**3GPP TSG RAN Meeting #106 RP-243279**

**Madrid, Spain, December 9-12, 2024**

**Agenda Item: 16**

**Source: Moderator (CMCC)**

**Title: Moderator's summary for discussion on IMT-2030 TPRs**

**Document for: Report**

# Introduction

In RAN#103, the following RAN plenary work plan was agreed for IMT-2030 aspects [1].

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| *RAN plenary work is split into an ITU focused SI (study item) and General RAN SI*   * *IMT-2030 discussion is expected in RAN from 09/24 to 12/24* * *RP SI Rel-20 focusing on ITU– IMT-2030: approval 12/24 until 06/25* * *RP SI Rel-20 focusing on 6G General: approval 03/25 (after WS), until 06/26* |

In June 2023, ITU-R Working Party 5D (WP5D) completed the development of 6G Framework in ITU-R M.2160. Compared with IMT-2020, the 6G framework presents:

* Expanded and new usage scenarios, and
* Enhanced and new capabilities.

In this meeting, an LS was received by RAN in RP-243202 [2], in which ITU-R WP 5D kindly invites External Organizations to provide their inputs on the minimum technical performance requirements (TPR) for IMT-2030 radio interface technologies. The key part of contents of the LS is copied below

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| Based on Recommendation [ITU-R M.2160](https://www.itu.int/rec/R-REC-M.2160/en) – *Framework and overall objectives of the future development of IMT for 2030 and beyond*, ITU-R Working Party (WP) 5D has started to develop a draft new Report ITU-R on Minimum requirements related to technical performance for IMT-2030 radio interface(s), which is planned to be finalized by February 2026.  Working Party 5D kindly invites External Organizations to provide their inputs on the minimum technical performance requirements for IMT-2030 radio interface technologies, including but not limited to,  – Proposed candidate items for minimum technical performance requirements based on M.2160 Usage Scenarios and Capabilities, including necessary background information and justification, which are requested to be provided preferably by WP 5D #48 (4-13 February 2025).  – Proposed associated target values for the above candidate items for the minimum technical performance requirements which are requested to be provided preferably by WP 5D #49 (24 June – 3 July 2025, TBC) |

As requested by the LS, one of the purpose in RAN SI is to investigate a candidate set of items for minimum TPRs based on the Recommendation ITU-R M.2160, and the associated target values for the identified minimum TPRs. Then, the output of the SI is expected to be shared with ITU-R in the form of official liaisons.

Based on the input from contributions, this document summarizes companies view and provides proposals for consensus on IMT-2030 TPRs.

# Discussion on IMT-2030 TPRs

This section is used for discussion on IMT-2030 TPRs, including candidate items for IMT-2030 TPRs, definition of candidate IMT-2030 TPRs and target value of candidate IMT-2030 TPRs. For each subsection, proposals are bought up with the consideration of company views in the contributions.

## Candidate items for IMT-2030 TPRs

As mentioned in RAN Chair’s guidance in RP-242439, [RP-243082 Indian Institute], [RP-243081 BOSCH], etc., the IMT-2030 (6G) framework document envisages six usage scenarios compared to the three in IMT-2020 (5G). The usage scenarios can be divided into two subcategories; Part 1 which includes the expansion of IMT-2020 usage scenarios from Enhanced Mobile Broadband to Immersive Communication (IC), Ultra Reliable Low Latency Communication to Hyper Reliable Low Latency Communication (HRLLC) and Massive Machine Type Communication to Massive Communication (MC). Part 2 consists of three new usage scenarios including Ubiquitous Connectivity (UC), Integrated Sensing & Communication (ISAC) and Artificial Intelligence & Communication (AIAC) which are expected to support new services beyond IMT-2020. Figure 2-1(a) indicates the set of the above usage scenarios as depicted in ITU-R M.2160.

Furthermore, fifteen capabilities were proposed, including nine capabilities enhanced from IMT-2020 and six new capabilities for IMT-2030 to support new usage scenarios and services. These capabilities are being discussed in the form of minimum Technical Performance Requirements (TPR) for IMT-2030 in ITU-R WP5D Sub-Working Group (SWG) Radio Aspects.

A diagram of a diagram

Description automatically generated

(a) Usage scenarios (b) capabilities

Figure 2-1 Usage scenarios and Capabilities of IMT-2030

As mentioned in [RP-242873 Huawei], [RP-242558 Qualcomm], [RP-243171 ZTE], [RP-243082 Indian Institute], [RP-243131 CATT], [RP-242778 KT], [RP-242988 Xiaomi] etc., and based on the discussion in ITU WP5D, Moderator thinks the TPR items can be basically divided into three groups as shown in the following table, where the first group is from IMT-2020, and the second group is proposed candidates to update or to be combined with some items in the first group. The third group is for brand new capabilities of IMT-2030.

