3GPP TSG RAN WG1 #103-e R1-20xxxxx

e-Meeting, October 26th – November 13th, 2020

Source: Moderator (vivo)

Title: Email discussion approval for applications, traffic model and evaluation methodology: Capacity evaluation

Agenda Item: 8.14.1

Document for: Discussion and Decision

# Introduction

This contribution is a summary on the capacity considerations for XR and Cloud Gaming in the contributions [1-18] submitted under AI 8.14.1. The AI is related to applications, traffic model and evaluation methodology as the following objectives of the study item on XR evaluation for NR:

|  |
| --- |
| 1. Confirm XR and Cloud Gaming applications of interest
2. Identify the traffic model for each application of interest taking outcome of SA WG4 work as input, including considering different upper layer assumptions, e.g. rendering latency, codec compression capability etc.
3. Identify evaluation methodology to assess XR and CG performance along with identification of KPIs of interest for relevant deployment scenarios
4. Once traffic model and evaluation methodologies are agreed, carry out performance evaluations towards characterization of identified KPIs
 |

# Capacity for XR

## Deployment

Use cases and deployment scenarios of XR/CG applications proposed by companies [2][3][4][8][11][12][13][15][18] are summarized as below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Companies/scenarios** | **VR** | **AR** | **Cloud gaming** |
| **Huawei** | Dense urbanUrban Macro | Dense urbanUrban Macro | Dense urbanUrban Macro |
| **vivo** | Indoor hotspotDense urban | Indoor hotspotDense urban | Indoor hotspotDense urban |
| **CATT** | Indoor hotspotDense urban | Indoor hotspotDense urban | Indoor hotspotDense urban |
| **LG** | Indoor with low mobility | AR1: Indoor/outdoor with low mobilityAR2: Indoor/outdoor with low/high mobility | Indoor/outdoor with low/high mobility |
| **MediaTek** | Indoor hotspot (FR1/FR2) | AR1: UMi(indoor & outdoor) (FR1/FR2), HST(FR1)AR2: UMi(indoor & outdoor) (FR1/FR2) | UMi(indoor & outdoor) (FR1)Rural(indoor & outdoor) (FR1)High speed train (FR1) |
| **Xiaomi** |  | Indoor/outdoor (FR1/FR2) | Indoor/outdoor (FR1/FR2) |
| **Qualcomm** | Indoor hotspot (open office) (FR1/FR2)UMi mixed (FR1) | UMi mixed (FR1)Indoor hotspot (open office) (FR1/FR2)UMi (outdoor) (FR2) | UMi mixed (FR1)Indoor hotspot (open office) (FR1/FR2)UMi (outdoor) (FR2) |
| **AT&T** | UMa(indoor &outdoor) (FR1)UMi(outdoor) (FR2)Indoor hotspot (FR1/FR2) | UMa(indoor & outdoor) (FR1)UMi(outdoor) (FR2)Indoor hotspot (FR1/FR2) | UMa(indoor & outdoor) (FR1)UMi(outdoor) (FR2)Indoor hotspot (FR1/FR2) |
| **Nokia** | Indoor hotspotUrban Macro (UMa) | Indoor hotspotUrban Macro (UMa) | Indoor hotspotUrban Macro (UMa) |

The use cases of XR and CG applications can occur in the indoor or outdoor scenarios. Based on the contributions from companies, the deployment scenarios proposed include InH, UMi, Dense Urban and UMa.

**Q1: For UMi and Dense urban scenarios, whether both of them need to be separately evaluated, or only UMi is to be evaluated for the sake of reducing the number of evaluation scenarios?**

**Please share your views on Q1.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | UMi scenario should be considered for the evaluation of XR and CG applications. |
| FUTUREWEI | UMi scenario should be used. Overall, we’d like to prioritize FR1 in this SI. |
| LG | We may focus only on InH snd UMi in this study. |
| DOCOMO | UMi scenario should be used. |
| InterDigital | We think UMi (indoor and outdoor) is sufficient for reducing the number of evaluation scenarios  |
| QC | Given that Dense urban and UMi are very similar scenario, we propose to evaluate with UMi only. This will help reducing the workload in RAN1. |
| MTK | We think we can choose one of them to reduce evaluation scenarios. Either UMi or dense urban is fine for us. |

**Q2: The deployment scenarios for evaluation may be applied to each of XR/CG applications of interest. However, if all the XR/CG applications are considered, there will be too many combinations of deployment scenarios and XR/CG applications, which could lead to numerous simulation work. Therefore, it may be desirable to consider prioritization of combinations of deployment scenarios and XR/CG applications, e.g.,**

* **FR 1:**
	+ **InH: CG and VR are prioritized.**
	+ **UMi: AR and CG are prioritized.**
	+ **UMa: AR (e.g., low rate AR)**
* **FR 2:**
	+ **InH: CG and VR are prioritized.**
	+ **UMi: AR and CG are prioritized.**
	+ **UMa: N/A**

**Please note that with such prioritization, companies can still submit evaluation results for de-prioritized scenarios.**

