Radiocommunication Study Groups

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GENERAL ASPECTS

IAFI[1]

PROPOSAL FOR FURTHER UPDATES TO THE WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R M.[IMT.VISION 2030 AND BEYOND]

1 Introduction

At the 42nd meeting of the Working Party (WP) 5D, the draft version of a working document towards a preliminary draft new Recommendation ITU-R M.[IMT.VISION 2030 AND BEYOND] was further developed. WP 5D further organized two coordination group meeting (CG#1 and CG#2) to further progress work on developing the usage scenarios. The document is further expected to be elevated to PDNR at the 43rd meeting based on the workplan.

2 Discussion

This contribution provides inputs in track changes to be considered at the 43rd meeting to help further develop the document into a PDNR.

3 Proposal

In this document we propose the following changes to the document, targeting the creation of the PDNR at meeting #43.

1 Proposals to section 1:
   a) Editorial changes aimed at improving the presentation
   b) A note that we need to use the term IMT-2030 consistently in the document.

2 Proposals to section 2.1:
   a) Editorial changes aimed at improving the presentation
   b) Text proposals to reflect the vision as applicable to an IMT system.

3 Proposals to section 2.2:
   a) Editorial changes aimed at improving the presentation, aimed at addressing what IMT can provide to humanity

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[1] IAFI - ITU-APT Foundation of India is a sector member of ITU-R.

b) Text proposal to section 2.2.6

c) Introduction of a new figure on use cases.

4 Proposals to section 2.3:

a) Reference to ITU-R M.2516 in the document

b) Text proposal to section 2.3.3.

5 Proposals to section 3:

a) Editorial changes aimed at improving the presentation

b) Proposals to corroborate on what IMT would do and how IMT could be utilized in the future (2030 and beyond)

c) Text proposals to section 3: Usage Scenario D.

6 Proposals to section 5:

a) Editorial changes aimed at improving the presentation

b) Text proposals to section 5.1.2.

Attachment: Annex 1: Inputs in track changes to the version of the working document at the end of CG#2.

ANNEXE 1

Annex 3.5 to Working Party 5D Chairman's Report

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R M.[IMT.VISION 2030 AND BEYOND]

IMT Vision – Framework and overall objectives of the future development of IMT for 2030 and beyond

[Editor's note: The use of the term "IMT-[2030]" below is a placeholder terminology and the specific nomenclature to be adopted for the future development of IMT is expected to be finalized at the RA-23.]

Summary

[Editor's note: To be developed according to 'Format of ITU-R Recommendations']

[SWG Chair: Development of this summary part would be started from WP5D #43.]

Scope

This Recommendation defines the framework and overall objectives for the development of International Mobile Telecommunications (IMT) for 2030 and beyond. IMT will continue to better serve the needs of the networked society, for both developed and developing countries in the future and this Recommendation outlines how that will be accomplished. This Recommendation also intends to drive the industries and administrations for encouraging further development of IMT for 2030 and beyond. In this Recommendation, the framework of the development of IMT for 2030 and beyond, including a broad variety of capabilities associated with envisaged usage scenarios, is described in detail. Furthermore, this Recommendation addresses the objectives for the development of IMT for 2030 and beyond, which includes further enhancement and evolution of existing IMT and the development of IMT-[2030]. It should be noted that this Recommendation is defined considering the development of IMT to date based on Recommendation ITU-R M.2083.

Keywords

IMT, IMT for 2030 and beyond, IMT-2020, [IMT-2030], IMT-Advanced

Abbreviations/Glossary

IMT International Mobile Telecommunications

[Editor's note: Abbreviations/Glossary will be made when the working document will be stabilized.]

Related documents: ITU Recommendations, Reports, Documents and Handbook

Recommendation ITU-R M.687 – International Mobile Telecommunications-2000 (IMT-2000)

Recommendation ITU-R M.816 – Framework for services supported on International Mobile Telecommunications-2000 (IMT-2000)

Recommendation ITU-R M.1645 – Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000

Recommendation ITU-R M.2083 – IMT Vision - "Framework and overall objectives of the future development of IMT for 2020 and beyond"

Recommendation ITU-R M.1457 – Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)

Recommendation ITU-R M.2012 – Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications Advanced (IMT-Advanced)

Recommendation ITU-R M.2150 – Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020)

Report ITU-R M.2243 – Assessment of the global mobile broadband deployments and forecasts for International Mobile Telecommunications

Report ITU-R M.2320 – Future technology trends of terrestrial IMT systems

Report ITU-R M.2370 – IMT Traffic estimates for the years 2020 to 2030

Report ITU-R M.2376 – Technical feasibility of IMT in bands above 6 GHz

Report ITU-R M.2134 – Requirements related to technical performance for IMT-Advanced radio interface(s)

Report ITU-R M.2410 – Minimum requirements related to technical performance for IMT-2020 radio interface(s)

Report ITU-R M.2441 – Emerging usage of the terrestrial component of International Mobile Telecommunication (IMT)

Report ITU-R M.[IMT.FUTURE TECHNOLOGY TRENDS TOWARDS 2030 AND BEYOND] – Future technology trends of terrestrial IMT systems towards 2030 and beyond

Report ITU-R M.2291 – The use of International Mobile Telecommunications for broadband public protection and disaster relief applications

Report ITU-R M.[IMT.APPLICATIONS] – Applications of IMT for specific societal, industrial and enterprise usages

Report ITU-R M.[IMT.Above 100 GHz] – Technical feasibility of IMT in bands above 100 GHz

The ITU Radiocommunication Assembly,

considering

a) that ITU has contributed to standardization and harmonized use of IMT, which has provided telecommunication services on a global scale;

b) that technological advancement and the corresponding user needs will promote innovation and accelerate the delivery of advanced communication applications to consumers;

c) that Question ITU-R 229/5 addresses further development of the terrestrial component of IMT and the relevant studies under this Question are in progress within ITU-R;

d) that Question ITU-R 262/5 addresses usage of the terrestrial component of IMT systems for specific applications and the relevant studies under this Question are in progress within ITU-R;

e) that Recommendation ITU-R M.1645 defines the framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000;

f) that Recommendation ITU-R M.2083 defines the framework and overall objectives of the future development of IMT for 2020 and beyond;

g) that for global operation and economies of scale, which are key requirements for the success of mobile telecommunication systems, it is desirable to establish a harmonized timeframe for future development of IMT considering technical, operational and spectrum related aspects;

h) that IMT interoperates and/or interworks with other radio systems,

[Editor's note: Some other texts such as trends and characteristics of IMT for 2030 and beyond can be described further, if necessary.]

recognizing

that development of new radio interfaces that support the new capabilities of IMT for 2030 and beyond is expected along with the enhancement of IMT-2000, IMT-Advanced and IMT-2020 systems,

noting

that pursuant to Article 44 of the ITU Constitution, Member States shall endeavour to apply the latest technical advances as soon as possible,

recommends

that the Annex should be used as the framework and the overall objectives for the future development of IMT for 2030 and beyond.

