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| **Keywords:** | Standardization; study groups; activity report; key results; |
| **Abstract:** | This report summarizes progress achieved ITU-T standardization from October to December 2021, as well as measures taken by TSB to enhance the ITU-T standardization platform. |

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# Executive Summary

ITU approved 60 new and revised ITU-T Recommendations and related texts from October to December 2021. Appendix I lists these texts, as well as texts currently under approval, and summarizes their contents. Section 1 provides a selection of texts approved in the reporting period. Executive summaries of ITU-T study meetings can be found on study group [homepages](https://www.itu.int/en/ITU-T/studygroups/Pages/default.aspx).

ITU-T membership maintained growth in 2021, welcoming 43 new members (10 Sector Members and 33 Associates), amounting to an overall net increase of 22 (as of 31 December 2021). In addition, a total of 18 new Academia members joined ITU in 2021. 43 of ITU-T’s Associates are participating under the reduced fee structure for SMEs.

Virtual meetings and electronic working methods remain the principal platform for ITU standardization work as part of the global response to the COVID-19 pandemic. ITU members are making optimal use of the personalized [MyWorkspace](https://www.itu.int/net4/ITU-T/myworkspace/) platform and associated TSB services and tools such as MyMeetings. Eight study group meetings were held online from October to December 2021. 19 workshops and symposia were held during this period, in addition to the weekly programming of the year-round [AI for Good](https://aiforgood.itu.int/) digital platform.

[ITU-T Focus Group on Quantum Information Technology for Networks (FG-QIT4N)](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/default.aspx), reporting to TSAG, held its first meeting from 9 to 10 December 2019 and completed and adopted nine [Deliverables](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/default.aspx) as technical reports on 24 November 2021 (watch a briefing on these Deliverables [here](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/SG11%2613.aspx)).A new [ITU-T Focus Group on Testbeds Federations for IMT-2020 and Beyond (FG-TBFxG)](https://www.itu.int/en/ITU-T/focusgroups/tbfxg/Pages/default.aspx) was established in December 2021 under ITU-T SG11, and a new [ITU-T Focus Group on AI and IoT for Digital Agriculture (FG-AI4A)](https://www.itu.int/en/ITU-T/focusgroups/ai4a/Pages/default.aspx) was established in October 2021 under ITU-T SG20.

The [ITU Challenge on AI/ML in 5G](https://aiforgood.itu.int/about/aiml-in-5g-challenge/) enables participants to connect with new partners in industry and academia – and new tools and data resources – to achieve goals set out by problem statements contributed by industry and academia. The second edition of Challenge in 2021 welcomed over 1,600 participants from 82 countries and culminated with a Grand Challenge Finale on 14 December 2021. The 2021 Challenge was sponsored by Xilinx and the Republic of Korea’s Ministry of Science and ICT. The Challenge is in focus throughout the year in a [series of AI for Good webinars](https://aiforgood.itu.int/eventcat/ai-ml-in-5g/).

A new security lab set up at ITU under the now concluded [Financial Inclusion Global Initiative (FIGI)](https://figi.itu.int/) will continue to support regulators and innovators in ensuring the security and resilience of financial applications and enabling infrastructure. The [Digital Financial Services Security Lab](https://figi.itu.int/figi-resources/dfs-security-lab) conducted six [DFS Security Clinics](https://www.itu.int/en/ITU-T/webinars/dfs/sc/Pages/default.aspx) in the reporting period, sponsored by the Republic of Korea’s Ministry of Science and ICT.

The [United for Smart Sustainable Cities (U4SSC)](http://www.itu.int/en/ITU-T/ssc/united/Pages/default.aspx) initiative is supported by 17 UN bodies with the aim of achieving SDG11: "Make cities and human settlements inclusive, safe, resilient and sustainable". The [sixth annual U4SSC meeting](https://www.itu.int/en/ITU-T/ssc/united/Pages/202112/meeting.aspx) was held on 7 December 2021 online. ITU, together with other organizations and UN agencies, is running [series of webinars on"Digital transformation for cities and communities"](https://www.itu.int/en/ITU-T/webinars/Pages/dt4cc.aspx), with seven held during in the reporting period.

The [10th Green Standards Week](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/gsw/202112/Pages/default.aspx) was held virtually from 14 to 16 December 2021. The event hosted the launch of a [case study (Spanish)](https://www.itu.int/en/publications/Documents/tsb/2021-Economia-Circular-Costa-Rica/index.html#p=1) sharing Costa Rica’s experience following the approach recommended by [Recommendation ITU-T L.1031](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14572) to achieve the e-waste targets of the Connect 2030 Agenda. The case study also explores Costa Rica’s actions in line with the ITU standard [Recommendation ITU-T L.1032](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=13963), which provides guidelines and certification schemes for e-waste recyclers.

High-level industry executives (CxOs) met with the senior management of TSB to exchange views on industry priorities and related standardization activities in hybrid format, with attendees online and in person in Dubai, UAE, 7 December 2021, co-hosted by Telecom Review and du. CxOs discussed industry priorities in fields including IMT-2020/5G, open RAN, light communication, AI/ML, environmental efficiency, supply chain security, and network infrastructure sharing – placing emphasis on their relationship with digital transformation. CxOs also shared views on means to support and capitalize on the growing synergy between industry and academia in the development and application of ICTs, particularly in the field of AI/ML. See CxO meeting [Communiqué](https://www.itu.int/en/ITU-T/tsbdir/cto/Documents/Communique_ITU_CxO_07.12.2021_f.pdf).

The [ITU Journal on Future and Evolving Technologies](https://www.itu.int/en/journal/j-fet/Pages/default.aspx), launched in September 2020, provides comprehensive coverage of communications and networking paradigms and is free of charge for both readers and authors. The journal published its first regular issue in December 2020, second regular issue in April 2021, and third regular issue in December 2021. It published five special issues in 2021 and is welcoming submissions to nine new special issues to published in 2022. Published papers are available to download free of charge from the [ITU Digital Library](https://www.itu.int/pub/S-JNL).

The 13th edition of [ITU Kaleidoscope: *Connecting physical and virtual worlds*](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Pages/default.aspx) was held online from 6 to 10 December 2021. The conference shared expert insights on the growing synergy between physical and virtual space and this synergy’s influence on art and culture. Alongside accepted papers presented at the conference, Kaleidoscope also featured keynote speeches, invited talks, special sessions and video demos, as well as coffee breaks hosting digitally enhanced art exhibitions and dance performances.

IEC, ISO, and ITU led the celebrations of [World Standards Day](https://www.worldstandardsday.org/home.html), 14 October 2021, themed "A Shared Vision for a Better World". The celebrations marked the start of a multi-year campaign aimed at raising awareness of how international standards contribute to the United Nations Sustainable Development Goals. IEC, ISO, and ITU issued a [joint declaration](https://eur01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.worldstandardscooperation.org%2Fwhat-we-do%2Fg20%2F&data=04%7C01%7CBULAY%40iso.org%7C195225c8f8cf4a2d1dd608d99a140418%7C8543418a200d4d6b88c979fb0b651354%7C0%7C0%7C637710233024490842%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=9g4DklKmM2tmQzzK4E28a4H%2FCqWtG1w98JjaIXIrt6w%3D&reserved=0) calling on all countries to recognize, support and adopt international standards in order to contribute directly to the three pillars of the Italian G20 Presidency, People, Planet and Prosperity, at the [International Standards Summit for People, Planet and Prosperity](https://www.worldstandardscooperation.org/what-we-do/g20/), 29 October 2021.

Over 4,000 pages of ITU-T Recommendations and Supplements were published in the reporting period. All major editions of ITU-T Recommendations continue to be converted to the reflowable ePub format, and are published for free download alongside the usual PDF format. The ITU product "ITU-T Recommendations and selected Handbooks" continues to be distributed on a quarterly basis as a USB key.

TSB continues to collect all new terms and definitions proposed by ITU-T SGs, entering them into the online ITU Terms and Definitions database. TSB has translated 12 Recommendations approved under the Alternative Approval Process in 2021, in accordance with requests received from ITU-T SGs and linguistic groups, and within the available budget

# Annex – Full Report of activities in ITU-T (from October to December 2021)

# 1 Selection of achievements in ITU-T standardization

Executive summaries for the various ITU-T SG meetings can be found on the homepages of [ITU-T SGs](https://www.itu.int/en/ITU-T/studygroups/Pages/default.aspx).

ITU approved [60](https://www.itu.int/itu-t/workprog/wp_search.aspx?isn_sp=3925&isn_status=-1,2&adf=2021-10-01&adt=2021-12-31&details=0&field=acdefghijo) new and revised ITU-T Recommendations and related texts from October to December 2021. Appendix I lists these texts, as well as texts currently under approval, and summarizes their contents.

**Transport, access and home:**

* Error performance parameters and objectives for multi-operator international paths within optical transport networks - Amendment 1 (G.8201 Amd.1, under publication)
* Optical transport network security (Supplement, under publication)
* Network slicing in a PON context (Supplement, under publication)
* 5G small cell backhaul/midhaul over TDM-PON (Supplement, under publication)
* Radio-over-fibre technologies and their applications (revised G.Suppl.55, under publication)
* UHD video service over G.hn (G.9976, under publication)
* Overview of the ITU-T G.hn Technology (Technical Report, under publication)

**Internet of Things (IoT) and smart cities:**

* Overview of smart oceans and seas, and requirements for their ICT implementations ([Y.4004](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14812))
* Requirements and capabilities of network connectivity management in IoT ([Y.4212](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14814))
* IoT requirements and capability framework for monitoring physical city assets ([Y.4213](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14815))
* Functional architecture for unmanned aerial vehicles (UAVs) and UAV controllers using IMT-2020 networks ([Y.4421](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14738))
* Framework of service interworking with device discovery and management in heterogeneous IoT environments ([Y.4477](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14816))
* Requirements and functional architecture for smart construction site services ([Y.4478](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14817))
* Low power protocol for wide area wireless networks ([Y.4480](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14818)). *Note: This protocol is technically equivalent to (and compatible with) the LoRaWAN protocol (version 1.0.4)*.
* Functions and metadata of spatiotemporal information service for smart cities ([Y.4562](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14833))
* Requirements and functional model to support data interoperability in IoT environments ([Y.4563](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14819))
* Unified IoT Identifiers for Intelligent Transport Systems ([Y.4809](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14739))
* Requirements of data security for the heterogeneous IoT devices ([Y.4810](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14820))
* Reference framework of converged service for identification and authentication for IoT devices in decentralized environment ([Y.4811](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14821))

**Quantum key distribution networks:**

* Security requirements and designs for quantum key distribution networks - key management ([X.1712](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14805))
* Quantum Key Distribution Networks - Software Defined Networking Control ([Y.3805](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14770))

**Broadband cable and TV**

* Analysis of the cost and complexity of IP Video Broadcast technology (Technical Paper, under publication)
* Use cases and service scenario of IP Video Broadcast for CATV Networks (Technical Paper, under publication)

**Big data and cloud:**

* Cloud computing - Functional requirements of edge cloud management ([Y.3526](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14759))
* Big data - deep packet inspection mechanism for network big data ([Y.3606](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14776))

**Telecoms management:**

* Requirements for QoE management of video in visual surveillance ([M.3365](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14744))

**Intelligent transport systems:**

* Vehicle domain service: General information and use case definitions ([F.749.5](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14792) | ISO 23239-1)

**Security and trust:**

* A trust index model for ICT infrastructures and services ([Y.3057](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14769))
* Guidelines for continuous protection of service access process ([X.1011](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14793))
* Security requirements and architecture for network slice orchestration and management ([X.1047](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14794))
* Security threats and requirements for data access and sharing based on distributed ledger technology ([X.1408](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14801))
* Security guidelines of web-based online customer service ([X.1470](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14803))
* Technical guidelines for secure multi-party computation ([X.1770](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14807))
* Low resource requirement, quantum resistant, encryption of USSD messages for use in financial services (Technical Paper, under publication)

**Environment and circular economy:**

* Guidelines on energy efficient blockchain systems ([L.1317](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14718))
* Guide for the institutions of higher learning to contribute in the effective life cycle management of e-equipment and e-waste ([L.1033](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14715))
* Smart energy solutions for cities and home applications ([L.1383](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14719))
* Radio base station site best practices ([L.Suppl.45](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14883))
* Definitions and recent trends in circular cities ([L.Suppl.46](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14884))
* Mitigation techniques to limit human exposure to electromagnetic fields (EMFs) in the vicinity of radiocommunication stations - Appendix I: Software "EMF-estimator" v8.0.32 and v8.64” (revised) ([K.70 Amd.1](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14880))
* Radiofrequency electromagnetic field exposure levels from mobile and portable devices during different conditions of use (revised [K.Suppl.13](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14881))

**Economic and policy issues:**

* Customer redress and consumer protection mechanisms for OTTs ([D.1102](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14730))
* Implementation guidelines for Recommendation ITU-T D.52 focusing on operationalization of regional Internet exchange points ([D.Suppl.5](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14879))

**Performance, QoS and QoE:**

* QoS metrics for the assessment of the impact of fixed geographic structures on telephony quality and call stability ([G.1027](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14822))
* Influencing factors on quality of experience for virtual reality services (revised [G.1035](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14826))
* Framework for creation and performance testing of machine learning based models for the assessment of transmission network impact on speech quality for mobile packet-switched voice services (revised [P.565](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14827))
* Machine learning model for the assessment of transmission network impact on speech quality for mobile packet-switched voice services ([P.565.1](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14823))
* Subjective video quality assessment methods for multimedia applications (revised [P.910](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14828))

**Combatting counterfeiting and use of stolen devices:**

* Use cases on the combat of counterfeit ICT and stolen mobile devices (Q.Suppl.75, under publication)

**Formal languages and identification:**

* Testing and Test Control Notation version 3: TTCN-3 core language (revised [Z.161](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14781))
* Testing and Test Control Notation version 3: TTCN-3 language extensions: Configuration and deployment support (revised [Z.161.2](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14782))
* Testing and Test Control Notation version 3: TTCN-3 language extensions: Advanced parameterization (revised [Z.161.3](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14783))
* Testing and Test Control Notation version 3: TTCN-3 language extensions: Behaviour types (revised [Z.161.4](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14784))
* Testing and Test Control Notation version 3: TTCN-3 language extensions: Object-Oriented Features (revised [Z.161.7](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14785))
* Testing and Test Control Notation version 3: Using ASN.1 with TTCN-3 (revised [Z.167](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14786))
* Testing and Test Control Notation version 3: The IDL to TTCN-3 mapping (revised [Z.168](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14787))
* Testing and Test Control Notation version 3: Using XML schema with TTCN-3 (revised [Z.169](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14788))
* Testing and Test Control Notation version 3: Using JSON with TTCN-3 (revised [Z.171](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14789))

# 2 ITU-T Focus Groups

## 2.1 Conclusion of ITU-T Focus Group on Quantum Information Technology for Networks

[ITU-T Focus Group on Quantum Information Technology for Networks (FG-QIT4N)](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/default.aspx) held its first meeting from 9 to 10 December 2019 and completed and adopted the following [Deliverables](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/default.aspx) as technical reports on 24 November 2021 (watch a briefing on these Deliverables [here](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Pages/SG11%2613.aspx)).

Deliverables:

* **D1.1:** Quantum information technology for networks terminology: Network aspects of quantum information technologies [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.1.pdf)]
* **D1.2:**Quantum information technology for networks use cases: Network aspects of quantum information technologies  [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.2.pdf)]
* **D1.4:** Standardization outlook and technology maturity: Network aspects of quantum information technologies  [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D1.4.pdf)]
* **D2.1:** Quantum information technology for networks terminology: QKDN [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.1.pdf)]
* **D2.2:**Quantum information technology for networks use cases: QKDN [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.2.pdf)]
* **D2.3:** Quantum key distribution network protocols: Quantum layer [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.3%20part%201.pdf)]
* **D2.3:**Quantum key distribution network protocols: Key management layer, QKDN control layer and QKDN management layer [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.3%20part%202.pdf)]
* **D2.4:** Quantum key distribution network transport technologies [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.4.pdf)]
* **D2.5:**Standardization outlook and technology maturity: Quantum key distribution network [[PDF](https://www.itu.int/en/ITU-T/focusgroups/qit4n/Documents/D2.5.pdf)]

## 2.2 New groups

The [ITU-T Focus Group on Testbeds Federations for IMT-2020 and Beyond (FG-TBFxG)](https://www.itu.int/en/ITU-T/focusgroups/tbfxg/Pages/default.aspx), established in December 2021 under ITU-T SG11, will support research communities in maximizing their collective return on testbed investments. It responds to urgent needs to build a technical and business ecosystem for the sustainable development, evolution, and federation of testbeds. It aims to build broader knowledge of the specializations of different testbeds and identify opportunities for mutually beneficial interactions. It will also provide a platform to harmonize specifications for testbed interoperability, fostering and enabling high degrees of quality assurance and security. Its work is intended to build on Recommendation ITU-T [Q.4068](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14765) specifying open application programming interfaces for interoperable testbed federations. See [Press Release](https://www.itu.int/en/mediacentre/Pages/PR-2021-12-21-Testbed-Federations.aspx).

The [ITU-T Focus Group on AI and IoT for Digital Agriculture (FG-AI4A)](https://www.itu.int/en/ITU-T/focusgroups/ai4a/Pages/default.aspx), established in October 2021 under ITU-T SG20, will examine emerging cyber-physical systems as groundwork for standardization to stimulate their deployment for agriculture worldwide. AI, IoT, connected services and autonomous systems together enable farmers to make decisions at the level of a single square metre or individual plant or animal, rather than entire fields or all livestock. This precision allows well-informed interventions that ultimately improve agricultural sustainability. The envisaged study aims to support global progress in areas such as precision farming, predictive analytics for smart farming, the optimization of cultivable acreage, remote cattle monitoring and management, agricultural robotics, and greenhouse automation. The group will work in close collaboration with the [Food and Agricultural Organization of the United Nations (FAO)](https://www.fao.org/home/en). See [Press Release](https://www.itu.int/en/mediacentre/Pages/PR-2021-11-16-Digital-Agriculture.aspx).

## 2.3 All active groups

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| **ITU-T Focus Group (FG)** | **Start date** |
| [Testbeds Federations for IMT-2020 and Beyond (FG-TBFxG)](https://www.itu.int/en/ITU-T/focusgroups/tbfxg/Pages/default.aspx) | 2021-12 |
| [AI and IoT for Digital Agriculture (FG-AI4A)](https://www.itu.int/en/ITU-T/focusgroups/ai4a/Pages/default.aspx) | 2021-10 |
| [AI for Natural Disaster Management (FG-AI4NDM)](https://www.itu.int/en/ITU-T/focusgroups/ai4ndm/Pages/default.aspx) | 2020-12 |
| [Autonomous Networks (FG-AN)](https://www.itu.int/en/ITU-T/focusgroups/an/Pages/default.aspx) | 2020-12 |
| [AI for Autonomous and Assisted Driving (FG-AI4AD)](https://www.itu.int/en/ITU-T/focusgroups/ai4ad/Pages/default.aspx) | 2019-10 |
| [Environmental Efficiency for AI and other Emerging Technologies (FG-AI4EE)](https://www.itu.int/en/ITU-T/focusgroups/ai4ee/Pages/default.aspx) | 2019-05 |
| [AI for Health (FG-AI4H)](https://www.itu.int/en/ITU-T/focusgroups/ai4h/Pages/default.aspx) | 2018-07 |
| [Vehicular Multimedia (FG-VM)](https://www.itu.int/en/ITU-T/focusgroups/vm/Pages/default.aspx) | 2018-07 |

# 3 Collaboration initiatives

## 3.1 Artificial intelligence and machine learning

**AI for Good:** [AI for Good](https://aiforgood.itu.int/) is the United Nations platform for AI. It is the world’s premier platform to advance AI’s contribution to sustainable development.

AI for Good is now presented as a year-round digital platform where AI innovators and problem owners learn, build and connect to help identify practical AI solutions to advance the United Nations Sustainable Development Goals. AI for Good is supported by close to 40 UN partners as well as a range of industry sponsors.

The AI for Good digital platform has accelerated the momentum created by the AI for Good Global Summits held in Geneva in 2017, 2018, and 2019.

AI for Good features weekly [programming](https://aiforgood.itu.int/programme/) with the following programming streams:

Learn:

* AI for Good Keynotes
* AI for Good Webinars
* AI for Good Discovery (trustworthiness, health, climate science)
* AI for Good Perspectives
* AI for Good On the Go!
* AI for Good Blog

Build:

* AI for Good Machine Learning 5G Challenge
* AI for Good Innovation Factory
* AI for Good related (Pre-)Standardization Efforts & Initiatives
AI for Good Breakthroughs
* AI for Good Gateway

Connect:

* AI for Good Global Summit
* AI for Good Artistic Intelligence
* UN AI Actions
* AI for Good Brain Trust
* AI for Good Neural Network (coming soon)

The AI for Good digital platform has accelerated the momentum created by AI for Good Global Summits held in Geneva in 2017, 2018, and 2019.

**AI and machine learning (ML) in IMT-2020/5G:** The [ITU Challenge on AI/ML in 5G](https://aiforgood.itu.int/about/aiml-in-5g-challenge/) enables participants to connect with new partners in industry and academia – and new tools and data resources ­– to achieve goals set out by problem statements contributed by industry and academia. The Challenge is in focus throughout the year in a [series of AI for Good webinars](https://aiforgood.itu.int/eventcat/ai-ml-in-5g/).

The Challenge encourages and supports the growing community driving the integration of AI/ML in networks (through problem statements, webinars, roundtables, etc.) and at the same time enhances the community driving standardization work for AI/ML.