* **For AI**: The general concept is supported by majority companies as a candidate item for IMT-2030 TPRs, but the details are still somehow divergent. [RP-242873 Huawei], [RP-242558 Qualcomm], [RP-243171 ZTE], [RP-243082 Indian Institute], [RP-242976 CMCC], [RP-242634 vivo], [RP-242988 Xiaomi], [RP-243213 MITRE], and [RP-242761 NVIDIA] support that, but [RP-242528 Samsung], [RP-242530 Nokia], [RP-243249 MTK], [RP-243131 CATT] prefer not to have quantitative targets. For example, [RP-242530 Nokia] thinks there is no need to define separate TPRs for “AI for Network” and an extension of the “Reliability” TPR can be used for “Network for AI”. [RP-242796 OPPO] also suggest not to define dedicate KPIs on “AI for Network”.
* **For sensing**, most companies support the quantitative capabilities which may include missed detection probability, false alarm probability, accuracy on position, velocity and reconstruction.
* **For sustainability/energy efficiency**: For the following bullet 10, it was suggested to support new definition using simulation method to evaluate energy efficiency in ITU WP5D discussion. For example, [RP-242634 vivo] thinks the definition of energy efficiency should jointly consider both power/energy consumption and communication throughput. As suggested in [RP-242528 Samsung], whether using simulation or analytical way can be FFS. [RP-243249 MTK] suggest to not define target value for both network EE and device EE, while the improve of network EE shall not impact the ability to fulfil the end user experience needs.
* **For immersive communication**, [RP-242634 vivo] propose to consider connection density for both Massive Communication and Immersive Communication usage scenarios. [RP-242873 Huawei] proposes to down select or combine those second group candidates (item 15-18) as one TPR item, named e.g. “Immersive system/communication capacity” for the following candidates: XR connection density/connection capacity, XR area capacity, XR area efficiency, and joint requirement on data rate, latency, and reliability or joint requirement of data rate, latency, reliability and capacity.
* **For Joint requirement**: For IC and probably HRLLC, it is suggested by [RP-242873 Huawei], [RP-243171 ZTE], [RP-242528 Samsung], [[RP-242639 Ericsson]](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_106/Docs/RP-242639.zip), and [RP-242778 KT], etc.. If it is supported, some items for IC and HRLLC, e.g. reliability can be replaced by the joint requirement.
* **For sustainable data rate**, [RP-242873 Huawei] propose to combine it with energy efficiency.
* **For Security, resilience, and interoperability**: In [RP-242528 Samsung], [RP-242873 Huawei], it is suggested not to include these as IMT-2030 quantitative TPRs, since it is not straight forward how to define them as TPRs. [RP-242530 Nokia] thinks it is hard to define technical performance requirements for interoperability. [RP-242825 DOCOMO] support with the current definition in ITU-R WP5D.
* **For coverage**, [RP-242873 Huawei] suggests FFS, while [RP-242530 Nokia] thinks the legacy TPRs can reflect this. In [RP-243249 MTK] and [RP-242528 Samsung], they mention that link level analysis may be sufficient as similar as in 38.913.
* **For bandwidth**, [RP-242530 Nokia] [RP-242634 vivo] propose to set the requirement for bandwidth to be 400 MHz. [RP-242530 Nokia] [RP-242873 Huawei] also suggest 200 MHz should be included for the requirement for bandwidth. [RP-243249 MTK] propose to enable use of multiple aggregated RF carriers to achieve any target value.

Based on the above analysis, moderator suggests the following proposal for further discussion.

### Proposal 1

**The following candidate items are to be considered from 3GPP RAN plenary’s perspective:**

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| **Number** | **Candidate IMT-2030 TPRs under discussion in ITU-R WP5D** | **Remark** |
| 1 | Peak data rate | Existing TPRs in IMT-2020 |
| 2 | Peak spectral efficiency |
| 3 | User experienced data rate |
| 4 | 5th percentile user spectral efficiency |
| 5 | Average spectral efficiency |
| 6 | Area traffic capacity |
| 7 | User plane latency |
| 8 | Control plane latency |
| 9 | Connection density |
| 10 | Sustainability/Energy efficiency  Note: Including both NW and Device |
| 11 | Reliability  FFS: to be replaced by joint requirement [18] |
| 12 | Mobility |
| 13 | Mobility interruption time |
| 14 | Bandwidth |
| 15 | XR connection density/connection capacity | Proposed in WP 5D, and may be combined or down-selected |
| 16 | XR area capacity |
| 17 | XR area efficiency |
| 18 | Joint requirement  FFS joint of data rate, latency, and reliability or joint of data rate, latency, reliability and capacity  FFS this is to replace reliability |
| 19 | Sustainable data rate  FFS this is combined with energy efficiency [10] |
| 20 | Coverage | Brand-new capabilities for IMT-2030 |
| 21 | Positioning  May include horizontal/vertical positioning accuracy |
| 22 | Sensing-related capabilities  May include missed detection probability, false alarm probability, accuracy on localization, accuracy on velocity, accuracy on reconstruction, |
| 23 | AI-related capabilities  May include qualitative metric and quantitative metrics (AI latency, AI accuracy, AI energy efficiency, etc.) |
| 24 | Security |
| 25 | Resilience |
| 26 | Interoperability |

## Definition of candidate IMT-2030 TPRs

Regarding the issue on definition of candidate IMT-2030 TPRs, moderator observes that some candidate TPRs are inherited from IMT-2020 TPRs and/or already have a stable version of definition, while some other candidate TPRs are still need more consideration and discussion. Moderator suggests to first focus on the former ones to see whether the definition on these TPRs are feasible from 3GPP RAN’s perspective. Note that the definitions on each candidate TPR below are derived from the latest working document in ITU-R WP5D in [3]:

### Proposal 2

**The definitions (captured from latest ITU-R WP5D document [3]) on the following TPRs are feasible from 3GPP RAN plenary’s perspective:**

* **Peak data rate**
* **User experienced data rate**
* **Spectral Efficiency (including Peak Spectral Efficiency, average Spectral Efficiency and 5th percentile user spectral efficiency)**
* **Area traffic capacity**
* **Latency (including User plane latency and** **Control plane latency)**
* **Connection density**
* **Mobility interruption time**
* **Bandwidth**

Definition on Peak data rate:

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| **4.1 Peak data rate**  Peak data rate is the maximum achievable data rate under ideal conditions (in bit/s), which is the received data bits assuming error-free conditions assignable to a single mobile station, when all assignable radio resources for the corresponding link direction are utilized (i.e. excluding radio resources that are used for physical layer synchronization, reference signals or pilots, guard bands and guard times) [365] and consider guard times and uplink/downlink ratio for TDD).  Peak data rate is defined for a single mobile station. In a single band, it is related to the peak Spectral efficiency in that band. Let W denote the channel bandwidth and SEp denote the peak Spectral efficiency in that band. Then the peak data rate Rp is given by:  Rp = W × SEp (1)  Peak Spectral efficiency and available bandwidth may have different values in different frequency ranges. In case bandwidth is aggregated across multiple bands, the peak data rate will be summed over the bands. The bands over which the bandwidth has been aggregated should be in the specified frequency*.* Therefore, if bandwidth is aggregated across *Q* bands then the total peak data rate is  Wi × SEpi (2)  where Wi and SEpi (i = 1,…Q) are the component bandwidths and Spectral efficiencies respectively.  This requirement is defined for the purpose of evaluation in the Immersive Communication usage scenario.  The minimum requirements for peak data rate are as follows:  – Downlink peak data rate is TBD Gbit/s.  – Uplink peak data rate is TBD Gbit/s. |

Definition on User experienced data rate:

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| **4.2 User experienced data rate**  User experienced data rate is the 5% point of the cumulative distribution function (CDF) of the user throughput. User throughput (during active time) is defined as the number of correctly received bits, i.e. the number of bits contained in the service data units (SDUs) delivered to Layer 3, over a certain period of time.  In case of one frequency band and one layer of transmission reception points (TRxP), the user experienced data rate could be derived from the 5th percentile user Spectral efficiency through equation (3). Let W denote the channel bandwidth and SEuser denote the 5th percentile user [184] Spectral efficiency. Then the user experienced data rate, Ruser is given by:  Ruser = W × SEuser (3)  In case bandwidth is aggregated across multiple bands (one or more TRxP layers), the user experienced data rate will be summed over the bands.  This requirement is defined for the purpose of evaluation in the Immersive Communication test environment(s).  The target values for the user experienced data rate are as follows [in the TBD usage scenarios and test environment(s)]:  – Downlink user experienced data rate is TBD Mbit/s.  – Uplink user experienced data rate is TBD Mbit/s. |

Definition on spectral Efficiency (including Peak Spectral Efficiency, average Spectral Efficiency and 5th percentile user spectral efficiency):

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| **4.3 Spectral Efficiency**  **4.3.1 Peak Spectral Efficiency**  Peak Spectral efficiency is the maximum data rate under ideal conditions normalized by channel bandwidth (in bit/s/Hz), where the maximum data rate is the received data bits assuming error-free conditions assignable to a single mobile station, when all assignable radio resources for the corresponding link direction are utilized (i.e. excluding radio resources that are used for physical layer synchronization, reference signals or pilots, guard bands, consider guard times and uplink/downlink ratio for TDD and guard times).  This requirement is defined for the purpose of evaluation in the Immersive Communication usage scenario.  The minimum requirements for peak Spectral efficiencies are as follows:  – Downlink peak Spectral efficiency is TBD bit/s/Hz.  – Uplink peak Spectral efficiency is TBD bit/s/Hz.  **4.3.2**  **Average Spectral efficiency**  Average Spectral efficiencyis the aggregate throughput of all users (the number of correctly received bits, i.e. the number of bits contained in the SDUs delivered to Layer 3, over a certain period of time) divided by the channel bandwidth of a specific band divided by the number of TRxPs and is measured in bit/s/Hz/TRxP.  The channel bandwidth for this purpose is defined as the effective bandwidth times the frequency reuse factor, where the effective bandwidth is the operating bandwidth normalized appropriately considering the uplink/downlink ratio.  Let Ri (*T*) denote the number of correctly received bits by user *i* (downlink) or from user *i* (uplink) in a system comprising a user population of *N* users and *M* TRxPs. Furthermore, let W denote the channel bandwidth and *T* the time over which the data bits are received. The average Spectral efficiency, SEavg is then defined according to equation (5).  (5)  This requirement is defined for the purpose of evaluation in the Immersive Communication and Ubiquitous Connectivity usage scenario.  **4.3.3 5th percentile user Spectral efficiency**  The 5th percentile user Spectral efficiency is the 5% point of the CDF of the normalized user throughput. The normalized user throughput is defined as the number of correctly received bits, i.e. the number of bits contained in the SDUs delivered to Layer 3, over a certain period of time, divided by the channel bandwidth and is measured in bit/s/Hz.  The channel bandwidth for this purpose is defined as the effective bandwidth times the frequency reuse factor, where the effective bandwidth is the operating bandwidth normalized appropriately considering the uplink/downlink ratio.  With R*i* (*Ti*) denoting the number of correctly received bits of user *i*, *Ti* the active session time for user *i* and W the channel bandwidth, the (normalized) user throughput of user *i*, *ri*, is defined according to equation (4).  (4)  This requirement is defined for the purpose of evaluation in the Immersive Communication and Ubiquitous Connectivity usage scenario. |

Definition on Area traffic capacity:

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| **4.4 Area traffic capacity**  Area traffic capacity is the total traffic throughput served per geographic area (in Mbit/s/m2). The throughput is the number of correctly received bits, i.e. the number of bits contained in the SDUs delivered to Layer 3, over a certain period of time.  This can be derived for a particular use case (or deployment scenario) of one frequency band and one TRxP layer, based on the achievable average Spectral efficiency, network deployment (e.g. TRxP (site) density) and bandwidth.  Let W denote the channel bandwidth and the TRxP density (TRxP/m2). The area traffic capacity Carea is related to average Spectral efficiency SEavg through equation (6).  Carea = ρ × W × SEavg (6)  In case bandwidth is aggregated across multiple bands, the area traffic capacity will be summed over the bands.  This requirement is defined for the purpose of evaluation in the related Immersive Communication test environment.  This requirement is defined for the purpose of evaluation in the Immersive Communication usage scenario.  The target value for area traffic capacity in the downlink is TBD in the Indoor Hotspot – IC test environment. |

Definition on Latency (including User plane latency and Control plane latency):

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| **4.7 Latency**  **4.7.1 User plane latency**  User plane latency is the contribution of the radio network to the time from when the source sends a packet to when the destination receives it (in ms). It is defined as the one-way time it takes to successfully deliver an application layer packet/message from the radio protocol layer 2/SDU ingress point to the radio protocol layer 2/SDU egress point of the radio interface in either uplink or downlink in the network for a given service in unloaded conditions, assuming the mobile station is in the active or battery efficient (e.g. inactive) state.  This requirement is defined for the purpose of evaluation in the Immersive Communication and Hyper Reliable and Low Latency Communication usage scenarios.  The minimum requirements for user plane latency are:  – X1 ms for immersive communication or hyper reliable and low latency communication.  assuming unloaded conditions (i.e. a single user) for TBD IP packets), for both downlink and uplink.  **4.7.2 Control plane latency**  Control plane latency refers to the time from a “battery efficient” state to the start of data transfer.  Control plane latency refers to the transition time from a most “battery efficient” state (e.g. Idle state) to the start of continuous data transfer (e.g. Active state).  This requirement is defined for the purpose of evaluation in the Immersive Communication and Hyper Reliable and Low Latency Communication usage scenarios.  The minimum requirement for control plane latency is TBD ms. |

Definition on Connection density:

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| **4.5 Connection Density**  Connection density is the total number of devices fulfilling a specific quality of service (QoS) per unit area (per km2).  Connection density should be achieved for a given bandwidth and a given number of TRxPs. The target QoS is to support delivery of a message of a certain size within a certain time and with a certain success probability, as specified in Report ITU-R M.  This requirement is defined for the purpose of evaluation in the Massive Communication and (for XR) the Immersive Communication usage scenario. [TBD: additional Usage Scenarios, if any].  The minimum requirement for connection density is TBD devices per km2. |

Definition on Mobility interruption time:

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| **4.6.1 Mobility interruption time**  Mobility interruption time is the shortest time duration supported by the system during which a user terminal cannot exchange user plane packets with any base station during transitions.  The mobility interruption time includes the time required to execute any radio access network procedure, radio resource control signaling protocol, or other message exchanges between the mobile station and the radio access network, as applicable to the candidate RIT/SRIT.  This requirement is defined for the purpose of evaluation in the Immersive Communication and Hyper Reliable and Low Latency Communication usage scenarios.  The minimum requirement for mobility interruption time is TBD ms. |

Definition on bandwidth:

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| **4.11 Bandwidth**  Bandwidth is the maximum aggregated system bandwidth. The bandwidth may be supported by single or multiple radio frequency (RF) carriers. The bandwidth capability of the RIT/SRIT is defined for the purpose of IMT-2030 evaluation.  The requirement for bandwidth is at least [100] MHz. |

## Target value of candidate IMT-2030 TPRs

Regarding the issue on target value of candidate IMT-2030 TPRs, in several contributions, e.g. [RP-242873 Huawei], [RP-243131 CATT], [RP-242796 OPPO], [RP-242634 vivo], [RP-242473 LGE], [RP-243082 Indian Institute] provide target values for the proposed TPR candidates.

Moderator observes that company views on the target values for each TPR are somehow divergent. Given consideration that target value for TPR should be determined under the exact definition, moderator suggest to first discuss the content in subsection 2.1 and 2.2, and look back if the candidate item and its corresponding definition are stable. Also note that companies are encouraged to provide target values for the corresponding TPR in future RAN plenary meeting(s).

### Moderator suggestion for RAN#106: wait for progress on subsection 2.1 and 2.2.

## Whether/how to reply the ITU LS

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| [RP-242528 Samsung] | Proposal: considering ITU-R work plan, we propose to send ITU-R 3GPP feedback on the  IMT-2030 TPRs as follows.   * RAN#106 to provide feedback on candidate items for IMT-2030 TPRs. * RAN#107 to provide feedback on target values of items for IMT-2030 TPRs |
| [RP-242825 DOCOMO] | Proposal 1: Candidate items for minimum TPRs should be studied and agreed within RAN#106 (Dec. 2024).  Proposal 2: Study on the associated target values for the candidate items should be done and liaison statement to WP 5D should be agreed until the middle term of RAN#108 (June 2025). |
| [RP-242873 Huawei] | Proposal 2: To adopt the candidate items in above table 1 for minimum technical performance requirements for IMT-2030 radio interface(s), and preferably provide feedback to ITU-R WP 5D#48 meeting by February 2025. |
| [RP-242921 SK Telecom] | Proposal 1: RP Rel-20 SI on IMT-2030 should aim to provide timely input on TPR to ITU-R via LS |
| [RP-242976 CMCC] | Work plan for RAN requirements study  RAN#106:  • Start discussing the candidate items to be defined for TPR  RAN#107&108:  • Discuss and agree on the candidate items and associated target values for TPR in 3GPP  • Send LS with agreed TPR items and associated target values by WP5D#49 (Jun/Jul 2025)  • Start discussing the typical deployment scenarios and specific requirements of 6G access technologies, to provide guidance to the technical work to be performed in RAN WGs.  RAN#109:  • Continue to discuss the items and target values in 3GPP. Send LS with updated  information by WP 5D#50 (Oct 2025) if necessary.  • Discuss the typical deployment scenarios and specific requirements of 6G access  technologies, to provide guidance to the technical work to be performed in RAN WGs.  RAN#110&111&112:  • Continue to discuss and finalize the study on the typical deployment scenarios and  specific requirements of 6G access technologies, to provide guidance to the technical  work to be performed in RAN WGs |
| [RP-242988 Xiaomi] | However, the timeline of input still depends on RAN-P discussion progress on issues  － Prefer to input complete conclusions of RAN-P study to ITU-R to avoid potential misunderstanding |
| [RP-243171 ZTE] | Proposal 2: No discussion is needed on any reply to ITU-R WP5D LS in this meeting   * The discussion on reply LS to ITU-R WP5D should begin after stable outcome from study item on IMT 2030 is available. |
| [RP-243131 CATT] | Proposal 1. Approval of SI as planned. With start of work on KPIs focused on ITU IMT-2030, to send the aligned items as proposal to ITU and prepare the corresponding target values, from this plenary meeting. To complete target values proposal preferably at RAN#107 and guarantee that by RAN#108. |

Considering the preferable deadline from the ITU-R LS, some companies, e.g. in [RP-242528 Samsung], [RP-242873 Huawei], [RP-242825 DOCOMO], [RP-242764 Apple], etc. propose to provide feedback on candidate items for IMT-2030 TPRs in this RAN#106 meeting, and provide feedback on target values in RAN#107 meeting. One draft LS can refer to [RP-242639 Ericsson].

While some other companies, e.g. in [RP-243171 ZTE], [RP-242988 Xiaomi] think it is not a harsh deadline for ITU-R considering the limited time in this RAN#106 meeting, and can further check if it is mature to reply the LS from ITU.

Given consideration on the time budget and company views, moderator suggests to first focus on subsection 2.1 and subsection 2.2, and see if companies can reach some consensus to input into LS reply.

### Moderator suggestion for RAN#106: decide whether/how to reply the LS based on the progress on subsection 2.1 and 2.2.

# Conclusion

**Proposal 1** RP-242440 should be approved with the following changes in 4.1:

This study item aims to

* investigate a candidate set of items for minimum TPRs based on the Recommendation ITU-R M.2160, and, where applicable, the associated target values and key assumptions for the identified minimum TPRs.
  + The outcome is expected to be shared by LS with ITU-R WP5D, as suitable, and used as a baseline for the subsequent study 6G in RAN
* [To fill in additional objectives, on general 6G RAN study, in March’2025]

**Proposal 2** It is concluded in RAN#106 that the following items will be considered as candidate items for IMT-2030 TPRs, where the definitions of these items will be further discussed, e.g. considering commercial relevance.

1. Peak data rate
2. Peak spectral efficiency
3. User experienced data rate
4. 5th percentile user spectral efficiency
5. Average spectral efficiency
6. Sustainability/Energy efficiency
7. Area traffic capacity
8. User plane latency
9. Control plane latency
10. Connection density
11. Reliability
12. Mobility
13. Mobility interruption time
14. Bandwidth

The list above should be seen as an initial view and additional candidates will be considered, e.g. considering new services.