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1 Introduction

[Editor's note: the term IMT-2030 need to be consistently used beyond this point]

With the evolution of information and communications technologies, human beings are becoming even more smarter using augmented intelligence enabled by ubiquitous intelligent networks. An enriched user experience will be achieved through the seamless unification of the physical and digital worlds, built over an ecosystem of networks and device technologies. An enhanced cyber-physical world will give an immersive experience using [multi-sensory communication], enable new forms of human collaboration, support life-improving use cases, bring benefits to industries, and open new business opportunities.

Advancing the capabilities of traditional communications, future IMT systems will be expected to achieve high capacity, low latency, enhanced security and resilience, [and decentralized computing,] as well as economic and efficient coverage for all. In addition to and along with the increasing ambitions with various use cases and enhanced performance, IMT-2030 systems will further support and accelerate a change for a better and sustainable world with significantly improved cost, energy, and resource efficiency.

The objective of this Recommendation is to establish a vision for IMT-2030 by providing guidelines on the framework and overall objectives of the future development of IMT for 2030 and beyond.

2 Trends of IMT for 2030 and beyond

[Editor's note: Following text and figure will be discussed at WP 5D #43.]

[1485/FIN]

[Figure Y presents the overall process for developing the vision of IMT towards 2030 and beyond. First, goals and expected impact are presented in Section 2.1 to respond to question "Why are we developing IMT towards 2030 and beyond?". Section 2.2 responds to question "Whom are we developing IMT towards 2030 and beyond for?" presenting different users. Use cases and usage scenarios are derived in Section 2.2 and Section 4, respectively, to respond to question "How are the users using IMT towards 2030 and beyond?". Technology trends are summarized in Section 2.4 in response to question "How do we make IMT towards 2030 and beyond function?". Finally, capabilities and measures including key performance indicators and key value indicators are presented in Section 4 to respond to question "How is the performance of IMT towards 2030 and beyond to be evaluated / measured?".]

FIGURE Y

[Overall process for developing the vision of IMT towards 2030 and beyond]

Goals and expected impact	Users	Use cases and usage scenarios	Technological enablers	Capabilities
Why are we developing IMT towards 2030 and beyond?	***Whom are we developing IMT towards 2030 and beyond for?***	***How are the users using IMT towards 2030 and beyond?***	***How do we make IMT towards 2030 and beyond function?***	***How is IMT towards 2030 and beyond measured?***
Human-centricity and inclusivity **Social, environmental and economic sustainability** **Resilience and sovereignty**	**Humans** **Machines** **Organizations (public & private)** **Communities**	**[Add use cases and usage scenarios when they are agreed]**	**Emerging technology trends and enablers** **Technologies to enhance radio interface** **Technology enablers to enhance radio network**	**Key performance indicators (KPIs)** **Key value indicators (KVIs)**
(Section 2.1)	**(Section 2.2)**	**(Sections 2.2 and 4)**	**(Section 2.3)**	**(Section 5)**

2.1 Motivation and societal considerations

For over two decades, IMT systems have served the telecommunication needs of people, and have supported the development of various industries, through the continuous development of IMT specifications. These include IMT-2000, IMT-Advanced, and IMT-2020, through Recommendations ITU-R M.1457, ITU-R M.2012, and ITU-R M.2150, respectively.

In continuation of this journey, the motivation for the development of IMT-2030 is to continue improving quality of life for all and to expand its goals towards societal, environmental, cultural and economic sustainability. This is expected to address such issues as global inclusion, health and education, sustainability and support connectivity, productivity and economic incentives, efficiency and management of resources.

IMT-2030 would be an important enabler of achieving the UN Sustainable Development Goals (SDGs) [and societal, economic, environmental and cultural development]. In 2030 and beyond, these goals include:

i) Inclusivity - Ensuring inclusion through connectivity to enable the active participation of all. The IMT-2030 should target by design the integration of terrestrial technology into addressing other domains

ii) Sustainability – Fostering growth with sustainable society, environment and economy for long-term protection and prosperity. The IMT-2030 should target by design sustainability aspects

iii) Dependability – Securing a society in which people and industries can grow, deliver value, and act safely. The IMT-2030 should target by design to be trustworthy.

Considering the above, IMT should continue to contribute to the following foundational aspects:

– **Sustainable Development:** Sustainability is the balancing of economic prosperity, environmental protection, resource conservation, social well-being, and equity. It is a major requirement to cope with environmental challenges. The IMT-2030 system must by design meet the UN's sustainable development goals to improve life quality, enabling healthcare, learning, reduce carbon footprint, maximize handprint, and eliminate digital divide. It should be stressed that information and communication technologies (ICTs) play an important role in society, for the environment, and to empower individuals and industries, towards protecting the environment by saving energy and maximizing efficiency. These systems must select energy-efficient networking technologies and products and minimizing resource use, whenever possible. The IMT technology design principles should encompass sustainability measures aimed toward achieving net zero emission. In addition to significantly reducing Greenhouse Gas (GHG) emissions to mitigate global warming, it is important for IMT-2030 systems to address biodiversity loss, pollution, and a fundamentally sustainable approach to raw and rare materials.

– **Economic Prosperity:** Sustainable economic growth can be fostered by leveraging IMT capabilities to increase productivity, innovation, effectiveness, efficient creation and delivery of new value propositions, business models, and market segments. Increased productivity can also reduce poverty and release resources that make it possible to improve other important sustainability goals such as health, pollution mitigation, security, and education.

– **Security and resilience:** The future IMT system should be secure by design. This is fundamental to achieving broader societal and economic goals. Resilience, availability, data protection and trustworthiness will be key considerations in the design, deployment and operation of IMT systems.

– **Ubiquitous Coverage and Connectivity:** The future IMT system design should ensure a simplified network architecture and flexible radio interface design with very high availability, to allow for its rapid deployments across diverse terrains and geographies, including through ancillary functions like fixed wireless access (FWA), backhaul, high-altitude IMT base stations (HIBS), and interconnectivity with satellite.

– **[[Open]/[Standardized] and Interoperable Networks:** To achieve wide industry support for IMT-2030, future IMT systems should be designed from the start to use standardized and interoperable interfaces, ensuring that different parts of the network elements from different vendors can be integrated to work together seamlessly as a fully functional system.]

2.2 User and application trends

[Editor's note: Footnote to be removed as the meeting suggests that no additional footnotes are necessary as the text is self-explanatory].

[Editor's note: The following have been discuses in the meeting and consensus reached to:

1. Section 2.2.9 on "Trustworthiness (Resilience, Security, and Privacy)" will be deleted, with the understanding that high-level expectations on security may be included elsewhere in the vision document, including, for example, in sections 2.1 and 4 at 5D #43

2. The text below is carried forward for possible consideration at WP 5D #43 meeting:

IMT for 2030 and beyond are expected to be privacy preserving, robust to data poisoning attacks, and explainable, functioning at the highest level of security and privacy - supported by a robust identity and authentication mechanism to overcome challenges such as unfairness and discrimination, purpose limitation, data minimization, non-transparency, and the limited right to access information.]

