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| A black and white logo  Description automatically generated with low confidence | INTERNATIONAL TELECOMMUNICATION UNION  **TELECOMMUNICATION STANDARDIZATION SECTOR**  STUDY PERIOD 2022-2024 | | | TSAG-TD020 |
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| **Contact:** | | TSB | | E-mail: [tsbtsag@itu.int](mailto:tsbtsag@itu.int) |

|  |  |
| --- | --- |
| **Abstract:** | This report summarizes TSB facilitation of ITU-T activities from January to November 2022. |

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# Executive Summary

ITU approved 233 new and revised ITU-T Recommendations and related texts in the reporting period. The appendix to this report lists these texts as well as texts undergoing approval and summarizes their contents. Executive summaries of ITU-T study group meetings can be found on their respective [homepages](https://www.itu.int/en/ITU-T/studygroups/Pages/default.aspx). See [section 1](#_1_ITU-T_Study).

Six ITU-T focus groups are active. The focus groups on [AI for autonomous and assisted driving](https://www.itu.int/en/ITU-T/focusgroups/ai4ad/Pages/default.aspx) and [vehicular multimedia](https://www.itu.int/en/ITU-T/focusgroups/vm/Pages/default.aspx) concluded their activities in September 2022. Information on the activities and deliverables of ITU-T focus groups can be found on their respective [homepages](https://www.itu.int/en/ITU-T/focusgroups/Pages/default.aspx) and an index of these groups and their timeframes is provided in [section 2](#_2_ITU-T_Focus).

60 ITU-T [workshops and symposia](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/Pages/default.aspx) were organized in the reporting period, in addition to the weekly programming of the year-round [AI for Good](https://aiforgood.itu.int/) digital platform. See [section 3](#_3_Workshops_and). TSB facilitated 3,656 virtual meetings in the reporting period, welcoming 50,220 attendees. See [section 4](#_4_Virtual_meetings).

ITU-T currently hosts 265 Sector Members and 224 Associates. ITU Academia members now total 172. 54 of ITU-T's Associates are now participating under the reduced fee structure for small and medium-sized enterprises which came into effect on 31 January 2020. See [section 11](#_11_Membership).

The upcoming [AI for Good Global Summit](https://aiforgood.itu.int/) in Geneva, 6-7 July 2023, will feature world-renowned experts in AI and humanitarian action. It will be preceded by expert-oriented ML workshops on 5 July, drawing on expertise from the AI for Good Discovery programme. The AI for Good digital platform has reached an audience of over 300,000 people from 183 countries with the all-year, always-online format introduced in 2020. Over 11,000 people have created profiles on the new [AI for Good Neural Network](https://aiforgood.itu.int/neural-network/) since its launch in February 2022. See [section 5.1](#_5.1_Artificial_intelligence).

[ITU Security Clinics for Digital Financial Services (DFS)](https://figi.itu.int/itu-dfs-security-clinics/) offer guidance to regulators and DFS providers on adopting the security best practices developed under the [Financial Inclusion Global Initiative (FIGI)](https://figi.itu.int/). The [ITU DFS Security Lab](https://figi.itu.int/figi-resources/dfs-security-lab/) helps stakeholders to verify that these best practices are being followed. A growing number of countries are adopting the DFS security recommendations developed under FIGI and establishing their own DFS security labs with the support of ITU knowledge-transfer activities. See [section 5.2](#_5.2_Digital_financial).

The first edition of the [DC3 Conference: From Cryptocurrencies to Central Bank Digital Currencies](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2022/0125/Pages/default.aspx) was held online, 25-27 January 2022. The [second edition of the conference](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2023/0124/Pages/default.aspx) is scheduled for 24-27 January 2023 online. The Policy and Governance Working Group of the [Digital Currency Global Initiative](https://www.itu.int/en/ITU-T/extcoop/dcgi/Pages/default.aspx) finalized a [report on digital currencies and financial inclusion](https://www.itu.int/en/ITU-T/extcoop/dcgi/Documents/Final%20Report_DCGI_Digital%20Currencies%20and%20Financial%20Inclusion.pdf) in May 2022, providing high-level design principles for CBDC for financial inclusion. The report has been submitted to ITU-T SG3. See [section 5.2](#_5.2_Digital_financial).

The [United for Smart Sustainable Cities (U4SSC)](http://www.itu.int/en/ITU-T/ssc/united/Pages/default.aspx) initiative is supported by 18 UN bodies with the aim of achieving the SDG11 ("Make cities and human settlements inclusive, safe, resilient and sustainable"). Kyebi, Ghana, is the latest city to implement the [U4SSC Key Performance Performance Indicators](https://www.itu.int/en/ITU-T/ssc/united/Pages/publication-U4SSC-KPIs.aspx). The first [U4SSC Hub](https://u4ssc.itu.int/u4ssc-hub/) has been established in Austria. U4SSC published [two new reports](https://u4ssc.itu.int/publications/) in the reporting period on "Smart tourism: A path to more secure and resilient destinations" and "Redefining smart city platforms: Setting the stage for Minimal Interoperability Mechanisms". See [section 5.3](#_5.3_Smart_cities).

The [UN Climate Change Conference (COP27)](https://unfccc.int/cop27) was hosted by Egypt in Sharm El-Sheikh, 17-18 November 2022. ITU organized an exhibit – themed "Turning digital innovation into climate action to reach net zero" – with the support of a range of UN partners. TSB/ITU-T led ITU's organization of six COP27 events on sustainable digital transformation, addressing topics including e-waste and circular economy, emission reduction, and smart cities and communities. See [section 5.4](#_5.4_Environment,_climate).

The [ITU-UNECE Future Networked Car Symposium](https://fnc.itu.int/) was held online, 22-25 March 2022. The next edition, 13-16 March 2023, will also be held online. The annual symposium examines the latest advances in vehicle connectivity, automated mobility, and the role of artificial intelligence in ​the transport sector, sharing unique insight into associated implications for technology, business and regulation. See [section 5.5](#_5.5_Intelligent_transport).

The next [CxO Meeting](https://www.itu.int/en/ITU-T/tsbdir/CxO/Pages/CxO-20221206.aspx) will be held on 6 December 2022 at the Telecom Review Leader's Summit in Dubai, United Arab Emirates, with additional participation online, hosted by Telecom Review with the support of the UAE Telecommunications and Digital Government Regulatory Authority, du, TELUS, IBM, and Huawei. See [section 5.6](#_5.6_CTO_and).

[ITU Academia membership](https://www.itu.int/hub/membership/), the [ITU Journal on Future and Evolving Technologies](https://www.itu.int/en/journal/j-fet/Pages/default.aspx), and [ITU Kaleidoscope conferences](https://www.itu.int/en/ITU-T/academia/kaleidoscope/Pages/default.aspx) form key avenues for academics to engage in ITU’s work. The ITU Journal has published 129 papers from 449 authors since launching in September 2020, free of charge to both authors and readers. Kaleidoscope 2022 in Accra, Ghana, 7-9 December 2022, will explore the innovation required to make the metaverse a reality. See [section 6](#_6_Academia).

[ITU's Bridging the Standardization Gap (BSG) programme](https://www.itu.int/en/ITU-T/gap/Pages/default.aspx) improves the capacity of developing countries to participate in the development and implementation of international ICT standards. Eight BSG training sessions on study group effectiveness were held in the reporting period, welcoming 225 ITU-T delegates. The [training course](https://academy.itu.int/training-courses/full-catalogue/recommendation-itu-t-a1-working-methods-itu-t-study-groups-1) on Recommendation ITU-T A.1 "Working methods for study groups of the ITU Telecommunication Standardization Sector" was updated following WTSA-20. See [section 12](#_12_Bridging_the).

The [second Women in Standardization Expert Group (WISE) event](https://www.itu.int/en/ITU-T/wtsa20/wise/Pages/default.aspx) – themed "Why gender matters in setting standards" – was organized on 8 March 2022 during WTSA-20. TSB is preparing a survey to collect more insights from ITU-T members on various ways to accelerate the improvement of gender balance ITU-T. TSB is also inviting ITU-T members and staff involved in standards-development processes to undertake a [training course](https://learnqi.unece.org/courses/gender-responsive-standards/) on gender-responsive standards development. See [section 13](#_13_Gender).

Testing labs can now obtain official recognition from ITU for their competence to test the conformance of products with ITU-T Recommendation. The first nine testing labs have been listed in the new [ITU Testing Laboratories Database](https://itu.int/go/tldb) for ITU-recognized facilities. For buyers seeking standards-based solutions, the complementary [ITU Product Conformity Database](http://www.itu.int/net/itu-t/cdb/ConformityDB.aspx) lists products compliant with ITU-T Recommendations. The testing lab recognition scheme, supported by the [ITU-T Conformity Assessment Steering Committee](https://www.itu.int/en/ITU-T/studygroups/com11/casc/Pages/default.aspx), is the latest initiative under the [ITU Conformity and Interoperability programme](https://www.itu.int/en/ITU-T/C-I/Pages/default.aspx). See [section 8](#_8_Conformity_and).

ITU works to increase access to ICTs for persons with disabilities by raising awareness of their right to access ICTs, mainstreaming accessibility in the development of international ICT standards, and providing education and training on key accessibility issues. A [new ITU-T Recommendation](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14967) developed collaboratively with the World Health Organization defines accessibility requirements for telehealth services. See [section 9](#_9_Mainstreaming_accessibility).

Over 13,500 pages of ITU-T Recommendations and Supplements were published in the reporting period. All major editions of ITU-T Recommendations are converted to the reflowable ePub format, and are published for free download alongside the usual PDF format. See [section 14.1](#_14.1_Recommendations_and).

TSB continues to collect all new terms and definitions proposed by ITU-T study groups, entering them into the online [ITU Terms and Definitions database](https://www.itu.int/br_tsb_terms/#/). TSB continues to translate all Recommendations approved under the Traditional Approval Process as well as all TSAG reports. On request, TSB translated 6 Recommendations approved under the Alternative Approval Process in the reporting period. See [section 14.2](#_14.2_Official_languages).

TSB continuously develops new applications using, where applicable, open-source and machine learning solutions, in addition to the ITU infrastructure services, while enhancing existing applications, to expand further its ongoing digital transformation. The "[AI-based mapping of ITU activities to UN-SDGs](https://aisdg.itu.int/)" maps ITU work to the UN Sustainable Development Goals according to semantic relevance. See [section 15](#_15_Services_and).

# Annex – Full report of activities in ITU-T in the study period

# 1 ITU-T Study Groups

ITU approved 233 new and revised ITU-T Recommendations and related texts in the reporting period. Annex 1 to this report lists these texts as well as texts undergoing approval and summarizes their contents. For all ITU-T Recommendations in force, see the [catalogue of ITU-T Recommendations](https://www.itu.int/en/ITU-T/publications/Pages/recs.aspx).

Executive summaries of ITU-T study group (SG) meetings can be found on their respective [homepages](https://www.itu.int/en/ITU-T/studygroups/Pages/default.aspx). ITU-T study group meetings held in the reporting period:

* [SG2](https://www.itu.int/go/tsg2): Geneva, 16-20 May 2022
* [SG3](https://www.itu.int/go/tsg3): Geneva, 23-27 May 2022; and Geneva, 11 November 2022
* [SG5](https://www.itu.int/go/tsg5): Geneva, 21 June - 1 July 2022; and Rome, 17-27 October 2022
* [SG9](https://www.itu.int/go/tsg9): E-Meeting, 6-14 September 2022
* [SG11](https://www.itu.int/go/tsg11): Geneva, 6-15 July 2022; and Geneva, 7 December 2022
* [SG12](https://www.itu.int/go/tsg12): Geneva, 7-17 June 2022
* [SG13](https://www.itu.int/go/tsg13): Geneva, 4-15 July 2022; Geneva, 14 November 2022; and Geneva, 25 November 2022
* [SG15](https://www.itu.int/go/tsg15): Geneva, 19-30 September 2022
* [SG16](https://www.itu.int/go/tsg16): Geneva, 17-28 October 2022
* [SG17](https://www.itu.int/go/tsg17): E-Meeting, 10-20 May 2022; and Geneva, 23 August - 02 September 2022
* [SG20](https://www.itu.int/go/tsg20): Geneva, 18 - 28 July 2022

## 1.2 Non-attendance of chairmen and vice-chairmen

PP Resolution 208 (Rev. Bucharest, 2022) "Appointment and maximum term of office for chairmen and vice-chairmen of Sector advisory groups, study groups and other groups" resolves that a Sector advisory group, study group or other group shall be made aware of the non-attendance of Chairmen and Vice-Chairmen in their respective groups and raise the issue through the Director of the relevant Bureau with the members concerned in an attempt to encourage and facilitate participation in these roles.

The following table lists vice-chairmen not in attendance at study group meetings held in the reporting period:

|  |  |  |
| --- | --- | --- |
| **Study Group** | **Non-attendance of** | **Meetings** |
| SG3 | Zuhair AL-ZUHAIR, Vice Chairman, Kuwait | 11 November 2022, Geneva |
| Karima MAHMOUDI, Vice Chairman, Tunisia |
| Marthe UWAMARIYA, Vice Chairman, Rwanda |
| SG5 | Vincent Urbain NAMRONA, Vice-Chairman, Central African Republic | 21 June - 1 July 2022, Geneva  17-27 October 2022, Rome, Italy |
| Pedro BRISSON, Vice-Chairman, Argentina | 17-27 October 2022, Rome, Italy |
| Saidiahrol SAIDIAKBAROV, Vice-Chairman, Republic of Uzbekistan |
| SG11 | Juan Matias CATTANEO, Vice-Chairman, Argentina | 6-15 July 2022, Geneva |
| SG13 | Bülent ARSAL, Vice-Chairman, Turkey | 4-15 July 2022, Geneva |
| Brice MURARA, Vice-Chairman, Rwanda |
| Bülent ARSAL, Vice-Chairman, Turkey | 14 November 2022, Geneva |
| Anabel DEL CARMEN CISNEROS, Vice-Chairman, Argentina |
| Hyung-Soo (Hans) KIM, Vice-Chairman, Korea (Rep. of) |
| Brice MURARA, Vice-Chairman, Rwanda |
| Mehmet TOY, Vice-chairman, United States |
| SG16 | Charles Zoé BANGA, Vice-Chairman, Central African Republic | 17-28 October 2022, Geneva |
| Akmal SAVURBAEV, Vice-Chairman, Uzbekistan |
| SG17 | Afnan ALROMI, Vice-Chairman, Saudi Arabia | 10-20 May 2022, virtual |
| Gökhan EVREN, Vice-Chairman, Turkey |
| Wala TURKI LATROUS, Vice-Chairman, Tunisia |
| Samir ABDELGAWAD, Vice-Chairman, Egypt | 23 August - 2 September 2022, Geneva |
| Abderrazak BACHIR BOUIADJRA, Vice-Chairman, Algérie Télécom SPA |
| Gökhan EVREN, Vice-Chairman, Turkey |
| Lia MOLINARI, Vice-Chairman, Argentina |
| SG20 | Achime Malick NDIAYE, Vice-Chairman, Senegal | 18-28 July 2022, Geneva |

# 2 ITU-T Focus Groups

Below lists the ITU-T focus groups (FGs) of the study period, with section 2.1 listing active groups and section 2.2 listing groups that completed activities. Information on the activities and deliverables of each group can be found on their respective homepages. See also the [ITU-T focus groups homepage](https://www.itu.int/en/ITU-T/focusgroups/Pages/default.aspx).

## 2.1 Active groups

| **ITU-T Focus Group** | **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 |
| [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 |

## 2.2 Concluded groups

|  |  |  |
| --- | --- | --- |
| **ITU-T Focus Group** | **Start date** | **End date** |
| [AI for Autonomous and Assisted Driving (FG-AI4AD)](https://www.itu.int/en/ITU-T/focusgroups/ai4ad/Pages/default.aspx) | 2019-10 | 2022-09 |
| [Vehicular Multimedia (FG-VM)](https://www.itu.int/en/ITU-T/focusgroups/vm/Pages/default.aspx) | 2018-07 | 2022-09 |

# 3 Workshops and symposia

60 ITU-T workshops and symposia were organized in the reporting period, in addition to the weekly programming of the year-round [AI for Good](https://aiforgood.itu.int/) digital platform. A listing of all past and planned events can be found on the [ITU-T events homepage](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/Pages/default.aspx).

ITU-T workshops and symposia discuss emerging trends in standardization, increase the visibility of ITU-T work, enhance ITU-T collaboration with other bodies, attract and recruit new ITU-T members, and encourage peer-learning relevant to the development and implementation of international standards.

# 4 Virtual meetings

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 lists of participants and their affiliations, moderated floor requests, 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 e-meetings and any on-demand ad-hoc meetings.

Statistics on e-meetings for the study period are shown below.

* 2017: 1,072 e-meetings; 5,254 attendees
* 2018: 1,558 e-meetings; 8,353 attendees
* 2019: 2,110 e-meetings; 17,657 attendees
* 2020: 4,220 e-meetings; 77,693 attendees
* 2021: 4,671 e-meetings; 87,302 attendees
* 2022 (until end-October): 3,656 e-meetings; 50,220 attendees

Figure 1 – Remote participation and e-meetings

# 5 Collaboration initiatives

## 5.1 Artificial intelligence and machine learning

[AI for Good](https://aiforgood.itu.int/) is the United Nations platform for artificial intelligence (AI). It is the world’s premier platform to advance AI’s contribution to sustainable development. AI for Good is supported by 40 UN partners as well as a range of industry sponsors.

**AI for Good Global Summit 2023:** The upcoming AI for Good Global Summit in Geneva, 6-7 July 2023, will feature world-renowned experts in AI and humanitarian action. This fourth summit follows summits held in Geneva in 2017, 2018, and 2019. The upcoming summit will be preceded by expert-oriented ML workshops on 5 July, drawing on expertise from the AI for Good Discovery programme.

**All year, always online:** 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 UN Sustainable Development Goals (SDGs). The digital platform has reached an audience of over 300,000 people from 183 countries with the all-year, always-online format introduced in 2020.

**AI for Good Neural Network:** February 2022 saw the launch of the [AI for Good Neural Network](https://aiforgood.itu.int/neural-network/) to accelerate exchanges among government and industry, as well as foster partnerships to achieve the SDGs. The new networking tool features AI-enabled smart matching to help users build connections with innovators and experts, link innovative ideas with social impact opportunities, and bring the community together to discuss AI applications for social good. Over 11,000 people have created profiles on the Neural Network since its launch in February and roughly 200 new profiles are created each week.

**Support to focus group activities:** The majority of the ITU-T focus groups addressing AI and machine learning (ML), as well as the Global Initiative on AI and Data Commons and the AI for Road Safety initiative, were first conceptualized during AI for Good activities and the AI for Good digital platform remains integral to the activities of such focus groups and initiatives.

**Programming streams:** 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
* AI for Good Perspectives
* 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

**ITU AI/ML Challenges:** ITU's AI/ML Challenges are competitions where anyone can participate to solve problem statements related to communication networks or geospatial data analysis. The competitions enable participants to connect with new partners – and new tools and data resources ­– to achieve goals set out by problem statements contributed by industry and academia.

These competitions have welcomed over 3,000 participants since their launch in 2020.

The competitions are stimulating global access to AI/ML expertise and capabilities. Some of the problem statements apply ITU standards for machine learning, with the effect of enhancing the skillsets of the next generation of AI/ML innovators, as well as their ability to contribute to ITU standardization work.

[The third edition of the ITU AI/ML in 5G Challenge](https://aiforgood.itu.int/about-ai-for-good/aiml-in-5g-challenge/) – which has remained in focus throughout the year in a [series of AI for Good webinars](https://aiforgood.itu.int/eventcat/ai-ml-in-5g/) – will culminate with a Grand Challenge Finale on 14 December 2022. The third edition of the Challenge is sponsored by the Republic of Korea’s Ministry of Science and ICT and ZTE. More than half of its participants are students, and a large majority are not yet ITU members (see figures 2 and 3).

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) has published two special issues on "AI/ML solutions in 5G and future networks" sharing solutions and learnings from participants and Challenge hosts (the originators of the problem statements) in 2020 and 2021, with the latest published in September 2022.

Figure 2 – Participants identifying as students and professionals

Figure 3 – Participants with and without ITU membership

## 5.2 Digital financial inclusion and fintech

For an overview of all TSB/ITU-T activities on digital financial inclusion and fintech, see dedicated [web page](https://www.itu.int/en/ITU-T/dfs/Pages/default.aspx).

**Status of digital financial services (DFS) security recommendations' adoption:** Through the activities of the [ITU DFS Security Lab](https://figi.itu.int/figi-resources/dfs-security-lab/),TSB contacted 33 telecom regulators of emerging economies and regional telecommunication regulatory bodies during the reporting period to present the security recommendations for DFS developed under the [Financial Inclusion Global Initiative (FIGI)](https://figi.itu.int/), inviting them to adopt the recommendations. This outreach aimed to encourage countries in Latin America and Asia to participate in these activities in addition to countries in Africa.

Regulators in the following countries are working towards adopting the security recommendations from FIGI: Côte d'Ivoire, The Gambia, Nigeria, Pakistan (State Bank of Pakistan), Peru, Sierra Leone, Tanzania, Uganda, and Zimbabwe.

In addition, the Communication Regulators Association of Southern Africa (CRASA), the East African Communications Organisation (EACO), and the West Africa Telecommunications Regulators Assembly (WATRA) have confirmed they are adopting the security recommendations at a regional level.

The following countries have adopted the Memorandum of Understanding (MoU) between their telecom regulator and central bank recommended under FIGI or developed working arrangements between the two regulators based on the recommended MoU: The Gambia, Malawi, Nigeria, Pakistan, Rwanda, Sierra Leone, Tanzania, and Zimbabwe.

**DFS Security Lab:** The [ITU DFS Security Lab](https://figi.itu.int/figi-resources/dfs-security-lab/) set up as part of FIGI activities developed a methodology for conducting security tests for mobile payment apps based on USSD, STK, and Android. In this reporting period, the DFS Security Lab security test was extended to include a security audit for iOS mobile payment apps.

As part of the activities of the ITU DFS Security Lab, [ITU DFS ​Security Clinics](https://figi.itu.int/itu-dfs-security-clinics/) offer guidance to regulators and DFS providers on adopting the security best practices developed under FIGI. The DFS Security Lab helps stakeholders to verify that these best practices are being followed.

The DFS Security Lab conducted 15 security clinics online, welcoming 807 participants, in the reporting period:

* [West Africa](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20221013/Pages/default.aspx), 13-14 October 2022, hosted by WATRA
* [Sierra Leone](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220913/Pages/default.aspx), 26-27 September 2022, hosted by the National Telecommunications Commission of Sierra Leone
* [Peru](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220908/Pages/default.aspx), 8-9 September 2022, hosted by the Superintendencia de Banca, Seguros y AFP del Perú
* [Côte d’Ivoire](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220906/Pages/default.aspx), 6-7 September 2022, hosted by the Autorité de Régulation des Télécommunications de Côte D'Ivoire
* [Democratic Republic of Congo](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220725/Pages/default.aspx), 26-27 July 2022, hosted by the Autorité de Régulation de la Poste et des Télécommunication du Congo
* [Tanzania](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220704/Pages/default.aspx), 11-12 July 2022, hosted by the Tanzania Communications Regulatory Authority
* [East Africa](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220706/Pages/default.aspx), 6 July 2022, hosted by EACO
* [The Gambia](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220629/Pages/default.aspx), 29-30 June 2022, hosted by The Gambia Public Utilities Regulatory Authority
* [Pakistan](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220601/Pages/default.aspx), 1-2 June 2022, hosted by the State Bank of Pakistan
* [Southern African Development Community](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220524/Pages/default.aspx), 24-15 May 2022, hosted by CRASA
* [Rwanda](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220412/Pages/default.aspx), 12-13 April 2022, hosted by the ​Rwanda Utilities Regulatory Authority
* [Pakistan](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220411/Pages/default.aspx), 12-13 April 2022, hosted by the State Bank of Pakistan
* [East Africa](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220330/Pages/default.aspx), 30-31 March 2022, hosted by the East African Communications Organisation
* [Zimbabwe](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220216/Pages/default.aspx), 16-17 February 2022, hosted by the Postal & Telecommunications Regulatory Authority of Zimbabwe
* [Zimbabwe](https://www.itu.int/en/ITU-T/webinars/dfs/sc/20220209/Pages/default.aspx), 9-10 February 2022, hosted by the Postal & Telecommunications Regulatory Authority of Zimbabwe

As part of the activities of the DFS Security Lab, ITU also supports telecom regulators in emerging economies interested in establishing their own labs and empowering their staff to implement the security methodology to conduct security audits of mobile payment applications based on USSD, iOS, and Android. ITU is currently providing this knowledge-transfer support to regulators in the following countries: Ghana, Peru, Tanzania, and Uganda.

At the request of regulators in The Gambia, Zimbabwe, Tanzania, Peru, and Uganda, the DFS Security Lab has also conducted security tests on mobile payment apps used in those countries.

**Digital currency:** The [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 and the development of specifications for technical standards to foster adoption, universal access, and ultimately financial inclusion.

The first edition of the [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, highlighted the work of the Digital Currency Global Initiative as well as emerging industry trends and initiatives in digital currencies, particular with regard to:

* The latest trends in central bank digital currency, cryptocurrency, and stablecoins.
* Emerging developments and areas where standards are needed for the architecture and interoperability of digital currencies and their integration with existing payment systems.
* Topics such as interoperability for central bank digital currencies and stablecoins and securing digital currency systems.
* Fostering dialogue among digital currency ecosystem stakeholders and regulators on key lessons learned from pilot implementations of digital currencies.

The [second edition of the conference](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2023/0124/Pages/default.aspx) is scheduled for 24-27 January 2023 online.

The Policy and Governance Working Group of the Digital Currency Global Initiative finalized a [report on digital currencies and financial inclusion](https://www.itu.int/en/ITU-T/extcoop/dcgi/Documents/Final%20Report_DCGI_Digital%20Currencies%20and%20Financial%20Inclusion.pdf) in May 2022, providing high-level design principles for CBDC for financial inclusion. The report has been submitted to ITU-T SG3.

## 5.3 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 18 UN bodies with the aim of achieving the SDG11 ("Make cities and human settlements inclusive, safe, resilient and sustainable").

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. A U4SSC Ceremony to celebrate Kyebi, Ghana – the latest city to implement the U4SSC KPIs – took place in Ghana on 7 December 2022.

The first [U4SSC Hub](https://u4ssc.itu.int/u4ssc-hub/) was established in Austria and launched during GSS-20 by H.E. Karoline Edtstadler, Austria's Federal Minister for the EU and Constitution.

It provides a unique platform to accelerate cooperation between the public and private sectors and help facilitate digital transformation in cities and communities, while enabling technology and knowledge transfer. It will bring together companies ranging from start-ups to multinational companies as well as universities and research institutes.

The Austrian U4SSC Hub is also supporting cities' pursuit of the SDGs by working together with ITU, national administrations, and city leaders to build 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:

* Digital city platforms to support the digital transformation of public services and their integrated management as well as studying the impact of multiverse in cities.
* 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.
* Developing AI frameworks and guidelines addressing principles, enablers, and governance for applying AI solutions, while taking into consideration targets set in the SDGs and other international commitments.
* Enabling people-centred cities through digital transformation, aiming to provide guidance and a series of policy-based recommendations and assessment frameworks for driving digital transformation in an urban context, while improving smart and sustainable city governance.

U4SSC published [two new reports](https://u4ssc.itu.int/publications/) in September and October 2022:

* Smart tourism: A path to more secure and resilient destinations (October 2022): This report is oriented towards demonstrating how technologies and the process of digitization are powerful tools for moving towards a tourism industry capable of ensuring its resilience, competitiveness, and sustainability in any scenario.
* Redefining smart city platforms: Setting the stage for Minimal Interoperability Mechanisms (September 2022): This report provides guidance to governments and cities at all levels – with a focus on the local and regional – on setting up smart city platforms, as well as on procuring the requisite elements for building them. It also illustrates the current state of the art of interoperable smart city platforms, and provides recommendations for technical specifications.

