 20 GHz (DL) and 30 GHz (UL) for FR2-NTN.* |
| *vivo* | *Around 2 GHz (S band)*  *Around 12/14 GHz (Ku band)*  *Around 20/30 GHz (Ka band)* |
| *xiaomi* | *S-band / Ka-band* |
| *ZTE* | *Around 1.5 or 2 GHz for both DL and UL*  *Around 20 GHz for DL Around 30 GHz for UL*  *Around 10 GHz for both DL and UL* |
| *Huawei* | *S/L band: Around 2 GHz for both DL and UL*  *Ka-band: Around 20 GHz for DL Around 30 GHz for UL* |
| *CATT* | *S-band (i.e. 2 GHz)*  *Ka-band (i.e. 30 GHz for UL, 20GHz for DL)* |
| *LGE* | *Proposal 5: For NTN evaluation assumption, following frequency ranges are considered as the starting points:*   * *Around 1.5 GHz* * *Around 2 GHz* * *Around 4 GHz* * *Around 11 GHz + Around 13 GHz* * *Around 20 GHz + Around 30 GHz* * *Around 40 GHz + Around 50 GHz*   *FFS: Satellite parameters for system level evaluation for each frequency range.* |
| *ETRI* | *S-band (2GHz)*  *Ka-band (20GHz for DL, 30GHz for UL)* |
| *ESA, Thales, Viasat, Eutelsat* | *L-, S-, C-, Ku-, Ka-, and Q/V bands* |
| *MediaTek* | *Ku-band (i.e. [12-14] GHz), S-band (i.e. 2 GHz)* |
| *Sharp* | *Ka/Ku* |
| *CSCN* | *S-band (i.e. 2 GHz)*  *Ka-band (i.e. 30 GHz for UL, 20GHz for DL)* |

### Discussions

*Background for this discussion*

- When discussing the common assumptions (i.e., antenna modelling and general system-level simulation assumptions) in the last meeting, it was clarified in the end that last meeting and the subsequent post-122 email discussion started with TN. The reason was that many assumptions rely on the carrier frequency, e.g., antenna modelling and bandwidth, etc., and the carrier frequency for TN has been decided from the RAN plenary meeting. Assumptions to NTN were pending and subject to plenary meeting decision on the carrier frequency first.

- During post-122 email discussion, some companies expressed the concerns of pending NTN assumptions and suggested starting the discussion as soon as possible. It was clarified then that RAN1 could start the discussion on the carrier frequency from RAN1#122bis based on companies’ inputs.

*Situations for this RAN1#122bis meeting on the carrier frequency*

- 12 companies discussed the evaluation assumptions for 6GR NTN, including carrier frequency/band and/or the associated system-level/link-level assumptions.

- The 12 companies all mentioned the carrier frequency for NTN can be considered includes S-band (i.e., 2GHz) and Ka-band (*i.e. 30 GHz for UL, 20GHz for DL*).

- 5 contributions *(vivo, LGE, ESA (with co-sourced), MediaTek, Sharp)* mentioned Ku-band (i.e. [12-14] GHz)

- A co-sourced *(by ESA, Thales, Viasat, Eutelsat)* contribution mentioned other bands as well, i.e., L-band, C-band

- 2 contributions *(ESA (with co-sourced), LGE)* mentioned Q/V bands.

*Plan for this meeting*

- Discussing/agreeing on the carrier frequency that could be used for 6GR NTN evaluations.

- Discussing/ agreeing on the assumption template for NTN, including the template on antenna modelling and general system-level simulations as what has done for TN.

- Post-122bis email discussion on collecting assumptions for NTN based on the templates can also be considered as what has don’t for NTN.

**Round-1 discussions**

(FL1) Proposal 6.1.2

At least the following carrier frequencies could be considered (from RAN1 perspective) for 6GR NTN evaluations:

* S-band (i.e. 2 GHz)
* Ka-band (i.e. 30 GHz for UL, 20GHz for DL)

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CMCC | Fine with the proposal |
| vivo | Based on RAN4 big CR[R4-2510831] as mentioned in our contribution, Ku band has been agreed to be included as NTN band. Thus, Ku band should be also supported for 6GR NTN evaluations. |
| MTK | We propose to add Ku-band into consideration:  *At least the following carrier frequencies could be considered (from RAN1 perspective) for 6GR NTN evaluations:*   * *S-band (i.e. 2 GHz)* * *Ku-band (i.e., TBD GHz)* * *Ka-band (i.e. 30 GHz for UL, 20GHz for DL)* |
| Ericsson1 | In our view, 6GR NTN should use as baseline frequency bands L-/S-/Ku-/Ka, which are specified as NTN bands (1.5, 2, 10-15 and 17-20/27-30 GHz). |
| CSCN | Considering the potential commertial application, we think C-band should also be added into the consideration:  *At least the following carrier frequencies could be considered (from RAN1 perspective) for 6GR NTN evaluations:*   * *S-band (i.e. 2 GHz)* * *C-band (i.e., around 4 GHz)* * *Ka-band (i.e. 30 GHz for UL, 20GHz for DL)* |
| Viasat | Our view is that we need to include the L-band and Ku-band frequencies as well. There are operational systems in those frequencies. |
| DOCOMO | We support the proposal. These carrier frequencies are aligned with TR 38.821 and are appropriate as a baseline. |
| Sharp | We think Ku-band should be also added to the template. Ku-band has been developed from Rel-19 and will be extended in Rel-20 WI under 5G-advanced. Therefore, Ku-band should also be important in 6G. |
| Huawei | Agree the proposal, the existing 5G NR NTN band defined in 3GPP RAN4 should be the baseline carrier frequency for 6GR NTN. |
| Nokia1 | Support FL proposal – we may be open to also consider Ku band as suggested by MTK. |

**Round-2 discussions:**

The most of comments seems to agree to have L/Ku band. The proposal is updated to include them for Round-2 discussions. However, the exact carrier frequency for Ku-band is unclear to me. If to agree on this proposal, it’ll be better to have a concrete number for Ku-band.

#### (FL4) Proposal 6.1.2-r1

At least the following carrier frequencies could be considered (from RAN1 perspective) for 6GR NTN evaluations:

* L-band (i.e., 1.5GHz)
* S-band (i.e. 2 GHz)
* Ku-band (i.e., [12-14] GHz)
* Ka-band (i.e. 30 GHz for UL, 20GHz for DL)

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | We are okay with FL Proposal 6.1.2-r1. |
| ESA | We are fine with the new proposal. Small correction: Ku-band (i.e., 10-14 GHz) |
| CATT | We are fin with ESA modification. |
| Qualcomm | We are OK. |
| CSCN | We are fine with this proposal. |
| Ericsson3 | We are ok with (FL4) Proposal 6.1.2-r. |

## Assumption template for NTN

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *CSCN* | *Along with the contribution, attached with a spreadsheet which suggested being the template for NTN.* |
| *Other 11 companies* | *Included in the contribution a table for system-level simulation assumptions.*  *The tables from different proponents have different numbers of rows or categorize the parameters from different angles/aspects.* |

### Discussions

*Plan for this meeting*

- Discussing/ agreeing on the assumption template for NTN, including the template on antenna modelling and general system-level simulations as what has done for TN.

- Post-122bis email discussion on collecting assumptions for NTN based on the templates can also be considered as what has don’t for NTN.

**Round-1 discussions**

Likewise, the templates for NTN will be provided in an attached spreadsheet.

(FL1) Proposal in Attachment3

Attached spreadsheet (labeled with ATMT3) includes

* the template for antenna modelling for 6GR NTN evaluations.
* the general system-level simulation assumption template for 6GR NTN evaluations.