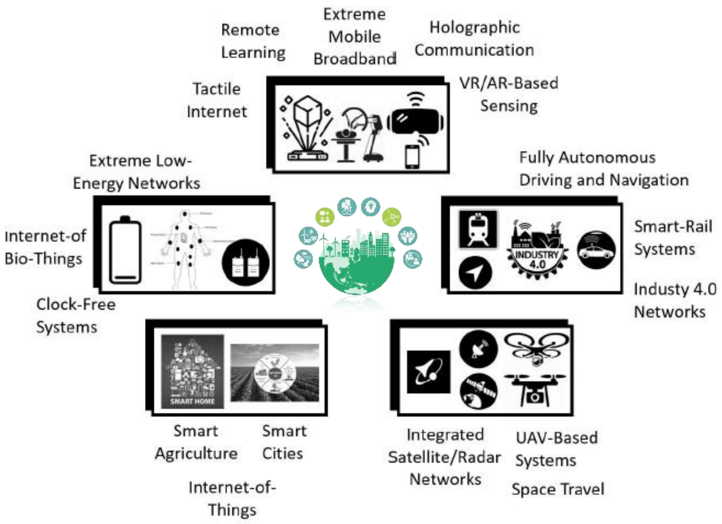
Applications and services enabled by future wireless communication technology will connect humans, machines and various other things together. With the advances in human-machine interfaces such as extended reality (XR) displays, haptic sensors and actuators, and multi-sensory interfaces, connected humans can have truly immersive experiences that are virtually generated or happening remotely. On the other hand, connected machines will be highly intelligent and autonomous that can function with high precision and responsiveness through advances in machine perception, robotics, and artificial intelligence (AI). In a physical world, humans and machines will continuously interact with each other, working with a digital world that extends the real world by using a great number of advanced sensors, future wireless communication technology and artificial intelligence. Such a digital world not only replicates but also affects the real world by providing virtual experiences to humans and computed control to machines.

The IMT-2030 is expected to integrate sensing, compute and intelligence capabilities into communication, and serve as a fundamental infrastructure to enable new user and application trends. These trends have a wide range of use cases from human-machine interaction and telepresence to tele-operation, and from leveraging digital replicas of physical objects and environments in smart industries, to detection and localization, with expected global connectivity and sustainability. IMT for 2030 and beyond can contribute to facilitate these technological innovations, while continuing to provide native support for essential communications such as voice calling. IMT technologies are further expected to usher in the next wave of digital economic growth, as well as drive far-reaching societal shifts in sustainability, digital equality, universal connectivity, and quality of life.

One of the most agreed ways to identify and analyse user demand is to consider new types of services (some of which are visually presented in Fig. x). This provides a good estimation of those new use cases and applications that are deemed necessary and its corresponding mapping to service requirements. This section deals with the user and application trends for the IMT technology evolution towards 2030 and beyond.

FIGURE X

Example use cases to be addressed by IMT-2030[2]



2.2.1 Ubiquitous Intelligence

With the steady progress and fast spread of technologies like artificial intelligence (AI) and particularly machine learning (ML), it is expected that the ubiquitous use of AI would enter every layer of the communication ecosystem to further support the building of smart societies to simplify the work and lives for people. Future connected devices may become fully context-aware for more intuitive and efficient interactions among humans, machines, and the environment. Autonomous networks may also be capable of performing self-monitoring, self-organizing, self-optimizing and self-healing functions without human intervention. It is expected that a particular or a series of protocols/functions of air-interface will be replaced by AI/ML models for better performance in an effective way. Intelligent agents, including autonomous agents with the capability of perception, recognition and thinking may produce active intelligent-interactive behaviours.

Future mobile communications systems could serve as an AI infrastructure capable of providing AI as a service for intelligent applications. More fundamentally, AI-based air interface design and air interface enablement for distributed computing and intelligence will allow for end-to-end native AI and the convergence of communication and computing. These systems may support inferences, model training, model deployment, as well as computing distributed across networks and devices, and are expected to operate meeting high expectations on security and privacy.

2.2.2 Immersive multimedia and multi-sensory communication

[Editor's note: The support of context-based communication can be considered as a technique. Therefore, further review and amendment would be needed for the last part of this section.]

The future of multimedia and human-centric communication is expected to give an immersive experience through multi-sensory (auditory, visual, haptic or gesture) interactions and in-depth integration between physical and digital worlds. Metaverse and cyber-physical systems (CPS) are

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2 Inspired by the figure in Doc. 5D/775, originally from "H. Tataria, M. Shafi, A. F. Molisch, M. Dohler, H. Sjöland and F. Tufvesson, "6G Wireless Systems: Vision, Requirements, Challenges, Insights, and Opportunities," in Proceedings of the IEEE, vol. 109, no. 7, pp. 1166-1199, July 2021, doi: 10.1109/JPROC.2021.3061701".

expected to be personalized and developed as a new trend to give truly immersive experiences to users via appropriate interactivities between physical space, cyber space, and users. Moreover, eXtended Reality (XR) and holographic telepresence may become common for work and social interactions, entertainment, tele-education, remote live performances, etc.

New human-machine interfaces are foreseen to enable immersive and full human-machine interaction in applications such as tele-surgery, tele-consultation, remote operation of machinery in industry (including of digital twins) and transportation.

2.2.3 Digital twin and extended world

IMT for 2030 and beyond is expected to be used to replicate the physical world in a digital world as precise real-time representations or digital twins. Digital twins have the potential to provide ubiquitous tools and knowledge platforms for the modelling of assets, resources, environment, and situations, and to allow for monitoring, design, management, analysing, diagnosing, simulating, navigation, interactive mapping, etc. of physical assets.

Using advanced technologies such as integration of communication with AI, sensing, and computing, digital twins will also synchronize the digital world to the physical world and provide connections between the digital replica components. Digital twins will not only replicate but also affect the physical world by providing digital maps for virtual experiences to humans and computed control to machines. Digital twins are envisaged to become a powerful tool in the evolution of multiple industries including health care, agriculture, construction, etc.

2.2.4 Smart industries and transportation

Machine-to-machine cooperation is a future direction for smart industries that would include aspects like smart manufacturing, smart energy[3], etc. Future automated industrial communication systems would be centred around collaborative robots (cobots), which require real-time intelligence and interaction between robots and humans. With the integration of AI and digital twin techniques, industrial robots and machines will have the capability to exchange intelligence and cooperate to enable efficient use of resources and energy, optimizations of manufacturing, automated product delivery, energy generation, etc.

Pervasive IoT will require connectivity to every intelligent device with highly reliable and low-latency connections to enable ubiquitous and real-time information collection, sharing, and intelligent control and feedback. Applications like automated driving/transportation, and industry automation will require higher flexibility, self-organization capabilities, local processing, and direct communication among entities.

2.2.5 E-health and well-being

[Editor's note: Further review for this Section is required at the WP 5D #43 meeting.]

[The evolution of IMT would help in improving the quality of life with better health, enabled through a full range of e-health services available anywhere. Pervasive IoT applications would be envisaged in various scenarios, such as massive connections through wearable devices, intra-body communications achieved via implanted sensors. Potential applications in e-health include interactive and immersive remote monitoring, prediction-based treatment, tele-diagnosis, remote and robotic surgery, tele-rehabilitation, enabling bio/nano sensors, digital clinical trials and connected ambulances for telemedicine, etc.]

