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:

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| --- |
| 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 urban (FR1)  Urban Macro (FR1) | Dense urban (FR1)  Urban Macro (FR1) | Dense urban (FR1)  Urban Macro (FR1) |
| **vivo** | Indoor hotspot  Dense urban | Indoor hotspot  Dense urban | Indoor hotspot  Dense urban |
| **CATT** | Indoor hotspot  Dense urban | Indoor hotspot  Dense urban | Indoor hotspot  Dense urban |
| **LG** | Indoor with low mobility | AR1: Indoor/outdoor with low mobility  AR2: 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 hotspot  Urban Macro (UMa) | Indoor hotspot  Urban Macro (UMa) | Indoor hotspot  Urban 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. |
| CMCC | We think either UMi or Dense urban can be considered. |
| Ericsson | It is not clear to us what deployment scenario UMi corresponds to. We would suggest using the scenario definitions in 38.913. We propose to use Dense Urban with only the macro layer. |
| Xiaomi | To reduce the evaluation workload, we are fine to only evaluate UMi scenario. |
| vivo | UMi is to evaluated for reducing the number of evaluation scenarios |
| Huawei, HiSilicon | The question needs to separate propagation channel models (InH, UMi, UMa; see TR 38.901) from deployment scenarios (Dense Urban, Urban Macro; see TR 38.913). Both parts need to be agreed.  For deployment scenario, we support Dense Urban with FR1 mainly because they are the typical commercial deployment of NR networks. We suggest to perform evaluation and provide valuable studies at least for the already deployed NR networks.  For the channel model, it can be further discussed.  Note: we added “(FR1)” to Huawei’s proposals in the table above. |
| Nokia, NSB | We think that the number of scenarios to be evaluated should be kept to a reasonable level. To this end, we think that we should select only UMi scenario. |
| CATT | Either Umi or dense urban is fine. |
| AT&T | Agree with Ericsson. Assuming 38.913 we prefer dense urban scenario for outdoor evaluations with highest priority |
| Intel | Agree with Huawei that we have 2 components – deployment scenario and channel model. Between UMi and DU we think one common scenario/channel-model combination is sufficient. |
| Facebook | We think either is fine. |
| Samsung | Either UMi or DU (one only – FR1). |
| Apple | Either one fine for FR1. |

**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. |
| CMCC | We think FR1 should be prioritized. |
| Xiaomi | We think InH is also an important scenario for AR applications, e.g. in smart home or office, and thus all the three use cases VR/AR/CG should be prioritized for InH scenario. We are fine to FL’s proposal on other scenarios.  To reduce the evaluation workload, we are fine to prioritize FR1 over FR2, and support to select only a subset within AR1/AR2, VR1/VR2 to evaluate. |
| vivo | Prioritization on some combinations of deployment scenarios and applications is needed.  For each application, it can be evaluated in a deployment scenario.   * FR 1:   + InH: CG and VR are prioritized.   + UMi: AR is prioritized.   + UMa: low rate AR * FR 2:   + InH: CG and VR are prioritized.   + UMi: AR is prioritized. |
| Huawei, HiSilicon | We think FR1 should be prioritized over FR2.  As for applications, since the traffic model of each application is unclear, we think it’s premature to prioritize among them at this stage. We suggest to discuss the traffic model first so that companies can have better understanding of each application, and then we can pick some representative cases for further evaluation.  As for “low rate AR”, some company [18] mentioned it is currently being studied in SA4. According to the following Note in chairman notes, RAN1 will not discuss this application in this meeting.   * *NOTE: SA4 has ongoing work in the XR area, RAN1 will not address these SA4 aspects but will wait for SA4’s outcome* |
| Nokia, NSB | We agree that there should be prioritization in order to reduce the total number of simulation scenarios and keep the simulation effort to a reasonable level. We think that CG and VR applications are more reasonable for indoor deployment (InH), while AR applications fit outdoor deployment (either UMa or UMi). Furthermore, we think that low-rate AR applications are less interesting for capacity evaluation and should not be considered in the simulation scenarios. |
| CATT | We would like to prioritize FR1 over FR2 |
| AT&T | We do not agree to any prioritization of FR1 or FR2 for this study. Both are important for different XR applications. We are OK with the mapping of applications to scenario given by the FL in Q2 except we believe AR should also be added for indoor evaluations in FR1 and FR2. |
| Intel | We think prioritization of FR1 over FR2 is okay from simulation load perspective. We think prioritization across use-cases is not desirable, so should equally cover AR/VR/CG use-cases. We can try this way  VR --> InH, UMi,...  AR --> UMi, UMa,...  CG --> InH, UMi,...  On the other hand, we also agree with Huawei that may be this prioritization exercise is pre-mature and we can wait for requirements, KPIs and traffic model discussions to progress further. |
| Facebook | We think AR should be added for both InH and Umi/Dense Urban as AR is envisioned to be use in all difference scenario. We also think that low rate AR is an important use case addressing the near term market need. |
| Samsung | Prioritize FR1 over FR2. Prioritize as AR > CG > VR. Support to consider low rate AR for UMa.  Basically, prefer initial focus of simulation to be on FR1 and on AR for UMi/DU and UMa. |
| Apple | Prioritize FR1, and also focus both both downlink heavy traffic and uplink heavy traffic. |