*Please check the templates and share your comments/views here if any:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Xiaomi | We think the full list *NTN reference orbit scenarios for 6G* in R1-2507343 needs to be considered and a template including at least the following aspects had better be formulated as below. Note that the current SLS parameter template only encapsulates a subset of this list.  *NTN reference orbit scenarios for 6G Template*   |  |  |  | | --- | --- | --- | |  | LEO (incl. vLEO if agreed)/MEO | GEO | | Orbit type |  |  | | Altitude |  |  | | Earth-fixed beams |  |  | | Max beam footprint size (edge to edge) regardless of the elevation angle |  |  | | Min Elevation angle for both sat-gateway and User Equipment |  |  | | Max distance between satellite and User Equipment at min elevation angle |  |  | | Max Round Trip Delay |  |  | | Max Doppler shift |  |  | | Max Doppler shift variation (earth fixed user equipment) |  |  |   And these parameters had better be merged into a separate template table than in the SLS assumptions given these values have both impact to SLS and further LLS discussion. Making this a separate table makes the evaluation assumption discussion more efficient.  [Mod] Green highlighted parameters are already captured in the template.   * Beam diameter parameter is already in the template 🡪 Max beam footprint size is not needed * Minimum User Elevation Angle is already in the template 🡪 Min Elevation angle for both sat-gateway and User Equipment * Max distance between satellite and User Equipment at min elevation angle can be obtained based on minimum elevation angle * Yellow highlighted parameters may be related to link level. It is not clear how they are relevant to SLS template and/or how they relate to the parameters already defined in the template. |
| Ericsson1 | One of the initial comments we have is that in several instances the term “BS” should be replaced by “Satellite”, for example:  “BS antenna configuration” should be “Satellite antenna configuration”.  “BS Polarized antenna modelling” should be “Satellite Polarized antenna modelling”.  “BS antenna element gain” should be “Satellite antenna element gain”.  [mod] ok to replace BS with satellite  Are "BS (or Satellite) antenna element gain" and "UE antenna element gain" needed if "Satellite EIRP density" and "UE EIRP" are specified?  [mod] ok to replace BS with satellite  "Satellite EIRP density" may be enough for **evaluation purpose**. Satellite Tx max Gain and Payload Total DL power level follow the equation Aggregated Satellite EIRP (Total) (dBW) = Satellite Tx max Gain + Payload Total DL power level (dBW)  Is the parameter "noise figure" needed if "G/T" is specified?  [mod] "Payload G/T" in the template refers to UL satellite reception whereas Antenna Temperature and Noise Figure are defined for UE DL reception |
| Qualcomm | As expressed in our document, we would like to assume as baseline that the satellite payload uses antenna arrays. In this sense, the following parameters may be redundant since they can be derived based on the antenna array size & per-element gain:   * Number of simultaneously active beams (can be replaced by number of TXRUs) * Beam diameter (can be derived based on array size and precoder weights) * Satellite 3dB beamwidth: similar to beam diameter   [mod] Companies may report how to calculate the Number of simultaneously active beams (e.g. number of TXRUs), Beam Diameter and Satellite 3dB beamwidth (e.g. derived based on array size and precoder weights) using the template.  Also, we are missing a constraint on total power at the satellite (i.e., aggregated EIRP density across all beams).  [mod] Seems this parameter may correspond to Aggregated Satellite EIRP (Total) (dBW)?  We would be OK with reporting the values above (for information), but they should be derived based on antenna array assumptions and consistent.  Similarly, for the UE EIRP and G/T:   * For FR1, we would like to reuse the values for TN in “around 2GHz or 4GHz” * For FR2, if the UE is based on antenna arrays, we would like to define the number of elements / TxRU.   [mod] It is ok for companies to report values of parameters based on phased antenna arrays for UE/satellite but it should be able to allow other companies to report other antenna model assumptions. |
| Sharp | Regarding the antenna model, we are wondering if we can use form factor or the size of antennas instead of the TN-based antenna configuration. In NTN, especially in higher frequency, circular antennas may be used as well as phased array. Circular antennas are difficult to be captured in the TN-based configuration like [M,N,P,MP,NP].  [mod] It is ok for companies to report values of parameters based on antenna model assumptions other than phased antenna arrays. They just need to indicate the type of antennas and relevant configuration parameters. |
| Huawei | Agree the current NTN template can be starting point, whether or not adding more items depend on further discussion. We agree that the suggestion from Ericsson regarding the term ”BS”. The term “Satellite” can be used to replace “BS”. |
| Nokia1 | For the discussion on polarization aspects (for instance “satellite antenna polarization modelling” in Ericsson’s comment), the terminology is not too important – the essential part is how much loss will be assumed when using mixed polarization in the system (and whether the UE will have any use for this information). |

**Round-2 discussions**

**Based on the comments received in the last round, the template is updated into version v02.**

(FL2) Proposal in Attachment3\_v02

Attached spreadsheet (labeled with ATMT3) includes

* the template for antenna modelling for 6GR NTN evaluations.
* the general system-level simulation assumption template for 6GR NTN evaluations.

*Please check the templates and share your comments/views here if any:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Samsung** | We are fine with current spreadsheet (v02) in general. However, we would like to ask clear clarification of the followings:   * Region of Interest (ROI) * Satellite position update frequency * Beam-to-satellite mapping (Multi-satellite)   [mod] - Region of Interest (ROI): This parameter indicates the number of tiers corresponding to the Total number of beam footprints. - Satellite position update frequency: This parameter indicates how frequently to update the satellite position due to satellite movement - Beam-to-satellite mapping (Multi-satellite): For multiple satellites, this refers to the criterion to associate beam footprint to satellites e.g. distance-based |
| Sharp2 | We suggest moving the row for “minimum user elevation angle” from payload parameters to deployment parameters since it is applicable to both satellite and UE. Minimum user elevation angle is also an important factor to derive UE’s phased array beam gain.  [mod] ok  Could we add “Option 2 circular antennas” also in the UE assumptions.  [mod] ok will rename this option as reflector antenna for both UE and satellite to avoid confusion with circular polarization  Could we add G/T for the UE side to represent the UE side Rx gain?  [mod] Companies should be able to indicate either UE G/T or Noise Figure/Antenna Temperature to represent UE side Rx gain  Could we also add “Gain reduction at the minimum elevation angle” in the satellite parameters and in the UE parameters?  [mod] If such gain reduction can be deduced from parameters already in the Table e.g. is this the same as steering loss to be indicated under antenna element pattern for BS and UE? If so, then no need to add another parameter for this. Can you please clarify? |
| ESA | We are fine with the new version v02 (Antenna Models and Tab-2 SLS).  In the “Payload parameters”, the row “bandwidth” is too vague. Do we mean carrier bandwidth?  [mod] Yes, will rename this parameter accordingly.  We agree also with Samsung about the need of some clarifications for some reference constellation parameters.  [mod] Please check above clarifications under SS comment. |
| CATT | For antenna model, we suggest a small revision: TXRU mapping (only for phased antenna array).  [mod] ok, added “for phased antenna array”  For Tab-2 SLS, we suggest the following changes:   1. Recover the item “Cell deployment”. The cell deployment can be configured with single beam per cell or multiple beams per cell.   [mod] ok   1. Change The Cell Type (Earth fixed, Earth moving) as The Cell Type ((quasi-)Earth fixed, Earth moving)   [mod] Added Quasi-earth fixed as an option   1. For bandwidth, it can be changed as “carrier bandwidth”   [mod] ok   1. The whole tem “Reference constellation parameters ” can be put with FFS before parameter because they are totally new compared to 5G NT.   Change as “FFS For Reference constellation parameters”  [mod] Reference constellation parameters are needed for multi-satellite simulations, as discussed by some companies, so it is better to keep with added clarifications.   1. The following parameters are not clear for their usage. FFS can be put before the paremeters.  |  | | --- | | **FFS on Propagation conditions** | | **FFS on UE distribution** | | **FFS on UE orientation** |   [mod] These parameters are from 38.821. I believe it is important to capture them. Companies are free to propose similar or different values compared to 38.821. For example, UE distribution can be uniform or non-uniform, as mentioned by some companies.  In general, we think FL proposals are quite useful to speed up the discussion and convergence. If there is something controversial, we can put one bracket for further discussion. |
| Qualcomm | 1. For “Satellite antenna pattern” in “Tab 2 SLS for NTN”, isn’t this already captured in “Antenna models for NTN”?   [mod] Right, deleted “Satellite antenna pattern” from “Tab 2 SLS for NTN”   1. “Payload Total DL power level (dBW)” and “Aggregated Satellite EIRP (Total) (dBW)” seem to be redundant, any reason to specify both?.   [mod] "Satellite EIRP density" may be enough for evaluation purpose. Satellite Tx max Gain and Payload Total DL power level follow the equation Aggregated Satellite EIRP (Total) (dBW) = Satellite Tx max Gain + Payload Total DL power level (dBW).   1. The row “Payload characteristics for UL transmissions” seems to be a header and not a entry on the table (lines 21 and 22 are payload characteristics for UL transmissions”   [mod] Correct. This row has been replaced with “UL carrier frequency”   1. “Constellation size i.e. number of orbits x number of satellites per orbit” cannot define the constellation completely. We would need to define the inclination of each of the orbital planes + number of satellites per orbital plane. We would recommend to replace with “Constellation details (orbital planes, satellites per orbital plane)”   [mod] ok   1. ”Satellite position update frequency” is unclear. The satellites are orbiting the earth and therefore their position can be easily propagated given the orbital parameters.   [mod] Agree with your description. This parameter is meant to capture how often satellite positions are updated according to the orbital parameters during the course of the simulations e.g. every 1s etc  We would like to highlight once again that there is a lot of redundancy in the parameters. For instance, “Satellite Tx max gain”, “Satellite 3dB beam width”, “Total number of simultaneously active beams”, “Rx max gain”, can be derived based on the antenna parameters. We would be OK with including these, but we need to make sure that the parameters are consistent.  [mod] Agree with the above. We can try to minimize the “redundancies” or make sure all the parameters are consistent. I believe the latter approach is better from a feature lead point of view. |
| CSCN | We are fine with the antenna model and Tab-1 SLS.  Regarding the Tab-2 SLS, we suggest the following adjustments:   * Add the “Quasi-Earth fixed” under “cell type” * Recover the "Cell deployment" item. For clarity, this item can be configured as "single-beam per cell" or "multi-beam per cell". * [mod] ok |
|  |  |