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[3] Smart energy is the process of using smart devices for energy-efficiency.

2.2.6 Contiguous and ubiquitous connectivity

Contiguous and ubiquitous connectivity is critical for delivering a wide range of services such as access to education, health, transport, logistics, and business opportunities. IMT-2030 is expected to contribute to achieving the UN SDGs, bridging the digital divide, and connecting the unconnected and under-connected areas in an efficient manner, by addressing the challenges of connectivity, coverage, capacity, data rate and the mobility of terminals.

IMT for 2030 and beyond is therefore expected to support the development of ubiquitous-mobile services to-society that would deliver on digital inclusion for all by meaningfully connecting the rural and remote communities, further extending into sparsely populated areas, and maintaining the consistency of user experience between different locations, including deep indoor coverage. Accordingly, the IMT-2030 system needs to holistically integrate terrestrial technology into other domains, and for the radio interface to be flexible enough to extend coverage to service NTN and other services not targeted by prior IMT systems.

2.2.7 [Joint/Integrated] Sensing and communication

[Editor's note: The title for this section will be further reviewed at WP 5D #43 meeting.]

The integration of sensing and communication in IMT for 2030 and beyond is expected to become a key enabler for a wide range of use cases, particularly in providing capabilities such as imaging, mapping and localization, high resolution and precise object detection, recognition and estimation of range, angle, and velocity. Moreover, measuring the physical surroundings through sensing combined with AI will further enable a full context awareness.

Sensing information is envisaged to be shared in certain environments and across network systems in a distributed manner to facilitate specialized services. Sensing would support various value-added innovative applications such as ultra-high precision positioning and localization of devices and passive objects, high resolution and real-time 3D-mapping for automated and safe driving/transport, and industrial automation. Other opportunities include gesture and activity recognition, environment sensing and material inspection.

[2.2.8 [Communication & Computing Convergence][Ubiquitous Computing]

[Editor's note: This section will be reviewed at WP 5D #43 meeting.]

[Ubiquitous computing, also referred to as communication and computing convergence, refers to the trend by which computing services and data services are expected to become an integral component of the future IMT system. Emerging technology trends include expansion of data processing from the core towards the device including at the network edge closer to the origination of information. This trend introduces improvements for real-time responses, low data transport costs, energy efficiency and privacy protection, as well as scaling out device computing capability for advanced application computing workloads.]

[2.2.9 Sustainability

[Editor's note: Sustainability is discussed as a design imperative and not necessarily as a use case or application trend. Further discussions are need on how treat this section, proposals are encouraged in this regard for the WP 5D #43 meeting.]

Sustainability is another foundational value for future IMT system design. Growing societal concerns on environmental, social, and economic sustainability as pointed out in UN SDGs need to be addressed by the future IMT generations. The next IMT system is expected to minimize its own environmental impacts by realizing a system which minimizes its use of energy to help the ICT sector move towards net-zero. IMT system implementations should also [make use of] [use] materials with lowest possible environmental impact and support a design which fosters a highly efficient use of resources considering aspects such as extended lifetime, reusability, and recyclability. Moreover, IMT systems shall allow for efficient deployment and operations, thereby improving both its environmental sustainability and affordability to support social sustainability goals. Beyond its own footprint, the IMT system is also expected to play a role in supporting other industries in reducing their climate impacts.

To support the UN SDGs, the absolute energy consumption and carbon footprint of future IMT systems, encompassing networks and user devices, should ultimately be lower than current IMT generations (sustainability-by-design). The next IMT system is expected to resolve the digital divide and prioritize coverage and cost efficiency in areas where people have no access or limited access to the internet, and to serve the global economy as a key digital infrastructure for all possible industrial sectors. Such solutions need to be implemented in a way that still minimize the environmental footprint.]

[Editor's note: In the followings are figures contributed to section 2.2 but not discussed in WP 5D #42 . Further discussion and review are needed at next WP 5D #43 meeting.]

// Next set of changes

2.3 Technology trends

[Editor's note: Following texts were provided from SWG Radio Aspects (Document 5D/TEMP/724. Further review will be focused on only editorial improvement.]

Report ITU-R M.2516 provides a broad view of future technical aspects of terrestrial IMT systems considering the timeframe up to 2030 and beyond, characterized with respect to key emerging services, applications trends, and relevant driving factors. It comprises a toolbox of technological enablers for terrestrial IMT systems, including the evolution of IMT through advances in technology, and their deployment. In the following sections a brief overview of emerging technology trends, technologies to enhance the radio interface, and technologies to enhance the radio network are presented.

2.3.1 Emerging Technology trends and enablers

Future IMT will consider an AI-native new air interface that refers to the use of AI to enhance radio interface performance such as symbol detection/decoding, channel estimation etc. An AI-native radio network will enable automated and intelligent networking services such as intelligent data perception, supply of on-demand capability etc. Radio network to support AI services is the design of IMT technologies to serve various AI applications, and the proposed directions include on-demand uplink-centric, deep edge and distributed machine learning.

Integrated sensing and communication (ISAC) systems will enable innovative services and solutions with higher degree of accuracy. In the ISAC system, sensing and communication function will mutually benefit within the integrated system. Combined with technologies such as AI, network cooperation and multi-nodes cooperative sensing, the ISAC system will have benefits in enhanced mutual performance, overall cost, size and power consumption of the whole system.

Computing services and data services are expected to become an integral component of the future IMT system. Emerging technology trends include processing data at the network edge close to the data source for real-time response, low data transport costs, energy efficiency and privacy protection, as well as scaling out device computing capability for advanced application computing workloads.

Device-to-device (D2D) wireless communication with extremely high throughput, ultra-accuracy positioning and low latency will be an important communication paradigm for the future IMT. Technologies such as THz technology, ultra-accuracy sidelink positioning and enhance terminal power reduction technology can be considered to satisfy requirements of new applications.

Future IMT systems will continue to utilize a mixture of different frequency bands as in current IMT system, but with potentially larger bandwidths and higher operating frequencies. Spectrum utilization can be further enhanced by efficiently managing resources through different technologies such as advanced carrier aggregation (CA) and distributed cell deployments, as well as spectrum sharing technologies and technologies for broader frequency spectrum.

Energy efficiency and low power consumption comprises both the user device and the network's perspectives. The promising technologies include energy harvesting, backscattering communications, on-demand access technologies, etc.

To achieve real-time communications with extremely low latency communications, two essential technology components are considered: accurate time and frequency information shared in the terrestrial network and fine-grained and proactive just-in-time radio access.

There is a need to ensure security, privacy, and resilient solutions allowing for the legitimate exchange of sensitive information through network entities. Potential technologies to enhance trustworthiness include those for RAN privacy, such as distributed ledger technologies, differential privacy and federated learning, quantum technology with respect to the RAN and physical-layer security technologies.