The first edition of the Challenge in 2020 welcomed over 1,300 participants from 62 countries. The second edition in 2021 welcomed over 1,600 participants from 82 countries and culminated with a Grand Challenge Finale on 14 December 2021. The 2021 edition of the Challenge was sponsored by Xilinx and the Republic of Korea’s Ministry of Science and ICT.

The 2021 winners were:

* 1st prize: Team BacalhauNET (Portugal) for "Lightning-Fast Modulation Classification with Hardware-Efficient Neural Networks"
* 2nd prize: Team PARANA (Brazil) for their solution to the "Graph Neural Network Challenge"
* Shared 3rd prize: Team FederationS (Ireland) for "Federated Learning for Spatial Reuse in a multi-BSS"; and Team Aaronica (Iran/Canada) for "Modulation Classification"

To share the solutions with the larger community, solutions submitted are shared as open source in several repositories on the Challenge GitHub: <https://github.com/ITU-AI-ML-in-5G-Challenge>.

In addition, the [ITU Journal on Future and Evolving Technologies](https://www.itu.int/en/journal/j-fet/Pages/default.aspx) published its first special issue on "AI/ML solutions in 5G and future networks" in October 2021, composed of 10 papers sharing solutions and learnings from participants and Challenge hosts in 2020 (i.e., the originators of the problem statements). Solutions and learnings from the 2021 edition of the Challenge will be shared by a second special issue on the topic to be published in 2022 – see [Call for Papers](https://www.itu.int/en/journal/j-fet/2022/004/Pages/default.aspx).

**AI for Road Safety:** ITU, the UN Secretary-General’s Special Envoy for Road Safety and the UN Secretary-General's Envoy on Technology together lead new initiative on AI for Road Safety in line with the UN General Assembly Resolution ([UN A/RES/74/299](https://undocs.org/en/A/RES/74/299)) on improving global road safety, which highlights the role of innovative automotive and digital technologies in this regard.

This initiative aims to leverage AI in enhancing the safe system approach to road safety. It will also support the achievement of SDG target 3.6 to halve the annual number of global deaths and injuries from road traffic accidents by 2030, and SDG target 11.2 to provide access to safe, affordable, accessible and sustainable transport systems for all by 2030.

The initiative launched during an [AI for Good webinar](https://aiforgood.itu.int/event/ai-for-road-safety/) on 6 October 2021. Activities in support of the initiative will include leveraging the ITU‑T Focus Group on AI for Autonomous and Assisted Driving. See [Press Release](https://www.itu.int/en/mediacentre/Pages/PR-2021-10-07-AI-Road-for-Safety.aspx).

## 3.2 Digital financial inclusion and fintech

**Financial inclusion:** The[Financial Inclusion Global Initiative (FIGI)](https://figi.itu.int) – led by ITU, the World Bank Group and the Committee on Payments and Market Infrastructures, with support from the Bill & Melinda Gates Foundation – has advanced research in digital finance and supported the acceleration of digital financial inclusion in developing countries. ITU led the FIGI Working Group on ‘Security, Infrastructure and Trust’ as well as the organization of FIGI symposia.

The 2021 online FIGI symposium (recordings accessible [here](https://figi.itu.int/programme/)) followed 2017 and 2019 FIGI symposia in Bangalore, India, and Cairo, Egypt.

**DFS Security Lab:** A new security lab set up at ITU under FIGI will continue to support regulators and innovators in ensuring the security and resilience of financial applications and enabling infrastructure. The [DFS Security Lab](https://figi.itu.int/figi-resources/dfs-security-lab) is a product of the ITU-led FIGI Working Group on "Security, Infrastructure and Trust".

The lab provides a structured approach to security audits of DFS applications. This structured approach targets greater consistency in the implementation of controls to protect personal data and the integrity and confidentiality of financial transactions.

Four main objectives:

The lab support government and industry in assessing compliance with established best practices in DFS security, establishing a security baseline for DFS applications, and adopting interoperable authentication technologies. It also organizes clinics for security professionals to exchange knowledge and stay up to date with the evolution of security risks and associated mitigation techniques.

The lab provides:

* Guidance to regulators in assessing the security of DFS infrastructure and conducting security audits of DFS applications
* Mechanisms for threat-intelligence sharing
* Guidance on implementing international standards for DFS security
* Assessments of cybersecurity preparedness across DFS value chains

The lab addresses the security of DFS applications running over legacy as well as cutting-edge network infrastructure, offering tests for DFS apps based on Unstructured Supplementary Service Data (USSD) and SIM Toolkit (STK), as well as tests for Android DFS apps are based on the Top 10 Mobile Risks from the Open Web Application Security Project (OWASP).

The lab conducted six [DFS Security Clinics](https://www.itu.int/en/ITU-T/webinars/dfs/sc/Pages/default.aspx) in the reporting period, sponsored by the Republic of Korea’s Ministry of Science and ICT:

* [Malawi](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20211208/Pages/default.aspx), 7-8 December 2021, hosted by the Malawi Communications Regulatory Authority
* [Eswatini](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20211129/Pages/default.aspx), 29-30 November 2021, hosted by the Eswatini Communications Commission
* [Nigeria](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20211117/Pages/default.aspx), 17-18 October 2021, hosted by the Nigerian Communications Commission
* [Zimbabwe](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20211027/Pages/default.aspx), 27-28 October 2021, hosted by the Postal & Telecommunications Regulatory Authority of Zimbabwe
* [Tunisia](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20211022/Pages/default.aspx), 22-23 October 2021, hosted by the Institut Supérieur des Etudes Technologiques en Communications de Tunis
* [Malawi](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20211012/Pages/default.aspx), 12-14 October 2021, hosted by the Malawi Communications Regulatory Authority

**Digital currency:** The new [Digital Currency Global Initiative](https://www.itu.int/en/ITU-T/extcoop/dcgi/Pages/default.aspx) is a collaboration between ITU and Stanford University established in July 2020. The Initiative is an open platform for dialogue and research on pilot implementations of digital currency, their use cases, applications and developing specifications for technical standards that will foster adoption, universal access, and ultimately financial inclusion.

Its main objectives are:

* Conduct further research on technical architecture, security, the technical implications and challenges in deployment caused by regulatory and policy requirements for central bank digital currency and other digital currencies, technology trends in digital currency and the use cases related to financial inclusion, operational efficiency and interoperability.
* Develop a set of metrics by which to evaluate the robustness of various digital currency technologies against the requirements set by various stakeholders.
* Identify areas for standardization to enable implementation of digital currency.
* Organize a conference on an annual basis to share information on best practices, technical standards and lessons learned on digital currency implementation.

Two webinars were held under the auspices of the Digital Currency Global Initiative in the reporting period:

* 23 November 2021: [Design of Wholesale Central Bank Digital Currency​](https://www.itu.int/en/ITU-T/webinars/dcgi/20211123/Pages/default.aspx)
* 19 November 2021: [Insights on Retail Central Bank Digital Currencies Implementation](https://www.itu.int/en/ITU-T/webinars/dcgi/20211119/Pages/default.aspx)

The upcoming [DC3 Conference: *From Cryptocurrencies to Central Bank Digital Currencies*](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2022/0125/Pages/default.aspx), 25-27 January 2022, will highlight the work of the Digital Currency Global Initiative as well as emerging industry trends and initiatives in digital currencies, particular with regard to:

* Sharing insights on the latest trends in central bank digital currency, cryptocurrency and stablecoins.
* Discuss emerging developments and areas where standards are needed for the architecture and interoperability of digital currencies and their integration with existing payment systems.
* Conduct deep-dive sessions on topics such as interoperability for central bank digital currencies and stablecoins and securing digital currency systems.
* Foster dialogue among digital currency ecosystem stakeholders and regulators on key lessons learned from digital currency pilot implementations.

## 3.3 Smart cities and communities

The [United for Smart Sustainable Cities (U4SSC)](http://www.itu.int/en/ITU-T/ssc/united/Pages/default.aspx) initiative is supported by 17 UN bodies with the aim of achieving SDG11: "Make cities and human settlements inclusive, safe, resilient and sustainable". The [sixth annual U4SSC meeting](https://www.itu.int/en/ITU-T/ssc/united/Pages/202112/meeting.aspx) was held on 7 December 2021 online.

Over 150 cities worldwide are evaluating their progress towards smart city objectives and the SDGs using [U4SSC Key Performance Indicators for Smart Sustainable Cities](https://www.itu.int/en/ITU-T/ssc/united/Pages/publication-U4SSC-KPIs.aspx) based on ITU standards. The results of the KPI evaluations are shared by [city snapshots, factsheets, verification reports](https://www.itu.int/en/ITU-T/ssc/united/Pages/publication-U4SSC-KPIs.aspx) and case studies.

The [U4SSC Implementation Programme](https://www.itu.int/en/ITU-T/ssc/united/Pages/U4SSC-IP.aspx) is supporting cities’ pursuit of the SDGs by working together with national administrations and city leaders to building a comprehensive approach to smart city development, looking at both KPI evaluations and wider national contexts for planning and action.

U4SSC is developing expert guidance on topics including:

* ICT-based smart city platforms support the digital transformation of public services and their integrated management.
* Cities’ resilience in the face of emergencies such as COVID-19 and routes to economic and financial recovery.
* Public procurement in the digital age to support city leaders in establishing effective processes for the procurement of ICT solutions for smart cities.
* Tools and mechanisms to finance smart city projects, benefiting from the contributions of a wide variety of smart city stakeholders in the public and private sectors.
* The potential for frontier technologies to contribute to smart city innovation, looking at smart-city use cases of technologies in fields such as AI and blockchain.

[U4SSC deliverables](https://www.itu.int/en/ITU-T/ssc/united/Pages/publications-U4SSC.aspx) published during the reporting period:

* Smart public health emergency management and ICT implementations (December 2021)
* Compendium of survey results on integrated digital solutions for city platforms around the world (December 2021)
* Digital solutions for integrated city management and use cases (December 2021)

ITU, together with other organizations and UN agencies, is running [series of webinars on"Digital transformation for cities and communities"](https://www.itu.int/en/ITU-T/webinars/Pages/dt4cc.aspx). The goal of this initiative is to increase collaboration with city stakeholders and share knowledge which may contribute to ITU-T standardization activities. It also acts as a channel to present activities and outcomes of ITU-T SG20. Seven webinars were held in the reporting period:

* 14 December 2021, Episode #12: Interoperability of IoT and satellite data for Earth observation supporting sustainable development, co-organized with Mandat International, and World Meteorological Organization
* 8 December 2021, Episode #11: Blockchain-based data management for supporting Internet of things and smart cities and communities, co-organized with Open & Agile Smart Cities, and United Nations University
* 7 December 2021, Episode #10: The role of digital technologies on aging and health, co-organized with Pan American Health Organization
* 6 December 2021, Episode #9: Addressing the Security Risks of Digital Transformation on IoT, co-organized with ITU-T SG17
* 18 November 2021, Episode #8: Network capabilities and emerging technologies to support IoT-enabled verticals, co-organized with China Information Communication Technologies Group, China Mobile, China Unicom, EADN, Huawei, OKI, and Tencent
* 2 November 2021, Episode #7: Crowdsourced Systems: A people-led paradigm, co-organized with Bournemouth University
* 1 November 2021, Episode #6: Smart City Platforms co-organized with China Information Communication Technologies Group, Electronics and Telecommunications Research Institute, and Spanish Association for Standardization

## 3.4 Green Standards Week

The [10th Green Standards Week (GSW)](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/gsw/202112/Pages/default.aspx) was held virtually from 14 to 16 December 2021. It discussed the latest e-waste management trends in Latin America. It also highlighted the role of international standards in achieving net-zero within the ICT sector and bringing sustainability to digital transformation in Latin America and worldwide.

The event also hosted the launch of a [case study (Spanish)](https://www.itu.int/en/publications/Documents/tsb/2021-Economia-Circular-Costa-Rica/index.html#p=1) sharing Costa Rica’s experience following the approach recommended by [Recommendation ITU-T L.1031](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14572) to achieve the e-waste targets of the Connect 2030 Agenda, targets that call for a 30 per cent increase in the global e-waste recycling rate and the percentage of countries with e-waste legislation to grow to 50 per cent. It also explores Costa Rica’s actions in line with the ITU standard [Recommendation ITU-T L.1032](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=13963), which provides guidelines and certification schemes for e-waste recyclers.

The case study was developed in collaboration by ITU, the Regional Centre of the Basel Convention for South America, and Costa Rica, within the UNIDO/GEF project on "Strengthening of National Initiatives and Enhancement of Regional Cooperation for the Environmentally Sound Management of Persistent Organic Pollutants (POPs) in waste electrical and electronic equipment (WEEE) in Latin American Countries".

Discussions were held in both English and Spanish.

ITU organized GSW 2021 in partnership with Ministry of Health, the Ministry of Science, Technology and Telecommunications of Costa Rica, UNIDO, UNEP DTU, the Secretariat of the Basel Convention, the Regional Centre of the Basel Convention for South America, and IDD LAC.

## 3.5 CxO meeting

High-level industry executives (CxOs) met with the senior management of the ITU Telecommunication Standardization Bureau to exchange views on industry priorities and related standardization activities in Dubai, UAE, 7 December 2021, co-hosted by Telecom Review and du. See CxO meeting [Communiqué](https://www.itu.int/en/ITU-T/tsbdir/cto/Documents/Communique_ITU_CxO_07.12.2021_f.pdf).

CxOs discussed industry priorities in fields including IMT-2020/5G, open RAN, light communication, AI/ML, environmental efficiency, supply chain security, and network infrastructure sharing – placing emphasis on their relationship with digital transformation.

CxOs shared views on means to support and capitalize on the growing synergy between industry and academia in the development and application of ICTs, particularly in the field of AI/ML.

CxOs also received an executive briefing on the outcomes of previous CxO meetings as well as preparations for the ITU World Telecommunication Standardization Assembly in Geneva, Switzerland, 1-9 March 2022, and the preceding ITU Global Standards Symposium, 28 February 2022.

# 4 Academia

[ITU Academia membership](https://www.itu.int/en/join/academia/Pages/default.aspx), [ITU Kaleidoscope conferences](https://www.itu.int/en/ITU-T/academia/kaleidoscope/Pages/default.aspx) and the [ITU Journal on Future and Evolving Technologies](https://www.itu.int/en/journal/j-fet/Pages/default.aspx) form key avenues for academics to engage in ITU’s work. The journal is the latest addition to ITU’s suite of services to academia.

## 4.1 ITU Journal

The [ITU Journal on Future and Evolving Technologie (J-FET)](https://www.itu.int/en/journal/j-fet/Pages/default.aspx), launched in September 2020, provides comprehensive coverage of communications and networking paradigms and is free of charge for both readers and authors. ITU J-FET addresses fundamental and applied research sharing new techniques, concepts, analyses, and tutorials while discussing implications of the latest research on policy, regulations, legal frameworks and the economy and society. It welcomes submissions at any time, on any topic within its scope, and publishes papers continuously throughout the year.

ITU J-FET published its first regular issue in December 2020, second regular issue in April 2021, and third regular issue in December 2021. Published papers are available to download free of charge from the [ITU Digital Library](https://www.itu.int/pub/S-JNL).

ITU J-FET published five special issues in 2021:

* [AI and machine learning solutions in 5G and future networks](https://www.itu.int/en/journal/j-fet/2021/005/Pages/default.aspx)
* [Internet of Everything](https://www.itu.int/en/journal/j-fet/2021/002/Pages/default.aspx)
* [Internet of Bio-NanoThings for health applications](https://www.itu.int/en/journal/j-fet/2021/001/Pages/default.aspx)
* [Terahertz communications](https://www.itu.int/en/journal/j-fet/2021/003/Pages/default.aspx)
* [Wireless communication systems in beyond 5G era](https://www.itu.int/en/journal/j-fet/2021/004/Pages/default.aspx)

ITU J-FET is currently welcoming submissions to nine new special issues to published in 2022:

* [AI-driven security in 5G and beyond](https://www.itu.int/en/journal/j-fet/2022/005/Pages/default.aspx)
* [Towards vehicular networks in the 6G era](https://www.itu.int/en/journal/j-fet/2022/001/Pages/default.aspx)
* [AI and machine learning solutions in 5G and future networks](https://www.itu.int/en/journal/j-fet/2022/004/Pages/default.aspx)
* [Future of networking beyond 2030](https://www.itu.int/en/journal/j-fet/2022/006/Pages/default.aspx)
* [Integrated and autonomous network management and control for 6G time-critical applications](https://www.itu.int/en/journal/j-fet/2022/002/Pages/default.aspx)
* [Digital continuum and next generation networks](https://www.itu.int/en/journal/j-fet/2022/007/Pages/default.aspx)
* [Emerging trends and applications in future communication networks](https://www.itu.int/en/journal/j-fet/2022/009/Pages/default.aspx)
* [Innovative network solutions for future services](https://www.itu.int/en/journal/j-fet/2022/003/Pages/default.aspx)
* [Intelligent surfaces and their applications towards wide-scale deployment](https://www.itu.int/en/journal/j-fet/2022/008/Pages/default.aspx)

A joint ITU-Tsinghua University Press journal on [Intelligent and Converged Networks](http://icn.tsinghuajournals.com/) was established in 2019 with the support of co-publishing agreement signed by ITU and Tsinghua University Press Ltd. All published papers are available on the [IEEE *Xplore* Digital Library](https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=9195266).

## 4.2 ITU Kaleidoscope academic conferences

The [ITU Kaleidoscope](https://www.itu.int/en/ITU-T/academia/kaleidoscope/Pages/default.aspx) series of peer-reviewed academic conferences – organized with the technical co-sponsorship of IEEE and the IEEE Communications Society (IEEE ComSoc) – calls for original research on topics of growing strategic relevance to ITU-T.

The 13th edition, [Connecting physical and virtual worlds](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Pages/default.aspx), was held online, 6-10 December 2021. The conference shared expert insights on the growing synergy between physical and virtual space and this synergy’s influence on art and culture.

**Papers accepted for presentation** at the conference explored: The prospects for future wireless networks; networking innovations for the Internet of Things (IoT) and industrial applications; new possibilities introduced by advances in augmented reality and machine learning; and the security dimensions of a world increasingly mirrored in cyberspace.

***The conference also featured keynote speeches, invited talks, special sessions and video demos, as well as coffee breaks hosting digitally enhanced art exhibitions and dance performances.***

**Keynotes** looked ahead towards mobile-connected intelligence, sustainability, and spectrum management in the 6G era. They also explored key ethical questions for the transition to smart cities and considered how future communications technology could engage all five human senses.

**Invited speakers** shared research on a serverless approach for IoT, an ITU standardization perspective on quantum key distribution networks for trust in 5G and beyond, and a proposal to accelerate the adoption of virtual reality in medical training.

**Two special sessions** explored the cultural dimensions of digital transformation, with the first considering the reciprocal relationship emerging between digital technologies and cultural heritage, and the second looking 20 years ahead to forecast the future of art, culture, and technology.

**Video demos** showcased 5G and beyond-5G system simulations, eco-friendly tethered drones to monitor electromagnetic fields, standardization bolstering cyber defence in Africa, and ways to discover security vulnerabilities in critical infrastructure.

**The 2021 winners were:**

1st prize: *Towards a robust new radio compatible with XR* **(**[Presentation](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Documents/Presentations/S1.2_1570738550%20presentation.pdf))

* **Yuzhou Hu** & **Jiajun Xu**
* **ZTE Corporation & State Key Laboratory of Mobile Network and Mobile Multimedia Technology, China**
* **Co-Authors:** Xiaoying Ma, Mengzhu Chen, Hong Tang and Jun Xu

2nd prize: Collaborative 5G multiaccess computing security: Threats, protection requirements and scenarios **(**[Presentation](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Documents/Presentations/S4.1_1570737909%20presentation.pdf))

* **Hongyang Zhang**
* **China Mobile, China**
* Co-Authors: Gang Zhao, Feng Zhang, Le Yu,Qin Qiu and Sijia Xu

Shared 3rd prize: Security vulnerability expressions: A technology for empowering novice practitioners around the world with security maturity capabilities ([Presentation](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Documents/Presentations/S4.2_1570748301%20presentation.pdf))

* **Jacques Francoeur**
* **Security Inclusion Now, USA**

Shared 3rd prize: Reinforcement learning for scheduling and MIMO beam selection using CAVIAR simulations ([Presentation](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Documents/Presentations/S6.3_1570747946%20presentation.pdf))

* **João Paulo Tavares Borges**
* Universidade Federal do Pará, Brazil
* Co-Authors: Ailton Pinto de Oliveira, Felipe Henrique Bastos e Bastos, Daniel Takashi Né do Nascimento Suzuki and Emerson Santos de Oliveira, Jr.; Lucas Matni Bezerra; Cleverson Veloso Nahum; Pedro dos Santos Batista; Aldebaro Barreto da Rocha Klautau, Jr.

Best video demonstration: *Enabling cyber defence in Africa through standardization* ([Abstract](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Documents/Demos/K-2021_VDT.1_abstract.pdf); [Video](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Pages/demos.aspx))

* **Mwende Njiraini** (DiploFoundation, Kenya) & **Racky Seye** (Ministry of Digital Economy and Telecommunications of Senegal, Senegal)

All papers accepted and presented at the conference are published in the [Kaleidoscope Proceedings](https://www.itu.int/pub/T-PROC-KALEI-2021) and the IEEE *Xplore* Digital Library. The best papers are also evaluated for potential publication in the IEEE Communications Standards Magazine. In addition, extended versions of selected papers are considered for publication in the [Journal of Standardisation​](https://journals.open.tudelft.nl/jos) or the [Journal of ICT Standardization](http://www.riverpublishers.com/journal.php?j=JICTS/2/2/jef).

# 5 Cooperation and coordination

TSB implements ITU-T Objective T.5 of the Strategic Plan of the Union, "Extend and facilitate cooperation with international, regional and national standardization bodies".