**Please share your views on Q2 including whether such prioritization is needed or not.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | We think from simulation work load perspective, it would be good to prioritize FR1 over FR2.In terms of the applications within FR1, clarification is needed regarding which one or both of {AR1,AR2}, {VR1, VR2} would be evaluated. The following note under the proposal would serve the purpose:***Note: Depending on the outcome of the further discussion, one or both of {AR1,AR2}, {VR1, VR2} are to be evaluated.*** |
| FUTUREWEI | Prioritize FR1 over FR2. Agree to reduce the number of combinations for evaluation. |
| LG | We are fine with the proposal without UMa. We also think it is better to focus on FR1. |
| DCOCOMO | Fine with the proposal. We also think FR1 should be prioritized for this work. |
| InterDigital | We think the following scenarios should be prioritized:* FR 1: InH: CG and VR, UMi: AR and CG and UMa: AR and CG
* FR 2: InH: CG and VR, UMi: AR and CG
 |
| QC | We support the above prioritization. Low rate AR (e.g., low rate streaming, text notification, etc.) is very interesting to study as it may be more relevant in the near term market. It is expected that such use case may be widely used in both indoor/outdoor scenarios. |
| Ericsson | Not sure if such priority categorization based on use cases is needed, since CG and VR may have very similar traffic models.Proposed prioritization:* CG in FR1: Urban macro and dense urban
* AR in FR1: Urban macro and dense urban
 |
| MTK | We think such prioritization is needed. We suggest to prioritize one scenario for FR1 and one scenario for FR2 and UMi is our preference.  |

## Evaluation methodology and assumptions

### Methodology

For evaluation of XR/CG applications, the definition of system capacity needs to be determined. In general, similar to the previous 3GPP study e.g. URLLC, the system capacity is defined as the maximum number of users per cell satisfying a certain set of requirements. Hence, for XR/CG evaluation, the system capacity can be defined as the following.

**Q3: System capacity is defined as the maximum number of users per cell with at least X % of UEs being satisfied (i.e., meeting a set of requirements). The exact requirements will be defined separately.**

**Please share your views on Q3. Companies can also present other definition of system capacity that they believe is appropriate.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | Agree that number of UEs under a given {PDB,PER} requirement in which X% is satisfied should be evaluated. |
| FUTUREWEI | Agree |
| LG | We are fine with FL’s proposal |
| DOCOMO | Agree in principle but we prefer to consider eMBB+URLLC multiplexing case. There would be the case where only URLLC devices are accommodated in a cell and both URLLC and eMBB devices are accommodated in a cell considering the commercial use cases. For example, the former can target e-sports event, and the latter can target AR conference or VR game on high speed train, where other eMBB devices are also located for other purposes, e.g. internet service. Besides, users who play AR/CG/VR would have mobile phone for eMBB in addition to AR/CG/VR devices for URLLC. |
| InterDigital | We are ok with the definition for system capacity. For the requirements we prefer to include different traffic requirements (e.g. DL/UL throughput, RTT latency, max UL/DL PDB, reliability) for different applications (e.g. VR, AR and CG) |
| QC | We think the above definition of XR capacity is reasonable. |
| Ericsson | Agree |
| MTK | The proposed definition is reasonable but may require a large simulation effort (since we have to sweep every user number). A possible alternative is to choose 3 user numbers, say 10, 15, 20, and defined the capacity to be the averaged satisfied user number. |

**Q4: For the system capacity definition in Q3, the X value needs to be determined, e.g., X=90. In addition, it may be useful to collect results (i.e., # UEs per cell being satisfied or meeting the requirements) for multiple values of X, e.g., X = 70, 80, 90, 95 to see the trend of # UEs per cell meeting the requirements as the number of UEs per cell increases.**

**Please share your views on Q4.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | X= 90 or 95 should be considered. |
| FUTUREWEI | X = 90 is a reasonable start. |
| LG | We are fine with FL’s proposal |
| DOCOMO | X= 90 or 95 should be considered. |
| InterDigital | We agree with collecting results for different values of X (e.g. 50,..,90, 95) |
| QC | We support reporting multiple data points for X=90, 80, 70. |
| Ericsson | X=90 or 95 should be considered |
| MTK | We prefer X=95. |

**Q5: For the system capacity definition, how to determine whether a UE is satisfied or not is to be deferred until the exact traffic model along with how to measure E2E user experience is available.**

**Please share your comment on Q5.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | Some high-level principle had better be settled such as the {PDB,PER} requirement. |
| FUTUREWEI | Agree to defer after traffic model and metric(s) for user experience are agreed |
| LG | We are fine with FL’s proposal |
| DOCOMO | Agree with the suggestion. |
| InterDigital | While we understand that using the exact traffic model per-application (i.e. from SA4) and measuring the QoE is important for determining capacity, we think in the evaluations the traffic parameters (e.g. PDB, PER) currently available from TR 26.928 for VR and CG can be used as baseline. The exact traffic model and parameters for AR can be included once available |
| QC | We support Q5. RAN1 is expected to discuss how to measure e2e user experience together with traffic model.  |
| Ericsson | Agree. However, it is clear that some definitions of UE satisfaction will provide huge challenges for the foreseen evaluations, e.g., extremely high reliability requirements. |
| MTK | We are fine with the proposal. |