2.3.2 Technologies to enhance the radio interface

New advanced modulation methods such as signal shaping, low PAPR modulation and good suppressing phase noise capability may be considered to achieve better performance. Technologies may also consider extreme performance and diverse use cases for advanced coding schemes (e.g., advanced versions of polar coding, LDPC and other coding schemes). Advanced waveform design among orthogonal, bi-orthogonal, non-orthogonal methods will be beneficial in specific scenarios to guarantee desirable performance. For multiple access, technologies including non-orthogonal multiple access (NOMA) such as multi-user shared, pattern division, rate-splitting, sparse code, cyclic prefix code division etc., as well as grant-based and grant-free multiple access are expected to meet future requirements.

Extreme MIMO (E-MIMO) will deploy new type and much larger-scale antenna arrays, a distributed mechanism as well as AI assistance. This will achieve better spectrum efficiency, larger network coverage, accurate positioning, accurate sensing, higher energy efficiency, etc.

Self-interference cancellation (SIC) technology will enable in-band Full Duplex (IBFD) in future mobile communications to enhance the spectrum efficiencies and suppress the interference between co-located heterogeneous systems, especially for high-power and massive MIMO scenarios.

Techniques such as Reconfigurable Intelligent Surfaces (RIS), Holographic radio (HR) and Orbital Angular Momentum (OAM) are potential technologies to improve the performance and overcome the challenges in traditional beam-space antenna array beamforming.

Sub-THz and THz frequency resources provide the potential of bandwidths up to hundreds GHz. Communications using such frequency resources are envisioned as key enablers for many future use cases (e.g. the use cases with extremely high-data-rate, low latency, high-resolution sensing and imaging, and high-precision positioning, etc).

Ultra-high accuracy positioning can be supported by ultra-wide bandwidth and E-MIMO in a millimetre wave or terahertz band, as well as carrier phase positioning (CPP) based on cellular signals, AI/Machine learning (ML) positioning techniques and integrating data communication and UE positioning.

2.3.3 Technology enablers to enhance the Radio Network

RAN slicing allows multiple independent logical networks to be created on a common shared physical infrastructure. The slices are configured to satisfy the specific needs of applications, services, customers, or network operators, and each network slice could be administered by an MVNO or the customers themselves.

QoS requirements vary from one user to another. The future network is proposed to be resilient and soft in QoS provisioning (e.g., user-centric, service oriented, flexible and powerful in capabilities, guaranteed in QoS, and consistent in user experience). Technologies such as the QoS guarantee mechanism, deterministic RAN, etc. can be considered.

RAN architecture will be reformed and simplified to achieve the goal of strongest capability, simplest architecture and plug-and-play in future IMT systems. The alternative approaches includes DOICT (data, operation, information, and communication technologies) convergence driven RAN architecture, native-AI enabled RAN functions, a thinner or lite protocol stack design, RAN node cooperation and aggregation and the User-centric network (UCN) architecture, etc. for further enhance the network performance.

With real-time interactive mapping between the physical network and virtual twin network, digital twin networks (DTNs) can help efficiently and intelligently investigate, simulate, deploy, and manage novel technology networks.

The interconnection of terrestrial IMT and non-terrestrial communications aims to expand future terrestrial IMT technology to support seamless interconnectivity with non-terrestrial networks (NTN), including satellite communications, high altitude platform stations (HIBS) and unmanned aircraft systems (UASs) as IMT base station platforms. NTN overlays over TN will enhance several critical aspects of communication such as service continuity, rural connectivity, and emergency response systems.

An ultra-dense network (UDN) is implemented by increasing the densification of TRxPs. It may be an effective way to fulfil various requirements such as user experienced data rates, connection density, energy efficiency, spectrum efficiency, area traffic capacity, coverage, etc.

New technologies such as trusted data storage and secure sharing and service-based architecture of RAN will enhance RAN infrastructure sharing in terms of transparency, reliability and rapid response.

// Next set of changes

3 Usage scenarios of IMT for 2030 and beyond: Communication base and beyond communication base

[Editor's note: This is a working title for this Section on usage scenarios.]

[Editor's note: introductory text/preambles to usage scenarios to further reviewed at next WP 5D #43 meeting.]

[Editor's note: introductory text/preambles to usage scenarios based on outcome from offline after CG#2.]

IMT for 2030 and beyond is expected to expand and support various user, application and technology trends as described in § 2, while providing prospects towards socio-economic digital transformation and well-being.
As a set of use cases enabled by a common set of capabilities, usage scenarios of IMT- 2030 are envisaged to encompass enhanced/expanded communication-based usage scenarios and beyond communication usage scenarios [that combine communications-based usages with beyond communication capabilities such as artificial intelligence (AI)-related and sensing-related capabilities]. Furthermore, a broad variety of capabilities would be tightly coupled with the intended usage scenarios and the corresponding use cases of IMT-2030.

[In addition, IMT for 2030 and beyond is also expected to be built on [overarching pillars] which act as design imperatives/principles of IMT systems commonly applicable throughout all usage scenarios. These distinguishing characteristics of the IMT-2030 system include sustainability for achieving sustainable communication (i.e., improving energy efficiency, reducing environmental impact, achieving carbon neutrality, etc.), AI as an enabler to improve overall system performance, and native-[security/trustworthiness], etc.]

[Editor's note: it is suggested that a condensed text to be used and what are the overarching aspects to be included : Sustainability, [Security]/ Privacy /[~~trustworthiness~~] /Resilience , AI for communications]

3.1 Communication-based usage scenarios

[Editor's note: A general description for communication-based usage scenarios could be included here, if needed.*]*

[Editor's note: introductory text/preambles to usage scenarios based on outcome from offline after CG#2.]

Usage scenarios of IMT for 2030 and beyond are envisaged to encompass communication-based usage scenarios which enhance/expand existing IMT usage scenarios into broader use requiring enhanced [as well as new] capabilities. The communication-based usage scenarios of IMT for 2030 and beyond include:

Usage scenario A: Immersive Communication

[Editor's note: This is a working title for usage scenario A.]

[Editor's note: This usage scenario needs further discussion on whether the scenario is only targeting the extension of eMBB or a combination of eMBB and URLLC and/or mMTC scenarios. Also, discussion whether aspects from Scenario D and H are reflected or possible merged into Scenario A.]

This usage scenario extends/] the enhanced Mobile Broadband (eMBB) of IMT-2020 and covers use cases which provide immersive communication experience to users, including the interactions with compute interfaces.

This usage scenario covers a range of environments, including e.g., hotspots, dense urban and rural, which come with various increasing or new requirements compared with those of mobile broadband from earlier IMT technologies. The capabilities to provide higher spectrum efficiency and consistent service experiences are required to leverage the balance between higher data rate and increased mobility in various environments. Example use cases include immersive extended reality (XR) and holographic communications, remote multi-sensory telepresence, [industrial robot tactile feedback and monitoring]. Supporting mixed traffic of video, audio, and other environment data in a time-synchronized manner is an integral part of immersive communications, including also stand-alone support of voice.

This usage scenario would also require extremely high data rates in combination with high reliability and low latency for responsive and accurate interaction with real and virtual objects, as well as larger system capacity for provisioning a large number of devices simultaneously.

The use cases emphasising immersive communication may also require high reliability and low latency, higher spectrum efficiency and increased mobility for responsive and accurate interaction with real and virtual objects, as well as larger system capacity for provisioning a large number of devices simultaneously.