## 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. |
| CMCC | Support FL proposal. |
| Xiaomi | Agree |
| vivo | We agree with the FL’s proposal. |
| Huawei, HiSilicon | We are generally fine with the proposal. However, at this stage, it’s unclear to use “a set of requirements” or just “one requirement”. So we suggest to use a more general expression as follows:  **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)~~. How to define the traffic requirement of a XR/CG user is satisfied ~~The exact ‘satisfied’ requirements~~ will be ~~defined~~discussed separately.** |
| Nokia, NSB | We agree with the system capacity definition proposed in Q3. However, while the exact set of requirements and values used to decide whether a UE is fully satisfied can be defined in a later stage, we think that UE satisfaction should be defined in terms of network-level requirements like PER, PDB and data-rate. Different set of requirements can be defined for UL and DL according to the traffic models and applications. |
| CATT | We agree with FL’s proposal |
| AT&T | Agree |
| Intel | At a high-level it make sense but this will get clearer once we know “requirements” better, as an example should we support user differentiation for services for e.g. UEs with geometry > threshold is considered for a particular service. MTK concern is also valid that whether it introduces too much simulation burden that will be clear once we know the range of PER. |
| Facebook | Agree |
| Samsung | Agree - the main issue is to define the requirements/metrics. |
| Apple | Agree |

**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.**

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| --- | --- |
| **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. |
| CMCC | X= 90 or 95 should be considered. |
| Xiaomi | X=90 or 95 |
| vivo | X=90 is adopted for the capacity evaluation. X=70,80 can be optionally assumed for the evaluation. |
| Huawei, HiSilicon | X=90 is fine. Other values of X can be FFS if necessary. |
| Nokia, NSB | We agree with the use of few X values for the definition of the system capacity in order to evaluate the trend as number of UEs per cell increase. However, the number of X values should be limited to two values like 90% and 95%. |
| CATT | X=95, which is 2-time standard deviation of normal distribution |
| AT&T | Ok with feature lead proposal |
| Intel | we are fine with the proposal, the exact values of X we can decide later |
| Facebook | Fine with the proposal. |
| Samsung | X=90 is fine to start with.  Importance/relative impact of other values (probably of ones > 90) can be discussed as the SI progresses. |
| Apple | X can be decided later. |

