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| **U.S. ITU-R WP 5D Fact Sheet** |
| **ITU-R WP 5D #50** | **Document #:**  USWP5D-50-13  |
| **Reference:** **5D/792 Chap. 5 Annex 5.14** | **Date:** 17 July 2025 |
| **Document Title:** Minimum requirements related to technical performance for IMT-2030 radio interface(s)  |
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| **Purpose/Objective:** To adapt the definition and/or calculation of KPIs that can be impacted when multicast / broadcast service architecture is employed. |
| **Abstract:** Previous 3GPP systems/releases include specifications for multicast / broadcast implementations in addition to unicast service implementations. In 4G/LTE, the MBMS, eMBMS, and FeMBMS were developed. This system was further refined in 5G as 5G Broadcast. In anticipation that multicast / broadcast specifications will be developed for 6G, the KPI definitions and/or calculations should reflect the use of a one-to-many service architecture by accounting for multiple UEs consuming the same data session. By accounting for the presence of a one-to-many architecture option in the KPIs, network operators can determine which use cases would be most suitable for unicast vs. multicast / broadcast operating modes. |

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| **Radiocommunication Study Groups** |  |
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| TEXT PROPOSALS FOR THE WORKING DOCUMENT TOWARDS PRELIMINARY DRAFT NEW REPORT ITU-R M.[IMT-2030.TECH PERF REQ] |
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# 1 Background

At the 49th meeting of ITU-R Working Party 5D, the working document on IMT-2030 Minimum Technical Performance Requirements (TPR) was discussed, with the aim to finalize requirements related to AI, energy efficiency, sensing and composite requirement, respectively. This document contains the USA’s views on certain definitions, applicable usage scenarios, and considering the presence of one-to-many service architectures (broadcast / multicast).

1 This contribution updates the text in the working document – specifically, text related to Area Traffic Capacity, Connection Density, Resilience, and a proposed new section on Interworking.

# 2 Proposals

The USA proposes that the meeting consider the inputs in Annex 1 to further develop the working document ITU-R M.[IMT-2030. TECH PERF REQ]. Changes are highlighted as tracked changes.

**Attachment:** 1

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| **Annex 1****SWG Radio Aspects** |
| 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)** |

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**1 Introduction**

As defined in [Resolution ITU-R 56-3](http://www.itu.int/pub/R-RES-R.56), International Mobile Telecommunications-2030 (IMT-2030) systems are mobile systems that include new radio interface(s) which support enhanced capabilities and new capabilities beyond IMT‑2020, IMT-Advanced and IMT-2000. In 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, the capabilities of IMT-2030 are identified, which aims to make IMT-2030 more capable, flexible, reliable and secure than previous IMT systems when providing diverse and novel services in the intended six usage scenarios, including immersive communication, hyper reliable and low‑latency communication (HRLLC), massive communication, ubiquitous connectivity, artificial intelligence and communication, and integrated sensing and communication (ISAC).

**2 Scope and purpose**

This Report describes the minimum technical performance requirements of IMT-2030 candidate radio interface technologies. It also provides information about the individual requirements for the items and values to be chosen. Provision of such information is needed for a broader understanding of the requirements.

These key technical performance requirements are used in the development of Report ITU-R M.[IMT‑2030.EVAL].

This Report is based on the ongoing development activities of external research and technology organizations.

**3 Related ITU-R documents**

**ITU-R Resolutions**

Resolution [ITU-R 56-3](https://www.itu.int/pub/R-RES-R.56): Naming for International Mobile Telecommunications

Resolution [ITU-R 65-1](https://www.itu.int/pub/R-RES-R.65): Principles for the process of future development of IMT-2020 and IMT‑2030

**ITU-R Recommendation**

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 Reports**

Report [ITU-R M.2410-0](https://www.itu.int/pub/R-REP-M.2410): Minimum requirements related to technical performance for IMT-2020 radio interface(s)

Report [ITU-R M.2516-0](https://www.itu.int/pub/R-REP-M.2516): Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond

Report ITU-R M.[2541-0]

Report ITU-R M.[IMT-2030.EVAL]

Report ITU-R M.[IMT-2030.SUBMISSION]

Document [IMT-2030/1](https://www.itu.int/md/R23-IMT2030-C-0001/en)

Document [IMT-2030/2](https://www.itu.int/md/R23-IMT2030-C-0002/en)

Circular Letter X/LCCE/xxx

**4 Minimum Technical Performance Requirements**

As noted in Recommendation ITU-R M.2160, IMT-2030 is expected to provide enhanced capabilities as well as new capabilities compared with those described in Recommendation ITU-R M.2083. In addition, IMT-2030 can be considered from multiple perspectives, including users, manufacturers, application developers, network operators, verticals, and service and content providers. Therefore, it is recognized that technologies for IMT-2030 can be applied in a variety of deployment scenarios and can support a range of environments, service capabilities, and technology options.

The key minimum technical performance requirements defined in this document are for the purpose of consistent definition, specification, and evaluation of the candidate IMT-2030 radio interface technologies (RITs)/Set of radio interface technologies (SRIT) in conjunction with the development of ITU-R Recommendations and Reports, such as the detailed specifications of IMT-2030. The intent of these requirements is to ensure that IMT-2030 technologies can fulfil the objectives of IMT‑2030 and to set a specific level of performance that each proposed RIT/SRIT needs to achieve in order to be considered by ITU-R for IMT-2030.

These requirements are not intended to restrict the full range of capabilities or performance that candidate RITs/SRITs for IMT-2030 might achieve, nor are they intended to describe how the RITs/SRITs might perform in actual deployments under operating conditions that could be different from those presented in other ITU-R Recommendations and Reports on IMT-2030. Delete sentence: Furthermore, this Report is not intended to restrict the implementation details of IMT-2030 technology on the aspect of how to meet these requirements. Further information on specific industry needs using the terrestrial component of IMT-2030 may be found in other ITU-R Reports on IMT-2030.

Requirements are to be evaluated according to the criteria defined in Report ITU-R M.[IMT‑2030.EVAL] and Report ITU-R M.[IMT-2030.SUBMISSION] for the development of IMT-2030.

Recommendation ITU-R M.2160 defines fifteen key “Capabilities of IMT-2030”, which form a basis for the [x] technical performance requirements presented here.

IMT-2030 is also expected to be built on overarching aspects which act as design principles commonly applicable to all usage scenarios. These distinguishing design principles of the IMT‑2030 are including, but are not limited to sustainability, security and resilience, connecting the unconnected for providing universal and affordable access to all users independent of the location, and ubiquitous intelligence for improving overall system performance. [These overarching design principles and relevant IMT-2030 capabilities that are not captured as specific technical performance requirements in this report, may instead be captured in ITU-R M.[IMT‑2030.SUBMISSION]].

**4.1 Peak data rate**

Peak data rate is the theoretical maximum [achievable] data rate under ideal conditions, 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)

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. Therefore, if bandwidth is aggregated across *Q* bands, then the total peak data rate is

 $R=\sum\_{i=1}^{Q} $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.

**4.2 5th percentile user data rate**

The 5th percentile user 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 downlink 5th percentile user 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 5th percentile user data rate, Ruser is given by:

 Ruser = W × SEuser (3)

For the downlink, in case bandwidth is aggregated across multiple bands (one or more TRxP layers), the 5th percentile user data rate will be summed over the bands.

This requirement is defined for the purpose of evaluation in the related Immersive Communication [and Ubiquitous Connectivity] test environment(s).

