**3GPP TSG-RAN WG1 Meeting #122** **R1-250xxxx**

**Bengaluru, India, August 25 – 29, 2025**

**Agenda Item: 11.2**

**Source: Moderator (Huawei)**

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

**Document for: Discussion and Decision**

# Introduction

## [Evaluation assumptions for 6G](#_Toc450829434)R air interface

*Discussions on models, scenarios, parameters, and methodology, metrics/criteria that can be used for evaluating technology proposals, energy efficiency, sensing performance (including potential extension of channel model).*

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

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

This is the first RAN1 meeting to discuss 6GR air interface. As planned, technical topics including waveforms/frame structure, coding and modulation, energy efficiency, and AI/ML start from this meeting, while other technical directions such as initial access, MIMO, physical channel signal design, duplexing, spectrum utilization, NTN, and ISAC will be addressed starting from RAN1#124/124bis. Based on the submitted contributions, most companies have analyzed the required evaluation assumptions and methodologies across these technical directions.

This summary aims to:

* ‌Consolidate cross-topic common evaluation assumptions and methodologies‌‌, providing common system-level, common link-level simulation assumptions, and traffic modelling for 6GR;
* ‌Identify technique-specific evaluation methodologies including evaluation assumptions and performance metric‌‌; further clarify or be decided by chairman whether such evaluations related should be discussed in AI 11.2 or other specific technical topics, such as channel coding, waveform, energy efficiency, AI/ML, sensing, etc…
* Highlight gaps‌ for conducting evaluations for the techniques, e.g., channel model, traffic model, etc.

# Common evaluation assumptions

Based on the submitted papers, quite a few companies proposed to consider the deployment scenarios and performance metrics in TR 38.914 or even take them as the baseline.

As the starting point, the common basic evaluation assumptions including BS/UE antenna configuration, basic configurations for the system-level and link-level simulations, and traffic model can be discussed first.

The evaluation assumptions for other specific technical topics are summarized in each subsequent section, where moderator’s observation and suggestions are provided regarding how to handle the assumptions in the future meetings. If companies have different views or better suggestions, can consider to leave them in the views collecting text boxes, so that companies can better understand how the evaluations will be handled in the future.

## Antenna modeling

### Companies’ views

Companies proposed the antenna configurations mostly according to the frequency range including both BS and UE.

**Companies’ views from contributions are summarized in the attached spreadsheet tabbed with ‘antenna model’.**

### Discussions

The summary includes all the options for now.

The plan for this meeting is figuring out all the options as summarized and if possible, ruling-out some of options or making some options as the baseline during the offline discussion.

#### Round-1

General comment/suggestion regarding the plan or summary of the ‘antenna model’, please leave them here.

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| **Company** | **Comments** |
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## System-level assumptions

### Companies’ views

The general discussion for the system-level evaluation includes the evaluation configurations for each deployment scenarios and particularly the carrier frequency and bandwidth together with other parameters.

**Deployment scenarios**:

Quite a few companies proposed to take the TR 38.914 as a starting point as follows:

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| **Scenarios** | **Mentioned by** |
| Indoor hotspot | ZTE, Sony, vivo, Xiaomi, Ofinno, IITH and WiSig, CMCC, NTT DOCOMO, NVIDIA |
| Dense urban | ZTE, Sony, vivo, Xiaomi, Ofinno, IITH and WiSig, MediaTek, ETRI, CMCC, NTT DOCOMO, NVIDIA |
| Rural | ZTE, Sony, vivo, Xiaomi, Ofinno, IITH and WiSig, CMCC, NTT DOCOMO, NVIDIA |
| Urban macro | ZTE, Sony, vivo, Xiaomi, Ofinno, IITH and WiSig, MediaTek, ETRI, CMCC, NTT DOCOMO, NVIDIA |
| Sub-Urban macro | ZTE, Spreadtrum, vivo, Ofinno, IITH and WiSig, MediaTek, ETRI, AT&T, NVIDIA, NTT DOCOMO |
| High speed | CMCC, Nokia, Ofinno |
| Extreme long-distance coverage in low density area | AT&T |
| Urban coverage for massive connection |  |
| Air-to-Ground Scenario | Spreadtrum |
| Non-Terrestrial Network | Nokia, Futurewei, CMCC, Huawei, ZTE, CATT, Xiaomi, Ofinno, MediaTek, LGE,Apple, Sharp, ETRI, Ericsson, AT&T, NTT docomo, |
| Urban grid | Huawei, ZTE, vivo,Xiaomi, OPPO |
| Highway Scenario | ZTE, vivo, Xiaomi, OPPO |

**Companies’ views from contributions are summarized in the attached spreadsheet tabbed with ‘General SLS’.**

### Discussions

The summary includes all the options for now.

The plan for this meeting is figuring out all the options as summarized and if possible, ruling-out some of options or making some options as the baseline during the offline discussion.

#### Round-1

General comment/suggestion regarding the plan or summary of the ‘General SLS’, please leave them here.

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| **Company** | **Comments** |
| NVIDIA | * The evaluation metrics for SLS should focus on spectral efficiency related KPIs including 1) Average Spectral Efficiency (bits/s/Hz/TRxP), 2) 5th-Percentile User Spectral Efficiency (bits/s/Hz) and 3) Area Traffic Capacity (bits/s/m2). * A new evaluation metrics called ‘Radio Resource Utilization Efficiency or RUE’ (unit-less) should be introduced to measure how efficiently 6G RAT utilizes the available radio resources. Applicable to either downlink or uplink, the metric is defined as the product of five components: * denotes the guard band ratio, i.e., total guard band divided by bandwidth. * denotes the ratio of the number of CP samples to the total number of samples in a slot. * denotes the overhead calculated as the average ratio of the number of resource elements occupied by L1/L2 control, SSB, reference signals, etc. This value heavily depends on how the system configures CORESETs for PDCCH, SSB, TRS, CSI-RS, DM-RS, etc. * is the forward error correction (FEC) code rate.   + Using maximum forward error correction code rate in the metric evaluates the peak performance. One can use, e.g., average forward error correction code rate to evaluate the average performance. * is the duplex factor reflecting the fraction of time/frequency resources available in the direction (downlink or uplink) in question:   + In FDD, because the radio resources are equally split between downlink and uplink.   + In TDD, and depend on how the specific TDD configuration splits the radio resources between downlink and uplink. * In Full Duplex, because the radio resources are fully available to both downlink and uplink. |
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## Link-level assumptions

Some of assumptions for link-level are the same as system-level, including carrier frequency and bandwidth, etc. Apart from that, other link-level assumptions might be technique-specific.

The plan is putting this discussion on hold and figuring out what to do next, e.g., after a bit progress on system-level assumptions or after discussing what should be discussed here per each technical topic.

### Companies’ views

### Discussions

#### Round-1

General comment/suggestion about what should be discussed as the common link-level assumptions, please leave them here.

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| **Company** | **Comments** |
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## Traffic model

The traffic model is needed in the system-level evaluations and will be used in multiple topics. This section summarizes and discusses the traffic model in general by identifying whether the existing traffic model is sufficient, whether the existing traffic model needs to be updated/adjusted, whether new model needs to be defined and the motivation for each.

### Companies’ views

**Reusing the existing models**:

* **Full buffer**
  + Mentioned by*: ZTE, Futurewei, Nokia, CATT, Huawei, Xiaomi, MediaTek, DOCOMO*
* **Conventional burst traffic model (FTP3, FTP3-IM, VOIP, XR)**
  + **FTP [36.814, 36872]***: mentioned by ZTE, Futurewei, Sony, CATT, Samsung, Huawei, vivo, Xiaomi, MediaTek, AT&T, DOCOMO*
  + **XR [38.838]**: *mentioned by Futurewei, Xiaomi, Huawei, Sony, vivo, MediaTek, AT&T, NVIDIA*
  + **VOIP**: *mentioned by Samsung, MediaTek*
  + **Instant message**: *mentioned by MediaTek*

**New traffic models**:

**New model 1**: (Ericsson, Apple)

Ericsson: **as mixed/variable packet size and time domain behaviors (e.g., time between individual packets)** are adequately reflected, while at the same time simulator complexity is not excessively impacted.

Apple: more realistic trafﬁc modeling and suiting the need for **new service/new use cases**, it should be explored whether trafﬁc model other than the ftp1 model can be considered, for example, considering **two trafﬁc ﬂows with different packet size distribution/latency bound**.

**New model 2**: (Ericsson)

Study more realistic modelling approaches that can reflect the impact of **bidirectional traffic flows** on performance metrics (e.g., impact of UL TCP ACK latency on DL throughput/latency)

**New model 3**:

Motivated by new services with AI related, e.g., immersive communication, token communication, etc.

* + ***Mentioned by****: MediaTek, AT&T, Google, NVIDIA, Sharp, Huawei,*
* uplink-heavy immersive
* AI applications related traffic.
* The token-streamlined traffic model

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| **Companies** | **Views from tdoc** |
| *MediaTek* | *AI applications: RAN1 to discuss whether a new traffic model is needed or not.* |
| *NVIDIA* | *Study traffic models for performance evaluation during 6GR study taking into consideration the unique characteristics (uplink-heavy, burst and highly dynamic with the uprise) of UL-heavy immersive and AI applications related traffic.* |
| *Sharp* | *RAN1 to discuss whether a new traffic model is needed or not for AI applications in 6G study.* |
| *AT&T* | *6GR SI to include a study of a new traffic model for generative AI traffic.*  *For 6GR evaluation, define a revised mixed-traffic profile including XR and GenAI.* |
| *Google* | *The study should incorporate an AI-specific traffic model for evaluations. The token-streamlined traffic model is proposed to accurately represent the data patterns and requirements of future AI/ML services. The reliability of CSI reporting for AI traffic should be prioritized and considered to be higher than that for other traffic types. Evaluations should consider a CQI report with a 1% target BLER for traffics with stringent reliability requirement including AI traffic.* |
| *Huawei* | * *The evaluation of token communications can consider the parameters that token arrival rate, token size, token success rate requirement, and token delay budget in Table 6.2.1.1 as the reference service requirement.*   Table 6.2.1.1: The example for the service requirement of token communications.   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | **Token arrival rate (Note 0)** | **Token size** | **Token success rate (Note 1)** | **Token Delay budget** | | Human-agent communication with text/visual tokens | 30K~100K tokens/second (Note 2) | [small: 10~20, large: ~400] bits/token (Note 5) | 99.9% for text tokens, [80~99]% for others (Note 3) | 0.1~1 s (Note 4) | | Robot-agent communication with visual tokens | 30K~60K tokens/second (Note 10) | [small: 10~20, large: ~400] bits/token (Note 5) | [80~99]% | 10~15 ms (Note 6) | | Agent-agent communication | up to 30K tokens/second (Note 7) | ~20 bits/token (Note 8) | 99.9% for text tokens, [90~99]% for others | [1~15] ms (Note 9) |   Downlink requirements for immersive XR gaming   |  |  |  |  | | --- | --- | --- | --- | | ***Resolution*** | ***Refresh rate User*** | ***Service data rate****[NOTE 1]* | ***DL latency****[NOTE 2]* | | *8K (7680×4320）* | *90* | *100Mbps* | *10ms* | | *16K (15360×8640)* | *120* | *500Mbps* | | ***NOTE 1:*** *Data Rate = Resolution × Bit Per Pixel × Refresh Rate / Compression Ratio, where compression ratio of 400 and 12 bits per pixel (YUV4:1:1 compression encoding) are considered [38].*  ***NOTE 2:*** *E2E latency for XR often refers to motion-to-render-to-photon (M2R2P) latency. 3GPP indicates preserving a low 50-70ms M2R2P) latency [39]. In addition, as per TR 38.838, a minimum RAN latency of 10ms is considered for DL cloud gaming use case, and reliability of 99%.* | | | | |

### Discussions

#### Round-1

**Proposal 1:**

**The following existing traffic models are supported for 6GR evaluations:**

* **Full buffer**
* **FTP 1/2/3**
* **XR**

**Proposal 2:**

**Study new traffic models including:**

* **New model 1**:

as mixed/variable packet size/latency bound and time domain behaviors (e.g., time between individual packets/latency bound) are adequately reflected, while at the same time simulator complexity is not excessively impacted.

* **New model 2**:

Study more realistic modelling approaches that can reflect the impact of bidirectional traffic flows on performance metrics (e.g., impact of UL TCP ACK latency on DL throughput/latency)

* **New model 3**: Motivated by new services, e.g., token communication, immersive communication, etc, considering
  + The token-streamlined traffic model
  + Immersive communication, e.g. uplink-heavy
  + Composite requirement with different values of latency and data rate.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
| NVIDIA | * Study a new UL-centric traffic model in 6GR focusing on – 1) asymmetrical UL/DL traffic profile, 2) more realistic ‘burstiness’ in the traffic pattern that is expected from emerging UL-heavy applications * Study variants of the new traffic model reflecting ‘context-awareness’ of specific 6G services, including * Data types (e.g., video/sensor data vs. data related to model parameters) * Application specific requirements (e.g., AI inference latency) * Application specific KPIs (e.g., AI inference accuracy with compute latency bounds, resource utilization efficiency for distributed computing and/or model aggregation) |
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# Specific assumption on coverage

## Companies’ views

**Co-site comparable coverage**

Now that with the new frequency range (6~24GHz) considered for 6GR study, one issue of high interest is the coverage with around 7GHz co-site deployment with 4GHz, as mentioned by several companies, e.g., *Nokia,* *Qualcomm, DOCOMO, Futurewei, Huawei, UNISOC, vivo, Intel, CMCC, CTC etc.*

**Coverage analysis method**

Link budget analysis from Rel-17 NR coverage enhancement in TR 38.830 can be used as a starting point for the evaluation.

## Discussions

### Round-1

**Proposal:**

**For the coverage evaluation on study to provide the comparable coverage for the co-site deployment, e.g., around 7GHz co-site deployment with 4GHz**

* **Link budget analysis is used.**

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
| NVIDIA | Besides link budget analysis, system level evaluation should be conducted to check if comparable coverage could be achieved for the co-site deployment |
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# Specific assumption on waveform

## Companies’ views

#### Aspect #1: General evaluation methodology

**Main point #1:** **Link-level simulation for waveform evaluation**

* + Mentioned by: Huawei/Hisi, Nokia, Spreadtrum, ZTE, Sony, CATT, vivo, Samsung, Interdigital, Lenovo, Apple, MTK, ETRI, CMCC, SK Telecom, Ericsson, Qualcomm, Tejas, DOCOMO

#### Aspect #2: Evaluation considerations for communication waveform

**Main point #1**: **The performance metric of link level simulation**

* + **Option 1**: BLER
    - Mentioned by: Huawei, Nokia, Spreadtrum, ZTE, Tejas, Docomo, CATT, vivo, Samsung, IITH, Interdigital, Lenovo, ETRI. CMCC, SK Telecom, Qualcomm
  + **Option 2**: throughput/spectral efficiency
    - Mentioned by: Huawei, Nokia, Spreadtrum, ZTE, Tejas, CATT, vivo, Samsung, IITH, Interdigital, Lenovo, ETRI, SK Telecom, Tejas
  + **Option 3**: OOBE
    - Mentioned by: Spreadtrum, SK Telecom, Qualcomm
  + **Option 4**: PAPR
    - Mentioned by: Nokia, Huawei, Spreadtrum, CATT, vivo, Samsung, Interdigital, SK Telecom, Qualcomm, Tejas
    - Concerned: Lenovo
  + **Option 5**: CM
    - Mentioned by: Nokia, Spreadtrum, Samsung, Interdigital, Lenovo, Qualcomm
  + **Option 6**: DCM
    - Mentioned by: vivo
  + **Option 7**: Net gain (Tx power gain minus the link loss)
    - Mentioned by: Huawei, Apple, ZTE, Vivo, CMCC, Nokia, Qualcomm, DOCOMO, Xiaomi, Tejas, Ericsson
  + **Option 8**: RAN4 requirement (include EVM, IBE, ACLR, SEM)
    - Mentioned by: Nokia, Huawei Samsung, SK Telecom, Ericsson, Qualcomm, Tejas
  + **Option 9**: Net Gain = SNR@10%BLER + (99% or 99.99%) PAPR
    - Mentioned by: Apple
  + **Option 10**: detection complexity
    - Mentioned by: ZTE, Huawei, Samsung, CATT, Interdigital, Lenovo, Qualcomm
  + **Option 11**: UE complexity
    - Mentioned by: Samsung, Lenovo
  + **Option 12**: Rx processing delay
    - Mentioned by: Samsung, Qualcomm, Huawei
  + **Option 13**: Take into account guard band and time domain overhead
    - Mentioned by: Samsung
  + **Option 14**: energy efficiency
    - Mentioned by: Spreadtrum
  + **Option 15**: robustness to Delay and Doppler offset
    - Mentioned by: Spreadtrum
  + **Option 16**: Transparency of transmitter’s spectral confinement technique(s) (e.g., filtering, windowing, etc.) at the receiver
    - Mentioned by: Samsung
  + **Option 17**: signalling overhead
    - Mentioned by: Lenovo