**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. |
| CMCC | Agree ZTE’s view. A basic principle can be considered. |
| Xiaomi | Agree |
| vivo | Support to defer the discussion on how to determine whether a UE is satisfied. |
| Huawei, HiSilicon | We agree with FL that for the system capacity definition, how to measure E2E user experience is critical when determining whether a UE is satisfied or not.  However, we suggest not to entirely defer the discussion in this meeting. In the SID, one objective is “3. Identify evaluation methodology to assess XR and CG performance along with identification of KPIs of interest for relevant deployment scenarios”. So RAN1 needs to identify proper KPIs to reflect XR/CG performance.  So for progress, we suggest that in this meeting, companies can discuss and agree some general principles on KPIs, i.e., the principles on how to define the traffic requirement of a XR/CG user is satisfied or not.  As mentioned in Q5, we think one principle is that RAN1 needs to identify a KPI that can reflect the user experience in XR and CG services. |
| Nokia, NSB | We agree that the definition whether a UE is satisfied or not should be deferred until the traffic models have been decided. However, we think that the set of constraints and values used to decide whether UE is satisfied should be defined in terms of network performance metrics like data-rate, PER, and PDB. |
| CATT | OK with the proposal |
| AT&T | Agree with InterDigital |
| Intel | We can discuss some principles but unless requirements/traffic-model are clear in terms of PDB, PER we cannot progress much in terms of developing criteria for user-satisfaction because we need to consider simulation complexity and time. So FL proposal is okay for us |
| Facebook | In general fine with the suggestions, but early discussion some system parameters maybe help per some companies suggested. |
| Samsung | OK with the FL proposal. |
| Apple | The latency requirement for a packet can be built in the traffic model itself. |

**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. |
| CMCC | We think RU can be reported for capacity evaluation. |
| Xiaomi | We think file transfer delay should be considered as round trip delay would have great impact on user experience especially for CG. |
| vivo | To Performance metrics can be additionally reported, including   * PER (file dropping rate) * UPT: UPT for each user can be collected and drawn in a UPT CDF curve, to show the throughput distribution among all users involved in the simulation * File transfer delay: CDF of file transfer delay * RU   Given that UPT and RU are reported and they are both related to the SE, it seems no need to report SE for the evaluation. |
| Huawei, HiSilicon | The relevant performance metrics should reflect user experience in XR/CG services.  However, if Q5 is not solved, then we are unclear about how to determine whether a UE is satisfied or not. Thus, we think it’s hard to determine which performance metrics are relevant.  So we suggest to discuss Q5 first, i.e., RAN1 can try to discuss and agree some general principles on KPIs first. We think there is no need to discuss Q6 in this meeting, companies are free to report the performance metrics. |
| Nokia, NSB | We think that is premature to discuss other performance metrics that may be reported. The discussion of other metrics should be deferred after the discussion on traffic models and the set of requirements used to decide whether the UE is satisfied. |
| CATT | UPT and latency are bi-product. We will define the KPI. |
| AT&T | At least UPT/RU/Delay should be reported |
| Intel | We need some clarifications here - PER, PDB, UPT are requirements – correct ? but RU/SE can be reported ? – is this the right understanding ? |
| Facebook | The proposed metrics are fine. However, more importantly we should further define some metrics/KPI capable of reflecting the user experiences depending on the use cases and applications. |
| Samsung | Can be further discussed. Somewhat premature to do so before Q5 is resolved. |

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. |
| CMCC | We think random offset (uniformly distributed) can be considered. |
| Xiaomi | Random/ Uniform distributed offset could be the baseline. But agree that evaluation with different assumptions on traffic arrival offset would be useful for potential collaboration between RAN and core network. |
| vivo | To simplify the evaluation, random offsets for the traffic arrival time among different UEs are assumed.  Other configuration for the traffic arrival offset can also be evaluated. |
| Huawei, HiSilicon | Premature to discuss. We think this is related to traffic model. So we suggest to discuss traffic model first. |
| Nokia, NSB | The offset among UE traffic arrivals can affect in a transitory period but given the likely high data rate requirements of the XR services, the impact of this offset should fade away. The decision of this parameter should be deferred after the decision of the traffic models appropriate to simulate XR and CG services. |
| CATT | The question of traffic arrival offset is not clear. For a stochastic process, it is statistic traffic inter-arrival among users. |
| AT&T | This will depend on the traffic model details |
| Intel | Our thinking is that this should be part of the traffic model discussion (in RAN1) |
| Facebook | Agree with AT&T. Once we finalize the traffic model details, we should be concluded the arrival offsets. |
| Samsung | Random offset with uniform distribution – although it can have a UE-common and a UE-dedicated component, it suffices to only consider a UE-dedicated component. |
| Apple | Traffic arrival at 120 Hz, 90 Hz, eg. Should be studied, random traffic arrival can be assumed. |