This requirement is defined for the purpose of evaluation of the test environments summarized in Table 3.

Table 3

**User Experienced Data Rate**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **DL user experienced Data Rate** | **UL user experienced Data Rate** |
| Dense Urban-IC |  |  |
| [Rural-UC] |  |  |

These values are defined assuming supportable bandwidth as described in Report ITU-R M.[IMT‑2030.EVAL] for each test environment. However, the bandwidth assumption does not form part of the requirement. The conditions for evaluation are described in Report ITU-R M.[IMT‑2030.EVAL].

**4.3 Spectral Efficiency**

**4.3.1 Peak Spectral Efficiency**

Peak Spectral efficiency is the maximum data rate under ideal conditions normalised 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 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.

These values were defined assuming an antenna configuration to enable TBD spatial layers (streams) in the downlink and TBD spatial layers (streams) in the uplink. However, this does not form part of the requirement and the conditions for evaluation are described in Report ITU-R M.[IMT-2030.EVAL].

**4.3.2** **Average Spectral efficiency**

Average Spectral efficiency[[1]](#footnote-1)is 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.

The minimum requirements for average Spectral efficiency for various test environments are summarized in Table 4.

Table 4

**Average Spectral efficiency**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **Downlink (bit/s/Hz/TRxP)** | **Uplink (bit/s/Hz/TRxP)** |
| Dense Urban – IC |  |  |
| Indoor Hotspot – IC |  |  |
| Rural – IC |  |  |
| [Rural – UC] |  |  |

The conditions for evaluation including carrier frequency and antenna configuration are described in Report ITU-R M.[IMT-2030.EVAL] for each test environment.

**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.

The minimum requirements for 5th percentile user Spectral efficiency for various test environments are summarized in Table 5.

Table 5

**5th percentile Spectral efficiency**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **Downlink (bit/s/Hz)** | **Uplink (bit/s/Hz)** |
| Dense Urban-IC |  |  |
| Indoor Hotspot-IC |  |  |
| Rural - IC |  |  |
| [Rural - UC] |  |  |

The conditions for evaluation including carrier frequency and antenna configuration are described in Report ITU-R M.[IMT-2030.EVAL] for each test environment.

**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 $ρ$ the TRxP density (TRxP/m2) and AveUEpSD denote the average numbers of UEs simultaneously consuming the same data session. The area traffic capacity Carea is related to average Spectral efficiency SEavg through equation (6).

 Carea = ρ × W × SEavg × AveUEpSD (6)

In case bandwidth is aggregated across multiple bands, the area traffic capacity will be summed over the bands. In case of unicast service AveUEpSD has a value of exactly one. In the case of broadcast / multicast services AveUEpSD has a value of one or more.

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 [and TBD in the Dense Urban IC test environment].

The conditions for evaluation including supportable bandwidth are described in Report ITU‑R M.[IMT-2030.EVAL] for the test environment.

**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.[IMT-2030.EVAL].

This requirement is defined for the purpose of evaluation in the Massive Communication Usage Scenario.

The minimum requirement for connection density is TBD devices per km2.

**4.6 Mobility**

Mobility is the maximum mobile station speed at which a defined QoS can be achieved (in km/h).

The following classes of mobility are defined:

– Stationary: 0 km/h

– Pedestrian: 0-10 km/h

– Vehicular: TBD km/h

– High speed vehicular: TBD km/h.

This requirement is defined for the purpose of evaluation in the Immersive Communication usage scenario.

Table 6 defines the mobility classes that shall be supported in the respective test environments.

TABLE 6

**Mobility classes**

|  |  |
| --- | --- |
|  | **Test environments** |
| **Dense Urban-IC** | **Indoor Hotspot-IC** | **Rural-IC** | **[Rural-UC]** |
| Mobility classes supported | Stationary, Pedestrian,Vehicular,  | Stationary, Pedestrian  | Pedestrian, Vehicular, [High speed vehicular]  | [Pedestrian, Vehicular, High speed vehicular ] |

A mobility class is supported if the traffic channel link data rate on the uplink, normalized by bandwidth, is as shown in Table 7. This assumes the user is moving at the maximum speed in that mobility class in each of the test environments.

This requirement is defined for the purpose of evaluation in the Immersive communication and [ubiquitous connectivity] usage scenario.

TABLE 7

**Traffic channel link data rates normalized by bandwidth**

|  |  |  |
| --- | --- | --- |
| **Test environment** | **Normalized traffic channel link data rate (bit/s/Hz)** | **Mobility(km/h)** |
| Dense Urban-IC |  |  |
| Indoor Hotspot-IC |  |  |
| Rural-IC[Rural-UC]  |  |  |
|  |  |

Note: For each mobility value different normalized traffic channel link data rate should be defined.

Note: There may be multiple values for a single test environment

These values were defined assuming an antenna configuration as described in Report ITU‑R M.[IMT‑2030.EVAL].

**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 signalling 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.

[In addition, proponents are encouraged to obtain the mobility interruption time considering consistent user experience especially in some pain point scenarios, e.g. passing street corners, entering or exiting elevator, etc., where wireless signal quality changes rapidly.]

**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 2/3 SDU ingress point to the radio protocol layer 2/3 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

 X2 ms for hyper reliable and low latency communication

Assuming unloaded conditions for small IP packets, (e.g. [TBD] byte payload + IP header), for both downlink and uplink.

**4.7.2 Control plane latency**

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.

**4.8 Reliability**

Reliability relates to the capability of transmitting a given amount of traffic within a predetermined time duration with high success probability.

Reliability is the success probability of transmitting a layer 2/3 packet within a required maximum time, which is the time it takes to deliver a small data packet from the radio protocol layer 2/3 SDU ingress point to the radio protocol layer 2/3 SDU egress point of the radio interface at a certain channel quality.

This requirement is defined for the purpose of evaluation in the Hyper Reliable and Low Latency Communication usage scenario.

The minimum requirement for the reliability is TBD success probability of transmitting a layer 2 PDU (protocol data unit) of [32] bytes within TBD ms in channel quality of coverage edge for Urban Macro-HRLLC test environment assuming small application data (e.g. [20] bytes application data + protocol overhead).

*(Editors note: Values above are the same as M.2410)*

**[4.9 Composite requirement**

*Editor’s note: there is concern expressed by a sector member and administration on this TPR and that it should be part of the submission template and will depend on the deployment scenarios.*

The composite requirement refers to simultaneously satisfying data rate, latency, packet success probability, and the number of users per [km2 or TRxP].

This requirement is defined as the number of users per [km2 or TRxP] of which at least [90%/95%] are satisfied, where each satisfied user achieves the required packet success probability of transmitting a layer 2/3 packet within a required latency. The latency is the time it takes to deliver a data packet for a given data rate from the radio protocol layer 2/3 SDU ingress point to the radio protocol layer 2/3 SDU egress point of the radio interface.

This requirement is defined for the purpose of evaluation in the Immersive Communication [and Hyper-Reliable Low Latency Communication] usage scenario.

The minimum performance requirement of composite requirement is summarized in Table X.