Memoranda of Understanding and Cooperation Agreements are listed and available on the relevant [web page](https://www.itu.int/en/ITU-T/extcoop/Pages/mou.aspx).

## 5.1 World Standards Cooperation

IEC, ISO, and ITU cooperate under the banner of the [World Standards Cooperation](https://www.worldstandardscooperation.org/).

Around 10% of ITU's standards are common or aligned texts with [ISO/IEC Joint Technical Committee 1 (Information Technology)](https://jtc1info.org/). Work of common interest benefits from the [ITU-ISO-IEC Standardization Programme Coordination Group](https://www.itu.int/en/ITU-T/extcoop/Documents/tor/ToR_SPCG.pdf) and the new [ITU-ISO-IEC Joint Task Force on Smart Cities](https://www.itu.int/en/myitu/News/2020/10/08/13/10/New-smart-city-standards-Joint-Task-Force-established-by-ITU-ISO-and-IEC).

[World Standards Day](https://www.worldstandardsday.org/home.html), 14 October: IEC, ISO, and ITU lead the celebrations of World Standards Day. "A Shared Vision for a Better World" was the theme of World Standards Day 2021, marking the start of a multi-year campaign aimed at raising awareness of how international standards contribute to the United Nations Sustainable Development Goals.

[International Standards Summit for People, Planet and Prosperity, 29 October 2021](https://www.worldstandardscooperation.org/what-we-do/g20/): IEC, ISO, and ITU issued a [joint declaration](https://eur01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.worldstandardscooperation.org%2Fwhat-we-do%2Fg20%2F&data=04%7C01%7CBULAY%40iso.org%7C195225c8f8cf4a2d1dd608d99a140418%7C8543418a200d4d6b88c979fb0b651354%7C0%7C0%7C637710233024490842%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=9g4DklKmM2tmQzzK4E28a4H%2FCqWtG1w98JjaIXIrt6w%3D&reserved=0) calling on all countries to recognize, support and adopt international standards in order to contribute directly to the three pillars of the Italian G20 Presidency: People, Planet and Prosperity.

The declaration highlights that, by referencing standards in policy, governments could significantly support employment, health and education (People), contribute to sustainability (Planet) and enable the economic resilience of businesses (Prosperity).

It also urged all countries to ensure that international standards and publications accelerate the successful achievement of the Paris Agreement, the United Nations Sustainable Development Goals and the United Nations Call for Action on Adaptation and Resilience.

The event was held under the aegis of the G20 Italian Presidency, with the contribution of the Italian Ministry of Economic Development and Ministry of Foreign Affairs. It was organized jointly by the [Italian Organization for Standardization (UNI)](https://www.uni.com/) and the [Italian Electrotechnical Committee (CEI)](https://www.ceinorme.it/en/cei-electrotechnical-italian-committee.html) together with IEC, ISO and ITU.

## 5.2 National and regional standardization organizations

TSB facilitates an ITU-T presence in activities arranged by other standards bodies, with a view to promoting other standards bodies' engagement with ITU-T workings groups, workshops and related ITU-T collaboration initiatives.

TSB’s efforts in this regard have strengthened the exchange of information between ITU-T and national and regional standards, supporting closer cooperation and collaboration.

Standardization bodies with which TSB has expanded cooperation include:

* African Regional Organization for Standardisation (ARSO)
* Pan American Standards Commission (COPANT)
* Pacific Area Standards Congress (PASC)
* South Asian Regional Standards Organization (SARSO)
* Cooperation Council for the Arab States of the Gulf (GCC) Standardization Organization (GSO).

## 5.3 Regional Organizations and ITU Regional and Area Offices

An overview of all WTSA regional preparatory meetings can be found on the [WTSA-20 web page](https://www.itu.int/en/ITU-T/wtsa20/prepmeet/Pages/default.aspx). The page is continuously updated and lists all relevant events.

At the initiative of the TSB Director, TSB has been organizing conference calls and face-to-face meetings on a regular basis with ITU’s Regional and Area Offices. The activity supports the coordination and efficiency of the activities, operations and events of ITU-T and TSB and also contributes to greater awareness of ITU-T standardization activities in all Regions.

## 5.4 ITU Sectors

TSAG maintains a close relationship with RAG and TDAG in order to develop synergies with the objective of strengthening coordination and cooperation among the three ITU Sectors on matters of mutual interest.

Three Inter-Sector Rapporteur groups (IRGs) work on items of interest to various ITU-T and ITU-R SGs.

* [IRG-AVA](https://www.itu.int/en/irg/ava): Intersector Rapporteur Group on Audiovisual Media Accessibility, among ITU-T SG9, ITU-T SG16 and ITU-R SG6. Meeting were held on 9 April 2021 and 23 September 2021.
* [IRG-AVQA](https://www.itu.int/en/irg/avqa): Intersector Rapporteur Group on Audiovisual Quality Assessment, among ITU-T SG12 and ITU-R SG6. A meeting was held on 9 June 2021, in conjunction with the Video Quality Expert Group (VQEG).
* [IRG-IBB](https://www.itu.int/en/irg/ibb): Intersector Rapporteur Group on Integrated Broadcast-Broadband, among ITU-T SG9, ITU-T SG16 and ITU-R WP 6B.

The Inter-Sector Coordination Team (ISCT) is composed of representatives of all three advisory groups, working to identify subjects of common interest to the three Sectors. It also seeks to identify the mechanisms necessary to strengthen cooperation and joint activities among the three Sectors, with particular emphasis on the interests of developing countries. In addition, the ITU Inter-Sectoral Coordination Task Force (ISC-TF) is coordinating activities among the three Bureaux. Both ISCT and of ISC-TF regularly report their progress to TSAG.

# 6 Membership

ITU-T membership maintained growth in 2021, welcoming 43 new members (10 Sector Members and 33 Associates), amounting to an overall net increase of 22 (as of 31 December 2021). In addition, a total of 18 new Academia members joined ITU in 2021.

43 of ITU-T’s Associates are participating under the reduced fee structure for SMEs.

## 6.1 Evolution of ITU-T membership

**New Sector Members in 2021:**

QRCrypto SA; New H3C Technologies Co., Ltd.; Zenaciti; Southern African Development Community (SADC); Organisation Internationale de la Francophonie – OIF; Inspur Tianyuan Communication Information System Co. Ltd.; Hewlett Packard Enterprise; Vivo Mobile Communication Co., Ltd; Semtech (International) AG; Mobile Communication Company of Iran (MCI).

**New Associates in 2021:**

BJT PARTNERS SAS (SG2); Airnity (SG2); iBasis Netherlands B.V. (SG2); Narayana OÜ (SG2); Eseye Ltd (SG2); Vast New Telecom SA (SG2); HMD Global Oy (SG2); Monty UK Global Limited (SG2); Webbing (SG2); World Mobile Group Ltd. (SG2); SkyFive AG (SG2); Svyazcom LLC (SG11); Net Vision Consultants Inc. (SG11); Sevana OU (SG12); Keysight Technologies, Inc. (SG12); Enablers DMCC (SG12); Mozark Pte Ltd. (SG12); Trace Media International FZ-LLC (SG13); TQ Delta (SG15); Hisense Broadband Multimedia Technologies Co., Ltd. (SG15); SiTime Corporation (SG15); Metanoia Communications Europe (SG15); Shenzhen SmartMore Technology Co., Ltd. (SG16); Chongqing Changan Automobile Co., Ltd. (SG16); Mimi Hearing Technologies GmbH (SG16); Huayou Digital Culture Technology Research Institute (Xiamen) Co., Ltd (SG16); KAMALEON (SG16); Dust Mobile (SG17); Insikt Intelligence (SG17); SAMA PARTNERS Business Solutions SARL (SG17); Companhia de Telecomunicações de Macau S.A.R.L. (SG20); Augmentcity AS (SG20); Citibeats (SG20)

**New Academia in 2021:**

Center for Technical and Higher Education (CETYS University); Shanghai Advanced Research Institute; University of the West of Scotland; Centro México Digital; EU Business School; Kadir Has University; United Arab Emirates University; University of Thessaly; Shenzhen University; University of Hawaii; State Grid Jiangsu Electric Power Research Institute; State Grid Zhejiang Electric Power Research Institute; Konrad-Adenauer-Stiftung; State Grid Beijing Electric Power Research Institute; University of Science and Technology Beijing; National University of Singapore; Universitat Politècnica de Catalunya; Centre Tecnològic de Telecomunicacions de Catalunya (CTTC)

**Total ITU-T Sector Members, Associates and Academia (31 December 2009 – 31 December 2021):**

The following table and figure illustrate the evolution of ITU-T membership from 31 December 2009 to 31 December 2021 (noting that the Academia membership category opened in 2011).

**Table 1: Evolution of ITU-T membership from 31 December 2009 to 31 December 2021**

|  | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sector Members | 290 | 261 | 263 | 267 | 274 | 272 | 266 | 253 | 257 | 257 | 268 | 273 | 269 |
| Associates | 101 | 111 | 119 | 128 | 130 | 132 | 132 | 128 | 137 | 157 | 184 | 195 | 221 |
| Academia | ‑ | ‑ | 23 | 40 | 58 | 73 | 95 | 107 | 124 | 153 | 159 | 161 | 161 |
| TOTAL | 391 | 372 | 405 | 435 | 462 | 477 | 493 | 488 | 518 | 567 | 611 | 629 | 651 |

NOTE – Some of the figures in the table above have been subject to retroactive changes

**Figure 1 – Evolution of ITU-T membership from 31 December 2009 to 31 December 2021**

NOTE – The Academia category was created in 2011.

## 6.2 Reduced Associate fee structure for SMEs

43 of ITU-T’s Associates are participating under the reduced fee structure for SMEs. The following ITU-T Associates have joined under this fee category in 2021:

| **Organization** | **Study Group** | **Area of Interest** |
| --- | --- | --- |
| BJT PARTNERS SAS | SG2 | International numbering resources |
| Airnity | SG2 | International numbering resources |
| Narayana OÜ | SG2 | International numbering resources |
| SkyFive AG | SG2 | International numbering resources |
| World Mobile Group Ltd. | SG2 | International numbering resources |
| Webbing | SG2 | International numbering resources |
| Svyazcom LLC | SG11 | Combating counterfeit and stolen telecommunication/ICT devices |
| Net Vision Consultants Inc. | SG11 | Network analysis and related systems |
| Sevana OU | SG12 | Call quality monitoring, VoIP Call, audio, voice quality testing |
| Enablers DMCC | SG12 | Perceptual-based objective methods for voice quality measurements & virtualized deployment of recommended methods for network performance, QoS and QoE assessment and frameworks for diagnostic functions  |
| Mozark Pte Ltd. | SG12 | Network experience measurement |
| Trace Media International FZ-LLC | SG13 | General interest in Study Group activities |
| Metanoia Communications Europe | SG15 | DSL related activities |
| TQ Delta | SG15 | DSL related activities |
| KAMALEON | SG16 | Accessibility and Digital Health related activities |
| Huayou Digital Culture Technology | SG16 | Digital culture-related systems and services |
| Mimi Hearing Technologies GmbH | SG16 | Safe listening related activities |
| Dust Mobile | SG17 | Secure mobile communications |
| Insikt Intelligence | SG17 | General interest in Study Group activities |
| SAMA PARTNERS Business Solutions SARL | SG17 | General interest in Study Group activities |
| Augmentcity AS | SG20 | Study Group work activities related to U4SSC Implementation Programme and FG-AI4EE |
| Citibeats | SG20 | Study Group activities related to KPIs for Smart Cities |

# 7 Virtual meetings

2021 has again highlighted the value of ITU-T’s electronic working environment. Virtual meetings and electronic working methods have come to form the principal platform for ITU standardization work as part of the global response to COVID-19. ITU members engaged in standards development and preparations for the ITU World Telecommunication Standardization Assembly (WTSA) are making optimal use of the personalized [MyWorkspace](https://www.itu.int/net4/ITU-T/myworkspace/) platform and associated TSB services and tools such as MyMeetings.

MyMeetings is the main platform for ITU-T statutory meetings. MyMeetings is also used to host Rapporteur Group Meetings and non-statutory events, such as webinars. MyMeetings features important elements found in ITU-T physical meetings, including participants’ list and affiliation, multilingual support, moderated floor request and captioning. Several layers of access control ensure that only registered participants gain access to statutory meetings.

Other electronic meeting tools, such as Zoom, are also provided by TSB for hosting fully online (virtual) and any on-demand ad-hoc meetings.

Statistics on e-meetings for the 2019, 2020 and 2021 (until end October) are shown below.

* 2019: 2,110 e-meetings; 17,657 attendees
* 2020: 4,220 e-meetings; 77,693 attendees
* 2021 (end October): 2,992 e-meetings; 69,532 attendees



Figure 2 – Remote participation and e-meetings

## 7.1 Study group meetings

ITU-T study group meetings held virtually from to October to December 2021:

* [SG3](https://www.itu.int/en/ITU-T/studygroups/2017-2020/03), 13-17 December 2021
* [SG15](https://www.itu.int/en/ITU-T/studygroups/2017-2020/15), 6-17 December 2021
* [SG11](https://www.itu.int/en/ITU-T/studygroups/2017-2020/15), 1-10 December 2021
* [SG13](https://www.itu.int/en/ITU-T/studygroups/2017-2020/13), 29 November - 10 December 2021
* [SG9](https://www.itu.int/en/ITU-T/studygroups/2017-2020/09), 15-24 November 2021
* [SG2](https://www.itu.int/en/ITU-T/studygroups/2017-2020/02), 8-19 November 2021
* [SG12](https://www.itu.int/en/ITU-T/studygroups/2017-2020/12), 12-21 October 2021
* [SG20](https://www.itu.int/en/ITU-T/studygroups/2017-2020/20), 11-21 October 2021

## 7.2 Workshops and symposia

Participation in ITU workshops and symposia has increased considerably in 2021. With all ITU-T workshops and symposia held virtually, open ITU-T events are welcoming a greater number and diversity of participants.

ITU workshops and symposia organized from October to December 2021:

* [AI for Good](https://aiforgood.itu.int/), Virtual, year-round
* [10th Green Standards Week](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/gsw/202112/Pages/default.aspx), Virtual Meeting, 14-16 December 2021
* [DT4CC Webinar Series - Episode #12: Interoperability of IoT and satellite data for Earth​ observation supporting sustainable development](https://www.itu.int/en/ITU-T/webinars/20211214/Pages/default.aspx), Virtual Meeting, 14 December 2021
* [Digital Financial Services (DFS) Security Clinics](https://www.itu.int/en/ITU-T/webinars/dfs/sc/Pages/default.aspx), Virtual Meeting, 12 October - 8 December 2021
* [DT4CC Webinar Series - Episode #11: Blockchain-based data management for supporting Internet of things and smart cities and communities](https://www.itu.int/en/ITU-T/webinars/20211208/Pages/default.aspx), Virtual Meeting, 8 December 2021
* [DT4CC Webinar Series - Episode #10: The role of digital technologies on aging and health](https://www.itu.int/en/ITU-T/webinars/20211207/Pages/default.aspx), Virtual Meeting, 7 December 2021
* [Sixth Meeting of the United for Smart Sustainable Cities Initiative (U4SSC),](https://www.itu.int/en/ITU-T/ssc/united/Pages/202112/meeting.aspx) Virtual Meeting, 7 December 2021
* [ITU Kaleidoscope 2021 Conference](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2021/Pages/default.aspx), Virtual Meeting, 6-10 December 2021
* [DT4CC Webinar Series - Episode #9: Addressing the Security Risks of Digital Transformation on IoT](https://www.itu.int/en/ITU-T/webinars/20211206/Pages/default.aspx), Virtual Meeting, 6 December 2021
* [ITU/WHO Workshop on "Safe listening in e-sports and video gaming: identifying use-cases and requirements"](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2021/1202/Pages/default.aspx), Virtual Meeting, 2 December 2021
* [ITU Workshop on "Improving the security of signalling protocols"](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2021/1129/Pages/default.aspx), Virtual Meeting, 29 November 2021
* [2nd Joint ITU/WHO Workshop on Digital COVID-19 Certificates](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2021/1126/Pages/default.aspx), Virtual Meeting, 26 November 2021
* [Digital Currency Global Initiative Webinars,](https://www.itu.int/en/ITU-T/webinars/dcgi/Pages/default.aspx) Virtual Meeting, 19-23 November 2021
* [ITU Workshop on "The Future of Television for Europe"](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2021/1119/Pages/default.aspx), Virtual Meeting, 19 November 2021
* [DT4CC Webinar Series - Episode #8: Network capabilities and emerging technologies to support IoT-enabled verticals](https://www.itu.int/en/ITU-T/webinars/20211118/Pages/default.aspx), Virtual Meeting, 18 November 2021
* [QIT Webinar Series - Episode 5: "Joint Symposium on Quantum Photonic Integrated Circuits"](https://www.itu.int/en/ITU-T/webinars/qit/20211102/Pages/default.aspx), Virtual Meeting, 2 November 2021
* [DT4CC Webinar Series - Episode #7: Crowdsourced Systems: A people-led paradigm](https://www.itu.int/en/ITU-T/webinars/20211102/Pages/default.aspx), Virtual Meeting, 2 November 2021
* [DT4CC Webinar Series - Episode #6: Smart City Platforms](https://www.itu.int/en/ITU-T/webinars/20211101/Pages/default.aspx), Virtual Meeting, 1 November 2021
* [ISO, IEC, ITU, UNECE webinar on e-business and blockchain](https://www.iso.org/blockchain-ebusiness-webinar.html), Virtual Meeting, 1 November 2021
* [Dialogue on Sustainable Digital Transformation in Asia and the Pacific](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/sg05rg/sdtd/20211019/Pages/default.aspx), Virtual Meeting, 19 October 2021.

# 8 Bridging the standardization gap

ITU's Bridging the Standardization Gap (BSG) programme improves the capacity of developing countries to participate in the development and implementation of international ICT standards.

WTSA-16 agreed an Action Plan to address further the disparity in standardization between developed and developing countries, including least-developed countries, Small Island Developing States (SIDS) and countries with economies in transition.

The revamped BSG Programme is structured around five pillars, responding to WTSA Resolution 44. The five pillars of the BSG programme include: Engagement, know-how, community, awareness, and partnering:

1. **Engagement** is about facilitating participation in standards development. This includes fellowship and mentorship programmes and tools for remote participation.
2. **Know-how** covers the development of skills and capabilities for standards-making. This includes standards-making effectiveness sessions, video tutorials and e-learning courses.
3. **Community** focused on empowerment at regional and national levels. Regional Groups within ITU-T SGs are a prime example, ensuring that standards-making is inclusive of the needs of all regions.
4. **Awareness** covers information sharing, using ITU-T publications on a wide range of topics as well as Regional and Inter-Regional standardization forums.
5. **Partnering** is about mobilizing resources and fostering collaboration.



Figure 3 - Five pillars of the BSG Programme

**BSG hands-on training sessions:** ITU-T regularly carries out 'BSG Hands-On SG effectiveness training' in response to WTSA Resolution 44. These trainings focus on the development of practical skills to maximize the effectiveness of developing countries' participation in the ITU-T standardization process, covering topics including strategies for participation in SGs, drafting contributions to meetings, presenting proposals, collaborative working methods, building consensus and utilization of TSB tools and services.

These training sessions have been attended by over 750 delegates since they were introduced in 2019. The following virtual BSG trainings have been held in 2021:

* 12 February 2021 – BSG Training for SG13
* 16 March 2021 – BSG Training for SG11
* 22 April 2021 – BSG Training for SG17
* 6 May 2021 - BSG Training for SG20 and SG5
* 10 May 2021 – BSG Training for SG2
* 26 August 2021 – BSG Training for SG17
* 4 October 2021 – BSG Training for SG20 and SG5
* 30 November 2021 – BSG Training for SG11 and SG13

**BSG training on services and tools:** On occasion, TSB also offers trainings on the use of TSB services and tools. These trainings introduce services and tools including remote participation, MyWorkspace and publications. Such BSG trainings facilitate more active and efficient participation in ITU-T work, particularly in view of the upcoming WTSA-20. For more on TSB services and tools, see section 10.

**Regional groups:** Regional groups within ITU-T SGs have proven effective mechanisms to coordinate regional contributions to ITU and increase the number and quality of technical contributions from developing countries. Stimulating effective participation in ITU-T SGs, regional groups play a key role in bridging the standardization gap between developed and developing countries.

ITU-T hosts 25 regional groups:

* Nine for Africa (SGs 2 (Africa; East Africa), 3, 5, 11, 12, 13, 17, and 20)
* Four for the Americas (SGs 2, 3, 5, and 20)
* Five for the Arab States (SGs 2, 3, 5, 17, and 20)
* Two for Asia and the Pacific (SGs 3 and 5)
* One for Europe and the Mediterranean Basin (SG3)
* Four for Eastern Europe, Central Asia and Transcaucasia (SGs 3, 11, 13, and 20).

**Regional Standardization Forums:** [Regional Standardization Forums (RSFs)](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/bsg/Pages/default.aspx) provide tutorials on ITU-T working methods as well as more technically-oriented themes such as human exposure to electromagnetic fields, quality of service, smart water management, international mobile roaming, mobile financial services, digital identity, big data, and security and trust.

RSFs are held in conjunction with meetings of regional groups to improve the alignment of RSF discussions and the priorities of ITU-T SGs. RSFs also raise awareness of ITU standardization activities through the participation of key decision-makers (Prime Ministers, Ministers, Heads of Regulators, CEOs, etc.).

**National Standardization Secretariats:** ITU-T’s [new Guidelines for National Standardization Secretariats (NSS)](https://www.itu.int/en/ITU-T/gap/Documents/nss-rep-may.pdf) take into account the membership feedback on the Guidelines first published in 2014. The Guidelines set out a number of options for developing national procedures and processes to support effective participation in the ITU-T standards-development process. An NSS, as described by the Guidelines, is the full set of arrangements by which participation in and contributions to ITU-T are coordinated within a country.