### 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 50m ISD: 20m TRP numbers: 12 | 21cells with wraparound |
| Carrier frequency | FR1: 3.5 GHz  FR2: 28 GHz | |
| Bandwidth | FR1: 100 MHz  FR2: 400 MHz | |
| Subcarrier spacing | FR1: 30 kHz  FR2: 120 kHz | |
| BS height | 3m | 25m |
| UE height | hUT=1.5 m | |
| UE power | FR1: 23 dBm  FR2: Maximum EIRP 43 dBm | |
| BS noise figure | FR1: 5 dB  FR2: 7 dB | |
| UE noise figure | FR1: 9 dB  FR2: 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. |
| CMCC | We think 4 or 4.9GHz can be used as carrier frequency for FR1. |
| Xiaomi | Agree |
| vivo | Support the proposal 1. |
| Huawei, HiSilicon | Since Q2 is discussing the deployment scenarios, we suggest to discuss Q2 first, and Q8 can be deferred. |
| Nokia, NSB | Considering the large number of simulation scenarios, simulation bandwidth should be reduced to limit the overall simulation time. The bandwidth should be large enough to capture system limits while keeping simulation time to a reasonable level. This would allow to scale up the results to larger bandwidth by an appropriate factor. We propose 40 MHz for FR1 and 80 MHz for FR2 as simulation bandwidth. The value of 80 MHz for FR2 has been discussed and agreed in another SI (R1-2007151) and could serve as a base for the discussion in this study.  For FR2, we propose up to 256QAM for DL and up to 64QAM for UL. |
| CATT | 4 GHz is widely used for evaluation in NR and should be considered here. |
| AT&T | Agree with Ericsson. 4GHz and 30GHz should be assumed for FR1 and FR2 to align with other evaluation campaigns in RAN1 |
| Intel | Same view as Nokia in terms of actual simulated BW – and similar concept was adopted for IMT-2020 eval as well. However, this would become more clear once we have a picture of traffic model and PER/PDB requirements. |
| Samsung | Fine with the proposal and the suggestion by Nokia. Prefer to prioritize FR1. |
| Apple | Focus on FR1, and 20 MHz for bandwidth, 1Tx, 2Rx should also be considered. |

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)λ  FR2:  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)λ  FR2: 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)λ  The polarization angles are 0° and 90° | |
| Downtilt | Outdoor:  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)  Indoor:  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 | Realistic  Companies should report CSI feedback delay, CSI report periodicity, whether using CSI quantization, CSI error model or not, and etc. | |
| PHY processing delay | UE Capability #1 Companies 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.**

|  |  |
| --- | --- |
| **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 . |
| CMCC | Support option 1 for FR1. |
| Xiaomi | We support option 1 for FR1 |
| vivo | For outdoor scenario, we prefer the following option   * + FR1:     - Option 1: 80% indoor, 20% outdoor |
| Huawei, HiSilicon | Support FR1 Option 1. |
| Nokia, NSB | The decision on the UE distribution should be deferred after the agreement on the prioritization of XR applications and deployments discussed on Q2. If only AR applications are evaluated in the outdoor deployments, we propose to consider the following options for UE distribution:   * FR1: 100% outdoor (Option 3) * FR2: 100% outdoor |
| CATT | Option 1 for FR1 |
| AT&T | Option 1 for FR1 is OK. **Again we do not agree to any prioritization of FR1 over FR2** |
| Intel | for FR2 it makes sense to use 100% outdoor  for FR1 Option 1 is typical assumption – we can keep it as default |
| Facebook | Support option 1 |
| Samsung | Prioritize FR1, option 1. |
| Apple | Both Option 1 and Option 2 can be considered. |