**Main point #2: channel model**

* + **Option 1: consider TDL**
    - Mentioned by: Huawei, ZTE, Sony, CATT, vivo, Samsung, Lenovo, Apple
  + **Option 2: consider CDL**
    - Mentioned by: Huawei, ZTE, Sony, Samsung, Lenovo, ETRI
  + **Option 3: Beyond statistical channel models**
    - Mentioned by: DeepSig

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| **Company** | **Views** |
| *Sony* | *TDL for non-MIMO evaluation; CDL for MIMO evaluation* |
| *vivo* | *low PAPR waveform can consider TDL for LLS* |
| *Samsung* | *All values of DS {10, 30, 100, 300, 1000} ns are evaluated with the selected TDL-DS combinations, i.e. TDL-A for DS {10, 30} ns, TDL-B for DS {100 } ns, TDL-C for DS {300, 1000} ns.* |
| *Lenovo* | *NTN TDL/CDL* |
| *Apple* | *TDL-C with Medium correlation and 300 ns delay spread* |
| *Samsung* | *CDL-{A,B,C} in TR 38.901 with {50, 300, 800} ns DS, with 15 degrees AoD spread for TRP, 45 degrees AoA for UE and beam forming scheme used for spatial filtering needs to be reported for CDL.* |
| *ETRI* | *CDL-A/B/C models*  *Possible DS values = {10, 30, 100, 300, 1000} ns.*  *ASA, ASD, ZSA, ZSD follow the values in sec 7.7.5.1 in TR 38.901* |
| *Deepsig* | *Performance evaluations should expand beyond statistical channel models such as TR 38.901 CDL (UMi, UMa, RMa, etc) class channel models – and should consider performance evaluation especially on measurement based data sets, RF ray tracing based channel models, “calibrated” RF ray tracing models, generative AI based channel models, or other more representative channel models (including ones derived from digital twins), which may more accurately reflect local conditions of various types of deployment conditions* |

**Main point #3: Realistic PA modelling**

* + Mentioned by: Nokia, Huawei, vivo, Samsung, Interdigital, Apple, Ericsson, QC

**Main point #4: The considered simulation speed for evaluation should be clearly illustrated in specified scenario, e.g., high-speed train**

* + Mentioned by: Nokia, Ofinno, CMCC, DOCOMO

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| **Company** | **Views** |
| *Nokia* | *For low and moderate UE speeds, use generic frequency-selective channel models such as TDL and CDL. For high UE speeds, define a clear use case (e.g., high-speed train) and apply an appropriate model such as the HST channel models defined in TS 38.101-4.* |
| *Ofinno* | *Discuss RAN1 level evaluation assumptions for high-speed scenario after the corresponding agreement in the RAN level SI on 6G.* |
| *CMCC* | *For simulation assumptions, RAN1 to take Table 1-5 in R1-2506096 as deployment scenarios for High speed scenario.* |

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| ***Considered simulation Speed*** | ***Companies’ proposal*** |
| *3kmh* | *SONY, CATT, VIVO, XIAOMI, Samsung, NVIDIA, Ofinno, Interdigital, Inc., Lenovo**, ETRI，CMCC**, Qualcomm Incorporated, NTT DOCOMO, INC., Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* |
| *30kmh* | *SONY, CATT, VIVO, XIAOMI, Samsung, NVIDIA, Ofinno, Interdigital, Inc. , ETRI，Qualcomm Incorporated, , NTT DOCOMO, INC., Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* |
| *60kmh* | *VIVO, Interdigital, Inc. , ETRI, Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* |
| *120kmh* | *SONY,CATT,VIVO, Samsung, NVIDIA, Interdigital, Inc. , ETRI,, NTT DOCOMO, INC.* |
| *500kmh* | *VIVO，NVIDIA, Ofinno, ETRI，CMCC(for HST channel)* |
| *1000kmh* | *NVIDIA, ETRI* |

#### Aspect #3: Evaluation considerations for ISAC waveform

**Main point #1**: link-level simulation for ISAC evaluations

* + Mentioned by: Nokia, ZTE, Interdigital., Apple, Qualcomm

**Main point #2**: System-level simulation for ISAC waveform should be further considered after RAN1 discussed.

* + Mentioned by: Qualcomm

**Main point #3**: Metrics for evaluate ISAC waveform

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| ***Metrics*** | ***Mentioned by*** |
| Doppler and Range Resolution for a target SINR | *Qualcomm, [Lenovo, Nokia, SS, IDC(LLS), Apple, MTK, google]* |
| Minimum/maximum range & maximum velocity | *Qualcomm* |
| Waveform Confinement and Emissions Compliance | *Qualcomm* |
| PAPR (Peak-to-Average Power Ratio) | *Qualcomm, Huawei, Hisilicon* |
| EVM (Error Vector Magnitude) | *Qualcomm* |
| Transmitter/Receiver Complexity | *Qualcomm* |
| Integration/harmonization between sensing & communication | *Qualcomm, [LG Electronics, Ericsson AB., AT&T, Google]* |
| Ambiguity Function | *Huawei, Hisilicon, Spreadtrum/UNISOC* |
| *PSLR* | *Huawei, Hisilicon* |
| *ISLR* | *Huawei, Hisilicon,* |

## Discussions

**Observations and suggestions from moderator**:

* The summarized specific assumptions and considerations for waveform can be discussed in the agenda for waveform study, e.g., link-level assumption and performance metrics.
* FFS PA modelling?

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on channel coding and modulation

## Companies’ views

#### Aspect#1: General evaluation methodology for Channel coding

* **Main point #1**: perform link-level simulation
  + Mentioned by: Spreadtrum, Lenovo, SK Telecom, Qualcomm, Huawei, NTT DOCOMO, INC., Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig

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| **Company** | **Views** |
| *Spreadtrum* | *evaluation can be performed through link-level simulation* |
| *Lenovo* | *Evaluate the block error rate (BLER) performance versus SNR* |
| *SK Telecom* | *Link level simulation is used for evaluation of waveform, channel coding, and modulation.* |
| *Qualcomm* | *In addition, link level evaluations results in fading and MIMO channels with fixed MCS as well as link adaptation could also be evaluated to reflect performance in real-world scenarios.* |
| *NTT DOCOMO, INC.* | *Technical topics for link-level simulation* |
| *Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* | *Evaluation methodology: Link level simulation* |

#### Aspect#2: Evaluation considerations for Channel coding

* **Main point #1**: low complexity
  + Mentioned by: Spreadtrum, Huawei, CATT, Samsung, Lenovo, SK Telecom, Qualcomm

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| **Company** | **Views** |
| *Spreadtrum* | *The complexity of encoding and decoding should be considered for channel coding evaluation.* |
| *Huawei* | *Complexity refers to the amount of computation performed by an encoder and a decoder*  *Algorithmic complexity of a decoding algorithm is widely used to compare between coding schemes as they can be aligned among different companies. It is measured by the number of arithmetic operations, such as additions, comparisons and table lookups.*  *In order to fairly compare different channel coding schemes, the comparisons should be made under the same or similar complexity. If a coding scheme has both better error correcting performance and lower complexity, it is considered the superior one.* |
| *CATT* | *For the modulation of 6G, BLER, PAPR, detection complexity and throughput performance should be considered when involving new coding and modulation schemes.* |
| *Samsung* | *Evaluate the complexity for LDPC code and Polar code.* |
| *Lenovo* | *Reduced computational complexity; Better area efficiency* |
| *SK Telecom* | *Proposal 5. For channel coding evaluation, at least BER/BLER, decoding/encoding complexity/latency should be considered as metric.* |
| *Qualcomm* | *Study the BLER vs SNR performance subject to decoding complexity constraint.*  *For LDPC code over data channel, study performance-complexity tradeoff over AWGN channel.* |

* **Main point #2**: low latency
  + Mentioned by: Huawei, Samsung, SK Telecom

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| **Company** | **Views** |
| *Huawei* | *Complexity refers to the amount of computation performed by an encoder and a decoder*  *o Algorithmic complexity of a decoding algorithm is widely used to compare between coding schemes as they can be aligned among different companies. It is measured by the number of arithmetic operations, such as additions, comparisons and table lookups.* |
| *Samsung* | *Evaluate the latency for LDPC code and Polar code* |
| *SK Telecom* | *For channel coding evaluation, at least BER/BLER, decoding/encoding complexity/latency should be considered as metric.* |

* **Main point #3**: large payload size
  + Mentioned by: Spreadtrum, CATT, SK Telecom

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| **Company** | **Views** |
| *Spreadtrum* | *larger information block length should be considered* |
| *CATT* | *Parameters for evaluating LDPC code should at least include information block size, coding rate, lifting size, modulation scheme, target BLER and decoding algorithms. Parameters for evaluating polar code should at least include information block size, coding rate, modulation scheme, target BLER and decoding algorithms.* |
| *SK Telecom* | *For channel coding evaluation, same code rates and block sizes should be considered.* |

* **Main point #4**: higher-order modulation
  + Mentioned by: Spreadtrum, Lenovo, Apple, QC

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| **Company** | **Views** |
| *Spreadtrum* | *The basic simulation assumptions can take the section A.1.3 of TR 38.802 as a baseline, and higher order modulation, larger information block length should be considered.* |
| *Lenovo* | *QPSK, 16-QAM, 64QAM, 256-QAM, 1024-QAM* |
| *Apple* | *Data channel: QPSK, 64,256 QAM, LDPC*  *Control channel: QPSK, 16,64 QAM, RM/Polar* |
| *Qualcomm* | *1.For modulation evaluations with higher order QAM, the BLER vs SNR performance over AWGN channel should be evaluated.*  *2.For LDPC code over data channel, study performance-complexity tradeoff over AWGN channel. Evaluate the performance of LDPC codes with higher order QAM (e.g., 256QAM and 1KQAM), and prioritize the coding rate, modulation order combinations specified in NR MCS table.*  *3.For polar code over control channel, evaluate BLER vs SNR performance for the channel coding rates and block sizes that are supported in 5G NR. QPSK modulation should be used, and higher order modulation may be considered if the use case can be justified.*  *4.For 6GR study on modulation, evaluate the designs based on the following considerations:*  *•At least BLER vs SNR performance over both AWGN channel should be evaluated.*  *•Link level performance over fading MIMO channels (with fixed MCS as well as link adaptation) could also be evaluated.*  *•PAPR of the modulation schemes should be studied, at least for applications in the uplink.* |

* **Main point #5**: Throughput
  + Mentioned by: Spreadtrum, Huawei, CATT, Lenovo, Qualcomm

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| **Company** | **Views** |
| *Huawei* | *Throughput is the data rate achieved by an encoder and a decoder.*  *Typically, the decoder determines the throughput because it is usually the bottleneck in the encoding and decoding chain.* |
| *Spreadtrum* | *higher data rate* |
| *CATT* | *For the modulation of 6G, BLER, PAPR, detection complexity and throughput performance should be considered.* |
| *Lenovo* | *Higher parallelism; Larger code blocks* |
| *Qualcomm* | *In addition, for high throughput use cases, typically higher order QAM is used.* |

* **Main point #6**: Area efficiency
  + Mentioned by: Huawei, Lenovo

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| **Company** | **Views** |
| *Huawei* | *The amount of throughput supported in a unit chip area, defined as Area Efficiency=Throughput/(Chip Area) ((bits/second)⁄〖mm〗^2 )*  *Besides BLER, the area efficiency and energy efficiency are intricately linked to encoding and decoding complexity.* |
| *Lenovo* | *Reduced bit/Joule encoding and decoding techniques, architectures and hardware implementations*  *Less retransmissions*  *Better performance at low E\_b/N\_0* |

* **Main point #7**: False alarm rate
  + Mentioned by: Samsung

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| **Company** | **Views** |
| *Samsung* | *Evaluate False Alarm Rate (FAR) for Polar code* |

* **Main point #8**: Coding rate
  + Mentioned by: CATT

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| **Company** | **Views** |
| *CATT* | *The evaluation can be performed based on the LDPC coding assumptions while the coding rate and information bit size for channel coding can be reused.  Parameters for evaluating LDPC code should at least include information block size, coding rate, lifting size, modulation scheme, target BLER and decoding algorithms.  Parameters for evaluating polar code should at least include information block size, coding rate, modulation scheme, target BLER and decoding algorithms.* |

* **Main point #9**: Total saved computational complexity ratio (TSCCR)
  + Mentioned by: Samsung

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| **Company** | **Views** |
| *Samsung* | *Evaluate total saved computational complexity ratio (TSCCR\*) for early termination gai for Polar code. \*TSCCR = 1- No. of information bits decoded with early termination / No. of information bits decoded without early termination.* |

* **Main point #10**: lifting size for LDPC
  + Mentioned by: CATT

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| **Company** | **Views** |
| *CATT* | *Parameters for evaluating LDPC code should at least include information block size, coding rate, lifting size, modulation scheme, target BLER and decoding algorithms.* |

#### Aspect#3: General evaluation methodology for modulation

* **Main point #1: link or system-level**
  + link-level simulation
    - Mentioned by: Huawei, ZTE, SK Telecom, Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig
  + System-level simulation
    - Mentioned by: Huawei

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| **Company** | **Views** |
| *Huawei* | *Link-level evaluations are used to justify the BLER performance gain for a modulation enhancement. These evaluations shall be thoroughly investigated across different modulation orders and code rates, e.g. at least including 64/256/1024QAM and code rates ranging from 0.33 to 0.93.*  *When comparing shaping and non-shaping schemes, the comparison shall be based on the same spectral efficiency. The modulation order and code rate should be chosen to achieve the best BLER performance of each scheme. This is important because the best MCS combination could be different for different schemes, especially in fading channels.*  *Additive White Gaussian Noise (AWGN)*  *Fading channels, such as Rayleigh, Tapped Delay Line (TDL), and Clustered Delay Line (CDL) channel models*  *Should consider cell-center/cell-edge SNR conditions, to evaluate all modulation orders and code rates in fading channels.*  *Should consider cell-center/cell-edge SNR conditions, to evaluate all modulation orders and code rates in fading channels.* |
| *ZTE* | *Link-level simulations can be utilized to evaluate some physical layer technologies of 6GR. After determining the above fundamental physical layer functions, the second phase should evaluate whether technical combinations can meet performance requirements for different scenario demands. For example, to support immersive multimedia services, 6GR needs to support more layer transmissions, and corresponding reference signals such as DM-RS and CSI-RS need to be enhanced. Furthermore, to ensure reception performance, we believe advanced receivers are very important, and so, besides for legacy MMSE-IRC, R-ML (Reduced-Maximum Likelihood) demodulation schemes can be considered in downlink evaluation. The basic idea of R-ML is to traverse candidate constellation points only within a limited hypersphere space, greatly reducing the complexity compared to the ML algorithm that traverses the entire space. This approach can be implemented within current receiver hardware computing capabilities. Compared to the MMSE scheme, the R-ML algorithm can significantly improve demodulation performance and BLER, and should serve as the starting point for 6GR evaluation. It should be noted that during MU-MIMO simulation, the target UE needs to obtain channel information and MCS of paired UEs during demodulation* |
| *SK Telecom* | *Link level simulation is used for evaluation of waveform, channel coding, and modulation.* |
| *Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* | *Evaluation method: Link level simulation* |
| *Huawei* | *system-level evaluations are also needed to evaluate the performance benefit at the system level. These evaluations should include at least average spectral efficiency, cell-edge spectral efficiency, average throughput and cell-edge throughput. To provide a system-level simulation (SLS) under high-order modulation scenarios, a typical dense urban environment can be considered for the study.*  *UMi, UMa, SMa, Rma*  *Follow current system level simulation methods, and assess all candidate modulation orders and code rates into the system level platform through link-to-system interface.* |
| *Nokia* | *Link-level physical layer evaluations isolate the link’s performance (as opposed to full network/system simulations) and use standard scenarios – e.g. AWGN and standardized multipath fading channels (EPA, EVA, TDL, CDL models, etc.), specific antenna, and sometimes mobility profiles for Doppler.* |