TABLE X Composite requirement

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test environment** | **Data rate (Mbits/s)** | **Latency (ms)** | **Packet success probability** | **Number of users ([/km2 or /TRxP])** |
|
| Dense Urban - Immersive Communication | [DL = 30 Mbps/UL=10 Mbps] | [DL=10 ms / UL=30 ms / In total 40 ms] | [99%] | TBD |
| [Indoor Factory – HRLLC] |  |  |  |  |
| Others if any, are FFS |  |  |  |  |

]

**[4.10 Coverage**

*Editor note: there is concern expressed by sector members and administrations on this TPR.*

Coverage refers to the ability to provide access to communication services for users in a desired service area. In the context of this capability of the RIT, coverage is defined as the cell edge distance of a single cell through link budget analysis.

This requirement is defined for the purpose of evaluation in the Ubiquitous Connectivity Usage Scenario.

This requirement is defined for the purpose of evaluation in the Rural-UC test environment.

|  |  |
| --- | --- |
| **Test Environment** | **Cell Edge1 Distance** |
| Rural-UC | [3-7] km for a single cell |
| 1 Depends on UE height (to be specified in the corresponding evaluation configuration). Lower cell edge distance corresponds to a typical UE at a height of 1.5 m and higher cell edge distance corresponds to an outdoor UE at a height of 5m. |

This capability does not require direct evaluation and could be described and reported by (S)RIT proponents as part of the technical characteristics template(s).

]

**4.11 Positioning**

Positioning is the ability to estimate the position of connected devices.

The positioning accuracy is the [90%] point of the CDF of the device positioning error for [both] horizontal [and vertical] direction[s].

Horizontal positioning accuracy is defined as the positioning accuracy in the horizontal plane (i.e., x/y axis, or latitude/longitude). [Vertical positioning accuracy is defined as the positioning accuracy in the vertical direction (i.e., z-axis, or altitude)].

This requirement is defined for the purpose of evaluation in the [Immersive Communication, and Integrated Sensing and Communication usage scenario[s]].

The minimum requirements for the device positioning accuracy for various test environments are summarized in Table 9.

Table 9

**Positioning accuracy**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **Horizontal Accuracy** | **Vertical Accuracy** |
| Indoor Factory - ISAC |  |  |
| [Urban Macro – ISAC / Urban – ISAC] |  |  |

**4.12 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 TBD MHz.

**4.13 Sensing-related capabilities**

Sensing-related capabilities are measured in terms of the following technical performance requirements:

• Detection Probability and False Alarm Probability: Detection probability is the probability of correctly detecting the presence of the sensing object, and false alarm probability is the associated probability that a sensing object is detected when no sensing object is actually present.

• Horizontal/Vertical Localization Accuracy: It is defined as the difference between the estimated horizontal/vertical location and the actual horizontal/vertical location of the sensing object. The required value of localization accuracy shall be obtained assuming [90%/95%] confidence level, which is the [90th/95th] percentile point of the cumulative distribution function (CDF) of the location estimation error.

• Velocity Accuracy: Velocity accuracy is defined as the difference between the estimated velocity and the actual velocity of the sensing object. The required value of velocity accuracy shall be obtained assuming [90%/95%] confidence level, which is the [90th/95th] percentile point of the cumulative distribution function (CDF) of the velocity estimation error.

• [Sensing Resolution: TBD]

**4.14 AI-related capabilities**

AI-related capabilities refer to the ability to provide certain functionalities throughout IMT-2030 to support AI enabled applications, including.

• RIT/SRIT facilitating AI applications i.e. “Network for AI”

• AI to improve RIT/SRIT performance, i.e. “AI for network”

The RIT should support AI-related capabilities, which refer to the ability for the RIT/SRIT to support mechanisms and/or signalling/ related to AI functionalities. This should include support for one or more of the following:

– Data collection

– Distributed processing

– Distributed learning

– AI model training

– AI computing

– AI model execution

– AI model inference

– or other AI capabilities of the RITs/SRITs (to be reported by the proponent)

**Option A**

RIT/SRIT should have the capability to enable and disable AI functionalities within the network (AI for network scenario only)

**Option B**

The proponent should report about mechanisms, e.g, related to enabling or disabling the supported AI functionalities, where applicable.

**4.15 Energy Efficiency for sustainability**

Energy efficiency is an important metric of sustainability. This requirement of the candidate RIT/SRIT is characterized by evaluating network and device energy efficiency. Network energy efficiency is the capability of a RIT/SRIT to support radio access network energy saving [in relation to the traffic capacity provided]. Device energy efficiency is the capability of the RIT/SRIT to support device modem power saving [in relation to the traffic characteristics].

The requirement is defined as the relative energy [savings/consumption] (in terms of percentage) for the selected load case(s) relative to a fully loaded reference case.

This requirement is defined for the purpose of evaluation in the Immersive communication usage scenario.

Proponents should report the power model used for the evaluation, as well as impacts on communication performance associated with the evaluated energy saving technologies.

The minimum requirements for Energy efficiency are summarized in Tables below.

*[Editor’s note: 5D#49 meeting agreed that Network and UE Energy efficiency in unloaded case compared to fully loaded case is evaluated analytically using power models. On the evaluation of partial loaded case(s) (low load, light load and/or medium load), there are divergent views including mandatory, optional or not included, as well as the evaluation method of analysis or simulations. Proponents are encouraged to submit more details including load level (i.e. A/B/C in tables), requirement value (i.e. X/Y in tables) and the associated evaluation method, to facilitate the discussion at 5D#50 meeting.]*

Table: The minimum requirements for Network Energy efficiency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **[Test environment(s)]\*\*** | **Selected load case(s)\*** | **The reference case** | **Relative energy [saving/consumption] (%)** | ***[Editor notes: Mandatory, optional or not i****nclud****ed – this is not part of the final document*** |
| N. A | empty load | Fully loaded case\* | [X1%] | Mandatory |
| [Dense urban-IC]\*\* | [A%]  | [X2%] | TBD |
| [Rural-IC]\*\* | [B%]  | [X3%] | TBD |
| \* empty load: L=0, low load: 0 < L≤15, light load: 15 < L≤30, medium load: 30 < L≤50, fully loaded case: L=100 \*\* needed only in case of simulation |

Table: The minimum requirements for Device Energy efficiency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **[Test environment(s)]\*\*** | **Selected load case(s)\*** | **The reference case** | **Relative energy [saving/consumption] (%)** | ***[Editor notes: Mandatory, optional or not i****nclud****ed - this is not part of the final document]*** |
| N. A | empty load | Fully loaded case | [Y1%] | Mandatory |
| [Dense urban-IC]\*\* | [C%]  | [Y2%] | TBD |
| \* empty load: L=0, low load: 0 < L≤15, light load: 15 < L≤30, medium load: 30 < L≤50, fully loaded case: L=100 \*\* needed only in case of simulation |

Conditions for evaluation are included in Report ITU-R M.[IMT‑2030.EVAL].

**[4.16 Security**

Security refers to preservation of confidentiality, integrity, and availability of information such as user data and signalling, and protection of networks, devices and systems against cyberattacks such as hacking, distributed denial of service, man in the middle, etc.

Security aspects of IMT-2030 will be considered as part of the S(RIT) description template:

•

*(Editor’s note: This section may be deleted in future revisions since it will be covered as part of the S(RIT) Description Template)*]

**4.17 Resilience**

*(Editor’s note: This may also include Extended Connectivity)*

Resilience refers to capabilities of the networks and systems to continue operating correctly during and after a natural or man-made disturbance, such as the loss of primary source of power, etc.