The [ITU webinar series on "digital transformation for cities and communities"](https://www.itu.int/en/ITU-T/webinars/dt4cc/Pages/default.aspx) featured the following webinars in the reporting period:

* [Cities in the age of artificial intelligence: How to leverage technology for digital transformation](https://www.itu.int/en/ITU-T/webinars/DT4CC/20221123/Pages/default.aspx), Episode #18, 23 November 2022, co-organized with the Austrian U4SSC Hub
* [Emergency responses in smart cities: Driving resilience in the post-pandemic era](https://www.itu.int/en/ITU-T/webinars/DT4CC/20221122/Pages/default.aspx), Episode #17, 22 November 2022
* [Procurement for Smart and Sustainable Cities: Innovative mechanisms for Digital Transformation](https://www.itu.int/en/ITU-T/webinars/DT4CC/20220909/Pages/default.aspx), Episode #16, 9 September 2022
* [Smart city platforms for an integrated management in smart sustainable cities](https://www.itu.int/en/ITU-T/webinars/DT4CC/20220428/Pages/default.aspx), Episode #15, 28 April 2022
* [Accelerating agricultural digital transformation through AI and IoT](https://www.itu.int/en/ITU-T/webinars/dt4cc/20220329/Pages/default.aspx), Episode #14, 29 March 2022, coordinated with FAO and ISO
* [Architecting the Web of Things](https://www.itu.int/en/ITU-T/webinars/20220203/Pages/default.aspx), Episode #13, 3 February 2022, coordinated with the W3C Web of Things Working Group

Upcoming webinars in 2022:

* [Tourism in smart cities: Reimagining the road to digital tourism](https://www.itu.int/en/ITU-T/webinars/DT4CC/20221207A/Pages/default.aspx), Episode #19, 7 December 2022
* [A one-of-a-kind platform for digital transformation: the U4SSC Austrian Country Hub](https://www.itu.int/en/ITU-T/webinars/DT4CC/20221207B/Pages/default.aspx), Episode #20, 7 December 2022

## 5.4 Environment, climate change and circular economy

The [UN Climate Change Conference (COP27)](https://unfccc.int/cop27) was hosted by Egypt in Sharm El-Sheikh, 17-18 November 2022.

ITU organized an exhibit – themed "Turning digital innovation into climate action to reach net zero" – with the support of UNEP, UN University, UNIDO, UN-HABITAT, WHO, ILO, UNITAR, ITC, Basel Convention, Rotterdam Convention, Stockholm Convention, UNECE, ECLAC, FAO, UNDP, UNECA, UNESCO, UNFCCC, UNOP, UN Women, and WMO.

TSB/ITU-T led ITU's organization of the following COP27 events:

* [Management of e-waste as a source of urban mining within the concept of circular economy (refurbish, reuse and recycle)](https://www.itu.int/en/action/environment-and-climate-change/Documents/COP27_PROGRAMMES/Programme-Management%20of%20e-waste%20as%20a%20source%20of%20urban%20mining%20within%20the%20concept%20of%20circular%20economy%20(refurbish,%20reuse%20and%20recycle)-v4.pdf), 17 November 2022, co-organized with Egypt's Ministry of Communications and Information Technology
* [Tutorial on ITU standards related togreen digital transformation – the role of the ICT sector in reducing GHG emissions globally](https://www.itu.int/en/action/environment-and-climate-change/Documents/COP27_PROGRAMMES/Programme-Tutorial%20on%20ITU%20Standards%20related%20to%20Green%20Digital%20Transformation;The%20role%20of%20the%20ICT%20sector%20in%20reducing%20GHG%20emissions%20globally-v1.pdf), 17 November 2022, co-organized with Egypt's Ministry of Communications and Information Technology
* [Side event: Leveraging private sector development to drive green transition](https://www.itu.int/en/action/environment-and-climate-change/Documents/COP27_PROGRAMMES/Programme-side%20event-Leveraging%20private%20sector%20development%20to%20drive%20green%20transition-v4.pdf), 15 November 2022, co-organized with UNECA
* [Climate classroom: Digital transformation for people-oriented cities and communities](https://www.uncclearn.org/climate-classroom-cop27-digital-transformation-for-people-oriented-cities-and-communities-reducing-the-environmental-impact-of-cities/), 10 November 2022, co-organized with UNITAR
* [Tutorial on leveraging international standards to support the advancement of climate-neutral cities](https://www.itu.int/en/action/environment-and-climate-change/Documents/COP27_PROGRAMMES/Programme-Tutorial%20on%20Leveraging%20International%20Standards%20to%20Support%20the%20Advancement%20of%20Climate-Neutral%20Cities.pdf), 10 November 2022, co-organized with Egypt's Ministry of Communications and Information Technology
* [Climate classroom: Information and communication technologies for the net zero transition](https://www.uncclearn.org/climate-classroom-cop27-information-and-communication-technologies-for-the-net-zero-transition/), 10 November 2022, co-organized with UNITAR

The [14th ITU Symposium on environment, climate change and circular economy](https://www.itu.int/en/ITU-T/climatechange/symposia/202210/Pages/default.aspx) – themed "Sustainable digital transformation: The role of ICTs and digital technologies in achieving net zero carbon" – was co-organized with Italy's Ministry of Economic Development and hosted by the University of Rome Tor Vergata in Rome, Italy, 25 October 2022.

A [Workshop on global digital ICT product passport to achieve a circular economy](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2022/0601/Pages/default.aspx) was organized on 1 June 2022 together with UNEP and ETSI within the European Union Green Week 2022.

## 5.5 Intelligent transport systems

The ITU-T focus groups on [AI for autonomous and assisted driving](https://www.itu.int/en/ITU-T/focusgroups/ai4ad/Pages/default.aspx) and [vehicular multimedia](https://www.itu.int/en/ITU-T/focusgroups/vm/Pages/default.aspx) concluded their activities in September 2022. Information on their activities and deliverables can be found on their respective web pages.

The [ITU-UNECE Future Networked Car Symposium](https://fnc.itu.int/) was held online from 22 to 25 March 2022. The next edition will also be held online from 13 to 16 March 2023. The annual symposium examines the latest advances in vehicle connectivity, automated mobility and the role of Artificial Intelligence in ​the transport sector, sharing unique insight into associated implications for technology, business and regulation.

The [Collaboration on ITS Communication Standards (CITS)](https://www.itu.int/en/ITU-T/extcoop/cits/Pages/default.aspx) is a forum supporting the coordination of an internationally accepted, globally harmonized set of Intelligent Transportation Systems (ITS) communication standards of the highest quality in the most expeditious manner possible to enable the rapid deployment of fully interoperable ITS communication-related products and services in the global marketplace.

CITS meetings are typically held twice a year, in March and September, and often organized back-to-back with other ITS events, e.g., annual ITU-UNECE Future Networked Car Symposia, that also provide opportunities to exchange information and keep experts updated on ITS standardization. The representatives of involved standards bodies are invited to submit status reports on ITS standardization ongoing in their respective organizations to CITS meetings.

CITS maintains the global [ITS Communication Standards Database](https://www.itu.int/net4/ITU-T/landscape#?topic=0.131&workgroup=1&searchValue=&page=1&sort=Revelance). The database is designed to assist the harmonization of ITS standards and includes standards developed by all relevant standards bodies, providing a reference to all standards supporting connected vehicles and automated driving.

## 5.6 CTO and CxO meetings

[CTO and CxO meetings](http://www.itu.int/en/ITU-T/tsbdir/cto/Pages/default.aspx) bring together high-level industry executives together with the senior management of TSB to exchange views on industry priorities and related standardization activities.

The next [CxO Meeting](https://www.itu.int/en/ITU-T/tsbdir/CxO/Pages/CxO-20221206.aspx) will be held on 6 December 2022 at the Telecom Review Leader's Summit in Dubai, United Arab Emirates, with additional participation online, hosted by Telecom Review with the support of the UAE Telecommunications and Digital Government Regulatory Authority, du, TELUS, IBM, and Huawei.

# 6 Academia

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

## 6.1 ITU Journal

The [ITU Journal on Future and Evolving Technologies (ITU J-FET)](https://www.itu.int/en/journal/j-fet/Pages/default.aspx) offers comprehensive coverage of communications and networking paradigms, free of charge to both authors and readers. The online journal welcomes research submissions on all relevant topics, all year long.

The Editor-in-Chief of the ITU Journal, [Professor Ian F. Akyildiz](https://www.itu.int/en/journal/j-fet/Pages/editorial-board.aspx), Ken Byers Chair Professor in Telecommunications Emeritus at the Georgia Institute of Technology, was presented with a certificate of appreciation at PP-22 for his "commitment and outstanding contribution to the ITU Journal, in his role as founding Editor-in-Chief, ensuring the publication of impactful results to advance science".

An upcoming issue of the ITU Journal in December 2022 will feature research on the digital continuum and next-generation networks, networking beyond 2030, and autonomous network management and control for 6G time-critical applications.

Past issues in 2022 have covered topics ranging from holographic communications, digital twins, and edge computing to the growing research challenges in wireless communications associated with extended reality. They have also addressed artificial intelligence and machine learning solutions for 5G and future networks, emerging trends and applications expected to shape future networks, and vehicular network innovations to support smart and safe mobility.

Upcoming issues in 2023 are set to address:

* Intelligent surfaces and their applications towards wide-scale deployment​
* Innovative network solutions for future services
* AI for accessibility
* AI-driven security in 5G and beyond
* Network virtualization, slicing, orchestration, fog and edge platforms for 5G and 6G wireless systems
* Metaverse: Communications, networking and computing
* Intelligent technologies for networking and distributed systems

## 6.2 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 the Institute of Electrical and Electronics Engineers (IEEE) and the IEEE Communications Society – calls for original research on topics of growing strategic relevance to ITU-T.

The [14th edition](https://www.itu.int/en/ITU-T/academia/kaleidoscope/2022/Pages/default.aspx) – themed "Extended reality – How to boost quality of experience and interoperability" – will explore the innovation required to make the metaverse a reality. It will take place in Accra, Ghana, 7-9 December 2022, hosted by the National Communications Authority of Ghana.

# 7 Cooperation and coordination

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).

## 7.1 International standardization bodies

[World Standards Cooperation (WSC)](https://www.itu.int/en/ITU-T/extcoop/Pages/wsc.aspx)

The World Standards Cooperation (WSC) was established in 2001 by the International Telecommunication Union (ITU), the International Organization for Standardization (ISO), and the International Electrotechnical Commission (IEC) in order to strengthen and advance the voluntary consensus-based international standards systems of ITU, ISO, and IEC.

* [World Standards Day](https://www.worldstandardsday.org/home.html), 14 October: ITU, ISO and IEC lead the celebrations of World Standards Day. "A Shared Vision for a Better World" was the theme of World Standards Day 2022, continuing a multi-year campaign launched in 2021 aimed at raising awareness of how international standards contribute to the SDGs. [All past editions of World Standards Day](https://www.worldstandardscooperation.org/what-we-do/world-standards-day/).
* [G20 International Standards Summit, 20 October 2022](https://www.worldstandardscooperation.org/g20/g20-2022/): Organized by ITU, ISO and IEC and hosted by the National Standardization Agency of Indonesia (BSN) as part of G20 activities, with the participation of the World Trade Organization (WTO), the summit concluded with a [Call to Action](https://www.worldstandardscooperation.org/g20/g20-2022/#section-group-od1iwA8DDFvjj1rWg9QcM) to recognize, support, and adopt international standards to meet G20 “Recover together, recover stronger” post-pandemic goals. The summit followed similar summits held as part of G20 activities under the G20 Presidencies of Italy (2021) and Saudi Arabia (2020).

[Technical coordination mechanism among IEC, ISO and ITU-T/ITU-R (including ISO/IEC JTC1)](https://www.itu.int/en/ITU-T/extcoop/Pages/WSC-coordination.aspx)

IEC, ISO and ITU-T/ITU-R have agreed that four coordination levels are to be followed when an issue regarding collaboration is identified (source: [TSAG TD138](https://www.itu.int/md/T13-TSAG-140617-TD-GEN-0138/en)).

[Global Standards Collaboration (GSC)](https://www.itu.int/en/ITU-T/gsc/Pages/default.aspx)

GSC is an unincorporated voluntary organization dedicated to enhancing global cooperation and collaboration regarding communications standards and the related standards development environment.

[IEC SMB/ISO TMB/ITU-T TSAG Standardization Programme Coordination Group (SPCG)](https://www.worldstandardscooperation.org/what-we-do/standards-programme-coordination-group-spcg/)

The IEC SMB/ISO TMB/ITU-T TSAG Standardization Programme Coordination Group (SPCG) was established in 2018 by ISO TMB, IEC SMB, and ITU-T TSAG, and conducts strategic coordination of future standardization work, coordination of existing standardization work, short-term related tasks identified by the SPCG and approved by the technical boards of IEC, ISO and ITU-T. The approved SPCG terms of reference are [here](https://www.itu.int/en/ITU-T/extcoop/Documents/tor/ToR_SPCG.pdf).

[IEC-ISO-ITU Joint Smart Cities Task Force (J-SCTF)](https://www.itu.int/hub/2020/10/new-smart-city-standards-joint-task-force-established-by-itu-iso-and-iec/)

J-SCTF was established in 2020 and supports the coordination of IEC, ISO and ITU-T work on smart city standardization. It aims to ensure standardization solutions for smart cities are comprehensive, capitalizing on synergies among IEC, ISO and ITU-T. IEC hosts the J-SCTF document [repository](https://collaborate.iec.ch/#/pages/workspaces/735898/dashboard).

## 7.2 National and regional standardization bodies

ITU-T/TSB has become more visible to national and regional standardization bodies, as well as built on and enhanced good collaboration with ITU Regional and Area Offices.

TSB facilitates an ITU-T presence in the activities of national and regional standardization bodies, as well as encourages national and regional standardization bodies' participation in ITU-T activities.

TSB’s efforts in this regard have strengthened the exchange of information between ITU-T and national and regional standardization bodies, 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)
* Asia-Pacific Telecommunity Standardization Program (ASTAP)
* South Asian Regional Standards Organization (SARSO)
* GCC Standardization Organization (GSO)
* European Committee for Standardization (CEN) and European Committee for Electrotechnical Standardization (CENELEC)
* European Telecommunications Standards Institute (ETSI)

An overview of the main engagements of TSB in this regard during the reporting period, organized in coordination with the ITU Regional and Area Offices, is provided below.

* ARSO: TSB participated in the 28th ARSO General Assembly in Yaoundé, Cameroon, 27 June - 1 July 2022. TSB is also regularly invited to participate in ARSO monthly webinars, seminars and events focused on themes such as continental certification, trade, and regulatory frameworks.
* ASTAP: TSB participated in the 34th APT Standardization Program Forum, 19-23 April 2022. The TSB Director offered updates on WTSA-20.
* ETSI: TSB participated in the 79th ETSI General Assembly, 29-30 March 2022.
* PASC: The TSB Director participated in the 44th PASC General Assembly alongside IEC and ISO executives on 18 May 2022.

## 7.3 TSB and ITU Regional and Area Offices

ITU Regional Offices regularly share information with the TSB Director on regional activities relevant to standardization and provide regular reports to TSAG.

At the initiative of the TSB Director, regular conference calls and face-to-face meetings are arranged between the ITU Regional and Area Offices and TSB senior management, covering overviews, updates, and briefings on activities organized by each TSB department in the Regions.

These efforts, as well as the establishment of a TSB Focal Point for the Regions, have supported improvements in coordination with ITU Regional and Area Offices with respect to standardization activities, operations, and events across the Regions.

## 7.4 ITU Sectors

TSAG maintains a close relationship with RAG and TDAG 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. Meetings 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.

## 7.5 External cooperation

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).

[Collaboration on ITS Communication Standards (CITS)](https://www.itu.int/en/ITU-T/extcoop/cits/Pages/default.aspx)

The intent of the CITS is to provide a globally recognized forum for the creation of an internationally accepted, globally harmonized set of ITS communication standards of the highest quality in the most expeditious manner possible to enable the rapid deployment of fully interoperable ITS communication-related products and services in the global marketplace.

[Digital Currency Global Initiative](https://www.itu.int/en/ITU-T/extcoop/dcgi/Pages/default.aspx)

The Digital Currency Global Initiative (DCGI) is collaboration between ITU and the Future of Digital Currency Program of Stanford University. DCGI continues the dialogue and research initiated by [FG DFC](https://www.itu.int/en/ITU-T/focusgroups/dfc/Pages/default.aspx) on pilot implementations, use cases, applications and developing specifications for technical standards that will foster adoption, universal access and ultimately financial inclusion. The goals of DCGI are to drive the synergistic engagement, innovative use, and standardization of digital currencies, which are the three pillars of the Initiative.

[FIGI resources for strong authentication](https://www.itu.int/en/ITU-T/extcoop/FIGIresources/authentication/Pages/default.aspx)

This is a compendium of resources for developers, provided under the Financial Inclusion Global Initiative (FIGI) to help foster the adoption of strong password-less authentication for user login and transaction confirmation especially for digital financial services. The resources mainly focus on demonstrating how easy and fast it is to eliminate the use of passwords with Recommendation ITU-T X.1277 that describes the Fast Identity Online (FIDO) Universal Authentication Framework.

[Financial Inclusion Global Initiative (FIGI) Symposium](https://www.itu.int/en/ITU-T/extcoop/figisymposium/Pages/default.aspx)

Three FIGI Symposium were held in 2017, 2019 and 2021 to provide a forum for dialogue regulators from telecom and financial services, DFS providers and all concerned stakeholders to share their experience and views on the main challenges to be addressed for scaling up DFS.

[Global Initiative on AI and Data Commons](https://www.itu.int/en/ITU-T/extcoop/ai-data-commons/Pages/default.aspx)

The Global Initiative on AI and Data Commons brings together AI specialists and data owners from industry, academia, member states, UN agencies and civil society to develop knowledge, specifications and guidelines to scale AI solutions with the help of shared datasets, testing and simulation environments, collaborative sandboxes, AI models and associated software, data discoverability and storage and computing resources.

[ITU-T and WSIS](https://www.itu.int/en/ITU-T/wsis/Pages/default.aspx)

As the UN specialized agency for ICTs, ITU was proud to have played the leading role in the organization of the [World Summit on the Information Society (WSIS)](https://www.itu.int/wsis/index.html).

[ITU/WMO/UNESCO-IOC Joint Task Force on SMART cable systems](https://www.itu.int/en/ITU-T/climatechange/task-force-sc/Pages/default.aspx)

ITU, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO-IOC), and the World Meteorological Organization (WMO) established the Joint Task Force (JTF) on SMART cable systems in 2012, dedicated to advancing the concept of ‘Science Monitoring And Reliable Telecommunications (SMART) cables’. The minimum set of requirements established by the JTF are now feeding into ITU-T standardization work, with two new work items established in 2021 on SMART submarine cable systems ([G.smart](https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=17089)) and dedicated scientific sensing submarine cable system ([G.dsssc](https://www.itu.int/ITU-T/workprog/wp_item.aspx?isn=17090)).

[Recognized standards-developing organizations (SDOs) under Recs. A.4, A.5 and A.6](https://www.itu.int/en/ITU-T/extcoop/Pages/sdo.aspx)

ITU-T's external cooperation is guided by three ITU-T Recommendations: [ITU-T A.4:](https://www.itu.int/rec/T-REC-A.4) procedures for communicating with forums and consortia, [ITU-T A.5:](https://www.itu.int/rec/T-REC-A.5) making reference to documents from other organizations, [ITU-T A.6:](https://www.itu.int/rec/T-REC-A.6) cooperation and exchange of information with national and regional SDOs.

# 8 Conformity and interoperability programme

The [ITU Conformity and Interoperability (C&I) programme](https://www.itu.int/en/ITU-T/C-I/Pages/default.aspx) aims to enhance the conformity and interoperability of ICT products implementing ITU-T Recommendations or part thereof, solicit feedback to improve the quality of ITU-T Recommendations, and reduce the digital divide and standardization gap by assisting developing countries with human resource and infrastructure capacity building.

Testing labs can now obtain official recognition from ITU for their competence to test the conformance of products with ITU-T Recommendations ([TSB Circular 368](https://www.itu.int/md/meetingdoc.asp?lang=en&parent=T17-TSB-CIR-0368)). The first nine testing labs have been listed in the new [ITU Testing Laboratories Database](https://itu.int/go/tldb) for ITU-recognized facilities. For buyers seeking standards-based solutions, the complementary [ITU Product Conformity Database](http://www.itu.int/net/itu-t/cdb/ConformityDB.aspx) lists products compliant with ITU-T Recommendations.

ITU-T determined the key criteria and [recognition procedure](https://www.itu.int/en/ITU-T/studygroups/com11/casc/Documents/TL-RP_pub_2022-07-15.pdf) for testing labs.

An earlier [Memorandum of Understanding](https://www.itu.int/en/ITU-T/extcoop/Documents/mou/MoU-ITU-T-IAF-ILAC-20220824.pdf) between ITU-T, the International Laboratory Accreditation Cooperation (ILAC) and the International Accreditation Forum (IAF) facilitates ITU's recognition of labs accredited by signatories to the [ILAC Mutual Recognition Arrangement](https://ilac.org/ilac-mra-and-signatories/).

Testing labs are invited to apply for ITU recognition using this [application form](https://www.itu.int/net/itu-t/cdb/secured/reg-tldb.aspx). Labs successful in their application are announced in the [ITU Operational Bulletin](https://www.itu.int/pub/T-SP).

Companies can apply for the inclusion of their products – products tested to applicable ITU-T Recommendations using ITU-T test specifications or procedures adopted by an SDO or forum qualified in accordance with Recommendation ITU-T A.5 – in the ITU Product Conformity Database using this [application form](https://www.itu.int/net/itu-t/cdb/secured/Register16.aspx). All criteria for populating the database are listed [here](https://www.itu.int/en/ITU-T/C-I/conformity/Pages/cdb.aspx).

The recognition procedure is supported by the [ITU-T Conformity Assessment Steering Committee](https://www.itu.int/en/ITU-T/studygroups/com11/casc/Pages/default.aspx" \t "_blank).

The testing lab recognition scheme is the latest initiative under ITU’s C&I programme. ITU-T SGs continue developing ITU-T Recommendations defining testing requirements and test suites. Along with conformity assessments, the programme organizes interoperability testing events, offers capacity building, and provides technical assistance in the establishment of testing centres.

# 9 Mainstreaming accessibility

ITU works to increase access to ICTs for persons with disabilities by raising awareness of their right to access ICTs, mainstreaming accessibility in the development of international ICT standards, and providing education and training on key accessibility issues.

Developed collaboratively with WHO, the new [Recommendation ITU-T F.780.2 "Accessibility of telehealth services"](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14967) approved in March 2022 defines accessibility requirements for technical features to be used and implemented by governments, healthcare providers and manufacturers of telehealth platforms to facilitate the access and use of telehealth services by persons with disabilities and specific needs, including older persons with age-related disabilities. The new standard was introduced at the 15th session of the Conference of States Parties to the Convention on the Rights of Persons with Disabilities by a side event on 16 June 2022 co-organized by ITU and WHO.

Also approved in March 2022 were Recommendations [ITU-T T.701.21 "Guidance on audio description"](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14972) and [ITU-T T.701.25 "Guidance on the audio presentation of text in videos, including captions, subtitles and other on-screen text"](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=14973). These standards are twins to ISO/IEC TS 20071-21:2015 "Information technology – User interface component accessibility – Part 21: Guidance on audio descriptions" and ISO/IEC TS 20071-25:2017 "Information Technology – User interface component accessibility – Part 25: Guidance on the audio presentation of text in videos, including captions, subtitles and other on-screen text", respectively.

For an overview of all ITU activities relevant to accessibility, see [ITU and Accessibility](https://www.itu.int/en/action/accessibility/Pages/hlmdd2013.aspx). For an overview of TSB/ITU-T activities relevant to accessibility, see [ITU-T and Accessibility](https://www.itu.int/en/ITU-T/accessibility/Pages/default.aspx).

# 10 Intellectual property rights

The [TSB Director's Ad Hoc Group on Intellectual Property Rights (IPR AHG)](http://www.itu.int/en/ITU-T/ipr/Pages/adhoc.aspx) continues its work to protect the integrity of the standards-development process by clarifying aspects of the [ITU-R/ITU-T/ISO/IEC Common Patent Policy and related Guidelines](http://www.itu.int/en/ITU-T/ipr/Pages/revpatent.aspx) – the Union's main tool to manage the challenges associated with the incorporation of patents in [ITU-T and ITU-R Recommendations](http://www.itu.int/en/ITU-T/publications/Pages/recs.aspx). Meeting reports are available [here](https://www.itu.int/oth/T0402/en).

All patent declarations received are listed on ITU’s website. See the [ITU-T IPR database](https://www.itu.int/net4/ipr/search.aspx).

# 11 Membership

ITU-T currently hosts 265 Sector Members and 224 Associates. ITU Academia members now total 172. 54 of ITU-T's Associates are now participating under the reduced fee structure for small and medium-sized enterprises (SMEs) which came into effect on 31 January 2020.

**New Sector Members welcomed in the reporting period:**

State Grid Corporation of China; Afnic; Globe Telecom, Inc.; Telecommunication Standards Development Society, India (TSDSI); Libyana Mobile Phone.

**New Associates welcomed in the reporting period:**

Globalmatix AG (SG2); KORE Wireless, Inc. (SG2); Aql (numbering) Ltd. (SG2); Skylo Technologies Inc. (SG2); Stacuity Limited (SG2); Satellio IoT Services, S.L (SG2); AB Handshake Corporation (SG2); RGTN Wholesale B.V. (SG2); Shuangdeng Group Co., Ltd (Chinashoto) (SG5); Mukti Mandiri Lestari (SG5); EFTS Group (SG12); Cerence GmbH (SG12); Case On IT (SG12); Fondation B-COM (SG13); Technology Innovation Institute (SG13); Beijing BizSeer Technology Co. Ltd. (SG13); Senko Advanced Components (Euro) Ltd. (SG15); Skyworks Solutions, Inc. (SG15); HMN Technologies Co., Ltd. (SG15); Retym (SG15); Luster LightTech Co., Ltd (SG16); Japan Industrial Imaging Association (SG16); Guangdong OPPO Mobile Telecommunications Corp., Ltd.(SG16); FNS (M) Sdn Bhd (SG17); HMN Smart Co., Ltd (SG20).

**Total ITU-T Sector Members, Associates and Academia (31 December 2009 – 30 November 2022):**

The following table and figure illustrate the evolution of ITU-T membership from 31 December 2009 to 30 November 2022 (noting that the Academia membership category opened in 2011).

|  | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sector Members | 286 | 256 | 258 | 263 | 270 | 267 | 262 | 251 | 256 | 256 | 265 | 275 | 269 | 265 |
| Associates | 101 | 111 | 119 | 128 | 130 | 132 | 131 | 127 | 135 | 153 | 179 | 194 | 216 | 224 |
| Academia | ‑ | ‑ | 22 | 39 | 56 | 70 | 92 | 104 | 120 | 147 | 156 | 160 | 159 | 172 |
| TOTAL | 387 | 367 | 399 | 430 | 456 | 469 | 485 | 482 | 511 | 556 | 600 | 629 | 644 | 661 |

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

**Figure 4 – Evolution of ITU-T membership from 31 December 2009 to 30 November 2022**

NOTE – The Academia category was created in 2011.

# 12 Bridging the standardization gap

[ITU's Bridging the Standardization Gap (BSG) programme](https://www.itu.int/en/ITU-T/gap/Pages/default.aspx) improves the capacity of developing countries to participate in the development and implementation of international ICT standards.