**Q6: On the XR/CG evaluation, other performance metrics (in addition to # of UEs per cell being satisfied) can be reported, e.g.,**

* **PER (file dropping rate)**
* **UPT**
* **File transfer delay**
* **RU**
* **Spectrum efficiency**
* **Etc.**

**Please share your comments on Q6. Please feel free to suggest additional metrics that you believe are useful to collect.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | Prefer to include only RU/UPT in this section given they are closely related to capacity. Compared with UPT, the additional information offered by PER is marginal. File Transfer delay is more related to latency. Spectrum efficiency metric may need some further clarification as to how or why it should be done given RU is already captured. |
| FUTUREWEI | Let’s wait until the traffic model and metric(s) for user experience are agreed. |
| LG | In principle, no agreement is necessary on this point since companies can report any performance results. For recommending specific additional metrics, further discussion is necessary based on further SA4 outcome |
| InterDigital | We think the E2E file transfer delay and RTT delay (e.g. for CG) can also be considered for capacity evaluations  |
| QC | We think the above metrics are useful. Details of how to report those metrics w/ capacity result should be further discussed, e.g., averaged over entire UEs or multiple data points (e.g., 10%, 50%, 90%) in CDF of per UE metrics.In addition, as another UL metric for XR, we could also measure pose related metric such as age of pose (AOP). An AOP is defined as time duration X-Y, where* X is the time a frame Z is generated at XR server
* Y is the time that a pose is generated at XR device which is used to render the frame Z

In XR user experience, the motion-to-render-to-photon (M2R2P) delay is one of important metrics measuring user experience. Lower value is required to make user feel “presence”. AOP is one part of M2R2P, so lower AOP is preferred.For CG, similarly user interaction delay could be considered [26.928]. They are measured in similar way but different requirement could be used. Whether and how to report AOP and/or user interaction delay for CG can be further discussed together with traffic model.  |
| Ericsson | Companies are free to present other results. However, the benefits are unclear. |
| MTK | UPT and RU can be useful. |

It is proposed in [18] that XR capacity could highly depend on the arrival time offset of XR traffics among UEs. It may be useful to study XR capacity under various assumptions on traffic arrival offset among UEs.

**Q7: Whether and how to evaluate XR capacity under various assumptions on traffic arrival offset among UEs (e.g., random offsets, uniform offsets)?**

**Please share your comments on the Q7.**

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| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | Traffic arrival offset among UEs should be unified for calibration purpose. It would be beneficial to have some cross verification if uniform offset is assumed for evaluation purpose. |
| FUTUREWEI | Let’s wait until the traffic model and metric(s) for user experience are agreed. |
| LG | This aspect should be discussed based on further SA4 outcome on the traffic model |
| InterDigital | For the evaluations of capacity, both random offset (e.g. offset is uniformly distributed) and uniform offset can be considered. The case for using different offsets for traffic arrival may be useful for determining the tradeoff between capacity and UE power savings  |
| QC | We think evaluation of different options of traffic arrival offset among UE’s is very useful. It can potentially motivate tight coordination/collaboration between gNB and application server if beneficial in terms of system capacity. We think following three cases can be evaluated for traffic arrival offset.* Case 1: traffic arrival offset is the same for all UEs. This is the worst case in terms of capacity.
* Case 2: UE’s traffic arrival offset is randomly distributed among UE’s following uniform distribution in [0, P], where P is the DL frame arrival periodicity.
* Case 3: UE’s traffic arrival offsets among UEs within a cell are evenly spaced within [0, P] where P is the DL frame arrival periodicity so that the minimum of traffic arrival offsets among UEs within a cell is maximized

To reduce simulation effort, those options may be simulated only for a limited number of scenarios. The exact scenarios to be evaluated can be further discussed. |
| Ericsson | Random traffic arrival should be assumed as baseline. |
| MTK | This depends on NW implementation. Random offsets seems to be more reasonable. |

### Evaluation assumptions

The evaluation assumptions are provided and discussed in [2][3][4][5][8][10][11][12][13][14][15][16][18]. To facilitate the evaluation and comparison of XR performance, it would be better to align as many assumptions as possible among companies.

According to the input, the evaluation assumptions are listed in Table 1 and Table 2.

Table 1 illustrates the simulation assumptions that are necessary for XR evaluation and for which there is a majority view among companies. So it is recommended to take the simulation assumptions in Table 1 for XR evaluation.