* **Main point #2**: Channel model
  + AWGN only: Lenovo, Apple
  + AWGN and fading: Huawei

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| **Company** | **Views** |
| *Huawei* | *As observed in section 3.1, the optimal modulation order and coding rate combination can be different for* ***AWGN and fading channels****. Similarly, performance comparisons for modulation enhancements can be significantly different depending on channel characteristics. For example, the best modulation scheme under AWGN might not be the best under fading channels. Therefore, a comprehensive investigation should include both AWGN and various fading channels, rather than focusing solely on AWGN.* |
| *Lenovo* | *AWGN* |
| *Apple* | *AWGN* |

#### Aspect#4: Evaluation considerations for modulation

* **Main point #1**: low complexity
  + Mentioned by: Huawei, Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig

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| **Company** | **Views** |
| *Huawei* | *At least computational complexity and storage complexity should be investigated for any proposed modulation enhancements, which is critical to evaluate the impact on the network and UE implementation.* |
| *Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* | *Modulation schemes directly impact spectral efficiency, robustness, and implementation complexity.* |

* **Main point #2**: low latency
  + Mentioned by: Huawei

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| **Company** | **Views** |
| *Huawei* | *The ability to parallelize related processing is important. For example, if the processing algorithm cannot be parallelized, the resulting processing latency can be large. This may become a bottleneck in the modulation and coding chains, ultimately impacting throughput.*  *Analyze latency by considering the serial processing steps inherent in the algorithms, and investigate the impact on the throughput.* |

* **Main point #3**: Throughput
  + Mentioned by: Huawei, Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig

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| **Company** | **Views** |
| *Huawei* | *Throughput: Investigate throughput by identifying and exploiting potential parallel processing steps within the algorithms.* |
| *Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* | *In 6GR, modulation design must balance high data throughput with resilience to channel impairments.* |

* **Main point #4**: PAPR and EVM
  + Mentioned by: Huawei, SK Telecom, Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig

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| **Company** | **Views** |
| *Huawei* | *PAPR and EVM: measure a signal's Peak-to-Average Power Ratio (PAPR) and Error Vector Magnitude (EVM) with hardware considerations.* |
| *SK Telecom* | *For waveform evaluation, at least spectral efficiency, BLER, PAPR, out-of-band emission, EVM, and ACLR should be considered as metric.*  *For modulation evaluation, at least spectral efficiency, BLER, PAPR, out-of-band emission, PSD, EVM, and ACLR should be considered as metric.* |
| *Tejas Networks, Indian Institute of Technology Madras (IITM), CEWiT, IITH, WiSig* | *KPI for evaluation: Spectral efficiency, EVM, Coverage* |

## Discussions

**Observations and suggestions from moderator**:

* The summarized specific assumptions and considerations for channel coding and modulation can be discussed in the specific agenda study, e.g., link-level assumptions and the performance metrics.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on energy efficiency

## Companies’ views

#### Aspect#1: General evaluation methodology

* **Main point #1**: **For zero-load case, use analytical method based on timeline. For loaded case, use SLS**
  + Mentioned by: *Almost all companies*

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| **Company** | **Views** |
| *Huawei* | * *Energy saving performance of unloaded case should be evaluated using a computational method based on energy consumption, not time ratio of sleep state over active state.* |
| *Nokia* | * *Network and UE Energy efficiency in unloaded case compared to fully loaded case can be evaluated analytically using base station and UE power models without a need for system-level simulations.* |
| *ZTE* | * *numerical simulation is sufficient for idle or inactive UEs or when the network is under an empty load. However, when multiple UEs are connected to the network and traffic is being exchanged between UEs and the network, system-level simulation becomes essential.* |

* **Main point #2**: **Deployment follows general 6GR evaluation assumption**
  + Mentioned by: *Almost all companies*

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| **Company** | **Views** |
| *Huawei* | * *dense urban and urban macro* |
| *Samsung* | * *at least dense urban and urban macro for FR1 can be considered for evaluation, others including rural and FR2 are not precluded.* |
| *Tejas Networks* | * *Deployment scenarios such as urban macro, urban micro, indoor hotspot, and rural micro should be studied to evaluate the energy efficiency. The percentage of indoor UEs and outdoor UEs needs to be defined for assessing energy efficiency techniques* |

* **Main point #3**: **Consider the energy cost and saving by running AI**
  + Mentioned by: *NVIDIA, ZTE*

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| **Company** | **Views** |
| *NVIDIA* | * *Energy consumption model of AI-native 6G base stations will be a complex function, reflecting both energy-savings from AI-driven network optimizations and the energy cost of AI algorithms execution.* |
| *ZTE* | * *propose an AI power consumption model based on FLOP* |

#### Aspect#2: Traffic model for NW energy saving evaluation

* **Main point #1**: **Expected traffic model characteristics may be burst traffic**
  + Mentioned by: *NVIDIA, Qualcomm*

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| **Company** | **Views** |
| *NVIDIA* | * *incorporating statistical models reflecting unpredictability aspects of AI traffic patterns* |
| *Qualcomm* | * *Include updated traffic models reflecting 6GR target application as baseline for evaluation, including bursty EMBB traffic and periodic video for AR/XR applications.* |

* **Main point #2**: **Practical traffic model used in the evaluation** 
  + **Option1: Use general 6GR traffic model, such as FTP3, FTP1**
    - Mentioned by: *ZTE, Samsung, Tejas, Huawei*

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| **Company** | **Views** |
| *ZTE* | * *FTP can be used as the starting point for the evaluation of the 6G energy efficiency. The evaluation results under different load conditions should be fully considered, such as idle/empty load, low, light, and medium* |
| *Samsung* | * *Adopt FTP3, FTP3 IM and VOIP defined in NR as the traffic models in 6GR. Resource utilization: 100% (full loaded), 50%, 30%, 10%, and 0%.* |
| *Tejas Networks* | * *different load conditions such as idle/empty load, low, medium, and high loads should be considered* |
| *Huawei* | * *FTP 3 model* |

* + **Option2: Use a mix of traffic model to represent and evaluate the performance on different load of day**
    - Mentioned by: *Qualcomm*

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| **Company** | **Views** |
| *Qualcomm* | * *the contribution of different traffic load is different. If a scheme saves 90% energy in a state that only accounts for 5% of the total energy over a day (4.5% total energy saving over a day), it should not be considered more beneficial than a scheme that saves 20% energy in a state that accounts for 50% of the total energy (10% total energy saving over a day). Consider a mix of traffic models by running multiple evaluations and combining the results according to prevalence of each traffic model or load state during a day* |

#### Aspect#3: Baseline schemes for energy saving evaluation

* **Main point #1**: **Use the latest 5G/5.5G energy saving schemes as baseline for comparison**
  + Mentioned by: *Qualcomm, Samsung, SK Telecom (commercialized schemes)*

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| **Company** | **Views** |
| *Qualcomm* | * *Baseline for energy analysis to include DRX, BWP switching, PDCCH skipping, minimum scheduling offset, and SSSG switching where applicable.* |
| *Samsung* | * *As a benchmark, the companies to report baseline for UE and BS side, respectively, e.g., from UE side, PO monitoring with i-DRX, e-DRX, with or without PEI in RRC INACTIVE/IDLE mode, PDCCH monitoring with c-DRX, with or without DCP in RRC CONNECTED mode, from BS side, Rel-19 NES can be used as a baseline* |

#### Aspect#4: Metric for energy saving evaluation

* **Main point #1**: **Use energy saving as metric and report the impact of system performance, such as UPT, latency**
  + Mentioned by: *ZTE, Samsung, VIVO, Nokia, Vodafone*

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| **Company** | **Views** |
| *ZTE* | * *For the evaluation of the energy saving, NW/UE energy saving gain, UPT and latency should be considered as the main metrics* |
| *Samsung:* | * *In order to assess the candidate techniques, the following performance metrics are provided: UE/BS power saving gain, System performance impact from network perspective, Resource overhead and capacity impact, System performance impact from UE perspective, Latency/access delay/scheduling delay, User throughput or UPT.* |
| *VIVO* | * *Evaluation metrics, e.g., power saving gain, latency, UPT, etc* |
| *NOKIA* | * *Evaluation of energy efficiency is based on comparison of relative energy consumption between different UE and network load states. Exact evaluation assumptions are aligned with IMT-2030 requirements* |
| *Vodafone* | * *For each proposed radio feature enhancement, the baseline framework should include measurement of percentage change in total energy consumption* |

* **Main point #2**: **Use energy saving as metric and report the impact of UE QoS satisfaction rate**
  + Mentioned by: *Huawei*

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| **Company** | **Views** |
| *Huawei* | * *UPT does not reflect user’s experience and UPT loss does not result in degradation in experience as long as user’s QoS is satisfied.* * *The transmission scheme for minimizing UPT loss, requires network to schedule packets as quickly as possible once packets arrived, which potentially causes higher energy consumption* * *It is hard to quantify impact of UPT with respect to impact on energy savings and it is hard to align evaluation results when different schemes reporting at different UPT loss* |

* **Main point #3**: **Use energy efficient, may in the unit of bit per Joule, as metric** 
  + mentioned by: *Xiaomi, NVIDIA*, *AT&T, TCL*

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| **Company** | **Views** |
| *Xiaomi* | * *propose the following EE definition (in bit per Joule) is the data rate, and , denotes the number of correctly transmitted or received bits during the total observation/evaluation time, i.e., . denotes the average energy consumption during the .* |
| *NVIDIA* | * *energy efficiency is defined as average energy efficiency across different traffic load, which can be shown as* |
| *AT&T* | * *the energy efficiency metric can be the following, Where Rk represents the (normalized) throughput of a user k, and Ptotal represents the total system power. Note that the total power does not only include the transmit power* |
| *TCL* | * *The amount of information (bits) transmitted per unit of energy (Joule) as baseline parameter of energy efficiency has been defined in IMT-2020.* |

* **Main point #4**: **Joint energy efficiency to consider both network energy efficiency and UE energy efficiency**
  + Mentioned by: *OPPO, InterDigital, Spreadtrum, MediaTek*

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| **Company** | **Views** |
| *OPPO, InterDigital* | * *Joint energy efficiency is defined as* ***P = α P1 + β P2*** |
| *Spreadtrum, UNISOC* | * *Proposal 6: The joint energy efficiency of the network and the device can be defined*   ***, where .***  *Energy efficiency (EE) is the quantity of information bits transmitted or received, per unit of energy consumption (in bit/Joule)* |
| *MediaTek* | * *Proposal 11 (11.5): define the following joint EE metrics:*   *where EER is the energy efficiency ratio between the energy saving scheme and the baseline scheme and EE is defined as* |

#### Aspect#5: Power model for NW/UE energy saving evaluation

* **Main point #1**: **reuse 5G power model without mentioning update**
  + mentioned by: *Nokia, Ericsson AB, Sony*

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| **Company** | **Views** |
| *Nokia* | * *The NR base station model provided in TR 38.864 (especially BS Category 2), and the UE power model provided in TR 38.840 can serve as the baseline for energy efficiency evaluations of 6G* |
| *Ericsson AB* | * *For Base Station energy consumption modelling, the relative power and transition time/energy values agreed for BS Category 1 in TR 38.864 should be used as baseline for 6G evaluations* |
| *Sony* | * *Proposal 10: The 6G energy consumption model for BS should reuse the 5G energy consumption model described in section 5.1 in TR 38.864.* * *Proposal 11: The 6G UE power consumption model should reuse the 5G power consumption model described in TR 38.875 for IoT and wearable devices / TR38.840 for eMBB and other cases.* |

* **Main point #2**: **5G power model as starting point, add another reference configuration for the new frequency range, and update the reference configuration for FR1 and FR2 due to 6G configuration change**
  + mentioned by: *Almost all companies mentioned*

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| **Company** | **Views** |
| *Huawei* | * *Proposal 23: reference configuration for BS power consumption model should be added, and with recommended setting shown in Table 4.3.1.3.* |
| *ZTE* | * *FR3 with TDD, other parameters are TBD.* |
| *VIVO* | * *For UE, consider at least the reference configurations in table X as starting point for power consumption* |
| *Apple* | * *For around 7GHz, number of TXRUs at BS should be increased and the exact number should follow MIMO* |
| *MediaTek* | * *Discuss and decide Set 4 FR3 reference configuration for BS power consumption model. BW: 200 MHz; SCS: 30 kHz; 256 TRxRUs. Reuse the scaling rule of BS power consumption model in TR 38.864 to estimate power values for Set 4 FR3 once reference configuration is decided. Discuss and decide reference configurations for FR3 devices and IOT device* |
| *Lenovo* | * *Consider in the Evaluation assumption for the network energy saving in the new upper-mid-band spectrum. Wider bandwidth, 200MHz. Increased Tx & Rx RUs – 256, considering XL-MIMO operations (~1000 AEs) . Various Duplexing operations i.e., TDD, SBFD* |
| *NEC* | * *very large antenna arrays, which may have layouts 4-16x denser than in 5G. It must also account for the significant circuit power associated with large bandwidths (e.g., up to 400MHz)* |

* **Main point #3**: **5G power model as starting point, update power value, transition time/energy of sleep slate due to the new 6G configuration**
  + mentioned by: *Almost all companies*

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| **Company** | **Views** |
| *Huawei* | * *Proposal 21: Different power consumption levels including much lower sleep level should be defined for each sleep state, according to the BS implementation configuration.* |
| *Xiaomi* | * *FR3 with TDD, other parameters are TBD.* |
| *CMCC* | * *The specific values of relative power and transition time shall be further discussed* |
| *Apple* | * *Energy consumption model for BS should be revisited and reasonably represent the actual BS energy consumption. The energy consumption model, especially the transition time of each sleep mode, has a large impact on the energy consumption* |

* **Main point #4**: **5G power model as starting point, add UE sleep state due to UE LP-Radio**
  + mentioned by: *ZTE, VIVO, Xiaomi, CMCC, Qualcomm, Samsung*

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| **Company** | **Views** |
| *ZTE* | * *add ultra-deep sleep for UE and WUS reception power for UE* |
| *VIVO* | * *consider power state for LR* |
| *Xiaomi* | * *Ultra-deep sleep state at UE side can be inherited in 6GR* |
| *CMCC* | * *For both NW and UE power model for 6GR, consider the following tables which add ultradeep sleep* |
| *Qualcomm* | * *Study new power states to introduce to the UE power model to reflect 6GR energy efficiency evaluations* |
| *Samsung* | * *Ultra-deep sleep state at UE side can be inherited in 6GR* |

* **Main point #5**: **5G power model as starting point, add TRP deeper sleep state** 
  + mentioned by: *Huawei, CMCC, Lenovo*

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| **Company** | **Views** |
| *Huawei* | * *Proposal 20: BS power model for 6G should consider a new TRP “OFF”* * ***Reason****: In 6G stage, dynamic TRP ON/OFF can be considered as one of the key technologies for energy saving, with the hardware and software deployment. OFF TRP power state will bring to consume less energy than current deep sleep assumption.* |
| *CMCC* | * *Proposal 16: For both NW and UE power model for 6GR, consider the following tables as the starting point (which add ultradeep sleep)* * *No detailed reason is given* |
| *Lenovo* | * *Proposal 6: Consider additional relative power value and transition time for ultra-deep sleep state to evaluate network energy saving for low load cases* * ***Reason****: the network energy saving gains saturates as the common channel periodicity increases, because the percentage of the time network spends in the deep sleep state gets saturated. A new ultra-deep sleep state can accurately quantify the network energy saving gain estimates for longer periodicity* |

* **Main point #6**: **5G power model as starting point, update UE scaling rule, due to the inaccuracy of the previous scaling rule**
  + mentioned by: *ZTE, Qualcomm, VIVO, MediaTek, CMCC, Vodafone*