The BSG Programme is structured around five pillars: 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.

**BSG hands-on training sessions:** ITU-T regularly carries out "BSG Hands-On SG effectiveness training" focused on the development of practical skills to maximize the effectiveness of developing countries' participation in the ITU-T standardization process. These training sessions cover 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. Eight training sessions were held in the reporting period, welcoming 225 ITU-T delegates.

**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. For more on TSB services and tools, see [section 14](#_14_Services_and).

**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. An overview of regional groups' activities can be found [here](https://www.itu.int/en/ITU-T/regional-groups/Pages/default.aspx).

Three regional group meetings were organized in the reporting period:

* SG13 Regional Group for Africa, virtual, 20 October 2022
* SG3 Regional Group for Latin America and the Caribbean, virtual, 6-7 September 2022
* SG3 Regional Group for Asia and Oceania, New Delhi, India, 9-12 August 2022, following an [ITU Regional Standardization Forum on "Regulatory and Policy aspects of Telecommunications/ICTs"](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2022/0808/Pages/default.aspx), 8 August 2022
* SG3 Regional Group for Africa, virtual, 2-5 May 2022

ITU-T hosts 24 regional groups:

* Eight for Africa (SGs 2, 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) and Inter-regional Standardization Forums provide tutorials on ITU-T working methods as well as more technically-oriented themes. RSFs are being held in conjunction with meetings of regional groups to improve the alignment of RSF discussions and the priorities of ITU-T SGs. RSFs are also raising awareness of ITU standardization activities through the participation of key decision-makers (Prime Ministers, Ministers, Heads of Regulators, CEOs, etc.).

* [An ITU Regional Standardization Forum on "Regulatory and Policy aspects of Telecommunications/ICTs"](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2022/0808/Pages/default.aspx) was held in New Delhi, India, 8 August 2022, ahead of a meeting of the SG3 Regional Group for Asia and Oceania, 9-12 August 2022.

**National Standardization Secretariates:** ITU-T's [Guidelines for National Standardization Secretariats (NSS)](https://www.itu.int/en/ITU-T/gap/Documents/nss-rep-may.pdf) 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.

**e-Learning courses:** The [training course](https://academy.itu.int/training-courses/full-catalogue/recommendation-itu-t-a1-working-methods-itu-t-study-groups-1) on [Recommendation ITU-T A.1 "Working methods for study groups of the ITU Telecommunication Standardization Sector"](https://www.itu.int/itu-t/recommendations/rec.aspx?rec=13851) was updated following WTSA-20. All training courses are available on the ITU Academy website at <http://academy.itu.int>.

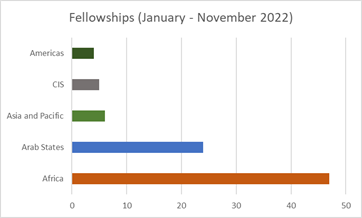
**SG mentoring programme:** In 2011, a mentoring programme for ITU-T SGs was introduced. The objective of the mentoring programme is to provide a contact point to assist new delegates with the working methods of ITU-T and to facilitate participation and contributions from developing countries. It has 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. 86 fellowships were awarded in the reporting period.

The figures below illustrate the distribution of awarded fellowships by region and gender, for the reporting period as well as the previous study period. No fellowships were awarded in the all-online meeting environment called for by the COVID-19 pandemic.

|  |  |
| --- | --- |
| ***Region*** | ***No. of Fellowships*** |
| Africa | 47 |
| Arab States | 24 |
| Asia and Pacific | 6 |
| CIS | 5 |
| Americas | 4 |



**Figure 5 – Awarded fellowships by region in the reporting period**

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**Figure 6 – Awarded fellowships by gender in the reporting period**

**Figure 7 – Awarded fellowships by region in the previous study period**

**Figure 8 – Awarded fellowships by gender in the previous study period**

# 13 Gender

TSB continues its efforts to include a gender perspective in all of its activities and programmes under the umbrella of the ITU Gender Task Force. TSB continues to undertake actions to improve gender equality in TSB and ITU-T. Diversity of staff, gender equality and the empowerment of women continue to be among TSB's priorities.

TSB is preparing a survey to collect more insights from ITU-T members on various ways to accelerate the improvement of gender balance in all areas of ITU-T’s work and its committees.

In accordance with the [UNECE Declaration on Gender Responsive Standards](https://unece.org/gender-responsive-standards-initiative), which was endorsed by ITU along with other major standards bodies, TSB is inviting ITU-T members and staff involved in standards-development processes to undertake a [training course](https://learnqi.unece.org/courses/gender-responsive-standards/) on gender-responsive standards development. Members and staff are invited to send certificates of completion to [wise@itu.int](mailto:wise@itu.int)

The [second Women in Standardization Expert Group (WISE) event](https://www.itu.int/en/ITU-T/wtsa20/wise/Pages/default.aspx) – themed "Why gender matters in setting standards" – was organized on 8 March 2022 during WTSA-20, featuring a panel discussion on the event's theme as well as discussions on the relationship between AI/ML and gender bias and fairness. The event also included a ceremony to recognize entities that have made remarkable contributions to ITU-T activities with respect to gender equality and the empowerment of women in terms of impact, continuity, and leadership.

The figures below provide an overview of TSB/ITU-T activities with respect to participants' gender.

|  |  |  |
| --- | --- | --- |
| Chart, sunburst chart  Description automatically generated | Chart, sunburst chart  Description automatically generated | Chart  Description automatically generated |

Figure 9.1, 9.2 and 9.3 – Participation in statutory events by study period and gender

Figure 10.1 and 10.2 – Current share of ITU-T leadership positions by gender

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Figure 11 - Awarded fellowships by gender in the reporting period

|  |  |  |
| --- | --- | --- |
|  | Chart, sunburst chart  Description automatically generated | Chart  Description automatically generated |

Figures 12.1, 12.1 and 12.3 – Current TSB staff positions by gender, overall, in the professional and director service categories, and in the general service category

# 14 Publications

## 14.1 Recommendations and Supplements

Over 13,500 pages of ITU-T Recommendations and Supplements were published in the reporting period. Figure 16 illustrates the number of ITU-T Recommendations and Supplements published per year since 2016.

All major editions of ITU-T Recommendations are 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" is produced on demand in 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 13 – Number of Recommendations, amendments and Supplements**   
**published per year since 2016**

## 14.1.1 Recommendations deleted between WTSAs

Since March 2022, the following ITU-T Recommendations were deleted in accordance with clause 9.8.2.2 of WTSA Resolution 1 (Rev., Geneva, 2022):

* Recommendation ITU-T D.280 "Principles for charging and billing, accounting and reimbursements for universal personal telecommunication"
* Recommendation ITU-T E.168 "Application of E.164 numbering plan for UPT"
* Recommendation ITU-T E.168.1 "Assignment procedures for universal personal telecommunications (UPT) numbers in the provisioning of the international UPT service"
* Recommendation ITU-T E.174 "Routing principles and guidance for Universal Personal Telecommunications (UPT)"
* Recommendation ITU-T E.755 "Reference connections for UPT traffic performance and GOS"
* Recommendation ITU-T E.775 "UPT grade of service concept"
* Recommendation ITU-T E.776 "Network grade of service parameters for UPT"
* Recommendation ITU-T F.850 "Principles of Universal Personal Telecommunication (UPT)"
* Recommendation ITU-T F.851 "Universal Personal Telecommunication (UPT) – Service description (service set 1)"
* Recommendation ITU-T F.852 "Universal Personal Telecommunication (UPT) – Service description (service set 2)"
* Recommendation ITU-T F.853 "Supplementary services in the Universal Personal Telecommunication (UPT) environment"
* Recommendation ITU-T Q.1521 "Requirements on underlying networks and signalling protocols to support UPT"
* Recommendation ITU-T Q.1531 "UPT security requirements for Service Set 1"
* Recommendation ITU-T Q.1541 "UPT stage 2 for Service Set 1 on IN CS-1 – Procedures for universal personal telecommunication: Functional modelling and information flows"
* Recommendation ITU-T Q.1542 "UPT stage 2 for Service Set 1 on IN CS-2 – Procedures for universal personal telecommunication: Functional modelling and information flows"
* Recommendation ITU-T Q.1551 "Application of Intelligent Network Application Protocols (INAP) CS-1 for UPT service set 1"

## 14.2 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](https://www.itu.int/br_tsb_terms/#/).

As requested by WTSA Resolution 67, TSB continues to translate all Recommendations approved under the Traditional Approval Process as well as all TSAG reports.

TSB also translated 6 Recommendations approved under the Alternative Approval Process in the reporting period, in accordance with requests received from ITU-T SGs and linguistic groups, and within the available budget.

# 15 Services and tools

TSB continuously develops new applications using, where applicable, open-source and machine learning solutions, in addition to the ITU infrastructure services, while enhancing existing applications, to expand further its ongoing digital transformation.

## 15.1 ITU-T activities and the SDGs

The "[AI-based mapping of ITU activities to UN-SDGs](https://aisdg.itu.int/)" maps ITU work to the SDGs according to semantic relevance. Developed by TSB, the solution continues to be improved with the support of feedback from ITU members and staff. The mapping is accessible in [MyWorkspace](https://www.itu.int/myworkspace/#/sdg) with ITU User Account (TIES) credentials. The solution has been applied to the work of ITU-T and ITU-D.

## 15.2 ITU-T applications

The following applications are made available for ITU-T delegates and secretariat staff:

* [Work Programme](http://www.itu.int/ITU-T/workprog), [Recommendations](http://www.itu.int/itu-t/recommendations), [IPR](https://www.itu.int/net4/ipr/search.aspx?sector=ITU&class=PS)  & [Liaison Statements](https://www.itu.int/net4/itu-t/ls)
* Publications Editing, Events Organization & Public Relations materials Workflows
* [Alternative Approval Process](https://www.itu.int/t/aap/about-aap): Online management tool
* [ICT standards landscape](https://www.itu.int/net4/ITU-T/landscape): Online ICT standards collaboration tool
* TSB Reporting: Microsoft Power BI Management Dashboard
* [MyWorkspace](http://www.itu.int/myworkspace): ITU-T Members’ workspace portal
* [Translate](https://www.itu.int/myworkspace/#/Translate): Open-source machine translation for Word file
* [Documents](https://www.itu.int/myworkspace/#/Documents/MyDocuments): Open-source search engine & machine translation for meeting documents
* [MyMeetings](https://www.itu.int/myworkspace/#/E-meetings): Open-source solution for ITU-T fully virtual meetings or physical with remote participation meetings
* [TSBCloud](https://tsbcloud.itu.int/nextcloud/login): Open-source ITU on-premises storage service allowing users to share and exchange up to 10 GB of files per user.

## 15.3 ITU-wide applications

The following ITU-wide applications are available:

* [ITU Search](https://www.itu.int/search): Open-source search engine on all ITU digital resources
* [ITU Conformity & Interoperability](https://www.itu.int/en/ITU-T/C-I/Pages/default.aspx): ICT products conformity and testing labs registry
* [International Numbering Resources](https://www.itu.int/en/ITU-T/inr/Pages/default.aspx): Online access to INRs
* [National Numbering Plans](https://www.itu.int/itu-t/nnp/#/home): Online repository of NNPs
* [Terminology](https://www.itu.int/br_tsb_terms/#/): Online ITU-R / ITU-T terms & definitions search

## 15.4 ITU-T services

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.

## 15.5 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 ITU-T Study Groups 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 FAQ 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).

## 15.6 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 Study Groups (Study Period 2022-2024) (<https://extranet.itu.int/sites/itu-t/studygroups/2022-2024/SitePages/Home.aspx>)
* 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/>)
* Joint IEC-ISO-ITU Smart Cities Task Force (<https://extranet.itu.int/sites/itu-t/initiatives/J-SCTF/>)
* Joint Coordination Activities (<https://extranet.itu.int/sites/itu-t/jca/>)
* Joint Groups with other SDOs (<https://extranet.itu.int/sites/itu-t/jointgroups/>)
* Intersector Rapporteur Groups (<https://extranet.itu.int/sites/irg/>)
* 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/>)
* FG-TBFxG - ITU-T Focus Group on Testbeds Federations for IMT-2000 and beyond – (<https://extranet.itu.int/sites/itu-t/focusgroups/tbfxg>)
* 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”**](https://www.itu.int/rec/T-REC-G.994.1-202204-I!Amd1) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14888) 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”**](https://www.itu.int/rec/T-REC-G.997.3-202204-I!Amd1) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14891) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14917) 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”**](https://www.itu.int/rec/T-REC-G.9711-202204-I!Amd1) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14927) 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.987.2 (revised) “10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification” (under approval)** specifies a new Annex on XG-PON Out-of-Band power spectral density.

[**ITU-T G.988 (revised) “ONU management and control interface (OMCI) specification”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15125) specifies the optical network unit (ONU) management and control interface (OMCI) for optical access networks. Recommendation ITU-T G.988 specifies the managed entities (MEs) of a protocol-independent management information base (MIB) that models the exchange of information between an optical line termination (OLT) and an ONU. In addition, it covers the ONU management and control channel, protocol and detailed messages.

[**ITU-T G.988 Amd.5 “ONU management and control interface (OMCI) specification - Amendment 5”**](https://www.itu.int/rec/T-REC-G.988-202206-I!Amd5) adds:

• Support of High Speed PON (HSP)

• Support of User Services Platform (USP).

**ITU-T G.9802.1 Amd.1 (revised) “Wavelength division multiplexed passive optical networks (WDM PON): General requirements - Amendment 1” (under approval)** includes additional requirements on CT, ODN or both failure protection requirements for WRP.

**ITU-T G.9804.2 Amd.1 “Higher Speed Passive Optical Networks - Common Transmission Convergence Layer Specification - Amendment 1” (under approval)** includes the dedicated activation wavelength definition in clause 3, processing sequency description on PSBd, FEC encoding, and scrambling in clauses 6 and 10, collision resolution condition update in clause 7, upstream FEC code description in clause 10 and Annex B, Burst\_Profile PLOAM message modifications in clause 11, Assign\_ONU-ID/Collision\_Feedback PLOAM message name update in clause 11, golden vectors in Appendix IV, and typo corrections.

**ITU-T G.9804.3 Amd.1 “50-Gigabit-capable passive optical networks (50G-PON): Physical media dependent (PMD) layer specification Amendment 1” (under approval)** defines a third upstream wavelength “option 3” to support triple WDM coexistence with both GPON and XG(S)-PON, optical interface parameters of 50Gbit/s upstream direction, optical interface parameters for non-MPM use cases, and the ONU out-of-band power spectral density requirements.

[**ITU-T G.9805 “Coexistence of Passive Optical Network Systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14918) 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.

**ITU-T G.Suppl. 45 (revised) “Optical access systems power conservation” (under publication)** consolidates the various optical access systems power-saving proposals in order to facilitate their consideration and comparative analysis from the perspective of the requirements satisfiability, on the one hand, and the overall system impact, on the other hand. This Supplement is formatted as a white paper encompassing the summary of the requirements gathering effort, the specification of the wide spectrum of potential solutions as well as their comparative analysis.

[**ITU-T L.210 “Requirements for passive optical nodes: optical wall outlets and extender boxes”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15123) refers to passive optical nodes (optical wall outlets and extender boxes) deployed in customer indoor premises. It deals with the node housing, fibre management system and specifies the mechanical and environmental characteristics as well.

I.1.3 Optical fibres

[**ITU-T G.9803 Amd.2 “Radio over fibre systems - Amendment 2”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14892) 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. 78 “Use case and Requirements of Fibre-to-The-Room for Small Business Applications (FTTR4B)” (under publication)** collects the use cases and requirements of Fibre-to-The-Room (FTTR) technology (G.fin) for small business applications. The advantages of the fibre-based technology are also analysed.

**ITU-T Technical Paper GSTR-SDM “Optical Fibre, Cable, and Components for Space Division Multiplexing Transmission” (under publication)** is established for analysing the current state of SDM technical maturity, clarifying the technical and commercial aspects of this technology, and highlighting the characteristics of related technologies and network configuration/installation/operations. The goal is to develop a cost-effective network and ecosystem utilizing SDM optical fibre and cable technologies. The classification and definition of existing SDM optical fibre and cable technologies are described from the viewpoint of the geometrical, mechanical, and optical properties of various SDM optical fibres. Potential application areas are investigated to examine the relationship between various SDM optical fibre and cable technologies. Furthermore, aspects of how to use SDM optical fibres in anticipated applications are addressed, including considerations on connectorisation, splicing, breakout technologies, and how to imbed this technology in current optical systems. The purpose of this technical report is to establish a clear and agreed upon roadmap for SDM optical fibre and cable technologies including related technologies such as test methods, connectivity, maintenance, and restoration.

[**ITU-T L.209 “Requirements for Fibre Optic Network Terminal Box (FONT**)”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14919) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14920) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14939): 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.

**ITU-T Technical Paper LSTP-GLSR (revised) “Guide on the use of ITU-T L-series Recommendations related to optical technologies for outside plant” (under publication)** provides information on the background, development and uses of L series Recommendations prepared by Working Party 2 of ITU-T Study Group 15. These Recommendations are related to the design, construction, maintenance and operation of the optical fibre outside plant. The items covered are related to the following areas:

– optical fibre cable characteristics, evaluation and installation techniques;

– construction of optical infrastructure;

– network design;

– network maintenance and operation, including disaster management;

– passive optical components.

I.1.5 Optical transport network (OTN)

[**ITU-T G.709/Y.1331 Amd.2 “Interfaces for the optical transport network - Amendment 2”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14894) 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.709.1/Y.1331 Amd. 3 “Flexible OTN short reach interfaces - Amendment 3”**](https://www.itu.int/rec/T-REC-G.709.1-202211-I!Amd3) adds additional payload types and makes a few editorial updates to some figures.

[**ITU-T G.709.3 Amd. 1 (revised) “Flexible OTN long reach interfaces - Amendment 1”**](https://www.itu.int/rec/T-REC-G.709.3-202211-I!Amd1) updates the text in Annex G of G.709.3 to support the FlexO-x-DO TS, PS and MFAS overhead bit values.

[**ITU-T G.798 Amd.4 “Characteristics of Optical Transport Network Hierarchy Equipment Functional Blocks - Amendment 4”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14896&lang=en) 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.806 Amd.1 “Characteristics of transport equipment - Description methodology and generic functionality - Amendment 1”**](https://www.itu.int/rec/T-REC-G.806-202211-I) updates:

- Clause 6.1 to indicate that TPmode and portmode are applicable only to SDH and PDH and superseded for new development (e.g., OTN).

- Table 7-1 to remove the columns for TPmode and portmode

- New Appendix IX to describe the behaviour of TPmode and portmode that are moved from clause 6.1.

[**ITU-T G.873.1 Amd.1 “Optical transport network: Linear protection - Amendment 1”**](https://www.itu.int/rec/T-REC-G.873.1-202202-I!Amd1) adds ODUCn as a server layer of protected entities in Table 8-1 and provides minor editorial changes.

[**ITU-T G.874 Amd.1 “Management aspects of optical transport network elements - Amendment 1”**](https://www.itu.int/rec/T-REC-G.874-202211-I!Amd1) aligns with the latest editions of ITU-T G.709 and ITU-T G.798, including their amendments.

[**ITU-T G.8251 (revised) “The control of jitter and wander within the optical transport network (OTN)”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15126) specifies the maximum network limits of jitter and wander that shall not be exceeded and the minimum equipment tolerance to jitter and wander that shall be provided at any relevant interfaces which are based on the optical transport network (OTN). The requirements for the jitter and wander characteristics that are specified in this Recommendation must be adhered to in order to ensure interoperability of equipment produced by different manufacturers and a satisfactory network performance.

**ITU-T G.Suppl. 58 (revised) “Optical transport network module framer interfaces” (under publication)** describes several interoperable component to component multilane interfaces (across different vendors) to connect an optical module (with or without digital signal processor (DSP)) to a framer device in a vendor's equipment supporting 25G, 40G, 50G, 100G or beyond 100G optical transport network (OTN) interfaces. Only the structure of the 11G, 28G, 56G, or 112G physical lanes of the different OTN module framer interface (MFI) examples is provided in this Supplement. Electrical parameters for these interfaces can use specifications provided in the relevant clauses of OIF-CEI implementation agreement (IA) specifications. For their electrical characteristics, the OIF-CEI IA specifications can be used. This Supplement relates to Recommendation ITU-T G.709/Y.1331.

I.1.6 Transport network control aspects

[**ITU-T G.7701 (revised) “Common control aspects”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14928) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14929) 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.7703 Amd.1 “Architecture for the automatically switched optical network – Amendment 1”**](https://www.itu.int/rec/T-REC-G.7703-202211-I!Amd1) aligns with G.7701 (2022), which specifies common control aspects for both ASON and software defined networking (SDN) architecture. This amendment refers to G.7701 common clauses.

[**ITU-T G.7710/Y.1701 Amd.1 (revised) “Common equipment management function requirements: Amendment 1”**](https://www.itu.int/rec/T-REC-G.7710-202211-I!Amd1): Edition 5.1 of this Recommendation adds specifications for administrative state management in clause 8.15 and Appendix IV. The numbers of the tables and figures are re-sequenced within each clause of the Recommendation.

[**ITU-T G.7711/Y.1702 (revised) “Generic protocol-neutral information model for transport resources”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14930): 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14900): 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.7716 (revised) “Architecture of management and control operations”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15145)addresses the architecture of management and control operations. Guidance for service providers on the transport network plan, initialization, performing typical operations and maintenance in the network, are described in this Recommendation.

[**ITU-T G.7718 Amd.1 (revised) “Framework for the management of management-control components and functions - Amendment 1”**](https://www.itu.int/rec/T-REC-G.7718-202211-I!Amd1) updates management requirements to align with the recent changes to ITU-T Recommendation G.7701, G.7702 and G.7703.

**ITU-T G.Imp8121 “Characteristics of MPLS-TP equipment functional blocks - Implementer’s Guide” (under publication)** is an Implementer’s Guide for Recommendation ITU-T G.8121/Y.1381 (2018). This edition contains all updates submitted up to and including those at Study Group 15 meeting in September 2022. This document was approved by ITU-T Study Group 15 on 30 September 2022.

**ITU-T G.8152.1/Y.1375.1 Amd.1 “Operation, administration, maintenance (OAM) management information and data models for the MPLS-TP network element - Amendment 1”** enhances the MPLS-TP OAM information/data model specification to specify the on-demand UML and YANG models. The OAM models, including the version 1.0 specified proactive OAM, are also aligned with the pattern of the Ethernet OAM model defined in ITU-T G.8052.1/Y.1346.1.

[**ITU-T G.8152.2/Y.1375.2 Amd.1 “Resilience information/data models for the MPLS-TP network element - Amendment 1”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15170) updates the UML model and data model for MPLS-TP linear protection.

[**ITU-T G.8312 Amd.1 “Interfaces for metro transport networks - Amendment 1”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14908) 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.8321 “Characteristics of Metro Transport Network equipment functional blocks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15120) specifies both the components and methodology that should be used in order to specify the MTN functionality of network elements; it does not specify individual MTN equipment.

[**ITU-T G.8331 “Metro transport network (MTN) linear protection”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14916) defines the operation of linear protection switching schemes for the Metro Transport Network (MTN) path layer, including the automatic protection switching (APS) protocol.

[**ITU-T G.8350 “Management and control for metro transport network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15121) provides the management and control requirements and a protocol-neutral management information model for managing network elements and network of MTN.

I.1.8 Ethernet over transport networks

[**ITU-T G.8012/Y.1308 (revised) “Ethernet UNI and Ethernet NNI”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14931) 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.Imp8013 “Operations, administration and maintenance (OAM) functions and mechanisms for Ethernet-based networks - Implementer’s Guide” (under publication)** is an Implementer’s Guide for Recommendation ITU-T G.8013/Y.1731 (2015). This revision contains all updates submitted up to and including those at Study Group 15 meeting in September 2022. This document was approved by ITU-T Study Group 15 on 30 September 2022.

[**ITU-T G.8021/Y.1341 (revised) “Characteristics of Ethernet transport network equipment functional blocks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14932) 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.Imp8021 “Characteristics of Ethernet transport network equipment functional blocks - Implementer’s Guide” (under publication)** is an Implementer's Guide for Recommendation ITU-T G.8021/Y.1341 (2022). This revision contains all updates submitted up to and including those at Study Group 15 meeting in September 2022. This document was approved by ITU-T Study Group 15 on 30 September 2022.

[**ITU-T G.8023 Amd.1 “Characteristics of equipment functional blocks supporting Ethernet physical layer and Flex Ethernet interfaces - Amendment 1”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14901) 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.

**ITU-T G.8052.1/Y.1346.1 Amd.1 (revised) “Operation, administration, maintenance (OAM) management information and data models for the Ethernet-transport network element - Amendment 1” (under approval)** updates the UML model for On-demand measurement and Proactive measurement.

I.1.9 Synchronization and timing

[**ITU-T G.781.1 “Synchronization layer functions for packet-based synchronization”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14914) 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.781 Amd.1 “Synchronization layer functions for frequency synchronization based on the physical layer - Amendment 1”**](https://www.itu.int/rec/T-REC-G.781-202211-I!Amd1) provides the following updates:

• Addition of FlexE to SD layer adaptation functions

• Addition of FlexE layer clock adaptation functions

• Minor corrections and clarifications.

[**ITU-T G.781.1 Amd.1 “Synchronization Layer Functions for packet-based networks - Amendment 1”**](https://www.itu.int/rec/T-REC-G.781.1-202211-I!Amd1) provides the following updates:

• Addition of FlexO to SD packet-based sync adaptation functions

• Minor corrections and clarifications.

[**ITU-T G.7721 Amd.1 “Management requirement and information model for synchronization – Amendment 1”**](https://www.itu.int/rec/T-REC-G.7721-202211-I!Amd1) updates the Recommendation to align the information model for PTP telecom profile with the data set defined in [IEEE 1588-2019].

[**ITU-T G.7721.1 “Data model of Synchronization management”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14915) 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.8260 (revised) “Definitions and terminology for synchronization in packet networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15127) provides the definitions, terminology and abbreviations used in ITU T Recommendations on timing and synchronization in packet networks.

[**ITU-T G.8262.1/Y.1362.1 (revised) “Timing characteristics of enhanced synchronous equipment slave clock”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15128) outlines requirements for timing devices used in synchronizing network equipment that uses the physical layer to deliver frequency synchronization. This Recommendation defines the requirements for clocks, e.g., bandwidth, frequency accuracy, holdover and noise generation.

[**ITU-T G.8265.1 (revised) “Precision time protocol telecom profile for frequency synchronization”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15129) describes the architecture and requirements for packet based frequency distribution in telecom networks. Examples of packet-based frequency distribution include the network time protocol (NTP), IEEE-1588-2008 and IEEE 1588-2019 and are briefly described here. Details necessary to utilize IEEE-1588-2008 and IEEE 588-2019 in a manner consistent with the architecture are defined in other Recommendations.

[**ITU-T G.8265.1/Y.1365.1 Amd.1 “Precision time protocol telecom profile for frequency synchronization - Amendment 1”**](https://www.itu.int/rec/T-REC-G.8265.1-202202-I!Amd1) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14903) provides the following updates:

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

− Clarifications to Appendix IX.

[**ITU-T G.8271.1/Y.1366.1 (revised) “Network limits for time synchronization in packet networks with full timing support from the network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15130) specifies the maximum network limits of phase and time error that shall not be exceeded. It specifies the minimum equipment tolerance to phase and time error that shall be provided at the boundary of packet networks at phase and time synchronization interfaces. It also outlines the minimum requirements for the synchronization function of network elements. This Recommendation addresses the case of time and phase distribution across a network by a packet-based method with full timing support to the protocol level from the network.