**Table 1: Simulation assumptions for XR evaluation (Part 1)**

|  |  |
| --- | --- |
| **Parameter** | **Proposed value** |
| **Indoor FR1/FR2** | **Outdoor FR1/FR2** |
| Layout | 120m x 50mISD: 20mTRP numbers: 12 | 21cells with wraparound |
| Carrier frequency | FR1: 3.5 GHzFR2: 28 GHz |
| Bandwidth | FR1: 100 MHzFR2: 400 MHz |
| Subcarrier spacing | FR1: 30 kHzFR2: 120 kHz |
| BS height | 3m | 25m |
| UE height | hUT=1.5 m |
| UE power | FR1: 23 dBmFR2: Maximum EIRP 43 dBm |
| BS noise figure | FR1: 5 dBFR2: 7 dB |
| UE noise figure | FR1: 9 dBFR2: 13 dB |
| BS receiver | MMSE-IRC |
| UE receiver | MMSE-IRC |
| Channel estimation | Realistic |
| UE speed | 3 km/h |
| MCS | Up to 256QAM |
| Target BLER | 10% |
| Max number of HARQ transmissions | 4 |
| BS antenna pattern | Ceiling-mount antenna radiation pattern, 5 dBi | 3-sector antenna radiation pattern, 8 dBi |
| UE antenna pattern | FR1: Omni-directional, 0 dBi, FR2: UE antenna radiation pattern model 1, 5dBi |

**Proposal 1: Adopt the simulation assumptions in Table 1 for XR evaluation**

**Q8. Please share your comments on the proposal 1.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | We agree with the proposal 1. |
| FUTUREWEI | Should Target BLER be First Transmission Target BLER? |
| LG | Assumption on target BLER may not need to be fixed at this stage but can be discussed after requirements for each XR application are settled down. |
| DOCOMO | Share same view as LG. |
| InterDigital | We agree with the simulation assumptions in Table 1 |
| QC | We generally agree with the parameters in Table 1.For FR2, EIRP < 31 dBm is deemed practical and preferred. UE EIRP of 43 dBm may lead to overly optimistic evaluation results. |
| Ericsson | The parameters are essentially OK, but why not use 4GHz and 30GHz as in 38.802?Max number of HARQ retransmissions does not need to be specified. |
| MTK | Current UE seldom supports one carrier > 100MHz. Also, SLS simulation for a > 100MHz carrier would be very time consuming. Therefore, we suggest to consider 100MHz as baseline for FR1/FR2 and companies can report CA settings or linear scaling the throughput if companies deem a larger BW result is preferred. For FR1 CA, we prefer 2CC CA for FR1 as follows:Total BW = 2 CCs x 100 MHz* CC1 = Lower band (licensed): 3.5 GHz (DDDSU DDSUU)
* CC2 = Higher band1 (licensed): 4.9 GHz (SUUDD) or Higher band2 (un-licensed): 5GHz (DDDDD)

We also think max number of HARQ retransmissions does not need to be specified. |

Table 2 illustrates the simulation parameters that are necessary for XR evaluation and are not converged yet. For these assumptions, options proposed by companies are given in the table. To reduce the simulation work, it is recommended for companies to consider to down-select from the options for the assumptions in Table 2. Furthermore, since power control, transmission scheme, PDCCH/DMRS overhead, CSI feedback mechanism and processing delay would affect the capacity performance, these assumptions need to be reported by companies

**Table 2: Simulation assumptions for XR evaluation (Part 2)**

|  |  |
| --- | --- |
| **Parameter** | **Proposed value** |
| **Indoor FR1/FR2** | **Outdoor FR1/FR2** |
| UE distribution | 100% indoor | Option 1: 80% indoor, 20% outdoor (HW, vivo, CATT, ZTE, QC-FR1)Option 2: 20% indoor, 80% outdoor (vivo, Intel)Option 3: 100% outdoor (MTK, AT&T-FR2, QC-FR2) |
| Frame structure | FR1: Option1: DDDSU (HW, vivo, E///)Option2: DSUUD (CATT)Option3: DDDSUDDSUU (vivo, MTK)Option4: SUUDD (MTK)Option5: DDDUU (CMCC)Option6: DU (CMCC)Option7: FDD (MTK, IDC, Nokia)FR2: Option 1: DDDSU (vivo, MTK)Option 2: DSUUD (CATT)Note: S is 10:2:2 |
| BS antennas | FR1: 32 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1;4,4) (vivo, CATT)(dH, dV) = (0.5, 0.5)λFR2:64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1;4,8) (vivo)2 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2,1,1;1,1) (QC)(dH, dV) = (0.5, 0.5)λ | FR1:Option 1: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (12,8,2,1,1;4,8) (HW, vivo)Option 2: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,4,2,1,1;8,4) (ZTE)Option 3: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1;4,8) (QC)Option 4: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (16,8,2,1,1;4,8) (CATT)Option 5: 32 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,1,1,2;4,4) (MTK)Option 6: TxRU, (M, N, P, Mg, Ng; Mp, Np) = (2, 8, 2, 1, 1;2,8) (E///)(dH, dV) = (0.5λ, 0.8λ)FR2:Option 1: 2 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,2,2;1,1) (vivo)Option 2: 2 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (32,8,2,1,1;1,1) (QC)(dH, dV) = (0.5λ, 0.5λ) |
| UE antennas | FR1: 2 or 4Tx/2 or 4Rx, (M, N, P, Mg, Ng; Mp, Np) = (1,2,1/2,1,1;1,2)(dH, dV) = (0.5, N/A)λFR2: 4 Tx/4Rx,Option 1: (M, N, P, Mg, Ng; Mp, Np) = (1,2,2,1,2;1,2) (MTK)Option 2: (M, N, P, Mg, Ng; Mp, Np) = (2,4,2,1,2;1,2) (vivo)Option 3: {2, 2, 2} per panel. Number/location of panels: 3 panels (left, right, and top) (QC)(dH,dV) = (0.5, 0.5)λThe polarization angles are 0° and 90° |
| Downtilt | FR1: Option 1: 6 degree (ZTE, QC)Option 2: 14 degree (MTK, E///) Option 3: 100 (Intel)Option 4: 90° in GCS (pointing to horizontal direction) (vivo)FR2: Option 1: 0 degree (MTK)Option 2: 180° in GCS (pointing to the ground) (vivo) |
| BS power | FR1: Alt1: 24dBm/20MHz (vivo, CATT, QC)Alt2: 30dBm (ZTE)FR2: Alt1: Maximum EIRP 58dBm (vivo)Alt2: 23dBm (QC) | FR1: Alt1: 46dBm (IDC)Alt2: 49dBm (E///)Alt3: 44dBm/20MHz (HW, CATT, ZTE, MTK, Intel, QC)Alt4: 53dBm (vivo)FR2:Alt1: Maximum EIRP 73dBm (vivo)Alt2: 37dBm (MTK)Alt3: 28dBm (QC) |
| Power control parameter | Companies should report |
| Transmission scheme | Companies should report, such as Type I/II codebook, rank assumption |
| Scheduler | MU-MIMO PF scheduler, other scheduler is up to companies report |
| CSI Feedback | RealisticCompanies should report CSI feedback delay, CSI report periodicity, whether using CSI quantization, CSI error model or not, and etc. |
| PHY processing delay | UE Capability #1Companies should report gNB processing delay, e.g. DL NACK to retransmission delay, UL previous transmission to current transmission delay and etc. |
| PDCCH overhead | Companies should report |
| DMRS overhead | Companies should report |