(FL4) Proposal in Attachment3\_v03

Attached spreadsheet (labeled with ATMT3) includes

* the template for antenna modelling for 6GR NTN evaluations.
* the general system-level simulation assumption template for 6GR NTN evaluations.

#### (FL4) Proposal in Attachment3\_v04 - Afteroffline

V04 is the stable version afteroffline

Attached spreadsheet (labeled with ATMT3) includes

* the template for antenna modelling for 6GR NTN evaluations.
* the general system-level simulation assumption template for 6GR NTN evaluations.

*Please check the templates and share your comments/views here if any:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson3 | One of the initial comments we have is that in several instances the term “BS” should be replaced by “Satellite”, for example:  “BS antenna configuration” should be “Satellite antenna configuration”.  “BS Polarized antenna modelling” should be “Satellite Polarized antenna modelling”.  “BS antenna element gain” should be “Satellite antenna element gain”.   Are "BS (or Satellite) antenna element gain" and "UE antenna element gain" needed if "Satellite EIRP density" and "UE EIRP" are specified?  Is the parameter "noise figure" needed if  "G/T" is specified? |
| Sharp | In RAN4 Ku band WI, beam gain reduction due to the lower elevation angle was discussed, and RAN4 agreed to take the gain reduction into account for specifying the VSAT requirement (e.g., in R4-2508778).  When a wave arrives from an elevation angle 𝜃, the apparent area of the VSAT phased array in the wave’s direction of travel is reduced by cos(90-θ). Due to the reduction of the apparent area, received energy at the phased array also be reduced. For example, in an ideal situation, the gain reduction can be represented by 10\*log10(cos(90-θ)).  This gain reduction is important for evaluation (e.g., at the minimum elevation angle) like in the figure below where the distance between the satellite and VSAT is the maximum, and thus important for e.g., coverage evaluation. |

# Other common assumptions?

Last meeting clarified that the common evaluation assumptions, traffic models, and link budget will be discussed in this agenda. Other topic specific assumptions will be discussed in other individual agendas including those have opened for discussions including waveform, coding and modulation, frame structure, AI/ML, energy efficiency and those will be discussed from RAN1#124/124bis including initial access, sensing, etc.

It was also noted that additional assumptions can also be discussed in this agenda if the necessity is being identified.

Companies’ views are briefly summarized in the next subsection and the discussion is supposed to identify whether additional common evaluation assumptions will be further discussed in this agenda.

### Companies’ views

|  |  |
| --- | --- |
| **Company** | **Views/proposals** |
| *Nokia* | *Discussed and proposed that RAN1 to define the scope of Link Level Simulations (LLS), e.g., LLS covers the evaluation of the PHY features, and shall include Hybrid ARQ, Dynamic link adaptation, and presence of interference for a single UE-gNB link.*  *Also proposed the detailed LLS simulation parameters RAN1 to consider, e.g., subcarrier spacing, channel model to be used, reference signals, performance metrics.* |
| *vivo* | *Discussed evaluation methodology in details for sensing, e.g., use case, metrics, channel model, etc.* |
| *ZTE* | *Discussed sensing related use cases and scenarios.* |
| *Huawei* | *Discussed sensing related use case, evaluation methodology.* |
| *OPPO* | *Discussed evaluation methodology for energy efficiency, including power model for BS and UE.* |
| *BUPT* | *Discussed channel model on advanced mobility and micro-doppler for ISAC evaluations.* |
| *Samsung* | *Discussed specific assumptions for MIMO, e.g., sTRP/mTRP, MIMO layers, channel and interference estimation error, etc.*  *Discussed specific assumptions for sensing, e.g., sensing modes, performance metrics, interference modelling, waveform, etc.*  *Discussed RF model with nonlinearity which in particular from PA and proposed to consider a PA model (e.g., GMP) in TR38.803 and an I/Q imbalance model for the evaluation.*  *Discussed a specific interference estimation modelling and proposed to use a realistic modelling* *e.g., Wishart distribution-based model according to TR 36.829 (Note: the parameters of the model should be reported by company).* |
| *LGE* | *Discussed MIMO related assumptions, e.g., antenna ports, rank numbers, MIMO layers, etc.*  *Discussed sensing related scenarios.* |
| *NEC* | *Discussed power model for energy efficiency.*  *Discussed AI/MI modeling, considering performance, overhead, complexity and also discussed the need to enhance the power model for AI/ML.* |
| *NVIDIA* | *Discussed power consumption model and proposed to study the model based on AI-driven NW energy optimization and energy cost of running AI models.*  *Discussed channel model and proposed Ray-tracing should be considered.*  *Discussed and proposed the performance metrics for 6GR evaluations.* |
| *InterDigital* | *Proposed that inter-RAT interference modelling should be considered to evaluate the co-existence impact in MRSS scenario.*  *View that it might be useful to align some link level evaluation parameters as much as possible so a common set of link level evaluation parameters that each topic can leverage needs to be defined.*  *Proposed a set of parameters for link-level evaluations.* |
| *Lenovo* | *Discussed power consumption model that needs to allow for the upper mid band spectrum operation, large antenna array, and larger bandwidth.*  *Discussed MIMO related evaluations aspects, including larger number of antennas for both base station and UEs and other related optimization.*  *Discussed and proposed the evaluation assumption for sensing related including use case, waveform, performance metrics.* |
| *ETRI* | *Proposed to study cost-efficient network architectures leveraging NCR and/or RIS technologies from the early stage of 6GR.*  *Discussed link-level evaluation assumptions for both TN and NTN.* |
| *Sony* | *Discussed power consumption models for BS and UE, performance metrics for 6GR evaluations, ISAC related performance metrics, link-level simulation assumptions.* |
| *Apple* | *Discussed and proposed evaluation assumptions for initial access, ISAC related assumptions, NTN related, MIMO related.* |
| *Qualcomm* | *Discussed evaluation assumptions for modulation coding, waveform, MIMO related, initial access, sensing and positioning related.* |
| *Ericsson* | *Discussed channel model enhancement for e.g., sensing, accurate Doppler modelling for high speed scenario.*  *Discussed evaluation assumptions for support of diverse device types.*  *Discussed UE RF and PA modelling. Proposed RAN4 should be involved early in high level aspect of RF performance and makes final conclusion on relative RF performance of schemes studied by RAN1.* |
| *BOOST* | *Discussed key principles for designing energy-efficient 6G Radio (6GR) by focusing on improvements at both the device and network levels. The strategy is three-fold: leveraging existing 5G energy efficiency techniques, employing AI/ML to optimize relevant algorithms, and utilizing Multi-Radio Signaling and Sharing (MRSS) to allow 6G and 5G to share signals and channels where they coexist. Ultimately, these principles guide 6GR development toward reducing overall power consumption while sustaining high performance and diverse service capabilities.* |

### Discussions

Except those have been clarified in the last meeting agreement, nothing else that can be decided that should be discussed in this agenda at this meeting per moderator’s assessment.

(FL1) Moderator’s suggestion

Continue discussing the issues as agreed to be discussed in this agenda first. TBD on any other issues that needs to be discussed in this agenda.