An extensive set of functions that an NSS could perform are presented, enabling a country to select functions and organizational arrangements in a modular fashion, considering factors such as its ICT standardization policies; the number and type of organizations with an interest in ICT standardization in the country (e.g., number of service providers, equipment manufacturers, and academic and research institutes); and the level of participation in ITU-T SGs (e.g., whether as an initiator of work items, active contributor or observer in one or more ITU-T SGs).

**e-Learning courses:** One of the BSG measures adopted under WTSA Resolution 44 calls for the exploration of e-learning channels for training on ITU-T Recommendations. These training courses are available on the ITU Academy website at <http://academy.itu.int>.

**SG mentoring programme:** In 2011, a mentoring programme for ITU-T SGs was introduced. The objective of the mentoring programme is to provide a contact point to assist new delegates with the working methods of ITU-T and to facilitate participation and contributions from developing countries. It has since featured as an important part of the work of ITU-T SGs and TSAG.

**Technical papers:** A series of Technical Papers and Technical Reports provide additional information for developing countries on best practices in implementing ITU-T Recommendations. See the Technical Reports [web page](https://www.itu.int/pub/T-TUT).

**Fellowships:** Fellowships provide financial support to ITU-T delegates from eligible developing countries to assist their participation in ITU-T meetings, however no fellowships are currently being awarded in the virtual meeting environment called for by the COVID-19 pandemic.

# 9 Publications

## 9.1 Recommendations and Supplements

Over 4,000 pages of ITU-T Recommendations and Supplements were published between October and December 2021. Figure 4 illustrates the number of Recommendations (including Supplements) published per year since 2016.

All major editions of ITU-T Recommendations continue to be converted to the reflowable ePub format, and are published for free download alongside the usual PDF format. The ePub format allows users to read the Recommendations on devices of different screen sizes, and also to apply functions such as bookmarks, notes and highlights.

As approved by TSAG, most corrigenda and amendments to ITU-T Recommendations are now integrated into the main edition. The changes introduced by the amendment or corrigendum are shown with revision marks.

The ITU product "ITU-T Recommendations and selected Handbooks" continues to be distributed on a quarterly basis as a USB key. This product represents a tool of great value to standards developers and implementers as a consolidated archive of the over 4,000 ITU-T standards in force.



**Figure 4 – Number of Recommendations, amendments and Supplements**
**published per year since 2016**

## 9.2 Official languages of the Union on an equal footing

The Standardization Committee for Vocabulary (SCV), composed of ITU-T members expert in all the official languages, serves as focal point to ITU-T SGs in terminology-related matters. SCV guides the adoption of terms and definitions in ITU-T Recommendations in accordance with WTSA Resolution 67.

TSB continues to collect all new terms and definitions proposed by ITU-T SGs, entering them into the online ITU Terms and Definitions database.

As requested by WTSA Resolution 67, TSB continues to translate all Recommendations approved under the Traditional Approval Process (TAP) and all TSAG reports.

In addition, 12 Recommendations approved under the Alternative Approval Process (AAP) were translated in 2021 in accordance with requests received from ITU-T SGs and linguistic groups, and within the available budget.

# 10 Services and tools

Electronic working methods offer crucial support to members engaged in ITU-T standardization work. TSB is continuously developing new applications and services, while enhancing existing services, to maintain and expand ITU-T's advanced electronic working environment.

## 10.1 ITU-T databases

Following databases are made available for ITU-T delegates and secretariat staff:

* [ITU-T Work Programme](http://www.itu.int/ITU-T/workprog)
* [ITU-T A.4, A.5 and A.6 recognized organizations](https://www.itu.int/en/ITU-T/extcoop/Pages/sdo.aspx)
* [ITU-T AAP](https://www.itu.int/ITU-T/aap/AAPSearch.aspx) & [TAP](https://www.itu.int/net/ITU-T/lists/t-approval.aspx)
* [ITU-T Recommendations](http://www.itu.int/itu-t/recommendations)
* [ITU-T Liaison Statements](https://www.itu.int/net/itu-t/ls/ils.aspx?to=3936&meeting=T17-TSAG-211025)
* [ITU-T Patents and Software Copyrights](http://www.itu.int/ipr/)
* [ITU Product Conformity Database](http://www.itu.int/net/itu-t/cdb/ConformityDB.aspx)
* [ITU-T Formal Descriptions and Object Identifiers](http://www.itu.int/ITU-T/formal-language/index.html)
* [ITU-T Test Signals](http://www.itu.int/net/itu-t/sigdb/menu.htm)
* [ITU-T Terms & Definitions](http://www.itu.int/ITU-R/go/terminology-database)
* [International Numbering Resources](http://www.itu.int/ITU-T/inr/index.html) (See section 10.6 for more details)
* [ICT standards landscape](https://www.itu.int/net4/ITU-T/landscape#?topic=0&workgroup=1&searchValue=&page=1&sort=Revelance):
	+ Access Network Transport Standards
	+ Cloud Computing
	+ Home Network Transport Standards
	+ ICT Security Standards
	+ IMT-2020 and beyond (and [Software-Defined Networking (SDN)](https://www.itu.int/net4/ITU-T/landscape))
	+ IoT & Smart Sustainable Cities Standards
	+ ITS Communication Standards.

## 10.2 MyWorkspace

[MyWorkspace](https://www.itu.int/myworkspace/) is a user-friendly mobile platform that centralizes a set of applications and services developed to strengthen electronic working methods for the work of ITU-T, as stated in WTSA Resolution 32. Since the first version was released in 2017, more than 4000 users have visited it, with an average of 500 visits per month. Secure access to MyWorkspace is enabled through ITU User Account (TIES) credentials.

The following applications and services are available in MyWorkspace:

* [ITU Translate](https://www.itu.int/myworkspace/#/Translate): Machine translation tool based on neural network, trained in-house on ITU documents official translations and supporting all six (6) UN official languages.
* [MyMeetings](https://www.itu.int/myworkspace/#/MyMeetings): Remote participation service based on an open-source solution and customized in-house to support requirements of both statutory and non-statutory ITU-T meetings.
* Documents:
	+ - [MyDocuments](https://www.itu.int/myworkspace/#/Documents/MyDocuments/meeting=T17-TSAG-211025&search=&type=&sources=&questions=): Simplified access to Study Group documents, per meeting, with multiple sorting and selection filters and full text search, and automatic translation from English into 5 others official ITU languages (available on request).
		- [Suggested documents](https://www.itu.int/myworkspace/#/Documents/Suggested-Documents): A proposed list of documents based on pre-set user interests, with the option to bookmark favourites.
* [Calendar](https://www.itu.int/myworkspace/#/Calendar): Monthly calendar view of all ITU events with filters on ITU sectors and ITU-T working groups, with detailed information.
* [MyEvents](https://www.itu.int/myworkspace/#/Myevents): Events management platform, which provides real time ITU-T events agenda, list of registered participants, speakers and exhibitors, as well as a ‘matchmaking’ function to enable networking among participants.
* [Mailing list](https://www.itu.int/myworkspace/#/Mailing): Subscription management with search functionality.
* [Community](https://www.itu.int/myworkspace/#/Community): MyWorkspace user’s directory.
* [ITU-T Cloud](http://tsbcloud.itu.int): ITU premises storage service allowing users to share and exchange up to 10 GB of files per user.
* [Profile](https://www.itu.int/myworkspace/#/profile): User personal information and interests.

## 10.3 ITU-T services & tools

The [Electronic Working Methods (EWM) webpage](https://www.itu.int/en/ITU-T/ewm/Pages/default.aspx) keeps the ITU-T community up to date with the latest available tools and service enhancements, which it now summarises more clearly. The [Announcements and Updates webpage](https://www.itu.int/en/ITU-T/ewm/Pages/EWM-Updates.aspx) now regularly presents service changes. The Electronic Working Methods section of the [ITU-T Resources webpage](https://www.itu.int/en/ITU-T/info/Pages/resources.aspx) provides more useful links to the most common tools.

## 10.4 Document Management System for Rapporteur Groups

The Microsoft SharePoint-based Document Management System for ITU-T Rapporteur Group Meetings (RGMs) has been used extensively by the majority of ITU-T SGs, notably SGs 2, 3, 9, 11, 13, 15, 16, 17 and TSAG. Feedback from Rapporteurs drives the continuous improvement of the RGM system.

Current and past RGM meetings can be accessed at <http://itu.int/go/itu-t/rgm>

A comprehensive support and FAQs page offering RGM tips and best practices is available at <http://itu.int/go/itu-t/rgm-support>

A detailed online user guide for the RGM System, including video tutorials, is available at <http://itu.int/go/itu-t/rgm-guide>

The RGM system is one of several services available in the ITU-T SharePoint collaboration sites. These sites are restricted to ITU-T members and can be accessed using an ITU User Account (TIES).

## 10.5 International Numbering Resources (INRs)

ITU assigns about two-dozen types of International Numbering Resources (INRs), either directly or indirectly.

Notifications of national numbering/identification plan updates and assignments or reclamations of national numbering/identification resources are received and published in the [ITU Operational Bulletin](http://www.itu.int/pub/T-SP-OB). The ITU Operational Bulletin is published in the six official languages of the Union twice a month. Some 20 annexes are maintained on numbers and codes allocated in accordance with the following recommendations:

* ITU-T E.164 "The international public telecommunication numbering plan"
* ITU-T E.118 "The international telecommunication charge card"
* ITU-T E.212 "The international identification plan for public networks and subscriptions"
* ITU-T E.218 "Management of the allocation of terrestrial trunk radio Mobile Country Codes"
* ITU-T Q.708 "Assignment procedures for international signalling point codes"

## 10.6 ITU-T SharePoint collaboration sites

The ITU-T SharePoint collaboration sites enable participants in ITU-T working groups to conduct online discussions, work on projects, schedule meetings and manage and store documents in a secure shared environment.

The home of ITU-T SharePoint collaboration sites can be accessed at: <https://extranet.itu.int/sites/ITU-T/>.

A selection of notable collaboration sites is listed below:

* ITU-T SGs (Study Period 2017-2021) (<https://extranet.itu.int/sites/itu-t/studygroups/2017-2020>)
* United for Smart Sustainable Cities (U4SSC) (<https://extranet.itu.int/sites/itu-t/initiatives/U4SSC/>)
* Security, Infrastructure and Trust Working Group (SIT WG) (<https://extranet.itu.int/sites/itu-t/initiatives/sitwg/>)
* FG-AI4AD – ITU-T Focus Group on Autonomous and Assisted Driving (<https://extranet.itu.int/sites/itu-t/focusgroups/ai4ad>)
* FG-AI4EE – Focus Group on Environmental Efficiency for AI and other Emerging Technologies
(<https://extranet.itu.int/sites/itu-t/focusgroups/ai4ee/>)
* FG-AI4H – ITU-T Focus Group on AI for Health (<https://extranet.itu.int/sites/itu-t/focusgroups/ai4h/>)
* FG-AN – ITU-T Focus Group on Autonomous Networks (<https://extranet.itu.int/sites/itu-t/focusgroups/an/SitePages/Home.aspx>)
* FG-AI4NDM – ITU-T Focus Group on Artificial Intelligence for Natural Disaster Management (<https://extranet.itu.int/sites/itu-t/focusgroups/ai4ndm/SitePages/Home.aspx>)
* FG-QIT4N – ITU-T Focus Group on Quantum Information Technology for Networks (<https://extranet.itu.int/sites/itu-t/focusgroups/qit4n>)
* FG-VM – ITU-T Focus Group on Vehicular Multimedia
(<https://extranet.itu.int/sites/itu-t/focusgroups/vm/>)
* JVDS – ITU-T SG16 & ISO TC22/SC31/WG8 Joint Project Team on Vehicle Domain Service (<https://extranet.itu.int/sites/itu-t/jointgroups/jvds/>)
* IRG-AVA - Intersector Rapporteur Group on Audiovisual Media Accessibility (<https://extranet.itu.int/sites/irg/ava/>)
* CASC – ITU-T Conformity Assessment Steering Committee
(<https://extranet.itu.int/sites/itu-t/studygroups/2017-2020/sg11/casc/>)
* Pathway #1: Circular Design (<https://extranet.itu.int/sites/itu-t/initiatives/circulardesign>)
* Digital Currency Global Initiative (<https://extranet.itu.int/sites/itu-t/initiatives/dcgi>)
* Project on E-waste (<https://extranet.itu.int/sites/itu-t/initiatives/E-waste>)
* Focal points and coordinators for WTSA-20 from regional organizations (<https://extranet.itu.int/sites/itu-t/wtsa-20/prepmeet/Lists/ContactSheet/DefViewContacts.aspx>)
* [Numbering Applications Monitor](https://extranet.itu.int/sites/itu-t/studygroups/2017-2020/sg2/SitePages/Numbering%20Applications%20Monitor.aspx)

A support site containing a knowledge base of FAQs and user guides on the various SharePoint services is available at: <https://extranet.itu.int/ITU-T/support/>.

Most of the collaboration sites are restricted to ITU-T members, accessed using an ITU User Account (TIES). Certain collaboration sites are open to non-members, accessed using non-member ITU User Accounts.

# Appendix I – List of approved texts and texts undergoing approval

NOTE – Corrigenda are not listed here.

I.1.1 G.fast and DSL: Breathing new life into existing copper infrastructure

**ITU-T G.994.1 Amd.1 “Handshake procedures for digital subscriber line transceivers - Amendment 1”** (under approval) includes the following new material

– Add codepoints for the support of G.fastback Recommendation.

**ITU-T G.997.2 Amd.3 “Physical layer management for G.fast transceivers - Amendment 3”** (under approval) integrates the Amendment 1 and 2 of ITU-T Rec. G.997.2 and includes the following new material:

– Managed objects for RMCR.

– Annex X, Annex D and Annex T of ITU-T G.9701 diagnostics and monitoring objects

– A new Annex B containing additional managed object for the support of G.9702.

In addition, it corrects the following items:

– A typological inconsistency in the naming of the persistency managed objects.

**ITU-T G.997.3 Amd.1 “Physical layer management for MGfast transceivers - Amendment 1”** (under approval) adds the following new material:

– Annex D and Annex T of ITU-T G.9711 diagnostics and monitoring objects

In addition, it corrects the following items:

– The description of the RMCR success counters in Table 7-9.

– A typological inconsistency in the naming of the persistency managed objects.

**ITU-T G.9701 (2019) Amd.4 “Fast access to subscriber terminals (G.fast) – Physical layer specification: Amendment 4”** (under approval) includes support for DTA diagnostics and monitoring, adds RMCR monitoring primitives, and corrects various deficiencies.

**ITU-T G.9702 “Transceiver and system specifications for backhaul applications based on G.fast”** (under approval) specifies means to support Distribution Point Unit - Fast Backhaul (DPU-FB), which uses the G.fast technology for both the backhaul connections (back lines) and the connections to the G.fast NTs (front lines) in an environment where crosstalk cancelling between the wire-pairs of the back lines and wire-pairs of the front lines is required in addition to the FEXT cancellation provided by G.fast. This Recommendation is written as a delta Recommendation relative to [ITU T G.9701]. For the clauses that have been changed, this Recommendation contains complete replacement text (unless explicitly indicated). For the clauses that have not been changed, this Recommendation contains only the clause heading, with reference to [ITU T G.9701].

**ITU-T G.9711 Amd.1 “Multi-gigabit fast access to subscriber terminals (MGfast) – Physical layer specification”** (under approval) specifies or corrects:

- DBR-PT and bidirectional DBR for facilitating the acceleration of DBR,

- diagnostics and monitoring of DTA,

- downstream PSD objects common to all links in the P2MP group,

- upstream frame configuration request, and

- support of DTFO in P2MP TDMA/FDMA.

I.1.2 Ultra-high-speed optical access

**ITU-T G.984.5 (revised) “Gigabit-capable passive optical networks (GPON): Enhancement band”** (under approval) defines wavelength ranges reserved for additional service signals to be overlaid via wavelength division multiplexing (WDM) in passive optical networks (PON) for maximizing the value of optical distribution networks (ODNs).

**ITU-T G.988 “ONU management and control interface (OMCI) specification - Amendment 5”** (under approval) adds:

• Support of High Speed PON (HSP)

• Support of User Services Platform (USP).

**ITU-T G.9805 “Coexistence of Passive Optical Network Systems”** (under approval) presents three methods for the coexistence of multiple PON generations on a common ODN: Coexistence element (CE), multi-PON module (MPM), and splitter-based. These allow the reuse of already deployed fibre and splitters when evolving a legacy PON to a higher capacity. Methods for calculating required isolation for Coexistence element, filter considerations for HSP and XG(S)-PON OLT, and optical interface parameters for GPON/XG(S)-PON MPM supporting Class B+, C+ and D OPL are also described.

I.1.3 Optical fibres

**ITU-T G.9803 Amd.2 “Radio over fibre systems - Amendment 2”** (under approval) develops a new type of optical access network based on radio-over-fibre (RoF) technologies. This Recommendation describes a fundamental architecture and requirements for RoF systems. This Recommendation specifies the system overview, physical layer requirements, system requirements and co-existence with passive optical network (PON) for analogue RoF systems supporting the international mobile telecommunication (IMT) system over optical distribution network (ODN). This Recommendation also describes the system overview and physical layer requirements for analogue RoF systems supporting the foreign object debris (FOD) detection system.

**ITU-T G.Suppl.55 (revised) “Radio-over-fibre (RoF) technologies and their applications”** (under publication) introduces the general radio-over-fibre (RoF) technology types and their applications in optical access networks. In general, RoF technologies can be classified into two categories, which are analogue RoF and digital RoF. It is noted that the RoF concept shown in this Supplement can be commonly used for both analogue RoF and digital RoF. The description of RoF network models is also considered for analogue RoF and digital RoF.

**ITU-T G.Suppl.XX “Network Slicing in a PON Context”** (under publication) considers the possible implications of network slicing and related functionality (e.g. as defined in 3GPP and IMT-2020 as part of 5G wireless) in the setting of optical access networks, in particular for PON systems. Use cases are identified for slicing with focus on PON slicing. The supplement describes functional expectations of the PON system to support PON slicing, and considers the architecture for the control of PON slices. Also, the aim is to provide clear demarcation of PON slicing such that it can be considered independently of slicing in any other segments of the network.

**ITU-T G.Suppl.YY “5G small cell backhaul/midhaul over TDM-PON”** (under publication) documents studies the best application scenario of TDM-PON in 5G small cell backhaul and midhaul, and researches and determines related technical requirements.

**ITU-T Technical Paper “Overview of the ITU-T G.hn Technology”** (under publication): The G.hn family of ITU-T Recommendations provides the framework and solution to implement in-premises communication system that may work over multiple physical media (power lines, phone lines, coaxial and plastic optical fiber). This paper provides a high-level overview of the G.hn system and a brief description of the relationships among the different Recommendations of G.hn family (including G.9960, G.9961, G.9962, G.9963, G.9964, G.9972, G.9977, G.9978 and G.9979). In addition, Recommendation ITU-T G.9991 for in-premises transmission over visible light Communication is also discussed since it is largely based on G.hn systems.

**ITU-T L.209 “Requirements for Fibre Optic Network Terminal Box (FONT**)” (under approval) describes the requirements of a combined housing for ‘Fibre Optic Network Terminal box’ (FONT) to keep in a single box active elements like ONT, battery and its charge controller (power supply) as well as passive elements like fibre patch panel, connectors, splitters and fibre splice trays, instead of having multiple boxes for active and passive elements separately. This recommendation will be especially helpful to service providers for FTTx applications in areas where ownership, space, safe custody and availability of power supply source are hurdles to deployment. The FONT should have two compartments with independent doors. The active elements compartment should have provision for natural ventilation required for active elements in addition to sealing against ingress of dust and liquid which is required for both the compartments. The passive element compartment should have the features of a standard FDB (Fibre Distribution Box).

The FONT comprises of:

- a mechanical structure (box housing) for mechanical and environmental protection of active and passive elements with provisions for thermal management/ventilation of active elements and sealing of internal systems;

- a simple fibre management system for guiding and managing the fibres and fibre connections inside the box;

- a cable attachment and termination system for attaching and terminating cable ends.

Mechanical and environmental characteristics and evaluation of performance should comply with the provisions of [ITU-T L.200/51] for passive element compartment and [ITU-T L.204/70] for active element compartment.

**ITU-T L.316 “Cable identification for the construction and maintenance of optical fibre cable networks with optical sensing technique”** (under approval) covers cable identification for the construction and maintenance of optical cable networks. Cable identification is performed to find and/or to trace target cable/route by using optical fibre sensing techniques under deployed conditions characterized by a number of cables.

**ITU-T L.400/L.12 (revised) “Optical fibre splices”** (under approval): Splices are critical points in the optical fibre network, because they strongly affect the quality of the links, as well as their lifetime. In fact the splice should ensure high quality and stability of performance with time. High quality in splicing is usually defined as low splice loss and tensile strength near that of the fibre proof-test level. Splices should be stable over the design life of the optical fibre link under its expected environmental conditions.

At present two technologies, fusion and mechanical can be used for splicing glass optical fibres and the choice between them depends upon the expected functional performance and considerations of installation and maintenance. These splices are designed to provide permanent connections.

The following elements are modified for this revision:

- Maximum attenuation of fibre splices depending the alignment method (active core, active cladding and passive V-groove alignment);

- Maximum attenuation for mechanical splices;

- Validation of splicing procedure is added with average and maximum attenuation (97% of the splices) of fibre splices;

- The appendix with Japanese experience is removed;

- An Appendix II which shows the increase in attenuation when splicing different types of optical fibres by taking into account the mode field diameter mismatch, the core-cladding concentricity and the cladding diameter;

- An Appendix III which explains the fibre imaging process in fusion splicing machines.