**Proposal 2: Regarding the UE distribution for outdoor scenario, down-select from the following options for XR evaluation.**

* **For outdoor scenario:**
	+ **FR1:**
		- **Option 1: 80% indoor, 20% outdoor**
		- **Option 2: 20% indoor, 80% outdoor**
		- **Option 3: 100% outdoor**
	+ **FR2:**
		- **100% outdoor**

**Q9. Please share your comments on the proposal 2.**

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| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | We prefer 80% indoor and 20% outdoor of FR1 in case of outdoor scenario. |
| FUTUREWEI | Prioritize FR1. At least Option 1 is simulated. |
| LG | For FR1, option1 can be prioritized. |
| DOCOMO | Option 1 for FR1 should be simulated. |
| InterDigital | We think i) FR1 Option 1 and Option 2 and ii) FR2 100% indoor and outdoor should be prioritized for evaluations |
| QC | We support option 1. |
| Ericsson | Support option 1 |
| MTK | We prefer Option 3. Also prefer to prioritize FR1 . |

**Proposal 3: Regarding the frame structure, down-select from the following options of FR1 and FR2 for XR evaluation.**

* **FR1:**
	+ **Option1: DDDSU**
	+ **Option2: DSUUD**
	+ **Option3: DDDSUDDSUU**
	+ **Option4: SUUDD**
	+ **Option5: DDDUU**
	+ **Option6: DU**
	+ **Option7: FDD**
* **FR2:**
	+ **Option 1: DDDSU**
	+ **Option 2: DSUUD**

**Note: S is 10:2:2**

**Q10. Please share your comments on the proposal 3.**

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| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | Option1 and option3 of FR1 should be prioritized for the evaluation of XR and CG applications. |
| FUTUREWEI | Prioritize FR1. Focus on Option 1. In terms of SLS performance, Option 2 and Option 4 should be the same and at most one may be considered. |
| LG | For FR1, two options can be chosen to consider different DL-UL ratios, but may not need to be decided in this meeting.  |
| DOCOMO | FR1 should be prioritized. Option1 (1st priority) or Option 3 for FR1. Regarding FR2, Option1 should be considered. |
| InterDigital | We think i) FR1 Option 1, Option 2, Option 3 and ii) FR2 Option 1, Option 2 should be prioritized for evaluations. |
| QC | For FR1, we are okay with option 1 or 5.For FR2, option 1 is preferred. |
| Ericsson | Option 1 is preferred for FR1 and FR2.  |
| MTK | For FR2, we prefer Option 1. For FR1, we suggest 2CC CA for FR1 as follows:Total BW = 2 CCs x 100 MHz;* CC1 = Lower band (licensed): 3.5 GHz (DDDSU DDSUU, Option 3)

CC2 = Higher band1 (licensed): 4.9 GHz (SUUDD, Option 4) or Higher band2 (un-licensed): 5GHz (DDDDD) |

**Proposal 4: Regarding the BS antennas, further discuss the assumptions and down-select from the following options for XR evaluation.**