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| **Company** | **Views** |
| *ZTE* | * *current UE power scaling is by multiplying different scaling factors. It is often inaccurate and can result in power values that are unrealistically low, even lower than the micro-sleep state. Propose an equation similar to BS scaling* * *Propose an equation for PDCCH candidate scaling, UL power scaling, multiple power state in one slot, carrier aggregation, micro sleep power state scaling and processing relaxing scaling* |
| *Qualcomm* | * *Proposal 20: Update scaling rules in the UE power model to independently scale RF and baseband power with bandwidth, number of CCs, and rank.* * *Bandwidth, multi-CC, and rank scaling in the UE power model should correctly capture the super-linear power scaling* |
| *VIVO* | * *study scaling mechanism for configuration different from reference configurations* |
| *MediaTek* | * *Reuse and extend the power scaling rule in TR 38.840 to estimate power values for FR3 device types once reference configurations are decided.* |
| *CMCC* | * *Extension of UE power model to consider joint scaling of time/bandwidth/antenna and other related aspects and propose a scaling rule for UE power* |
| *Vodafone* | * *For scaling method, for non-sleep mode, the scaling can be based on one or more of the following* |

* **Main point #7**: **5G power model as starting point, update static power scaling rule**
  + mentioned by: *Huawei, ZTE*

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| **Company** | **Views** |
| *Huawei* | * *Proposal 22: The static power for BS can be scaled based on reference configuration* * ***Reason****: Like in unloaded or low loaded case, there is no need for a high transmission rate. Part of hardware and software can be shut down, benefiting both dynamic and static power saving. Therefore, the static power for BS is assume to be scaled based on reference configuration.* |
| *ZTE* | * *Scaling on micro sleep power* * ***Reason****: during the Rel-17 RedCap discussions, the reduced RF bandwidth of RedCap UEs (from 100 MHz to 20 MHz) and its impact on power values of sleep states is considered. Need the sleep state scaling for diverse device types.* |

* **Main point #8**: Use a unified UE/BS relative power consumption model to align the system parameters inside UE/BS reference configuration
  + mentioned by: *ZTE*

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| **Company** | **Views** |
| *ZTE* | * *Proposal 3-1-1: A unified UE/BS relative power consumption model can be used as a starting point for 6GR evaluation.* * *In both TR38.840 and TR38.864 [9], it can be observed that he relative power consumption values of different states are derived from different reference configurations, which comprises key parameters, such as SCS, system bandwidth, number of Rx and Tx chains, etc.* |

* **Main point #9**: Use a more dynamic power model which can give a variable power consumption level of one state based on different parameter to reflect the dynamic change of the power when using AI based power management.
  + mentioned by: *NVIDIA*

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| **Company** | **Views** |
| *NVIDIA* | * *The present rule-based energy modeling approach in 5G, where BS’s energy consumption is estimated based on ‘fixed’ power consumption levels at different operational states or energy profiles (deep sleep vs. active) should evolve to take into consideration AI-driven ‘dynamic and predictive’ network energy optimization in 6G, making the power consumption levels of various energy profiles as ‘variables’ with appropriate parameterization.* * *AI-driven energy optimization mechanisms of 6G may involve cross-layer joint coordination, wherein 6G BSs would manage energy at a network level instead of at a single BS in silo. The energy modeling of 6G BS needs to evolve considering possibilities of such cross-layer energy optimization.* |

## Discussions

**Observations and suggestions from moderator**:

* The traffic model could be discussed as a common assumption in section 2.4.
* The power consumption or energy efficiency for AI related use cases will be discussed in the agenda of AI/ML study.
* Other assumptions, e.g., power model, metrics for energy efficiency evaluation, and baseline schemes could be discussed in the agenda of energy efficiency study.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on AI/ML

## Companies’ views

#### Aspect#1: General evaluation considerations for AI/ML

* + Considering not only performance, but also robustness/overhead
    - Mentioned by: Nokia, vivo, NEC, DeepSig
      * *Nokia: Evaluation of AI/ML features in the RAN should address not only performance gains, but also robustness and operational overheads under a wide range of conditions, including realistic deployment scenarios.*
  + Considering energy consumption
    - Mentioned by: Futurewei, ZTE, vivo, xiaomi, NVIDIA, SK Telecom
      * *Futurewei: Include energy consumption as part of the required evaluation criteria/KPIs in 6G AI/ML: AI engine hardware and its architecture; Model complexity; Inference optimization, e.g., model parameter precision*
      * *ZTE, vivo: Power consumption of AI model can be reflected by FLOPs/OPS*
  + Considering generalization performance
    - Mentioned by: Futurewei, vivo, Samsung, Nokia
      * *Futurewei: deployment scenarios; configurations; outdoor/indoor UE distributions; UE speeds*
  + Aligned assumptions between AI/ML and non-AI/ML solutions
    - Mentioned by: CATT, Apple, SK Telecom, Ericsson
      * *CATT: The evaluation assumption and use-specific KPI of each AI/ML use case can be discussed in the corresponding topic agenda to ensure aligned assumptions between AI/ML and non-AI/ML solutions.*
  + Modifications on top of 5G evaluation methodology
    - Mentioned by: vivo, xiaomi, NEC, DeepSig, NTT DCM
      * *xiaomi: Field data shall be incorporated as a complementary approach for model training and testing*
      * *vivo: DL and UL PHY abstract method in SLS performance evaluations may need to be re-established for some AIML use cases.*
      * *DeepSig: Methods such as RF ray tracing, calibrated RF ray tracing, measurement or simulation datasets, or generative AI methods should be considered as possible methods; use of open-source simulation frameworks such as Sionna*

## Discussions

**Observations and suggestions from moderator**:

* The current general considerations for the evaluation for AI/ML could be discussed in the agenda of AI/ML study.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on initial access

## Companies’ views

#### Asepct#1: General evaluation methodology

* **Main point #1**: link-level simulation for Initial Access evaluation.
  + **Mentioned by**: Sony, MediaTek, CATT, CMCC, Qualcomm, Apple ...

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| **Company** | **Views** |
| *Sony* | *Link level simulation should be able to be used for evaluation of Synchronization signal/broadcast channel.* |
| *CATT* | *As a starting point, Table 1 shows the essential parameters for SLS and LLS for initial access. Other parameters for initial access can follow the designs in MIMO* |
| *MediaTek* | *As detailed assumptions on deployment scenarios are still under discussion in RAN Plenary 6G study, the parameters of link-level evaluation assumptions from TR38.802 [7] and the latest version of TR38.914 [2] can be used as a starting point for the framework of link-level evaluation assumptions in RAN1.* |
| *CMCC* | *In general, the link level and system level simulation methodology and assumptions for 6GR initial access should reuse that defined for NR initial access as a starting point.* |
| *Qualcomm* | *The simulation assumption should be discussed at least for link-level simulation while the need of having system-level simulation can be further discussed.* |

* **Main point #2**: LLS assumptions provided in TR 38.830 / TR 38.802 / TR 38.914 can be a starting point to evaluate the signals/channels involved in the initial access procedures such as SI, paging and RACH.
  + **Mentioned by:** Qualcomm, Huawei, Hisilicon, NTT DOCOMO, Apple, MediaTek, CMCC

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| **Company** | **Views** |
| *Huawei, Hisilicon* | *In terms of evaluation methodology, the link budget analysis from Rel-17 NR coverage enhancement in TR 38.830 can be used as a starting point. In particular, the Table A.3: Link budget template in A.3 and the performance metrics listed in section 4.2 in TR 38.830 can be reused for coverage analysis.* |
| *Qualcomm* | *RAN1 should discuss the link-level simulation assumptions and coverage evaluation methodology to properly evaluate the coverage of the signals/channels involved in the initial access procedures such as SI, paging and RACH. In particular, the evaluation methodology and simulation assumption that are provided in TR 38.830 can be a starting point for discussion* |
| *NTT DOCOMO* | *For the topics evaluated by LLS in 5G NR, the following 5G NR assumptions should be a baseline*   * *Initial Access (SS/PRACH/PBCH) TR38.802 clause A.1.5* |
| *Apple* | *Simulation assumption in TR 38.802 as starting point* |
| *MediaTek* | *the parameters of link-level evaluation assumptions from TR38.802 [7] and the latest version of TR38.914 [2] can be used as a starting point for the framework of link-level evaluation assumptions in RAN1* |
| *CMCC* | *The link level and system level simulation methodology and assumptions for 6GR initial access should reuse that defined for NR initial access, as captured in TR 38.802 Table A.1.5-1, Table A.1.5-2, Table A.1.5-3, and Table A.2.3-1, as a starting point.* |

* **Main point #3**: System-level simulation for Initial Access evaluation.
  + Mentioned by: CATT, CMCC, NTT DOCOMO...
  + FFS: Qualcomm

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| **Company** | **Views** |
| *CATT* | *As a starting point, Table 1 shows the essential parameters for SLS and LLS for initial access. Other parameters for initial access can follow the designs in MIMO* |
| *CMCC* | *In general, the link level and system level simulation methodology and assumptions for 6GR initial access should reuse that defined for NR initial access as a starting point.* |
| *Qualcomm* | *The simulation assumption should be discussed at least for link-level simulation while the need of having system-level simulation can be further discussed.* |

* **Main point #4**: SLS assumptions provided in TR 38.802 can be a starting point to evaluate the signals/channels involved in the initial access procedures such as SI, paging and RACH.
  + **Mentioned by:** DOCOMO

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| **Company** | **Views** |
| *DOCOMO* | *For the topics evaluated by SLS in 5G NR, the following 5G NR assumptions should be a baseline*   * *Initial Access (SS/PRACH/PBCH) TR38.802 clause A.2.3* |

#### Asepct#2: Evaluation considerations on PRACH

* **Main point #1**: **Evaluate PRACH capacity enhancement** 
  + Mentioned by*: CMCC, Qualcomm*
    - *Motivation 1: RACH blocking rate as a new performance metric is proposed. (CMCC)*
    - *Motivation 2: RAN1 discusses method to model the overall initial cell selection latency. (Qualcomm)*

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| ***Company*** | ***View*** |
| *CMCC* | *RACH blocking probability should be further considered in system-level simulation performance metrics. In case of cell free deployment, potential benefits including reduction of RACH blocking rate can be obtained. To further justify the gain on cell free deployment,* ***RACH blocking rate as a new performance metric is proposed.*** |
| *Qualcomm* | *RAN1 discusses link-level simulation assumptions to evaluate the coverage of signals/channels for system information, paging and RACH.* ***RAN1 discusses method to model the overall initial cell selection latency.*** |

* **Main point #2**: **Evaluate PRACH robust to large Doppler shift** 
  + Mentioned by*: LG Electronics, CMCC*
    - *Motivation 1:* *New NTN scenarios e.g., GNSS-less operation, VLEO support. (LGE)*
    - *Motivation 2:* *For 6G NTN evaluation, initial access channels/signals can be evaluated as a baseline. (CMCC)*

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| ***Company*** | ***Views*** |
| *LGE* | *RAN1 studies the evaluation assumptions for new NTN scenarios (e.g.,* ***GNSS-less operation****, VLEO support) that can be considered in 6GR. In this case, the TO/FO compensation would be performed based on a certain reference point instead of the actual UE location.* |
| *CMCC* | *For 6G NTN evaluation, initial access channels/signals can be evaluated as a baseline.* |

#### Aspect#3: Evaluation considerations on initial access

* **Main point #1**: Channel model for initial access LLS evaluation.
  + **Option 1**: TDL-C for LLS
    - **Mentioned by**: CATT, CMCC, Apple
  + **Option 2**: CDL-C for LLS
    - **Mentioned by**: Samsung, CMCC

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| **Company** | **Views** |
| *CATT* | *TDL-C for LLS*  *Dense urban, urban Macro, Rural for SLS* |
| *Samsung* | *CDL-C with delay scaling values of 100 ns for 4/7 GHz and 30 ns for 40 GHz* |
| *CMCC* | *CDL-C or TDL-C(\*) model with delay scaling values of 100 ns* |
| *Apple* | *Simulation assumption in TR 38.802 as starting point: TDL channel model* |

* **Main point #2**: Carrier frequency of LLS for initial access evaluation
  + **Option 1**: ~4 GHz,
    - Mentioned by: Samsung, CMCC, Qualcomm, Apple
  + **Option 2**: ~7 GHz
    - Mentioned by: Samsung, CMCC, Huawei, Hisilicon, Qualcomm, Apple
  + **Option 3**: ~30 GHz
    - Mentioned by: Apple
  + **Option 4**: ~40 GHz
    - Mentioned by: Samsung, Qualcomm

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| **Company** | **Views** |
| *Samsung* | *4 GHz, 7 GHz, 40 GHz (FFS for down-selection)* |
| *Huawei, Hisilicon* | *Evaluate the coverage performance of common channels and signals during initial access based on link budget analysis for ~7GHz, using the evaluation methodology in TR 38.830 as a starting point.* |
| *Qualcom* | *based on 6G SID [1], the study will address frequency ranges up to 52.6GHz, including at least the full range of FR1 (up to 7.125GHz), the range between FR1 and FR2-1 (including around ~7GHz), and FR2-1 (24.25 GHz – 52.6GHz). While the 5G assumptions may be reused for FR1 and FR2-1, the new assumption for the frequency range between FR1 and FR2-1 should be introduced.* |
| *Apple* | *4GHz, 7GHz, 30GHz* |

* **Main point #3**: Subcarrier Spacing
  + **Option 1**: 15 kHz,
    - Mentioned by: CMCC
  + **Option 2**: 30 kHz
    - Mentioned by: CMCC, Apple
  + **Option 3**: 120 kHz
    - Mentioned by: Samsung, Apple

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| **Company** | **Views** |
| *CMCC* | *15 kHz, 30 kHz (other values are not precluded and reported by companies)* |
| *Samsung* | *30 kHz for 4GHz, 30 kHz for 7 GHz, 120 kHz for 40 GHz* |
| *Apple* | *SCS30 for 4GHz and 7GHz carrier frequency*  *SCS120 for 30GHz* |

* **Main point #4**: Transmission bandwidth:
  + **Option 1**: mentioned by CMCC for SS, PBCH and RACH synchronization signal, PBCH and RACH.
    - **3MHz with 15kHz SCS**
    - **5MHz with 15&30kHz SCS**
  + **Option 2**: mentioned by Apple for SS, PBCH
    - **12 RBs for SS and PBCH.**

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| **Company** | **Views** |
| *CMCC* | *In our view, transmission bandwidth of 3 MHz (with 15 kHz SCS) and 5 MHz (with 15 kHz and 30 kHz SCS) can be additionally considered.* |
| *Apple* | *Evaluation assumption for Synchronization Signals/Channels, Number of RBs: 12*  *Evaluation assumption for PBCH, Number of RBs: same as PSS/SSS (12)*  *Companies should provide other details of simulated PBCH e.g., DMRS overhead, number of symbols* |

* **Main point #5**: Duplex Mode for initial access LLS evaluation
  + FDD should be included
    - Mentioned by: DOCOMO

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| **Company** | **Views** |
| *DOCOMO* | ***FR1 FDD band should be included as a carrier frequency for evaluation of SS/PRACH/PBCH***  *One reason is that 6GR would be expected to be deployed in standalone at the very initial stage, and in this case, there would be benefit for FDD rather than TDD from operation perspective.*  *The other reason is that considering standalone operation, we prefer to use low frequency band for initial access from a coverage perspective.* |

* **Main point #6**: TRP Antenna configuration for initial access evaluation
  + **Option 1**: 1T1R
    - Mentioned by: Apple
  + **Option 2**: 2T2R
    - Mentioned by: CMCC, Apple
  + **Option 3**: 16T16R
    - Mentioned by: CMCC
  + **Option 4**: Follow MIMO
    - Mentioned by: CATT

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| **Company** | **Views** |
| *CMCC* | *(1,1,2) with omni-directional antenna element*  *(8,1,2) with directional antenna element (HPBW=65, directivity 8dB)* |
| *CATT* | *As a starting point, Table 1 shows the essential parameters for SLS and LLS for initial access. Other parameters for initial access can follow the designs in MIMO.*  *For the BS and UE antenna elements, the detailed configurations are illustrated as follows:*   * *Indoor-hotspot* * *Around 4 GHz: TRP: Up to 256 Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* * *Around 7 GHz: TRP: Up to 1024 Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* * *Dense Urban* * *Around 4 GHz: TRP: Up to 256 Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* * *Around 7 GHz: TRP: Up to 1024Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* * *Urban Macro* * *Around 4 GHz: TRP: Up to 256 Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* * *Around 7 GHz: TRP: Up to 1024Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* * *Rural* * *Around 700 MHz: TRP: Up to 64 Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* * *Around 4GHz: TRP: Up to 256 Tx/Rx; UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* |
| *Apple* | *1 or 2 for gNB*  *Other parameters to be clarified* |