I.1.5 Optical transport network (OTN)

**ITU-T G.709/Y.1331 Amd.2 “Interfaces for the optical transport network - Amendment 2”** (under approval) adds specifications for OTUk, k=0, references to specific bit patterns that may appear in Status and Payload Type overhead fields during the presence of the FlexO Squelch text pattern [ITU-T G.709.1], a clarification of the ODU Locked maintenance signal and an enhancement of the introductory text in Annex L.

**ITU-T G.798 Amd.4 “Characteristics of Optical Transport Network Hierarchy Equipment Functional Blocks - Amendment 4”** (under approval) adds new and modified atomic functions to align with the recent changes to ITU-T Recommendations G.709.1 and G.709.3, and to align with ITU-T Recommendation G.709 Amendment 2, including the introduction of OTU0. It corrects a number of technical errors in the FlexO-x/OTUCn\_A, FlexO-x/OTUCni\_A, OTU/ODU\_A, and OTSi/OTUk-RS\_A functions, as well as in the description of some generic FlexO-related processes in clause 8.5.

**ITU-T G.873.1 Amd.1 “Optical transport network: Linear protection - Amendment 1”** (under approval) adds ODUCn as a server layer of protected entities in Table 8-1 and provides minor editorial changes.

**ITU-T G.8201 Amd.1 “Error performance parameters and objectives for multi-operator international paths within optical transport networks - Amendment 1”** (under publication) adds ODU0, ODU2e, ODU4 and ODUflex to the list of ODUk types in footnote 1.

**ITU-T G.Suppl.OTNsec “Optical transport network security”** (under publication) describes optical transport security applications, requirements and the use of multiple OTN signals and structures to assist in implementing security solutions.

I.1.6 Transport network control aspects

**ITU-T G.7701 (revised) “Common control aspects”** (under approval) describes the concepts and the aspects of management control components that are common to the use of either software defined networking (SDN) and automatically switched optical network (ASON) approaches to the management of a transport network. It also describes the common aspects of the interaction between the management-control functions and the transport network resources.

**ITU-T G.7702 (revised) “Architecture for SDN control of transport networks”** (under approval) describes the reference architecture for software defined networking (SDN) control of transport networks applicable to both connection-oriented circuit and/or packet transport networks. This architecture is described in terms of abstract components and interfaces that represent logical functions (abstract entities versus physical implementations).

**ITU-T G.7711/Y.1702 (revised) “Generic protocol-neutral information model for transport resources”** (under approval): The 2021 edition of this Recommendation has added the new Annex M the Party model, new Annex N the Location model, new Annex Q the Foundation – State, and has significant improvement to the model structure so the UML model is aligned with the documents. The modeling tool has been up-versioned to Eclipse 4.13.0 (2019-09) and Papyrus 4.5.0.

**ITU-T G.7712/Y.1703 Amd.1 “Architecture and specification of data communication network - Amendment 1”** (under approval): Recommendation ITU-T G.7712/Y.1703 defines the architecture requirements for a data communication network (DCN) which may support distributed management communications related to the telecommunication management network (TMN), distributed control communications (e.g., signalling and routing) related to the automatically switched optical network (ASON), distributed control communications (e.g., signalling and routing) related to multiprotocol label switching – transport profile (MPLS-TP), control communications related to software defined networking (SDN), and other distributed communications (e.g., orderwire or voice communications, software download). The DCN architecture considers networks that are IP only, open system interface (OSI)-only, and mixed (i.e., support both IP and OSI). The interworking between parts of the DCN supporting IP-only, parts supporting OSI only, and parts supporting both IP and OSI are also specified – other protocols (other than IP or OSI) are outside the current scope of this Recommendation.

Various applications (e.g., TMN, ASON) require a packet-based communications network to transport information between various components. For example, the TMN requires a communications network, which is referred to as the management communication network (MCN) to transport management messages between TMN components (e.g., network element function (NEF) component and operations system function (OSF) component). ASON requires a communication network, which is referred to as the control communication network (CCN), and MPLS-TP requires a communication network, which is referred to as the signalling communication network (SCN) to transport signalling and routing messages between functional management and control (MC) components (e.g., connection controller (CC) components and routing controller (RC) components). This Recommendation specifies data communication functions that can be used to support one or more application's communication network.

The data communication functions provided in the 2001 version (version 1) of this Recommendation support connectionless network services. The 2003 revision (version 2) of this Recommendation adds the support of connection-oriented network SCN services by including a specific MPLS-based mechanism.

The 2010 revision (version 4) of this Recommendation provides the requirements for the MPLS transport profile (MPLS-TP) signalling communication channel (SCC) and management communication channel (MCC) data communication functions. The part of this Recommendation that addresses MPLS for transport networks complies with the transport profile of MPLS architecture as defined by Internet Engineering Task Force (IETF). In the event of a difference between this ITU-T Recommendation and any of the normatively referenced request for comments (RFCs) for MPLS-TP, the RFCs will take precedence.

The 2020 version (version 5) provides updates that cover control communications related to software defined networking (SDN). A new Appendix V is also added to this version to provide a mapping between clauses here and prior versions due to restructuring.

This Recommendation forms part of a family of Recommendations covering transport networks.

**ITU-T G.8312 Amd.1 “Interfaces for metro transport networks - Amendment 1”** (under approval) specifies the rates and formats for use in metro transport network (MTN) digital layer networks: the MTN path (MTNP) layer and the MTN section (MTNS) layer, which support the transport of distributed radio access network (D-RAN) and centralized radio access network (C-RAN) traffic. It includes the following elements:

– frame structures;

– functionality of the overhead;

– formats for mapping client signals (CSs).

The MTNP layer provides flexible connections that carry client data and path operations, administration, and maintenance (OAM) in 64 bit/66 bit (64B/66B) blocks that are conformant to the encoding rules in clause 82 of [IEEE 802.3]. OAM functions include connectivity verification (CV), performance monitoring, path status and delay measurement (DM). Overhead to support MTNP layer protection is also supported. The MTNS layer operates over 50GBASE-R, 100GBASE-R, 200GBASE-R or 400GBASE-R server layers. The MTNS frame format is specified in a way that maximizes reuse of [OIF FLEXE IA] implementation logic, including support for bonding homogenous groups of 50GBASE-R, 100GBASE-R, 200GBASE-R, 400GBASE-R interfaces. The MTNS layer uses 64B/66B blocks that are conformant to the encoding rules in clause 82 of [IEEE 802.3], which allow the MTNS layer to be transported transparently over the lower layers of the Ethernet protocol stack. Functions and process flows associated with the interfaces specified lie outside the scope of this Recommendation.

**ITU-T G.8331 “Metro transport network (MTN) linear protection”** (under approval) defines the operation of linear protection switching schemes for the Metro Transport Network (MTN) path layer, including the automatic protection switching (APS) protocol.

I.1.8 Ethernet over transport networks

**ITU-T G.8012/Y.1308 (revised) “Ethernet UNI and Ethernet NNI”** (under approval) specifies the Ethernet UNI and the Ethernet NNI. A set of physical Ethernet interfaces is defined for the Ethernet UNI and the Ethernet NNI. Further, an Ethernet over Transport interface is defined for the Ethernet NNI. The Ethernet over Transport NNI uses the OTH server layer network. This Recommendation supersedes ITU-T Recommendation G.8012.1/Y.1308.1 (12/2012), and together with ITU-T Recommendation G.8021/Y.1341, supersedes ITU-T Recommendation G.8021.1/Y.1341.1 (10/2012). This Recommendation also removes items formerly considered for further study and incorporates terms formerly defined in ITU-T Recommendation G.8001/Y.1354 (04/2016) and in ITU-T Recommendation G.8101/Y.1355 (11/2016).

**ITU-T G.8021/Y.1341 (revised) “Characteristics of Ethernet transport network equipment functional blocks”** (under approval) specifies both the functional components and the methodology that should be used in order to specify the Ethernet transport network functionality of network elements; it does not specify individual Ethernet transport network equipment. This Recommendation, together with Recommendation ITU-T G.8012/Y.1308, supersedes Recommendation ITU-T G.8021.1/Y.1341.1 (10/2012). This Recommendation also removes items formerly considered for further study and incorporates terms formerly defined in ITU-T Recommendation G.8001/Y.1354 (04/2016).

**ITU-T G.8023 Amd.1 “Characteristics of equipment functional blocks supporting Ethernet physical layer and Flex Ethernet interfaces - Amendment 1”** (under approval) contains text modifications:

– to update references in clauses 1, 2, and 6.3

– to align terminology with OIF FLEXE IA

– to align terminology with ITU-T G.807

– to add 50G PHYs from 802.3cd

– to clarify that the use of the ESMC is optional

– to update server/ETH\_A functions to remove details of client-specific processes that are covered in ITU-T G.8021

– to correct errors in Tables 8-4 and 8-5

– to add new clause 6.6 and update Annex A regarding FlexE aware mapping

– to include common processes for FlexE that were formerly in Annex B/G.798.

I.1.9 Synchronization and timing

**ITU-T G.781.1 “Synchronization layer functions for packet-based synchronization”** (under approval) specifies a functional architecture model and corresponding atomic functions for the transport of time and frequency synchronization via packet-based methods using PTP.

**ITU-T G.7721.1 “Data model of Synchronization management”** (under approval) specifies the synchronization information models and data models for Transport Network Element (NE) to support specific interface protocols and specific management and control (MC) functions. The information models are interface protocol neutral and specified using the Unified Modelling Language (UML). The data models are interface protocol specific and are directly derived from these information models. The specific data models considered in this Recommendation include, but are not limited to, YANG data models. The specific MC functions for synchronization covered by this Recommendation are specified in [ITU-T G.8265.1], [ITU-T G.8275.1] and [ITU-T G.8275.2]. The PTP telecom profile YANG module defined in this Recommendation augments the PTP YANG module defined in [IETF RFC 8575] for the management of the Precision Time Protocol (PTP) defined in [IEEE 1588-2008]. The UML information model and YANG data model in this version of the Recommendation covers the PTP telecom profiles defined in [ITU-T G.8265.1] Edition 2.2 (08/2019), [ITU-T G.8275.1] Edition 3.0 (03/2020), and [ITU-T G.8275.2] Edition 2.0 (03/2021), which are based on [IEEE 1588-2008].

**ITU-T G.8265.1/Y.1365.1 Amd.1 “Precision time protocol telecom profile for frequency synchronization - Amendment 1”** (under approval) includes the following changes:

-IPv6 mapping, in addition to IPv4, is now mandatory;

-Clarifying notes have been added to the tables in Annex A which contains the PTP profile.

- Provides clarifications to PTP attribute values.

**ITU-T G.8271.1/Y.1366.1 Amd.2 “Network limits for time synchronization in packet networks with full timing support from the network - Amendment 2”** (under approval) provides the following updates:

− Addition of a high-pass filtered limit in clause 7.5

− Clarifications to Appendix IX.

**ITU-T G.8273.2/Y.1368.2 Amd.1 “Timing characteristics of telecom boundary clocks and telecom time slave clocks for use with full timing support from the network - Amendment 1”** (under approval) provides the following updates:

– Add a reference and one acronym

– Changes in clauses 6.1 and 6.2

– Changes in clause 7.1

– Changes in Clause 7.5

– Adds Appendix IX.

**ITU-T G.8275/Y.1369 Amd.2 “Architecture and requirements for packet-based time and phase distribution - Amendment 2”** (under approval) incorporates

- Updates to Appendix III Generic IWF node.

**ITU-T G.8275.1/Y.1369.1 Amd.3 “Precision time protocol telecom profile for phase/time synchronization with full timing support from the network - Amendment 3”** (under approval) provides the following updates:

- Replace masterOnly procedures with a pointer to the procedures defined in [IEEE 1588-2019]

- Add new per port notMaster attribute

- Add indication of datatype for all dataset members (Annex A)

- Add some notes to dataset tables (Annex A)

- Enhance Appendix XIV wording related to multiple external PTP ports visible via one PTP port

- New Appendix XV on considerations of deploying ePRTC and PRTC in the network.

**ITU-T G.8275.2/Y.1369.2 Amd.3 “Precision time protocol telecom profile for phase/time synchronization with partial timing support from the network – Amendment 3”** (under approval) provides the following updates:

- Replaced masterOnly procedures with a pointer to the procedures defined in [IEEE 1588-2019]

- Added new per port notMaster attribute

- Added indication of datatype for all dataset members (Annex A)

- Added some notes to dataset tables (Annex A)

- Updated requirements related to IPv4 and IPv6 (6.4 and A.3.2).

I.1.10 Cable

**ITU-T J.198.1 “Functional requirements for third-generation HiNoC” (under approval)** describes the third generation HiNoC which provides 10 Gbit/s data transmission over coaxial network in cable industry. This document contains descriptions for functional requirements of general system, physical layer and MAC layer.

**ITU-T J.299 (revised) “Functional requirements for remote management of cable STB by auto configuration server” (under approval)** defines the functional requirements for the interface between auto configuration server (ACS) at the cable headend or other cable operator locations and cable set-top box (STB) to remotely set up and maintain the STB and collect data from the STB. In addition, a function to enable network address translation (NAT) traversal and means to securely handle the collected data are also considered.

**ITU-T J.483 “Architecture and Functional Specifications of a radio frequency (RF)/Internet protocol (IP) video switching system" (under approval)** defines the Architecture and Functional Specifications of a radio frequency (RF)/Internet protocol (I/IP) video switching system. This Recommendation document is Part 2 of a multi-part deliverable covering both the Requirements [ITU-T J.482] as well as the Architecture and Functional Specifications for RF/IP switching system, as identified below:

Part 1: Requirements [ITU-T J.482];

Part 2: Architecture and functional specifications;

Cable television operators provide subscribers with a variety of video services composed of RF-signal-based video (RF-video) and IP-signal-based video (IP-video) over cable networks. While the bandwidth is limited, cable operators are facing subscriber needs to watch higher quality video such as 4K in either RF or IP format. Under these circumstances, the purpose of RF/IP switching system is to create an environment where almost all the subscribers can watch 4K videos if they so wish.

**ITU-T J.1026 (revised) “Downloadable conditional access system for unidirectional networks – Requirements” (under approval)** specifies requirements for one-way downloadable conditional access system (DCAS) for unidirectional networks. One-way DCAS protects broadcast content/services and controls consumer entitlements like traditional conditional access (CA) systems, and enables a terminal, such as a set-top-box (STB), to adapt to a new CA system by downloading and installing the new CA system's client without changing the hardware. In particular, one-way DCAS can fully work in unidirectional cable TV networks and other unidirectional networks such as satellite TV networks.

**ITU-T J.1027 (revised) “Downloadable conditional access system for unidirectional networks - System architecture” (under approval)** specifies a system architecture for a one-way downloadable conditional access system (DCAS) for unidirectional networks. One-way DCAS protects broadcast content/services and controls consumer entitlements like traditional conditional access (CA) systems, and enables a terminal, such as a set-top-box (STB), to adapt to a new CA system by downloading and installing the new CA system's client without hardware changing. In particular one-way DCAS can fully work in unidirectional cable TV networks and other unidirectional networks such as satellite TV networks.

**ITU-T J.1028 (revised) “Downloadable conditional access system for unidirectional networks - Terminal system” (under approval)** specifies a terminal for a one-way downloadable conditional access system (DCAS) for unidirectional networks. One-way DCAS protects broadcast content/services and controls consumer entitlements like traditional conditional access (CA) systems and enables a terminal, such as a set-top-box (STB), to adapt to a new CA system by downloading and installing the new CA system's client without hardware changing. In particular one-way DCAS can fully work in unidirectional cable TV networks and other unidirectional networks such as satellite TV networks.

**ITU-T J.1111 “Requirements for advanced IP-based digital video convergence service” (under approval)**: As digital broadcasting services have been rapidly deployed, many service operators are considering more effective transmission of digital broadcasting services. Recently, the digital broadcasting services have been changed to use resources efficiently and transmits them to easily accommodate the consideration varying needs and environments of subscribers. Therefore, it is necessary to redefine the advanced IP-based digital video convergence service for maintaining QoS (Quality of Service) and using bandwidth effectively transmission on broadband network environment. The switched digital video (SDV) service is a service mechanism for distributing digital video via RF-based broadband networks, while the IP-based SDV Service is a service mechanism for distributing digital video via IP-based broadband networks. The advanced IP-based digital video convergence service is the service mechanism for providing interfaces and functionalities to enable the service operators to offer quality of service (QoS)-guaranteed broadcasting to subscribers via IP-based converged broadband networks. This Recommendation aims to define the service requirements of IP-based digital video convergence service including IP-based SDV technologies considering the convergence environment. ITU-T J.1111 references normatively the ITU-T J.1101 (i.e. functional requirement for the IP-based switched digital video service).

**ITU-T J.1201 (revised) “Functional requirements of a smart TV operating system” (under approval)** specifies the functional requirements of a smart TV operating system over integrated broadcast and broadband cable networks. A smart TV operating system is intended to be installed in an integrated broadcast and broadband (IBB) capable cable set-top box (STB) and TV and to enable broadcasting and IP-based interactive services provided by cable television operators and third party providers. By running a smart TV operating system, the IBB-capable cable STB and TV will be able to intelligently provide subscribers with advanced and personalized services by downloading and installing advanced and personalized apps from cable operators' platforms and third party platforms, which are interconnected with the related cable operators' platforms. This Recommendation is the first of a series of smart TV operating system Recommendations. The Recommendations for this smart TV operating system will cover functional requirements, architecture, security and application programming interfaces (APIs).

**ITU-T J.1202 (revised) “The architecture of a smart TV operating system” (under approval)** defines the architecture of a smart television TV operating system (TVOS) to enable integrated broadcast and broadband (IBB)-capable cable set-top box (STB) and TV to apply to broadcasting services and IP-based interactive services provided by cable television operators and third-party providers. By running the smart TV operating system, the IBB capable STB and TV will be able to provide subscribers with advanced and personalized services by downloading and installing advanced and personalized apps from cable operators' platforms and third-party platforms, which are interconnected with the related cable operators' platforms.

**ITU-T J.1203 (revised) “The specification of a smart TV operating system” (under approval)** defines the detailed specification of a smart TV operating system (TVOS) to enable integrated broadcast and broadband (IBB)-capable cable set-top box (STB) and TV to apply to broadcasting services and IP-based interactive services provided by cable television operators and third-party providers. By running the smart TV operating system, the IBB capable STB and TV will be able to provide subscribers with advanced and personalized services by downloading and installing advanced and personalized apps from cable operators' platforms and third-party platforms, which are interconnected with the related cable operators' platforms. Recommendation ITU-T J.1203 is developed in accordance with the requirements defined in Recommendation ITU T J.1201 and based on the architecture defined in Recommendation ITU-T J.1202. This Recommendation provides a specification for administrations and entities who intend to implement a smart TV operating system over integrated broadcast and broadband cable networks.

**ITU-T J.1204 (revised) “The security framework of a smart TV operating system” (under approval)** defines the security framework of a smart television operating system (TVOS) to enable integrated broadcast and broadband (IBB)-capable cable set-top box (STB) and TV to apply to broadcasting services and IP-based interactive services provided by cable television operators and third-party providers. By running the smart TV operating system, the IBB capable STB and TV will be able to provide subscribers with advanced and personalized services by downloading and installing advanced and personalized apps from cable operators' platforms and third-party platforms, which are interconnected with the related cable operators' platforms. Recommendation ITU-T J.1204 intends to specify the security framework of a smart TV operating system over integrated broadcast and broadband cable networks, which exploits the popular hardware based trusted execution environment (TEE) technology and has multiple security defence capabilities.

**ITU-T J.1205 “The HAL API of a smart TV operating system” (under approval)** defines the hardware abstract layer API of a smart TV operating system (TVOS) to enable integrated broadcast and broadband (IBB)-capable cable set-top box (STB) and TV to apply to broadcasting services and IP-based interactive services provided by cable television operators and third-party providers. The TVOS hardware abstract layer (HAL) consists of multiple hardware abstraction functional interface modules. These modules implement abstraction and encapsulation of different hardware capabilities and provide the upper-layer software with interfaces used to invoke the corresponding hardware capabilities.

**ITU-T J.1303 “The specification of cloud-based converged media service to support IP and Broadcast Cable TV - System specification on collaboration between production media cloud and cable service cloud” (under approval)** is Part 3 of a multi-part deliverable covering the high-level system architecture for cloud-based converged media service to support IP and Broadcast Cable TV, as identified below:

Part 1: Requirements;

Part 2: System architecture

Part 3: System specification on collaboration between production media cloud and cable service cloud.

**ITU-T J.1304 “Functional requirements for service collaboration between cable television operator and OTT service provider” (under approval)** defines functional requirements for a cable television operator to provide an OTT service to cable television customers in conjunction with their cable television services, VOD service, high-speed cable internet and so on by collaboration with an OTT service provider. As a reference architecture, the system architecture and interfaces between a cable television operator and one or more OTT service provider(s) are specified. To exemplify collaboration patterns of a cable television operator with an OTT provider, this Recommendation also describes the configuration patterns of relevant entities including a user, a cable television operator and one or more OTT service provider(s).

**ITU-T J.1401 “Television Content Distribution Platforms: Requirements for Open Access and Signal Quality” (under approval)**: In a country where analogue TV to digital TV (DTT) migration is taking place, the use of fibre optic backbone and local loop is considered as affordable and reliable for content delivery. When such digital television content distribution platforms are provided by single signal distribution provider and National Fibre Optic Infrastructure provider, it is imperative that they are open for access by any entity providing DTT and other television content on an equal basis. This Recommendation defines technical requirements for digital television content distribution platforms that consist of national fibre optic lines and local loops that provide Open Access to entities who wish to deliver content to end users, as well as expected signal quality.