* **For indoor scenario:**
	+ **FR1:**
		- **32 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1;4,4)**
		- **(dH, dV) = (0.5, 0.5)λ**
	+ **FR2:**
		- **64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1;4,8)**
		- **2 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2,1,1;1,1)**
		- **(dH, dV) = (0.5, 0.5)λ**
* **For outdoor scenario:**
	+ **FR1:**
		- **Option 1: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (12,8,2,1,1;4,8)**
		- **Option 2: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,4,2,1,1;8,4)**
		- **Option 3: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1;4,8)**
		- **Option 4: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (16,8,2,1,1;4,8)**
		- **Option 5: 32 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,1,1,2;4,4)**
		- **Option 6: TxRU, (M, N, P, Mg, Ng; Mp, Np) = (2, 8, 2, 1, 1;2,8)**

**(dH, dV) = (0.5λ, 0.8λ)**

* + **FR2:**
		- **Option 1: 2 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,2,2;1,1)**
		- **Option 2: 2 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (32,8,2,1,1;1,1)**

**(dH, dV) = (0.5λ, 0.5λ)**

**Q11. Please share your comments on the proposal 4.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | 32TxRU for indoor scenario and 64TxRU for outdoor scenario in FR1 will be considered is preferred the evaluation. |
| FUTUREWEI | Prioritize FR1 and focus on FR1 Option 3 outdoor. |
| LG | For indoor FR2, 2 TxRU can be more general assumption. |
| DOCOMO | FR1 should be prioritized and Option 3 is preferred for FR1 outdoor. |
| InterDigital | For Indoor scenario, we think the given antenna configuration for FR1 is good while for FR2, it would be good to prioritize the configuration 2 TxRU. For Outdoor scenario, we think i) For FR1, Option 2, Option 5 and Option 6 should be prioritized. ii) For FR2 both option 1 and option 2 can be prioritized.  |
| QC | For indoor scenario, * In the summary text for indoor - FR2 case, Option 1 and Option 2 were missing
* For FR2, we prefer Option 2:  **2TxRU, (M, N, P, Mg, Ng; Mp, Np) = (16, 8, 2,1,1;1,1) (dH, dV) = (0.5, 0.5)λ**

For outdoor scenario, * FR1: option 3 is preferred.
* FR2: option 2 is preferred.
 |
| Ericsson | Larger antennas provide better performance. However, the focus of the XR work should not be to investigate advanced MIMO schemes. Therefore, we propose a conservative antenna layout:Indoor FR2: 2TxRUOutdoor FR1: Option 6 (32TxRU)Outdoor FR2: Option 1 |
| MTK | For FR1, we prefer (8,8,2,1,1;2,8) which is most close to Option 3. For FR2, we prefer Option 1 or (M, N, P, Mg, Ng; Mp, Np) = (4,8,2,1,1;1,1). For FR2, it would be good to prioritize the configuration 2 TxRU. |

**Proposal 5: Regarding the UE antennas, adopt the following assumption for FR1 and down-select from the following options for FR2 for XR evaluation.**

* **FR1:**
	+ **2 or 4Tx/2 or 4Rx, (M, N, P, Mg, Ng; Mp, Np) = (1,2,1/2,1,1;1,2)**

**(dH, dV) = (0.5, N/A)λ**

* **FR2: 4 Tx/4Rx,**
	+ **Option 1: (M, N, P, Mg, Ng; Mp, Np) = (1,2,2,1,2;1,2)**
	+ **Option 2: (M, N, P, Mg, Ng; Mp, Np) = (2,4,2,1,2;1,2)**
	+ **Option 3: {2, 2, 2} per panel. Number/location of panels: 3 panels (left, right, and top)**

**(dH,dV) = (0.5, 0.5)λ**

**The polarization angles are 0° and 90°**

**Q12. Please share your comments on the proposal 5.**

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| **Company** | **Comment** |
| ZTE,Sanechips | For FR1, 4Tx/4Rx, (M, N, P, Mg, Ng; Mp, Np) = (1,2,2,1,1;1,2) should be considered. |
| FUTUREWEI | Prioritize FR1. And focus on FR1 4T4R. |
| LG | For FR1, 2TX should be included.For FR2, option 3 may not be appropriate as general assumption. |
| DOCOMO | FR1 should be prioritized. |
| InterDigital | We think i) the proposed configuration for FR1 is good. ii) For FR2, we think Option 1 and Option 2 should be prioritized. |
| QC | For FR1, * We prefer 2Tx/4Rx, (M, N, P, Mg, Ng; Mp, Np) = (1,2,1/2,1,1;1,2). Both P=1 or 2 should be supported depending on the number of antennas.

For FR2,* In the above text for FR2, prefer Option 3.