The RIT/SRIT should support functionalities over the radio interface that enable continuous operation or rapid temporary restoration during and after disturbance to radio infrastructure. These functionalities may include, but are not limited to, support for connecting to one or more of the following network infrastructures within the terrestrial component of IMT, which are temporarily operated to enhance connectivity during these situations:

‒ HIBS

‒ [Advanced] relays and repeaters

‒ Base station onboard a vehicle, airship and/or vessel

‒ or other mechanisms for resilience using network infrastructures within the terrestrial component of IMT

- through Interworking with alternative wireless bearers such as other terrestrial, non-terrestrial and/or free-space optical RIT/SRITs

[**4.X Extended connectivity**

Extended Connectivity is defined as the ability to provide connectivity in areas that are currently uncovered or scarcely covered due to challenges arising from geographical conditions, such as the lack of ground infrastructure (e.g., Fiber cables and power supply), where users desire access to communication services.

The RIT/SRIT should have functionalities that support providing extended connectivity in these areas. These functionalities may include, but are not limited to, support for one or more of the following schemes within the terrestrial component of IMT to geographically expand connectivity:

‒ HIBS

‒ Advanced relays and repeaters

‒ or other schemes within the terrestrial component of IMT to enhance connectivity (to be reported by the proponent).

This requirement is defined for the purpose of evaluation in the Ubiquitous Connectivity usage scenario.]

**[4.18 Interoperability**

Interoperability refers to the radio interface being based on member-inclusivity and transparency, so as to enable functionality(ies) between different entities of the system.

The RIT/SRIT shall work as a fully functional and interoperable system, whether (physical and/or virtually) distinct functional elements, interconnected via open and standardised interfaces using open, standards-based protocols, are from a single or multiple vendors.

**[4.X Interworking**

 The interworking aspects of the terrestrial component of IMT-2030 with other terrestrial and non-terrestrial networks (NTN) in support of ubiquitous connectivity, should be provided by the proponents in the characteristic template during the RIT submission to aid the IEGs.

**]****5 List of acronyms and abbreviations**

API Application programming interface

CDF Cumulative distribution function

HIBS High altitude IMT base stations

HRLLC Hyper-reliable and low-latency communications

ML Machine learning

RIT Radio interface technology

SRIT Set of radio interface technologies

SDU Service data units

SE Spectrum efficiency

TPR Technical performance requirements

TRxP Transmission reception points

QoS Quality of service

Annex 1

Inputs to Minimum Technical Performance
Requirement Values

*Editors note: These tables are captured here for reference only; final values will be included in the main Report and this Annex will be deleted.*

[640 ONE6G]

Table 1

**IMT 2030 – overall technical performance requirements**

|  |  |  |
| --- | --- | --- |
| **ITU IMT-2030 TPR** | **Proposed target TPRs & use cases** | **Comments** |
| Peak data rate (Gbps) | DL: 100~200, UL: 50~100 GbpsDL: 200, UL: 100 Gbps | 10 × IMT-2020 |
| Peak spectral efficiency (bps/Hz) | DL: 60~90, UL: 30~45 bps/HzDL: 90, UL: 45 bps/Hz | 3 × IMT-2020 |
| User experienced data rate/cell edge user data rate (Mbps) | DL: 500~1000, UL: 100 MbpsDL: 1 000, UL: 100 Mbps | DL: 10 × IMT-2020UL: without “bandwidth scaling” |
| 5th percentile user spectral efficiency (bps/Hz) | Indoor Hotspot: 0.9-1.5 (DL), 0.63-1.05 (UL)Dense Urban: 0.67-1.12, 0.45-0.75Rural: 0.36-0.6, 0.13-0.22 | 3~5 × IMT-2020 |
| Average spectral efficiency (bps/Hz) | Indoor Hotspot: 27-45 (DL), 20-33 (UL)Dense Urban: 23-39, 16-27Rural: 9.9-16.5, 4.8-8 bps/Hz |
| Area traffic capacity | 50~100 Mbps/s/m2 @ Indoor Hotspot | 5~10 × IMT-2020 |
| Latency | User plane latency | <0.5 ms for one-way, 32-byte packet, unloaded network, measured at the cell edge in the HRLLC scenario<1 ms for Immersive communication | 1/2-1 × IMT-2020 |
| Control plane latency | 10 ms | 1/2 × IMT-2020 |
| Connection density | 107-108 devices/km2 for IoT traffic | 10-100 × IMT-2020 |
| Energy efficiency | N.A. | N.A.  |
| Reliability | 1-10-6 ~ 1-10-7 for HRLLC1-10-7 for HRLLC | 100 × IMT-2020  |
| Mobility | Support 1 000 km/h |  |
| Mobility interruption time | 0 ms |  |
| Bandwidth | At least 400 MHz | 4 × IMT-2020 |
| Positioning | Horizontal accuracy: [10 cm] @90% for indoor, [3-5 m] @90% for outdoor[Vertical accuracy]: [10 cm] @90% for indoor | Assume 200 MHz bandwidth |
| AI-related capabilities | N.A. | N.A. |
| Composite requirement | 500-1 000 users/km2  | Corresponding to 6-12 users per cell of ISD = 200 m |

[640 ONE6G]

Table 2

**IMT 2030 – positioning related technical performance requirements**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | **Sensing service area** | **Confidence level [%]** | **Accuracy of positioning estimate by sensing (for a target confidence level)** | **Accuracy of velocity estimate by sensing (for a target confidence level)** | **Accuracy of rotation estimate by sensing (for a target confidence level)** | **Sensing resolution** | **Max sensing service latency [ms]** | **Refreshing rate [s]** | **Missed detection [%]** | **False alarm [%]** |
| **Horizontal****[m]** | **Vertical****[m]** | **Horizontal****[m/s]** | **Vertical****[m/s]** | **Rotation [degree/s]** | **Range resolution****[m]** | **Velocity resolution (horizontal/ vertical)****[m/s × m/s]** |
| Safety sensing | Indoor composed of up to 8 multiple 3D Cubic’s, cylinders, frames in different levels | [99] | ≤0.04see Note 4 | ≤0.04Note 4 | [≤ 0.1]Note 3  | ≤ 0.1 | <45 with resolution of 1 Note 8  |  < 1% of the measurement distance Ranging distance: 1 m to 10 m (sensor at ceiling) | 0.1Note 6 | [<10]Note 7 | ≤ 0.016Note 5: up to 60Hz | [≤ 1] | [<1] |
| NOTE 1: SICK AG is a reference for competitive safety sensors. Safety radar sensors, multibeam, laser, camera sensors <https://www.sick.com/de/de/c/products>.NOTE 2: PILZ AG is a reference for competitive safety sensors. [www.pilz.com](http://www.pilz.com/)NOTE 3: Speed of robots is approximate 3-5 m/s. Speed of robot arms/joints 0.25 to 1.5 m/s. Speed of human hands/arms 1-2 m/s.NOTE 4: Diameter of human arms is approximately 0.5-0.1 m. Safety resolution of industrial sensors is <40 mm ([www.pilz.com](http://www.pilz.com/)).NOTE 5: Update rate (refresh rate) of up to 60Hz is industrial standard (Sick AG [1]).NOTE 6: 6G system shall be able to measure the speed in the range of 0.4 m/s to 2.4 m/s with a resolution of 0.1 m/s.NOTE 7: Reference to TS22.104 functional safety. Low latency typically means below 10 ms delivery time. This definition is taken from IEC 62657-1 [1].NOTE 8: 6G system shall be capable to measure of rotation rate of > 45 degree/second (refer to industrial safety sensors from SICK AG). Rotation speed complements the tracking function of the 6G system (position, moving vector, rotation of the object orientation). If the 6G system outputs dot-clouds the rotation speed is covered by the refresh rate (1/45 degree/s). |