* **Main point #6**: UE Antenna configuration for initial access evaluation
  + **Option 1**: 1T1R,
    - Mentioned by: CATT,
  + **Option 2**: 1T2R,
    - Mentioned by: CATT
  + **Option 3**: 1T4R,
    - Mentioned by: Samsung
  + **Option 4**: 2T2R,
    - Mentioned by: CMCC, Apple

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| **Company** | **Views** |
| *CMCC* | *(1,1,2) with omni-directional antenna element* |
| *CATT* | *1T1R with omni-directional antenna element Since unified initial access that is applicable to different types of UE is desirable for 6GR, the UE’s antenna configuration assumption should consider the lowest-end UE, i.e. 1T2R.* |
| *Samsung* | *Antenna configuration 1T4R* |
| *Apple* | *2 for UE*  *Other parameters to be clarified* |

* **Main point #7**: UE’s distribution of Frequency offset for initial access evaluation
  + **Option 1**: +/- 5 ppm,
    - Mentioned by: CATT, Samsung, CMCC, Apple
  + **Option 2**: +/- 10 ppm
    - Mentioned by: CATT, CMCC, Apple
  + **Option 3**: +/- 20 ppm
    - Mentioned by: CATT, CMCC, Apple

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| **Company** | **Views** |
| *Samsung* | * *Initial acquisition*    + *BS: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 5 ppm* * *Non-initial acquisition*   + *BS: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 0.1 ppm* |
| *CATT* | * *Initial acquisition*    + *BS: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 5, 10, 20 ppm* * *Non-initial acquisition*   + *BS: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 0.1 ppm (or provided by each company)* |
| *CMCC* | * *Initial acquisition*   + *TRP: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 5, 10, 20 ppm (each company to choose one)* * *Non-initial acquisition*   + *TRP: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 0.1 ppm* |
| *Apple* | * *Initial acquisition*   + *TRP: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 5, 10, 20 ppm (each company to choose one)* * *Non-initial acquisition*   + *TRP: uniform distribution +/- 0.05 ppm*   + *UE: uniform distribution +/- 0.1 ppm* |

* **Main point #8:** UE speed for initial access evaluation
  + **Option 1**: 3km/h and 120 km/h,
    - Mentioned by: Apple
  + **Option 2**: 3km/h,
    - Mentioned by: Samsung
  + **Option 3**: 120km/h,
    - Mentioned by: Samsung
  + **Option 4**: 3km/h, 120 km/h, 30km/h and 500km/h
    - Mentioned by: Apple

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| **Company** | **Views** |
| *Samsung* | *3 km/h or 120 km/h* |
| *Apple* | *3 km/h and 120 km/h (mandatory)*  *30km/h and 500km/h (optional)* |

* **Main point #9:** Interference model for initial access evaluation
  + **Option 1**: 0 interfering TRP,
    - Mentioned by: CATT, Samsung, CMCC, Apple
  + **Option 2**: 2 interfering TRPs,
    - Mentioned by: CATT, Samsung, CMCC, Apple
  + **Option 3**: at least 3 interfering TRPs
    - Mentioned by: CMCC

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| **Company** | **Views** |
| *Samsung* | * *No interference* * *2 interfering TRPs (1st SIR = 0dB, 2nd SIR = - 3dB; SIR is defined as the ratio of power between a reference cell and interfered cell) – timing arrival differences from TRPs are provided by each proponent* |
| *CATT* | * *0 TRP* * *2 interfering TRPs* |
| *CMCC* | *Case 1: (Non-cell free case)*   1. *No interferences assumed: mandatory* 2. *2 interfering TRPs (1st SIR = 0dB, 2nd SIR = -3dB; SIR is defined as the ratio of power between a reference cell and interfered cell) – timing arrival differences from TRPs are provided by each proponent: optional*   *Case 2: (Cell free case)*  *Multiple SS are received from at least 3 TRPs. (0dB, 0dB, 3dB) is assumed as the ratio of power between the strongest signal and the 2nd ,3rd signal. Timing arrival differences from TRPs are provided by each proponent: optional* |
| *Apple* | *0 TRP: mandatory*  *2 interfering TRPs (1st SIR = 0dB, 2nd SIR = -3dB; SIR is defined as the ratio of power between a reference cell and interfered cell) – timing arrival differences from TRPs are provided by each proponent: optional1. 0 TRP* |

* + **Main point #10: Two ports transmission for synchronization signals**
    - **Mentioned by: Apple**

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| **Company** | **Views** |
| *Apple* | *Study two ports transmission for synchronization signals* |

* **Main point #11**: performance metrics of LLS for initial access evaluation
  + **Option 1**: BLER
    - **Mentioned by**: CATT, MediaTek, CMCC, Apple
  + **Option 2**: Miss detection rate for SS
    - **Mentioned by**: MediaTek, Apple
  + **Option 3**: Residual timing and freq. error for SS
    - **Mentioned by**: MediaTek, Apple
  + **Option 4**: UE frequency scan Latency, UE complexity
    - **Mentioned by**: Qualcomm
  + **Option 5**: False detection rate for SS
    - **Mentioned by**: Apple, CATT
  + **Option 6**: PAPR, CM values
    - **Mentioned by**: Apple, CMCC
  + **Option 7: Search Window**: The time window to search (correlate) PSS. It depends on the periodicity of SS transmission.
    - **Mentioned by:** CATT, CMCC, Apple

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| **Company** | **Views** |
| *CATT* | *1% BLER/false alarm rate@-6dB (average received SNR) for SSB* |
| *MediaTek* | * *SS*   + *Miss detection rate*   + *Residual timing and freq. error* * *PBCH*   + *BLER* |
| *CMCC* | *At least the following performance metric should be considered, which is same as that defined in NR:*   * *Signal detection rate, e.g. 1% BLER @ -6dB (average received SNR)* * *Misdetection probability* * *Residual timing and frequency errors after synchronization* * *Other metrics (e.g., PAPR) are not precluded* |
| *Qualcomm* | *See other points* ***UE frequency scan Latency*** *part* |
| *Apple* | *Performance Metrics*  *- Miss detection rate (MDR);*  *- False detection rate (FDR);*  *- Residual offset and carrier frequency offset.*  *- PAPR, CM values*  *Performance Target: 1% BLER @ -6dB (average received SNR)* |
| *CATT* | *The time window to search (correlate) PSS. It depends on the periodicity of SS transmission, e.g. 80ms or 160ms.* |
| *CMCC* | *The time window to search (correlate) PSS. It depends on the periodicity of SS transmission. Candidate values such as 40 ms, 80 ms, 160 ms, can be taken as a starting point.* |
| *Apple* | *The time window to search (correlate) NR-PSS. It depends on the periodicity of NR-SS transmission. The value needs to be provided by each proponent* |

* **Main point #12**: performance metrics of SLS for initial access evaluation: CMCC, CATT
  + Distribution of acquisition time (i.e., cell search time)
  + Network power consumption for supporting UE initial acquisition and after initial acquisition in IDLE mode.
  + UE power consumption after initial acquisition in IDLE mode.
  + RACH blocking probability.
  + Distribution of SINR.

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| **Company** | **Views** |
| *CMCC* | *The following system level simulation performance metric can be used for 6GR initial access simulation:*  * Distribution of acquisition time (i.e., cell search time)*  * Network power consumption for supporting UE initial acquisition and after initial acquisition in IDLE mode.*  * UE power consumption after initial acquisition in IDLE mode.*  * RACH blocking probability.*  * Distribution of SINR.*  *1% BLER @ -6dB (average received SNR)* |
| *CATT* | *1% BLER/false alarm rate@-6dB (average received SNR)* |

## Discussions

**Observations and suggestions from moderator**:

* Carrier frequency, subcarrier spacing, bandwidth, TRP/UE antenna configurations will be discussed as the common assumptions in section 2.2.
* Other assumptions, e.g., UE’s distribution of Frequency offset, UE speed, interference model, performance metrics will be discussed in the agenda of initial access.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on MIMO

## Companies’ views

#### Aspect#1: Evaluation methodology for MIMO

* **Main point #1**: system-level simulation for MIMO evaluation.
  + Mentioned by: Huawei/Hisi, Nokia, Samsung, QC, Tejas, ...

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| **Company** | **Views** |
| *Huawei/Hisi* | *Applied for CSI measurement & feedback, UL MIMO design and so on.* |
| *QC* | *System-level simulation will be used to evaluate the KPIs of key scenarios proposed for 6G.* |

* **Main point #2**: link-level simulation for MIMO evaluation
  + Mentioned by: Huawei/Hisi, Nokia, Samsung, Tejas, Docomo, CMCC, MTK, …

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| **Company** | **Views** |
| *Huawei/Hisi* | *Applied for RS design, channel estimation & reconstruction related design and so on.* |
| *ZTE* | *Regarding receiver type, both MMSE-IRC and R-ML algorithms for downlink reception should be considered* |
| *QC* | *Adopt link-level simulation for evaluating MIMO designs, at least for reference signals and CSI feedback.* |
| *CMCC* | *Link level simulation can be carried out to evaluate the SINR requirements for the specific channel and traffic. Link budget template from Rel-16 CE and IMT-2020 self-evaluations can be considered as a starting point.* |
| *MTK* | *For MIMO-related physical signals (not limited to DMRS and CSI-RS), take Table 4 and Table 5 as a starting point for further discussion on the link-level evaluation assumption in 6G study.* |

* **Main point #3**: performance metric of SLS for MIMO evaluation
  + **Option 1**: spectral efficiency (5%-th spectral efficiency; average spectral efficiency, etc.)
    - Mentioned by: Huawei/Hisi, Nokia, MTK, Apple, NVIDIA, CATT, Sony
  + **Option 2**: user throughput (peak throughput, user-experienced throughput)
    - Mentioned by: Huawei/Hisi, Nokia, CATT, Sony
  + **Option 3**: UPT (user perceived throughput)
    - Mentioned by: Huawei/Hisi, vivo
  + **Option 4**: Others (Energy consumption and overhead, BM latency, etc.)
    - Mentioned by: Futurewei

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| **Company** | **Views** |
| *Futurewei* | *Include energy consumption and overhead into MIMO evaluation results.*  *For example, the current Type II codebook design may be generalized from up to 128 ports to up to 1024 ports or even more in a relatively straightforward way, but the high energy consumption, high overhead, and resulting high complexity may become prohibitive in a practical network.* |
| *Futurewei* | *For performance evaluation of FR2, include a mandatory metric of beam acquisition / reacquisition latency.* |

* **Main point #4**: performance metric of LLS for MIMO evaluation
  + **Option 1**: BLER
    - Mentioned by: Huawei/Hisi, Nokia, ZTE, Tejas, Docomo
  + **Option 2**: throughput/spectral efficiency
    - Mentioned by: Huawei/Hisi, Nokia, ZTE, Tejas
  + **Option 3**: intermediate ones (such as Squared Generalized Cosine Similarity and post-SINR)
    - Mentioned by: Huawei/Hisi
* **Main point #5**: baseline/starting point e.g., 5G NR for 6GR MIMO evaluations
  + Mentioned by: Docomo, Sony, CATT, Apple, Ericsson, SKT

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| **Company** | **Views** |
| *Docomo* | *It would be desirable to use 5G NR evaluation assumptions as a starting point.* |
| *Sony* | *Evaluation assumption made in 5G should be a baseline for discussion on 6G evaluation assumption.* |
| *CATT* | *The start point on evaluation assumption for 6GR is to study on whether the existing simulation scenarios, deployment and associated parameters in 5G can be reused or not.* |
| *Apple* | *Use Rel-16/17/18/19 MIMO evaluation assumptions as baseline for single TRP, CJT, predictive CSI.* |
| *Ericsson* | *NR as deployed by the operators should be used as baseline for evaluations comparing 6GR performance with NR.* |
| *SKT* | *Any evaluation for 6GR air interface should be compared with appropriate baseline scheme (e.g., based on the commercialized features)* |

#### Aspect#2: Carrier frequency and aggregated system bandwidth

* **Main point #1**: MIMO evaluation on new spectrum, e.g., around 7GHz
  + **Option 1**: around 7GHz
    - Mentioned by: Huawei/Hisi, Samsung, QC, Sony, OPPO, vivo, Apple, CATT, ETRI, LGE, Docomo, CMCC
  + **Option 2**: around 15GHz
    - Mentioned by: Docomo, LGE,
  + **Option 3**: general support FR3, no explicit value
    - Mentioned by: Futurewei

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| **Company** | **Views** |
| *Huawei/Hisi* | *For new spectrum, ~7GHz with at least 400MHz system bandwidth shall be evaluated.* |
|  | *As carrier frequency of FR3 band, both 7 GHz and 15 GHz should be evaluated. BW = 40/100/200MHz, up to [400] MHz (DL+UL)​. (Docomo)* |
| *ETRI* | *Around 7 GHz: Up to 400 MHz (DL+UL)* |
| *Futurewei* | *Extreme MIMO on FR3 may support up to 400 MHz bandwidth in a carrier.* |
| *Sony* | *for around 7 GHz. 200-400 MHz per CC for FR3* |
| *Samsung* | *BW = [20, 100, 200] MHz at 7GHz for SLS; BW = 200MHz as baseline at 7GHz for LLS.* |
| *OPPO* | *considering new frequency bands (e.g. 7GHz), BWs (e.g. 200MHz).* |
| *vivo* | *Up to 200MHz at 7GHz.* |
| *Apple* | *BW: FR3 7GHz - 20MHz as baseline, 40MHz as optional.* |
| *CATT* | *for 7GHz, bandwidth = 20MHz should be the baseline;* |
| *QC* | *limit the carrier frequency to around 2GHz, around 4GHz, and around 7GHz (and, say, with single layer) to show that 6GR can boost the spectral efficiency on important bands with decent CAPEX/OPEX.* |
| *LGE* | *support FR3 (e.g., 7.8GHz, 13GHz).* |
| *CATT* | *7GHz can be considered as main operation frequency for the coverage evaluations.* |

* **Main point #2**: the bandwidth of new spectrum for MIMO evaluation
  + **Option 1**: 400MHz
    - Mentioned by: Huawei/Hisi, ETRI, Docomo, Futurewei, Sony
  + **Option 2**: 200MHz
    - Mentioned by: Docomo, Sony, Samsung, OPPO, vivo
  + **Option 3**: 100MHz
    - Mentioned by: Docomo, Samsung
  + **Option 4**: 40MHz
    - Mentioned by: Docomo, [Apple],
  + **Option 5**: 20MHz
    - Mentioned by: Samsung, Apple, CATT
* **Main point #3**: MIMO evaluation on FR1
  + **Option 1**: 4GHz
    - Mentioned by: Huawei/Hisi, Samsung, QC, Apple, CATT, ATT, Docomo
  + **Option 2**: 2GHz
    - Mentioned by: Huawei/Hisi, Samsung, QC, Docomo,
  + **Option 3**: Sub1GHz, e.g., 700MHz
    - Mentioned by: Huawei/Hisi, Samsung, Docomo, CATT

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| **Company** | **Views** |
| *Huawei/Hisi* | *existing frequencies (e.g., around 4GHz, around 2GHz FDD and sub-1G band FDD) should be included in 6G MIMO evaluation.*   * *up to 200MHz around 4GHz* * *up to 20MHz around 2GHz* * *up to 10MHz around Sub1GHz* |
| *ETRI* | *Around 4 GHz: Up to 200 MHz (DL+UL)* |
| *Samsung* | *BW = 10, 20, 100 MHz at 0.7, 2, 4GHz for SLS.* |
| *Docomo* | *700 MHz: Up to [60] MHz (DL+UL); 2GHz: Up to [120] MHz (DL+UL); 4GHz: Up to [200] MHz (DL+UL)* |
| *Apple* | *BW: FR1 4GHz - 20MHz.* |
| *CATT* | *for 4GHz, 700MHz, bandwidth = 20MHz should be the baseline;* |
| *ATT* | *FR1 bands (sub-4.5GHz) and corresponding parameters are considered with high priority.* |
|  | *limit the carrier frequency to around 2GHz, around 4GHz, and around 7GHz (and, say, with single layer) to show that 6GR can boost the spectral efficiency on important bands with decent CAPEX/OPEX.* |