*Any comments/suggestions, please leave them here:*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | We suggest adding evaluations that include assisting nodes, as described in Section 2.1.5 of our tdoc, since both simulation and field measurements have shown their benefits in improving coverage and enhancing network energy efficiency. For example, the existing high-speed train scenario in TR 38.914 already includes assisting nodes. |
|  |  |

# Proposals for offline/online

## Proposals for online on Wednesday

(FL2) Proposal 4.1.2-r1

The following existing traffic models could be used for 6GR performance evaluations, e.g.,

* Full buffer
* FTP Model 1 (in TR 36.814)
* FTP Model 2 (in TR 36.814)
* FTP Model 3 (in TR 36.872)
* XR Traffic models (in TR 38.838)
* VoIP model (as in TR 36.814)
* Instant message (as in TR 38.840)
* Note that which model(s) will be used can be further decided when performing simulations in each individual topic.

(FL2) Proposal 4.2.2-r2

For the study in RAN1 on traffic model(s) for 6GR AI/ML services:

* + A representative AI/ML service is the generative AI, e.g., Image based GenAI app, Video based GenAI app, or Chatbot as defined in TR22.870.

RAN1 is discussing the following options for the model:

* + Option-1a: The model is parameterized by at least Token size, Token arrival rate, ~~[Token success rate]~~, and Token delay budget.
    - Token is the minimum unit of data generated in the application layer.
    - How to associate Tokens to PHY layer packets.
    - Values for these parameters in RAN1 evaluation.
    - How to reflect the variable importance of tokens.
    - Whether other parameters are additionally needed when tokens are encapsulated together into a packet, e.g., packet arrival rate, packet success rate, and packet delay.
  + Option-1b: The model is characterized by the parameters of PHY layer packet, including e.g., packet size, arrival rates, latency requirement, reliability requirement, etc.
  + Option-1c, e.g., reusing or extending the FTP-3/XR traffic model.
  + FFS other models/options need to be defined for other AI/ML services.

Send LS to SA2/SA4 (cc RAN2) requesting input if any on traffic characteristics for AI/ML services, RAN1 can continue the study before SA2/SA4 potential response.

(FL2) Proposal 4.3.2-r2

Study traffic modelling for evaluations related to immersive communication services including but not limited to XR and haptics services,

* XR traffic models (in TR 38.838) are considered as starting point.
  + FFS the detailed modifications on the parameters to the XR traffic model
* FFS how many models need to be defined and the corresponding representative use cases.
* FFS how to incorporate haptics traffic (TR26.854).

Send LS to SA4 requesting input regarding the model parameters, e.g., the distribution of the packet size, packet arrival rate, and packet delay budget, RAN1 can continue the study before SA4 potential response.

(FL2) Proposal 4.5.2-r2

Study extensions to FTP Model 1/FTP Model 3 to incorporate the following:

* Multiple packet sizes and associated time-domain behaviors (e.g., inter arrival time)
  + FFS number packet sizes (e.g., 2 or 3)
  + FFS: Whether the packets size for a given UE is the same or different.
  + FFS: applicability of multiple packet sizes to only one or both of FTP Model 1/FTP Model 3
  + FFS: packet size and arrival rate characteristics
* Packet delay budget (PDB) related parameters
  + FFS PDB applicability to packets (e.g., one PDB parameter for only one traffic flow or different PDB parameters for different traffic flows)
  + FFS how to consider the PDB, e.g., whether to drop packets exceeding the budget, PDB aware metric
* Note consider the following for PDB:
  + Applicability to the extension to FTP Model 1/3 with one packet size
  + Applicability or not to the extension to FTP Model 1/3 with multiple packet sizes.

## Proposals for offline on Thursday

|  |
| --- |
| *Here is the brief summary of the discussion situation for this meeting:*   * *Current agreement reached:*   + *Antenna modelling for 700MHz and 2GHz carrier frequency.*   + *Traffic model for AI/ML services* * *Two offline was used for traffic model discussion only*   + *Two more traffic models were discussed offline but not treated online yet.* * *Other issues not discussed yet in either offline or online*   + *Antenna modelling for other frequency*   + *Any SLS assumptions*   + *Link budget*   + *Carrier frequency and evaluation assumption template for NTN*   + *Comeback for the LS out.* |

Based on the latest schedule, **we have 150 mins offline on Thursday afternoon**, here is the rough plan for all the [FL4] proposals:

* Link budget (~20mins)
* Quick check on the two remaining traffic models (~20 mins)
* Antenna modelling for TN for 4/7/15/30GHz (~50mins)
* SLS assumptions for TN, including carrier frequency & bandwidth, and transmission power (~40mins)
* Carrier frequency and evaluation assumption template for NTN (~20mins)

## Proposals for online on Friday

#### (FL4) Proposals 4.3.2-r3 – Afteroffline (stable)

Study traffic modelling for evaluations related to immersive communication services including but not limited to advanced XR [TR22.870, section 9] and haptics services,

* XR traffic models (in TR 38.838) are considered as starting point.
  + FFS the detailed modifications on the parameters to the XR traffic model, e.g., higher packet size, higher packet arrival rate, higher packet size deviation, PDB, etc.
* FFS how many models need to be defined and the corresponding representative use cases.
* FFS how to incorporate haptics traffic (TR26.854).

Send LS to SA4 requesting input if any on the relevant traffic characteristics, RAN1 can continue the study before SA4 potential response.

#### (FL4) Proposal 4.5.2-r2 – Afteroffline (stable)

Study extensions to FTP Model 1/FTP Model 3 to incorporate the following:

* Multiple packet sizes and associated time-domain behaviors (e.g., inter arrival time)
  + FFS number of packet sizes (e.g., 2 or 3).
  + FFS whether to have fixed or variable packet size and packet arrival rate for a given UE.
  + ~~FFS whether packet size(s) and arrival rate are identical or different for different UEs.~~
  + FFS applicability of multiple packet sizes to only one or both of FTP Model 1/FTP Model 3.
  + FFS packet size and arrival rate characteristics.
* Packet delay budget (PDB) related parameters
  + FFS PDB applicability to packets (e.g., one PDB parameter for only one traffic flow or different PDB parameters for different traffic flows).
  + FFS how to consider the PDB, e.g., whether to drop packets when exceeding the budget, PDB aware metric.
* Note consider the following for PDB:
  + Applicability to the extension to FTP Model 1/ FTP Model 3 with one packet size.
  + Applicability or not to the extension to FTP Model 1/ FTP Model 3 with multiple packet sizes.

#### (FL4) Proposal for NTN template (Attachment3\_v04) - Afteroffline (stable)

*The template for NTN evaluation assumptions (labeled with ATMT3) in V04 is the stable version after offline.*

**Proposal:**

Template for 6GR NTN evaluation assumptions is as attached including

* the template for antenna modelling.
* the template for the general system-level simulation assumption.

#### (FL4) Proposal for BS atenna modelling for 4/7/15/30GHz – Afteroffline (unstable)

**For around 4GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 32 | 32 | (4, 4, 2, 1, 1; 4, 4) | (0.5, 0.5)λ |
| Combination 2 | 128 | 32 | (8, 8, 2, 1, 1; 2, 8) | (0.5, 0.5)λ |
| ~~Combination 3 (optional)~~ | ~~256~~ | ~~64~~ | ~~(16, 8, 2, 1, 1;4, 8)~~ | ~~(0.5, 0.5)λ~~ |
| **Outdoor** | | | | |
| Combination 1 (optional) | 192 | 64 | (12, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Combination 2 (baseline) | 256 | 64 | (16, 8, 2, 1, 1; 4, 8) | (0.5, 0.8)λ |
| Combination 3 (optional) | 512 | 128 | (16, 16, 2, 1, 1; 4, 16) | (0.5, 0.5)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 7GHz carrier frequency:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 64 | 32 | (4, 8, 2, 1, 1; 2, 8) | (0.5, 0.5)λ |
| Combination 2 | 256 | 64 | (16, 8, 2, 1, 1; 4, 8) | (0.5, 0.5)λ |
| Combination 3 | 512 | 128 | (32, 8, 2, 1, 1; 8, 8) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 768 | 128 | (24, 16, 2, 1, 1; 4, 16) | (0.5, 0.8)λ |
| Combination 2 | 1024 | 256 | (32, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 3 | 1536 | 256 | (48, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 4 | 2048 | 256 | (32, 32, 2, 1, 1, 8, 16) | (0.5, 0.5)λ |
| Combination 5 | 2048 | 512 | (64, 16, 2, 1, 1; 16, 16) | (0.5, 0.5)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 15GHz carrier frequency: (Not reached in offline)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 128 | 32 | (8, 8, 2, 1, 1; 2, 8) | (0.5, 0.5)λ |
| Combination 2 | 256 | 256 | (8, 16, 2, 1, 1; 8, 16) | (0.5, 0.5)λ |
| Combination 3 | 512 | 256 | (16, 16, 2, 1, 1; 8, 16) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 1536 | 256 | (48, 16, 2, 1, 1; 8, 16) | (0.5, 0.8)λ |
| Combination 2 | 2048 | 512 | (64, 16, 2, 1, 1; 16, 16) | (0.5, 0.8)λ |
| Note1: A single TXRU is mapped per panel per subarray per polarization as mandatory option. Companies can provide results optionally, assuming fully connected TXRU mapping within a panel per polarization.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