**ITU-T J.1612 “The Architecture for Smart Home Gateway” (under approval)**: Smart home is a kind of home automation system in which a wide range of IoT devices in a home cooperate to provide intelligent controlling and monitoring functions for home users. Smart home gateway connects various smart home devices, provides hardware interfaces of various smart home communication protocols, runs communication protocols, performs protocol conversion and bridging, realizes the interaction between user control terminal and Cloud server. This Recommendation aims to define the architecture for the smart home gateway (SHGW) which addresses the functional requirements found in [ITU-T J.1611]. The Recommendation consists of concepts of virtual device model, dynamic device profile and other important software modules. With introduction of these important modules, the architecture can dynamically support existing smart home devices and the devices in future.

[**ITU-T J.1631 "Functional requirements of E2E network platform for Cloud-VR services"**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14648) describes functional requirements of the end-to-end (E2E) network platform to deliver 360°/Virtual Reality (VR) video services from the video cloud to the terminal devices over integrated broadband cable networks. Cloud VR is a new cloud computing technology for VR services. With fast and stable transport networks, VR contents are stored and rendered in the cloud. Audio-visual contents are encoded, compressed, and transmitted to user terminals. This Recommendation specifies the network requirements of Cloud VR services.

NOTE: Integrated broadband cable networks can be referred to as a cable network, e.g., coaxial cable, optical fibre, hybrid fibre coaxial (HFC), etc., that has also capability to provide broadband services integrated with television services over the same network.

**ITU-T Technical Paper JSTP-IPVB-ACC “Analysis of the cost and complexity of IPVB technology” (under publication)**: In recent years, the high-definition video services based on large bandwidth, such as 4K, 8K, VR, etc., have been developed rapidly, and each of them requires a bandwidth exceeding 35Mbps or even up to 100Mbps. Accordingly, this leads to the requirement of huge downlink transmission bandwidth and poses a great challenge to the existing broadcast transmission networks. The recommended IPVB technology can greatly increase the bandwidth of downlink programs and relieve the bandwidth pressure with features of low cost and low complexity. It broadcasts IP-based video streams over the CATV networks to all subscribers in downlink direction. In IPVB, IP-based video streams are delivered through multicast channels which are identified by multicast IP addresses and UDP port numbers. In this document, the characteristics of IPVB technology are compared and discussed from the aspects of network complexity and construction costs.

**ITU-T Technical Paper JSTP-IPVB-UC “Use cases and service scenario of IP Video Broadcast (IPVB) for CATV Networks”** (under publication): In recent years, the high-definition video services based on large bandwidth, such as 4K, 8K, VR, etc., have been developed rapidly, and each of them requires a bandwidth exceeding 35Mbps or even up to 100Mbps. Accordingly, this leads to the requirement of huge downlink transmission bandwidth and poses a great challenge to the existing broadcast transmission networks. The recommended IPVB technology can greatly increase the bandwidth of downlink programs and relieve the bandwidth pressure with features of low cost and low complexity. It broadcasts IP-based video streams over the CATV networks to all subscribers in downlink direction. In IPVB, IP-based video streams are delivered through multicast channels which are identified by multicast IP addresses and UDP port numbers. In this document, the use cases and service scenario of IPVB technology are introduced and described.

I.2.2 Smart ubiquitous networks, next-generation networks evolution, and future networks

**ITU-T Implementer’s Guide Y.110 “Implementors' Guide for Recommendation Y.110” (under publication):** This Implementor’s Guide contains editorial updates to be incorporated within Y.110 (06/98) when it is re-published.

**ITU-T Y.3090 “Digital twin network - Requirements and architecture”** (under approval): Digital twin network (DTN) is a virtual representation of a physical network. It is useful for analysing, diagnosing, emulating and controlling the physical network based on data, model and interface, so as to achieve the real-time interactive mapping between the physical network and the digital twin network. This Recommendation describes the requirements and architecture of DTN.

**ITU-T Q.4102 “Hybrid peer-to-peer (P2P) communications: Peer protocol”** (under approval) specifies the peer protocol for communication among peers. The peer protocol enables peers to organize tree-based overlay network of hybrid peer-to-peer overlay network and to distribute data over the overlay network. For overlay network organization, this protocol supports the establishment of connections among peers, maintenance of the connections, data delivery, and data recovery. This Recommendation specifies connection types among peers, resource elements types used in message header, protocol messages exchanged among peers and information flows for describing behaviors of peer.

**ITU-T Q.4103 “Hybrid peer-to-per (P2P) communications: Overlay management protocol” (under approval)** specifies a protocol for managing hybrid peer-to-peer overlay network for being used between hybrid peer and hybrid overlay management server. This protocol supports of overlay network management such as creation, query, modification and removal, and peer management such as join, leave, report and refresh. In order to manage the overlay network, it needs to specifies the control data to be conveyed and method to deliver the control message. For this, this Recommendation specifies resource elements for managing hybrid peer-to-peer overlay network and the message syntaxes, and provides protocol operations and information flows.

I.2.3 IMT-2020/5G networks

**ITU-T M.3381 “Requirements for energy saving management of 5G RAN system with AI” (under approval)** provides requirements for energy saving management of 5G RAN system with artificial intelligence (AI). The goal of the Recommendation is to explain the requirements of using AI technology to achieve energy saving management for communication units and virtualized hardware resources of 5G RAN system, via EMS and open interfaces provided by vendors, from the OSS level. In addition, this Recommendation includes process recommendations for sending intelligent energy saving strategies from OSS to EMS and then to wireless equipment. This Recommendation describes functional requirements for energy saving management of 5G RAN system with AI, and it also describes use cases of energy saving management of 5G RAN system with AI.

**ITU-T Y.3078 “Information centric networking for IMT-2020 and beyond - Requirements and capabilities of data object segmentation”** (under approval) starts with the introduction to data object segmentation in information centric networking (ICN) for IMT-2020 and beyond. It specifies the service and functional requirements and capabilities of data object segmentation achieve high efficiency of caching and forwarding in ICN.

**ITU-T Y.3114 “Future networks including IMT-2020: requirements and functional architecture of lightweight core for dedicated networks”** (under approval): In the context of future networks including IMT-2020, dedicated networks are networks designed for application domains with common requirements. Lightweight core is a core network designed for dedicated networks, which builds on the integration of IMT-2020 core network functions. This Recommendation specifies requirements, functional architecture, reference points, and procedures of lightweight core for dedicated networks.

**ITU-T Y.3115 “AI enabled cross-domain network architectural requirements and framework for future networks including IMT-2020”** (under approval) points out the problem that the current network domains lack an architecture to coordinate the artificial intelligence (AI) capabilities, and specifies architectural requirements and framework of AI enabled cross-domain network for future networks including IMT-2020, which aim to achieve overall network intelligence.

**ITU-T Y.3116 “Traffic typization IMT-2020 management based on an artificial intelligent approach”** (under approval): At present, the standardization of IMT-2020 networks aims at dealing with architectural issues (infrastructure and new services), analyzing and ensuring signaling at the management level and ensuring the quality and security of IoT services. As is well known, according to ITU-R Recommendation ITU-R M.2083-0 “IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond”, one of the IMT-2020 infrastructure technologies is SDN. Given the heterogeneous nature of the traffic, it is necessary to ensure efficient and effective infrastructure management. With a view to increasing the effectiveness of the automation of management, the use of artificial intelligence (AI) technologies needs to be considered for traffic detection and typization. In this way, Recommendation considering the following: an overview of machine learning (ML) technologies for the traffic detection and method of the traffic typization and recognition for IMT-2020 management based on an ML approach.

**ITU-T Y.3200 “Information centric networking for IMT-2020 and beyond - Requirements and capabilities of data object segmentation”** (under approval) starts with the introduction to data object segmentation in information centric networking (ICN) for IMT-2020 and beyond. It specifies the service and functional requirements and capabilities of data object segmentation achieve high efficiency of caching and forwarding in ICN.

**[ITU-T Y.4421 “Functional architecture for unmanned aerial vehicles and unmanned aerial vehicle controllers using IMT-2020 networks”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14738):** The widely used civilian UAVs generate increasing requirements for communication and network capability, including seamless coverage, low latency, Gbps-level rate and high-accuracy positioning. The existing commercial products of civilian UAVs utilize direct radio link, which is limited by service distance and quality. Therefore IMT-2020 can be employed for UAV communication. The UAV requires simultaneous services with different characters, which is a brand-new type of user terminal to IMT-2020. Likewise, IMT-2020 is a novel communication network to the UAVs since it is originally designed for ground coverage. With the purpose of implementing the support of civilian UAV operations in IMT-2020 networks and improving quality of UAV application service, a set of functionalities is needed to bridge the gap for interoperation between UAS and IMT-2020 networks. This Recommendation provides a functional architecture for UAVs and UAV controllers using IMT-2020 networks and functionalities defined in application layer, service and application support layer, and security capabilities. The motivation of this Recommendation is to solve the issues of civilian UAVs accessing and communicating in IMT-2020 networks using its transmission capabilities.

I.2.4 Home networking

**ITU-T G.9960 Amd.3 “Unified high-speed wire-line based home networking transceivers - System architecture and physical layer specification - Amendment 3”** (under approval) corrects the duration of MSG, BMSG and BACK frames, corrects a test vector in clause G.4.1, and reserves PROBE frame and BACK PHY-frame type field values for use by ITU-T G.9963.

**ITU-T G.9961 Amd.4 “Unified high-speed wireline-based home networking transceivers – Data link layer specification - Amendment 4”** (under approval).

**ITU-T G.9976 “Support UHD video service over G.hn”** (under publication) studies the specificities of transmission of UHD video service over G.hn. This document provides analysis on typical deployment of UHD video types in home network, typical scenarios (including network topology, medium usage, support endpoints, etc.), and network requirements.

**ITU-T G.9978 (revised) “Secure admission in G.hn network”** (under approval) specifies secure admission methods that are needed for a G.hn node to establish a secure domain (SD) and admit other G.hn nodes to the SD. These methods include media access control (MAC) authorization-based Nsecure admission, push button pairing, autopairing and passphrase-based secure admission. The Recommendation also specifies the mechanism for selecting appropriate secure admission methods and addresses interactions between these different secure admission methods.

I.2.6 Software-defined networking

**ITU-T Y.3529 “Cloud computing - Data model framework for NaaS OSS virtualized network function”** (under approval) specifies the data model framework for NaaS OSS network function (OSS-NF), as a functional component of NaaS functional architecture defined in Recommendation ITU-T Y.3515, in the virtualized environment. It covers both of the basic functions (non-SDN) and SDN functions of NaaS OSS-NF.

**[ITU-T Y.3805 “Quantum Key Distribution Networks - Software Defined Networking Control”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14770)** specifies the requirements, functional architecture, reference points, hierarchical SDN controller and overall operational procedures of SDN control.

I.2.7 Cloud computing and data handling

**ITU-T Y.3505 (revised) “Cloud computing – Overview and functional requirements for data storage federation”** (under approval) provides overview and functional requirements of data storage federation. Data storage federation provides a single virtual volume from multiple data sources in heterogeneous storages. In this Recommendation, configuration for logical components, and ecosystem of data storage federation as well as cloud computing based data storage federation are introduced for data storage federation. Functional requirements are derived from use cases.

**[ITU-T Y.3526 “Cloud computing - Functional requirements of edge cloud management”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14759)** provides requirements for edge cloud management. It introduces the overview of edge cloud management including advantages of edge cloud management and relationship with global management in distributed cloud. It describes the edge cloud management local functions and mode. Additionally, this Recommendation provides edge cloud management functional requirements derived from use cases.

**ITU-T Y.3528 “Cloud computing - Framework and requirements of container management in inter-cloud”** (under approval) provides framework and functional requirements of container management in inter-cloud. It addresses overview, framework, functional requirements and use cases of container management in inter-cloud. The functional requirements are derived from the corresponding typical use cases.

**ITU-T Y.3529 “Cloud computing - Data model framework for NaaS OSS virtualized network function”** (under approval) specifies the data model framework for NaaS OSS network function (OSS-NF), as a functional component of NaaS functional architecture defined in Recommendation ITU-T Y.3515, in the virtualized environment. It covers both of the basic functions (non-SDN) and SDN functions of NaaS OSS-NF.

**ITU-T Y.3535 “Cloud Computing – Functional requirements for container”** (under approval) provides the overview and functional requirements of container in cloud computing. It describes the technical aspects of container and provides the relationship between containers and cloud computing. It also provides functional requirements for container in term of container engine, container management system and cloud computing to support container.

**ITU-T Y.3536 “Cloud computing - Functional architecture for cloud service brokerage”** (under approval) describes functional architecture for cloud service brokerage (CSB) based on functional requirements defined in [ITU-T Y.3506]. This Recommendation also provides the reference points among CSB functions, and the relationship between the CSB functional architecture and the cloud computing reference architecture specified in [ITU-T Y.3502].

I.2.8 Big data

**[ITU-T Y.3606 “Big data - deep packet inspection mechanism for network big data”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14776)** specifies mechanism of deep packet inspection applied in big data in network context. This Recommendation specifies introduction of differences between generic DPI and big data DPI , overview of big data processing procedure, relationship between deep packet inspection and big data related technologies, data classification mechanism using deep packet inspection for big data in network, data pre-processing mechanism using deep packet inspection for big data in network, coordination processing mechanism of deep packet inspection in context of big data in network and interfaces between deep packet inspection and the upper-layer big data related methods.

**ITU-T Y.3654 “Big data driven networking - Machine learning mechanism”** (under approval) specifies the mechanisms of machine learning in big data driven networking (bDDN). A set of related aspects of machine learning in bDDN are presented, these aspects include: overview, learning procedure, deployment, interfaces, learning path and control path, security consideration.

I.2.9 Network Management

**[ITU-T M.3365 “Requirements for QoE management of video in visual surveillance”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14744)** introduces requirements for QoE management of video in visual surveillance, includes management of video resource, management of QoE indicators for video, configuration management of QoE evaluation activity, management of QoE evaluation record. This Recommendation provides scenario of video quality evaluation system, which is a tool that implement the requirements given in this Recommendation. This Recommendation also gives examples of video quality evaluation record for reference.

**ITU-T M.3381 “Requirements for energy saving management of 5G RAN system with AI” (under approval)** provides requirements for energy saving management of 5G RAN system with artificial intelligence (AI). The goal of the Recommendation is to explain the requirements of using AI technology to achieve energy saving management for communication units and virtualized hardware resources of 5G RAN system, via EMS and open interfaces provided by vendors, from the OSS level. In addition, this Recommendation includes process recommendations for sending intelligent energy saving strategies from OSS to EMS and then to wireless equipment. This Recommendation describes functional requirements for energy saving management of 5G RAN system with AI, and it also describes use cases of energy saving management of 5G RAN system with AI.

**ITU-T Q.819 “REST-based Management Services” (under approval)** defines a set of services required to support REST-based interfaces and along with Recommendation ITU-T X.785 composes a framework for REST-based network management interfaces. It specifies protocol requirements, and defines some network management-specific support services, which are notification service, heartbeat service, and containment service. The JSON/YAML interface definitions for the network management-specific support services are also provided.

**ITU-T X.786 “Guidelines for implementation conformance statement proformas associated with REST-based management systems” (under approval)** provides guidelines for implementation conformance statement (ICS) proformas for REST-based interface systems. It provides an overview and constructions for the OpenAPI Specification (OAS), and provides several proformas (tables) for each OAS syntax component to be used in REST-based interfaces. Instructions on how to complete the columns in the conformance tables are also provided. Examples of REST-based interface ICSs are provided in appendices.

I.2.10 Artificial Intelligence (AI), Machine Learning (ML)

**ITU-T M.3381 “Requirements for energy saving management of 5G RAN system with AI” (under approval)** provides requirements for energy saving management of 5G RAN system with artificial intelligence (AI). The goal of the Recommendation is to explain the requirements of using AI technology to achieve energy saving management for communication units and virtualized hardware resources of 5G RAN system, via EMS and open interfaces provided by vendors, from the OSS level. In addition, this Recommendation includes process recommendations for sending intelligent energy saving strategies from OSS to EMS and then to wireless equipment. This Recommendation describes functional requirements for energy saving management of 5G RAN system with AI, and it also describes use cases of energy saving management of 5G RAN system with AI.

**ITU-T Y.3115 “AI enabled cross-domain network architectural requirements and framework for future networks including IMT-2020”** (under approval) points out the problem that the current network domains lack an architecture to coordinate the artificial intelligence (AI) capabilities, and specifies architectural requirements and framework of AI enabled cross-domain network for future networks including IMT-2020, which aim to achieve overall network intelligence.

**ITU-T Y.3116 “Traffic typization IMT-2020 management based on an artificial intelligent approach”** (under approval): At present, the standardization of IMT-2020 networks aims at dealing with architectural issues (infrastructure and new services), analyzing and ensuring signaling at the management level and ensuring the quality and security of IoT services. As is well known, according to ITU-R Recommendation ITU-R M.2083-0 “IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond”, one of the IMT-2020 infrastructure technologies is SDN. Given the heterogeneous nature of the traffic, it is necessary to ensure efficient and effective infrastructure management. With a view to increasing the effectiveness of the automation of management, the use of artificial intelligence (AI) technologies needs to be considered for traffic detection and typization. In this way, Recommendation considering the following: an overview of machine learning (ML) technologies for the traffic detection and method of the traffic typization and recognition for IMT-2020 management based on an ML approach.

**ITU-T Y.3180 “Mechanism of traffic awareness for application-descriptor-agnostic traffic based on machine learning”** (under approval) specifies the mechanism of traffic awareness for application-descriptor-agnostic traffic based on machine learning. This Recommendation specifies the following aspects related to traffic awareness for application-descriptor-agnostic traffic: overview, general mechanism, used machine learning methods, implementation consideration based on machine learning, report and auxiliary control mechanism for the malicious application-descriptor-agnostic traffic and security consideration.

**ITU-T Y.3654 “Big data driven networking - Machine learning mechanism”** (under approval) specifies the mechanisms of machine learning in big data driven networking (bDDN). A set of related aspects of machine learning in bDDN are presented, these aspects include: overview, learning procedure, deployment, interfaces, learning path and control path, security consideration.

**ITU-T Y.3680 “Framework of human-like networking”** (under approval): Artificial intelligence technologies, network awareness technologies, network self-restructuring technologies and other technologies applied into network area can bring about innovation of network and new network architecture. Introducing human-like features into network can make the network make full use of advantages of human being and bring a new network architecture named human-like networking to birth. This Recommendation specifies framework for human-like networking. This Recommendation specifies following aspects of human-like networking: overview of human-like networking, framework of human-like networking, generic architecture model for human-like networking based on function and capability, relationship between layers, sub-network and networks for human-like networking, interface aspect of human-like networking and security consideration.

I.4.1 Internet of Things and Smart City

[**ITU-T Y.4004 “Overview of smart oceans and seas, and requirements for their ICT implementations”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14812): Smart Oceans and Seas (SO&S) permit to use telecommunication/ICTs to conserve and sustainably use the oceans, seas and marine resources. This Recommendation provides an overview of SO&S, clarifies the high-level requirements of SO&S implementations. In addition, some representative use cases of SO&S are also provided in the appendix.

**ITU-T Y.4123 “Requirements and capability framework of smart shopping mall” (under approval)**: By deploying IoT devices, smart shopping malls make use of IoT technologies to collect data, control device remotely, monitor the environment, etc. These IoT technologies can enable intelligent services such as intelligent device collaboration, indoor navigation, asset tracking etc., which can help to improve management efficiency, resulting in enhanced consumer experience and more businesses opportunities. This Recommendation specifies requirements and capability framework of smart shopping mall.

**[ITU-T Y.4212 “Requirements and capabilities of network connectivity management in the Internet of things”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14814)** specifies the requirements and capabilities of network connectivity management in the Internet of Things (IoT). The specified requirements and capabilities are intended to be generally applicable in network connectivity management application scenarios.

[**ITU-T Y.4213 “IoT requirements and capability framework for monitoring physical city assets”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14815) identifies specific IoT requirements for monitoring physical city assets in smart cities. Common requirements of the IoT [ITU-T Y.4100], requirements for the interoperability of smart city platforms [ITU-T Y.4200] and high-level requirements and reference framework of smart city platforms [ITU-T Y.4201] constitute the basis for these specific requirements. Based on the identified requirements, a capability framework of a city asset monitoring system is provided, composed of city asset monitoring device capabilities, network connectivity management capability, IoT device management capabilities, identifier management capabilities, and city asset monitoring service capabilities. The requirements and capabilities only address technical aspects of the IoT-enabled city infrastructure, but the analysis of specific city assets is beyond the scope of this Recommendation. Other aspects, including regulatory and economic ones, are out of the scope of this document.

**ITU-T Y.4214 “Requirements of IoT-based civil engineering infrastructure health monitoring system” (under approval)**: Monitoring the safety and integrity of civil engineering infrastructures using objective data collected from the infrastructures themselves with Internet of things (IoT) capabilities is an effective means to supplement inspection and diagnosis for advanced and efficient maintenance work on civil engineering infrastructures. In this Recommendation, an IoT-based system for this purpose is called a civil engineering infrastructure health monitoring system. This Recommendation describes the requirements specific to the IoT-based civil engineering infrastructure health monitoring system for the purpose of maintaining civil engineering infrastructures.

**ITU-T Y.4215 “Use cases, requirements and capabilities of unmanned aircraft systems for the Internet of Things” (under approval)** describes the use cases, requirements and capabilities of unmanned aircraft systems (UASs) for the Internet of things (IoT). According to different wireless communication scenarios, the use cases are classified in four categories: UAS-aided offloading, UAS-aided emergency response, UAS-aided relaying and UAS-aided information dissemination and data collection. Common and specific requirements and capabilities of UASs for IoT support of the different use cases are described in this Recommendation.