**Proposal 3** Draft Reply LS in RP-243272 should be further discussed online.

# References

1. RP-240823 Additional Considerations for 6G Timeline Source: TSG Chairs
2. RP-243202 Liaison Statement to External Organizations Minimum requirements related to technical performance for IMT-2030 radio interface(s), source ITU-R WP5D, 3GPP TSG#106, December 2024
3. “Working Document towards a Preliminary Draft New Report ITU-R M.[IMT-2030.TECH PERF REQ]: Minimum requirements related to technical performance for IMT-2030 radio interface(s)”, [Annex 5.7 to Document 5D/413](https://www.itu.int/dms_ties/itu-r/md/23/wp5d/c/R23-WP5D-C-0413!H5-N5.07!MSW-E.docx) (Working Party 5D Chairman’s Report).
4. RP-242473 LGE’s views on 6G TPR (Technical Performance Requirements) LG Electronics
5. RP-242548 Views on IMT-2030 Technical Performance Requirements (TPRs) Samsung
6. RP-242530 Nokia views on IMT-2030 Technical Performance Requirements Nokia
7. RP-242634 Discussion on IMT-2030 technical performance requirements (TPR) Vivo
8. RP-242639 Proposed Technical Performance Requirements (TPR) for IMT-2030 Ericsson
9. RP-242761 Views on RAN study on IMT-2030 NVIDIA
10. RP-242764 On ITU IMT-2030 requirements SI Apple
11. RP-242778 Considerations for IMT-2030 KPIs KT Corp.
12. RP-242796 Discussion on RAN requirement for 6G OPPO
13. RP-242825 Discussions on minimum technical performance requirements for IMT-2030 radio interface(s) NTT DOCOMO, INC.
14. RP-242873 Scope of RAN-level SID focusing on ITU IMT-2030 and initial considerations on IMT-2030 TPRs Huawei, HiSilicon, CAICT
15. RP-242920 Views on RAN requirements for 6G CBN, China Broadnet
16. RP-242921 Views on RAN Study for IMT-2030 SK Telecom
17. RP-242976 Views on 3GPP RAN 6G requirements study CMCC
18. RP-242988 Discussions on 6G SI on IMT-2030 Xiaomi
19. RP-243249 MediaTek Views on RANp SI on ITU IMT-2030 MediaTek Inc.
20. RP-243081 Views on RAN Study Item for IMT-2030 BOSCH
21. RP-243082 Views on the study of IMT-2030 requirements Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks
22. RP-243131 Consideration and proposals on KPIs for IMT-2030 CATT
23. RP-243142 Operator's view on Radio Performance Assessment for IMT-2030/ “6G” Deutsche Telekom, Vodafone, BT, Orange, Spark NZ, Odido, KPN, Rakuten, Boost Mobile Network, Telefonica, Telia Company, Telenor
24. RP-243143 Scope of IMT-2030 RAN P Study Deutsche Telekom AG
25. RP-243171 Views on RAN study for IMT-2030 ZTE Corporation, Sanechips
26. RP-243213 RAN Study for IMT-2030 Initial Views MITRE

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# Annex A: Summary on company views for IMT-2030 TPRs