*[[Editor's note: This is a proposal to merge Usage Scenario G" **Super mobile broadband"** with Usage Scenario A. The text below needs to be revised and streamlined at the next WP 5D #43 meeting.]*

Usage Scenario B: Extreme/critical Communication // Extreme/ Communication //Critical communication

[Editor's note: The text in this usage scenario needs to be reviewed and revised taken into consideration discussions in the DG Capability].

This usage scenario extends the Ultra-Reliable Low-Latency Communication (URLLC) of IMT-2020 and covers use cases that typically have more stringent requirements on/of /for reliability and , latency, time-synchronized operation, where failure in meeting these requirements could lead to severe consequences for the applications.

Typical use cases include smart industries, such as smart manufacturing, [smart energy], etc., with extended and new applications such as full automation and industrial control and operation, , drone operation, remote and autonomous operation, remote medical surgery, [energy generation], etc.

[Editor's note: Qualifier for some capabilities needs to be added, if required.]

This usage scenario would require extreme reliability and low latency. In addition, it may require time-synchronized operation and other capabilities such as precise positioning [data rate], and connection density, depending on the use case

The use cases emphasising extreme communications may also require precise positioning [data rate], and connection density, depending on the use case, in addition to requiring extreme reliability, latency, and [availability]. Some of the uses may also involve network enablers beyond connectivity, such as dependable compute, accurate positioning, or sensing, among others.

Usage Scenario C: Massive Communication

This usage scenario extends massive Machine Type Communications (mMTC) of IMT-2020. It involves ubiquitous connectivity of massive number of devices or sensors of many types, for a wide range of environments, with sporadic or simultaneous traffic in daily life.

This usage scenario is expected to enable applications to sense the environment, monitor, track, measure, control, and allow development of insights from massive number of real-world objects.

Example use cases are expected to include expanded and new applications in smart cities, transportation, logistics, health, energy, environmental monitoring, agriculture, infrastructure, and many other areas.

The use cases emphasising massive communications may also require wide range of data rates, low [complexity] and low power consumption, long battery life, [extended coverage], and high security and reliability.

Usage Scenario D [Global mobile connectivity// Global Broadband communications // Ubiquitous Connectivity

[Editor's note : during the 1st CG ->Sustainability is cross theme not necessary a usage scenario. also this scenario global mobile connectivity may not belong to section 3.2 as it contains as well communications aspects , why IMT-2030 highlight this as one scenario since this main goal of WP5D?could this be similar as HAPS/drone application , can this be moved to section 5: how IMT-2030 can in future be interoperable with other services , the context of how to apply Sustainability

[Editor's note : also consider to address how to connect the unconnected, redrafting and then decide where to place this scenario in the WD, suggestions currently is section 3.1 or section 5]

[Editor's note for usage scenario D: .

There are diverge views on inclusion of this Scenario and suggestions this scenario can be merged into scenario A: immersive communication.

As well views expressed that sustainability could be considered as enabler and not necessarily as use case.

In the meeting views expressed on inclusion of coverage and NTN aspects in the text

Other views expressed that this Scenario needs to be retained as it describes use cases and application that would be needed by IMT-2030 and beyond not necessary covered by Scenario A: immersive communication where the focus is on capabilities and applications expected to have higher date rate s and very low latencies, whereas in this scenario emphasise on connectivity with moderate data rates mobility and basic connectivity. Further discussion and review are needed at next WP 5D #43 meeting.]

[Editor's note : HIBS is expected to be deployed before 2030, also it represent specific technical solution /or use case , it may not fit in IMT-2030 timeframe, suggestion is to move this Scenario to section 5 as an example, also suggestion to move Scenario D to section 3.1]

[Editor's note: Text proposal for usage scenario D after CG#2. Outcome from offline discussions, it is also suggesting this text to be retained in section 3.1.]

This usage scenario is intended to connect the unconnected and [provide][extend] IMT into previously unserved areas. This includes affordable connectivity[4] and, at minimum, basic broadband services with extended coverage, including remote and sparsely populated areas, thus contributing to achieving the UN SDGs[5]. The next generation of radio interface technology design need to integrate and extend mobile services to NTN and other services to achieve true ubiquitous connectivity. Under this scenario, future IMT networks can also support public safety, including the application of communication for rescue and recovery efforts in the event of natural disasters as disaster-resilient infrastructures.

Typical use cases could range from IoT and low data-rate services such as supporting emergency calls or navigation guidance, to moderate data-rate services such as basic video communication for virtual doctors' interview to logistics tracking done over UAVs' into remotely serviced areas, as well as basic broadband services in those remote and sparsely populated areas to bridge the digital divide.

Coverage/Reachability is the key capability to be considered in this usage scenario while, at minimum, moderate user experienced data rate, latency and high mobility requirements should also be supported.

3.2 Beyond Communication usage scenarios

[Editor's note: The text in this section needs to be further reviewed at next WP 5D #43 meeting.]

[Editor's note: Introductory text/preambles to usage scenarios based on outcome from offline after CG#2.]

In addition to the communication-based usage scenarios in section 3.1, IMT-2030 is envisaged to address beyond-communication usage scenarios. These usage scenarios will enable new use cases with beyond communication capabilities such as artificial intelligence and sensing that the previous generation of IMT systems were not designed to support natively. The beyond communication usage scenarios of IMT for 2030 and beyond include:

Usage Scenario E: Integrated Artificial Intelligence and Communication// Integrated Communication and Artificial Intelligence/ Integrated compute and Artificial Intelligence

[Editor's note: The introductory text for this usage scenario E needs to be further reviewed.]

[Editor's note : from the 1st CG meeting discussions -> aspects need to be highlight in this usage scenario such as AI as services , networks will have compute-related functionalities

Addressing Ubiquitous Computing_ need further offline discussions

Addressing **intelligent customization/computing – need further offline discussions]**

[Editor's note: text proposal for usage scenario E after CG#2 . outcome from offline discussions]

This usage scenario is one of the beyond-communication services in which IMT-2030 system would support [computation offloading and] AI-powered applications namely AI as a service. It will support unprecedented specialized use cases by leveraging AI-related functionalities in future IMT system, including data collection, the distributed training and inference of AI models,

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[4] [For providing affordable connectivity, all interconnected future IMT networks connect to mobile terminals using the radio interface of the terrestrial component of IMT.]

associated with local or distributed computation offloading across various intelligent nodes in the network and devices.

Typical use cases range from network assisted automated driving to autonomous collaboration between implanted devices inside human body as zero-touch capabilities for medical treatment applications, [offloading of heavy computation operations from devices to the networks,] the creation of and prediction with digital twins, and network assisted collaborative robots/cobots for the handling of complex tasks.

A network supporting AI-powered use cases is expected to have high requirements on area capacity and user experienced data rates, as well as low latency and high reliability, depending on the specific use case to be supported. Besides communication aspects, this usage scenario would demand a set of new capabilities related to [the integration of] artificial intelligence [and computation power of networks and devices], including data acquisition and fusion, joint AI model training, model sharing and distributed inference across network and devices, and computing resource orchestration and chaining.