**For around 30GHz carrier frequency: (Not reached in offline)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BS antenna modelling** | Total number of antenna elements | Total number of TXRU | (M, N, P, Mg, Ng; Mp, Np) | (dH,dV) |
| **Indoor** | | | | |
| Combination 1 | 128 | 8 | (8, 8, 2, 1, 1; 2, 2) | (0.5, 0.5)λ |
| Combination 2 | 512 | 8 | (8, 8, 2, 2, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 3 | 1024 | 8 | (16, 8, 2, 2, 2; 1, 1) | (0.5, 0.5)λ |
| **Outdoor** | | | | |
| Combination 1 | 1024 | 8 | (16, 8, 2, 2, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 2 | 2048 | 16 | (16, 8, 2, 4, 2; 1, 1) | (0.5, 0.5)λ |
| Combination 3 | 4096 | 64 | (16, 8, 2, 4, 2; 2, 2) | (0.5, 0.5)λ |
| Note1: A single TXRU is mapped per panel per polarization as mandatory option. Companies can provide results optionally, assuming a single TXRU is mapped per panel per subarray per polarization as mandatory option.  Note2: Other combinations used in the simulation results are up to company to report. | | | | |

#### (FL4) Proposal 3.1.1-1 on carrier frequency and bandwidth – Afteroffline (stable?)

**The following configurations for system-level simulations could be used for 6GR evaluation:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Indoor Hotspot** | **Dense Urban** | **Rural** | **Urban Macro** | **Sub-urban macro** |
| Carrier frequency | Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz | Around 700 MHz  Around 2 GHz  Around 4 GHz  Around 7 GHz  Around 15 GHz  Around 30 GHz |
| Aggregated BW | Follow system bandwidth per carrier frequency in TR 38.914 as 1) Around 700 MHz: Up to 60 MHz 2) Around 2GHz: Up to 200 MHz 3) Around 4GHz: Up to 300 MHz  4) Around 7GHz: Up to 400MHz 5) Around 15GHz: Up to 400MHz  6) Around 30GHz: Up to 1GHz | | | | |
| Simulation BW | Around 700 MHz: 20MHz, 60MHz | | | | |
| Around 2 GHz: 20MHz, 100MHz, 200MHz | | | | |
| Around 4 GHz: 20MHz, 100MHz, 200MHz, 300MHz | | | | |
| Around 7 GHz: 20MHz, 100MHz, 200MHz, 400MHz | | | | |
| Around 15 GHz: 20MHz, 100MHz, 200MHz, 400MHz | | | | |
| Around 30GHz: 100MHz, 400MHz, 800MHz | | | | |
| Note: other simulation BW could be considered. | | | | |
| **Note: The layout for each scenario will be separately discussed, including the carrier frequency combination for single layer and/or two layers.** | | | | | |

#### (FL4) Proposal 3.1.1-2 on BS Tx power – Afteroffline (unstable)

**The following total transmit power per BS for system-level simulations can be used for 6GR evaluation:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Indoor Hotspot** | **Dense Urban** | **Rural** | **Urban Macro** | **Sub-urban macro** |
| **Around 700MHz** | **NA** | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 2GHz** | 24 dBm per 20 MHz | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 4GHz** | 24 dBm per 20 MHz | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 7GHz** | 24 dBm per 20 MHz | Macro BS: 44 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz | Macro BS: 49 dBm per 20 MHz  Micro BS: 33 dBm per 20 MHz | 49 dBm per 20 MHz |
| **Around 15GHz** | BS transmit power is 23 dBm per 20 MHz, EIRP not exceed 58dBm | Macro BS: BS transmit power is 40 dBm per 20 MHz, EIRP not exceed 73dBm  Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm |  | Macro BS: BS transmit power is 43 dBm per 20 MHz, EIRP not exceed 78dBm  Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm | BS transmit power is 43 dBm per 20 MHz, EIRP not exceed 78dBm |
| **Around 30GHz** | BS transmit power is 23 dBm per 100 MHz, EIRP not exceed 58dBm | Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm |  | Micro BS: 33 dBm per 20 MHz, EIRP not exceed 68dBm |  |
| **Note:** BS Tx power scales up with bandwidth proportionally.  **Note**: The maximum BS Tx power for each scanrio will be defined. FFS values. | | | | | |

#### FL4) Proposal 5.2.2 – Afteroffline (Unstable)

To target the comparable coverage to 5G mid-band for reusing 5G mid-band (~3.5GHz) site grid for 6G deployments in at least around 7 GHz, the performance metrics of MCL/MIL/MPL could be considered for 6GR coverage analysis with definitions referring to TR38.830:

* MCL can be used for carrier frequency independent coverage comparison.
* MIL can be used for comparing different channels where antenna gains differ among physical channels
* MPL can be used as for the supported cell size (i.e., ISD) conversion.
* FFS: For MCL definition, whether the gNB antenna gain comprising component 2 should be updated to include components 2+3+4.
* FFS which one is used for coverage target setting.

#### (FL4) Proposal 5.3.2 – Not discussed in offline

Reusing the link budget template from TR38.830 (with the deletion highlighted) for 6GR coverage evaluation, i.e., the following table with notes as follows:

* The values of the parameters are TBD.
* The row (22bis) of MCL may be updated based on the performance metric discussion.