**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.**

|  |  |
| --- | --- |
| **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) |
| CMCC | For FR1, We support option 1,5,6. We think Option 6 can be change to DS. |
| Xiaomi | Agree to prioritize FR1, and support option 1 for FR1. |
| vivo | It is necessary to limit the number of options for frame structure so that the simulation work load can be controllable.  Following options for FR1 and FR2 can be adopted   * FR1   + Option1: DDDSU (S: 10D:2G:2U)   + Option2: DDDSUDDSUU (S: 10D:2G:2U) * FR2   + DDDSU (S: 10D:2G:2U) |
| Huawei, HiSilicon | Support FR1 Option 1. |
| Nokia, NSB | We think that FDD (option 7) for both UL and DL can be used for FR1, whereas TDD Option 1 (DDDSU) should be considered for FR2. However, we underline that a decision on TDD frame structure should be deferred after decisions (i) on the traffic models for XR applications and (ii) on the PHY processing delay. Indeed, XR performance can be affected by the delay introduced by TDD frame design (e.g., higher RTT that decreases XR performance). Furthermore, the PHY processing delay affects the design of the frame structure. |
| CATT | Option 1 or 5 for FR1 |
| AT&T | Option 1 for both FR1/FR2 |
| Intel | We also feel its better to understand delay requirements and traffic model first |
| Facebook | For FR1, we think both option 1 and option 5 should be included. The reason option 5 is mainly due to the increasing uplink traffic in lots of AR sharing applications as in SA4 TR 26.928.  FR2, Option 1 |
| Samsung | FR1, option 1 or option 5. |
| Apple | Option 1 for FR1, Option 5 for FR1 |

**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: 2TxRU  Outdoor 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. |
| CMCC | For outdoor FR1:Option 1 is preferred. |
| vivo | We prefer the following option   * 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) * For outdoor scenario:   + FR1:     - Option 1: 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (12,8,2,1,1;4,8)   (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)   (dH, dV) = (0.5λ, 0.5λ) |
| Huawei, HiSilicon | Fine to FR1 outdoor scenario, Option 1 |
| Nokia, NSB | We think that for the evaluation in FR1 we should use a relatively small antenna array panel and a larger one for FR2. Furthermore, for indoor scenario (InH) we could further down-select the possible options, since UEs are expected to have good channel conditions. We propose to consider the following options for BS antenna configurations and open to discuss a down selection of these options.   * Indoor scenario:   + FR1: Option 1) 4 Tx/4 Rx, (M, N, P, Mg, Ng; Mp, Np) = (8, 4, 2, 1, 1; 1, 2), (dH, dV) = (0.5, 0.5)λ, Option 2) 8 Tx/8 Rx, (M, N, P, Mg, Ng; Mp, Np) = (8, 4, 2, 1, 1; 1, 4), (dH, dV) = (0.5, 0.5)λ   + FR2: Option1) 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1;4,8), (dH, dV) = (0.5, 0.5)λ – Option 2) 32 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1;4,4), (dH, dV) = (0.5, 0.5)λ * Outdoor scenario:   + FR1: Option 1) 4 Tx/4 Rx, (M, N, P, Mg, Ng; Mp, Np) = (8, 4, 2, 1, 1; 1, 2), (dH, dV) = (0.5, 0.5)λ, Option 2) 8 Tx/8 Rx, (M, N, P, Mg, Ng; Mp, Np) = (8, 4, 2, 1, 1; 1, 4), (dH, dV) = (0.5, 0.5)λss   + FR2: Option1) 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,8,2,1,1;4,8), (dH, dV) = (0.5, 0.5)λ – Option 2) 32 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (4,4,2,1,1;4,4) |
| CATT | Option 4 for FR1 outdoor. |
| AT&T | **No prioritization of FR1 over FR2. Both should be considered.**  For FR1: Option 3 for outdoor  For FR2: 2TxRU configuration: Option 2 for indoor, Option 1 for outdoor |
| Intel | We need to understand how much TXRU configuration is playing a role in user-satisfaction – this is not clear yet. We provide tentative view below:  for FR1 outdoor:   * massive MIMO case: Option 2 64 TxRU, (M, N, P, Mg, Ng; Mp, Np) = (8,4,2,1,1;8,4) * current typical deployment case: 4 TXRU if it makes sense and user-satisfaction is acceptable   for FR1 indoor:   * 32 TXRU square array   for FR2, we can use 2 TXRU/single-panel for both outdoor (tall) and indoor (square) |
| Samsung | Option 3 for FR1 outdoor. |
| Apple | Considering for XR evaluation, as packet arrivals are not so frequent, the simulation time can be long in order to generate reliable statistics. Increasing the TxRU number can substantially prolong the simulation time. For indoor, 2Tx from gNB, and for outdoor cases, a relatively small number, e.g. 8Tx or even 4Tx can be considered. |