[**ITU-T G.8271.2/Y.1366.2 Amd.1 (revised) “Network limits for time synchronization in packet networks with partial timing support from the network - Amendment 1”**](https://www.itu.int/rec/T-REC-G.8271.2-202211-I!Amd1): The changes in this Amendment include the following:

– Addition of notes regarding the use of T-BC-A and T-BC-P in clauses 7.4.1 and 7.4.2 respectively.

[**ITU-T G.8272/Y.1367 Amd.2 “Timing characteristics of primary reference time clocks - Amendment 2”**](https://www.itu.int/rec/T-REC-G.8272-202211-I!Amd2) specifies the requirements for primary reference time clocks (PRTCs) suitable for time, phase and frequency synchronization in packet networks. It defines the error allowed at the time output of the PRTC. These requirements apply under the normal environmental conditions specified for the equipment. Amendment 2 provides the following updates:

• Modification to scope.

• Updates to the reference clause 2.

• Clause 6 text modified.

• Added reference to IEEE 1588-2019 in clause 6.2.

• New text added under clause 7. Holdover.

[b-1588-2009] is removed from the bibliography section.

[**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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14904) 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.8273.2/Y.1368.2 (2020) Amd. 2 (revised) “Timing characteristics of telecom boundary clocks and telecom time slave clocks for use with full timing support from the network - Amendment 2”**](https://www.itu.int/rec/T-REC-G.8273.2-202211-I!Amd2) provides the following updates:

– Clause 7.1.2 – Adds dynamic time error low-pass filtered noise generation (MTIE) for T-BC/T-TSC Class C with variable temperature in Clause

– Editorial changes in Annex B and Appendix II

– Updates in Appendix VI.

[**ITU-T G.8273.4/Y.1368.4 Amd.2 “Timing Characteristics of Telecom Boundary Clocks and Telecom Time Slave Clocks for Use with Partial Timing Support from the Network - Amendment 2”**](https://www.itu.int/rec/T-REC-G.8273.4-202211-I!Amd2) specifies minimum requirements for time and phase synchronization equipment used in synchronization networks that operates in the assisted partial timing support (APTS) and partial timing support (PTS) architectures. Amendment 2 provides the following updates:

– Changes in Clause 7.3

– Changes in Clause 7.5

– Changes in Clause 8.3

– Changes in Clause 8.6.1

– Changes in Clause 9

– Add a note in Annex B

– Changes in Appendix VI

– Adds Appendices VII and VIII.

[**ITU-T G.8275.1/Y.1369.1 (revised) “Precision time protocol telecom profile for phase/time synchronization with full timing support from the network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15131) contains the ITU-T precision time protocol (PTP) profile for phase and time distribution with full timing support from the network. It provides the necessary details to utilize IEEE 1588 in a manner consistent with the architecture described in Recommendation ITU T G.8275/Y.1369.

[**ITU-T G.8275/Y.1369 Amd.2 “Architecture and requirements for packet-based time and phase distribution - Amendment 2”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14905) incorporates

- Updates to Appendix III Generic IWF node.

[**ITU-T G.8275/Y.1369 (2020) Amd. 3 “Architecture and requirements for packet-based time and phase distribution - Amendment 3”**](https://www.itu.int/rec/T-REC-G.8275-202211-I!Amd3) describes the architecture and requirements for packet based time and phase distribution in telecom networks. The architecture described is mainly applicable to the use of IEEE 1588. Details necessary to utilize IEEE 1588 in a manner consistent with the architecture are defined in other Recommendations. Amendment 3 incorporates a new PRTC deployment use case in clause 7.2.1, a new Annex on the use of masterOnly and notMaster and some modifications to align with updates to the profiles.

[**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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14913) 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 (revised) “Precision time protocol telecom profile for phase/time synchronization with partial timing support from the network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15132) contains the ITU-T precision time protocol (PTP) profile for phase/time distribution with partial timing support from the network (unicast mode). It provides the necessary details to utilize IEEE 1588 in a manner consistent with the architecture described in Recommendation ITU-T G. 8275/Y.1369. This Recommendation defines the PTP profile for unicast mode only. Future editions of this Recommendation may contain a separate profile for a mixed unicast/multicast case.

[**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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14906) 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 L.109.1 “Type II optical/electrical hybrid cables for access points and other terminal equipment”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15122)**:** The current application scenarios for remote powering and data transmission of access points and other equipment, require a type of a hybrid cable that has a small footprint, is light weight, and is convenient for installation. This Recommendation deals with a type II optical/electrical hybrid cable (OEHC) in which a copper pair is used for power delivery (not for telecommunication) and an optical fibre can support data transmission up to and beyond 1 Gbit/s.

[**ITU-T J.1 (revised) “Terms, definitions and acronyms for television and sound transmission and integrated broadband cable networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15115) compiles all the definitions related to television and sound transmission, and integrated broadband cable networks, and which are in force in J-series and N-series Recommendations developed under the responsibility of SG9. The Recommendation is regularly updated to reflect newly-approved terms and definitions.

[**ITU-T J.198.1 “Functional requirements for third-generation HiNoC”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14838) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14867) 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.224 (revised) “Fifth-generation transmission systems for interactive cable television services - IP cable modems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15116) specifies the fifth generation of high-speed data-over-cable systems. Fifth generation transmission systems introduce a number of new features that build upon what was present in previous ITU-T Recommendations, namely ITU-T J.112, ITU-T J.122, the ITU-T J.222.x-series and the ITU-T J.223.x-series. Recommendation ITU-T J.224 includes key new features for the physical (PHY) layer and establishes a full duplex data-over-cable service interface specification (DOCSIS) mode of operation, including enhancements to media access control (MAC) layer protocols, as well as requirements for those in the upper layer, e.g., the Internet protocol (IP) and dynamic host configuration protocol (DHCP). Fifth generation cable modem specifications fully incorporate those of the fourth generation.

NOTE – The structure and content of Recommendation ITU-T J.224 have been organized for ease of use through direct reference to the original source material, based on the recognition of CableLabs by ITU in accordance with Recommendation ITU-T A.5.

[**ITU-T J.225 (revised) “Fourth-generation transmission systems for interactive cable television services - IP cable modems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15117) defines the fourth generation of high-speed data-over-cable systems. The fourth-generation transmission systems introduce a number of new features that build upon what was present in previous Recommendations ITU-T J.112, ITU-T J.122, ITU-T J.222 and ITU T J.223. This Recommendation includes key new features for the physical (PHY) layer and defines Full Duplex DOCSIS Mode of operation, including enhancements to the media access control (MAC) layer protocols as well as requirements for upper layer protocols (e.g., IP, DHCP, etc.). The fourth-generation cable modem specifications are incorporated fully in this Recommendation. Informative Supplement 10 to the ITU-T J series of Recommendations contains the correspondence between the DOCSIS versions and the ITU-T Recommendations revisions and generations.

NOTE – The structure and content of this Recommendation have been organized for ease of use through direct reference to the original source material, based on the recognition of CableLabs by ITU in accordance with Recommendation ITU-T A.5.

[**ITU-T J.483 “Architecture and Functional Specifications of a radio frequency (RF)/Internet protocol (IP) video switching system"**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14839) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14868) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14869) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14870) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14840): 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14871) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14872) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14873) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14874) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14841) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14842) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14843)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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14844): 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.1611 (revised) “Functional requirements for Smart Home Gateway”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15118): In a smart home solution, a smart home gateway is incorporated to connect various smart home appliances. In addition, an IoT-based connection management platform is required to enable various applications. These applicable solutions include home health, entertainment, security, and home automation, which promotes a safer, happier, and more comfortable and convenient lifestyle. This Recommendation aims to define the functional requirements for a smart home gateway from both hardware and software point of view to ensure secure interoperability among consumers, businesses and industries by delivering a standardized communications platform and allowing devices to communicate cross operating system, service provider, transport technology or ecosystem.

[**ITU-T J.1612 “The Architecture for Smart Home Gateway”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14845): 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.Suppl.10 (revised) “Correspondence between CableLabs DOCSIS Specifications and ITU-T J-series Recommendations”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15183) clarifies the relationship between the multiple generations of CableLabs DOCSIS specifications and the ITU-T J-series of DOCSIS-based Recommendations.

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

[**ITU-T Q.4102 “Hybrid peer-to-peer (P2P) communications: Peer protocol”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14923) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14924) 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.

**ITU-T Y.2248 “Service model for entry-level smart farm” (under approval):** Entry-level smart farms can provide convenience of use and increased economic profits to agricultural producers that have not been familiar with high-level ICT technologies. This Recommendation describes the service model for entry-level smart farm. The scope of this Recommendation covers reference architecture, service requirements and service scenarios for the entry-level smart farm.

**ITU-T Y.2344 “Scenarios and requirements of Intent-Based Network for network evolution” (under approval)** aims to provide the scenarios and requirements of Intent-Based Network for network evolution. The scope of this Recommendation includes:

• Scenarios and workflow of Intent-Based Network for network evolution.

• Capability requirements of Intent-Based Network for network evolution.

• General framework of Intent-Based Network for network evolution.

[**ITU-T Y.3079 “Information-Centric Networking in networks beyond IMT-2020: Framework of locally enhanced name mapping and resolution”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15049) specifies the framework of locally enhanced name mapping and resolution to achieve high performance of deterministic latency and scalability for a massive number of named objects for information centric networking (ICN)in networks beyond IMT-2020.

[**ITU-T Y.3080 “Information-Centric Networking in networks beyond IMT-2020: Requirements and Mechanisms of Transport Layer”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15050) describes the requirements and mechanisms of transport layer for information-centric networking (ICN) in networks beyond IMT-2020. (1) It provides an introduction to transport layer in networks beyond IMT-2020. (2) It describes service and functional requirements of transport layer. (3) Based on the requirements, it specifies the mechanisms of transport layer for information-centric networking (ICN) in networks beyond IMT-2020.

[**ITU-T Y.3081 “Self-Controlled Identity based on Blockchain: Requirements and Framework”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15051)presents the motivations and principles for self-controlled identity based on blockchain in future networks including networks beyond IMT-2020. It provides the high-level framework and requirements of self-controlled identity based on blockchain. It specifies the capability requirements of the self-controlled identity based on blockchain accordingly in the context of future networks including networks beyond IMT-2020. Detailed descriptions of the use cases and business models are listed in the appendix.

[**ITU-T Y.3090 “Digital twin network - Requirements and architecture”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14852): 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 Y.3119 “Future networks including IMT-2020: capability classification framework 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. The capabilities of dedicated networks include, but are not limited to, core network, transport network, access network, service support, management, infrastructure, and artificial intelligence (AI)/machine learning (ML) enabling capabilities. To evaluate the capabilities of dedicated networks in a standardized way, there exists the need to introduce capability classification for dedicated networks. With the understanding that the capability level is the level of availability of capabilities in a network, the capability classification is based on the evaluation of the capability level of the network. This Recommendation specifies the methods and framework of capability classification for dedicated networks.

**ITU-T Y.3120 “Functional Architecture for latency guarantee in large scale networks including IMT-2020 and beyond” (under approval)** specifies the functional architecture, functional entities, reference points, and operational procedures, for the requirements and framework defined in Y.3113, based on the architecture defined in Y.2111. Meanwhile, Y.3113 specifies the use of flow aggregate (FA)-based scheduling and regulators at aggregation domain (AD) boundaries. Y.2111 specifies the resource and admission control functions (RACF) in support of end-to-end quality of service (QoS) and necessary transport functions in next generation networks (NGNs).

[**ITU-T Y.Suppl.71 to ITU-T Y.3000-series “Use cases for Autonomous Networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=15041) discusses use cases for autonomous networks. The use cases are divided into two categories, and possible requirements, interactions among actors and possible key components are also discussed. Various use cases are derived according to the key concepts behind autonomous networks of exploratory evolution, real-time responsive experimentation and dynamic adaptation to enable handling of hitherto unseen changes in network scenarios or inputs to reduce the human effort involved in managing the network.

I.2.3 IMT-2020/5G networks

**ITU-T F.743.18 “Requirements for IMT-2020 ultra-high definition surveillance camera” (under approval)** defines typical use cases, functional requirements, performance requirements and security requirements for IMT-2020 UHD surveillance cameras, in order to solve UHD video reliably transmission in IMT-2020. This Recommendation also defines the classification of IMT-2020 UHD surveillance service, SLA rank of IMT-2020 UHD surveillance service, the network requirements for IMT-2020 UHD video surveillance service which are very relevant to IMT-2020 surveillance scenarios, so as to meet the actual user’s UHD video captured and transmission requirements.

[**ITU-T K.Suppl.16 (revised) “Electromagnetic field compliance assessments for 5G wireless networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15079) provides guidance on the radio frequency electromagnetic field (RF-EMF) compliance assessment considerations for IMT 2020 wireless networks also known as 5G. Given that the 5G technical standards have just been finalised and commercial 5G networks are not due to be launched before 2019-2020, the first version of this Supplement is to mainly address the computational assessment options and the assessments of trial networks.

**ITU-T L.1390 “Energy saving technologies and best practices for 5G RAN equipment” (under approval):** With the rapid development and commercialization of 5G radio communication technology, the 5G network construction is further accelerated. While being an important enabler for digitalization of other industries and thereby contribute to significant energy savings and emission reductions, it is also important to consider the energy consumption of the 5G network infrastructure itself. This Recommendation identifies energy saving potentials, describes energy-saving principles and technologies for 5G RAN and related equipment, and provides best practice recommendations when and how these technologies should be used and controlled thereby reducing the 5G RAN energy consumption, saving operational costs, and making the 5G RAN a green and high-efficiency network.

[**ITU-T M.3381 “Requirements for energy saving management of 5G RAN system with AI”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14834) 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.5025 “Protocol for managing User Plane function in IMT-2020 network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15047) specifies protocol for managing user plane function (UPF) in IMT-2020 network. It describes the communication mechanism inside UPF. It also describes API management, procedure, signalling flow and message format between UPF and other core network functions or third-party applications.

[**ITU-T X.1812 “Security framework based on trust relationship for IMT-2020 ecosystem”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14808) identifies stakeholders in IMT-2020 ecosystem, analyses trust relationships amongst them, identifies threats and clarifies security responsibilities for each stakeholder, defines security boundaries between stakeholders, and establishes a security framework based on these trust relationships.

[**ITU-T X.1813 “Security and monitoring requirements for operation of vertical services supporting ultra-reliable and low latency communication (URLLC) in IMT-2020 private network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14991)**:** IMT-2020 private network, also regarded as IMT-2020 non-public network (NPN), is intended for the sole use of a private entity such as an enterprise and may be deployed in a variety of configurations, utilizing both virtual and physical elements. It will deliver speed, low latency and other benefits promised by IMT-2020 to support next-generation applications. In vertical services for smart factories and smart cities that use a private IMT-2020 network, many Internet of things (IoT) devices use massive machine type communications (mMTC) and ultra-reliable low latency communications (URLLC). These communications can be exposed to security threats and their associated risks. In addition, these threats can deteriorate the stable operation of the vertical services supporting URLLC. It cannot be guaranteed when the performance of vertical services is degraded due to these risks. This Recommendation specifies security requirements for operation of vertical services supporting URLLC in IMT-2020 private network. It identifies threats and risks which arise when providing vertical services supporting URLLC in IMT-2020 private network and describes security deployment scenarios of IMT-2020 private network for operation of vertical services supporting URLLC. Monitoring of communication contents is out of the scope of this Recommendation.

[**ITU-T X.1814 “Security guidelines for IMT-2020 communication system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14992): Connected IoT devices and mobile applications require wireless network access that is resilient, secure, and able to protect individuals' privacy. IMT-2020 communication systems should be designed to meet these high-level requirements. There is a need to define a security framework for IMT-2020 communication systems which could act as a foundation for developing further detailed technical Recommendations on IMT-2020 security topics. This Recommendation identifies all components related to the security of IMT-2020 communication systems and defines security guidelines for the IMT-2020 communication system. It describes a generic IMT-2020 architecture and its domains. It also identifies threats to and specifies requirements on security capabilities for each component, taking into account unique network features. This Recommendation is based on 3GPP 5G security architecture.

**ITU-T X.1815 “Security guidelines and requirements for IMT-2020 edge computing services” (under approval)**: The IMT-2020 network will enable a variety of services, including enhanced mobile broadband (eMBB) services, massive machine type communications (mMTC) based services and ultrareliable low latency communications (URLLC) based services, on an infrastructure of network and computing resources. In line with the key features and the requirements identified for the IMT-2020 network, it is required to be more efficient, personalized, intelligent, reliable and flexible. To support the typical services in the IMT-2020 network, especially eMBB services and URLLC based services, edge computing is acknowledged to be one of the key technologies for meeting the demanding key performance indicators (KPIs) of the IMT-2020 network, especially as far as low latency and bandwidth efficiency are concerned. Edge computing enables the operator and the third part service provider to deploy the services close to the user's access point, thus achieving high-efficiency service delivery through reduced end-to-end latency and load on the transport network. In order to ensure the security of edge computing service deployment and application, the security threats and relevant security requirements specific to edge computing service need to be analysed and the overall security framework need to be established. This Recommendation aims to analyses the deployment scheme and typical application scenarios of edge computing services, specifies the security threats and requirements specific to edge computing services in IMT-2020 and thus establishes security capabilities for the operator to safeguard its applications.

**ITU-T X.1816 “Guidelines and requirements for classifying security capabilities in IMT-2020 network slice” (under approval)**: The definition of basic network slicing technology functions and processes has laid a solid foundation for the first wave of IMT-2020 deployment and commercial use of network slicing services. As an end-to-end logical network that is customized on demand, slicing can provide differentiation security capabilities: First, the IMT-2020 network slicing provides the supporting security measures for the differentiated network implementation. Second, the IMT-2020 network supports some optional security measures at the slice level. Some security measures can also provide multiple security options and operators may own different security resources. These may bring different degrees of security guarantee or non-security performance. Slice customers also have specific security requirements and may request customized network slices with different security protection levels from slice operators. There exist some challenges for the slice customers or the slice operators choosing the security capabilities of their slices such as management cost and definition inconsistency, etc. The objective of this Recommendation is to provide a description of differentiated IMT-2020 network slice security capabilities and guidance for classifying the IMT-2020 network slice security capabilities and IMT-2020 network slice security to help the ecosystem more clearly understand and choose the slicing security capabilities.

[**ITU-T Y.3117 “Quality of service assurance-related requirements and framework for smart education supported by IMT-2020 and beyond”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15052) specifies the quality of service (QoS) assurance-related requirements and framework for smart education supported by the international mobile telecommunications 2020 (IMT-2020) and beyond. Recommendation ITU-T Y.3117 (Y.IMT2020-qos-req-se) first provides an overview of smart education supported by IMT2020 and beyond. It then specifies the QoS assurance-related requirements and a framework. Finally, the QoS consideration for smart education services are described in Appendix I.

**ITU-T Y.3121 “QoS requirements and framework for supporting deterministic communication services in local area network for IMT-2020” (under approval)** specifies QoS requirements and framework for supporting deterministic communication services in a local area network (LAN). First, it presents the concept and benefits of deterministic communication services in a LAN consisting of heterogeneous network technologies. Then it specifies a high-level model and associated QoS requirements for inter- technology domain deterministic communication services in LAN. Based on the identified QoS requirements, it identifies a framework and an example operational procedure. Finally, it provides three scenarios and associated use cases as informal material in appendixes.

[**ITU-T Y.3138 “Unified multi-access edge computing for supporting fixed mobile convergence in IMT-2020 networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15055)**:** A unified and cloud-based edge computing platform allows operators to flexibly deploy network functions and support infrastructure for fixed mobile convergence (FMC), to provide unified multi-access edge computing capabilities for all the access network technologies in IMT-2020 networks. This Recommendation specifies the requirements, architecture and functions of unified multi-access edge computing for supporting FMC network.

[**ITU-T Y.3139 “Fixed mobile convergence enhancements to support IMT-2020 based software-defined wide area networking service”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15056)**:** IMT-2020 based fixed mobile convergence (FMC) is one of the main trends in the future development of telecommunication. The main purpose of FMC is to combine all access technologies, including fixed and mobile access method, to access the network without network constraints. By adopting IMT-2020 technologies, SD-WAN service is required to support IMT-2020 access as one of the multiple connection types. By having the enhancements of FMC, IMT-2020 based SD-WAN service could have some features such as end to end isolated connections and duel link transmission. This Recommendation provides specification about fixed mobile convergence enhancements to support IMT-2020 based software-defined wide area networking service.

[**ITU-T Y.3158 “Local shunting for multi-access edge computing in IMT-2020 networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15057) points out the relationship between IMT-2020 networks and MEC system, and specifies an architecture for transmitting traffic flows at the edge of IMT-2020 networks. The objective of this Recommendation is to specify the requirements, architecture, functional entities, reference points and information flows for multi-access edge computing in IMT-2020 networks.

[**ITU-T Technical Report XSTP-5Gsec-RM “5G Security Standardization Roadmap”**](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-ICTS-2022-2) provides the standardization roadmap for 5G security. This roadmap is prepared to assist in developing 5G security standards by providing information on existing and under developing standards at key standards developing organizations (SDOs). In addition, it describes the overviews of 5G security from standards perspective and gap analysis.

[**ITU-T Y.3078 “Information centric networking for IMT-2020 and beyond - Requirements and capabilities of data object segmentation”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14851) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14853): 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14854) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14855): 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14857) 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.3201 “Fixed, mobile and satellite convergence – Framework for IMT-2020 networks and beyond” (under approval):** Fixed, mobile and satellite convergence (FMSC) is the capability that provides services and applications to end users regardless of the fixed, mobile or satellite access technologies. This Recommendation specifies the design considerations, framework, enabling technologies, network function enhancements, procedures, and security considerations of FMSC, in the context of IMT-2020 networks and beyond.

**ITU-T Y.Suppl.59 (revised) to ITU-T Y.3100 of Recommendations “IMT-2020 standardization roadmap” (under publication)** provides the standardization roadmap for IMT-2020 area in the telecommunication sector. It addresses the following subjects:

• The collection/pointers to the standards and publications of IMT-2020 deliverables in ITU T study groups (SGs) and other standards development organisations (SDOs);

• Responsible group (owner);

• Status;

• Subject;

• Topics.

I.2.4 Home networking

**ITU-T G.9901 Amd.1 “Narrowband orthogonal frequency division multiplexing power line communication transceivers – Power spectral density specification – Amendment 1” (under approval)** introduces FCC-Low and FCC-High bandplans in Annex B.

**ITU-T G.9903 Amd.2 “Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC networks” (under approval)** covers Cenelec A, Cenelec B, ARIB and FCC bandplans. It adds new mechanisms to improve efficiency of broadcast transmissions (for both data traffic and LOADng RREQ routing messages) and extends the G3-PLC Hybrid PLC & RF Profile with new operating frequency bands, an RF transmit power adaptation mechanism, frequency hopping and a last gasp feature (consisting in an alerting mechanism in case a power outage is experienced by a device in the network).

[**ITU-T G.9960 Amd.3 “Unified high-speed wire-line based home networking transceivers - System architecture and physical layer specification - Amendment 3”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14909) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14910) includes enhancements to the secure admission methods, extends the maximum MAC cycle duration for operation over powerlines (to support Smart Grid applications), and provides updates to account for revisions to IEEE 802.1Q.

**ITU-T G.9962 Amd.2 “Unified high-speed wire-line based home networking transceivers - Management Specification: Amendment 2” (under approval)** includes the data model needed for centralized NDIM.

**[ITU-T G.9976 “Support UHD video service over G.hn”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14634)** 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 Amd.1 (revised) “Secure admission in G.hn network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14911) adds support for native authentication and external authentication, as specified in [ITU-T G.9961].

**ITU-T Technical Paper GSTP-OPHN “Operation of G.hn technology over access and in-premises phone line medium” (under publication)** describes typical network architectures, parameters, and implementation issues regarding broadband applications that use ITU-T G.9960/G.9961 transceivers (called here “G.996x transceivers”). G.996x devices are designed to be capable of operating over different types of physical media, using different frequency ranges, and different sets of PHY and MAC parameters. Each of these applications has specific characteristics that may require optimized settings (configuration options) to be used. Additionally, implementations themselves need to consider various aspects of the applications, which are described in detail in this document. This document is not an ITU-T Recommendation, but rather a tutorial that provides guidance for the user and describes how to configure ITU-T G.996x home networking systems to operate in the context of applications that require operating over various phone lines with potentially high level of crosstalk, such as phone line cables within private apartment buildings, connecting GAM equipment in the basement with GNT equipment in the individual apartments.

I.2.6 Software-defined networking

I.2.7 Cloud computing and data handling

**ITU-T F.746.14 “Requirements and reference framework for cloud virtual reality systems” (under approval)** Cloud virtual reality based on cloud capabilities, can effectively shield terminal differences, reduce the difficulty of application development, lower some specific industry entry barriers, and promote the industry business chain cooperation. This recommendation focuses on the overall requirements of cloud virtual reality systems and the related requirements of each layer including content requirements, network requirements, control requirements, resource requirements and terminal requirements, as well as the reference framework for related high-level functions.

**ITU-T F.748.17 “Technical specification for artificial intelligence cloud platform: AI model development” (under approval)** provides a framework for the cloud-based development of AI models. It covers the terminology, features, and reference design of an AI cloud platform to enable the development of AI models. It establishes the technical specifications of the platform's supporting functional modules, core functional modules, and auxiliary functional modules.

**ITU-T X.1380 “Security guidelines for cloud-based data recorders in automotive environments” (under approval):** The purpose of this Recommendation is to standardize security guidelines for cloud-based data recorders in automotive environments. This Recommendation describes threats, vulnerabilities, security requirements, and use cases for cloud-based data recorders in automotive environments. Event data recorders are one of the most important components installed in automotive road vehicles in order to record vehicle status, vehicle movements and user inputs during crashes. Through analysing the event data, we can understand the cause of a crash and eventually use it to improve safety in automotive environments. A data storage system for automated driving is also an important component to record a set of data that will give a clear picture of the interactions between the driver and the automated driving system. However, conventional event data recorders record and manage the whole data locally, and in this way the data might come under threats of loss and destruction. Meanwhile, cloud computing is being considered an enabler of network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand. Industries such as the aviation industry are already attempting to apply cloud services to event data recording systems to increase safety in the aviation environment. According to the current trend of connectivity among the vehicles, the event data recorders and the data storage system for automated driving in automotive will be implemented to increase their overall safety. However, They have various vulnerabilities in the process of collecting, transferring, storing, managing, and using the recorded data according to the distinctive characteristics of the automotive environment. Therefore, it is necessary to study these vulnerabilities, security requirements, and use cases for cloud-based data recorders in automotive environments.

[**ITU-T X.1643 “Security requirements and guidelines of virtualization container in cloud computing environment”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14804) analyses security threats and challenges on virtualization container in cloud computing environment and specifies a reference framework with security guidelines for virtualization container in cloud.

**ITU-T X.1644 “Security guidelines for distributed cloud” (under approval)** analyses security threats and challenges on distributed cloud and propose security guidelines against threats for distributed cloud, which includes the security guidelines for core cloud, regional cloud and edge cloud.

[**ITU-T Y.3505 (revised) “Cloud computing – Overview and functional requirements for data storage federation”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14941) 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.3528 “Cloud computing - Framework and requirements of container management in inter-cloud”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14858) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14859) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14860) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14861) 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].

[**ITU-T Y.3537 “Cloud computing – Functional requirements of cloud service partner for multi-cloud”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15060) provides the overview of multi-cloud and the functional requirements of cloud service partner for supporting multi-cloud by identifying various use cases related with multi-cloud in terms of cloud service customer, cloud service provider and cloud service partner. It also provides cloud computing activities to support multi-cloud as sub-role of cloud service partner by identifying interactions between cloud service customer, cloud service provider and cloud service partner.