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| --- | --- |
| TPR | Views from companies |
| Peak data rate | **LGE:** [50Gbps] by assuming FR3 400MHz BW. Further consideration on # of MIMO streams, modulation order.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Vivo:**   * TPR definition: Same as in IMT-2020. * Applicable usage scenario: Immersive Communication. * The minimum requirements for peak data rate is 2.0~4.0 times of IMT-2020, i.e., 40~80 Gbps for downlink and 20~40 Gbps for uplink.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** No need to further increase Peak data rate and Peak spectral efficiency.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 10 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is mostly the same as IMT-2020. * Value is 1.5-5x as IMT-2020. * Further study should consider (1) guard times (2) uplink/downlink ratio for TDD and (3) the bands over which the bandwidth is aggregated   **CATT:** The target value is expected to reach 2.5x of IMT-2020 targets, i.e. 75bps/Hz for downlink and 37.5bps/Hz for uplink.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| User experienced data rate | **LGE:** [300 Mbps], 3 x IMT-2020 target, Further consideration on hyper-immersive multimedia requirement.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Vivo:**   * TPR definition: Same as in IMT-2020. * Applicable usage scenario: Immersive Communication. * The minimum requirements for downlink user experience data rate is 2.0~4.0 times of IMT-2020 and for uplink user experience data rate is 1.5~4.0 times of IMT-2020, i.e., 200~400 Mbit/s for downlink and 75~200 Mbit/s for uplink.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** Consider User experienced data rate and Area traffic capacity 1.5× ~ 2× over 5G.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 10 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020 * Value is 2-3x as IMT-2020. Note for Ubiquitous Connectivity, lower values compared to IMT-2020 can be considered.   **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Peak spectral efficiency | **LGE:** [3x IMT-2020] for peak, average, 5th-percentile user SEs. Need to clarify the enabling technologies, e.g. e-MIMO, higher-order modulation.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Vivo:**   * TPR definition: Same as in IMT-2020. * Applicable usage scenario: Immersive Communication. * The minimum requirements for peak spectrum efficiency is 2.0 times of IMT-2020, i.e., 60 bit/s/Hz for downlink and 30 bit/s/Hz for uplink.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** No need to further increase Peak data rate and Peak spectral efficiency.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 2-3 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is mostly the same as IMT-2020. * Value is 1.5-3x as IMT-2020.   **CATT:** The target values of these KPIs are expected to be 2~3x of IMT-2020 targets.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Average spectral efficiency | **LGE:** [3x IMT-2020] for peak, average, 5th-percentile user SEs. Need to clarify the enabling technologies, e.g. e-MIMO, higher-order modulation.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Vivo:**   * TPR definition: Same as in IMT-2020. * Applicable usage scenario: Immersive Communication. * The minimum requirements for downlink user experience data rate is 2.0~4.0 times of IMT-2020 and for uplink user experience data rate is 1.5~4.0 times of IMT-2020, i.e., 200~400 Mbit/s for downlink and 75~200 Mbit/s for uplink.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** Consider Average spectral efficiency 1.5× ~ 2× over 5G.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 3-5 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020.   **CATT:** 2~3x of IMT-2020 targets are proposed.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| 5th percentile user spectral efficiency | **LGE:** [3x IMT-2020] for peak, average, 5th-percentile user SEs. Need to clarify the enabling technologies, e.g. e-MIMO, higher-order modulation.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Vivo:**   * TPR definition: Same as in IMT-2020. * Applicable usage scenario: Immersive Communication. * The minimum requirements for average spectrum efficiency is 2.0 times of IMT-2020 for downlink and 1.5~2.0 times of IMT-2020 for uplink.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** Consider 5%th percentile user spectral efficiency 2× over 5G.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 3-5 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020.   **CATT:** 2~3x of IMT-2020 targets are proposed.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Area traffic capacity | **LGE:** [30 Mbit/s/m2] Need to consider the use case requirement.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Vivo:**   * TPR definition: Same as in IMT-2020. * The connection density should be applicable to both Massive Communication and Immersive Communication usage scenarios.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** Consider User experienced data rate and Area traffic capacity 1.5× ~ 2× over 5G.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 10 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020. * 2-3 x IMT-2020 value   **CATT:** The target values of these KPIs are expected to be 2~3x of IMT-2020 targets.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Connection density | **LGE:** [106/km2 as a baseline] Need to consider the requirement for a given usage scenario.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** Not pursue immediate KPI improvements on Latency, Reliability and Connection density on 6G Day1. Wait for market feedback on 5G system, and justify need of further enhancements taking lessons from market.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 10-100 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020. * 1-10 x IMT-2020 value.   **CATT:** This KPI is expected to reach 10~100x of IMT-2020 target.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Mobility | **LGE:** [1000 km/h] considering future aerial vehicle support.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:**   * The capabilities defined for IMT-2020 should naturally carry over to IMT-2030. * Same mobility classes as in IMT-2020 are sufficient.   **Vivo：**   * For mobility, identify the pain point deployment scenarios and define the definition and requirement of performance metrics to quantify the user experience in the pain point scenarios. * For pain point scenarios in mobility, the performance metric can be normalized data rate (bit/s/Hz) and mobility interruption time (ms) same as IMT-2020 mobility evaluation, traditional mobility performance matric, e.g. HOF, RLF can also be the performance metrics. FFS detailed performance metric requirements. * Urban Grid deployment scenario with building modelled among the lanes can be used as a starting point for the pain point scenarios.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020.   **CATT:** The target value is TBD.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Mobility interruption time | **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * Value is 0ms   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020. * Value is 0ms.   **CATT:** The target value should be 0ms.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| User plane latency | **LGE:** [TBD (1ms as a baseline)] Need to consider whether further enhancement is required from 6G core applications.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:**   * The capabilities defined for IMT-2020 should naturally carry over to IMT-2030. * No need to reduce UP latency below 1ms.   **Vivo：**   * TPR definition: Same as in IMT-2020. * Applicable usage scenario: Immersive Communication, Hyper Reliable and Low-Latency Communication. * The minimum requirement for user plane latency is 1ms for Immersive Communication and 0.1ms for Hyper Reliable and Low-Latency Communication.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** Not pursue immediate KPI improvements on Latency, Reliability and Connection density on 6G Day1. Wait for market feedback on 5G system, and justify need of further enhancements taking lessons from market.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 0.5-1ms for HRLLC, 1ms for Immersive communication   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **MediaTek:**   * No target for lower latency/higher reliability than already achieved for 5G * Focus on practical side conditions-packet sizes, etc. Open to consider joint KPI for Immersive Communication   **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020. * Value is 0.5-1ms.   **CATT:** Not sure yet the remarkable use case to apply lower value of user plane latency because end-end latency seems more important to immersive cases while the latency only from radio interface may not be the key.