* **Main point #4**: the bandwidth of around 4GHz for MIMO evaluation
  + **Option 1**: 200MHz
    - Mentioned by: Huawei/Hisi, ETRI, Docomo
  + **Option 2**: 100MHz
    - Mentioned by: Samsung
  + **Option 3**: 20MHz
    - Mentioned by: Apple, CATT
* **Main point #5**: the bandwidth of around 2GHz for MIMO evaluation
  + **Option 1**: 120MHz
    - Mentioned by: Docomo
  + **Option 2**: 20MHz
    - Mentioned by: Huawei/Hisi, Samsung
* **Main point #6**: the bandwidth of around 700MHz for MIMO evaluation
  + **Option 1**: 60MHz
    - Mentioned by: Docomo
  + **Option 2**: 20MHz
    - Mentioned by: CATT
  + **Option 3**: 10MHz
    - Mentioned by: Huawei/Hisi, Samsung
* **Main point #7**: MIMO evaluation on FR2
  + **Option 1**: 30GHz
    - Mentioned by: Docomo
  + **Option 2**: 28GHz
    - Mentioned by: Samsung
  + **Option 3**: general support FR2, no explicit value
    - Mentioned by: Google

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| **Company** | **Views** |
| *Samsung* | *BW = 800MHz at 28GHz for SLS.* |
| *Docomo* | *30GHz: Up to [1] GHz (DL+UL)* |
| *Google* | *Prioritize a single-panel UE configuration for evaluations for FR2/FR3.* |

* **Main point #8**: the bandwidth of FR2 for MIMO evaluation
  + **Option 1**: 1GHz
    - Mentioned by: Docomo
  + **Option 2**: 800MHz
    - Mentioned by: Samsung

#### Aspect#3: MIMO configuration and dimension

* **Main point #1**: antenna elements at BS-side for new spectrum, e.g., around 7GHz
  + **Option 1**: 4096 AEs
    - Mentioned by: Futurewei
  + **Opiton 2**: 3072 AEs
    - Mentioned by: Huawei/Hisi
  + **Option 3**: 2048 AEs
    - Mentioned by: ETRI, ZTE
  + **Option 4**: 1536 AEs
    - Mentioned by: ZTE
  + **Option 5**: 1024 AEs
    - Mentioned by: CATT, Ericsson, Lenovo, OPPO, vivo, Xiaomi
  + **Option 6**: 768 AEs
    - Mentioned by: Samsung
  + **Option 7**: 512 AEs
    - Mentioned by: Apple, Docomo
  + **Option 8**: 128 AEs
    - Mentioned by: Xiaomi
  + **Option 9**: others
    - Mentioned by: Ofinno

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| **Company** | **Views** |
| *Futurewei* | *Up to 4096 AEs (e.g., [M, N, P] = [64, 32, 2]); typically < ~256 AEs. Up to ~ 256 APs; typically < ~64 APs* |
| *Huawei/Hisi* | *up to 3072 AEs, and up to 512 TRX at BS.* |
| *ETRI* | *up to 2048 AEs; up to 256 TXRUs* |
| *ZTE* | *up to 1536 or 2048 AEs for U6GHz;* |
| *CATT* | *Around 7 GHz: TRP: Up to 1024 Tx/Rx.* |
| *Ericsson* | *up to at least 1024 AEs at the BS.* |
| *Lenovo* | *up to 1024 AEs at NW side.* |
| *OPPO* | *For evaluations in FR3, BS: up to 1024AEs/256APs.* |
| *vivo* | *Up to 1024 AEs and 256 APs, e.g., (M,N,P, Mg, Ng, Mp, Np) = (32, 16, 2,1,1, 8, 16)* |
| *Samsung* | *assume 768AEs, 128 and 256 APs at the BS. To evaluate the tradeoff between RS overhead and performance, sparser RS mapping should be assumed.* |
| *Apple* | *BS: 512 AEs, 128 APs as baseline (for CSI-RS): (M, N, P, Mg, Ng, Mp, Np) = (8,32,2,1,1,2,32), (dH,dV) = (0.5, 0.5)λ* |
| *Docomo* | *Practical number of BS/UE antenna elements (e.g., 512 BS AEs) for FR3 should be used for evaluation as the baseline.* |
| *LGE* | *at least up to 256 Tx/256 Rx APs.* |
| *Xiaomi* | *UMa 7GHz, 128 AEs driven by 32 APs as a starting point, and 1024 AEs or even higher number corresponding to 256 APs can also be considered in the evaluation of 6GR.* |
| *Sony* | *More than 128 BS antennas (e.g., 256 BS antennas) should be assumed for the evaluation of 6G massive MIMO. e.g., 2, 4, 8, 16, 32, 64, 128, 256 antennas* |
| *Ofinno* | *Evaluation in 7GHz assumes at least 4 times more antenna elements compared to 4 GHz.* |

* **Main point #2**: antenna ports at BS-side for new spectrum, e.g., around 7GHz
  + **Opiton 1**: 512 APs
    - Mentioned by: Huawei/Hisi
  + **Option 2**: 256 APs
    - Mentioned by: Futurewei, ETRI, OPPO, vivo, Samsung, LGE, Xiaomi, Sony
  + **Option 3**: 128 APs
    - Mentioned by: Samsung, Apple,
  + **Option 4**: 32 APs
    - Mentioned by: Xiaomi
* **Main point #3**: antenna elements at UE-side for new spectrum, e.g., around 7GHz
  + **Option 1**: 16 AEs
    - Mentioned by: Huawei/Hisi, ETRI
  + **Opiton 2**: 8 AEs
    - Mentioned by: LGE, Ericsson, CATT, Sony, OPPO, vivo, ZTE, Google
  + **Option 3**: 6 AEs
    - Mentioned by: Apple, Google,
  + **Option 4**: 4 AEs
    - Mentioned by: CATT, Sony, OPPO, vivo, Apple, Lenovo, Google, Xiaomi, Docomo, Samsung
  + **Option 5**: 2 AEs
    - Mentioned by: Sony, vivo
  + **Option 6**: 1 AEs
    - Mentioned by: vivo, Samsung

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| **Company** | **Views** |
| *Huawei/Hisi* | *up to 16 AEs, and up to 16 TRX at UE.* |
| *ETRI* | *UE: up to 16 AEs; up to 16 TXRUs* |
| *LGE* | *up to 8 Tx/8 Rx antenna ports.* |
| *Ericsson* | *up to at least 8 AEs at the UE.* |
| *CATT* | *Around 7 GHz: UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device).* |
| *Sony* | *4RX, 2TX for mobile device; 4/8RX, 4/8TX for FWA/CPE.* |
| *OPPO* | *FR3 UE: up to 4AEs/4APs(mobile UE) or 8AEs/8APs(FWA or CPE).* |
| *vivo* | *Handheld/Smart phone: 2Tx/4Rx as baseline; XR/Wearable/IoT: 1Tx/2Rx as baseline; FWA/CPE can consider [4 or 8] Tx/8Rx;* |
| *ZTE* | *for CPE applications, the existing 5G model of 8-TX/RX UE antenna array with parameters (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 2, 1, 1; 2, 2) and (dH, dV) = (0.5, 0.5)λ should be supported as well.* |
| *Apple* | *4 TX/Rx as baseline: (M, N, P, Mg, Ng, Mp, Np) = (1,2,2,1,1,1,2), (dH,dV) = (0.5, 0.5)λ; Number of UE antennas: {4Rx, 2Rx, 6Rx} for TDD* |
| *Lenovo* | *up to 4 Tx/Rx ports at the UE side.* |
| *Google* | *2T4R, 4T6R, 4T8R.* |
| *Xiaomi* | *2T4R as a typical case at a single UE* |
| *Docomo* | *UE antenna array number = 4​.* |
| *Samsung* | *1T4R, 4ports.* |

* **Main point #4**: antenna ports at UE-side for new spectrum, e.g., around 7GHz
  + **Opiton 1**: 16 APs
    - Mentioned by: Huawei/Hisi, ETRI
  + **Option 2**: 8 APs
    - Mentioned by: LGE, CATT, Sony, OPPO, vivo, ZTE,
  + **Option 3**: 4 APs
    - Mentioned by: CATT, Sony, OPPO, vivo, Apple, Lenovo, Google, Samsung
  + **Option 4**: 2 APs
    - Mentioned by: Sony, vivo, Google, Xiaomi
  + **Option 5**: 1 APs
    - Mentioned by: vivo, Samsung
* **Main point #5**: antenna elements and antenna ports at BS-side for FR1
  + **Option 1**: 128 APs
    - Mentioned by: Huawei/Hisi, Futurewei,
  + **Opiton 2**: 64 APs
    - Mentioned by: Huawei/Hisi, Samsung,
  + **Option 3**: 32 APs
    - Mentioned by: Apple
  + **Option 4**: 16 APs
    - Mentioned by: Huawei/Hisi

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| **Company** | **Views** |
| *Huawei/Hisi* | * *around 4GHz: up to 640 antenna elements, 128 TRX at BS.* * *around 2GHz: up to 128 antenna elements, Up to 64 TRX at BS.* * *sub-1G band (700/800MHz): Up to 16 TRX at BS.* |
| *Samsung* | *BS: 192/128 AEs, with 64 APs or more.* |
| *Apple* | *BS: 128 AEs, 32 ports as baseline: (M, N, P, Mg, Ng, Mp, Np) = (8,8,2,1,1,2,8), (dH,dV) = (0.5, 0.8)λ* |
| *CATT* | * *Around 4 GHz: TRP: Up to 256 Tx/Rx.* * *Around 700 MHz: TRP: Up to 64 Tx/Rx.* |
| *Futurewei* | *Up to ~ 512 AEs (e.g., [M, N, P] = [16, 16, 2]); typically < ~64AEs. Up to ~ 128 APs; typically < ~16APs.* |

* **Main point #6**: antenna elements and antenna ports at UE-side for FR1
  + **Option 1**: 8 APs
    - Mentioned by: Huawei/Hisi, CATT,
  + **Opiton 2**: 4 APs
    - Mentioned by: Huawei/Hisi, CATT,
  + **Option 3**: 1 APs
    - Mentioned by: Samsung, Apple

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| **Company** | **Views** |
| *Huawei/Hisi* | * *around 4GHz: up to 8 TRX at UE.* * *around 2GHz: up to 4TRX at UE.* * *sub-1G band (700/800MHz): up to 4 TRX at UE.* |
| *CATT* | * *Around 4 GHz: UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device).* * *Around 700 MHz: UE: Up to 8Tx/Rx ([4]Tx/Rx for handheld device)* |
| *Samsung* | *UE: 1T4R, 1T2R* |
| *Apple* | *UE: 2Rx for FDD* |

* **Main point #7**: antenna elements for FR2
  + **Option 1**: 1024 AEs
    - Mentioned by: Ericsson, Futurewei,

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| ***Company*** | ***Views*** |
| *Ericsson* | *For 30 GHz evaluations, consider up to at least 1024 AEs at the BS.* |
| *Futurewei* | *Up to ~ 1024 AEs (e.g., [M, N, P] = [32, 16, 2]); typically < ~128AEs; Up to ~ 8 APs; typically =2APs* |

* **Main point #8**: Maximum number of layers for single user
  + **Option 1**: 16 layers
    - Mentioned by: Huawei/Hisi,
  + **Option 2**: 8 layers
    - Mentioned by: Huawei/Hisi, ETRI, LGE
  + **Option 3**: 4 layers
    - Mentioned by: Huawei/Hisi, Samsung
  + **Option 4**: 2 layers
    - Mentioned by: Samsung
  + **Option 5**: 1 layer
    - Mentioned by: Samsung

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| **Company** | **Views** |
| *Huawei/Hisi* | * *around 7GHz: up to 16* * *around 4GHz: up to 8* * *around 2GHz: up to 4* * *sub 1GHz: up to 4* |
| *ETRI* | *For Around 4 GHz, Around 7GHz, SU-MIMO: up to 8 layers; MU-MIMO: up to 64 layers;* |
| *LGE* | *For FR3 (e.g., 7.8GHz, 13GHz), Max transmission rank: 8 for both DL and UL; Max number of MU layers: 48 MU layers.* |
| *Samsung* | *For maximum SU-MIMO layers or MU-MIMO layers,*   * *7GHz: For handheld, supporting up to 4 layers per UE for DL and 1 layer per UE for UL; FFS for other device types* * *28GHz: DL: up to 2 layers, UL: up to 2 layers* * *0.7, 2, 4GHz: DL: up to 4 layers, UL: up to 1 layer for handheld* |

* **Main point #9**: R-ML receiver
  + Mentioned by: ZTE, QC

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| **Company** | **Views** |
| *ZTE* | *Regarding receiver type, both MMSE-IRC and R-ML algorithms for downlink reception should be considered* |
| *QC* | *Assume UE is equipped with the R-ML receiver in both link- and system-level evaluation.* |

* **Main point #10**: other aspects (e.g, Single Panel, HBF, etc.)
  + Mentioned by: Google, Xiaomi, Futurewei, Samsung, ZTE

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| **Company** | **Views** |
| *Google* | *Prioritize a single-panel UE configuration for evaluations for FR2/FR3.* |
| *Xiaomi* | *Support hybrid beamforming at BS operating on FR3.* |
| *Futurewei* | *Hybrid antenna architecture should be considered at least for: Bands at the higher end of the upper midband, e.g., > 15 GHz. Carriers with very wide bandwidth, e.g., > 100 MHz bandwidth. Antenna panel with a large number of antenna elements, e.g., > 256 elements.* |
| *Samsung* | *In FR2, assume analog beamforming including precoded CSI-RS. Additionally, to promote more use cases for FR2, various device types like CPE/FWA should be considered. BS/UE APs FFS* |
| *ZTE* | *6GR evaluation should consider both the subarray-specific and fully-connected mapping approaches from TXRU to antenna elements, where subarray-specific is considered as the evaluation starting point.* |

#### Aspect#4: Deployment scenarios

* **Main point #1**: scenario of FWA
  + Mentioned by: Ericsson, Samsung, MTK

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| **Company** | **Views** |
| *Ericsson* | *Evaluation scenarios focusing on fixed wireless access (FWA) should be added to 38.914.* |
| *Samsung* | *FWA at 28GHz.* |
| *MTK* | *Urban Macro, Sub-urban Macro.* |

* **Main point #2**: consider practical UL MIMO assumptions:
  + Mentioned by: QC, Samsung, Lenovo

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| **Company** | **Views** |
| *Samsung* | *To reflect realistic assumption for both UE and BS, Consider channel and interference estimation error, especially for UL evaluation with large number of antenna ports.* |
| *QC* | *UL MIMO evaluation needs to properly model UE sub-optimality, e.g., antenna imbalance between UL and DL, insertion loss imbalance among Tx chains, Tx-Rx calibration error, etc.* |
| *Lenovo* | *For Uplink evaluations, study SRS port imbalance and consider both open-loop precoding as well as closed-loop Uplink precoding with wide-band and sub-band TPMI reporting.* |

* **Main point #3**: considering high speed channel modeling
  + Mentioned by: Nokia, Ofinno, CMCC

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| **Company** | **Views** |
| *Nokia* | *For low and moderate UE speeds, use generic frequency-selective channel models such as TDL and CDL. For high UE speeds, define a clear use case (e.g., high-speed train) and apply an appropriate model such as the HST channel models defined in TS 38.101-4.* |
| *Ofinno* | *Discuss RAN1 level evaluation assumptions for high-speed scenario after the corresponding agreement in the RAN level SI on 6G.* |
| *CMCC* | *For simulation assumptions, RAN1 to take Table 1-5 in R1-2506096 as deployment scenarios for High speed scenario.* |

* **Main point #4**: scenario of multi-TRP operation
  + Mentioned by: ZTE, Samsung, Xiaomi, QC, Lenovo, Futurewei