[640 ONE6G]

Table 3

**IMT 2030 – sensing related technical performance requirements [6]**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | **Sensing service area** | **Confidence level [%]** | **Human motion rate accuracy [Hz]** | **Max sensing service latency [ms]** | **Refreshing rate [s]** | **Missed detection [%]** | **False alarm [%]** |
| Synchronous heartbeat measurements in medical care units | Indoor  | [99.9] | 0.003see Note 1 | [100] | [1] | [<0.01]see Note 2 | [<0.01]see Note 2 |
| NOTE 1: Norm DIN EN 60601 defines the requirement of the measurement of a heartbeat within +/− 75 ms around the actual heartbeat (i.e., 0.0317 Hz considering heart rates as low as 40 bpm). To be competitive with ECG measurements, human motion rate accuracy should be significantly more precise in medical care units (assuming a factor of 10). NOTE 2: Minimum false alarms are required so that healthcare professionals trust the continuous contactless heart rate monitoring system in the palliative care unit, where patients may suddenly be in critical situation. |

**[641 3GPP]**

| **Proposed TPR items** | **Proposed requirement values** |
| --- | --- |
| 1. Peak Data Rate | TBD |
| 2. Peak Spectral Efficiency  | TBD on the values |
| 3. User Experienced Data Rate | TBD on the values3GPP RAN agreed to use system level simulation for the evaluation of UL user experienced data rate with no bandwidth scaling taking UE maximum output power into account. Due to the different evaluation methodology, a new title can be considered to avoid the confusion with previous IMT‑2020 values. |
| 4. 5th percentile user Spectral Efficiency  | Indoor hotspot-IC/Dense urban-IC: – 3x of IMT-2020 for DL– TBD for ULAssuming 7GHz with:– BS: up to 1024 elements– UE: 4Rx or 6Rx or 8RxForm factor and other operational considerations may limit the number of receiver antennas of UE |
| 5. Average Spectral Efficiency  | Indoor hotspot-IC/Dense urban-IC: – 3x of IMT-2020 for DL– TBD for ULAssuming 7GHz with:– BS: up to 1024 elements– UE: 4Rx or 6Rx or 8RxForm factor and other operational considerations may limit the number of receiver antennas of UE |
| 6. Sustainability / Energy Efficiency | TBD |
| 7. Area Traffic Capacity | TBD on values |
| 8. User Plane Latency | IC: 4msHRLLC: 1ms |
| 9. Control Plane Latency | 20ms |
| 10. Connection Density | 10⁶ (devices/km2) for massive communication |
| 11. Reliability | 1-10-5 with same IMT-2020 assumptions |
| 12. Mobility | Indoor Hotspot-IC: 2.25 (bit/s/Hz) @10 km/hDense Urban- IC: 1.68 (bit/s/Hz) @30 km/hRural-IC: [0.8~1.2] (bit/s/Hz)@120 km/h [0.45~0.675] (bit/s/Hz) @500 km/hNOTE1: Maximum velocity is up to 1000/1200km/h. Do not set spectrum efficiency target for this velocity for ITU TPRs.NOTE2: For Rural-IC, TBD on whether to include other velocities, e.g. 30km/h, 60km/h |
| 13. Mobility Interruption Time | TBD |
| 14. Bandwidth  | 400MHz (same definition as IMT-2020) |
| 15. Positioning  | Quantitative TPR, TBD on the values |
| 16. Sensing-related capabilities  | TBD |
| 17. AI-related capabilities | Qualitative TPR |
| 18. Joint/composite requirement | TPR related to data rate, latency, reliability, capacity etc.Applicable usage scenario: immersive communication |

Note: For the TBD, 3GPP will continue to discuss and may provide feedback to ITU-R in future meetings.

3GPP TSG RAN also reached following agreements:

– Do not define security and interoperability as IMT-2030 TPRs, these can be covered by submission template for IMT-2030.

– Sustainability is covered by energy efficiency, do not define separate TPR for sustainability.

– For resilience, whether to define a qualitative TPR or to use the submission template for IMT-2030 is TBD.

3GPP TSG RAN will keep ITU-R WP5D proactively apprised of further developments, including the outcomes of 3GPP TSG RAN’s study, and very much looks forward to future co-operation with ITU-R WP5D on the TPRs and evaluation assumptions for IMT-2030.

**[658 KOREA]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **TPRs** | **IMT-2020 target****(Reference)** | **Initial proposal** | **Notes** |
| 1 | Peak data rate(Gbit/s) | DL: 20UL: 10 | [1.5x] | It is preferred not to overemphasize this item considering practicality and the absence of commercial use cases requiring high peak data rate. |
| 2 | Peak spectral efficiency(bit/s/Hz) | DL: 30UL: 15 | [1.5x] | Assuming 1024 QAM (~25% over 256 QAM), 8/4 layers for DL/UL, overhead reduction compared to IMT-2020 (~30% to 20%). |
| 3 | User experienced data rate(Mbit/s) | DL: 100UL: 50 | DL: [4x]UL: TBD | UL: It is proposed to set target values after discussion on UL evaluation configurations. |
| 4 | 5th percentile spectral efficiency(bit/s/Hz) | Indoor Hotspot-eMBB (DL/UL): 0.3/0.21Dense Urban-eMBB (DL/UL): 0.225/0.15Rural-eMBB (DL/UL): 0.12/0.045 | DL: [3x]UL: [2x] | Assuming a larger number of antenna elements than those used for IMT-2020. |
| 5 | Average spectral efficiency(bit/s/Hz/TRxP) | Indoor Hotspot-eMBB (DL/UL): 9/6.75Dense Urban-eMBB (DL/UL): 7.8/5.4Rural-eMBB (DL/UL): 3.3/1.6 | DL: [3x]UL: [3x] |
| 6 | Area traffic capacity(Mbit/s/m2) | 10 | [3-5x] | Assuming enhanced average spectral efficiency and wider bandwidth |
| 7 | User plane latency(ms) | eMBB: 4URLLC: 1 | IC: 4HRLLC: 1 | The requirement of IMT-2020 would be sufficient for IMT-2030 use cases. |
| 8 | Control plane latency(ms) | 20 | [10] | [1/2x] of IMT-2020 considering 2-step RACH in Rel-16 or potential enhancements such as RACH-less approach for IMT-2030 |
| 9 | Connection density(devices/km2) | 106 | Same as IMT-2020 | The requirement of IMT-2020 would be sufficient for IMT-2030 use cases. |
| 10 | Reliability | 1-10-5 | Same as IMT-2020 | The requirement of IMT-2020 would be sufficient for IMT-2030 use cases. |
| 11 | Mobility(bit/s/Hz@km/h) | Indoor Hotspot-eMBB: 1.5@10Dense Urban-eMBB: 1.12@30Rural-eMBB: 0.8@120, 0.45@500 | Same as IMT-2020 | It is preferred not to add additional mobility classes, unless there is a justification. |
| 12 | Mobility interruption time(ms) | 0 | Same as IMT-2020 |  |
| 13 | Bandwidth(MHz) | 100 | [400] |  |
| 14 | Energy efficiency(%) | Inspection on high sleep ratio and sleep duration | Relative network energy saving gain: [TBD] %Relative device energy saving gain: [TBD] % | It is proposed to consider the following considerations for energy efficiency. – Metric: Relative energy saving gain (in %) for unloaded case over fully loaded case.– Evaluation: Analytical evaluation for the unloaded case only is preferred. – Power model: Proponents should report the power model used for the evaluation. |
| 15 | Positioning(m) | N/A | Indoor (H/V): [1]/[3] for 90% of UEsOutdoor (H/V): [3]/[3] for 90% of UEs | It should be noted that the target positioning accuracies may not necessarily be reached for all scenarios and deployments. |
| 16 | Composite requirement | N/A | Data rate (DL/UL): [30/10] MbpsLatency (DL/UL): [10/30] msReliability (DL/UL): [99/99] %Number of users per TRxP: [10] users | It is proposed to define it as an IMT-2030 TPR for supporting immersive communication, e.g., XR use cases. |
| 17 | Sensing-related capabilities | N/A | Detectability: TBDLocalization accuracy: TBDVelocity accuracy: TBDSensing Resolution: TBD | To facilitate discussion, it is preferred to continue discussion focusing on the list of metrics defined in the last meeting, e.g., detectability, localization accuracy velocity accuracy, and sensing resolution. Detailed evaluation methodology, e.g., simulation, analytical, and inspection, for each metric is TBD. |
| 18 | AI-related capabilities | N/A | N/A | As most of AI operation performance (related to e.g., training, inferencing) is highly dependent on implementation aspects such as computing power, it is proposed not to define quantitative targets for AI-related capabilities. |