Usage Scenario F: /Integrated Communication and Sensing /Integrated sensing and communication // Integrated Communication and Sensing // Integrated sensing

This usage scenario integrates sensing with communication systems to realize ubiquitous transmission of sensor data, to utilize wireless communication systems more effectively and facilitate beyond-communication applications. Sensing-information enabled usage makes use of the communication system to offer wide area multi-dimensional sensing that provides spatial information about unconnected as well as connected objects and their movements and surroundings. It is a beyond communication usage scenario built over the communication-based usage scenarios to enable new use cases with beyond communication capabilities. In addition, the related beyond communication technologies can also be used to enhance the overall system performance associated with every communication-based usage scenario.

This usage scenario refers to the technologies that integrate Sensing with Communication Systems to realize ubiquitous transmission of sensor data, to utilize wireless communication systems more effectively and facilitate beyond-communication applications. Sensing-information enabled usage makes use of the communication system to offer wide area multi-dimensional sensing that provides spatial information about unconnected as well as connected objects and their movements and surroundings. The usage scenario should guarantee an agreed positioning/range accuracy and extreme/ultra high sensing resolution.

Information from sensing can be used, for example in navigation (automotive and aerial), to recognize posture/gestures, localize, track movements, detect fall (healthcare) and to offer environments/spatial descriptions to XR applications

) Besides communication aspect, this usage scenario would demand high-precision positioning and a set of new capabilities related to the sensing sensing, including range/velocity/angle estimation, object detection, localization, imaging, mapping, [information provisioning about environment etc., and [could be] measured in terms of accuracy, resolution, missed detection rate, etc as the context may be

This usage scenario would require sensing-related capabilities high detection probability, high sensing resolution and accuracy in range/ precision, velocity/angles/ high-precision positioning, etc.

[Editor's note: It is proposed to added after the end of description of usage scenario F following paragraph]

/// Section break ///

[Use cases which are not foreseen are expected to emerge, and some of the use cases might be enabled by different set of capabilities inherited from multiple usage scenarios. For future IMT, flexibility will be necessary to adapt new use cases that come with a wide range of requirements.

Future IMT systems will encompass a large number of different features. Depending on the circumstances and the different needs in different countries, future IMT systems should be designed in a highly modular manner so that not all features have to be implemented in all systems.]

Typical use cases include for example in navigation situations (automotive and aerial), to recognize posture/gestures, localize, track movements, detect fall (healthcare) and to offer environments/spatial descriptions to mixed reality applications, such as training and interactive gaming. Smart homes, smart factories, smart cities, and smart highways are other examples of areas where sensing will add new and vital information that applications can make use of. Integration of sensors for digitization and programmability of the physical world facilitates real time interaction between virtual and physical worlds.

The use cases emphasising integrated communication and sensing may also needs, accuracy in precision, velocity, angles, , and confidence level, the requirements of which varies from applications to applications.

// Next set of changes

5 Additional framework and objectives

[Editor's note: Due to lack of time, following texts were not reviewed at WP 5D #42. It will be reviewed at WP 5D #43.]

[The objective of the development of IMT for 2030 and beyond is to address the anticipated needs of users of mobile services in the years 2030 and beyond. The goals for the capabilities of IMT for 2030 and beyond system described in § 4 are only targets for research and investigation and may be further developed in other ITU Recommendations and may be revised in the light of future studies. This section provides relationships between IMT for 2030 and beyond and existing IMT/other access systems, timelines and focus areas for further study as additional framework and objectives for the development of IMT for 2030 and beyond.]

5.1 Relationships

[5.1.1 Relationship between existing IMT and IMT-2030]

[Editor's note: Due to lack of time, following texts were not reviewed at WP 5D #42. It will be reviewed at WP 5D #43.]

[In order to support emerging usage scenarios and applications for 2030 and beyond, it is foreseen that development of IMT-2030 would be required to offer enhanced capabilities as those described in § 4. The values of these capabilities go beyond those described in Recommendation ITU-R M.2083. The minimum technical requirements (and corresponding evaluation criteria) to be defined by ITU-R based on these capabilities for IMT-2030 could potentially be met by adding enhancements to existing IMT, incorporating new technology components and functionalities, and/or the development of new radio interface technologies.

Furthermore, IMT-2030 may interwork with and complement existing IMT and its enhancements.]

[5.1.2 Relationship between IMT-2030 and other access systems]

[Editor's note: Due to lack of time, following texts were not reviewed at WP 5D #42. It will be reviewed at WP 5D #43.]

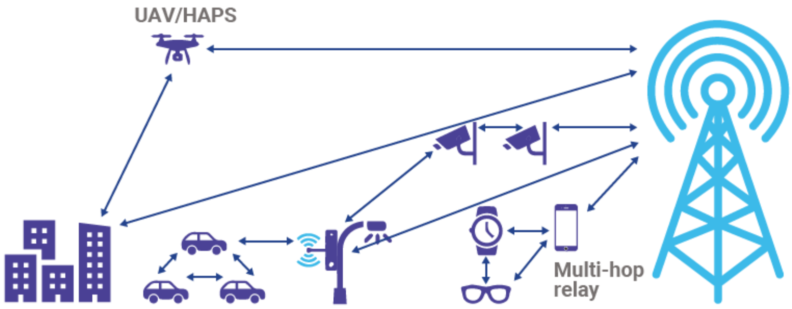
[Users should be able to access services anywhere, anytime. To achieve this goal, interworking and interconnecting will be necessary among various access technologies, which might include a combination of different fixed, terrestrial and satellite networks. Each component should fulfil its own role, but also should be interconnected or interoperable with other components to provide ubiquitous seamless coverage.

IMT-2030 will interwork with other radio systems, such as RLANs, broadband wireless access, broadcast networks, and their possible future enhancements. IMT systems will also closely interwork with other radio systems for users to be optimally and cost-effectively connected.]

[Mobile networks are defined by functionalities divided into Core Network (CN) and Radio Access Network (RAN) which are connected through open, multi-vendor interfaces. A key architectural change in the core with IMT-2020 systems was the transition to a cloud native service-based approach. This trend will further extend towards the edge and the radio access in IMT-2030 with the benefit of enabling end-to-end deployments using a harmonized, cloud-based framework with common operational tools. These network needs to accommodate to an even more diverse set of use cases, services, and access technologies with different topologies. Cloud-based service delivery platforms will be diversified into on premises, edge, core and public clouds through different processing and service capabilities matching the needs of these services. The target architecture should be flexible enough so that network functions and services can be deployed across different cloud platforms, edge, and central cloud sites.