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| **Company** | **Views** |
| *ZTE* | *6GR evaluation should consider multi-TRP operation with CJT (targeting for FR1/around-7GHz) and NCJT transmission (targeting FR2/around 30GHz).*  *To reduce deployment cost, ensure UL coverage and save NW energy cost, 6GR evaluation should consider the new architecture of DL-TRP and UL-TRP decoupling, i.e., asymmetric DL sTRP/UL mTRP* |
| *Samsung* | *In FR1, evaluate both sTRP and mTRP CJT. For the evaluation of mTRP CJT scenario, NR Rel-18 EVM for mTRP CJT scheme can be baseline* |
| *Xiaomi* | *Consider different backhaul hypotheses in mTRP transmission and cell-free MIMO.* |
| *QC* | *The primary scenario for CJT evaluation should assume outdoor co-site deployment on macro-cell existing grid, rather than dense multi-TRP deployment. For CJT evaluations, the residual synchronization error and delay offset should be properly modelled.* |
| *Lenovo* | *For multi-TRP evaluations both in FR1 and FR3 consider up to 4 TRPs both in CJT and NCJT, under various synchronization/calibration assumptions and for different deployment scenarios.* |
| *Futurewei* | *To evaluate performance of multi-cell / multi-TRP deployment, at least consider: Nonideal backhaul; Imperfect network synchronization.* |
| *Google* | *Focus on single-TRP operations in the initial study and design phase to reduce complexity.* |

* **Main point #5**: SMa scenario,
  + Mentioned by: Docomo, ATT, MTK, Interdigital

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| **Company** | **Views** |
| *Docomo* | *FR3 should be baseline as carrier frequency for suburban macro scenario.* |
| *ATT* | *Suburban Macro deployments, based on the SMa model introduced and developed in Rel. 19, is used for evaluations for 6GR design for services and features.* |
| *MTK* | *Sub-urban Macro (FWA)* |
| *Interdigital* | *UMi and SMa should be prioritized at least for the evaluation for IC.* |

* **Main point #6**: other aspects (general discussion of deployment scenarios)
  + Mentioned by: Nokia, QC

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| **Company** | **Views** |
| *Nokia* | *RAN1 should identify for each evaluated feature/KPI the most relevant deployment scenario. The IMT-2030 test environments defined at ITU-R are considered as the baseline.* |
| *QC* | *Study how 7GHz co-site deployment with 4GHz can be effectively supported.* |

#### Aspect#5: Traffic model

* **Main point #1**: evaluation under burst/non-fullbuffer traffic for eMBB
  + Mentioned by: Huawei/Hisi, Ericsson, ZTE, Samsung, CATT, Docomo, MTK, Xiaomi, vivo, Sony, Futurewei

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| **Company** | **Views** |
| *Huawei/Hisi* | *[Full Buffer], FTP3, other traffic is not precluded.* |
| *Ericsson* | *Study bursty traffic model enhancements, ensuring that aspects such as mixed/variable packet size and time domain behaviors are adequately reflected, while at the same time simulator complexity is not excessively impacted. Leverage and/or reuse existing RAN1 traffic models where feasible; Identify any performance metrics needed for the traffic models.* |
| *Ericsson* | *Study bursty traffic model enhancements, ensuring that aspects such as mixed/variable packet size and time domain behaviors are adequately reflected, while at the same time simulator complexity is not excessively impacted.*  *Study more realistic modelling approaches that can reflect the impact of bidirectional traffic flows on performance metrics (e.g., impact of UL TCP ACK latency on DL throughput/latency)* |
| *ZTE* | *FTP can be used as the starting point for the evaluation of the 6G energy efficiency.* |
| *Samsung* | *Non-full buffer (FTP traffic model 3, S=0.5Mbytes)* |
| *Xiaomi* | *Support both full buffer and non-full buffer traffic models in 6GR.* |
| *CATT* | *FTP model can be a start point of non-full-buffer traffic.* |
| *Sony* | *FTP model 3 for mobile broadband.* |
| *Futurewei* | *Focus on non-full-buffer traffic profiles with realistic utilization ratios;* |

* **Main point #2**: evaluation under fullbuffer traffic
  + Mentioned by: Huawei/Hisi, Samsung, Docomo, MTK, Xiaomi

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| **Company** | **Views** |
| *Huawei/Hisi* | *[Full Buffer], FTP3, other traffic is not precluded.* |
| *MTK* | *Full buffer traffic model as baseline.* |
| *Xiaomi* | *Support both full buffer and non-full buffer traffic models in 6GR.* |

* **Main point #3**: traffic model for new services (XR, AI, etc.)
  + Mentioned by: ATT, vivo, Sony, Futurewei, Google, Apple, Nvidia

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| **Company** | **Views** |
| *vivo* | *support FTP, XR (Ref. TR38.838)* |
| *Sony* | *Periodic traffic with 60/120 fps for XR devices.* |
| *Futurewei* | *Include at least XR traffic profiles and FTP traffic profiles. FFS mixed traffic profiles.* |
| *ATT* | *define a revised mixed-traffic profile including XR and GenAI.* |
| *Nvidia* | *For more realistic traffic modeling and suiting the need for new service/new use cases, it should Study traffic models for performance evaluation during 6GR study taking into consideration the unique characteristics of UL-heavy immersive and AI applications related traffic.* |
| *Google* | *Introduce an AI-specific traffic model using a token-streamlined approach.* |
| *Apple* | *be explored whether traffic model other than the ftp1 model can be considered, for example, considering two traffic flows with different packet size distribution/latency bound. Modeling complexity should be carefully assessed.* |

#### Aspect#6: Channel model

* **Main point #1**: R19 Channel Model as baseline for 6GR MIMO evaluation
  + Mentioned by: Nokia, Ericsson, Huawei/Hisi, LGE, Interdigital, OPPO, vivo, Spreadtrum

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| **Company** | **Views** |
| *Nokia* | *RAN1 to use channel model parameters from Rel-19 version of TR 38.901 for the 6G study.* |
| *Ericsson* | *Channel models in 38.901 should be used as the baseline for 6G evaluations.* |
| *LGE* | *For channel modeling of FR3, it was intensively studied in Rel-19 and the outcome is captured in TR 38.901. Therefore, channel modeling in TR 38.901 can be adopted for MIMO evaluation. For channel modeling of FR3, it was intensively studied in Rel-19 and the outcome is captured in TR 38.901. Therefore, channel modeling in TR 38.901 can be adopted for MIMO evaluation.* |
| *OPPO* | *The channel model output of 7-24GHz channel modeling in Rel-19 can be applied for 6G evaluation.* |
| *vivo* | *Adopt Rel-19 7-24GHz channel model as specified in TR38.901* |
| *Spreadtrum* | *Adopt the latest R19 channel model.* |

* **Main point #2**: considering realistic UE antenna modelling
  + Mentioned by: Ericsson, ZTE, QC, Huawei/Hisi, Apple, Xiaomi

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| **Company** | **Views** |
| *Ericsson* | *Evaluations should consider realistic UE antenna modelling (e.g., non-uniform antenna positioning, use of directional antennas, power imbalance / insertion loss among antennas, and limited control of relative phase). UE/CPE models in TR38.901 can be considered as the starting point with further elaboration when needed.* |
| *ZTE* | *6GR evaluation should consider the handheld UE antenna model introduced in Rel-19.* |
| *QC* | *The 6GR study should use more realistic antenna radiation patterns as the default in system-level simulations.* |
| *Apple* | *Support more realistic UE modeling as amended TR 38.901 (for FR3) including single polarization and antenna placement locations.* |
| *InterDigital* | *New UE hand-held modelling and new UE spatial blockage model defined in TR 38.901 V19.0.0 should be considered for wide range of evaluations in 6G.* |
| *xiaomi* | *Consider the antennas models of UE’s in TR38.901 Consider the antennas models of UE’s in TR38.901* |

* **Main point #3**: consider near-field channel modeling
  + Mentioned by: ZTE, [ETRI], Xiaomi, vivo
  + Far-field as baseline: QC, CATT

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| **Company** | **Views** |
| *ZTE* | *(U6G) near-field and SNS channel models in TR 38.901 should be considered.* |
| *Ofinno* | *Evaluation in 7GHz considers also near-field channel model for the users in the near-field zone in 7 GHz.* |
| *Xiaomi* | *Support channel modelling for FR3 including near-field and spatial non-stationarity in the evaluations involved in 6GR, esp. for the cases with larger-scale antenna arrays.* |
| *vivo* | *Consider spherical wave and both NW side and UE side spatial non-stationary* |
| *QC* | *Far-field channel models are the baseline for MIMO evaluation. The use of near-field channel models must be well-justified by the practical deployment scenarios.* |
| *CATT* | *For the study on MIMO evaluation assumption in 6GR, near-field and spatial non-stationarity should only be optional instead of default.* |

* **Main point #4**: considering new stochastic channel model
  + Mentioned by: QC

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| **Company** | **Views** |
| *QC* | *For time-domain CSI extrapolation, deterministic channel models (e.g., CDL-like) shall not be used. The stochastic channel models (filtering white Gaussian process by a Doppler spectrum shaping filter) shall be used to avoid overestimating the potential of time-domain prediction.* |
| *QC* | *The evaluation methodology shall avoid being overfit to or favouring a specific type of designs.* |

* **Main point #5**: considering new channel model,
  + Mentioned by: DeepSig, Nvidia

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| **Company** | **Views** |
| *DeepSig* | *consider more structured channel model techniques which more accurately reflect the ability of various methods to exploit real world structure … the use of open-source simulation frameworks such as Sionna might even be considered with standard simulation geometries or scenarios to allow for fair comparisons and evaluation of air interface techniques with reproducible and realistic statistics.* |
| *NVIDIA* | *Besides stochastic channel model, deterministic physics-based channel model, especially ray tracing, should be considered for 6GR study.* |

## Discussions

**Observations and suggestions from moderator**:

* System-level assumptions including scenarios carrier frequency, subcarrier spacing, bandwidth, TRP/UE antenna configurations will be discussed as the common assumptions in section 2.2.
* The traffic model could be discussed as a common assumption in section 2.4.
* Other assumptions, e.g., maximum layers, number of TRP/UE antenna ports, will be discussed in the agenda of MIMO.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on duplex

## Companies’ views

#### Aspect#1: Duplex schemes for evaluations

* **Main point #1**: duplex schemes considered
  + **Dynamic TDD:** CATT, Ericsson, Huawei
  + **Semi-**static SBFD: CATT, Ericsson, Huawei, Google, Interdigital
  + **Dynamic SBFD:** CATT, Huawei, Interdigital
  + **SBFD@UE side:** Interdigital
  + **Enhanced D-**TDD: Huawei

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| --- | --- |
| **Company** | **Views** |
| *Huawei/Hisi* | *FDD, semi-static TDD, dynamic TDD, as well as SBFD, enhancement on existing NR duplex schemes and new duplex schemes as well as the complexity and commercial feasibility* |
| *CATT* | * *If* ***dynamic SBFD*** *is to be studied, evaluation is needed with the following considerations:* * *How dynamic SBFD is achieved;*   *Whether* ***baseline should be semi-static SBFD or dynamic TDD****.* |
| *Ericsson* | *If* ***dynamic SBFD*** *is studied for 6G,* ***dynamic TDD or protected dynamic TDD scenario is considered as the baseline*** *for evaluations.* |
| *Interdigital* | *Support following evaluation assumptions for full duplex study in 6GR*   * *Define UE antenna configuration assumptions for UE-side SBFD, including separate Tx/Rx arrays and self-interference modelling.* * *Support evaluation of flexible FD resource configurations (e.g., variable UL subband sizes, DL/UL slot fallback) in addition to semi-static SBFD.* * *Include advanced CLI handling techniques (spatial/power-domain, adjacent-carrier leakage) in 6G FD evaluation.* |

#### Aspect#2: Evaluation methodology and assumption for Duplex

* **Main point #1:** Evaluation assumptions assumed in TR 38.802 and TR 38.858 can be considered as baseline
  + **Mentioned by:** Huawei/Hisi, CATT

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| --- | --- |
| **Company** | **Views** |
| *Huawei/Hisi* | *Evaluation scenarios and assumptions of duplex evaluation assumed in TR 38.802 and TR 38.858 can be taken as the starting point for the 6GR duplex evaluation, with studying necessary methodology and metric modifications such as the QoS based performance metric etc.* |
| *CATT* | *evaluation assumptions defined in NR Rel-18 Evolution of NR Duplex Operation can be considered as baseline and updated based on the assumption of 6GR for dynamic TDD and SBFD, including carrier frequency, typical scenarios and channel models, SBFD slot configurations and SBFD subband configurations.* |

* **Main point #2: Evaluation scenario**
  + **Option 1:** two-operator urban macro scenario
    - **Mentioned by:** Ericsson, Interdigital

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| --- | --- |
| **Company** | **Views** |
| *Ericsson* | *two-operator urban macro scenario with an adjacent operator deploying legacy TDD network should be considered as the baseline for evaluations. It is also important to consider co-located deployments with higher priority.* |
| *Interdigital* | *advanced CLI handling techniques (spatial/power-domain, adjacent-carrier leakage) in 6G FD evaluation.* |

* **Main point #3: Evaluation metric**
  + **Option 1:** throughput
    - **Mentioned by:** CATT
  + **Option 2:** latency
    - **Mentioned by:** CATT
  + **Option 3:** coverage
    - **Mentioned by:** CATT
  + **Option 4:** QoS based performance metric
    - **Mentioned by:** Huawei

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| --- | --- |
| **Company** | **Views** |
| *CATT* | *SLS: throughput and latency*  *LLS: coverage* |
| *Huawei* | *QoS based performance metric: X% UEs’ QoS target are fulfilled* |

* **Main point #4: Traffic model**
  + **Option 1:** FTP
    - **Mentioned by:** Futurewei, Huawei, Hisi
  + **Option 2:** XR
    - **Mentioned by:** Futurewei

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| **Company** | **Views** |
| *Futurewei* | *non-full-buffer traffic profiles with realistic utilization ratios:*   * *Include at least XR traffic profiles and FTP traffic profiles.* * *Include a range of traffic loads, e.g., low load with ~10% resource utilization ratio, medium load with ~25% resource utilization ratio, high load with ~50% resource utilization ratio,* |
| *Huawei* | |  |  | | --- | --- | | *Parameter* | *value* | | *DL & UL traffic model* | *FTP 3: Each UE is assigned both UL traffic and DL traffic*  *Packet size: 0.1/0.5/1MBits for DL/UL* | | *DL/UL traffic ratio* | *3:1, 2:1,1:1, 1:2* | | *DL&UL arrival rate* | *Low load: static TDD RU(DL+UL) <20%*  *Medium load: 30%<static TDD RU(DL+UL)<40%*  *High load: 40%<static TDD RU(DL+UL)<55%* | | *Packet delay budget* | *50ms/80ms/100ms/200ms* | |

* **Main point #4: Other detailed assumptions**

|  |  |
| --- | --- |
| **UE distribution** | * ***Interdigital:*** Retain **Rel-18 outdoor UE clustering distribution assumptions** for CLI impact evaluation in FD scenarios. * ***Huawei***: 21 BS, 210 UE |
| **gNB antenna configuration** | * ***Interdigital:*** Use separate Tx/Rx antenna arrays at BS with at least twice the antenna elements of TDD, as per Rel-18 duplex studies |
| **UE antenna configuration** | * ***Interdigital:*** UE antenna configuration assumptions for UE-side SBFD, including **separate Tx/Rx arrays** and self-interference modelling. |
| **Channel model** | * ***Huawei***: 38901 UMA as the starting point |
| **Carrier frequency** | * ***Huawei***: 7GHz, 4GHz |
| **Bandwidth** | * ***Huawei***: Up to 400MHz for 7GHz, up to 200MHz for 4GHz |
| **Inter-BS distance** | * ***Huawei***: 500m |

## Discussions

**Observations and suggestions from moderator**:

* System-level assumptions including scenarios carrier frequency, subcarrier spacing, bandwidth, TRP/UE antenna configurations will be discussed as the common assumptions in section 2.2.
* The traffic model could be discussed as a common assumption in section 2.4.
* Other assumptions, e.g., performance metrics, will be discussed in the agenda of duplex.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on NTN