**[695 India]**

**User Experienced Data Rate**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **DL user experienced Data Rate (Mbps)** | **UL user experienced Data Rate (Mbps)** |
| Dense Urban-IC | 1.5x compared to IMT-2020 | [1.5-2]x compared to IMT-2020 |
| Rural-UC | TBD | TBD |

**Average Spectral efficiency**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **Downlink (bit/s/Hz/TRxP)** | **Uplink (bit/s/Hz/TRxP)** |
| Dense Urban – IC | 1.5x compared to IMT-2020 | [1.5-2]x compared to IMT-2020 |
| x Indoor Hotspot – IC | 1.5x compared to IMT-2020 | [1.5-2]x compared to IMT-2020 |
| Rural – IC | TBD | TBD |
| Rural - UC | TBD | TBD |

**5th percentile Spectral efficiency**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **Downlink (bit/s/Hz)** | **Uplink (bit/s/Hz)** |
| Dense Urban-IC | 1.5x compared to IMT-2020 | [1.5-2]x compared to IMT-2020 |
| Indoor Hotspot-IC | 1.5x compared to IMT-2020 | [1.5-2]x compared to IMT-2020 |
| Rural - IC | TBD | TBD |
| Rural - UC | TBD | TBD |

**Area Traffic Capacity**

**The target value for area traffic capacity in the downlink is [2-10]x compared to IMT-2020 in the– [TBD] test environment.**

**Connection Density**

**The minimum requirement for connection density is [5-10]x compared to IMT-2020 devices per km2.**

Mobility

‒ Stationary: 0 km/h

‒ Pedestrian: 0 to 10 km/h

‒ Low speed Vehicular: 10 to [30-60] km/h

‒ Medium speed Vehicular: [30-60] km/h to 120 km/h

‒ High speed vehicular: 120 to 500 km/h, as a special case for high-speed train.

User Plane Latency

The minimum requirements for user plane latency are:

‒ [2 – 4] ms for IC

‒ 1 ms for HRLLC.

Control plane latency

The minimum requirement for control plane latency is [10-20]

**[695 India]**

Coverage

|  |  |
| --- | --- |
| **Test Environment** | **Cell Edge1 Distance** |
| Rural-UC | [3-7] km for a single cell |

**Positioning accuracy in case of evaluation through inspection**

|  |  |  |
| --- | --- | --- |
| **Places where UE is used** | **Horizontal Accuracy** | **Vertical Accuracy** |
| Outdoor | sub-meter or longer\*2 | meter-level\*2 |
| Indoor | sub-meter level\*2 | sub-meter level\*2 |
| Specific indoor environment requiring high accuracy | 10 cm or less\*2 | 10 cm or less\*2 |

**Positioning accuracy**

|  |  |  |
| --- | --- | --- |
| **Test Environment** | **Horizontal Accuracy (m)** | **Vertical Accuracy (m)** |
|  Dense Urban-IC | [1-5] | [1-3] |
|  Rural-IC | [3-5] | [1-3] |
| Indoor Factory – HRLLC | [0.1-3] | [0.1-3] |

**Bandwidth**

The requirement for bandwidth is at least 200 MHz.

**Sensing-related Capabilities**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test Environment** | **SR** | **R** | **HSA** | **VSA** | **VAH** | **VAV** | **PD** | **PFA** |
|  |  |  | **Task 1: Object detection, localization and movement characterization** |
| Indoor Factory-ISAC |  |  |  |  |  |  |  |  |
| Dense Urban-ISAC |  |  | [0.07-3] m | [0.1-3] m | [0.03-0.83] m/s | [0.03-0.49] m/s | [0.7-1] | [0.03-0.05] |

**The minimum requirements for Network Energy efficiency**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **[Test environment(s)]\*\*** | **Selected load case(s)** | **The reference case** | **Achievable SR (%)** | **Achievable SD [ms]** |
| TBD | [empty load, low load, light load and/or medium load] \* | Fully loaded IMT-2030 case \* | [X1%, X2%, ...] | [X1 ms, X2 ms, …] |
| \* empty load: L=0, low load: 0 < L≤15, light load: 15 < L≤30, medium load: 30 < L≤50, fully loaded case: L=100\*\* needed only in case of simulation |

**The minimum requirements for Device Energy efficiency**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **[Test environment(s)]\*\*** | **Selected load case(s)** | **The reference case** | **Achievable SR (%)** | **Achievable SD [ms]** |
| TBD | [empty load, low load, light load and/or medium load]\* | Fully loaded IMT-2030 case \* | [A1%, A2%, …] | [A1 ms, A2 ms, …] |

**[729 JAPAN]**

**Summary of technical performance requirements**

| Minimum technical performance requirements (TPRs) | Usage scenario | Test environment | Downlink (DL) or uplink (UL) | Required value |
| --- | --- | --- | --- | --- |
| Peak data rate | Immersive Communication | [TBD] | Downlink and uplink | [TBD] |
| User experienced data rate | Immersive Communication | [TBD] | Downlink and uplink | DL: 500 MbpsUL: [TBD] |
| Peak spectral efficiency | Immersive Communication | [TBD] | Downlink and uplink | [TBD] |
| Average spectral efficiency | Immersive Communication | [TBD] | Downlink and uplink | 3 times of IMT-2020 |
| 5th percentile user spectral efficiency | Immersive Communication | [TBD] | Downlink and uplink | 3 times of IMT-2020 |
| Area traffic capacity | Immersive Communication | [TBD] | Downlink | 50 Mbit/s/m2 for indoor TE0.8 Mbit/s/m2 for Dense Urban TE |
| Connection Density | Massive Communication | [TBD] | Uplink | 107 devices per km2 |
| Mobility | Immersive CommunicationandMassive Communication | [TBD] | Uplink | [TBD] |
| Mobility interruption time | Immersive CommunicationandMassive Communication | [TBD] | N/A | 0 ms |
| User plane latency | Immersive CommunicationandHyper Reliable and Low Latency Communication | [TBD] | Downlink and uplink | 0.5 ms for HRLLC1 ms for IC |
| Control plane latency | Immersive CommunicationandHyper Reliable and Low Latency Communication | [TBD] | N/A | [TBD] |
| Reliability | Hyper Reliable and Low Latency Communication | [TBD] | Downlink or uplink | 1-10−6 |
| Composite requirement | Immersive Communication | [TBD] | [TBD] | [TBD] |
| Extended Connectivity | General/Non-specific | General/Non-specific | N/A | N/A(\*) |
| Positioning | Hyper Reliable and Low Latency Communication | [TBD] | [TBD] | [TBD] |
| Bandwidth | General/Non-specific | General/Non-specific | Downlink and Uplink | 400MHz(\*) |
| Sensing-related capabilities | Integrated Sensing and Communication | [TBD] | [TBD] | [TBD] |
| AI-related capabilities | AI and Communication | [TBD] | [TBD] | N/A(\*) |
| Energy Efficiency | Immersive Communication | [TBD] | N/A | [TBD] |
| Resilience | General/Non-specific | General/Non‑specific | N/A  | N/A(\*) |
| \* Items in the column is verified by inspection. |