[**ITU-T Y.3538 “Cloud computing - Global management framework of distributed cloud”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15061) introduces the framework and functional requirements of the global management of distributed cloud. The global management framework includes resource management, data management, platform service management, application service management, operation and maintenance management, and risk management.

I.2.8 Big data

[**ITU-T X.1752 “Security guidelines for big data infrastructure and platform”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14806) analyses security threats and challenges on big data infrastructure and platform and specifies a reference framework to mapping security guidelines against threats for big data infrastructure and platform.

[**ITU-T Y.3602 (revised) “Big data – Functional requirements for data provenance”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15074) describes a model and operations for big data provenance. Also, this Recommendation provides the functional requirements for big data service provider (BDSP) to manage big data provenance. The reliability of data is an important factor in determining the reliability of the analysis result. Data provenance aims to ensure the reliability of data by providing transparency of the historical path of the data. In a big data environment, complex data processing and migration due to the big data lifecycle and data distribution cause various difficulties in managing data provenance.

**ITU-T Y.3607 “Big data – Functional architecture for data provenance” (under approval)** describes a functional architecture for big data provenance. To provide the functional architecture for big data provenance, the big data provenance functions are defined based on the functional requirements and logical components identified in [ITU-T Y.3602]. This Recommendation also provides the relationship between the functional architecture of big data provenance and the big data reference architecture in [ITU-T Y.3605].

[**ITU-T Y.3654 “Big data driven networking - Machine learning mechanism”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14862) 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.3655 ”Big data driven networking - management and control mechanisms”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=15062) specifies the management and control mechanisms of big data driven networking. The Recommendation studies general mechanisms related to management and control aspects of big data driven networking, and management mechanisms, control mechanisms, orchestration mechanisms of big data driven networking, and other consideration related to management and control mechanisms of big data driven networking.

I.2.9 Network Management

**[ITU-T M.3381 “Requirements for energy saving management of 5G RAN system with AI”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14834)** 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 M.3382 “Requirements for work order processing in telecom management with AI”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14993) provides requirements for work order processing in telecom management with AI. Based on AI models and features extraction, work orders will be collected, analyzed, forwarded and archived. This Recommendation describes the framework and functional requirements for work order processing in telecom management with AI, and requirements of work orders. It also describes the process of text and image feature extraction.

[**ITU-T Q.819 “REST-based Management Services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14835) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14836) 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 F.742.1 “Requirements for smart class based on artificial intelligence” (under approval)** describes application scenarios and requirements for smart class system based on artificial intelligence, including application scenarios, service requirements, management requirements, and security considerations.

**ITU-T F.746.16 “Technical requirements and evaluation methods of intelligent levels of intelligent customer service systems” (under approval)**: The intelligent customer service system can provide more convenient, efficient, and stable services for users through the application of AI technologies such as speech recognition, text to speech and natural language processing. Improving and evaluating the intelligence levels of the intelligent customer service system are valuable. This Recommendation specifies the requirements and evaluation methods for system intelligence of intelligence customer service system in four aspects, including the basic functions, the core technologies of AI, the maturation of system and the service experience.

**ITU-T F.747.12 “Requirements for artificial intelligence based machine vision system in smart logistics warehouse” (under approval):** With the rapid development of industrial automation and logistics technology in accordance with the market demand for high-tech, machine vision technology has begun to enable the automation transformation of logistics warehouse systems. The application of machine vision technology in the field of logistics warehouse has enabled the rapid evolution of goods sorting, goods palletizing and de-palletizing, goods handling, and shelf inventory from intensive manual work to intelligence and automation, improving the operational efficiency and management capabilities of logistics warehouse. This Recommendation specifies the requirements and framework for artificial intelligence based machine vision system in smart logistics warehouse, and provides use cases. This Recommendation is intended to guide the design and development of machine vision systems in smart logistics warehouse.

**ITU-T F.748.17 “Technical specification for artificial intelligence cloud platform: AI model development” (under approval)** provides a framework for the cloud-based development of AI models. It covers the terminology, features, and reference design of an AI cloud platform to enable the development of AI models. It establishes the technical specifications of the platform's supporting functional modules, core functional modules, and auxiliary functional modules.

**ITU-T F.748.18 “Metric and evaluation methods for AI-enabled multimedia application computing power benchmark” (under approval):** Facing more and more diverse AI computing systems, users hope to have a unified evaluation metric for the system that provides AI computing power. The establishment of relevant real application performance evaluation benchmarks can objectively reflect the current state of the AI computing ability by providing objective metrics and comparison dimensions. This Recommendation provides an AI computing power benchmark framework, evaluation metrics and methods, and a guideline for technical testing for AI clusters.

**ITU-T F.748.19 “Framework for audio structuralizing based on deep neural network” (under approval)** presents an overview of the framework for audio structuralizing based on deep neural network. It provides a high-level description of architecture, processing flows, data categories, audio processing tasks and requirements for data management.

**ITU-T F.748.20 “Technical framework for deep neural network model partition and collaborative execution” (under approval):** Deep neural network (DNN) model inference process usually requires a large amount of computing resources and memory. Therefore, it is difficult for end devices to perform DNN models independently. It is an effective way to implement end-edge collaborative DNN execution through DNN model partition, which can reduce latency and improve resource utilization at the same time. This recommendation aims to specify the technical framework of DNN model partition and collaborative execution. First, it is necessary to predict the overall inference latency under the current system state according to different DNN partition strategies in advance. Then, choose the appropriate partition locations and collaborative execution strategy based on the equipment computation capabilities, network status and DNN model properties. Finally, implement the model collaborative execution and optimize the resource allocation in the meanwhile.

**ITU-T F.748.21 “Requirements and framework for feature-based distributed intelligent systems” (under approval)** introduces the use cases, classification of features and framework for feature-based distributed intelligent systems relevant to intelligent scenarios, specifying the service requirement, functional requirements, and security requirements for feature-based distributed intelligent systems.

[**ITU-T L.Suppl.48 “Data center energy saving: Application of artificial intelligence technology in improving energy efficiency of telecommunication room and data center infrastructure”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=6304): Telecommunication Room and Data Center (DC) Infrastructure is containing a huge number of Information and Communication equipment. In order to keep the equipment running continuously and reliably, the room is necessarily equipped with air-conditioners to create a suitable environment for equipment operation. Nevertheless, it will cause a large amount of energy consumption and carbon emissions. This Supplement focuses on the application of AI technology and other emerging technologies such as digital twin, to improve the energy efficiency and reduce the carbon emissions of telecommunication room and DC infrastructures.

Most of the existing telecommunication room and DC infrastructures do not have the full ability to identify the distribution of indoor temperatures. Therefore, it is difficult to analyse the heat flow and the related power consumption in real-time and make appropriate adjustments timely. Consequently, it leads to unnecessary consumption of energy. This Supplement will address how AI-based power management can achieve the following capabilities:

• Data collections in telecommunication room and DC infrastructure;

• Real-time analysis of the historical power consumption and parameters of the target equipment room;

• The ability of training an intelligent model;

• Making reasonable adjustments dynamically to the air-conditioning and temperature, so as to achieve energy saving in the telecommunication room and DC infrastructure.

[**ITU-T M.3381 “Requirements for energy saving management of 5G RAN system with AI”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14834) 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 M.3382 “Requirements for work order processing in telecom management with AI” (under approval)** provides requirements for work order processing in telecom management with AI. Based on AI models and features extraction, work orders will be collected, analyzed, forwarded and archived. This Recommendation describes the framework and functional requirements for work order processing in telecom management with AI, and requirements of work orders. It also describes the process of text and image feature extraction.

**ITU-T P.1402 “Guidance for the development of machine learning based solutions for QoS/QoE prediction and network performances management in telecommunication scenarios” (under approval)** introduces Machine Learning techniques and their application for QoS/QoE prediction and network performance management in telecommunication scenarios. Especially, the design of training and evaluation data is described and means to avoid overtraining for Machine Learning models. It is also discussed the relation to classical model or algorithm development and differences are described. This recommendation gives best practice guidance for the successful development and evaluation of models based on Machine Learning but does not describe concrete models or algorithms for a dedicated purpose.

**ITU-T Q.3646 “Framework and protocols for signalling network analyses and optimization in VoLTE” (under approval)**: Signalling network includes the network entities and the signalling exchange which are related to telecommunications services. Analyses and optimization on signalling network are important methods for network and service-related management and operation. This Recommendation specifies the framework, interfaces, protocols, service procedures, AI/ML-assisted functions, and security considerations of signalling network analyses and optimization in the context of VoLTE network.

[**ITU-T X.Suppl.37 “Supplement to ITU-T X.1231: Countering spam based on machine learning”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=15119) defines a technical framework for countering spam based on machine learning. It may help some relevant persons and companies in spam management, reduce the benefit loss of users and providers, improve user experience and promote the healthy development of telecommunication business. This Supplement to Recommendation ITU-T X.1231 provides some general scenarios, characteristics of spam, and define general technical framework, work flows about countering spam based on ML.

[**ITU-T Technical Report TR.sec-ai “Guidelines for security management of using artificial intelligence technology”**](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-ICTS-2022-2): As a new generation of information and communication technology (ICT) infrastructure, Artificial Intelligence (AI) has been widely used in various fields of social economy. In the development and application of AI technology, AI may also bring some security threats, which may run through the whole process of AI products, applications and services from design and development to retirement. Organizations need to identify the source of security threats according to the using process of AI technology, so as to deploy targeted security defense strategies. This Technical Report focuses on the security threats faced by the current use of AI technology, puts forward AI security management suggestions, and provides a useful reference for organizations to improve the security protection ability in the use of AI technology.

[**ITU-T Y.3180 “Mechanism of traffic awareness for application-descriptor-agnostic traffic based on machine learning”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14856) 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.3181 “Architectural framework for Machine Learning Sandbox in future networks including IMT-2020”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15058) provides an architectural framework for machine learning (ML) sandbox in future networks including IMT-2020. More precisely, it describes requirements and high-level architecture for ML sandbox in future networks including IMT-2020.

[**ITU-T Y.3182 “Machine learning based end-to-end multi-domain network slice management and orchestration”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15059) describes an intelligent cost-effective network management and orchestration framework that can cope with the challenges of multi-domain network slicing, while minimizing human intervention towards full automation of slice lifecycle management and runtime operation. It addresses the following subjects:

· Overview and interoperability requirements of machine learning based multi-domain end-to-end network slice management and orchestration;

· Functional requirements of machine learning based multi-domain end-to-end network slice management and orchestration;

· Framework of machine learning based multi-domain end-to-end network slice management and orchestration;

· Cognitive components for the framework.

**ITU-T Y.3183 “Framework for network slicing management assisted by machine learning leveraging QoE feedback from verticals” (under approval)** provides a framework for machine learning assisted network slicing management, leveraging vertical end users’ feedback on QoE, which can help achieve run-time optimisation of user perceived performance. The overall architecture, components, workflow and related APIs of this framework are specified with respect to the high-level requirements identified. A use case is provided in appendix to show an application example of this framework. Example implementations of the key APIs are also provided.

**ITU-T Y.3325 “Framework for high-level AI-based management communicating with external management systems” (under approval):** After the IMT-2020 technology and network virtualization technology spread, the appearance of emerging services such as multimedia services (high resolution, AR, VR, etc.) and IoT will be expected. Since huge amount of traffic of these new coming services will be incurred to the network, the importance of the network flexibility and stability will increase. Network operators intend to improve network operations such as provisioning, resource control, failure detection and recovery, etc. Automatic network management supported by recent AI technologies, called AI-based network, will play an essential role for such era. On the other hand, service provider needs to manage service dynamically based on service and network status for better quality of service (QoS). In order for service providers to use the information managed by AI-based network effectively, common interface between system of service providers over AI-based network and AI-based network is required. This Recommendation describes requirements for reference model of such interactions including interface and metadata.

[**ITU-T Y.3654 “Big data driven networking - Machine learning mechanism”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14862) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14863): 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.

[**ITU-T Y.3812 “Quantum key distribution networks - Requirements for machine learning based quality of service assurance”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15065) specifies high-level and functional requirements of machine learning (ML) based QoS assurance for the quantum key distribution networks (QKDN). This recommendation first provides an overview of requirements of ML based QoS assurance for the QKDN. It describes a functional model of ML based QoS assurance and followed by associated high level and functional requirements of ML based QoS assurance. And some use cases are described.

**ITU-T Y.3814 “Quantum key distribution networks - functional requirements and architecture for machine learning enablement” (under approval):** QKDN is expected to maintain stable operations and meet the requirements of various cryptographic applications efficiently. Due to the advantages of machine learning (ML) related to autonomous learning, ML can help to overcome the challenges of QKDN in terms of quantum layer performances, key management layer performances and QKDN control and management efficiency. Based on the functional requirements and architecture of QKDN in [ITU-T Y.3801] and [ITU-T Y.3802], this recommendation is to specify one possible set of functional requirements and a possible architecture for ML-enabled QKDN (QKDNml), including the overview, the functional requirements, architecture and operational procedures of QKDNml.

**ITU-T Y.Sup.72 to Y.3000-series of Recommendations “Artificial Intelligence Standardization Roadmap” (under publication)** provides the standardization roadmap for artificial intelligence (AI) in the information and communication technologies area. This AI standardization roadmap has been developed to assist in the development of AI related standards in the ICT fields by providing information about existing and under developing standards in key standards development organizations (SDOs). In addition, it provides the overviews of AI and AI related technical areas from standards perspective, AI related activities in standards development organizations (SDOs), and gap analysis.

I.3.3 IPTV and digital signage

[**ITU-T H.721 (V3) (revised) “IPTV terminal devices: Basic model”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14952) describes and specifies the functionalities of the Internet protocol television (IPTV) terminal devices for the IPTV basic services defined in Recommendation ITU-T H.720. This Recommendation is targeted at IPTV terminal devices capable of receiving linear television (TV) service and video-on-demand services, with additional data content (such as text) using a managed content delivery network. The service definition takes into consideration conditions on content delivery such as quality of service (QoS). The expected types of IPTV terminal devices are set-top boxes and digital TV sets with embedded IPTV capabilities. The second edition introduced support for high efficiency video coding (HEVC), dynamic adaptive streaming over HTTP (DASH), MPEG-4 audio lossless coding (ALS), MPEG-4 advanced audio coding (AAC), DTS-HD, timed text markup language (TTML), MPEG media transport (MMT) and several corrections and clarifications. The third edition introduces support for new technologies such as timestamped fragmented TLV (TFT).

I.3.6 New services and applications

**ITU-T F.742.1 “Requirements for smart class based on artificial intelligence” (under approval)** describes application scenarios and requirements for smart class system based on artificial intelligence, including application scenarios, service requirements, management requirements, and security considerations.

[**ITU-T F.743.13 “Requirements for cooperation of multiple edge gateways”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14954) describes the requirements for a function which enables the cooperation of multiple edge gateways (CMEG) to complete complex tasks. It also describes the required capabilities and requirements of key components. The CEMG function can support the information exchanging among multiple edge gateways and deal with gateway failure cooperatively. It can also specify the central gateway which is responsible for selecting a cooperative gateway for each gateway, which in turn monitors the status of its partner gateway, and manages the cooperative data and devices.

[**ITU-T F.743.14 “Requirements for video distribution systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14955): Video distribution system is an Internet application system which is built based on the underlying content delivery network, and can provide the video collection, distribution and viewing functions for the Internet users without any system development. This Recommendation describes the requirements and application scenarios for video distribution system.

[**ITU-T F.743.15 “Requirements for multi-operator core network enabled multimedia services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14956) specifies the requirements for Multi-operator Core Network (MOCN) enabled multimedia services (MOCN-MS). This Recommendation not only defines a high-level functional framework of MOCN enabled multimedia services, but also specifies the Sharing Capability Information Unit (SCIU) function requirements and MOCN-MS system requirements according to this framework. In addition, several scenarios for MOCN enabled multimedia services are provided in this Recommendation. MOCN enabled multimedia service defined in this Recommendation can improve the conventional multimedia service quality by taking advantage of the network sharing capability of the Co-construction network, without bring any additional impact on the base station. The MOCN enabled multimedia service providers will be benefit from the requirements and reference framework defined in this Recommendation so that the extension and optimization of the existing multimedia service can be estimated efficiently. In addition, it is possible for the multimedia service provider to discover and develop the new features while the MOCN-MS is employed.

[**ITU-T F.743.16 “Requirements for communication resource management in intelligent visual surveillance system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14957) defines the architecture and specifies requirements for communication resource management in IVS system, including the requirements of communication resource monitoring, resource provisioning and resource scheduling. Communication resource management in IVS system aims to make rational use of communication resources, so that it can complete the tasks which are generated by the IVS system efficiently.

[**ITU-T F.743.17 “Requirements for cloud gaming system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14958) describes the requirements for cloud gaming system including user requirements, service requirements, performance requirements, management requirements, security requirements, network requirements and terminal requirements for cloud gaming system. It also describes the typical scenarios including cloud game distribution scenario, cloud game running scenario, cloud game cross-platform scenario and cloud game live streaming scenario for cloud gaming system in the Appendix. This Recommendation is intended to provide a reference for cloud gaming service providers, platform providers and developers when they build and operate a cloud gaming system.

**ITU-T F.743.18 “Requirements for IMT-2020 ultra-high definition surveillance camera” (under approval)** defines typical use cases, functional requirements, performance requirements and security requirements for IMT-2020 UHD surveillance cameras, in order to solve UHD video reliably transmission in IMT-2020. This Recommendation also defines the classification of IMT-2020 UHD surveillance service, SLA rank of IMT-2020 UHD surveillance service, the network requirements for IMT-2020 UHD video surveillance service which are very relevant to IMT-2020 surveillance scenarios, so as to meet the actual user’s UHD video captured and transmission requirements.

**ITU-T F.743.19 “Requirements for intelligent surveillance camera in intelligent video surveillance systems” (under approval)** specifies the intelligent analysis functions classification, intelligent analysis function scenarios, intelligent analysis function and grading requirements for intelligent surveillance camera. The related intelligent analysis functions include video diagnosis, tampering detection, video enhancement, target detection and feature extraction and object behaviours identification. The basic functions of a camera (see PU defined in [ITU-T H.626]) such as multimedia capturing, multimedia encoding, output alarm signal, parsing PTZ command, etc. are outside the scope of this Recommendation. This Recommendation defines the relevant intelligent analysis function and grading requirements for intelligent surveillance camera in IVS.

**ITU-T F.743.22 “Requirements and architecture of algorithm training system for intelligent video surveillance” (under approval)** specifies the requirements and architecture of the algorithm training system (ATS) for intelligent video surveillance (IVS) and provides the workflow of the algorithm training in the ATS. The intelligent analysis algorithm in IVS needs to train a large amount of actual scene data to improve the accuracy and the recall of identification. The ATS can collect video and image data from the IVS, complete sample data selection, data annotation, algorithm training, and deploy the algorithm into the IVS, so that the IVS has the reasoning capability of new scenarios, and the ATS can continuously iteratively improve on the algorithm identification performance. This Recommendation aims to solve the problems of difficult application of algorithm customization in various industries, long algorithm development and iteration cycle, and effective protection of user privacy and improvement of data security.

[**ITU-T F.746.12 “Requirements for a real-time interactive multimedia service under poor network conditions”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14959) describes the scenarios, general framework, and requirements for a real-time interactive multimedia service (RIMS) under poor network conditions. The RIMS system plays an important role in many scenarios and situations, e.g., emergency relief, remote education and emergency communication. The RIMS requires providing measures for adjustment of coding parameters, including video and audio coding parameters, dynamically, and it requires setting maximal priority of audio communication under low-speed network conditions and configuring usage priority attributes to ensure that high-priority uses have priority of service over low-priority uses.

[**ITU-T F.746.13 “Requirements for smart speaker based intelligent multimedia communication system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14960) defines the requirements of intelligent multimedia communication for varied types of smart speakers, including the reference architecture, requirements of smart devices, requirements of signalling and platform, as well as a few typical scenario examples. This Recommendation specifies the requirements to eliminate the difference in multimedia communication and access management of heterogeneous devices, to simplify the construction complexity of intelligent multimedia communication system, to improve the security and reliability of signalling and multimedia data transmission between smart speakers and the intelligent multimedia communication system, to finally guarantee high-qualified multimedia communication service.

**ITU-T F.746.14 “Requirements and reference framework for cloud virtual reality systems” (under approval):** Cloud virtual reality based on cloud capabilities, can effectively shield terminal differences, reduce the difficulty of application development, lower some specific industry entry barriers, and promote the industry business chain cooperation. This recommendation focuses on the overall requirements of cloud virtual reality systems and the related requirements of each layer including content requirements, network requirements, control requirements, resource requirements and terminal requirements, as well as the reference framework for related high-level functions.

**ITU-T F.746.15 “Requirements for smart broadband network gateway in multimedia content transmission” (under approval)** specifies requirements for smart broadband network gateway (BNG) in multimedia content transmission, which specifically describes the functional requirements and architecture, security requirements, typical application scenarios and use cases.

**ITU-T F.746.16 “Technical requirements and evaluation methods of intelligent levels of intelligent customer service systems” (under approval)**: The intelligent customer service system can provide more convenient, efficient, and stable services for users through the application of AI technologies such as speech recognition, text to speech and natural language processing. Improving and evaluating the intelligence levels of the intelligent customer service system are valuable. This Recommendation specifies the requirements and evaluation methods for system intelligence of intelligence customer service system in four aspects, including the basic functions, the core technologies of AI, the maturation of system and the service experience.

**ITU-T F.746.17 “Requirements for media processing services” (under approval)** identifies the functional requirements for the media processing services. In particular, the scope of this Recommendation includes functional requirements and application scenarios. Media processing services utilize a set of techniques including cloud computing, computing resource virtualization, and job queue processing to dynamically control and manage computing resources, which improves scalability, flexibility, and availability. This Recommendation specifies the functional requirements of general requirements, service provision requirements, service management requirements, security considerations, etc.

**ITU-T F.747.11 “Requirements for intelligent surface-defect detection service in industrial production line” (under approval)**: Intelligent surface-defect detection service in industrial production line refers to accurate positioning of products defects, high-speed classification of defects types, real-time output and transmission of visual and auditory information to ensure the quality of industrial products. Compared with the inspection carried out manually by workers, the ISD service can improve the efficiency and consistency and reduce manual operations in dangerous areas. This work item specifies requirements for intelligent surface-defect detection service in industrial production line, including performance requirements, application requirements and functional requirements. To provide effective surface-defect detection service, it is required to fulfil three important parts. Firstly, it is important to ensure the accuracy of positioning and classification. Secondly, the inference efficiency of the service is also required to satisfy the real-time settings. Last but not the least, the service is required to adapt to the typical application scenarios in industrial production line inspection task. This Recommendation provides related requirements for intelligent surface-defect detection service in industrial production line.

**ITU-T F.747.12 “Requirements for artificial intelligence based machine vision system in smart logistics warehouse” (under approval):** With the rapid development of industrial automation and logistics technology in accordance with the market demand for high-tech, machine vision technology has begun to enable the automation transformation of logistics warehouse systems. The application of machine vision technology in the field of logistics warehouse has enabled the rapid evolution of goods sorting, goods palletizing and de-palletizing, goods handling, and shelf inventory from intensive manual work to intelligence and automation, improving the operational efficiency and management capabilities of logistics warehouse. This Recommendation specifies the requirements and framework for artificial intelligence based machine vision system in smart logistics warehouse, and provides use cases. This Recommendation is intended to guide the design and development of machine vision systems in smart logistics warehouse.

[**ITU-T F.748.14 “Requirements and evaluation methods of non-interactive 2D real-person digital human application systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14961) specifies the requirements and evaluation methods of non-interactive 2D real-person digital human application systems, in terms of image, voice, movement, display, etc. It can be used to guide relevant parties to test, select or evaluate the non-interactive 2D real-person digital human application system. The evaluation methodology can reflect the current state of non-interactive 2D real-person digital human application system by providing meaningful comparison dimensions.

[**ITU-T F.748.15 “Framework and metrics for digital human application systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14962) is for the digital human application system, which specifies the framework of the digital human application system, and the corresponding subjective and objective metrics are accordingly proposed from the dimensions of image, speech, animation, interactive processing and multimodal I/O. This Recommendation can be used to guide relevant parties to test, select or evaluate the digital human application system. The metrics can reflect the current state of the digital human application system by providing meaningful comparison dimensions.

[**ITU-T F.748.16 “Requirements for machine vision-based applications and services in smart manufacturing”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14963) presents the overview and requirements for machine vision-based applications and services in smart manufacturing. It describes basic concept, scenario and ecosystem of machine vision, and identifies several typical requirements which are data acquisition, data pre-processing, data processing and etc. This Recommendation also gives reference model for machine vision-based applications and services in smart manufacturing. The general goals of standardization for machine vision service are:

– Define the requirements of machine vision-based services and applications

– Help ender users and providers to specify the machine vision tasks and the solutions.

– Enhance confidence in machine vision ecosystem and open new applications for machine vision system.

**ITU-T F.748.17 “Technical specification for artificial intelligence cloud platform: AI model development” (under approval)** provides a framework for the cloud-based development of AI models. It covers the terminology, features, and reference design of an AI cloud platform to enable the development of AI models. It establishes the technical specifications of the platform's supporting functional modules, core functional modules, and auxiliary functional modules.

**ITU-T F.748.18 “Metric and evaluation methods for AI-enabled multimedia application computing power benchmark” (under approval):** Facing more and more diverse AI computing systems, users hope to have a unified evaluation metric for the system that provides AI computing power. The establishment of relevant real application performance evaluation benchmarks can objectively reflect the current state of the AI computing ability by providing objective metrics and comparison dimensions. This Recommendation provides an AI computing power benchmark framework, evaluation metrics and methods, and a guideline for technical testing for AI clusters.

**ITU-T F.748.19 “Framework for audio structuralizing based on deep neural network” (under approval)** presents an overview of the framework for audio structuralizing based on deep neural network. It provides a high-level description of architecture, processing flows, data categories, audio processing tasks and requirements for data management.

**ITU-T F.748.20 “Technical framework for deep neural network model partition and collaborative execution” (under approval):** Deep neural network (DNN) model inference process usually requires a large amount of computing resources and memory. Therefore, it is difficult for end devices to perform DNN models independently. It is an effective way to implement end-edge collaborative DNN execution through DNN model partition, which can reduce latency and improve resource utilization at the same time. This recommendation aims to specify the technical framework of DNN model partition and collaborative execution. First, it is necessary to predict the overall inference latency under the current system state according to different DNN partition strategies in advance. Then, choose the appropriate partition locations and collaborative execution strategy based on the equipment computation capabilities, network status and DNN model properties. Finally, implement the model collaborative execution and optimize the resource allocation in the meanwhile.

**ITU-T F.748.21 “Requirements and framework for feature-based distributed intelligent systems” (under approval)** introduces the use cases, classification of features and framework for feature-based distributed intelligent systems relevant to intelligent scenarios, specifying the service requirement, functional requirements, and security requirements for feature-based distributed intelligent systems.

[**ITU-T F.749.15 “Requirements for inspection and examination services using civilian unmanned aerial vehicles”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14964): There are many requirements for careful inspection and examination of specific objects / facilities and surroundings, such as power lines, oil pipelines, bridges and viaducts on water and land, rivers and lakes, or inspection the emergency disaster scene, etc. With the help of high-definition cameras, panoramic camera and other sensors (such as infrared sensors), the civilian unmanned aerial vehicle (CUAV) can easily help accomplish the inspection and examination job quickly, efficiently with high quality. This Recommendation specifies the requirements for high definition and virtual reality inspection and examination services by human being using CUAV, including the requirements for fore-end devices capturing HD images and videos of objects and surroundings, network communication, service and application support as well as service presentation and playback.