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Control plane latency | **Samsung:** Take similar approach as IMT-2020.  **Nokia:** The capabilities defined for IMT-2020 should naturally carry over to IMT-2030.  **Vivo：**   * Study control plane latency definition to include the cases with and without device state transition. * Applicable usage scenario: Immersive Communication, Hyper Reliable and Low-Latency Communication. * The minimum requirement for control plane latency is 10ms with device state transition and 4ms without device state transition.   **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **OPPO:** Not pursue immediate KPI improvements on Latency, Reliability and Connection density on 6G Day1. Wait for market feedback on 5G system, and justify need of further enhancements taking lessons from market.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * Value is 10ms   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **MediaTek:**   * No target for lower latency/higher reliability than already achieved for 5G * Focus on practical side conditions-packet sizes, etc. Open to consider joint KPI for Immersive Communication   **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020. * Value is 5-20ms.   **CATT:** The target value is expected to be 10ms. Not sure yet the remarkable use case to apply lower value of user plane latency because end-end latency seems more important to immersive cases while the latency only from radio interface may not be the key.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Reliability | **LGE:** [TBD (10-5 as a baseline)] Need to consider whether further enhancement is required from 6G core applications.  **Samsung:** Take similar approach as IMT-2020.  **Nokia:**   * The capabilities defined for IMT-2020 should naturally carry over to IMT-2030. * The evaluation scenarios can be extended beyond URLLC to cover new use cases such as AI, XR, etc with moderately low latency (a few ms) and medium to high data rates.   **Vivo:**   * TPR definition: Same as in IMT-2020. * Applicable usage scenario: Hyper Reliable and Low-Latency Communication. * The minimum requirement for reliability is 1-10-5.   **Ericsson:**   * A Technical Performance Requirement (TPR) is proposed that jointly evaluates the capabilities Data rate, Latency and Reliability. * By setting and evaluating such a requirement with higher data rates than for IMT-2020 it would replace Reliability.   **OPPO:** Not pursue immediate KPI improvements on Latency, Reliability and Connection density on 6G Day1. Wait for market feedback on 5G system, and justify need of further enhancements taking lessons from market.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * 10-100 x IMT-2020 value   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **MediaTek:**   * No target for lower latency/higher reliability than already achieved for 5G * Focus on practical side conditions-packet sizes, etc. Open to consider joint KPI for Immersive Communication   **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020. * Value is 1-10−5 to 1-10−7.   **CATT:** The target value is TBD.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Bandwidth | **Samsung:** Take similar approach as IMT-2020.  **Nokia:**   * The capabilities defined for IMT-2020 should naturally carry over to IMT-2030. * 400 MHz and 200 MHz channel bandwidths are included in the set of evaluation parameters of IMT-2030.   **Vivo:** The maximum bandwidth for single radio frequency (RF) carrier can be 400Mhz, and the maximum aggregated system bandwidth is TBD, which is relevant to the requirement of peak data rate.  **Ericsson:** TPR from IMT-2020 is proposed to be applied also for IMT-2030.  **DOCOMO:** The definition of the candidate items which has been used for IMT-2020 should be reused as starting point unless critical issue is identified.  **Huawei, HiSilicon, CAICT:**   * Proposed to be defined as ITU IMT-2030 TPR * At least 200MHz (2x IMT-2020) is supported   **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **MediaTek:** Enable use of multiple aggregated RF carriers to achieve any target value.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * Definition is same as IMT-2020.   **CATT:** The target value is TBD.  **MITRE:** Consider HRLLC, MT and IC leap-frog corresponding IMT-2020 (e.g. URLLC) RAN TPRs. |
| Spectrum band/range | **Nokia:** 7 GHz carrier frequency is included in the set of evaluation parameters of IMT-2030, to reflect the frequency ranges 6.425-7.125 and 7.125-8.4 GHz.  **Ericsson:**   * Add a frequency band in the range 7-8 GHz to the existing set of IMT-2020 frequency bands. * For the frequency band in the range 7-8GHz, use up to four times more antennas elements than used for 4GHz for IMT-2020.   **MediaTek:**   * Propose to evaluate 7.x GHz for modelling. Open to add a 2nd higher FR3 frequency value. Test environment mapping can be discussed further. * Propose that 0.7, 4, 30GHz evaluated frequencies from IMT-2020 are retained.   **BOSCH:** For spectrum consideration, study FR3 (7-24 GHz) considering existing regulations; prioritize utilization of existing FR1 and FR2 at the early 6G phase. |
| Sustainability/Energy efficiency | **LGE:** Quantitative or qualitative metrics need to be defined due to the assessed prioritization  **Samsung:**   * Energy efficiency could be considered as a representative TPR for sustainability. * It is preferred to define a quantitative TPR (exact definition FFS) for energy efficiency (e.g., relative energy saving gain).   Vivo:   * The definition of energy efficiency should jointly consider both power/energy consumption and communication related performance metric, such as user experienced data rate, and latency for control signaling/paging or data. * For loaded case, the energy efficiency can be the ratio of data rate and power consumption. or , where *P* is the power consumption*, v* is the user perceived throughput (UPT)   **Ericsson:** Proposed to use ambition level 3 for further work on Energy efficiency.  **OPPO:**  For 6G Energy saving, use power/energy saving percentage over 5G as the baseline KPI.   * Study the feasibility to define energy efficiency formulation.   **DOCOMO:** Support with ITU WP 5D definition.  **Huawei, HiSilicon, CAICT:** Proposed to be defined as ITU IMT-2030 TPR  **CMCC:** IMT-2020 TPRs can be considered as baseline.  **Xiaomi:** The existing IMT-2020 TPR items can be reused.  **MediaTek:**   * No target value for both network EE and device EE. * Add a side condition that improved network EE shall not impact the ability to fulfil the end user experience needs including device battery lifetime considerations.   **CATT:** The target value should be defined quantitatively.  **MITRE:** Consider for new ones (energy efficiency, sustainability enhancements) qualitative or qualitative TPRs. |
| Positioning | **LGE:** [10cm] Need to consider the requirement for a given usage scenario. Need of relevancy check with 'sensing related capabilities  **Samsung:**   * Numerical targets (e.g., horizontal/vertical positioning accuracy) could be considered with the test environment for immersive communication as the positioning typically is a part of basic mobile network operation. * It should be noted that the target positioning accuracies may not necessarily be reached for all scenarios and deployments.   **Nokia:** Define requirements for vertical and horizontal positioning accuracy. The requirements need to take into account the deployment scenarios, and same accuracy cannot be assumed in all cases.  **Ericsson:**   * Horizontal and vertical position estimation performance can be different depending on the system configuration and deployment. Additionally, the requirements on the horizontal error and vertical error put by an application can be different. * The position estimation error should be seen as having a spatial distribution. The accuracy should thus be defined as a percentile point of the cumulative distribution (CDF) of the positioning errors. * Position estimation accuracy is dependent on many parameters, including signal bandwidth, measurement capabilities, deployment, radio conditions, etc. It is proposed that minimum requirements are defined for more than one bandwidth configuration.   **Huawei, HiSilicon, CAICT:**   * Horizontal accuracy: [20cm] @90% for indoor, [3-5m] @90% for outdoor * Vertical accuracy: [1-3m] @90% for indoor   **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * It is the ability to calculate the approximate position of connected devices. * Positioning accuracy is defined as the difference between the calculated horizontal/vertical position and the actual horizontal/vertical position of a device. * It is characterized by the 90th percentile on the CDF curve of positioning accuracy for both horizontal and vertical directions. * Value is 0.5-3m   **CATT:**   * 1~10cm for horizontal plane * TBD for vertical plane |