**[742 - Ericsson, Nokia, Orange, Telefónica, TIM]**

In the following table you can find the proposed target values for each KPI:

• The first column indicates the section in chapter 4 of Annex 5.9 to Document 5D/563 **[3].**

• The value ranges provided are intended to indicate the level of agreement between the members of 6G-IA. They are not to be interpreted as that individual 6G-IA members agree to all values in the range.

• Some capabilities and values ranges require further analysis.

| **Section** | **Capability** | **Target value** |
| --- | --- | --- |
| **4.1** | **Peak data rate** |  |
|  | Downlink | **20-50 Gbps** [1-2.5]x IMT-2020 |
|  | Uplink | **10-25 Gbps** [1-2.5]x IMT-2020 |
| **4.2** | **User experienced data rate** |  |
|  | Dense urban, Immersive Communication, downlink | **125-500 Mbps** [1.25-5]x IMT-2020 |
|  | For uplink, the definition requires further discussion. | **tbd** |
| **4.3** | **Spectral Efficiency** |  |
| **4.3.1** | **Peak Spectral Efficiency** |  |
|  | Downlink, Immersive Communication | **45-60 bps/Hz** [1.5-2]x IMT-2020 |
|  | Uplink, Immersive Communication | **22.5-30 bps/Hz** [1.5-2]x IMT-2020 |
| **4.3.2** | **Average Spectral efficiency** |  |
|  | Dense urban, Immersive Communication, downlink | **11.7-23.4 bps/Hz** [1.5-3]x IMT-2020 |
|  | Dense urban, Immersive Communication, uplink | **8.1-16.2 bps/Hz** [1.5-3]x IMT-2020 |
|  | Indoor Hotspot, Immersive Communication, downlink | **13.5-27 bps/Hz** [1.5-3]x IMT-2020 |
|  | Indoor Hotspot, Immersive Communication, uplink | **10.12-20.25 bps/Hz** [1.5-3]x IMT-2020 |
|  | Rural, Immersive Communication, downlink | **4.95-9.9 bps/Hz** [1.5-3]x IMT-2020 |
|  | Rural, Immersive Communication, uplink | **2.4-4.8 bps/Hz** [1.5-3]x IMT-2020 |
| **4.3.3** | **5th percentile user Spectral efficiency** |  |
|  | Dense urban, Immersive Communication, downlink | **0.337-0.675 bps/Hz** [1.5-3]x IMT-2020 |
|  | Dense urban, Immersive Communication, uplink | **0.225-0.45 bps/Hz** [1.5-3]x IMT-2020 |
|  | Indoor Hotspot, Immersive Communication, downlink | **0.45-0.9 bps/Hz** [1.5-3]x IMT-2020 |
|  | Indoor Hotspot, Immersive Communication, uplink | **0.315-0.63 bps/Hz** [1.5-3]x IMT-2020 |
|  | Rural, Immersive Communication, downlink | **0.18-0.36 bps/Hz** [1.5-3]x IMT-2020 |
|  | Rural, Immersive Communication, uplink | **0.067-0.135 bps/Hz** [1.5-3]x IMT-2020 |
| **4.4** | **Area traffic capacity** |  |
|  | Indoor Hotspot, Immersive Communication, downlink | **10-50 Mbps/m2** [1-5]x IMT-2020 |
| **4.5** | Connection Density |  |
|  | Massive Communication | **106 – 107 devices/km2**[1-10]x IMT-2020 |
| **4.6** | **Mobility** |  |
|  | Dense urban, Immersive Communication | **30-50 km/h** |
|  | Indoor Hotspot, Immersive Communication | **10-20 km/h** |
|  | Rural, Immersive Communication | **120-500 km/h** |
| **4.6.1** | **Mobility interruption time** |  |
| **4.7** | **Latency** |  |
| **4.7.1** | **User plane latency** |  |
|  | Immersive Communication, downlink | **2-8 ms** |
|  | Immersive Communication, uplink | **2-8 ms** |
|  | Hyper Reliable and Low Latency Communication, downlink | **1 ms** |
|  | Hyper Reliable and Low Latency Communication, uplink | **1 ms** |
| **4.7.2** | **Control plane latency** |  |
|  | Immersive Communication | **10-20 ms** |
|  | Hyper Reliable and Low Latency Communication | **10-20 ms** |
| **4.8** | **Reliability** |  |
|  | Hyper Reliable and Low Latency Communication | **99,999%** |
| **4.9** | Joint / Composite requirement [on data rate, …] |  |
|  | The definition requires further discussion. | **tbd** |
| **4.10** | **Coverage** |  |
|  | Coverage does not require direct evaluation and could be described and reported by (S)RIT proponents as part of the submission template. Coverage refers to the ability to provide access to communication services for users in a desired service area as defined in **[2].** | **Target values are not applicable** |
| **4.11** | **Positioning** |  |
|  |  | **0.4 m - < 1 m** |
| **4.12** | **Bandwidth** |  |
|  |  | **400 MHz** |
| **4.13** | **Sensing-related capabilities** |  |
|  | 6G-IA could give elements for definition and targets values later in time. | **tbd** |
| **4.14** | **AI-related capabilities** |  |
|  | 6G-IA could give elements for definition later in time. AI‑related capabilities could be evaluated by inspection. | **Target values are not applicable** |
| **4.15** | **Energy Efficiency** |  |
|  | 6G-IA could give elements for definition and targets values later in time. | **tdb** |
| **4.16** | **Security** |  |
|  | Details are still under discussion.Security capabilities could be evaluated by inspection or be moved to the submission template. | **Target values are not applicable** |
| **4.17** | **Resilience** |  |
|  | Details are still under discussion.Resilience capabilities could be evaluated by inspection or be moved to the submission template. | **Target values are not applicable** |
| **4.18** | **Interoperability** |  |
|  | Details are still under discussion.Interoperability capabilities could be evaluated by inspection or be moved to the submission template. | **Target values are not applicable** |