**ITU-T F.749.16 “Requirements for logistics express delivery based on civilian unmanned aerial vehicle” (under approval)**: At present, logistics express delivery based on civilian unmanned aerial vehicle (CUAV) is developing rapidly all over the world. Compared with general water transportation and land transportation, CUAV transportation has the advantages of low cost, flexible scheduling, and can make up for the shortcomings of traditional air transportation. It will change people's consumption mode. This Recommendation provides the requirements for service system and management of CUAV logistics express delivery.

**ITU-T F.751.5 “Requirements for distributed ledger technology-based power grid data management” (under approval)** defines requirements for distributed ledger technology (DLT)-based power grid data management, including framework of DLT-based power grid data management, requirements for infrastructure layer, requirements for service layer, requirements for application layer and requirements for data governance. This Recommendation can be used as a guideline for power grid data management with DLT technologies.

**ITU-T F.751.6 “Performance assessment methods for distributed ledger technology platforms” (under approval)** is an extension to the ITU-T F.751.1 and focuses on distributed ledger technology (DLT) performance assessment methods. Based on the performance assessment criteria defined in ITU-T F.751.1, this Recommendation defines specific performance metrics and relevant workflow for the quantitative performance assessment for DLT platform. This Recommendation can be used as a guideline of DLT platform performance assessment for developers, users, third party testers and researchers.

**ITU-T F.751.7 “Functional assessment methods for distributed ledger technology platforms” (under approval)** defines functional assessment methods for DLT platforms based on the assessment criteria defined in ITU-T Recommendation F.751.1. For each item of the assessment criteria defined in ITU-T F.751.1, one test case is defined in this Recommendation accordingly. The description of each test case is composed of test purpose, test workflows and expected results.

**ITU-T F.760.1 “Requirements and reference framework for emergency rescue systems” (under approval)** describes the application scenarios, functional requirements, and reference architecture of pre-hospital emergency rescue and applies to the planning and designing emergency rescue systems in emergency centres, hospitals and other medical institutions. The appendix to this Recommendation includes some use cases of the proposed reference system.

**ITU-T H.222.0 (Ed.8) Amd.1 “Information technology - Generic coding of moving pictures and associated audio information: Systems: Carriage of LCEVC and other improvements” (under approval)** extends the specification by defining how LCEVC (ISO/IEC 23094-2) is carried over MPEG-2 systems. It also defines an additional descriptor signalling the kind of media service and its usage. Further, it includes clarifications for the specification of carriage of JPEG XS. It does this in a compatible way with existing support for other codecs.

[**ITU-T H.225.0 (V8) (revised) “Call signalling protocols and media stream packetization for packet-based multimedia communication systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14946) covers the technical requirements for narrow-band visual telephone services defined in H.200 and F.720-series Recommendations, in those situations where the transmission path includes one or more packet-based networks, each of which is configured and managed to provide a non-guaranteed Quality of Service (QoS) which is not equivalent to that of N-ISDN, such that additional protection or recovery mechanisms beyond those mandated by ITU-T Rec. H.320 need be provided in the terminals. It is noted that ITU-T Rec. H.322 addresses the use of some other LANs which are able to provide the underlying performance not assumed by the ITU-T Recs H.323 and H.225.0. This Recommendation describes how audio, video, data, and control information on a packet-based network can be managed to provide conversational services in H.323 equipment. Products claiming compliance with Version 8 of H.225.0 (this version) shall comply with all of the mandatory requirements of this Recommendation. Version 8 products can be identified by H.225.0 messages containing a protocolIdentifier value of {itu-t (0) recommendation (0) h (8) 2250 version (0) 8}.

This revision incorporates the following changes:

1) Enhancements for language capability exchange

2) Modification to the scope regarding use on the Internet

3) Clarification that the Facility message may be used to initiate call transfer.

[**ITU-T H.245 (V17) (revised) “Control protocol for multimedia communication”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14947) specifies syntax and semantics of terminal information messages as well as procedures to use them for in-band negotiation at the start of or during communication. The messages cover receiving and transmitting capabilities as well as mode preference from the receiving end, logical channel signalling, and Control & Indication. Acknowledged signalling procedures are specified to ensure reliable audiovisual and data communication. Products claiming compliance with Version 17 of ITU T H.245 shall comply with all of the mandatory requirements of this Recommendation. Version 17 products can be identified by ITU T H.245 TerminalCapabilitySet messages containing a protocolIdentifier value of {ITU T (0) recommendation (0) h (8) 245 version (0) 17}. Relative to ITU T H.245 Version 16 (2011), this version incorporates the following changes:

– Add procedures in Annex V to support better interoperability between IPv4 and IPv6 devices

– Updated Table VIII.1 to support the revisions made to H.241

– Support of an SCTP media transport in H.323 systems, including the addition of Annex U

– Support of DTLS media transport in H.323 systems, including the addition of Annex U

– Support of out of band data channel establishment for Annex U

– Propose updates to H.245 to support SCTP: split dtls-sctp into udp-dtls-sctp and tcp-dtls-sctp

– Add ExtendedAudioCapability and ExtendedDataCapability in H.245.

[**ITU-T H.266 (V2) (revised) “Versatile video coding”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14948) specifies a video coding technology known as Versatile Video Coding and it has been designed with two primary goals. The first of these is to specify a video coding technology with a compression capability that is substantially beyond that of the prior generations of such standards, and the second is for this technology to be highly versatile for effective use in a broadened range of applications than that addressed by prior standards. Some key application areas for the use of this standard particularly include ultra-high-definition video (e.g., with 3840×2160 or 7620×4320 picture resolution and bit depth of 10 bits as specified in Rec. ITU-R BT.2100), video with a high dynamic range and wide colour gamut (e.g., with the perceptual quantization or hybrid log-gamma transfer characteristics specified in Rec. ITU-R BT.2100), and video for immersive media applications such as 360° omnidirectional video projected using a common projection format such as the equirectangular or cubemap projection formats, in addition to the applications that have commonly been addressed by prior video coding standards. This Recommendation was developed collaboratively with ISO/IEC JTC 1/SC 29, and corresponds with ISO/IEC 23090 3 as technically aligned twin text.

[**ITU-T H.266.1 “Conformance specification for ITU-T H.266 versatile video coding”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14969) specifies tests for (non-exhaustive) testing to verify whether bitstreams and decoders meet the normative requirements specified in ITU T H.266 | ISO/IEC 23090-3 Versatile video coding (VVC). The bitstreams provided with this document correspond to the 08/2020 (V1) edition of Rec. ITU-T H.266. This Recommendation was developed collaboratively with ISO/IEC JTC 1, Information technology, Subcommittee SC 29, Coding of audio, picture, multimedia and hypermedia information, and corresponds with ISO/IEC 23090-15 as technically aligned twin text. The conformance bitstreams needed for this Recommendation are available at the following link: <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC/FDIS/>

[**ITU-T H.266.2 “Reference software for ITU-T H.266 versatile video coding”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14970) provides as an electronic attachment reference software for Rec. ITU-T H.266 | ISO/IEC 23090-3 "Versatile video coding" and corresponds to the 2nd edition of Rec. ITU-T H.266. The reference software includes both encoder and decoder functionality. Reference software is useful in aiding users of a video coding standard to establish and test conformance and interoperability, and to educate users and demonstrate the capabilities of the standard. For these purposes, the accompanying software is provided as an aid for the study and implementation of Rec. ITU-T H.266 "Versatile video coding". This Recommendation was developed collaboratively with ISO/IEC JTC 1, Information technology, Subcommittee SC 29, Coding of audio, picture, multimedia and hypermedia information, and corresponds with ISO/IEC 23090-16 as technically aligned twin text.

[**ITU-T H.274 (V2) (revised) “Versatile supplemental enhancement information messages for coded video bitstreams”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14949)specifies the syntax and semantics of video usability information (VUI) parameters and supplemental enhancement information (SEI) messages for use with coded video bitstreams. The VUI parameters and SEI messages defined in this Recommendation may be conveyed within coded video bitstreams in a manner specified in a video coding specification or may be conveyed by other means as determined by the specifications for systems that make use of such coded video bitstreams. This Recommendation is particularly intended for use with coded video bitstreams as specified by Rec. ITU-T H.266 | ISO/IEC 23090-3, although it is drafted in a manner intended to be sufficiently versatile and generic that it may also be used with other types of coded video bitstreams. This Recommendation was developed collaboratively with ISO/IEC JTC 1/SC 29, and corresponds with ISO/IEC 23002 7 as technically aligned twin text.

[**ITU-T H.323 (V8) (revised) “Packet-based multimedia communications systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14950) describes terminals and other entities that provide multimedia communications services over Packet-Based Networks (PBN) which may not provide a guaranteed Quality of Service. H.323 entities may provide real-time audio, video and/or data communications. Support for audio is mandatory, while data and video are optional, but if supported, the ability to use a specified common mode of operation is required, so that all terminals supporting that media type can interwork.

The packet-based network over which H.323 entities communicate may be a point-to-point connection, a single network segment, or an internetwork having multiple segments with complex topologies.

H.323 entities may be used in point-to-point, multipoint, or broadcast (as described in Rec. ITU T H.332) configurations. They may interwork with H.310 terminals on B-ISDN, H.320 terminals on N-ISDN, H.321 terminals on B-ISDN, H.322 terminals on Guaranteed Quality of Service LANs, H.324 terminals on GSTN and wireless networks, V.70 terminals on GSTN, and voice terminals on GSTN or ISDN through the use of Gateways.

H.323 entities may be integrated into personal computers or implemented in stand-alone devices such as videotelephones.

Note that the title of H.323 (1996) was "Visual telephone systems and equipment for local area networks which provide a non-guaranteed quality of service". The title changed in Version 2 to be consistent with its expanded scope.

Products claiming compliance with Version 8 of H.323 shall comply with all of the mandatory requirements of this Recommendation, H.323 (2022), which references Rec. ITU T H.225.0 (2022) and Rec. ITU T H.245 (2022 or later). Version 8 products shall be identified by H.225.0 messages containing a protocolIdentifier = {itu t(0) recommendation(0) h(8) 2250 version(0) 8} and H.245 messages containing a protocolIdentifier = {itu-t(0) recommendation(0) h(8) 245 version(0) x}, where "x" is 16 or higher. In addition to many minor corrections and clarifications, this version of Rec. ITU T H.323 incorporates enhancements and clarifications to Annex O and to Annex M5 to support ITU-T X1303 bis.

[**ITU-T H.626.5 (V2) (revised) “Architecture for intelligent video surveillance systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14951) defines an architecture for intelligent video surveillance systems, including the functional requirements, functional architecture and reference points. The intelligent video surveillance system provides intelligent analysis capabilities and services for users based on the images, video slices or video streams from surveillance cameras. Meanwhile, the system also aggregates and stores the video and image information from the intelligent analysis, the surveillance devices, or manual annotation. Based on these aggregation and storage, the system provides application services and sharing services for users through the network, such as query and retrieval about the video and image information, subscription and notification, etc. This Recommendation is based on Recommendation ITU-T F.743.1, "Requirements for intelligent visual surveillance". This edition updates the title, functional architecture, delete the service control flow and signaling, as well as revising the references points.

[**ITU-T H.627.2 “Requirements and protocols for home surveillance systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14971) defines the requirements and protocols for IP based network access of varied types of equipment under home security surveillance scenarios including the architecture, protocol for transmission, access and service functions as well as other relevant requirements under the home surveillance considerations. This Recommendation specifies a way to eliminate the difference in network communication and access management of heterogeneous devices, to simplify the construction complexity of home security platforms, to improve the security and reliability of data transmission between home security equipment and the home surveillance platform, and finally to guarantee high-qualified development of home surveillance service.

**ITU-T H.627.3 “Protocols for intelligent video surveillance systems” (under approval)** defines protocols for intelligent video surveillance systems, including the functional architecture, functional interface, overall requirements of the protocol, message flows and relevant protocols. This Recommendation is based on Recommendation ITU-T H.626.5, "Architecture for intelligent video surveillance systems".

[**ITU-T T.701.21 “Guidance on audio description”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14972)**:** Audio description is a service or feature of the auditory modality that contains an oral narration with details or context involving situations and scenes found in an audiovisual content (such as recorded video presentations, broadcast television, cinema, live or recorded drama). The primary users of audio description are blind persons or persons with low vision and their friends and family. Recommendation ITU-T T.701.21 provides guidance to audio description developers and practitioners in creating effective content describing audiovisual material in an auditory-only modality, the style or manner in which audio description is delivered, the audio description script and script time cues, in relation to the original content. ITU-T T.701.21 is twin with the published ISO/IEC TS 20071-21:2015 "Information Technology – User interface component accessibility – Part 21: Guidance on audio description" developed by ISO/IEC JTC1 SC35.

[**ITU-T T.701.25 “Guidance on the audio presentation of text in videos, including captions, subtitles and other on-screen text”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14973)**:** Audiovisual content (such as video) often contain text, which cannot be easily accessed by a wide section of the audience. While captions/subtitles provide text alternatives to audio elements in audiovisual content, other on-screen text may have various functions. It can be part of the story (as a message written on a piece of paper by one of the characters) or it can provide additional information (such as graphs, emergency alerts or superimposed titles). Complementarily, audio description provides a description of audiovisual content auditorily, including captions/subtitles and other on-screen text if present and are of particular benefit to persons who, for different reasons, cannot access on-screen text. However, some users may only require captions/subtitles and other on-screen text to be made accessible as audio because they already have access to other visual content such as the images.

This Recommendation provides guidance for audiovisual content producers, distributors and exhibitors on the audio presentation of captions/subtitles and other on-screen text. It acknowledges the relationship with existing access services such as audio description. While considering current implementations, as well as future possibilities suggested by research, and bearing in mind possible trade-offs between quantity and quality, this document positions itself for situations in which various access services coexist and users are given the choice to select those best suited to their needs.

**ITU-T T.808 (V2) “Information technology – JPEG 2000 image coding system: Interactivity tools, APIs and protocols” (under approval):** This second edition cancels and replaces the first edition, which has been technically revised. The main changes compared to the previous edition are as follows:

1. consolidates all outstanding amendments and corrigenda published since the first edition;

2. extends support for the file format specified in Rec. ITU-T T.815 | ISO/IEC 15444-16;

3. clarifies normative server responsibilities in response to certain request fields documented in Annex C;

4. removes the registration authority (Annex L); and

5. adds media type registration information (Annex O).

**ITU-T Technical Paper FSTP.ACC-WebVRI “Guideline on web-based remote sign language interpretation or video remote interpretation (VRI) system” (under publication):** Due to the COVID-19 pandemic, the practice of physical distancing makes it difficult for a sign language interpreter to accompany a deaf or a hard of hearing person when the latter visits places such as a government agency, a school, a meeting, or a hospital. It is now almost imperative that a remote sign language interpretation, or a video remote interpretation (VRI) be implemented. During the time of physical distancing when almost any schooling and medical consultation needs to be done remotely, a non-interoperable VRI system for deaf and hard of hearing persons will exclude them from important social services. It is therefore important to have a standard guideline for a VRI or VRI system, which considers interoperability and future effectiveness. Considering the immediacy of the need as well as the cost of system introduction and practicality of the implementation, such a guideline is most likely to be based on web-based technologies. This Technical Paper describes a web-based VRI, based on Web real time communication (RTC), and describes how it can be used in a scenario where community sign language interpreters can participate, as well as ways in which other remote services, online medical treatment and distance education, can harmonize with the Web-based VRI system.

**ITU-T Technical Paper FSTP-VS-SDCA “Application of software-defined camera in surveillance industry” (under publication)** introduces several use cases of software-defined camera in multiple surveillance scenarios, analyses the possible requirements and pain points that customers may put forward, providing guidance for the further development of software-defined camera technology in the future. This technical paper also specifies the entire software-defined camera system ecosystem mechanism and security implementations. This technical paper aims to provide a comprehensive guidance for SDC technology usage in surveillance industry.

I.4.1 Internet of Things and Smart City

[**ITU-T Q.4069 “Testing requirements and procedures for Internet of Things based green data centres”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15046)specifies testing requirements and procedures for Internet of Things based green data centres. This Recommendation introduces testing requirements including interoperability testing requirements between platform, systems and IoT devices, functional testing requirements(e.g. testing requirement of analysis of IoT devices status) and self-optimization testing requirements (e.g. testing requirement of data quality audit), and testing procedures including interoperability testing procedure, functional testing procedure, and self-optimization testing procedure for IoT based green data centres.

[**ITU-T X.1352 “Security Requirements for Internet of things (IoT) device and gateway”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14990) establishes detailed requirements for five security dimensions applicable to Internet of things (IoT) device and gateway: authentication, cryptography, data security, device platform security, and physical security, based on the IoT reference model specified in [ITU-T Y.4100] and the IoT security framework in [ITU-T X.1361]. The authentication dimension includes user authentication, secure use of authentication credentials and device authentication. The cryptography dimension includes the use of secure cryptography, secure key management and secure random number generation. The data security dimension includes secure transmission and storage, information flow control, secure session management and personally identifiable information (PII) management. The device platform security dimension includes five elements: software security; secure update; security management; logging; and timestamp. Likewise, the physical security dimension includes a secure physical interface and tamper-proofing.

**ITU-T X.1353 “Security methodology for zero-touch deployment in massive IoT based on blockchain” (under approval)**: Massive Internet of Things (mIoT) is a significant application of future communication networks. With diverse use cases anticipated in mIoT, it is difficult for manufactures to pre-install their manufactured IoT devices with mobile-operator-specific and/or the service-specific information (e.g., identities and keys), since manufactures may not know where their devices will eventually be deployed and activated. The current approach relies on customers’ manual configuration. This is acceptable for small-scale IoT applications. However, for mIoT devices, the aforementioned approach is unacceptable due to the fact that manual configuration is time consuming, cost-ineffective and cumbersome. Thus, automatic credential provisioning without user involvement, known as "zero-touch" is needed for mIoT. This Recommendation provides a security methodology on designing such a decentralized identity management system to support the zero-touch deployment of future mIoT. Zero-touch deployment will enable IoT devices to automatically find their mobile network operator and their service provider, automatically obtain credentials from them and automatically connect to the network and the service. This will greatly facilitate the future deployment of mIoT devices for verticals. The content of this Recommendation will cover the security architecture, the security considerations and the related security procedures (such as device attestations, authentication, and credential provisioning) which are needed for building such a zero-touch mIoT deployment platform.

[**ITU-T X.1369 “Security requirements for IoT service platform”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14799) specifies security requirements for IoT service platform. It assesses security threats and challenges to IoT business service platform and describes security measures that could mitigate security threats and challenges.

**[ITU-T Y.4052 “Vocabulary for blockchain for supporting Internet of things and smart cities and communities in data processing and management aspects”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15066)** contains blockchain-related vocabulary to be used for Internet of things (IoT) and smart cities and communities (SC&C) in aspects of data processing and management (DPM). The vocabulary in this Recommendation is collected from the Recommendations, Supplements and standards published by ITU and ISO. In addition, this Recommendation includes and defines new terms to meet the needs of SC&C work within ITU.

[**ITU-T Y.4123 “Requirements and capability framework of smart shopping mall system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14813): 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 system.

[**ITU-T Y.4214 “Requirements of IoT-based civil engineering infrastructure health monitoring system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14824): 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14825) 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.4216 “Requirements of sensing and data collection system for city infrastructure”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15067) provides the concept and classification of basic city infrastructures. The sensing and data collection system of city infrastructure is also described. A lot of city infrastructures are taken into consideration in building smart cities such as energy, transportation, healthcare, cultural, sports and educational infrastructures. This Recommendation identifies these infrastructures and provides the functions and requirements of sensing and data collection system for those city infrastructures. The sensing and data collection system provides unified management to the sensing devices attached to various city infrastructures. This Recommendation is helpful for the cities to build smart city by improving the efficiency and resilience of city infrastructure through using ICT.

[**ITU-T Y.4217 “Service requirements and capability framework for IoT-related crowdsourced systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15068)**:** Service requirements and capability framework for IoT-related crowdsourced systems can help the implementation of IoT-related crowdsourced systems. This Recommendation specifies service requirements of IoT-related crowdsourced systems, in addition to the requirements of IoT-related crowdsourced system [ITU-T Y.4205] and the common requirements of IoT [ITU-T Y.4100]. Based on these requirements, a capability framework of IoT-related crowdsourced systems is developed.

**[ITU-T Y.4481 “Framework for data middle-platform in IoT and smart sustainable cities”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15069)**: A data middle-platform (DM) is expected to provide innovative digital data services to deliver data value. It allows separation of the fundamental technical supporting capabilities from the business-related services. The main purpose of a DM is to aggregate and manage cross-domain data into services. For Internet of things (IoT) and smart sustainable cities (SSC), a DM aims at providing common data services that can be reused in diverse application domains by governments, enterprises, organizations and individuals.

[**ITU-T Y.4482 “Requirements and framework for smart livestock farming based on the Internet of things”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15070): Smart livestock farming (SLF) is a convergence service where Information and Communication Technologies (ICT) are applied into the livestock value chains. It has the potential to deliver a more productive and sustainable production by integrating processes of the smart farming, Management Information Systems (MIS), stockbreeding automation and robotics to provide a better decision making or more effective exploitation operations and management of livestock value chains. The use of Internet of Things (IoT) technologies in the SLF aims at providing a full coverage of the processes by collecting and transmitting data from the entire agroecosystem. That means SLF can establish contact with each participant of a livestock chain, bringing and collecting information about their processes, increasing the possibilities for control and improvement on the efficiency of their tasks. This Recommendation provides an overview of SLF based on IoT, high-level requirements for SLF, as well as a reference model which represents a generic sequence for the livestock value chains and is applicable to these chains as a whole, regardless of species or rearing techniques.

[**ITU-T Y.4483 “Reference architecture of service exposure for decentralized services for Internet of things applications”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15071) introduces a service exposure for decentralized services (DSE) for Internet of things (IoT) applications and specifies its common characteristics, general requirements, reference architecture and common capabilities. A DSE is a functional entity for IoT applications in an IoT device, which integrates multiple decentralized services (such as services based on distributed ledger technologies) and exposes uniform interfaces to IoT applications. Those integrated decentralized services may support the same or different types of decentralization solutions. IoT applications can use uniform interfaces to integrate and access multiple decentralized services at the same time, regardless of their decentralization solutions. A DSE can bring efficiencies and benefits to application providers and users.

[**ITU-T Y.4484 “Framework to support Web of Objects ontology based semantic data interoperability of eHealth services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15072) specifies the framework to support Web of Objects (WoO) ontology based semantic data interoperability of eHealth services in accordance with [ITU-T Y.4452] and [ITU-T Y.4563]. A semantic data interoperability enables the various eHealth systems to combine received information with other information resources and to process it in a manner that preserves meaning. In order to support the semantic data interoperability functions among eHealth systems, this draft Recommendation applies the WoO framework in [ITU-T Y.4452] and the semantic data interoperability function in [ITU-T Y.4563].

**ITU-T Y.4500.3 ”oneM2M - Security solutions” (under approval)** provides specifications for machine to machine (M2M) security and privacy protection.

**[ITU-T Y.4600 “Requirements and capabilities of a digital twin system for smart cities”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15073):** A digital twin is a digital representation of an object of interest and may require different capabilities according to the specific domain of application, such as synchronization between a physical thing and its digital representation, and real-time support. A smart city digital twin can be defined as a digital twin for a smart city that can be used to develop strategies to achieve specific goals for a smart city, by conducting simulations and to increase visibility of human-infrastructure-strategy interactions. A smart city digital twin allows the simulation of plans before implementing them, exposing problems before they become a reality. In other word, it is possible to conduct simulations on a digital replica of the city (virtual cities) before actually implementing the strategy on the real city. In this way, it is also possible to find the best strategies to achieve a specific goal or strategies that have similar effects while minimizing budget and resource usage. Therefore, a smart city digital twin is a tool for improving urban operations, efficiencies and resilience of a city.

**ITU-T Y.4601 “Requirements and capability framework of digital twin for smart firefighting” (under approval)**: A digital twin is a digital representation of an object of interest, and may require different capabilities according to the specific domain of application such as synchronization between a physical thing and its digital representation, and real-time support [ITU-T Y.4600]. Through the IoT technology deployment and the information integration process, a digital twin can provide high fidelity digital representation of the fire scene, enable dynamic convergence between the physical entity and digital entity, and achieve comprehensive understanding and control of the past, present, and future of the fire scene. The current state of the art for firefighting lacks comprehensive dynamic sensing capability and prediction capability, it cannot provide delayed information, and adequate visibility of the interaction between personnel and fire scene. Through the deployment of gateways, sensors, high quality network, multi-physics simulation, dynamic analysis and prediction, 3D visualizations. The smart firefighting digital twin enables intelligent services such as personnel tracking, hazard tracking, fire scene dynamic analysis, rescue strategy optimization, pre-simulation, historical scene reconstruction, etc., these intelligent services can help to improve decision-making processes and reduce the casualties. This Recommendation specifies the requirements and capability framework of digital twin for smart firefighting.

**[ITU-T Y.4903 (revised) “Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14173)** provides key performance indicators (KPIs) for smart sustainable cities (SSCs) and general principles for selecting KPIs to help cities achieve sustainable development goals (SDGs). This Recommendation provides a means to benchmarking and disseminating best practices in utilizing ICTs and other technologies to enhance cities’ sustainability and connect their smart strategies to the SDGs through an inclusive process. These KPIs are designed to evaluate the role and performance of Information Communication Technologies (ICTs) in the three dimensions of a city: Economics, Environment, and Society and Culture. The indicators are uniquely coordinated to allow cities to measure their progress on reaching the ambitious targets set by the SDGs.

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

**[ITU-T H.551 “Architecture of vehicular multimedia systems”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14811)** 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.

**ITU-T Supplement H.Sup20 “Practice for intelligent traffic sensing device deployment in the roadside” (under publication):** The detection and analysis of traffic elements based on roadside sensing devices is an important foundation for intelligent transportation. Sensing devices used in roadside to build an intelligent transport system generally include cameras, lidars, millimetre wave radars, etc. The requirements for sensing devices, such as the deployment and the function characteristics will affect the quality of data for intelligent transportation system. In order to support ITS to obtain comprehensive and effective perception data, this supplement gives the practice references for roadside sensing devices’ deployment in ITS. This Supplement applies to ITU-T H.550-H.599 series: Vehicular gateways and intelligent transportation systems (ITS).

[**ITU-T X.1377 “Guidelines for an intrusion prevention system for connected vehicles”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15103) establishes guidelines for an intrusion prevention system (IPS) for connected vehicles. This Recommendation mainly focuses on aspects of active response capability for intrusion and includes the implementation guidance and use cases of IPS for connected vehicles. Prior in-vehicle intrusion detection systems (IDSs) have limitations, e.g., requiring too many computing resources that a vehicle cannot provide and being unable to mitigate intrusions due to characteristics of protocol and bus topology. To address these limitations of conventional in-vehicle IDSs, this Recommendation provides methodologies for intrusion detection and intrusion prevention. The proposed IPS consists of the intrusion detection plane – an external component that calculates intrusion detection algorithms – and the data plane – in-vehicle networks (IVNs) where traffic monitoring and active response happen. This Recommendation aims to protect (automotive) Ethernet-based IVNs.

[**ITU-T X.1379 “Security requirements for roadside unit in intelligent transportation system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14994) specifies security requirements for roadside unit (RSU) in intelligent transportation system (ITS) based on security threat analysis. This Recommendation will help to guide vendors and operators of RSUs to adopt appropriate security schemes to fulfil security requirements specified to protect RSUs from security risks and attacks from cyberspace thus to ensure the security of ITS.