|  |  |
| --- | --- |
| System configuration | |
| Channel for evaluation |  |
| Scenarios and Carrier frequency (GHz) |  |
| BS antenna heights (m) |  |
| UT antenna heights (m) |  |
| Cell area reliability (%) |  |
| Lognormal shadow fading std deviation (dB) |  |
| Tx Diversity |  |
| Number of SSB |  |
| Transmitter | |
| (1) Number of transmit antenna elements |  |
| (2) Number of transmit TxRUsNote: this row is void (left empty) for uplink |  |
| (2a) Number of transmit chains modelled in LLS |  |
| (3) Total transmit power (dBm) Note: total transmit power for system bandwidth |  |
| (3a) System bandwidth for downlink, or occupied bandwidth for uplink (Hz) |  |
| (3b) Power Spectrum Density = (3) - 10 log( (3a) / 1000000 ) (dBm/MHz)  ~~Note: For FR1 downlink, (3b) should satisfy the following:   For 4GHz frequency, 24 and 33  For 2.6 GHz frequency, 33  For 700MH and 2GHz frequency, 36 Note: For FR2 downlink, the following should be satisfied:  40 dBm for 100 MHz Urban scenario,  23 dBm for 100 MHz Indoor scenario.~~ Note: no PSD constraint for uplink |  |
| (3c) Bandwidth used for the evaluated channel (Hz) Note: (3c) is identical to the number of PRBs assigned to the channel evaluated. For uplink, (3a) = (3c) |  |
| (3bis) Total transmit power for occupied bandwidth = (3b) + 10 log ((3c) /1000000) (dBm) |  |
| (4) Total antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4a) – (4b) (dB) |  |
| (4a) Antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4c) + 10 log ((1) / (2)) (dB) for downlink, and = (4c) + 10 log ((1) / (2a)) (dB) for uplink |  |
| (4b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of transmitter (dB) |  |
| (4c) Gain of antenna element (dBi) |  |
| (5) Total antenna gain at antenna gain component 2 of transmitter = (5a) - (5b) (dB) Note: zero for uplink |  |
| (5a) Antenna gain at antenna gain component 2 of transmitter = 10 log((2)/(2a)) (dB) Note: zero for uplink |  |
| (5b) Antenna gain correction factor at antenna gain component 2 of transmitter (dB) Note: zero for uplink |  |
| (8) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for downlink) |  |
| (9) EIRP = (3bis) + (4) + (5) – (8) dBm |  |
| Receiver | |
| (10) Number of receive antenna elements |  |
| (10a) Number of receive TxRUs Note: this row is void (empty) for downlink |  |
| (10b) Number of receive chains modelled in LLS |  |
| (11) Total antenna gain at antenna gain component 3 & antenna gain component 4 of receiver = (11a) - (11b) (dB) |  |
| (11a) Antenna gain at antenna gain component 3 & antenna gain component 4 of receiver  = (11c) + 10 log ((10)/(10a)) (dB) for uplink  = (11c) + 10 log ((10)/(10b)) (dB) for downlink |  |
| (11b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of receiver (dB) |  |
| (11c) Gain of antenna element (dBi) |  |
| (11bis) Total antenna gain at antenna gain component 2 of receiver = (11bis-a) - (11bis-b) (dB) Note: zero for downlink |  |
| (11bis-a) Antenna gain at antenna gain component 2 of receiver = 10 log((10a)/(10b)) (dB) Note: zero for downlink |  |
| (11bis-b) Antenna gain correction factor at antenna gain component 2 of receiver (dB) Note: zero for downlink |  |
| (12) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for uplink) |  |
| (13) Receiver noise figure (dB) |  |
| (14) Thermal noise density (dBm/Hz) |  |
| (15) Receiver interference density (dBm/Hz) |  |
| (16) Total noise plus interference density = 10 log (10^(( (13) + (14))/10) + 10^((15)/10)) (dBm/Hz) |  |
| (18) Effective noise power = (16) + 10 log ((3c)) (dBm) |  |
| (19) Required SNR (dB) |  |
| (20) Receiver implementation margin (dB) |  |
| (21) H-ARQ gain (dB) Note: Only applicable if HARQ is not considered in LLS |  |
| (22) Receiver sensitivity = (18) + (19) + (20) – (21) (dBm) |  |
| (22bis) MCL = (3bis) – (22) + (5) + (11bis) (dB) |  |
| (23) Hardware link budget, a.k.a. MIL = (9) + (11) + (11bis) − (12) − (22) (dB) Note: MIL can also be derived by (22bis) + (4) – (8) + (11) − (12) |  |
| Calculation of available pathloss | |
| (25) Shadow fading margin (function of the cell area reliability and lognormal shadow fading std deviation) (dB) |  |
| (26) BS selection/macro-diversity gain (dB) |  |
| (27) Penetration margin (dB) |  |
| (28) Other gains (dB) (if any please specify) |  |
| (29) Available path loss = (23) – (25) + (26) – (27) + (28) (dB) |  |
| Range/coverage efficiency calculation | |
| (30) Maximum range (based on (29) and according to the system configuration section of the link budget) (m) |  |

#### (FL4) Proposal 6.1.2-r1 – Not discussed in offline

At least the following carrier frequencies could be considered (from RAN1 perspective) for 6GR NTN evaluations:

* L-band (i.e., 1.5GHz)
* S-band (i.e. 2 GHz)
* Ku-band (i.e., [12-14] GHz)
* Ka-band (i.e. 30 GHz for UL, 20GHz for DL)

# References

1. R1-2507292 Post-122 email discussion on 6GR common evaluation assumptions Moderator (Huawei)
2. R1-2506739 Evaluation assumptions for 6GR air interface FUTUREWEI
3. R1-2506751 On Evaluation Assumptions for Study of 6G Radio Air Interface Nokia
4. R1-2506814 Discussion on evaluation assumption for 6GR Spreadtrum, UNISOC
5. R1-2506898 Evaluation methodology and assumptions for 6GR air interface vivo
6. R1-2506989 Discussion on evaluation assumptions for 6GR air interface Xiaomi
7. R1-2507014 Discussion on evaluation assumptions for 6GR air interface CMCC
8. R1-2507022 Evaluation assumptions for 6GR Tejas Network Limited (Withdrawn)
9. R1-2507042 Discussion on evaluation assumptions for 6GR air interface ZTE Corporation, Sanechips
10. R1-2507058 Evaluation assumptions for 6GR air interface Huawei, HiSilicon
11. R1-2507105 On evaluation assumptions for 6GR air interface CATT
12. R1-2507176 Evaluation assumption for 6GR air interface OPPO
13. R1-2507215 Considerations on channel modeling and evaluation assumptions for 6GR air interface BUPT, CMCC, vivo, X-Net
14. R1-2507253 Evaluation assumptions for 6GR Samsung
15. R1-2507361 Discussion on evaluation assumptions for 6GR air interface LG Electronics
16. R1-2507411 Discussion on 6G Evaluation Requirements NEC
17. R1-2507434 Evaluation assumptions for 6GR air interface NVIDIA
18. R1-2507467 Discussion on Evaluation assumptions for 6GR air interface Ofinno
19. R1-2507479 Evaluation assumptions for 6GR air interface InterDigital, Inc.
20. R1-2507481 Evaluation assumptions for 6GR air interface Lenovo
21. R1-2507506 Discussion on evaluation assumptions for 6GR air interface ETRI
22. R1-2507571 Satellite Access Node Characteristics for the Evaluation Assumptions for 6GR air interface ESA, Thales, Viasat
23. R1-2507596 Evaluation assumptions for 6GR air interface Sony
24. R1-2507607 Evaluation assumptions for 6GR air interface MediaTek Inc.
25. R1-2507635 On Evaluation Assumptions for the 6GR air interface Google
26. R1-2507677 Evaluation assumptions for 6GR air interface Apple
27. R1-2507721 Evaluation assumptions for 6GR air interface Qualcomm Incorporated
28. R1-2507731 Views on evaluation assumptions for 6GR Intel
29. R1-2507746 Evaluation Assumptions for 6GR Air Interface AT&T
30. R1-2507766 Evaluation assumptions for 6GR air interface for NTN Ka/Ku band Sharp
31. R1-2507815 Discussion on Evaluation assumptions for 6GR air interface NTT DOCOMO, INC.
32. R1-2507825 Evaluation assumptions for 6GR Ericsson AB.
33. R1-2507853 Views on evaluation assumptions for 6GR air interface CSCN
34. R1-2507895 Evaluation assumptions for 6GR Tejas Network Limited
35. R1-2507939 BOOST Mobile Network Boost Mobile Network

# Appendix – Existing traffic models

* **FTP Model 1, FTP Model 2, and VOIP (in TR 36.814)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *A.2.1.3 Traffic models*  *Traffic models for system performance evaluations are given in Table A.2.1.3-1. System throughput studies shall be assessed using full-buffer traffic model capturing continuous traffic and non-varying interference. Additionally, evaluations with time-varying interference shall be carried out using bursty traffic models. Table A.2.1.3-1 proposes FTP traffic models to exercise system performance studies in bursty traffic.*  ***Table A.2.1.3-1. Traffic Models***   |  |  | | --- | --- | | ***Traffic Models*** | ***Model Applies to*** | | *Full buffer* | *DL and UL.  Continuous traffic.* | | *Non-full buffer*  *FTP models* | *DL and UL.  Bursty traffic.* | | *VoIP* | *DL and UL Real time services* |   *A.2.1.3.1 FTP traffic models*  *Two FTP traffic models are considered as non-full buffer traffic models. Tables A.2.1.3-2 and A.2.1.3-3 show the parameters for FTP traffic model 1 and model 2, respectively. Figure A.2.1.3.1-1 and A.2.1.3.1-2 illustrate the user arrival of traffic model 1 and 2, respectively. Baseline model is Model 1 with file size of 2 Mbytes, however Model 1 with file size of 0.5 Mbytes and Model 2 with file size of 0.5 Mbytes can be also evaluated.*  ***Table A.2.1.3.1-1. FTP Traffic Model 1***   |  |  | | --- | --- | | ***Parameter*** | ***Statistical Characterization*** | | *File size, S* | *2 Mbytes (0.5 Mbytes optional)*  *(one user downloads a single file)* | | *User arrival rate λ* | *Poisson distributed with arrival rate λ* |   *- Small file size of 0.5 Mbytes can be chosen to speed-up the simulation.*  *- Simulations are run for various λ to find performance metrics covering at least the range of HM-NCT (See A.2.1.3.2) that leads to [10%, 50%] of RU (See A.2.1.3.2) in non-CoMP SU-MIMO.*  *- Possible range of λ: [0.5, 1, 1.5, 2, 2.5] for 0.5 Mbytes, [0.12, 0.25, 0.37, 0.5, 0.625] for 2 Mbytes (See A.2.1.3.4 for more details). Range of λ can further be adjusted.*  *- The same traffic should be simulated for CoMP and non-CoMP schemes. The above range of λ will cover RU from 10% to 50% for non-CoMP SU-MIMO*    ***Figure A.2.1.3.1-1: Traffic generation of FTP Model 1***  ***Table A.2.1.3.1-2. FTP Traffic Model 2***   |  |  | | --- | --- | | ***Parameter*** | ***Statistical Characterization*** | | *File Size, S* | *0.5 Mbytes* | | *Reading Time, D* | *Exponential Distribution, Mean= 5 seconds*  *PDF:  λ = 0.2* | | *Number of users, K* | *Fixed* |   *- Simulations are run for various K to find performance metrics covering at least the range of HM-NCT that leads to [10%, 50%] of RU in non-CoMP SU-MIMO.*  *- Possible range of K: [2, 5, 8, 10, 14] (See A.2.1.3.4 for more details). Range of K can further be adjusted.*  *- The reading time D is the time interval between end of download of previous file and the user request for the next file.*  *- The same traffic should be simulated for evaluating CoMP and non-CoMP schemes. The above range of K will cover RU from 10% to 50% for non-CoMP SU-MIMO.*    ***Figure A.2.1.3.1-2: Traffic generation of FTP Model 2*** |