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Table 1

**Proposed TPR values**

| **IMT-2030 TPR** | **Corresponding IMT-2020 value** | **Proposed TPR value for IMT-2030** |
| --- | --- | --- |
| Peak data rate (Gbit/s) | DL: 20UL: 10 | TBD |
| Peak spectral efficiency (bit/s/Hz) | DL: 30UL: 15 | TBD |
| User experienced data rate (Mbit/s) | DL: 100UL: 50 | TBD |
| 5th percentile user spectralefficiency (bit/s/Hz) | Indoor Hotspot-eMBB:– DL: 0.3– UL: 0.21Dense Urban - eMBB: – DL: 0.225– UL: 0.15Rural-eMBB:– DL: 0.12– UL: 0.045 | Indoor hotspot-IC/Dense urban-IC/Rural: DL: 3x of IMT-2020UL: 3x of IMT-2020Assumptions: 7 GHz with:- BS: up to 1024 elements- UE: up to 8 elements30 GHz with:- BS: up to 1024 elementsOtherwise as for IMT-2020. |
| Average spectral efficiency (bit/s/Hz) | Indoor Hotspot - eMBB: – DL: 9– UL: 6.75Dense Urban - eMBB: – DL: 7.8– UL: 5.4Rural - eMBB:– DL: 3.3– UL: 1.6 | Indoor hotspot-IC/Dense urban-IC/Rural: DL: 3x of IMT-2020UL: 3x of IMT-2020Assumptions: Same as 5th percentile S.E. |
| Area traffic capacity (Mbit/s/m²) | DL: 10 | 3x of IMT-2020 |
| latency | User plane latency (ms) | eMBB: 4URLLC: 1 | IC: 4 msHRLLC: 1 ms |
| Control plane latency (ms) | 20 | 20 ms |
| Connection density (devices/km²) | 10⁶ | 10⁶ |
| Reliability | 1 - 10⁻⁵ | 1 - 10⁻⁵ |
| Mobility (bit/s/Hz @ km/h) | Indoor Hotspot-eMBB:1.5 @10 km/hDense Urban- eMBB:1.12 @30 km/hRural-eMBB:0.8 @120 km/h0.45 @500 km/h | Mobility up to 500km/h:1.5x of IMT-2020No Spectrum efficiency value defined for mobility above 500km/h. |
| Mobility interruption time (ms) | 0 | [0] |
| Bandwidth (MHz) | 100 | 400 MHz (System bandwidth) |
| Positioning | − | TBD |
| Composite requirement | − | TBDNOTE: An indicative set of values for Dense Urban-IC is given in the Section 4.9 text proposal in the Annex. |

ANNEX 2

*Editors note: this annex is here for reference only and will be removed in the final report.*

**Mapping between capabilities (TPRs) and usage scenarios**

|  |
| --- |
| **Legend for Tables (1 and 2)** |
| G: GSA [171], [301] | J: Japan [353] |  |
| I: India [224], [365] | A: Apple [173][368][369] |  |
| R: Reliance Jio [227] | Q: Qualcomm [219], [376] |  |
| C: China [150][335] | E: Ericsson [387] |  |
| H: Huawei from China [335] | CU: China Unicom from China [335] |  |
| N: Next G Alliance [282] | CZ: ZTE from China [335] |  |
| K: Korea [312] | CC: CICT from China [335] |  |

TABLE 1

**Mapping between Candidate TPRs and Usage Scenarios**

| **Candidate Technical Performance Requirements** | **Usage Scenarios** |  | **Not defined as TPR** |
| --- | --- | --- | --- |
| **Immersive Communi-cation** | **Hyper Reliable and Low Latency Communi-cation** | **Massive Communi-cation** | **Ubiqui-tous Connecti-vity** | **AI and Communi-cation** | **Integrated Sensing and Communi-cation** | **General/Non-specific** |
| Peak data rate | G, N, K, J, Q |  |  |  |  |  |  |  |
| User experienced data rate | G, I, N, K, J, Q |  |  | I |  |  |  |  |
| Sustainable data rate | A |  |  |  |  |  |  |  |
| Peak spectral efficiency | G, N, K, J, I, Q |  |  |  |  |  |  |  |
| Average spectral efficiency | G, I, N, K, J, Q |  |  | I |  |  |  |  |
| 5th percentile user spectral efficiency | G, I, N, K, J, Q |  |  | I |  |  |  |  |
| Area traffic capacity | G, N, K, J, I, A, Q |  |  |  |  |  |  |  |
| Connection density | H, CU |  | G, N, H, K, C, J, I, A, Q |  |  |  |  |  |
| XR connection density/connection capacity | H, CU |  |  |  |  |  |  |  |
| XR area capacity | CZ |  |  |  |  |  |  |  |
| XR area efficiency | CZ |  |  |  |  |  |  |  |
| Mobility | G, I, R, N, K, J, Q |  | J | I |  |  |  |  |
| Mobility interruption time | K, J, I, Q | K, [I], Q | J |  |  |  |  |  |
| User plane latency | G, K, C, J, Q | G, N, K, C, J, Q |  |  |  |  |  |  |
| Control plane latency | G, K, C, J, Q | G, N, K, C, J, Q |  |  |  |  |  |  |
| Reliability | J | G, N, K, J, I, Q |  |  |  |  |  |  |
| Joint requirement on data rate, latency, and reliability | E | E |  |  |  |  |  |  |
| Joint requirement of data rate, latency, reliability and capacity | J |  |  |  |  |  |  |  |
| Coverage |  |  |  | I |  |  | J | N |
| Positioning | G, I, E | J, I |  |  |  | N, CC |  |  |
| Bandwidth | N |  |  |  |  |  | J |  |
| Sensing-related capabilities |  |  |  |  |  | G, N, J, I, A, Q, E |  |  |
| AI-related capabilities | I | I |  |  | C, J |  |  | N, Q |
| Sustainability/Energy efficiency | G, CZ, J, Q |  | CZ | I | CZ | CZ |  | N |
| Security |  |  |  | I |  |  |  | C, G, N, K, Q |
| Resilience |  |  |  | I |  |  | J | C, G, N, K, Q |
| Interoperability |  |  |  | I |  |  |  | G, N, J, Q |

TABLE 2

**Mapping between Capabilities and Usage Scenarios**

|  |  |  |
| --- | --- | --- |
| **Capabilities** | **Usage Scenarios** | **Not defined** |
| **Immersive Communi-cation** | **Hyper Reliable and Low Latency Communi-cation** | **Massive Communi-cation** | **Ubiquitous Connectivity** | **AI and Communi-cation** | **Integrated Sensing and Communi-cation** |
| Peak data rate | G, N |  |  |  |  |  |  |
| User experienced data rate | G, I, N | I |  | I |  |  |  |
| Spectrum efficiency | G, I, N | I |  | I |  |  |  |
| Area traffic capacity | G, N |  |  |  |  |  |  |
| Connection density | H |  | G, N, H |  |  |  |  |
| Mobility | G, I, R, N |  |  | I |  |  |  |
| Latency | G | G, N |  |  |  |  |  |
| Reliability |  | G, N |  |  |  |  |  |
| Security and resilience |  |  |  | I |  |  | G, N, Q |
| Coverage |  |  |  | I |  |  | N |
| Positioning | G, E |  |  |  |  | N |  |
| Sensing-related capabilities |  |  |  |  |  | N, G |  |
| Applicable AI‑related capabilities |  |  |  |  | C |  | N, Q |
| Sustainability | G |  |  | I |  |  | N |
| Interoperability |  |  |  | I |  |  | G, N, Q |

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1. Average spectrum efficiency corresponds to “spectrum efficiency” in Recommendation ITU‑R M.2160. [↑](#footnote-ref-1)