**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.**

|  |  |
| --- | --- |
| **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. |
| CMCC | We propose to prioritize FR1 2T4R. |
| Xiaomi | We agree FL proposal on FR1 and open for FR2. |
| vivo | * 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 2: (M, N, P, Mg, Ng; Mp, Np) = (2,4,2,1,2;1,2)   The polarization angles are 0° and 90° |
| Huawei, HiSilicon | Support FR1, 4T4R |
| Nokia, NSB |  FR1: 2 or 4Tx/4Rx, (M, N, P, Mg, Ng; Mp, Np) = (1,2,1/2,1,1;1,2) (dH, dV) = (0.5, N/A)λ   * + 2 Rx can be considered if lower frequency bands where 2Rx is applicable are used.    FR2: Option 2: (M, N, P, Mg, Ng; Mp, Np) = (2,4,2,1,2;1,2) |
| CATT | Support FR1 2T4R |
| AT&T | **No prioritization of FR1 over FR2.**  FR1: (1,2,2,1,1;1,2)  FR2: option 2 or option 3 (need to align it with other evaluation campaigns in NR) |
| Intel | FR1 2T4R and FR2 2T2R |
| Facebook | FR1: 2Tx/4Rx or 1Tx/2Rx per many companies suggested  FR2: ok with more conservative antenna numbers per Ericsson suggestion. However, option 3 should be included as a practical scenario as well. |
| Samsung | FR1: 2Rx and 4Rx – 1Tx with higher priority than 2Tx. |
| Apple | 1Tx and 2Rx should also be considered, they are more practically for XR. |

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

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

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

|  |  |
| --- | --- |
| **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. |
| vivo | * Outdoor:   + Option 1: 6 degree * Indoor:   + Option 1: 0 degree |
| Huawei, HiSilicon | Fine to FR1. Detailed options may depend on scenarios. |
| Nokia, NSB | The decision on the antenna downtilt should be deferred after the decisions on the deployment scenarios and on the antenna configuration, since this parameter can be optimized based on the deployment scenario. Furthermore, we think that a downtilt should depend also on the deployment scenario, since ISD for InH and UMa is notably different (20m and 200m, respectively). |
| CATT | Antenna down tilt is a parameter for coverage tuning in the field deployment. |
| AT&T | Agree with Ericsson that the tilt will depend on the scenario for outdoor. For indoor, pointing to the ground. |
| Intel | Outdoor it depends on ISD and antenna configuration, indoor we should aim for ceiling mounted (pointing to ground) |