* **FTP Model 3 (in TR 36.872)**

|  |
| --- |
| *FTP Model 3: based on FTP model 2 with the exception that packets for the same UE arrive according to a Poisson process and the transmission time of a packet is counted from the time instance it arrives in the queue  0.5Mbytes file size. The offered traffic is generated per macro cell geographical area when FTP model 1 is used.* |

* **XR Traffic models (in TR 38.838)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *5 Traffic models*  *In this clause, we provide the DL and UL traffic models for VR, CG, and AR applications. Since DL/UL traffic models for these applications share similar characteristics, we first define a generic and parameterized DL / UL traffic model, which could be later used in defining VR, CG, AR applications.*  *The traffic model defined in this clause is statistical traffic model, where packet size and packet arrival process are characterized by certain random variables. The described model is based on the input XR traffic study from SA4 [7][3][4].*  *5.1 Generic DL traffic model*  *5.1.1 Single stream DL traffic model*  *This clause provides a parameterized generic single stream DL traffic model. In this model, as shown in Figure 5.1-1, the XR DL traffic is modelled as a sequence of video frames arriving at gNB according to the considered video frame rates and random jitter. The size of each frame is also random according to a certain distribution.*    ***Figure 5.1.1-1: Single stream DL traffic model***  *5.1.1.1 Packet Size*  *In this model, a packet models the set of IP packets belong to the same video frame. The video frame includes both left and right eye frame sharing the same buffer, which is referred to as 'single stream for dual eye buffer' or 'single eye buffer' throughout this document.*  *The size of a packet is determined by the given data rates and frame rates, which is modelled as a random variable following truncated Gaussian distribution with following statistical parameters.*  ***Table 5.1.1.1-1: Statistical parameters for packet size following truncated Gaussian distribution***   |  |  |  |  | | --- | --- | --- | --- | | ***Parameter*** | ***unit*** | ***Baseline values for evaluation*** | ***Optional values for evaluation for single eye buffer*** | | *Mean: M* | *byte* | *R×1e6 / F / 8* | *R×1e6 / F / 8* | | *STD* | *byte* | *10.5% of M* | *3 % of M* | | *Max* | *byte* | *150% of M* | *109% of M* | | *Min* | *byte* | *50% of M* | *91% of M* | | *R: data rate of the flow in Mbps.*  *F: frame generation rate of the flow in fps.*  *Note that the mean and STD apply before truncation applies.*  *Note that the value of R, F depend on application.* | | | |   *Exploration to other distributions for packet size are left up to each company and could be reported with the modelling details.*  *5.1.1.2 Packet arrival*  *In this model, the packet arrival rate is determined by the frame generation rate, e.g., 60fps. Accordingly, the average packet arrival periodicity is given by the inverse of the frame rate, e.g., 16.6667ms = 1/60fps. The periodic arrival without jitter gives the arrival time at gNB for packet with index k (=1,2,3….) as*  *k/F\*1000 [ms],*  *where F is the given frame generation rates (per second).*  *Note that this periodic packet arrival implicitly assumes fixed delay contributed from network side including fixed video encoding time, fixed network transfer delay, etc.*  *However, in a real system, the varying frame encoding delay and network transfer time introduces* ***jitter*** *in packet arrival time at gNB which. In this model, the jitter is modelled as a random variable added on top of periodic arrivals. The jitter follows truncated Gaussian distribution with following statistical parameters shown in Table 5.1-2.*  ***Table 5.1.1.2-1: Statistical parameters for jitter***   |  |  |  |  | | --- | --- | --- | --- | | ***Parameter*** | ***unit*** | ***Baseline value for evaluation*** | ***Optional value for evaluation*** | | *Mean* | *ms* | *0* |  | | *STD* | *ms* | *2* |  | | *Truncation range* | *ms* | *[-4, 4]* | *[-5, 5]* |   *Note that the given parameter values and considered frame generation rates (60 or 120 in this model) ensure that packet arrivals are in order (i.e., arrival time of a next packet is always larger than that of the previous packet).*  *Thus, the periodic arrival with jitter gives the arrival time for packet with index k (=1,2,3….) as*  *offset + k/F\*1000 + J [ms],*  *where F is the given frame generation rates (per second) and J is a random variable capturing jitter. Note that actual traffic arrival timing of traffic for each UE could be shifted by the UE specific arbitrary offset.*  *5.1.1.3 Packet delay budget*  *The latency requirement of XR traffic in RAN side (i.e., air interface) is modelled as packet delay budget (PDB). The PDB is a limited time budget for a packet to be transmitted over the air from a gNB to a UE.*  *For a given packet, the delay of the packet incurred in air interface is measured from the time that the packet arrives at the gNB to the time that it is successfully transferred to the UE. If the delay is larger than a given PDB for the packet, then, the packet is said to violate PDB, otherwise the packet is said to be successfully delivered.*  *The value of PDB may vary for different applications and traffic types.*  *5.1.1.4 Packet success rate requirement*  *The performance requirement in terms of packet success rate is given as X (%). If packet delivery delay exceed a given PDB, then, the packet is counted as failure. Following values for packet success rate X are considered.*  ***Table 5.1.1.4-1: Packet Success Rate Requirement***   |  |  |  |  | | --- | --- | --- | --- | | ***Parameter*** | ***unit*** | ***Baseline values for evaluation*** | ***Optional values for evaluation*** | | *Packet success rate requirement X for DL single stream* | *%* | *99* | *95, 99.99, etc.* |   *Note that the Packet error rate (PER) in percentage is given as PER = 100 – X.*  *5.1.1.5 Dual eye buffer model*  *This clause describes optional modification of packet size and frame rates for separate packet arrival for dual-eye buffer.*  *In single eye buffer model, the frame for both eyes arrive at the same time as a single packet. Thus, mean packet size M is given as R×1e6 / F, where R is frame generation rate in Mbps and F is frame generation rate.*  *Whereas, in dual eye buffer model of data rate R, the left and right eye frame arrive separately with a time offset, which makes the arrival process effectively equivalent to have two times of frame rates and half mean packet size of that of single eye buffer model. Accordingly, we have mean packet size M of dual eye buffer model is given as R×1e6 / (2×F) for dual eye buffer model.*  ***Table 5.1.1.5-1: Statistical parameter values for dual eye buffer packet size***   |  |  |  |  | | --- | --- | --- | --- | | ***Parameter*** | ***unit*** | ***values for evaluation*** | ***Optional values for evaluation*** | | *Mean: M* | *byte* | *R×1e6 / (2×F) /8* | *R×1e6 / (2×F) / 8* | | *STD* | *byte* | *10.5% of M* | *4% of M* | | *Max* | *byte* | *150% of M* | *112% of M* | | *Min* | *byte* | *50% of M* | *88% of M* | | *R: data rate of the flow in Mbps*  *F: frame generation rate of the flow in fps* | | | |   *5.1.2 Multi-streams DL traffic model*  *This clause provides optional multi-streams model for XR DL traffic.*  *- Option 1: I-frame + P-frame*  *- Option 1A: slice-based traffic model*  *- Option 1B: Group-Of-Picture (GOP) based traffic model*  *- Option 2: video + audio/data*  *- Option 3: FOV + omnidirectional stream*  *5.1.2.1 Option 1 (I+P)*  *For Option 1, two streams (I-stream and P-stream) are modelled according to Table 5.1-5.*  *- Stream 1: I stream*  *- Stream 2: P stream*  *Depending on the video encoding scheme, two additional sub models – slice based, and Group of Picture (GOP)-based models are defined.*  *- Slice-based: In this encoding scheme, a single video frame is divided into N slices. Out of N, one slice is I slice and remaining N-1 slices are P slices. N packets (one I and N-1 P) packets corresponds to one video frame arriving at the same time.*  *- GOP-based: In this encoding scheme, a single video frame is either I frame or P frame. I frame is transmitted every K frames, where K is the GOP size, i.e., every group of picture. One video frame arrives at a time as a packet.*  ***Table 5.1.2.1-1: Statistical parameters for Option 1 multi streams DL traffic model***   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | *Two data streams* | *Option 1A: slice-based* | | *Option 1B: GOP-based* | | | | *I-stream* | *P-stream* | *I-stream* | | *P-stream* | | *Packet modelling* | *Slice-level* | | *Frame-level* | | | | *Traffic pattern* | *Both streams are periodic at 60 fps with the same jitter model as for single stream.* | | *Follow the GOP structure, where GOP size K = 8 with the same jitter model as for single stream.* | | | | *Number of packets per stream at a time* | *1* | *N-1* | *I-frame: 1 or 0*  *P-frame: 0 or 1*  *At each time instant, there is either only one I-stream packet or only one P-stream packet* | | | | *N = 8: the number of slices per frame.* | | | *Average data rate per stream* |  |  |  | |  | | *- R: average data rate of a single stream video*  *- : average size ratio between one I-frame/slice and one P-frame/slice*  *- = 1.5, 2 (baseline)*  *- = 3 (optional)* | | | | | | *Packet size distribution* | *Truncated Gaussian distribution* | | | | | | *Mean =* | *Mean =* | *Mean =* | *Mean =* | | | *- [STD, Max, Min]: [10.5, 150, 50]% of Mean packet size*  *- FPS is the frame rate of the single stream video* | | | | | |  | *Depends on application, see 6.3.1, 6.4.1, 6.5.1 for VR, CG, AR respectively.* | | | | | | *PDB* | *Depends on application, see 6.3.1, 6.4.1, 6.5.1 for VR, CG, AR respectively.* | | | | |   *5.1.2.2 Option 2 (video + audio/data)*  *For Option 2, two streams (video + audio/data) are modelled.*  *- Stream 1: video*  *- Stream 2: audio/data*  *The stream 1 - video stream follows the generic single stream model given in clause 5.1.1. The stream 2 - audio/data a periodic traffic with following parameters.*  ***Table 5.1.2.2-1: Statistical parameter values for Option 2 multi streams model***   |  |  |  |  | | --- | --- | --- | --- | | ***Parameters*** | ***unit*** | ***Baseline values for evaluation*** | ***Optional values for evaluation*** | | *Periodicity P* | *ms* | *10* |  | | *Data rate: R* | *Mbps* | *0.756, 1.12* |  | | *Packet size* | *byte* | *R×1e6 × P /1000 / 8* |  | | *PDB* | *ms* | *30* | *Other values can be optionally evaluated* | | *Packet Success Rate* | *%* | *99* | *99.9* |   *5.1.2.3 Option 3 (FOV + omnidirectional view)*  *For Option 3, following two streams are modelled.*  *- Stream 1: FOV*  *- Stream 2: omnidirectional view stream*  *The detailed modelling of the two streams is left to company with the report of evaluation results.*  *5.2 Generic UL pose/control traffic*  *In this clause, we provide the generic UL pose/control stream traffic model. A packet for UL pose/control arrives at UE periodically with following parameters.*  ***Table 5.2-1: Statistical parameters for the UL pose/control traffic***   |  |  |  |  | | --- | --- | --- | --- | | ***Parameters*** | ***unit*** | ***Baseline values for evaluation*** | ***Optional value for evaluation*** | | *Periodicity* | *ms* | *4* | *Other values can be optionally evaluated.* | | *Jitter* | *ms* | *No jitter* |  | | *Packet size* | *byte* | *100* |  | | *PDB* | *ms* | *10* |  | | *Packet Success Rate X* | *%* | *99* | *90, 95* | |