Option 3 is preferred. |
| Ericsson | More UE antennas provide better performance. However, the focus of the XR work should not be to investigate benefits of more UE antennas. There we propose conservative numbers:For FR1: 1Tx and 2Rx (4Rx is also OK)For FR2: 1Tx and 2Rx |
| MTK | Agree with Ericsson, for FR1: 1Tx and 2Rx seems better.For FR2, we prefer Option 1.Also prefer to prioritize FR1. |

**Proposal 6: Regarding the downtilt, down-select from the following options for FR1 and FR2 for XR evaluation.**

* **FR1:**
	+ **Option 1: 6 degree**
	+ **Option 2: 14 degree**
	+ **Option 3: 100**
	+ **Option 4: 90° in GCS (pointing to horizontal direction)**
* **FR2:**
	+ **Option 1: 0 degree**
	+ **Option 2: 180° in GCS (pointing to the ground)**

**Q13. Please share your comments on the proposal 6.**

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| **Company** | **Comment** |
| ZTE,Sanechips | FR1: 90 degrees for indoor and 6 degree for outdoor  |
| FUTUREWEI | Prioritize FR1. And focus on FR1 Option 1. |
| LG | This should depends on other scenarios such as antenna heights. |
| InterDigital | 1. For FR1, we think Option 2 & Option 4 can be prioritized
2. For FR2, we think Both Options 1 & Options 2 need to be evaluated
 |
| QC | For FR1* Prefer option 1.

For FR2,For maximum coverage, for outdoors a vertical panel (0 degree) is preferred and for indoors, the panel is expected to be horizontal (90 degrees) (i.e. pointing to the ground). |
| Ericsson | For outdoor, the appropriate tilt would depend on the scenario. For indoor hotspot, 90 degree tilt would be appropriate  |
| MTK | For FR1, we prefer Option 2. For FR2, we prefer Option 1. |

**Proposal 7: Regarding the BS Tx power, down-select from the following options for XR evaluation.**

* **For indoor scenario:**
	+ **FR1:**
		- **Alt1: 24dBm/20MHz**
		- **Alt2: 30dBm**
	+ **FR2:**
		- **Alt1: Maximum EIRP 58dBm**
		- **Alt2: 23dBm**
* **For outdoor scenario:**
	+ **FR1:**
		- **Alt1: 46dBm**
		- **Alt2: 49dBm**
		- **Alt3: 44dBm/20MHz**
		- **Alt4: 53dBm**
	+ **FR2:**
		- **Alt1: Maximum EIRP 73dBm**
		- **Alt2: 37dBm**
		- **Alt3: 28dBm**

**Q14. Please share your comments on the proposal 7.**

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| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | For indoor scenario, consider Alt 1/Alt 2 depending on the system bandwidth |
| FUTUREWEI | Prioritize FR1. Support at least outdoor FR1 Alt3. |
| DOCOMO | FR1 should be prioritized. Alt.1 for FR1 indoor and Alt.3 for FR1 outdoor would be preferable. |
| InterDigital | We think that for indoor scenario, FR1-Alt 1 and FR2-Alt 1 should be prioritized. For outdoor scenario, we think that FR1 – Alt2 & Alt4 and FR2-Alt1 can be prioritized.  |
| QC | For indoor scenario:* FR1: 24dBm for 100MHz
* FR2: Alt2 is preferred, Alt1 is acceptable.

For outdoor scenario: the BS tx power depends on scenarios; UMi and UMa.For FR1* For UMi: 44dBm for 100MHz
* For UMa: 49dBm for 100MHz

For FR2* For UMi: Alt3 is preferred, Alt1 is acceptable

For UMa: Alt3 is preferred, Alt1 is acceptable |
| Ericsson | Follow 38.802, Table A.2.1-1 |
| MTK | For indoor FR1, we prefer Alt 1. For indoor FR2, we prefer Alt 2. For outdoor FR1, we prefer Alt3. For outdoor FR2, we prefer Alt2. |

**For the following assumptions in Table 2, they are important for the XR evaluation and may be related to the implementation/configuration. Hence, they should be reported by company with detailed assumptions for the evaluation.**

**Proposal 8: Adopt the following simulation assumptions in Table 2 for XR evaluation.**

|  |  |
| --- | --- |
| **Power control parameter** | Companies should report |
| **Transmission scheme** | Companies should report, such as Type I/II codebook, rank assumption |
| **Scheduler** | MU-MIMO PF scheduler, other scheduler (e.g., delay aware scheduler) is up to companies report |
| **CSI Feedback** | RealisticCompanies should report CSI feedback delay, CSI report periodicity, whether using CSI quantization, CSI error model or not, and etc. |
| **PHY processing delay** | UE Capability #1Companies should report gNB processing delay, e.g. DL NACK to retransmission delay, UL previous transmission to current transmission delay and etc. |
| **PDCCH overhead** | Companies should report |
| **DMRS overhead** | Companies should report |
| **SRS**  | Companies should report |