**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.**

|  |  |
| --- | --- |
| **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. |
| CMCC | For indoor scenario:   * FR1: 24dBm for 100MHz   For outdoor scenario:   * FR1: 53dBm for 100MHz |
| vivo | * For indoor scenario:   + FR1:     - 24dBm for 100MHz   + FR2:     - Alt1: Maximum EIRP 58dBm * For outdoor scenario:   + FR1:     - Alt4: 53dBm   + FR2:     - Alt1: Maximum EIRP 73dBm |
| Huawei, HiSilicon | FR1 outdoor scenario, Alt3. |
| Nokia, NSB | Regarding the BS transmission power, we consider the following options:   * Indoor scenario:   + FR1: 24 dBm / 20 MHz   + FR2: 23 dBm * Outdoor scenario:   + FR1: 43 dBm / 20 MHz   + FR2: 43 dBm |
| CATT | For indoor scenario:   * FR1: 24dBm for 100MHz   For outdoor scenario:   * FR1: 46 dBm for 100MHz |
| AT&T | **No prioritization of FR1 over FR2.**  For Indoor: FR1: 24dBm/100MHz, FR2: Alt. 1.  For outdoor: depends on scenario (e.g. Umi or Uma): For Umi: 44dBm/100MHz, for Uma: 49dBm/100MHz. |
| Samsung | Prioritize FR1. OK with corresponding values suggested by QC. |

**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** | Realistic  Companies should report CSI feedback delay, CSI report periodicity, whether using CSI quantization, CSI error model or not, and etc. |
| **PHY processing delay** | UE Capability #1 Companies 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.**

|  |  |
| --- | --- |
| **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. |
| CMCC | Support the proposal. |
| vivo | Support the proposal 8. |
| Huawei, HiSilicon | SU/MU-MIMO PF scheduler should be the baseline in order to provide a performance reference for different companies. Otherwise, the performance may be difficult to be compared due to different schedulers. |
| Nokia, NSB | We propose the following parameters for proposal 8:   |  |  | | --- | --- | | **Power control parameter** | Indoor: Open Loop, , dBm  Outdoor: Open Loop, , dBm | | **Transmission scheme** | Indoor:   * DL: dynamic rank adaptation (up to 2 streams per UE) * UL: rank 1   Outdoor:   * DL: dynamic rank adaptation (up to 4 streams per UE) * UL: rank 1 | | **Scheduler** | Latency and frequency aware scheduler | | **CSI Feedback** | Realistic  CQI feedback delay: 2ms  CQI report periodicity: 2ms  CQI quantization step: 1 dB,  CQI error model: no error | | **PHY processing delay** | UE Capability #2 (URLLC) Companies 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 PDCCH overhead | | **DMRS overhead** | Companies should report DMRS overhead | | **SRS** | Companies should report SRS settings | |
| CATT | OK with the proposal |
| AT&T | Support the proposal |
| Intel | OK |
| Samsung | Support the proposal |

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

|  |  |
| --- | --- |
| **Company** | **Comment** |
| AT&T | Any restrictions on PDSCH mapping type A/B? |
| Samsung | It is understood that, if requested, more assumptions may need to be reported. |
|  |  |

**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. |
| Nokia, NSB | The assumptions regarding the transport protocol(s) used should be decided at some point, as this will affect the simulation 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.**

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| --- | --- |
| **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. |
| Xiaomi | Agree with ZTE view. NW delay can be considered in traffic model discussion. |
| vivo | No need to consider these simulation assumptions for evaluations. |
| Huawei, HiSilicon | No need to consider beam related operation. |
| Nokia, NSB | Decision related to beam related operations, such as beam update mechanism, beam activation delay, beam metric should be deferred after the decision on the deployment scenarios and antenna configurations.  L2 (MAC, RLC, PDCP) and core network parameters affects the performance of TCP-like connections which are used for CG and on-demand VR applications. The decision L2 and core network settings (e.g., core network delay) should be deferred after the decision on traffic models for XR applications. |
| Intel | It can be left to companies to report |
| Samsung | Agree in principle with previous comments to not consider such aspects.  Companies can, of course, still report. |

**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. |
| Intel | Agree with MTK – we can start from IMT and see what changes are necessary. Another question is whether calibration campaign is planned for this SID ? |
|  |  |

# 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