FIGURE Y

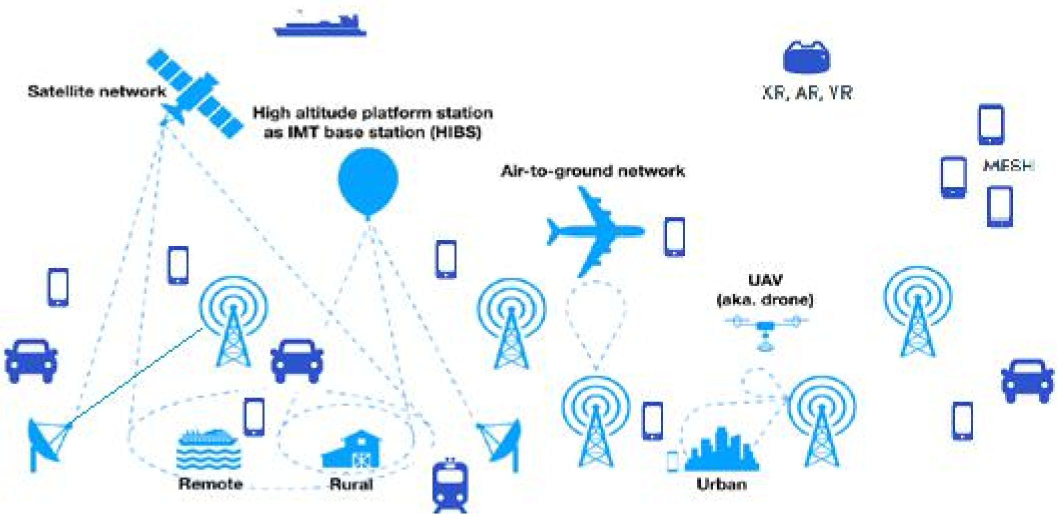
Depiction of a future mobile network



Conventional mobile networks assume fixed network topology, so the connectivity between the device and the network has been the primary focus of system design. With IMT-2030, it is expected that radio technologies for advanced topology and networking such as UE cooperative communication, Non-Terrestrial Networks (NTN), and mesh networking will play more critical roles to support various non-conventional types of connectivity, as well as continuously evolving network topology to adaptively meet the varying traffic demand. New topology and networking to support extreme industrial and commercial use cases are also considered as an important part of this system to promote new use cases.

FIGURE Y

Depiction of multiple network topologies for IMT-2030



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5.2 Timelines

[Editor's note: Following texts based on Recommendation ITU-R M.2083 are proposed for discussion. It could be improved based on further inputs and discussion.]

[Editor's note: Highlighted in yellow in § 5.2, 5.2.1 and 5.2.2 will be discussed at WP 5D #43.]

In planning for the development of IMT-[2030] as well as future enhancement of the existing IMTs, it is important to consider the timelines associated with their realization, which depend on a number of factors:

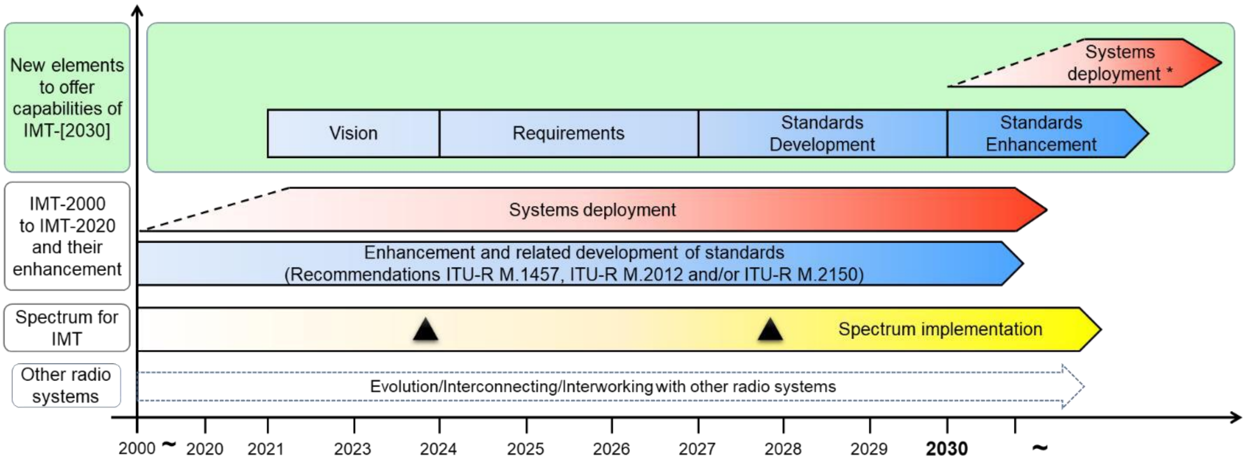
– user trends, requirements and user demand;
– technical capabilities and technology development;
– standards development and their enhancement;
– spectrum matters;
– regulatory considerations;
– system deployment.

All of these factors are interrelated. The first five have been and will continue to be addressed within ITU [as well as other industry-led expert groups, such as 3GPP]. System development and deployment relates to the practical aspects of deploying new networks, taking into account the need to minimize additional infrastructure investment and to allow time for customer adoption of the services of a new system. ITU will complete its work for standardization of IMT-[2030] no later than the year 2030 to support IMT-[2030] deployment by ITU members expected from the year 2030 onwards.

The timelines associated with these different factors are depicted in Figure A. When discussing the phases and timelines for IMT-[2030], it is important to specify the time at which the standards are completed, when spectrum would be available [and under which spectrum access approach], and when deployment may start.

FIGURE A

Phase and expected timelines for IMT-[2030]



The sloped dotted lines in systems deployment indicate that the exact starting point cannot yet be fixed.

▲ : Possible spectrum identification at WRC-23, WRC-27 and future WRCs

* : Systems to satisfy the technical performance requirements of IMT-[2030] could be developed before year 2030 in some countries.
: Possible deployment around the year 2030 in some countries (including trial systems)

[Editor's note: The use of the term "IMT-[2030]" above is a placeholder terminology and the specific nomenclature to be adopted for the future development of IMT is expected to be finalized at the RA-23.]

5.2.1 Medium term

In the medium-term (up to about the year 2030) it is envisaged that the future development of IMT-2000, IMT-Advanced and IMT-2020 will progress with the ongoing enhancement of the capabilities of the initial deployments, as demanded by the marketplace in addressing user needs and allowed by the status of technical developments. This phase will be led by the growth in traffic and emerging new use cases within the existing IMT spectrum[, on both an exclusive and shared basis with other services.~~, and t~~T]he development of IMT-2000, IMT-Advanced and IMT-2020 during this time will be distinguished by incremental or evolutionary changes to the existing IMT-2000, IMT-Advanced and IMT-2020 radio interface specifications (i.e. Recommendations ITU-R M.1457 for IMT-2000, ITU-R M.2012 for IMT-Advanced and ITU-R M.2150 for IMT-2020, respectively).

It is envisaged that the bands identified by WRCs will be made available for IMT within this timeframe subject to user demand and other consideration.

5.2.2 Long term

The long term (beginning around the year 2030) is associated with the potential introduction of IMT-[2030] which could be deployed around the year 2030 in some countries. It is envisaged that IMT-[2030] will add enhanced capabilities described in § 4, and they may need additional frequency bands in which to operate [on either an exclusive or shared licence basis].

[The introduction of IMT-2030 will lay the foundation for the continuous evolution of features, reducing the need for major generational upgrades further in the future and improving sustainability outcomes.]

5.3 Focus areas for further study

The research forums and other external organizations wishing to contribute to the future development of "IMT-[2030]" are encouraged to focus especially in the following key areas:

a) radio interface(s) standards development and their interoperability;

b) access network related issues;

c) spectrum related issues;

d) traffic characteristics.