**[ITU-T Y.4421 “Functional architecture for unmanned aerial vehicles and unmanned aerial vehicle controllers using IMT-2020 networks”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14738):** The widely used civilian UAVs generate increasing requirements for communication and network capability, including seamless coverage, low latency, Gbps-level rate and high-accuracy positioning. The existing commercial products of civilian UAVs utilize direct radio link, which is limited by service distance and quality. Therefore IMT-2020 can be employed for UAV communication. The UAV requires simultaneous services with different characters, which is a brand-new type of user terminal to IMT-2020. Likewise, IMT-2020 is a novel communication network to the UAVs since it is originally designed for ground coverage. With the purpose of implementing the support of civilian UAV operations in IMT-2020 networks and improving quality of UAV application service, a set of functionalities is needed to bridge the gap for interoperation between UAS and IMT-2020 networks. This Recommendation provides a functional architecture for UAVs and UAV controllers using IMT-2020 networks and functionalities defined in application layer, service and application support layer, and security capabilities. The motivation of this Recommendation is to solve the issues of civilian UAVs accessing and communicating in IMT-2020 networks using its transmission capabilities.

**[ITU-T Y.4477 “Framework of service interworking with device discovery and management in heterogeneous Internet of things environments”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14816)** specifies a framework of service interworking with device discovery and management in heterogeneous Internet of things (IoT) environments.

[**ITU-T Y.4478 “Requirements and functional architecture for smart construction site services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14817) introduces requirements and functional architecture for smart construction site (SCS) services with a concept, its goals and key components. SCS services offered by a system integrator can deploy and operate various techniques for construction units to effectively improve the remote management level of the construction site and accelerate the speed of handling hidden dangers. This Recommendation analyses common characteristics and specifies requirements of SCS services and describes a functional architecture of smart construction site service platform (SCS-SP) and smart construction site devices (SCS-D).

[**ITU-T Y.4480 “Low power protocol for wide area wireless networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14818) describes a protocol for wide area wireless networks, which is optimized for battery-powered end-devices that may be either mobile or mounted at a fixed location. Note: This protocol is technically equivalent to (and compatible with) the LoRaWAN® protocol (version 1.0.4).

[**ITU-T Y.4562 “Functions and metadata of spatiotemporal information service for smart cities”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14833): In a city, there are the basic elements like people, things and events. Their mobility and positioning are increasingly dependent upon information related to location and/or time, supported by a spatiotemporal information service (STIS). Although related services have already emerged and been provided, the lack of standards may affect their sharing, service capabilities, and interoperability. Therefore, a standard is needed to specify what kinds of STIS should be provided for people, things and events in smart cities, including the functions and metadata of STIS. This Recommendation introduces the concepts of STIS for smart cities, and specifies the functions and metadata of STIS. The functions and metadata of STIS can support the applications of STIS for smart cities, so as to better meet the needs of people, things and events. The functions and metadata are universal and can be applied to any cities in the world.

**[ITU-T Y.4563 “Requirements and functional model to support data interoperability in IoT environments”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14819)** specifies requirements and functional model to support data interoperability in IoT environments. The relevant requirements and technologies that support the data interoperability have been proposed here.

[**ITU-T Y.4809 “Unified IoT Identifiers for Intelligent Transport Systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14739) defines field formats for identifying road signs/signals and identifies specific values for identifiers of such signs/signals.

[**ITU-T Y.4810 “Requirements of data security for the heterogeneous IoT devices”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14820): Deploying existing data security solutions to the Internet of Things (IoT) presents challenges because of limited hardware and software resources, IoT device management and IoT deployment specific scenarios. This Recommendation aims to describe requirements of data security for the heterogeneous IoT devices under specific scenarios. With the purpose of providing a general reference recommendation for data security for the heterogeneous IoT devices, with the purposes of ensuring data safety for IoT.

[**ITU-T Y.4811 “Reference framework of converged service for identification and authentication for IoT devices in decentralized environment”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14821) targets to develop a converged identification and authentication service to overcome relevant challenges in decentralized IoT identification and authentication management systems, so as to ensure efficient communication among IoT devices and services in decentralized environment. The challenges in decentralized environment are to support effective and efficient interactions (e.g. secured interoperability, scalability, low latency, etc.) among huge number of IoT devices and IoT services, which are using different decentralized IoT identification and authentication systems. This Recommendation introduces a converged service for identification and authentication for IoT devices in decentralized environment (CSIADE), and provides relevant common characteristics, general requirements, functional architecture, main capabilities and procedures of CSIADE. CSIADE can facilitate IoT devices and IoT services to identify and authenticate each other in IoT decentralized environments when they use same or different types of decentralized IoT identification solutions.

I.4.4 Connected vehicles, automated driving and intelligent transport systems

[**ITU-T F.749.5 (H.VDS-UC) | ISO 23239-1 “Vehicle domain service: General information and use case definitions”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14792)**:** Connected vehicles are expected to expand and become even more popular in different markets worldwide. A variety of technologies are being developed and discussed for many applications. This document provides a basic definition of vehicle domain service and supplementary information on detailed concepts, as well as definitions of the typical and supplementary use cases being used to define the specification of applications. Detailed specifications of communications and applications are provided in other documents in the series, and they are not provided in this Recommendation.

**ITU-T H.551 “Architecture of vehicular multimedia systems” (under approval)** defines the configuration for vehicle multimedia systems (VMSs), the reference model of VMS architecture, and the reference solution for VMS multimedia applications. VMS security issues and personally identifiable information protection and privacy issues are also described.

I.4.5 Connected health: e-Health

[**ITU-T X.1080.2 “Biology to machine protocol”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14795) allows a medical centre remotely to monitor a patient and to retrieve information from that patient. It defines a general protocol for exchange of biometric information from a patient facility to a medical expert facility. It also allows the medical expert facility to control the sensors and other devices at the patient facility and to establish the environment for a monitor session at the patient facility. It also defines a versatile and open-ended information model that allows any type of medical and non-medical information to be transferred.
Recommendation ITU-T X.1080.2 is a biosignal communication protocol between computing devices and biological systems. X.b2m protocol is based upon an aggregation of the interactions between a computing device and the biological system. Biometric interactions are described using the telebiometric multimodal model as defined by [ITU-T X.1081], which is a three-layer model combining the sciences, sensors, and metric layers. X.b2m is a horizontal market protocol designed to be used for all IoT biometric metric applications i.e. aerospace, medical, automotive, industrial and consumer markets. For the case of clinical medical trials, ITU-T X.1080.2 protocol enriches the application with a versatile and open-ended information model filled with interaction descriptions thereby ensuring an accurate comparison of measurement processes.

I.5.1 New security standards

**ITU-T G.9978 (revised) “Secure admission in G.hn network”** (under approval) specifies secure admission methods that are needed for a G.hn node to establish a secure domain (SD) and admit other G.hn nodes to the SD. These methods include media access control (MAC) authorization-based Nsecure admission, push button pairing, autopairing and passphrase-based secure admission. The Recommendation also specifies the mechanism for selecting appropriate secure admission methods and addresses interactions between these different secure admission methods.

**ITU-T G.Suppl.OTNsec “Optical transport network security”** (under publication) describes optical transport security applications, requirements and the use of multiple OTN signals and structures to assist in implementing security solutions.

**[ITU-T X.501 Amd.1 “Information Technology - Open systems Interconnection - The Directory – Models: Draft amendment 1 (to Rec. ITU-T X.501(2019) | ISO/IEC 9594-2:2020): Miscellaneous enhancements”](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14790)** has successfully gone through the enquiry state at ISO/IEC and ISO/IEC does not anymore accept any technical comments. ITU-T SG 17 members have been part of the ISO/IEC ballot process and have had ample opportunities in the past to influence the technical content.

[**ITU-T X.1011 “Guidelines for continuous protection of service access process”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14793): To prevent the unauthorized access to information and the abuse of ICT resources is fundamental to the cybersecurity. An extensive effort had been made towards the standardization of identity and access management. However, the access environment is continuously changing and traditional mechanisms could not deal with the challenges of current security threats. Firstly, traditional data center infrastructure is moving to the cloud, consequently the perimeter security device for traditional data center is not applicable to cloud data center. Secondly, internal threats are becoming more and more serious, e.g. authorized user trying to perform dangerous operations caused by negligence, and internal users being attacked by social engineering which may lead to impersonation risk. Thirdly, the status of the device or resource may become insecure during access process, e.g. OS or software in device and resource platform getting compromised by exploitation of misconfigure, and access request being intercepted, etc. Service access process is the process during the interval between a subject initiating access requests and receiving responses from a service, which may include a variety of above mentioned security threats. In order to deal with above challenges, it is crucial to continuously analyse related security status, keep the rationality of access activity, protect the security of access process and prevent unsecure access. Referring to the zero trust in current security industry, this recommendation is to define a reference framework for keeping continuous protection of service access process.

**[ITU-T X.1047 “Security requirements and architecture for network slice orchestration and management”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14794)** establishes security requirements and architecture for network slice management and orchestration, as well as automatic creation of end-to-end (E2E) network slices with customized security capabilities, to deploy full-scale E2E network slicing for consumer, business and government segments.
Mobile communication has enriched people’s lives. In the future, there is no reason to doubt that mobile communication will continue to develop, reaching industries such as automotive, manufacturing, logistics and energy, as well as sectors such as finance and healthcare that do not currently fully exploit the potential of mobile services. However, various applications have different requirements. Some applications may require ultra-reliable communication, whereas others may require ultra-high-bandwidth communication or extremely low latency. So, network slicing has been introduced to offer a different mix of capabilities to meet all these diverse requirements at the same time.
With network slicing, various types of users or customers can enjoy connectivity and data processing tailored to their specific requirements (e.g., data speed, quality, latency, reliability, security and pricing model) that adhere to a service level agreement agreed with consumers, enterprises and vertical industries. However, there are some challenges for implementing full-scale E2E network slicing deployments for consumer, business and government segments, e.g., E2E precision slicing, network slice reliability, network slice scalability and network slice lifecycle management. One of the most important challenges is network slice security, which is beginning to receive attention from academia and industry.
[b-3GPP TR 33.811] studies security for network slice management exposure interface and integrity protection of the network slice subnet template, and [3GPP TS 33.501] specifies management security for network slices (e.g., authentication, authorization, integrity protection, and confidentiality protection for the interface between the management service producer and the management service consumer) based on the study. [b-3GPP TR 33.813] studies network slice specific authentication and authorization, data confidentiality and integrity, user identification privacy and inter-slice security isolation.

**[ITU-T X.1080.2 “Biology to machine protocol”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14795)** allows a medical centre remotely to monitor a patient and to retrieve information from that patient. It defines a general protocol for exchange of biometric information from a patient facility to a medical expert facility. It also allows the medical expert facility to control the sensors and other devices at the patient facility and to establish the environment for a monitor session at the patient facility. It also defines a versatile and open-ended information model that allows any type of medical and non-medical information to be transferred.
Recommendation ITU-T X.1080.2 is a biosignal communication protocol between computing devices and biological systems. X.b2m protocol is based upon an aggregation of the interactions between a computing device and the biological system. Biometric interactions are described using the telebiometric multimodal model as defined by [ITU-T X.1081], which is a three-layer model combining the sciences, sensors, and metric layers. X.b2m is a horizontal market protocol designed to be used for all IoT biometric metric applications i.e. aerospace, medical, automotive, industrial and consumer markets. For the case of clinical medical trials, ITU-T X.1080.2 protocol enriches the application with a versatile and open-ended information model filled with interaction descriptions thereby ensuring an accurate comparison of measurement processes.

**[ITU-T X.1408 “Security threats and requirements for data access and sharing based on distributed ledger technology”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14801)**: A distributed ledger technology (DLT) is defined as a shared digital ledger, or a continually updated list of all transactions. Data is accessed by a data controller (organization) and is possibly transferred to a data processor (organization) that will be responsible for processing the data on behalf of the data controller. A data controller should determine the purpose and the manner in which the data will be processed according to the constraints imposed by the data policy set by organizations. In this context, there is a necessity of trusted and transparent solution to enhance
1) traceability of the data being accessed by data controllers and data processors directly or indirectly;
2) verifiability that if the data was accessed, used, and transferred without violating the data policy set by organizations, and;
3) changeability of data status in case of modification of data policy or any other cases.
An important aspect of this solution is to enable trust and transparency on data accountability and provenance & usage tracking. It should offer transparent and controlled data access, sharing and processing, so that unauthorized users or untrusted servers cannot process data without the authorization.
This Recommendation focuses on the solution which provides a way to improve traceability of data, verifiability of data, and changeability of data status. The solution is suitable for implementation using private distributed ledger technology where data is accessed and shared less frequently. This Recommendation provides security threats and requirements for data access and sharing based on the distributed ledger technology (DLT). It describes the framework and models for data access and sharing based on DLT. It identifies entities and their roles for data access and sharing based on DLT. It also identifies security threats. In addition, security requirements that address these security threats are described.

**[ITU-T X.1470 “Security guidelines of web-based online customer service”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14803):** Web-based online customer service is an important service for a service provider. It contains the user's important data and provides critical operational functions of the user’s services. It is the service provider’s responsibility to provide security to web-based online customer service. This Recommendation analyses the security threats of web-based online customer service in three aspects: network security, system security, service security It specifies security guidelines of web-based online customer service and corresponding security measures. It also proposes test procedures to verify the specified security requirements are satisfied by corresponding security measures. This Recommendation can help service providers to ensure their web-based online customer services’ security and protect benefits of their users.

[**ITU-T X.1712 “Security requirements and designs for quantum key distribution networks - key management”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14805) specifies security threats and security requirements for key management in quantum key distribution networks (QKDNs), and then it specifies security measures of key management to meet the security requirements. This Recommendation provides support for design, implementation, and operation of key management in QKDN with approved security.

[**ITU-T X.1770 “Technical guidelines for secure multi-party computation”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14807): Multi-party computation (MPC) could build trust and security in data collaboration and big data analysis related areas. Data has become one of the most important assets in ICT area. MPC plays a very important role in balancing data usage and data protection. The purpose of this recommendation is to provide technical guidelines for MPC, and provide technical and standard basis for ICT stakeholders to use MPC to protect data in data collaboration and big data analysis scenarios. It also describes applications on what MPC can be used for and how to use MPC. It can provide reference for ICT stakeholders to develop MPC applications. The content of the Recommendation includes:
• Technical framework of MPC: defines the elements in MPC and the work flow between the elements;
• Security levels of MPC protocols: analyse and define the security model and threshold;
• Applications of MPC: describe different use cases of MPC, including scene description, processes, etc.
Based on this recommendation, standards for MPC applications in different fields can be defined.

**ITU-T Y.3808 “Framework for integration of quantum key distribution network and secure storage network”** (under approval): For quantum key distribution networks (QKDN), this Recommendation provides an overview of secure storage networks (SSNs). It specifies functional requirements, functional architecture model, reference points and operational procedures for SSNs.

**ITU-T Technical Paper QSTR-USSD “Low resource requirement, quantum resistant, encryption of USSD messages for use in financial services”** (under publication): According to ITU-T QSTR-SS7-DFS "SS7 vulnerabilities and mitigation measures for digital financial services transactions" USSD is a main medium in which financial fraud is being committed. Due to its clear text form and lack of authentication, fraudsters can gain unlawful access to victim's accounts and transfer money out. The purpose of the Technical Report is to examine new technologies for encryption of USSD in end-to-end manner and estimate its applicability to be integrated into existing USSD technology, suggesting new recommendation and signalling requirements for the integration of such technology into the existing reference architecture. The Technical Report focuses both on the core-network end and on the UE end, to recommend the appropriate and most secure location for such encryption technology to me implemented. Another aspect of this Technical Report is to examine the encryption under quantum computing attacks, and to set the standard for quantum resistant encryption in telecom.

I.5.2 Quantum key distribution networks

[**ITU-T X.1712 “Security requirements and designs for quantum key distribution networks - key management”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14805) specifies security threats and security requirements for key management in quantum key distribution networks (QKDNs), and then it specifies security measures of key management to meet the security requirements. This Recommendation provides support for design, implementation, and operation of key management in QKDN with approved security.

[**ITU-T Y.3805 “Quantum Key Distribution Networks - Software Defined Networking Control”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14770) specifies the requirements, functional architecture, reference points, hierarchical SDN controller and overall operational procedures of SDN control.

**ITU-T Y.3807 “Quantum Key Distribution networks – QoS parameters”** (under approval) specifies an overview on networks supporting quantum key distribution (QKD). For the purpose of design, deployment, operation and maintenance to support QKD network (QKDN) implementation, the required quality level of quantum key distribution service should be identified and quantified. ITU-T Recommendation Y.3806 describes high-level and functional Quality of Service (QoS) requirements for QKDN. This Recommendation helps to quantify what kind of QoS requirements should be monitored and measured for this purpose; QoS parameters. This Recommendation describes QoS and Network Performance (NP) on QKDN and specifies the associated relative parameters for QoS and their definitions.

**ITU-T Y.3808 “Framework for integration of quantum key distribution network and secure storage network”** (under approval): For quantum key distribution networks (QKDN), this Recommendation provides an overview of secure storage networks (SSNs). It specifies functional requirements, functional architecture model, reference points and operational procedures for SSNs.

**ITU-T Y.3809 “Quantum Key Distribution Networks - Business role-based models”** (under approval): This Recommendation describes business roles, business role-based models, and service scenarios in Quantum Key Distribution Network (QKDN) from different deployment and operation perspectives with existing user networks for supporting security applications services. This draft Recommendation can be used as a guideline for applying QKDN from business point of views as well as for deployment and operation of QKDN from telecom operators’ point of views.

I.5.3 Trust

[**ITU-T X.1770 “Technical guidelines for secure multi-party computation”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14807): Multi-party computation (MPC) could build trust and security in data collaboration and big data analysis related areas. Data has become one of the most important assets in ICT area. MPC plays a very important role in balancing data usage and data protection. The purpose of this recommendation is to provide technical guidelines for MPC, and provide technical and standard basis for ICT stakeholders to use MPC to protect data in data collaboration and big data analysis scenarios. It also describes applications on what MPC can be used for and how to use MPC. It can provide reference for ICT stakeholders to develop MPC applications. The content of the Recommendation includes:
• Technical framework of MPC: defines the elements in MPC and the work flow between the elements;
• Security levels of MPC protocols: analyse and define the security model and threshold;
• Applications of MPC: describe different use cases of MPC, including scene description, processes, etc.
Based on this recommendation, standards for MPC applications in different fields can be defined.

**[ITU-T Y.3057 “A trust index model for ICT infrastructures and services”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14769)** describes a trust index model for ICT infrastructures and services. In order to provide a commonly applicable way for evaluating trust that covers different characteristics, trust index is a key concept for trust provisioning by considering trust value chain in ICT environment. Particularly, trust index, which can evaluate and quantify trust of stakeholders, is a comprehensive accumulation of trust indicators. This Recommendation identifies trust indicators that represent fundamental criteria for evaluating trust of entities in ICT environments. To represent characteristics of trust, trust indicators are categorized into two parts: objective trust indicators and subjective trust indicators. A list of trust indicators and an application of trust index are introduced.

I.5.4 Distributed Ledger Technology

[**ITU-T L.1317 “Guidelines on energy efficient blockchain systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14718)**:** Several models have been introduced to calculate the urban energy system and to demonstrate the variants that calibrate the local energy efficiency. This Recommendation focuses on the impact of blockchain in energy efficiency. A literature analysis is performed with regard to the understanding of the blockchain energy demands and how these can be optimized. The aim of this Recommendation is to explain the energy demand of blockchain, to define the blockchain energy model and to describe the energy efficiency parameters that can be calibrated in order to enhance the corresponding energy efficiency.

[**ITU-T X.1408 “Security threats and requirements for data access and sharing based on distributed ledger technology”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14801): A distributed ledger technology (DLT) is defined as a shared digital ledger, or a continually updated list of all transactions. Data is accessed by a data controller (organization) and is possibly transferred to a data processor (organization) that will be responsible for processing the data on behalf of the data controller. A data controller should determine the purpose and the manner in which the data will be processed according to the constraints imposed by the data policy set by organizations. In this context, there is a necessity of trusted and transparent solution to enhance
1) traceability of the data being accessed by data controllers and data processors directly or indirectly;
2) verifiability that if the data was accessed, used, and transferred without violating the data policy set by organizations, and;
3) changeability of data status in case of modification of data policy or any other cases.
An important aspect of this solution is to enable trust and transparency on data accountability and provenance & usage tracking. It should offer transparent and controlled data access, sharing and processing, so that unauthorized users or untrusted servers cannot process data without the authorization.
This Recommendation focuses on the solution which provides a way to improve traceability of data, verifiability of data, and changeability of data status. The solution is suitable for implementation using private distributed ledger technology where data is accessed and shared less frequently. This Recommendation provides security threats and requirements for data access and sharing based on the distributed ledger technology (DLT). It describes the framework and models for data access and sharing based on DLT. It identifies entities and their roles for data access and sharing based on DLT. It also identifies security threats. In addition, security requirements that address these security threats are described.