**Q15. Please share your comments on the proposal 8.**

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| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | We agree with the proposal 8. |
| FUTUREWEI | “CSI feedback” may be changed to “CSI acquisition”, and CSI feedback and/or SRS may be used. |
| LG | Scheduler assumption can be fully up to each companies report. |
| InterDigital | We support the simulation assumptions in the proposal |
| QC | In scheduler, we think delay aware needs to be evaluated as one option in capacity evaluation. The XR traffic typically has tight delay budget and therefore the role of scheduling algorithm may be critical. Although scheduling algorithm is up to implementation, a study on delay aware scheduler can be very useful which can potentially motivate tighter collaboration/coordination between gNB and application/edge server, where some enhancements to specifications may be needed. |
| Ericsson | Support. Question for clarification: UE capability #1, does that mean PDSCH processing capability 1? |
| MTK | For PDCCH overhead, we suggest to consider PDCCH region of 1/3 symbols at beginning of a slot. |

**Q16. Please share additional comments if any on Table 2.**

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| --- | --- |
| **Company** | **Comment** |
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**Q17: In addition to the assumptions in Table 1 and Table 2, are there any assumptions which are necessary to define for XR evaluation?**

**Please share your comments on the Q17.**

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| --- | --- |
| **Company** | **Comment** |
| InterDigital | We think that channel model assumptions might be missing. TDL-A/B/C/D/E or CDL-A/B/C/D |
| QC | In general, the simulation assumptions between capacity evaluation (which does not require power evaluation at all) and power evaluation (where capacity should be evaluated subject to a capacity constraint) need to be the same. In case different parameters need to be considered, they should be reported with the results. |
|  |  |

The following simulation assumptions are proposed by one or only a few companies for XR evaluation. More clarifications on whether and how to consider these simulation assumptions for the XR evaluation are needed.

* Beam related operation, such as beam update mechanism, beam activation delay, beam metric
* Others, e.g. RLC, network layer setting, core network delay

*FL’s comment: For the assumptions that may be related to traffic model, they can be discussed with traffic model after there is more input from SA4.*

**Q18: Whether or not to consider the following simulation assumptions for XR evaluation?**

* **Beam related operation, such as beam update mechanism, beam activation delay, beam metric**
* **Others, e.g. RLC, network layer setting, core network delay**

**Please share your comments on the Q18.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| ZTE,Sanechips | Prefer not to consider beam related operation. In terms of RLC, network delay consideration, this had better be discussed with traffic model and thus it's suggested this discussion, if needed, take place during next meeting when SA4 outcome is supposed to be available. |
| FUTUREWEI | Prefer not to consider these aspects with limited TU for this SI |
| LG | This details can be up to further discussion and may be up to each company’s report in the end. |
| DOCOMO | Share the same view as ZTE and FUTUREWEI. |
| InterDigital | We think the additional assumptions related to UP and CP delay in CN (e.g. between edge function/server and RAN) that affects the end-to-end performance (e.g. user experience and capacity) may be considered in the evaluations |
| QC | In our view, RLC, network layer setting, and core network delay are not explicitly evaluated. Rather, it can be captured in latency requirements for RAN transmission. |
| Ericsson | Beam layout would be sufficient, but dynamic mechanisms are unnecessary.RLC mode needs to be specified – we assume RLC UM. Delays in transport network and CN needs to be stated, perhaps assumed to be 0. Note that quality requirements from SA4 will consider total delay, including delays in transport and core network.  |
| MTK | No. Companies can report the used values if necessary. |

**Q19. Please share any other comments if any on capacity evaluation for XR and CG.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| MTK | Why not just align to IMT 2020 settings (dense urban, InH …) of **System level simulation assumptions** as in 38.840? Discussing the various simulation parameter possibilities can be time consuming. |
|  |  |
|  |  |

# Summary

# Reference

1. R1-2007555 XR applications and scenarios FUTUREWEI
2. R1-2007561 Discussion on applications, traffic model, and evaluation methodology for XR and Cloud Gaming Huawei, HiSilicon
3. R1-2007698 Discussion on XR applications, traffic model and evaluation methodologies vivo
4. R1-2007843 XR use cases, evaluation methodologies and traffic model CATT
5. R1-2007976 Discussion on applications, traffic model and evaluation methodology for XR ZTE
6. R1-2008037 Discussion on XR evaluation and Challenges for NR CMCC
7. R1-2008198 Applications, Evaluation Methodology, and KPIs for XR Samsung
8. R1-2008311 XR evaluations for NR: Applications and Evaluation Methodology AT&T
9. R1-2008454 XR Applications, Traffic Model and Evaluation Methodology Apple
10. R1-2008818 Discussion on traffic models and evaluation assumptions for XR InterDigital, Inc.
11. R1-2008896 Applications, Traffic Model and Evaluation Methodology for XR evaluations for NR Nokia, Nokia Shanghai Bell
12. R1-2008939 Discussion for study in XR evaluation for NR LG Electronics
13. R1-2008967 On Applications, Traffic Model, and Evaluation Methodology for XR and CG MediaTek Inc.
14. R1-2009006 Scenarios, Traffic Model and EVM for XR Intel Corporation
15. R1-2009041 Discussion on XR application and evaluation methodology Xiaomi
16. R1-2009087 XR use cases, traffic modelling and performance measure Ericsson
17. R1-2009198 Discussion on study on XR evaluations for NR NTT DOCOMO, INC.
18. R1-2009280 Evaluation Methodology for XR Qualcomm Incorporated

# List of agreements