| Sensing-related capabilities | **LGE:** Quantitative metrics for localization/reconstruction, e.g. accuracy on range, angular, and Doppler freq. Detailed TPR value definitions are now being investigated  **Samsung:**   * While sensing-related TPRs (e.g., detectability, accuracy, resolution) could be defined in a quantitative manner, the relevant performance metrics and requirements are highly dependent on the selected use cases. * Considering divergent views on sensing metrics and use cases, selecting only a few use cases in ITU-R at this early stage might lead to excluding other potential use cases. * Therefore, we prefer to evaluate sensing by inspection and let proponent (e.g., 3GPP) to describe representative use cases during the submission stage.   **Nokia:** Focus on TPRs that are use-case agnostic, e.g. localization accuracy and/or resolution, while considering detection probability and false alarm rate as side conditions.  **Vivo:** Study sensing-related TPRs including range accuracy, angle accuracy, velocity accuracy and detection/recognition accuracy.  **Ericsson:**  Example sensing tasks:   * Object detection (e.g., presence/absence detection) * Object characterization (e.g., classification, size determination, feature extraction), * Movement detection (e.g., detection of a movement occurrence), * Movement characterization (e.g., velocity estimation), * Localization (at least of passive/non-connected objects), * Mapping (building a map of unknown environment).   Each basic sensing task is characterized with at least one KPI that defines the minimum requirement.  **OPPO:** For 6G Integrated Sensing and Communication, KPIs for both basic and advanced physical parameters can be defined.  **DOCOMO:** Support with ITU WP 5D definition, includingDetectability (Detection/False alarm probability), Localization accuracy, Velocity accuracy and Sensing resolution.  **Huawei, HiSilicon, CAICT:** Support to define Detection/False alarm probability，Localization accuracy，Velocity accuracy，Sensing resolution，Reconstruction accuracy.  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * It is the ability to provide functionalities in the radio interface including range/velocity/angle estimation, object detection, localization, imaging, mapping, etc. * These capabilities could be measured in terms of accuracy, resolution, detection probability, false alarm probability, etc. It is characterized by Sensing Range, Horizontal/Vertical Sensing Accuracy, Velocity Accuracy, Detection Probability and False Alarm Probability.   **SK Telecom:** RP Rel-20 SI on IMT-2030 should aim to study TPR for sensing-related capabilities to accommodate all sensing modes and use cases.  **CMCC:**   * Consider to use sensing localization accuracy as a TPR * Consider to use sensing density/capacity as a TPR to reflect the system performance.   **Xiaomi:**  Quantitative TPR items for sensing related capabilities should be defined, including:   * Missed detection probability and False alarm probability * Sensing accuracy on position and velocity * Sensing accuracy   **MediaTek:** Consider KPI definition for Detection Probability, False Alarm Probability, Object Location Accuracy. No ITU target value required.  **CATT:** The definition is TBD.  **MITRE:** Considers sensing accuracy, detection/false alarm probability |
| AI-related capabilities | **LGE:** Mixed qualitative (functional req.) + quantitative (accuracy, model transfer latency) metrics. Detailed TPR value definitions are now being investigated  **Samsung:**   * Despite the great potential of AI in many aspects (i.e., AI for network, network for AI), it is not straightforward to define quantitative AI-related TPRs. * Moreover, most of AI operation performance (related to e.g., training, inferencing) is highly dependent on implementation aspects such as computing power. * Therefore, it is preferred not to have quantitative targets but to use inspection for evaluation.   **NVIDIA:**  RAN study on IMT-2030 should at least define the following capabilities   * AI-related capabilities * Computing capabilities   **OPPO:**   * No need to define dedicate KPIs for “AI for 6G”. * Consider dedicate KPIs for “6G for AI”, e.g., AI/ML inference accuracy, AI/ML inference latency, AI/ML training accuracy, AI/ML training latency. * Some reference use case (e.g., image recognition, voice recognition) and reference model can be defined to define KPI values.   **DOCOMO:** Support with ITU WP 5D definition.  **Huawei, HiSilicon, CAICT:** Support to define qualitative metric like AI service functionality requirements，AI service accuracy，AI service latency，AI service density.  **CMCC:**   * Consider AI service density/capacity as a TPR to reflect system performance. * Considering the various use cases for AI services, different quality of AI services (QoAIS) requirements in AI service density/capacity for different use cases can be defined.   **Xiaomi:**  Consider qualitative evaluation (by inspection) for the 3 categories of capabilities related to AI and communication:   * AI and Communication comprise various usage scenarios, it is difficult to converge to one or several representative KPIs * Some factors impacting the performance depends on implementation or deployment strategy, which are beyond IMT-2030 design scope * Some factors impacting the performance can be included in the existing connection-related metrics   **MediaTek:**   * Conventional KPI definitions sufficient for serving AI application traffic * Qualitative approach (i.e. describing Characteristics) of AI integrated radio functions   **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * It is the ability to provide certain functionalities throughout IMT-2030 to support AI enabled applications. * These functionalities include distributed data processing, distributed learning, AI computing, AI model execution and AI model inference, etc.   **CATT:** The definition for the qualitative target value is TBD  **MITRE:** Priority to RAN workloads processing and energy efficiency. |
| Coverage | **LGE:** No need to be obligated as a quantized value  **Samsung:** Coverage could be evaluated using the link-budget template by inspection.  **Huawei, HiSilicon, CAICT:** Need FFS  **Indian Institute of Technology (Madras), CEWiT, Tejas Networks, Indian Institute of Technology (Hyderabad), WiSig Networks:**   * It is the ability to provide access to communication services for users in a desired service area. In the context of this capability. * Coverage is defined as the cell edge distance of a single cell through link budget analysis. |
| Immersive communication and Joint requirements | **Vivo:** The connection density should be applicable to both Massive Communication and Immersive Communication usage scenarios.  **Samsung:**   * Introducing the concept of joint TPR is preferable for supporting immersive communication. * Further study is needed on which TPRs (e.g., data rate, latency, reliability, and connection density) should be jointly considered and how to define the joint TPR. Introducing the concept of joint TPR is preferable for supporting immersive communication.   **Huawei, HiSilicon, CAICT:**   * Support to define XR area capacity，XR area efficiency，Joint requirement on data rate, latency, and reliability，Joint requirement of data rate, latency, reliability and capacity as one TPR item, i.e., “Immersive system/communication capacity” * 500-1000 users/km2 for XR use case * Corresponding to 6-12 users per cell of ISD=200m   **CMCC:** Consider to define TPRs for Immersive connection density/capacity with the total number of devices fulfilling a specific quality of service (QoS) per unit area (per km2), for the purpose of evaluation in the Immersive communication usage scenario.  **Ericsson:**   * A Technical Performance Requirement (TPR) is proposed that jointly evaluates the capabilities Data rate, Latency and Reliability. * By setting and evaluating such a requirement with higher data rates than for IMT-2020 it would replace Reliability. |
| Security and Resilience | **LGE:** No numerical TPR definition is now considered due to difficulty for evaluation both by quantitative and qualitative methods  **Samsung:** It is suggested not to include these as IMT-2030 TPRs, since it is not straight forward how to define them as TPRs.  **DOCOMO:** Support with ITU WP 5D definition.  **Huawei, HiSilicon, CAICT:** Proposed not to be defined as ITU IMT-2030 TPR.  **MITRE:** SupportSecurity i.e., most mentioned 'Driver of 6G' at IMT-2030 Use Case Workshop. |
| Interoperability | **LGE:** Quantitative or qualitative metrics need to be defined due to the assessed prioritization.  **Samsung:** It is suggested not to include these as IMT-2030 TPRs, since it is not straight forward how to define them as TPRs.  **DOCOMO:** Support with ITU WP 5D definition.  **Huawei, HiSilicon, CAICT:** Proposed not to be defined as ITU IMT-2030 TPR. |
| Sustainable data rate | **Huawei, HiSilicon, CAICT:** Should be Combined with energy efficiency. |