I.6.1 Green ICT standards

**ITU-T L.1016 “Method for evaluation of the environmental, health and safety performance of true wireless stereo headphones”** (under approval): In recent years, more and more headphones belonging to the group of True Wireless Stereo products are sold. In 2019, sales of TWS earbuds surpassed the sales of (non-TWS) wireless earphones. The advent of True Wireless Stereo headphones raises the question on their performance in terms of health and safety of the user. There is a close link between the health/safety of the user and substances used in True Wireless Stereo headphones. The concept of products with minimal substances of concern and phasing out of harmful substances for non-essential uses is one of the key aspects in the European Sustainable Chemicals Strategy, which is an important building block towards a zero pollution goal, essential for a circular economy. While the idea of non-essential uses is somewhat new in EU legislative initiatives, it originates from the 1978 US Toxic Substances Control Act, and was taken up by other countries like Canada. The concept was finally enshrined in the Montreal Protocol, designed to protect the ozone layer. As more and more countries recognize the importance of a circular economy to combat climate change, the notion of products with minimal substances of concern gains relevance. With increasing relevance, the need for a method to compare the environmental, health and safety performance of TWS products is rising. This Recommendation aims to establish a methodology to evaluate a score of aforementioned aspects.

**[ITU-T L.1033 “Guide for the institutions of higher learning to contribute in the effective life cycle management of e-equipment and e-waste”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14715):** Managing e-waste has been a major problem in many countries. Emerging economies still face a multitude of challenges that hinder the effective management of e-equipment and e-waste. Many of them do not have suitable facilities to handle e-equipment and e-waste and have inadequate implementation frameworks and structures due to: the lack of quantifiable data and statistics on e-equipment and e-waste, inadequate policies, regulations, standards and enforcement strategies, low stakeholder engagement/collaboration and limited expertise. Institutions of higher learning have a crucial role in leading society through their influence and development of individuals. As societal issues become more complex and the boundaries between academia, industry, and government become unclear, institutions of higher learning must remain the cornerstone of development. Universities, among other higher learning institutions, are better placed to ensure that circularity of EEE is achieved so as to minimize the effects of WEEE. The role of universities as examples of institutions of higher learning, is to offer training, carry out research and share knowledge, ideas, research output and innovations developed and applied for their own benefit and for their surrounding communities. Universities have the capacity to develop curriculum on life cycle- economy processes, including e-waste management, for formal training and material for informal and non-formal training. Universities can also join efforts to research and provide reliable information that can be used in policy formulation, development of standards and strategies on imports and exports to the region. This Recommendation aims therefore to be a guide for institutions of higher learning to collaboratively contribute on key aspects of managing e-resources and e-waste. It explores how institutions of Higher learning can engage in EEE circularity by checking their effective involvement in every EEE and WEEE process.

**ITU-T L.1035 “Sustainable management of batteries”** (under approval): Batteries are crucial for the functioning of information and communication technologies (ICTs). Improving their design, prolonging their lifespan, improving their recyclability and preventing the dumping of waste batteries can lower their overall energy consumption, reduce exposure of humans and the environment to hazardous substances and reduce global greenhouse gas emissions. This Recommendation provides guidance on the sustainable management of used batteries in ICT equipment and the environmentally responsible management of waste batteries from ICT products, including waste prevention, minimization, recycling, recovery and final disposal. It also provides information on best practices in recycling batteries for dissemination.

**ITU-T L.1036 “Scheduled waste management for base station (inclusive of e-waste)” (under approval)** was developed pursuant general environment quality act of the members country. At the moment, there is no standard governing the scheduled waste specifically in Base Station (BS). Upon the enrolment of 5G era, it is expected a huge global discharge of telecommunication equipment and upgrading of equipment at each BS, globally. This Recommendation is an extension to any requirement as stipulated in national Environment quality or protection acts, a technical requirement for telecommunication industry to adopt as a practice to reduce scheduled waste including e-waste at the Base Station (BS), as well as it provides guidance on how to dispose e-waste from a base station including the shared responsibility of owners and third parties involved.

**ITU-T L.1331 (revised) “Assessment of mobile network energy efficiency” (under approval)** aims to provide a better understanding of the energy efficiency of mobile networks. The focus of this Recommendation is on the metrics and methods of assessing energy efficiency in operational networks. The networks considered are those whose size and scale could be defined by topologic, geographic or demographic boundaries. This Recommendation explains how to extrapolate the measurements made on partial networks to the level of the total network. Such a simplified approach is proposed as a way of making approximate energy efficiency evaluations at the level of network elements and cannot therefore be considered sufficient for the entire network operation including, for example, transport.

**[ITU-T L.1383 “Smart energy solutions for cities and home applications”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14719)** focuses on smart energy solutions in different application scenarios basically on energy saving and carbon emission reduction. Besides their application in the field of ICT, such as base stations, data centers and telecom centers, smart energy solutions have eventually been applied in cities and homes as the advanced update of ICTs. Cities play a different role in different parts of the world. With the development of smart energy technologies, in cities is possible to answer key issues worldwide due to the urgent necessity of GHG emissions reduction. This Recommendation includes specific smart energy applications in cities and homes such as energy sources, energy management functions, etc.

[**ITU-T L.Suppl.45 “Radio base station site best practices”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14883) contains best practices for the realization of radio site to improve site energy efficiency (SEE) of a site as defined in ITU-T L.1350 and considering the measurement method reported in ITU-T L.1351. The supplement contains cases about:

• Radio base station site from indoor to outdoor; SEE improvement 64%

• Intelligent OSS implementation

• Room modernization; SEE improvement 19%.

**[ITU-T L.Suppl.46 “Definitions and Recent Trends in Circular Cities”](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14884)**: Circularity in cities appears to be more that then sum of multiplication of urban circular economies and it is increasingly the subject of policy innovations, urban strategies, and research & development agendas. However, it remains unclear the concept of circular city and the terminology that deals with it, regardless the emerging scientific and political attention that it gains. The aim of this document is to provide with definition and conceptualization the circular city; to identify the terminology that deals with circular city; to define these terms; and to uncover the recent trends of circular city, based on systematic literature review and bibliometric analysis. The main elements examined in this document are:

- The definition of circular cities

- The determination of a conceptual architecture of circular cities

- The identification of recent trends in circular city.

I.6.2 Electromagnetic fields

[**Recommendation ITU-T K.70 Amd.1 “Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations - Appendix I: Software "EMF-estimator" v8.0.32 and v8.64” (revised)**](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14880)**:** The EMF-estimator software has been developed to support the application of the methods described in this Recommendation. It may help to make an estimation of the cumulative exposure in the vicinity of transmitting stations in the case of many different transmitting systems operating at different frequencies. The EMF-estimator is one of the available programs that may be used for that purpose. This software is not intended to be used, and in fact cannot be used, for any certification procedure of the transmitting equipment.

**ITU-T K.83 (revised) “Monitoring of electromagnetic field levels” (under approval)** gives guidance on how to make long-term measurements for the monitoring of electromagnetic fields (EMF) in the selected areas that are under public concern, in order to show that EMFs are under control and under the limits. The purpose of this Recommendation is to provide for the general public clear and easily available data concerning electromagnetic field levels in the form of results of continuous measurement.

**ITU-T K.91 (revised) “Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields” (under approval)**: There are many possible methods of exposure assessment and each of them has its own advantages and disadvantages. Recommendation ITU-T K.91 gives guidance on how to assess and monitor human exposure to radio frequency (RF) electromagnetic fields (EMFs) in areas with surrounding radiocommunication installations based on existing exposure and compliance standards in the 8.3 kHz to 300 GHz range. This includes procedures for evaluating exposure and how to show compliance with exposure limits with reference to existing standards. Recommendation ITU-T K.91 is oriented to the examination of the area accessible to people in the real environment of currently operated services with many different sources of RF EMF, but also gives references to standards and Recommendations related to EMF compliance of products. Recommendation ITU-T K.91 includes an electronic attachment containing an uncertainty calculator and the Watt guard modules.

**ITU-T K.124 (revised) “Overview of particle radiation effects on telecommunication systems” (under approval)** provides basic guidance on soft errors that are caused by particle radiation and that affect telecommunication systems. This Recommendation details the phenomena of soft errors that arise from particle radiation. A brief explanation of the procedures for design, test and mitigation measures are also included in this Recommendation.

**ITU-T K.130 (revised) “Neutron irradiation test methods for telecommunication equipment” (under approval)** describes soft error test methods for the telecommunication equipment that composes carrier telecommunications networks. The objective of soft error tests of the telecommunication equipment using an accelerator-driven neutron source is described first. An overview of the soft error tests and operating principles of an accelerator-driven neutron source are then introduced. The requirements of the accelerator-driven neutron sources and test sites are specified. The test conditions including test set-up, operational conditions and error monitoring and test procedures for the telecommunication equipment are specified. Notes for determining specific detailed test methods, such as the neutron flux to be used for irradiation and conditions for counting as failures in estimation of the reliability are also described.

**ITU-T K.131 (revised) “Design methodologies for telecommunication systems applying soft error measures” (under approval)** describes the principles and design methods for soft error measures for the equipment that composes carrier telecommunications networks. It also describes basic configurations of telecommunication equipment, definitions and methods to determine reliability requirements and procedures for the design of equipment from the perspective of mitigation of failures caused by soft errors. Also included are the methods to determine the areas, e.g., circuit blocks or circuit packs, requiring soft error measures in telecommunication equipment in order to conform to the reliability requirements. The main design issues to be considered for soft error measures are described as well as the actual design methods for the application of measures against soft errors and their effects. Finally, the reliability evaluation methods using theoretical calculations and tests of actual equipment are described to confirm the effect of the applied measures and conformity to the reliability requirements.

**ITU-T K.137 (revised) “Electromagnetic compatibility requirements and measurement methods for wireline telecommunication network equipment” (under approval)** specifies the electromagnetic compatibility (EMC) common requirements and test methods for wireline telecommunication network equipment, used in public telecommunication networks to provide telecommunication services, including voice, data, audio and video to end-users, using all applicable media and all types of wireline access technologies, such as digital subscriber line (DSL), plain old telephone service (POTS), Ethernet, E1, fibre. Test conditions for all types of wireline telecommunication network equipment are described, e.g., access equipment, router and switching equipment, optical transmission equipment, data centre and cloud computing equipment. This Recommendation describes the specific testing levels to be applied to wireline telecommunication environments, such as telecommunication centres, customer premises and outdoor locations.

**ITU-T K.138 (revised) “Quality estimation methods and application guidelines for mitigation measures based on particle radiation tests” (under approval)** describes the reliability estimation methods based on the results of a neutron irradiation test taking into account the severity of the effect caused by soft errors. The soft error rate in the natural environment has to be calculated from the number of soft errors that occur during a neutron irradiation test. The severity of the impact of a soft error on telecommunications systems, such as the impact on the client signal and control system is analysed from the error logs created during the test. Additional mitigation measures should be applied if the equipment is less reliable than the target level. This Recommendation also provides guidelines for applying these mitigation measures in light of the results of soft error tests.

**ITU-T K.139 (revised) “Reliability requirements for telecommunication systems affected by particle radiation” (under approval)** describes the reliability requirements for telecommunication equipment in relation to the soft errors that are caused by particle radiation. The principles for determination of reliability requirements are described and three types of reliability requirements (alert function reliability, service reliability and maintenance reliability) are defined. Three reliability classes for each type of requirement are defined based on the acceptable soft error failure rate. Specific values are determined for each type and class of reliability requirement.

**ITU-T K.151 “Electrical safety and lightning protection of medium voltage input and up to ±400VDC output power system in ICT data centre and telecommunication centre” (under approval)** provides guidelines for electrical safety and lightning protection requirements for medium voltage power electronic converter systems, which has medium voltage input with rated system voltages from 1 000 V AC up to 36 kV AC and low voltage output with rated voltages up to ±400V DC, used in ICT data centre, telecommunication centre, or other application environments. With the development of big data and cloud computing technology, the quantity and total capacity of the data centres and telecommunication centres together with ICT equipment power densities are increasing rapidly. In this condition, it was found that the traditional power distribution equipment and power systems had the disadvantages of low energy efficiency, high energy consumption, high maintenance difficulties, high cost in lots of existing data centres and telecommunication centres. In order to solve the problems above, it is necessary to develop a new structure of whole power system, which may be powered directly by medium voltage and based on power electronic conversion. From the perspective of electrical safety and lightning protection, there are lots of differences between the data centre and telecommunication centre powered by traditional low-voltage AC and that of powered by medium voltage. This Recommendation will be focused mainly on electrical insulation, partial discharge, electrical safety, resistibility and lightning surge protection.

**[ITU-T K.Suppl.13 (revised) “Radiofrequency electromagnetic field (RF-EMF) exposure levels from mobile and portable devices during different conditions of use”](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14881)**: Modern mobile devices may be used for many different purposes. There are differences between the ways of using them depending on the service. Also, the exposure to radio frequency electromagnetic field (RF-EMF) is different depending on the service, environment and the conditions of the use of the mobile devices. This Supplement describes various factors that determine the level of RF-EMF exposure, as defined by the specific absorption rate (SAR) that is induced in the users of mobile and portable radiocommunication devices. Based on this technical information, practical information and guidance is provided for users of mobile devices.

**ITU-T K.Suppl.20 (revised) “Supplement on radiofrequency exposure evaluation around underground base station”** (under publication): Measurement and computation methods of human exposure to electromagnetic fields (EMFs) from fixed radio sources like mobile base stations have been standardized and published as ITU T K series Recommendations and IEC 62232. These also include methods prescribed in Japanese regulation and have been basically assumed to be applied to radio sources installed above the ground. Underground base stations for use in small cells of fourth generation (4G) mobile networks are installed underground to construct service areas above the ground and also expected to be used for fifth generation (5G) mobile networks. Supplement 20 to ITU-T K-series Recommendations contains the measurement and full-wave computation results of radio frequency exposure from underground base stations, to evaluate the exposure from these base stations.

I.7.1 Economic impact of IXP, Universal service, NGN, Mobile Roaming and SMPOTT and Valuation of spectrum

[**ITU-T D.1102 “Customer redress and consumer protection mechanisms for OTTs”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14730) proposes possible customer redress and consumer protection mechanisms related to the provision and consumption of OTTs. This comes in the wake of the increasing use of over the top (OTT) applications for voice calling, instant messaging and video calling in the absence of an international framework to ensure consumer protection and redress where necessary.

[**ITU-T Supplement 5 to Recommendation ITU-T D.52 “Implementation guidelines for Recommendation ITU-T D.52 focusing on operationalization of regional Internet exchange points”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14730) is focused on addressing the challenges related to the operationalization of regional internet exchange points and identifying the most cost-effective mechanisms for interconnecting regional Internet exchange points.

I.8 Quality of service and experience, and network performance

[**ITU-T G.1027 “QoS metrics for the assessment of the impact of fixed geographic structures on telephony quality and call stability”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14822)**:** Often, poor call stability or a degradation in speech quality is associated with natural or artificial geographic or topological structures, such as tunnels, ravines or noise barriers. This Recommendation extends ITU-T Rec. G.1034 by defining a set of metrics which describe call stability and changes of speech quality related to such structures.

[**ITU-T G.1035 (revised) “Influencing factors on quality of experience for virtual reality services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14826) classifies virtual reality (VR) services and identifies the key quality of experience (QoE) factors of VR.

[**ITU-T P.565 (revised) “Framework for creation and performance testing of machine learning based models for the assessment of transmission network impact on speech quality for mobile packet-switched voice services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14827) provides the output of the framework which is a machine learning based speech quality prediction model that predicts the impact on the speech quality from the Internet protocol (IP) transport and underlying transport, as well as a standardized or pre-defined jitter buffer in the end client; thus, providing a network centric view on the speech quality service delivered on mobile packet switched networks. This is expressed in terms of a mean opinion score-listening quality objective (MOS-LQO) under the assumption of an otherwise clean transmission, without background noise, non-standard-conformant encoding on sending device, automatic gain control, voice enhancement devices, transcoding, bridging, frequency response, non-standard-conformant jitter-buffer (for IMS mobile calls) or decoding, clock drift or any other impairment not caused by the IP transport and underlying transport. The models according to this framework can use information on the temporal structure of the reference signal to identify the importance of individual sections of the bitstream with regard to speech quality. These models do not perform any perceptual analysis of the recorded speech signal. The framework specifies three modules required for the development of these kinds of metrics: the databases generator module, the machine learning module, and the validation module for the trained model. In addition, the database content and the features used by the machine learning algorithm are described. The framework also provides a large set of test vectors, in the form of error (jitter and packet loss) patterns files for learning and validation. This Recommendation specifies the minimum required performance, as well as conditions and requirements for an independent additional validation for models developed based on the framework. The Recommendation also specifies implementation requirements. The models developed based on the framework enable the assessment of transmission network impact on speech quality for mobile packet-switched voice services, and therefore benefit operators and regulators alike with a fast and easy speech quality trend monitoring/benchmarking and troubleshooting. In addition, if predictors according to this framework are used together with perceptual speech quality metrics like [ITU-T P.863], it is possible to identify if the source of problems resides inside or outside the transport network observed by the predictor according to this framework. Consequently, a more detailed analysis of the situation can be achieved and troubleshooting of less obvious degradations such as the ones occurring outside of the transport network (e.g., emerged from automatic gain control, voice enhancement devices, transcoding or analogue processing) is enabled.

**[ITU-T P.565.1 “Machine learning model for the assessment of transmission network impact on speech quality for mobile packet-switched voice services”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14823)** is based on the ITU-T P.565 framework. It provides a machine learning based model that predicts the impact on the speech quality from the Internet Protocol (IP) transport and underlying transport, as well as a standardized or pre-defined jitter buffer in the end client; thus, providing a network centric view on the speech quality service delivered on mobile packet switched networks. This is expressed in terms of a mean opinion score-listening quality objective (MOS-LQO) under the assumption of an otherwise clean transmission, without background noise, non-standard-conformant encoding on sending device, automatic gain control, voice enhancement devices, transcoding, bridging, frequency response, non-standard-conformant jitter-buffer (for IMS mobile calls) or decoding, clock drift or any other impairment not caused by the IP transport and underlying transport. The model supports the uses cases and applications defined in revised ITU-T P.565 for IMS mobile calls (VoLTE/VoNR with EVS, AMRWB codecs) and OTT/WhatsApp. In addition, it meets the minimum performance requirements for the provided test vectors (see ITU-T P.565, Annex D) and it also passed an independent validation on an additional unknown live recorded data set (see ITU-T P.565, Annex D). The model enables the assessment of transmission network impact on speech quality for mobile packet-switched voice services. In addition, if this predictor is used together with perceptual speech analysis or perceptual speech quality metrics like [ITU-T P.863], it is possible to identify if the source of problems resides inside or outside the transport network observed by the predictor.

**[ITU-T P.910 (revised) “Subjective video quality assessment methods for multimedia applications”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14828)** describes non-interactive subjective assessment methods for evaluating the one-way overall video quality for multimedia applications such as videoconferencing, storage and retrieval applications, telemedical applications, etc. These methods can be used for several different purposes including, but not limited to, selection of algorithms, ranking of audiovisual system performance and evaluation of the quality level during an audiovisual connection. This Recommendation also outlines the characteristics of the source sequences to be used, like duration, kind of content, number of sequences, etc.

ITU-T Y.3807 “Quantum Key Distribution networks – QoS parameters” (under approval) specifies an overview on networks supporting quantum key distribution (QKD). For the purpose of design, deployment, operation and maintenance to support QKD network (QKDN) implementation, the required quality level of quantum key distribution service should be identified and quantified. ITU-T Recommendation Y.3806 describes high-level and functional Quality of Service (QoS) requirements for QKDN. This Recommendation helps to quantify what kind of QoS requirements should be monitored and measured for this purpose; QoS parameters. This Recommendation describes QoS and Network Performance (NP) on QKDN and specifies the associated relative parameters for QoS and their definitions.

I.9 Conformity, interoperability and testing

ITU-T Q.5024 “Protocol for providing intelligent analysis services in IMT-2020 network” (under approval) specifies architecture for supporting intelligent analysis services in IMT-2020 network, and intelligent analysis services offered by Data Analysis Function (DAF) including load balancing, network functions fault location and advance warning, device on/off analysis, mobility analysis, etc. It includes signalling flows for network functions (NFs) event exposure to DAF and DAF analytics exposure to NFs, message format, and security considerations.

I.11 Combating Counterfeiting and the use of stolen ICT devices

**ITU-T Q.Suppl.75 “Use cases on the combat of counterfeit ICT and stolen mobile devices”** (under publication) collects use cases from ITU Members that reflects challenges, opportunities and results on the combat of counterfeit ICT and stolen mobile devices and, with this information compendium, assist new members in engaging better this problem. To facilitate this information collection, this document proposed a template to be used when including information from new sources, that can either be new members state engaging the problem or solution providers.

I.12 Signalling Protocols

**ITU-T Q.3061 “Signalling requirements for service function paths load balancing traceroute in service function chaining”** (under approval) specifies the signalling requirements for service function paths (SFPs) load balancing traceroute in service function chaining (SFC). The signalling is used for tracing and figuring out the set of load balanced SFPs more efficiently.

**ITU-T Q.3631 “Interworking between ISDN and the IP Multimedia (IM) Core Network (CN) subsystem”** (under approval) specifies the requirements for providing the interworking between ISDN and the IP Multimedia (IM) Core Network (CN) subsystem. This Recommendation endorses ETSI TS 183 036 (2021-02) “Core Network and Interoperability Testing (INT); ISDN/SIP interworking; Protocol specification”.

**ITU-T Q.5003 “Signalling requirement and architecture for federated multi-access edge computing”** (under approval): MEC is considered as a key successful factor in 5G era that can provide low latency user experience and huge data volume. Latency sensitive services are expected to have benefits from being hosted in the distributed cloud close to mobile network users. MEC services are typically envisaged as being offered and supplied by mobile network operators. These MEC systems have developing separately and become difference verticals, which will significantly increase the complexity for application providers in extending the reach of applications. To resolve this limitation, MEC providers need to adopt a federation model to interconnect each separated MECs with unified interfaces. As the federated members share their network and resource capabilities and secure interfaces between their systems, the total MEC coverage can be extended and consistent service delivery can be guaranteed. Thus, this Recommendation ITU-T Q.5003 specifies signalling requirements and architecture for federated MEC.

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