## Companies’ views

#### Aspect#1: NTN evaluation methodology

**Main point #1**: system or link-level simulation

* ***System Level:*** *Huawei, CATT, Xiaomi, Lenovo, MediaTek*

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| --- | --- |
| **Company** | **Views** |
| *Huawei* | * + *The system level simulations for 6G-based NTN should consider the following assumptions:*     - *Dense/sparse (V)LEO constellation with massive beam footprints per satellite*     - *Uneven UE distribution across the service area*   *In order to natively incorporate highly accurate inter-beam interference modelling for 6G NTN, a modelling methodology based on 3D hexagonal tessellation of Earth should be utilized.* |
| *Lenovo* | *To have a unified air interface for TN and NTN, it is recommended to evaluate waveform enhancements for both TN and NTN channel models (at least for NTN NGSO scenarios).* |
| *MediaTek* | *Based on TR38.821 and TR38.811, the system-level evaluation assumptions are suggested to be the starting point for further discussion on system-level evaluation assumptions for 6G NTN evaluation* |

* ***Link Level:*** *Nokia, Apple, CMCC*

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| --- | --- |
| **Company** | **Views** |
| *Nokia* | *The NTN channel models and evaluation assumptions as defined for 5G in TR 38.811 and TR 38.821, respectively, should be applied for 6G NTN evaluations* |
| *Apple* | *The basic evaluation methodology is based on link-level simulation.* |
| *CMCC* | *It is suggested to first evaluate the coverage performance based on the new 6G structure. Channel model defined in TR 38.811 could be a starting point*   * + *For 6G NTN evaluation, the following channels/signals can be evaluated as a baseline*     - *Synchronization signal*     - *Broadcast signals/channels*     - *Initial access channels/signals*     - *Other UL/DL channels/signals* |

#### Aspect#2: NTN Evaluation scenarios/assumptions：

* + **Satellite mobility modelling** 
    - **Mentioned by*:*** *Nokia, Huawei*

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| --- | --- |
| **Company** | **Views** |
| *Nokia* | *The snapshot-based NTN channel models of TR 38.811 do not account for satellite mobility, when determining the LoS probability and this is a potential aspect for 3GPP to address in order to evaluate handover/mobility performance.* |

* + **Single/Multi-satellite SLS evaluation methodology/Beam layout/inter-beam interference modeling:** 
    - **Mentioned by*:*** *Huawei, Xiaomi*

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| --- | --- |
| **Company** | **Views** |
| *Huawei* | *In order to natively incorporate highly accurate inter-beam interference modelling for 6G NTN, a modelling methodology based on 3D hexagonal tessellation of Earth should be utilized* |
| *xiaomi* | *Determine the position of adjacent satellites based on the relationship between the edge beams of central satellite and adjacent satellites.*  *Multi-satellite case:7 satellite; the outer beams of central satellite can be selected for metrics statistic, only the UEs placed in the outer beams are considered for coupling loss, geometry calculation.*  *Single satellite case: only the UEs placed in the inner-19 beams are considered for metrics static* |
| *ZTE* | *Number of planned footprints for a satellite and number of simultaneous active beams.* |

* + **Non-Uniform UE distribution** 
    - **Mentioned by*:*** *Ericsson, Huawei*

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| --- | --- |
| **Company** | **Views** |
| *Ericsson* | UE distribution within the NTN cell 🡪 Models can be further studied to reflect relevant NTN deployment aspects, including non-uniformity of the traffic distribution along with the ones from TR 38.821 used as baseline. |
| *Huawei* | *Due to the 6G ubiquitous coverage requirements, NTN deployments may cover extremely uneven user distributions across the surface of the earth* |

* + **Satellite orbits**
    - **vLEO:** Nokia, Huawei, Sony, LGE
    - **LEO:** Huawei, Sony, MediaTek
    - **MEO:** Futurewei
    - **GEO/GSO:** Sony, CMCC
    - **Multi orbits:** ZTE, Futurewei

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| --- | --- |
| **Company** | **Views** |
| *Nokia* | Add an additional satellite set, which covers very LEO deployments. Such a set can be based on one of the LEO sets of TR 38.821. |
| *Futurewei* | *6G radio study should include heterogeneous satellite constellations (or multi-orbit satellites), comprising a combination of VLEO, LEO, MEO, and GEO satellites.* |
| *Huawei* | *The system level simulations for 6G-based NTN should consider the following assumptions:*   * *Dense/sparse (V)LEO constellation with massive beam footprints per satellite* * *Uneven UE distribution across the service area* |
| *Sony* | *While higher data rate services are likely to be provided by LEO constellations, the study can also consider MEO, GEO and VLEO constellations, according to satellite operator commercial interest.* |
| *LGE* | *Determine the parameters including the altitude, the maximum RTT, the maximum Doppler shift, and the maximum Doppler rate. The attitude of 300km could be a good starting point.* |
| *MediaTek* | *LEO-600 should be prioritized* |
| *CMCC* | *At least support GSO and NGSO* |
| *ZTE* | *In addition to single-orbit system, multi-orbits system and* ***TN-NTN integrated*** *system should also be considered.* |

* + **Duplex Mode**
    - **Mentioned by*:*** *Sharp, CATT, CMCC*

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| **Company** | **Views** |
| *Sharp* | *HD-FDD should be included in the evaluation assumptions for the* ***Ku- and Ka-bands*** |
| *CATT* | *For duplex mode, FDD, HD-FDD and TDD should be supported* |
| *CMCC* | *FDD mode* |

* + **Band**
    - **S band**: Sony, MediaTek, CATT
    - **Ka band**: Sony, MediaTek, CATT, ETRI, NEC, Sharp
    - **Ku band**: Sony, MediaTek, CATT, ETRI, NEC, Sharp

|  |  |
| --- | --- |
| **Company** | **Views** |
| *Sony* | *We propose 6G evaluation should consider both FR1-NTN and FR2 NTN.* |
| *MediaTek* | *Ka-band (i.e. 30 GHz UL and 20 GHz DL) for VSAT, S-band (i.e. 2 GHz) for handheld device, FFS Ku-band (i.e. 14 GHz UL and 12.5 GHz DL)*  *Ka-band for VSAT, S-band and Ku band for handheld* |
| *CATT* | *FR1&FR2* |
| *ETRI* | *evaluations on Ka-bands have the first priority over the other bands due to the (planed) frequency allocation environments. Up to 400MHz for Ka band, but 100M could provide practical result.* |
| *NEC* | *The model must be extended to incorporate UE power consumption characteristics for operation in new bands like FR3 (7-24GHz), including the impact of its specific RF hardware constraints on the UE.* |
| *Sharp* | *evaluation assumptions will be discussed, focusing on the NTN Ka/Ku band.* |

* + **Traffic model service: CMCC**

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| --- | --- |
| **Company** | **Views** |
| *CMCC* | *The following target services (i.e., VoIP and low-data rate services for commercial handset terminals) and the target data rate assumptions can be considered*   * *For VoIP, AMR 4.75 kbps (TBS of 184 bits without CRC in physical layer) with 20 ms data arriving interval is used in the evaluations.* * *For low-data rate service, both 3 kbps and 1Mbps can be considered as DL date rate, 3 kbps and 100 kbps can be considered for UL.* |

* + **UE Transmit power** 
    - 23dBm: *Sony*
    - IoT/Handheld UE 20dBm: *ETRI*
    - VAST 44dBm: *ETRI*

|  |  |
| --- | --- |
| **Company** | **Views** |
| *Sony* | *The baseline assumption should be a UE TX power of 23dBm* |
| *ETRI* | *Max Transmit power of IoT/Handheld UE: 20dBm; VAST terminals: 44dBm* |

* + **UE Antenna gain:** *CATT, Sharp, ETRI,*

|  |  |
| --- | --- |
| **Company** | **Views** |
| *CATT* | *the maximum gain of the satellite antenna should be increased to 35dBi to provide better link conditions.*  *The antenna gain of the handheld terminal should be configured to -5.5dB which is used in the 5G NTN Evaluation* |
| *Sharp* | *A form factor of up to 20 × 20 cm (e.g., 10 × 10 cm and 20 × 20 cm) should be included in the evaluation assumptions for the Ku-band and Ka-bands (for VSAT terminals).* |
| *ETRI* | *The number of antenna elements for a VSAT antenna array is 2,048* |

#### Aspect#3: Potential feature to be evaluated:

* + **GNSS availability:** *Nokia, NEC, LG, ETRI*

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| --- | --- |
| **Company** | **Views** |
| *Nokia* | *Evaluate the impact of either a less accurate UE position/no UE position, or the achievable position accuracy if the 6G NTN satellites are used for positioning* |
| *NEC* | *UE power potential savings from features like GNSS-independent operation should be considered* |
| *LGE* | *the TO/FO need to be evaluated* |
| *ETRI* | *performance degradation of the corresponding time/frequency tracking should be evaluated* |

* + **Beam hopping/management:** *Huawei*

|  |  |
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| **Company** | **Views** |
| *Huawei* | *In order to natively incorporate highly accurate inter-beam interference modelling for 6G NTN, a modelling methodology based on 3D hexagonal tessellation of Earth should be utilized.* |

* + **Energy efficiency/saving:** *FUTUREWEI, NEC*

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| --- | --- |
| **Company** | **Views** |
| *Futurewei* | *6G radio study should include energy efficiency for 6G NTN including UE with and without a GNSS receiver* |
| *NEC* | *UE power consumption related to satellite beam hopping and potential savings from features like GNSS-independent operation should be considered.* |

* + **Waveform design:** *Lenovo, DOCOMO, ETRI*

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| --- | --- |
| **Company** | **Views** |
| *Lenovo* | *evaluate waveform enhancements for both TN and NTN channel models (at least for NTN NGSO scenarios)* |
| *Docomo* | *In order to achieve wider coverage for both TN and NTN operations, it may be beneficial to jointly evaluate candidate schemes for waveform and modulation to reduce PAPR.* |
| *ETRI* | *At least one more waveform other than CP-OFDM should be studied and specified for 6GR to support coverage-limited 6G scenarios like uplink transmission in NTN. The additional waveform may provide robustness to large delay/doppler environments, low PAPR, low power/memory consumption, at the cost of low migration efforts from 5G NR* |

* + **Channel coding:** *ETRI*

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| --- | --- |
| **Company** | **Views** |
| *ETRI* | *6G needs to cover one more scenario of 10-7 iBLER for DL/UL emergent data transmission without HARQ through NTN. Considering such low target iBLER, legacy NR channel coding scheme may need to be revised and reflected to the evaluation campaign, accordingly.* |

## Discussions

**Observations and suggestions from moderator**:

* The traffic model could be discussed as a common assumption in section 2.4.
* The general assumptions for NTN can be discussed in the agenda of NTN.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Specific assumption on sensing

## Companies’ views

#### Aspect#1: ISAC use cases

**Use cases:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Detection and tracking | Infrastructure collapse monitoring | Environmental reconstruction | Human monitoring | Sensing assisted communication | Joint sensing and localization optimization | Object identification |
| Sony, Xiaomi, ZTE, CATT, LGE, vivo, Huawei, Lenovo, Spreadtrum, Samsung, OPPO, interdigital, Lenovo, Ericsson | ZTE | CMCC, Huawei | vivo, Interdigital, OPPO, Huawei, Lenovo | vivo, Huawei, | QC, Apple, Huawei | Ericsson |

#### Aspect#2: Scenarios and sensing modes for ISAC

**Scenario associated with detection and tracking and infrastructure collapse monitoring:**

|  |  |
| --- | --- |
| **Scenarios** | **Detection and tracking** |
| Indoor hotspot | * Human: Sony, Xiaomi, OPPO |
| Indoor factory | * Human: ZTE * AGV: ZTE, CATT, Samsung, OPPO |
| Dense urban | * UAV: ZTE * vehicle: Sony |
| Urban Macro | * UAV: CATT, ZTE, Xiaomi, Samsung (outdoor), OPPO |
| RMa/RMa-AV | * UAV: ZTE, Sony |
| Urban grid | * Human: Xiaomi * Vehicle: Huawei, ZTE, Xiaomi, OPPO * Geological disaster: ZTE |
| Highway | * Vehicle: ZTE, OPPO * Geological disaster: ZTE |
| Nearshore waters | * Ship: ZTE |

**Sensing modes:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Companies*** | ***BS mono*** | ***BS-BS*** | ***BS-UE*** | ***UE-BS*** | ***UE mono*** | ***UE bi*** |
| Nokia | *support* | *support* | *support* | *support* | *support* | *support* |
| Samsung | *prioritize* | *prioritize* |  |  |  |  |
| Huawei | *support* | *support* | *support* | *support* | *support* |  |
| Sony | *support* | *support* | *support* | *support* | *support* | *Can be introduced at the later stage* |
| Qualcomm | *support* | *support* | *support* | *support* | *support* | *support* |
| Xiaomi | *support* | *support* | *support* | *support* | *support* | *support* |
| OPPO |  |  | *prioritize* | *prioritize* | *prioritize* | *prioritize* |
| Interdigital |  |  | *support* | *support* | *support* |  |
| Lenovo | *support* | *support* | *support* | *support* |  |  |
| LGE | *support* | *support* | *support* | *support* | *support* | *support* |
| Apple | *support* | *support* | *support* | *support* | *support* | *support* |
| Google |  |  | *prioritize* | *prioritize* | *prioritize* | *prioritize* |

* *Qualcomm****:*** *should not attempt to down scope specific sensing modes.*

#### Aspect#3: Channel model extension for ISAC

**Channel model extension:**

|  |  |  |
| --- | --- | --- |
| ***Potential extension*** | ***Detail*** | ***Mentioned by*** |
| Micro-doppler | * vivo:   + rotation   + swinging * OPPO: functions for UAV, birds, Respiration rate. | Qualcomm, vivo, OPPO, Interdigital, BUPT, Ericsson, CMCC |
| Precipitation modeling | backscatter and attenuation | Qualcomm |
| Multiple scattering points for human and UAV | Location and corresponding RCS model for each point. | vivo |
| Remaining issues from Rel-19 | * Type-1 EO: Bird/tree, * angular correlation of B2/CPM * moving scatters | Ericsson |
| CPM | polarization state and phase of signals | BUPT, CMCC, vivo |
| Link-level simulation model |  | Qualcomm, Interdigital, Apple, Nokia |
| New scenario and requirements |  | CMCC |
| Ray tracing |  | CMCC, NVIDIA |

* **Xiaomi:** RAN1 defers the discussion on ISAC channel model update until further progress has *been achieved on supported use cases and deployments scenarios.*

#### Aspect#4: Performance metrics

***Evaluation metrics:***

|  |  |
| --- | --- |
| ***KPIs*** | ***Mentioned by*** |
| Sensing resolution | Nokia, Samsung, Interdigital (LLS), Apple, MTK, Google |
| Detection probability and false alarm probability | Nokia, Huawei, Spreadtrum, ZTE, CATT, vivo, Qualcomm, Samsung, OPPO, Lenovo, Apple, MTK, Google |
| Localization accuracy | Nokia, Huawei, Spreadtrum, ZTE, CATT, vivo, Qualcomm, Samsung, OPPO, Lenovo, Apple, MTK, Google |
| Velocity accuracy | Nokia, Huawei, Spreadtrum, ZTE, CATT, vivo, Qualcomm, Samsung, Lenovo, Apple, MTK, Google |
| Reconstruction accuracy | Huawei |
| Micro-doppler accuracy | vivo |
| Confidence level | Qualcomm, Apple |
| reliability | Lenovo |
| latency | Qualcomm, Lenovo, Apple, Google |
| Sensing coverage | Samsung |
| Refreshing rate | Apple |
| Number of targets | MediaTek |
| The loss of the communication performance | LGE |
| Traditional communication performance metrics | CMCC, vivo |

***Evaluation methodology and assumptions:***

|  |  |
| --- | --- |
| ***assumptions*** | ***Mentioned by*** |
| interference | Huawei, vivo, Ericsson, Samsung, Lenovo |
| Impact on communication | LGE, AT&T, Spreadtrum |
| Tracking model | vivo |
| Mixed type of sensing target | Ericsson |
| Data fusion | Ericsson |

## Discussions

**Observations and suggestions from moderator**:

* Whether the Rel-19 channel model is sufficient or needed to be enhanced for ISAC study depends on the use cases that will be studied.
* The evaluation assumptions and the performance metrics also vary depending on the use cases.
* How to evaluate performance for ISAC can be discussed once the use cases to be studied are decided. The evaluation methodology can be discussed in the agenda of ISAC.

Any comments/suggestions, please leave them here:

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| **Company** | **Comments** |
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# Conclusions

TBD.

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