* **Instant message (as in TR 38.840)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Traffic model used for the UE power saving scheme evaluation***  *- Applications with the traffic model for the evaluation of the UE power saving scheme*  *- FTP - FTP model 3*  *- Other bursty traffic arrival models can be considered*  *- Web-browsing*  *- Video streaming*  *- Instant messaging*  *- VoIP*  *- Gaming*  *- Background app sync*  *For FTP, instant messaging, and VoIP application, the following traffic models and DRX configuration should be included for evaluation:*   |  |  |  |  | | --- | --- | --- | --- | |  | ***FTP traffic*** | ***Instant messaging*** | ***VoIP*** | | *Model* | *FTP model 3* | *FTP model 3* | *As defined in R1-070674.*  *Assume max two packets bundled.* | | *Packet size* | *0.5 Mbytes* | *0.1 Mbytes* | | *Mean inter-arrival time* | *200 ms* | *2 sec* | | *DRX setting* | *Period = 160 ms*  *Inactivity timer = 100 ms* | *Period = 320 ms*  *Inactivity timer = 80 ms* | *Period = 40 ms*  *Inactivity timer = 10 ms* |   *Note: For ON duration setting, following reference DRX configurations as previously agreed.*  *- For web-browsing, video streaming, and gaming applications, the traffic models and the delay requirements defined in R1-070674 can be used in the evaluation. The parameters (e.g. packet size) may be updated to be in line with EMBB traffic requirements.*  *- For background app sync application, for power consumption evaluation purpose, it can be assumed that idle mode operations (inclusive of page detection, RRM, deep sleep and transition overhead) contributes to X% of the use case power. The remaining portion is contributed by intermittent RRC connections due to background activities (FFS: value of X)*  *- Companies should report the assumptions made in the evaluation* |

# Appendix - Agreements

# Agreements from RAN1#122

Agreement

* The deployment scenarios in TR38.914 should be considered for evaluation assumption
* The common evaluation assumptions including the antenna modelling, general system-level simulation assumptions (including the carrier frequency, bandwidth and subcarrier spacing used for link-level simulation) for the deployment scenarios in TR38.914, link budget and traffic models will be discussed in AI 11.2
  + Other assumptions including for link-level simulation specific to each technical topic will be separately discussed under each individual agenda.
  + Note: Subcarrier spacing decision is up to AI 11.3.2.

Conclusion

* Template in R1-2506582 is to be used for collecting inputs from companies.
  + Additional NTN or TN assumptions, if any, or any necessary change of the parameters, are to be incorporated into the updated one of R1-2506582.

Agreement

* Study which of the following traffic models are to be used for 6G evaluations, e.g.,
  + Full buffer
  + FTP Model 1 (in TR 36.814)
  + FTP Model 2 (in TR 36.814)
  + FTP Model 3 (in TR 36.872)
  + XR Traffic models (in TR 38.838)
  + VoIP model (as in TR 36.814)
  + Instant message (as in TR 38.840)
* Study whether to introduce the following traffic models for 6G evaluations considering, e.g.,
  + FTP-3 variant with packet delay budget requirement
    - Details FFS
  + New traffic model considering a mixed/variable packet size and the associated time domain behaviors (e.g., time between adjacent packet arrivals, packet delay budget)
    - Details FFS
  + New traffic model(s) considering the new use cases or services, e.g., AI/ML services, immersive communication services, etc.
    - Details FFS
* Study whether to introduce new/additional approaches that can reflect the impact of bidirectional traffic flows on performance metrics (e.g., impact of UL TCP ACK latency on DL throughput/latency)

Note: Whether/how to consider the combination of traffic model and loading level will be studied under individual agendas.