**ITU-T X.1381 “Security guidelines for Ethernet-based In-Vehicle networks” (under approval)** provides security guidelines for Ethernet-based in-vehicle networks (IVNs). The current trend in electrical and electronic (E/E) architecture is to integrate the Ethernet with legacy IVNs such as the controller area network (CAN), local interconnect network (LIN), media-oriented systems transport (MOST) and FlexRay. In the past, the Ethernet was considered only as a connection between vehicles with external environments. Standard protocols that enable Internet protocol-based connections over the Ethernet (e.g., diagnostic communication over Internet protocol or universal measurement and calibration protocol) have been used to enable communications between the external environment and vehicles. These use cases generally do not need to meet stringent real-time constraints. However, in-vehicle applications using Ethernet communication require characteristics that include high time sensitivity and reliability. Current developments in in-vehicle communication technologies require increased bandwidth in the network. Compared to the Ethernet, legacy IVNs are insufficient to meet the bandwidth requirements of current in-vehicle applications. Therefore, now and in the future, Ethernet-based IVNs are a major part of E/E architecture. However, countermeasures known from common computer networks cannot be suitable for an automotive application because they were not designed with regard to automotive requirements and capabilities. To address this demand, this Recommendation provides security guidelines for automotive Ethernet technology. This Recommendation includes a reference model of automotive Ethernet and analysis of threat and vulnerability for Ethernet-based IVNs. In addition, this Recommendation provides security requirements and use cases of Ethernet-based IVNs.

**ITU-T X.1382 “Guidelines for sharing security threat information on connected vehicles” (under approval)**: Connected vehicles are facing increasingly prominent network security issues along with their rapid development. Security threat information of connected vehicles means any information that can help an organization identify, assess, monitor, and respond to the connected vehicle, which plays an integral role in securing connected vehicles. Organizations that share threat information for connected vehicles can improve their own security postures and those of other organizations. This Recommendation is a guide on the principles, rules, methodology and procedures of sharing security information for connected vehicles. This Recommendation also provides a brief description of the different scopes, roles and effectiveness of the various organizations while they engage in the life cycle of security threat information sharing. This Recommendation is intended to help organizations stay in touch with the existing shared community. Furthermore, this Recommendation helps organizations contribute to the threat information of a connected vehicles sharing community, which would support the practices of connected vehicles safety protection. Overall, this Recommendation aims to enhance security threat information sharing; and mitigate the potential impact of cyber security attacks on connected vehicles.

**ITU-T X.1383 “Security requirements for categorized data in vehicle-to-everything (V2X) communication” (under approval):** Data security is one of the most important works for vehicle-to-everything (V2X) communication. However, in a resource constrained environment such as in-vehicle communication, a lot of resources are consumed protecting data as cryptographic functions are required. This Recommendation categorizes the data used in V2X communication into several types such as object attribute data, vehicle status data, environmental perception data, vehicle control data, application service data and user personal data, and assigns three security levels for categorized data types. Based on these categorized data types and assigned data security levels, this Recommendation provides security requirements for categorized data in V2X communication.

I.4.5 Connected health: e-Health

**ITU-T F.760.1 “Requirements and reference framework for emergency rescue systems” (under approval)** describes the application scenarios, functional requirements, and reference architecture of pre-hospital emergency rescue and applies to the planning and designing emergency rescue systems in emergency centres, hospitals and other medical institutions. The appendix to this Recommendation includes some use cases of the proposed reference system.

[**ITU-T F.780.1 (V2) (revised) “Framework for telemedicine systems using ultra-high definition imaging”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14945)describes requirements for using ultra-high definition (UHD) imaging, such as 4K and 8K video, for telemedicine. The purpose of these requirements is to use UHD systems for medical practices that use endoscopes and/or microscopes. This Recommendation also describes a list of requirements for using a UHD-based "endoscopic video camera" as a medical device. In addition, Annex A describes the requirements on the use of this technology as a medical device. This revision adds the clause for profiles of UHD imaging for medical services, as well as new definitions and abbreviations.

[**ITU-T F.780.2 “Accessibility of telehealth services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14967) defines accessibility requirements for technical features to be used and implemented by governments, healthcare providers and manufacturers of telehealth platforms to facilitate the access and use of telehealth services by persons with disabilities, older persons with age-related disabilities and persons with specific needs.

With the passage of the United Nations Convention on the Rights of Persons with Disabilities in 2006, and its ratification by numerous countries, persons with disabilities have the right to enjoy the highest attainable standard of health without discrimination on the basis of disability. Countries need to take all appropriate measures to ensure access for persons with disabilities to health services.

During the current Covid-19 pandemic, the use of telehealth services has increased substantially in many countries and telehealth has become a basic need for the general population, especially for those in quarantine, enabling patients in real time through contact with health care providers to access advice. However, due to the lack of global and comprehensive standards and guidelines for accessibility of telehealth services, many persons with disabilities experience difficulties accessing and using such services and are often forgotten. This Recommendation summarizes and defines those requirements and features that industries can implement to ensure accessible provision of telehealth services.

Technical requirements defined in this Recommendation are based on a comprehensive feedback collected from civil society on barriers that persons with disabilities experience when accessing and using telehealth services, as well as on the feedback from the industry. This is a first edition of the document. This Recommendation was developed collaboratively by the World Health Organization (WHO) and ITU.

**ITU-T F.780.3 “Use cases and requirements for ultra-high-definition teleconsulting system” (under approval)** describes the use cases and technical requirements of ultra-high-definition (UHD) teleconsulting system. UHD teleconsulting system is an important application of UHD display technology and ICT in the medical field, under the background of unbalanced medical resources, especially the COVID-19 pandemic, which can realize the optimal allocation of medical resources and benefit people in areas with less developed medical resources. It recommends the framework, functional requirements, and performance requirements of UHD teleconsulting system which are the necessary hardware and software foundations for teleconsultation. Finally, the Recommendation gives two application cases of UHD teleconsulting system in Appendix I, including the roles of different participants, as well as the teleconsultation process. The Recommendation is suitable for the development, construction and evaluation of UHD teleconsulting system in different countries and regions.

**ITU-T H.845.10 (revised) “Conformance of ITU-T H.810 personal health system: Personal Health Devices interface Part 5J: Insulin pump” (under approval)**: This edition includes the corrections approved in ITU-T H.845.10 (2017) Corrigendum 1 (11/2017), and the maintenance contents from ISO/IEEE 11073-20601:2022 and ISO/IEEE 11073-10419:2019 (Insulin Pump) versions.

[**ITU-T H.870 (V2) (revised) “Guidelines for safe listening devices/systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14953)describes the requirements on safe listening devices and systems, called personal/portable audio systems, especially those for playing music, to protect people from hearing loss. It also gives a glossary for common understanding as well as background information on sound, hearing and hearing loss. It recommends the criteria for avoiding unsafe listening: one for adults and the other for children, both based on the equal energy principle, the assumption that equal amounts of sound energy will cause equal amounts of sound induced permanent threshold shift regardless of the distribution of the energy over time. Importantly, this Recommendation provides guidelines on health communication for safe listening so that appropriate warning messages can be delivered effectively when necessary. Examples of such messages can be found in Appendix VII. Finally, this Recommendation also gives information about the implementation of dosimetry and related issues. Communication devices and assistive devices are excluded from the scope of this Recommendation. Gaming devices are also for future study. This standard was developed collaboratively by the World Health Organization (WHO) and ITU under the 'Make Listening Safe' initiative, and it is adopted by both organizations.

**[ITU-T X.Suppl.38 “Supplement to ITU-T X.1152: Use cases for contact tracing applications to prevent spread of infectious diseases”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15165)** describes various use cases for contact tracing technologies. It also provides data processing models including their procedures, data processing flow and security considerations. In addition, practical use cases are described in Appendix I.

**ITU-T Technical Paper FSTP-CONF-F780.1 “Conformance testing specification for F.780.1 - Framework for telemedicine systems using ultra-high definition imaging" (under publication)** defines the testing specification for F.780.1 "Framework for telemedicine systems using ultra-high definition imaging".

I.5.1 New security standards

[**ITU-T F.747.10 “Requirements of distributed ledger systems for secure human factor services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14644) provides general requirements and functional capabilities for distributed ledger systems (DLS) for secure human factor services. This Recommendation describes the requirements for the secure human factor distributed ledger service model, which can solve conflicting goals of privacy protection and big personal human factor data utilization. This Recommendation also includes the functional capabilities for human factor distributed ledger shared nodes to perform machine learning without decryption on encrypted human factor data. However, the computational burden of machine learning for encrypted data may be excessive. To solve this problem, this human factor distributed ledger service model provides procedures for allowing the use of two or more encryption key pairs and notifying the key type. In addition, this Recommendation involves the integrity maintaining requirements for secure human factor services to maintain a safe distributed ledger and checked from the beginning to distribute personal human factor information. Therefore, the application of distributed ledger system in the distribution of personal secure human factor information can ensure transparent tracking from the distribution process to the final use path.

**[ITU-T H.235.10 “H.323 security: Support of DTLS for media streams”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14968)** describes the security procedures for the establishment of media streams utilising Datagram Transport Layer Security (DTLS). DTLS is becoming more widely used for securing media streams, for example in WebRTC systems.

**[ITU-T X.1234 (revised) “Guidelines for countering multimedia messaging service spam”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14796)** specifies guidelines for countering MMS spam. It analyses typical scenarios, characteristics, and recognition methods of MMS spam, and provides a technical framework, work flows and some key technologies of MMS spam recognition, to help MMS providers and MMS users to counter spam.

[**ITU-T X.1235 “Technologies in countering website spoofing for telecommunication organizations”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14797): Website spoofing is a major threat for telecommunication organizations, especially operators. It is recommended for telecommunication operators to adopt counter website spoofing technologies to protect their customers and guard their reputation and revenue. This Recommendation analyses the main measures to spoof a website and recommends technologies to identify spoofed websites, which can be regarded as guidelines for protecting websites from being spoofed for telecommunication organizations. Similar approach may be implemented against spoofing of any web-site, including banks, insurance companies, internet shops, etc.

[**ITU-T X.1246 Amd.1 “Technologies involved in countering voice spam in telecommunication organizations – Annex A: Interactive and technical measures to combat spam calls”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14988) introduces the feedback mechanism from the client, receiving possible spam call (with voice, SMS, or MMS) to its operator. It provides technical requirements for telecommunication management systems and/or client support services to receive notifications of income spam calls, voice or messages (SMS/MMS). Scenarios of interactive interaction of clients with operators/service providers of telephone communication networks about incoming spam calls and the necessary technical measures to maintain such interaction are presented. Such interaction is based on making a call to the anti-spam number provided by the telecom operator in advance by the recipient of the spam call immediately after it is completed.

[**ITU-T X.1247 Amd.1 “Technical framework for countering mobile messaging spam – Annex A: Interactive and technical measures to combat spam calls“**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14989) introduces the feedback mechanism from the client, receiving possible spam call (with voice, SMS, or MMS) to its operator. It provides technical requirements for telecommunication management systems and/or client support services to receive notifications of income spam calls, voice or messages (SMS/MMS). Scenarios of interactive interaction of clients with operators/service providers of telephone communication networks about incoming spam calls and the necessary technical measures to maintain such interaction are presented. Such interaction is based on making a call to the anti-spam number provided by the telecom operator in advance by the recipient of the spam call immediately after it is completed.

[**ITU-T X.1333 “Security guidelines for use of remote access tools in Internet-connected control systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14798): Remote access tools (RATs) are widely used on control systems for monitoring, control and maintenance to reduce maintenance costs and minimize the response time in the event of a malfunction. RATs provide the ability to manipulate control systems remotely, but at the same time, an insecure configuration of RATs and vulnerabilities in RATs could significantly increase the attack surface of control systems. The most serious problem is an interface to access a control system from the external networks that could make attackers access to control system from the Internet. The Recommendation describes a whole picture to employ RATs securely for monitoring, control and maintenance. In this Recommendation, threats to network configuration due to the use of RATs are identified and security guidelines are provided to adapt secure configuration and security measures for the use of RATs in Internet-connected control systems. Providing well-organized security controls on the use of RATs would be helpful for digital service providers operating control systems to reduce the attack surface and the threats from external networks. Moreover, it would be beneficial to align the security levels between developed and developing countries, since this is not a local problem, but a global problem.

[**ITU-T X.1352 “Security Requirements for Internet of things (IoT) device and gateway”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14990) establishes detailed requirements for five security dimensions applicable to Internet of things (IoT) device and gateway: authentication, cryptography, data security, device platform security, and physical security, based on the IoT reference model specified in [ITU-T Y.4100] and the IoT security framework in [ITU-T X.1361]. The authentication dimension includes user authentication, secure use of authentication credentials and device authentication. The cryptography dimension includes the use of secure cryptography, secure key management and secure random number generation. The data security dimension includes secure transmission and storage, information flow control, secure session management and personally identifiable information (PII) management. The device platform security dimension includes five elements: software security; secure update; security management; logging; and timestamp. Likewise, the physical security dimension includes a secure physical interface and tamper-proofing.

**ITU-T X.1353 “Security methodology for zero-touch deployment in massive IoT based on blockchain” (under approval)**: Massive Internet of Things (mIoT) is a significant application of future communication networks. With diverse use cases anticipated in mIoT, it is difficult for manufactures to pre-install their manufactured IoT devices with mobile-operator-specific and/or the service-specific information (e.g., identities and keys), since manufactures may not know where their devices will eventually be deployed and activated. The current approach relies on customers’ manual configuration. This is acceptable for small-scale IoT applications. However, for mIoT devices, the aforementioned approach is unacceptable due to the fact that manual configuration is time consuming, cost-ineffective and cumbersome. Thus, automatic credential provisioning without user involvement, known as "zero-touch" is needed for mIoT. This Recommendation provides a security methodology on designing such a decentralized identity management system to support the zero-touch deployment of future mIoT. Zero-touch deployment will enable IoT devices to automatically find their mobile network operator and their service provider, automatically obtain credentials from them and automatically connect to the network and the service. This will greatly facilitate the future deployment of mIoT devices for verticals. The content of this Recommendation will cover the security architecture, the security considerations and the related security procedures (such as device attestations, authentication, and credential provisioning) which are needed for building such a zero-touch mIoT deployment platform.

[**ITU-T X.1369 “Security requirements for IoT service platform”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14799) specifies security requirements for IoT service platform. It assesses security threats and challenges to IoT business service platform and describes security measures that could mitigate security threats and challenges.

[**ITU-T X.1377 “Guidelines for an intrusion prevention system for connected vehicles”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15103) establishes guidelines for an intrusion prevention system (IPS) for connected vehicles. This Recommendation mainly focuses on aspects of active response capability for intrusion and includes the implementation guidance and use cases of IPS for connected vehicles. Prior in-vehicle intrusion detection systems (IDSs) have limitations, e.g., requiring too many computing resources that a vehicle cannot provide and being unable to mitigate intrusions due to characteristics of protocol and bus topology. To address these limitations of conventional in-vehicle IDSs, this Recommendation provides methodologies for intrusion detection and intrusion prevention. The proposed IPS consists of the intrusion detection plane – an external component that calculates intrusion detection algorithms – and the data plane – in-vehicle networks (IVNs) where traffic monitoring and active response happen. This Recommendation aims to protect (automotive) Ethernet-based IVNs.

[**ITU-T X.1379 “Security requirements for roadside unit in intelligent transportation system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14994) specifies security requirements for roadside unit (RSU) in intelligent transportation system (ITS) based on security threat analysis. This Recommendation will help to guide vendors and operators of RSUs to adopt appropriate security schemes to fulfil security requirements specified to protect RSUs from security risks and attacks from cyberspace thus to ensure the security of ITS.

**ITU-T X.1380 “Security guidelines for cloud-based data recorders in automotive environments” (under approval):** The purpose of this Recommendation is to standardize security guidelines for cloud-based data recorders in automotive environments. This Recommendation describes threats, vulnerabilities, security requirements, and use cases for cloud-based data recorders in automotive environments. Event data recorders are one of the most important components installed in automotive road vehicles in order to record vehicle status, vehicle movements and user inputs during crashes. Through analysing the event data, we can understand the cause of a crash and eventually use it to improve safety in automotive environments. A data storage system for automated driving is also an important component to record a set of data that will give a clear picture of the interactions between the driver and the automated driving system. However, conventional event data recorders record and manage the whole data locally, and in this way the data might come under threats of loss and destruction. Meanwhile, cloud computing is being considered an enabler of network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand. Industries such as the aviation industry are already attempting to apply cloud services to event data recording systems to increase safety in the aviation environment. According to the current trend of connectivity among the vehicles, the event data recorders and the data storage system for automated driving in automotive will be implemented to increase their overall safety. However, They have various vulnerabilities in the process of collecting, transferring, storing, managing, and using the recorded data according to the distinctive characteristics of the automotive environment. Therefore, it is necessary to study these vulnerabilities, security requirements, and use cases for cloud-based data recorders in automotive environments.

**ITU-T X.1381 “Security guidelines for Ethernet-based In-Vehicle networks” (under approval)** provides security guidelines for Ethernet-based in-vehicle networks (IVNs). The current trend in electrical and electronic (E/E) architecture is to integrate the Ethernet with legacy IVNs such as the controller area network (CAN), local interconnect network (LIN), media-oriented systems transport (MOST) and FlexRay. In the past, the Ethernet was considered only as a connection between vehicles with external environments. Standard protocols that enable Internet protocol-based connections over the Ethernet (e.g., diagnostic communication over Internet protocol or universal measurement and calibration protocol) have been used to enable communications between the external environment and vehicles. These use cases generally do not need to meet stringent real-time constraints. However, in-vehicle applications using Ethernet communication require characteristics that include high time sensitivity and reliability. Current developments in in-vehicle communication technologies require increased bandwidth in the network. Compared to the Ethernet, legacy IVNs are insufficient to meet the bandwidth requirements of current in-vehicle applications. Therefore, now and in the future, Ethernet-based IVNs are a major part of E/E architecture. However, countermeasures known from common computer networks cannot be suitable for an automotive application because they were not designed with regard to automotive requirements and capabilities. To address this demand, this Recommendation provides security guidelines for automotive Ethernet technology. This Recommendation includes a reference model of automotive Ethernet and analysis of threat and vulnerability for Ethernet-based IVNs. In addition, this Recommendation provides security requirements and use cases of Ethernet-based IVNs.

**ITU-T X.1382 “Guidelines for sharing security threat information on connected vehicles” (under approval)**: Connected vehicles are facing increasingly prominent network security issues along with their rapid development. Security threat information of connected vehicles means any information that can help an organization identify, assess, monitor, and respond to the connected vehicle, which plays an integral role in securing connected vehicles. Organizations that share threat information for connected vehicles can improve their own security postures and those of other organizations. This Recommendation is a guide on the principles, rules, methodology and procedures of sharing security information for connected vehicles. This Recommendation also provides a brief description of the different scopes, roles and effectiveness of the various organizations while they engage in the life cycle of security threat information sharing. This Recommendation is intended to help organizations stay in touch with the existing shared community. Furthermore, this Recommendation helps organizations contribute to the threat information of a connected vehicles sharing community, which would support the practices of connected vehicles safety protection. Overall, this Recommendation aims to enhance security threat information sharing; and mitigate the potential impact of cyber security attacks on connected vehicles.

**ITU-T X.1383 “Security requirements for categorized data in vehicle-to-everything (V2X) communication” (under approval):** Data security is one of the most important works for vehicle-to-everything (V2X) communication. However, in a resource constrained environment such as in-vehicle communication, a lot of resources are consumed protecting data as cryptographic functions are required. This Recommendation categorizes the data used in V2X communication into several types such as object attribute data, vehicle status data, environmental perception data, vehicle control data, application service data and user personal data, and assigns three security levels for categorized data types. Based on these categorized data types and assigned data security levels, this Recommendation provides security requirements for categorized data in V2X communication.

[**ITU-T X.1407 “Security requirements for digital integrity proofing service based on distributed ledger technology”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14800) specifies the security threats and requirements in digital integrity proofing based on distributed ledger technology (DLT). The original proof protected is stored in the off-chain. The hashed data values are stored in the on chain. Recommendation X.1407 analyses the security threats to the digital integrity proofing services based on DLT, namely, proof registration and proof provenance. Recommendation X.1407 describes the security requirements that could address these security threats.

[**ITU-T X.1409 “Security services based on distributed ledger technology”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15035): Distributed ledger technology (DLT) has features include immutability, data sharing, decentralization, and tamper-resistance. Certain security services can benefit from the decentralized nodes of DLT to solve problems such as single point of failure, bottleneck performance and tampering. This Recommendation identifies aspects to be evaluated before delivering a security service based on DLT and provides examples to implement four security services which could be delivered based on DLT, namely:

• DLT-based public-key certificate management;

• DLT-based software defined perimeter;

• DLT-based threat intelligence sharing; and

• DLT-based security audit.

**ITU-T X.1410 “Security architecture for data-sharing management based on the distributed ledger technology” (under approval)** specifies a security architecture of data-sharing management based on distributed ledger technologies (DLTs). Based on the architecture, this Recommendation specifies the interfaces between the functional entities and the procedures of data-sharing management based on DLT. Distributed ledger technology is transforming the industries with innovative solutions and changing the way governments, institutions, and businesses operate. It provides a solution for securely replicating, sharing, and synchronizing data across a distributed computer network, considering its decentralization and tamper-proof features. Current approaches for sharing business data and personally identifiable information (PII) data with companies and digital platforms have led to privacy vulnerabilities from hacks or poor data management. Adopting DLT or blockchain in data-sharing management allows individuals or companies to maintain more direct control over their own confidential information. In the DLT-based solution, only non-PII data, e.g., hashed data values, are stored in the on-chain. PII data about a data owner are stored in the off-chain. A DLT-based solution provides a way that improves the traceability, verifiability and changeability of status of data.

**ITU-T X.1411 “Guidelines on blockchain as a service (BaaS) security” (under approval)** provides generic guidelines for blockchain as a service (BaaS). The security threat and vulnerabilities of blockchain as a service (BaaS) are analysed, followed by the security measures of blockchain as a service (BaaS). The Recommendation addresses the security requirements and provides guidelines for all the activities in the construction, operation and use of BaaS. Blockchain as a service has become a mainstream of blockchain development, due to its promising capability and support from giant tech companies, especially top cloud providers. As blockchain as a service (BaaS) provides the fundamental service and resources for blockchain applications and BaaS security also faces challenges arising from both blockchain core technologies and cloud platforms, the guidance on blockchain as a service security is of great importance and a necessity.

[**ITU-T X.1453 “Security threats and requirements for video management systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14802): Video management system (VMS) is the core of video surveillance systems used for public safety, traffic monitoring, etc. Basically, a VMS receives video from cameras and allows someone to view that video either live or recorded. Currently emerging VMS approaches incorporate more and more intelligence into their design, including video analytics and access control. As VMS is networked, it is fully exposed to various vulnerabilities such as those faced by internet web services and can easily be a target of cyberattacks. This Recommendation analyzes the security threats to server platform based VMS running on an IP network and specifies security requirements to counteract identified security threats.

**ITU-T X.1454 “Security measures for location enabled smart office service” (under approval):** The smart office service combining multiple smart applications aims to improve the quality of official businesses, and efficiency management. Since information and communication technologies (ICTs) serve as the basis for technologies in smart office services, the telecommunication operator plays an important role among stakeholders in smart office services. The typical smart office services include smart parking, smart driving, smart retail shop, smart office, smart meeting room management, smart water, and smart energy consumption management, etc. Among these typical smart office services, the location data provided by the operator is one of the key elements in most of these services implementations. In order to ensure the security of location enabled smart office services, security threats and relevant security requirements, specific to location enabled services need to be analysed and the overall security measures established. This draft Recommendation aims to analyse the typical application scenarios of location enabled smart office services, specifies the security threats and requirements that are specific to the location enabled services and thereby establishing security measures for the operator and key stakeholders in a smart office to safeguard location enabled services.

**[ITU-T X.1643 “Security requirements and guidelines of virtualization container in cloud computing environment”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14804)** analyses security threats and challenges on virtualization container in cloud computing environment and specifies a reference framework with security guidelines for virtualization container in cloud.

**ITU-T X.1644 “Security guidelines for distributed cloud” (under approval)** analyses security threats and challenges on distributed cloud and propose security guidelines against threats for distributed cloud, which includes the security guidelines for core cloud, regional cloud and edge cloud.

[**ITU-T X.1715 “Security requirements and measures for integration of quantum key distribution network (QKDN) and secure storage network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14995) specifies security requirements and measures for integrating quantum key distribution network (QKDN) with secure storage network (SSN) in the service layer [ITU-T Y.3800] and public key infrastructure (PKI) [ITU-T X.509].

[**ITU-T X.1752 “Security guidelines for big data infrastructure and platform”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14806) analyses security threats and challenges on big data infrastructure and platform and specifies a reference framework to mapping security guidelines against threats for big data infrastructure and platform.

**[ITU-T X.1812 “Security framework based on trust relationship for IMT-2020 ecosystem”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14808)** identifies stakeholders in IMT-2020 ecosystem, analyses trust relationships amongst them, identifies threats and clarifies security responsibilities for each stakeholder, defines security boundaries between stakeholders, and establishes a security framework based on these trust relationships.

[**ITU-T X.1813 “Security and monitoring requirements for operation of vertical services supporting ultra-reliable and low latency communication (URLLC) in IMT-2020 private network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14991)**:** IMT-2020 private network, also regarded as IMT-2020 non-public network (NPN), is intended for the sole use of a private entity such as an enterprise and may be deployed in a variety of configurations, utilizing both virtual and physical elements. It will deliver speed, low latency and other benefits promised by IMT-2020 to support next-generation applications. In vertical services for smart factories and smart cities that use a private IMT-2020 network, many Internet of things (IoT) devices use massive machine type communications (mMTC) and ultra-reliable low latency communications (URLLC). These communications can be exposed to security threats and their associated risks. In addition, these threats can deteriorate the stable operation of the vertical services supporting URLLC. It cannot be guaranteed when the performance of vertical services is degraded due to these risks. This Recommendation specifies security requirements for operation of vertical services supporting URLLC in IMT-2020 private network. It identifies threats and risks which arise when providing vertical services supporting URLLC in IMT-2020 private network and describes security deployment scenarios of IMT-2020 private network for operation of vertical services supporting URLLC. Monitoring of communication contents is out of the scope of this Recommendation.

[**ITU-T X.1814 “Security guidelines for IMT-2020 communication system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14992): Connected IoT devices and mobile applications require wireless network access that is resilient, secure, and able to protect individuals' privacy. IMT-2020 communication systems should be designed to meet these high-level requirements. There is a need to define a security framework for IMT-2020 communication systems which could act as a foundation for developing further detailed technical Recommendations on IMT-2020 security topics. This Recommendation identifies all components related to the security of IMT-2020 communication systems and defines security guidelines for the IMT-2020 communication system. It describes a generic IMT-2020 architecture and its domains. It also identifies threats to and specifies requirements on security capabilities for each component, taking into account unique network features. This Recommendation is based on 3GPP 5G security architecture.

**ITU-T X.1815 “Security guidelines and requirements for IMT-2020 edge computing services” (under approval)**: The IMT-2020 network will enable a variety of services, including enhanced mobile broadband (eMBB) services, massive machine type communications (mMTC) based services and ultrareliable low latency communications (URLLC) based services, on an infrastructure of network and computing resources. In line with the key features and the requirements identified for the IMT-2020 network, it is required to be more efficient, personalized, intelligent, reliable and flexible. To support the typical services in the IMT-2020 network, especially eMBB services and URLLC based services, edge computing is acknowledged to be one of the key technologies for meeting the demanding key performance indicators (KPIs) of the IMT-2020 network, especially as far as low latency and bandwidth efficiency are concerned. Edge computing enables the operator and the third part service provider to deploy the services close to the user's access point, thus achieving high-efficiency service delivery through reduced end-to-end latency and load on the transport network. In order to ensure the security of edge computing service deployment and application, the security threats and relevant security requirements specific to edge computing service need to be analysed and the overall security framework need to be established. This Recommendation aims to analyses the deployment scheme and typical application scenarios of edge computing services, specifies the security threats and requirements specific to edge computing services in IMT-2020 and thus establishes security capabilities for the operator to safeguard its applications.

**ITU-T X.1816 “Guidelines and requirements for classifying security capabilities in IMT-2020 network slice” (under approval)**: The definition of basic network slicing technology functions and processes has laid a solid foundation for the first wave of IMT-2020 deployment and commercial use of network slicing services. As an end-to-end logical network that is customized on demand, slicing can provide differentiation security capabilities: First, the IMT-2020 network slicing provides the supporting security measures for the differentiated network implementation. Second, the IMT-2020 network supports some optional security measures at the slice level. Some security measures can also provide multiple security options and operators may own different security resources. These may bring different degrees of security guarantee or non-security performance. Slice customers also have specific security requirements and may request customized network slices with different security protection levels from slice operators. There exist some challenges for the slice customers or the slice operators choosing the security capabilities of their slices such as management cost and definition inconsistency, etc. The objective of this Recommendation is to provide a description of differentiated IMT-2020 network slice security capabilities and guidance for classifying the IMT-2020 network slice security capabilities and IMT-2020 network slice security to help the ecosystem more clearly understand and choose the slicing security capabilities.

[**ITU-T X.Suppl.37 “Supplement to ITU-T X.1231: Countering spam based on machine learning”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=15119) defines a technical framework for countering spam based on machine learning. It may help some relevant persons and companies in spam management, reduce the benefit loss of users and providers, improve user experience and promote the healthy development of telecommunication business. This Supplement to Recommendation ITU-T X.1231 provides some general scenarios, characteristics of spam, and define general technical framework, work flows about countering spam based on ML.

[**ITU-T X.Suppl.38 “Supplement to ITU-T X.1152: Use cases for contact tracing applications to prevent spread of infectious diseases”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15165) describes various use cases for contact tracing technologies. It also provides data processing models including their procedures, data processing flow and security considerations. In addition, practical use cases are described in Appendix I.

[**ITU-T Y.3808 “Framework for integration of quantum key distribution network and secure storage network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14865): 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.3810 “Quantum key distribution network interworking – framework”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15063)**:** For quantum key distribution networks (QKDN), Recommendation ITU-T Y.3810 specifies framework of QKDN interworking (QKDNi). This Recommendation describes the overview of interworking QKDNs, the reference models, and the functional models of gateway functions (GWFs) and interworking functions (IWFs). The configurations for QKDNi are specified. Appendix I includes QKDNi with different key relay schemes.

[**ITU-T Y.3811 “Quantum key distribution networks - Functional architecture for quality of service assurance”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15064) specifies a functional architecture of QoS assurance for the quantum key distribution networks (QKDN). This recommendation first provides an overview of the functional architecture of QoS assurance for the QKDN. It then describes the functional architecture of QoS assurance which includes functional entities such as QoS data collection, data processing, data storage, data analytics, QoS anomaly detection and prediction, QoS policy decision making, and enforcement and reporting. Based on the functional entities described in the functional architecture, this Recommendation specifies a basic operational procedure of QoS assurance for the QKDN.

[**ITU-T Y.3812 “Quantum key distribution networks - Requirements for machine learning based quality of service assurance”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15065) specifies high-level and functional requirements of machine learning (ML) based QoS assurance for the quantum key distribution networks (QKDN). This recommendation first provides an overview of requirements of ML based QoS assurance for the QKDN. It describes a functional model of ML based QoS assurance and followed by associated high level and functional requirements of ML based QoS assurance. And some use cases are described.

**ITU-T Y.3813 “Quantum key distribution networks interworking – functional requirements” (under approval)**: For quantum key distribution networks (QKDN), Recommendation ITU-T Y.3813 specifies functional requirements for QKDN interworking (QKDNi). This Recommendation describes the functional requirements for key management layer, QKDN control layer, and QKDN management layer, for interworking using gateway nodes (GWNs) and/or interworking nodes (IWNs).

**ITU-T Y.3814 “Quantum key distribution networks - functional requirements and architecture for machine learning enablement” (under approval):** QKDN is expected to maintain stable operations and meet the requirements of various cryptographic applications efficiently. Due to the advantages of machine learning (ML) related to autonomous learning, ML can help to overcome the challenges of QKDN in terms of quantum layer performances, key management layer performances and QKDN control and management efficiency. Based on the functional requirements and architecture of QKDN in [ITU-T Y.3801] and [ITU-T Y.3802], this recommendation is to specify one possible set of functional requirements and a possible architecture for ML-enabled QKDN (QKDNml), including the overview, the functional requirements, architecture and operational procedures of QKDNml.

**ITU-T Y.4500.3 ”oneM2M - Security solutions” (under approval)** provides specifications for M2M security and privacy protection.

**[ITU-T Technical Report XSTP-5Gsec-RM “5G Security Standardization Roadmap”](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-ICTS-2022-2)** provides the standardization roadmap for 5G security. This roadmap is prepared to assist in developing 5G security standards by providing information on existing and under developing standards at key standards developing organizations (SDOs). In addition, it describes the overviews of 5G security from standards perspective and gap analysis.

[**ITU-T Technical Report TR.sec-ai “Guidelines for security management of using artificial intelligence technology”**](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-ICTS-2022-2): As a new generation of information and communication technology (ICT) infrastructure, Artificial Intelligence (AI) has been widely used in various fields of social economy. In the development and application of AI technology, AI may also bring some security threats, which may run through the whole process of AI products, applications and services from design and development to retirement. Organizations need to identify the source of security threats according to the using process of AI technology, so as to deploy targeted security defense strategies. This Technical Report focuses on the security threats faced by the current use of AI technology, puts forward AI security management suggestions, and provides a useful reference for organizations to improve the security protection ability in the use of AI technology.

[**ITU-T Technical Report TR.hyb-qkd “Overview of hybrid approaches for key exchange with QKD”**](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-ICTS-2022-1) provides a landscape of the standardization activities on hybrid approaches for migration towards quantum-safe algorithms or protocols within international, regional and national organizations. The hybrid approach that is covered by this technical report is for key exchange. Hybrid approaches are for key exchange consist in generating a key exchange functionality by combining at least two different key exchange methods. This Technical Report studies the possible way forward to accommodate Quantum Key Distribution protocols in the context of the hybrid approaches for key exchange. This compatibility is studied for generic hybrid key exchange and hybrid key exchange specific to certain communication protocols.

I.5.2 Quantum key distribution networks

[**ITU-T X.1715 “Security requirements and measures for integration of quantum key distribution network (QKDN) and secure storage network”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14995) specifies security requirements and measures for integrating quantum key distribution network (QKDN) with secure storage network (SSN) in the service layer [ITU-T Y.3800] and public key infrastructure (PKI) [ITU-T X.509].

[**ITU-T Technical Report TR.hyb-qkd “Overview of hybrid approaches for key exchange with QKD”**](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-ICTS-2022-1) provides a landscape of the standardization activities on hybrid approaches for migration towards quantum-safe algorithms or protocols within international, regional and national organizations. The hybrid approach that is covered by this technical report is for key exchange. Hybrid approaches are for key exchange consist in generating a key exchange functionality by combining at least two different key exchange methods. This Technical Report studies the possible way forward to accommodate Quantum Key Distribution protocols in the context of the hybrid approaches for key exchange. This compatibility is studied for generic hybrid key exchange and hybrid key exchange specific to certain communication protocols.

**[ITU-T Y.3807 “Quantum Key Distribution networks – QoS parameters”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14864)** 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14865): 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14865) provides an overview of secure storage networks (SSNs) for quantum key distribution networks (QKDNs). It specifies the functional requirements, functional architecture model, reference points and operational procedures for SSNs.

[**ITU-T Y.3810 “Quantum key distribution network interworking – framework”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15063)**:** For quantum key distribution networks (QKDN), Recommendation ITU-T Y.3810 specifies framework of QKDN interworking (QKDNi). This Recommendation describes the overview of interworking QKDNs, the reference models, and the functional models of gateway functions (GWFs) and interworking functions (IWFs). The configurations for QKDNi are specified. Appendix I includes QKDNi with different key relay schemes.

[**ITU-T Y.3811 “Quantum key distribution networks - Functional architecture for quality of service assurance”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15064) specifies a functional architecture of QoS assurance for the quantum key distribution networks (QKDN). This recommendation first provides an overview of the functional architecture of QoS assurance for the QKDN. It then describes the functional architecture of QoS assurance which includes functional entities such as QoS data collection, data processing, data storage, data analytics, QoS anomaly detection and prediction, QoS policy decision making, and enforcement and reporting. Based on the functional entities described in the functional architecture, this Recommendation specifies a basic operational procedure of QoS assurance for the QKDN.

[**ITU-T Y.3812 “Quantum key distribution networks - Requirements for machine learning based quality of service assurance”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15065) specifies high-level and functional requirements of machine learning (ML) based QoS assurance for the quantum key distribution networks (QKDN). This recommendation first provides an overview of requirements of ML based QoS assurance for the QKDN. It describes a functional model of ML based QoS assurance and followed by associated high level and functional requirements of ML based QoS assurance. And some use cases are described.

**ITU-T Y.3813 “Quantum key distribution networks interworking – functional requirements” (under approval)**: For quantum key distribution networks (QKDN), Recommendation ITU-T Y.3813 specifies functional requirements for QKDN interworking (QKDNi). This Recommendation describes the functional requirements for key management layer, QKDN control layer, and QKDN management layer, for interworking using gateway nodes (GWNs) and/or interworking nodes (IWNs).

**ITU-T Y.3814 “Quantum key distribution networks - functional requirements and architecture for machine learning enablement” (under approval)**: QKDN is expected to maintain stable operations and meet the requirements of various cryptographic applications efficiently. Due to the advantages of machine learning (ML) related to autonomous learning, ML can help to overcome the challenges of QKDN in terms of quantum layer performances, key management layer performances and QKDN control and management efficiency. Based on the functional requirements and architecture of QKDN in [ITU-T Y.3801] and [ITU-T Y.3802], this recommendation is to specify one possible set of functional requirements and a possible architecture for ML-enabled QKDN (QKDNml), including the overview, the functional requirements, architecture and operational procedures of QKDNml.

I.5.3 Trust

[**ITU-T Q.3062 “Signalling procedures and protocols for enabling interconnection between trustable network entities in support of existing and emerging networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15042): Signaling System No. 7 (SS7) is a stack of signaling protocols, which was initially developed by ITU (CCITT) in the 1980s. Since then, SS7 standards has become a generic stack which are widely applied in public switched telephone network (PSTN) all over the globe. With the growth of mobile telecommunications and appearance of the MAP and CAP protocols, SS7 stack has become suitable for public land mobile network (PLMN), e.g., 2G, 3G networks. Later, SS7 migrated to SIGTRAN stack developed by IETF which allows operators to setup interconnection of SS7-based networks over IP networks. Furthermore, the SS7 logic migrated to DIAMETER which is currently widely used for interconnection of IMS-based networks, including 4G (VoLTE/ViLTE).

At the development stage, SS7 was designed to be managed by operators with the understanding that anyone connected to SS7 network was considered trustworthy. With the current network environment, including interconnection over the Internet, SS7-based networks have become vulnerable and can be easily attacked. Moreover, the latest move to Diameter protocol has not solved any of the basic vulnerabilities found in SS7.

Presently, there have been multiple cases where SS7 vulnerabilities have been used for different hackers’ attacks. Amongst well-known attacks on SS7 networks include telephone spam, spoofing numbers, location tracking, subscriber fraud, intercept calls and messages, DoS, infiltration attacks, routing attacks, etc.

The goal of this Recommendation is to define the signalling requirements for authentication of signalling messages, in order for operators to be able to verify the authenticity of signalling exchange based on an accepted trust anchor. This Recommendation includes codes and signalling procedures based on ITU-T Q.3057.

[**ITU-T Q.3063 “Signalling procedures of calling line identification authentication”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15043): SS7 was originally designed for operator management on the assumption that anyone connected to the SS7 network was trustable. In the current network environment, however, there appear more and more untrusted devices (including the PABX, call centre and VoIP access system) that interconnect to PLMN/PSTN. As a result, calling line identification spoofing is particularly effective at defeating call blockers, thus leading to a variety of scams by avoiding identification. The goal of this document is to identify the signalling requirements of calling line identification authentication including codes and signalling procedure base on the mechanism defined in the ITU-T Q.3057.

**ITU-T Y.3140 “Service brokering network framework for Trusted Reality” (under approval)** describes service brokering network framework for Trusted Reality featuring application-aware brokering capabilities in terms of context, data and computation. The service brokering network framework for Trusted Reality aims to deliver customized immersive application service experience with real-time communication and recognition of knowledge and information in a safe and convenient way for anyone throughout the automated connection of real and cyber world.

I.5.4 Distributed Ledger Technology

[**ITU-T F.747.10 “Requirements of distributed ledger systems for secure human factor services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14644) provides general requirements and functional capabilities for distributed ledger systems (DLS) for secure human factor services. This Recommendation describes the requirements for the secure human factor distributed ledger service model, which can solve conflicting goals of privacy protection and big personal human factor data utilization. This Recommendation also includes the functional capabilities for human factor distributed ledger shared nodes to perform machine learning without decryption on encrypted human factor data. However, the computational burden of machine learning for encrypted data may be excessive. To solve this problem, this human factor distributed ledger service model provides procedures for allowing the use of two or more encryption key pairs and notifying the key type. In addition, this Recommendation involves the integrity maintaining requirements for secure human factor services to maintain a safe distributed ledger and checked from the beginning to distribute personal human factor information. Therefore, the application of distributed ledger system in the distribution of personal secure human factor information can ensure transparent tracking from the distribution process to the final use path.

[**ITU-T F.751.3 “Requirements for change management in DLT-based decentralized applications”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14966)**:** The development of applications using distributed ledger technology (DLT) enables the creation of new business models in various sectors of the economy and it has the potential to tackle, on a large scale, important challenges for our society, due to its ability to increase trust in the relationship among stakeholders. Technical immutability is key to build trust among stakeholders. On the other hand, real-life introduces practical needs to update applications with smart contracts. This document defines some recommendations to tackle changes in applications using smart contracts. The discussion of whether DLT networks provide different levels of technical immutability is out of scope of this document.

[**ITU-T F.751.4 “General framework for DLT-based invoices”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14966): DLT-based invoice is an invoice that can be issued, transferred and received in a structured electronic format over digital ledgers which allows for its automatic, electronic transactions based on the smart contracts. It presents as a novel invoice service category, emerges as a promising solution to tackle the challenges by leveraging the capability of distributed ledger technology and the trust requirement of the stakeholders in the ecosystem. The usage of DLT-based invoices is driven mainly by seeking to optimize the end-to-end trustworthy business process across the jurisdictions in the major processes, e.g., issuance, routing, processing, re-imbursement, auditing and so on. The document is not proposing a "regulatory" framework. However, tax consideration involved by nature regulatory considerations must be addressed at a national level and are not the subject of this Recommendation. The electronic exchange of the invoice content between trading partners’ accounts receivable and accounts payable business processes is to be recorded over the invoice digital ledger in trustworthy way with local tax compliance. From a technology perspective, it needs to determine how the invoice will be transferred in a secure and interoperable way and how policies in different jurisdiction is enforced, and in the meanwhile the data privacy, security, trust and confidentiality have to be guaranteed, which is relevant to the following aspects:

– Secure messaging infrastructure to ensure that senders and receivers can trust the system and confidently exchange invoices.

– Programmable government tax policies that can be securely enforced.

– Invoice data validation schemes to ensure that integrity of the invoice content.

Immutability of the digital distributed ledgers to allow stakeholders to store, validate the invoice based on their corresponding privileges.

**ITU-T F.751.5 “Requirements for distributed ledger technology-based power grid data management” (under approval)** defines requirements for distributed ledger technology (DLT)-based power grid data management, including framework of DLT-based power grid data management, requirements for infrastructure layer, requirements for service layer, requirements for application layer and requirements for data governance. This Recommendation can be used as a guideline for power grid data management with DLT technologies.

**ITU-T F.751.6 “Performance assessment methods for distributed ledger technology platforms” (under approval)** is an extension to the ITU-T F.751.1 and focuses on distributed ledger technology (DLT) performance assessment methods. Based on the performance assessment criteria defined in ITU-T F.751.1, this Recommendation defines specific performance metrics and relevant workflow for the quantitative performance assessment for DLT platform. This Recommendation can be used as a guideline of DLT platform performance assessment for developers, users, third party testers and researchers.

**ITU-T F.751.7 “Functional assessment methods for distributed ledger technology platforms” (under approval)** defines functional assessment methods for DLT platforms based on the assessment criteria defined in ITU-T Recommendation F.751.1. For each item of the assessment criteria defined in ITU-T F.751.1, one test case is defined in this Recommendation accordingly. The description of each test case is composed of test purpose, test workflows and expected results.

**ITU-T F.751.8 “Technical framework for DLT to cope with regulation” (under approval)** defines the technical framework for DLT to cope with regulation, including the regulatory challenges and the technical capacities. The design of the technical framework of DLT in this Recommendation is closely related to the DLT properties including decentralization, immutability and openness. This Recommendation can be used as a guidance of DLT system when facing regulation for DLT service providers and DLT system developers.

[**ITU-T X.1407 “Security requirements for digital integrity proofing service based on distributed ledger technology”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14800) specifies the security threats and requirements in digital integrity proofing based on distributed ledger technology (DLT). The original proof protected is stored in the off-chain. The hashed data values are stored in the on chain. Recommendation X.1407 analyses the security threats to the digital integrity proofing services based on DLT, namely, proof registration and proof provenance. Recommendation X.1407 describes the security requirements that could address these security threats.

**[ITU-T X.1409 “Security services based on distributed ledger technology”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15035)**: Distributed ledger technology (DLT) has features include immutability, data sharing, decentralization, and tamper-resistance. Certain security services can benefit from the decentralized nodes of DLT to solve problems such as single point of failure, bottleneck performance and tampering. This Recommendation identifies aspects to be evaluated before delivering a security service based on DLT and provides examples to implement four security services which could be delivered based on DLT, namely:

• DLT-based public-key certificate management;

• DLT-based software defined perimeter;

• DLT-based threat intelligence sharing; and

• DLT-based security audit.

**ITU-T X.1410 “Security architecture for data-sharing management based on the distributed ledger technology” (under approval)** specifies a security architecture of data-sharing management based on distributed ledger technologies (DLTs). Based on the architecture, this Recommendation specifies the interfaces between the functional entities and the procedures of data-sharing management based on DLT. Distributed ledger technology is transforming the industries with innovative solutions and changing the way governments, institutions, and businesses operate. It provides a solution for securely replicating, sharing, and synchronizing data across a distributed computer network, considering its decentralization and tamper-proof features. Current approaches for sharing business data and personally identifiable information (PII) data with companies and digital platforms have led to privacy vulnerabilities from hacks or poor data management. Adopting DLT or blockchain in data-sharing management allows individuals or companies to maintain more direct control over their own confidential information. In the DLT-based solution, only non-PII data, e.g., hashed data values, are stored in the on-chain. PII data about a data owner are stored in the off-chain. A DLT-based solution provides a way that improves the traceability, verifiability and changeability of status of data.

**ITU-T X.1411 “Guidelines on blockchain as a service (BaaS) security” (under approval)** provides generic guidelines for blockchain as a service (BaaS). The security threat and vulnerabilities of blockchain as a service (BaaS) are analysed, followed by the security measures of blockchain as a service (BaaS). The Recommendation addresses the security requirements and provides guidelines for all the activities in the construction, operation and use of BaaS. Blockchain as a service has become a mainstream of blockchain development, due to its promising capability and support from giant tech companies, especially top cloud providers. As blockchain as a service (BaaS) provides the fundamental service and resources for blockchain applications and BaaS security also faces challenges arising from both blockchain core technologies and cloud platforms, the guidance on blockchain as a service security is of great importance and a necessity.

**ITU-T Y.2247 “Framework and requirements of network-oriented data Integrity verification service based on blockchain in future network” (under approval)** specifies the network-oriented data integrity verification service based on blockchain in future networks. It provides the service requirements, framework and service scenarios of the network-oriented data integrity verification service based on blockchain and specifies the network capability requirements accordingly in the context of future networks including IMT-2020 network and beyond. Detailed descriptions of the use cases are listed in the appendix.

ITU- T Y.3082 “Mobile network sharing based on distributed ledger technology for networks beyond IMT-2020: Requirements and framework**” (under approval)** specifies the requirements and framework of distributed ledger technology used in mobile network sharing for networks beyond IMT-2020. The detailed requirements of distributed ledger technology based mobile network sharing are put forward. The high-level framework, service procedures and security considerations are presented. The detailed use cases are described in the appendix.

[**ITU-T Y.4052 “Vocabulary for blockchain for supporting Internet of things and smart cities and communities in data processing and management aspects”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15066) contains blockchain-related vocabulary to be used for Internet of things (IoT) and smart cities and communities (SC&C) in aspects of data processing and management (DPM). The vocabulary in this Recommendation is collected from the Recommendations, Supplements and standards published by ITU and ISO. In addition, this Recommendation includes and defines new terms to meet the needs of SC&C work within ITU.

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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14847): 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.1034 “Adequate assessment and sensitisation on counterfeit ICT products and their environmental impact”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15023) provides awareness and guidance on counterfeit ICT products' health and environmental impacts. The intention is to create awareness and sensitisation on human health and environmental risks and measures implemented in different countries for risk mitigation.

[**ITU-T L.1035 “Sustainable management of batteries”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14848): 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)”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14849) 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.1040 “Effects of ICT enabled autonomy on vehicles longevity and waste creation”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15024) defines guidelines and requirements on ICT Original Equipment Manufacturer (OEM) vendors providing equipment to autonomous vehicles aiming at reducing the amount of future e-waste. The Recommendation aims to analyse the e-waste risks and other sustainability indicators of autonomous vehicles and propose how these potential challenges can be mitigated. This Recommendation utilises information compiled from stakeholders which can provide good insights into the specified potential challenge.

[**ITU-T L.1050 “Methodology to identify the key equipment in order to assess the environmental impact and e-waste generation of different network architectures”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14716): While an assessment framework for environmental impacts of the ICT sector does exist (as developed by ITU with for example [ITU-T L.1410] on environmental life cycle assessments of information and communication technology goods, networks and services), best practices for equipment identification, developed specifically to assess the environmental impacts of network architecture, remain lacking. In this Recommendation, key equipment in the networks are identified for smoother LCA calculations. . Different types of network architecture employ different goods which entail differences in terms of energy usage, e-waste generation as well as environmental footprints. This Recommendation will examine three types of network architectures and will suggest an appropriate set of equipment to be considered for each. This Recommendation will begin to support network designers in determining the environmental and circular performance of different network architectures. This Recommendation utilises information compiled from stakeholders which can provide good insights into the specified potential challenge.

[**ITU-T L.1230 “Specifications of 10 kVAC input and up to 400 VDC output integrated power system in data center and telecommunication room”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15025)**:** With the development of big data and cloud computing technology, the quantity and total capacity of the data center and telecommunication room as well as ICT equipment power density is increasing rapidly. Furthermore, it was found that the traditional power systems had the disadvantages of low energy efficiency, high energy consumption and maintenance difficulties in existing data center and telecommunication room. Therefore, it is necessary to develop a new structure of the whole power system, which integrated traditional 10 kVAC voltage distribution equipment, transformer, low voltage distribution equipment and up to 400 VDC equipment. The distribution system of each voltage level is simplified, so that the maintenance work is reduced, and the reliability of the whole power system is improved. This Recommendation includes system composition, general requirements, monitoring system , etc of 10 kVAC input and up to 400 VDC.

[**ITU-T L.1240 “Evaluation method of safety operations and energy saving for power supply system in telecommunication room/building”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15026) specifies the overall evaluation framework, classification of telecommunication room/building, reliability grading, evaluation items, evaluation methods for power supply system in telecommunication room/building. It is applicable to the evaluation of power supply system, maintenance capability, safety operations and energy saving of various telecommunication room/building.

**ITU-T L.1306 “Specification of edge data center infrastructure” (under approval)** makes systematic requirements on infrastructure including ICT equipment, power feedingsystem, cooling system, monitoring system, etc. to get green, safe, reliable, smart, energy-saving for edge data center.

[**ITU-T L.1318 “Q factor: A fundamental metric expressing integrated circuit energy efficiency”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15027) outlines a method and fundamental metric for expressing integrated circuit energy efficiency, the Q factor. The Q factor could be applied to measure and improve the integrated circuit technology behind information and communication technology itself. The method consists of two separate parts: 1) Method and metric development; 2) Examples of Q factor scores for different integrated circuits and energy and carbon saving potentials in relation to Q factors.

[**ITU-T L.1331 (revised) “Assessment of mobile network energy efficiency”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14940) 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.1333 “Carbon data intensity for network energy performance monitoring”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15028): To meet the targets of the Paris agreement, telecom operators, as other industries, need to set targets on their emission reduction to arrive at a net zero situation as reported in Recommendation [b-ITU-T L.1470]. In a moment in which the network traffic will increase, this Recommendation defines a KPI useful to evaluate network emission and give an indication on how a network reduce its emission due to the energy usage. This Recommendation defines a KPI called Network Carbon Intensity energy NCIe; also, it defines how to apply the Recommendation: which part of the network is covered and finally how to calculate the metric and continuously in network evolution. This Recommendation also defines correlation between the carbon intensity indicator and energy efficiency metric. The carbon KPI defined in this Recommendation refers to the energy efficiency metric defined in [ITU-T L.1331].

**ITU-T L.1630 “Framework of building infrastructure management system for sustainable city” (under approval)**: One of the sustainable development goals of sustainable city is to build resilient and safe city assets. Building is one of the key city assets and closely related with circular and sustainable city. Typically, energy and firefighting equipment are key equipment within the building infrastructure, which may affect the safety of people. Currently, many energy and firefighting equipment are separately deployed and managed, so there exist gaps between energy equipment management and firefighting equipment management. This Recommendation defines the framework of building infrastructure management system which improves the sustainability of city, particularly building as a city asset. The framework provides a holistic management of building infrastructure. It also presents a service use cases composed of functional elements.

[**ITU-T L.1390 “Energy saving technologies and best practices for 5G RAN equipment”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15029)**:** With the rapid development and commercialization of 5G radio communication technology, the 5G network construction is further accelerated. While being an important enabler for digitalization of other industries and thereby contribute to significant energy savings and emission reductions, it is also important to consider the energy consumption of the 5G network infrastructure itself. This Recommendation identifies energy saving potentials, describes energy-saving principles and technologies for 5G RAN and related equipment, and provides best practice recommendations when and how these technologies should be used and controlled thereby reducing the 5G RAN energy consumption, saving operational costs, and making the 5G RAN a green and high-efficiency network.

**ITU-T L.1400 (revised) “Overview and general principles of methodologies for assessing the environmental impact of Information and Communication Technologies” (under approval)** presents the general principles on assessing the environmental impact of information and communication technologies (ICT) and outlines the different methodologies that have been developed in the L.14xx-series:

• Assessment of the environmental impact of ICT goods, networks, and services

• Assessment of the environmental impact of ICT projects

• Assessment of the environmental impact of ICT in organizations

• Assessment of the environmental impact of ICT in cities

• Assessment of the environmental impact of the ICT sector

• Assessment on how the use of ICT solutions impacts GHG emissions of other sectors

• Decarbonization trajectories for the ICT sector

• Net zero guidance for ICT organizations

• Guidance on how to address the ITU´s Connect 20xx targets

The Recommendation describes the intended usage of each Recommendation and the connections between them. Finally, it lists ongoing work items.

**ITU-T L.1480 “Enabling the Net Zero transition: Assessing how the use of ICT solutions impacts GHG emissions of other sectors” (under approval)** provides methodology for the quantitative assessment of the net second order effect of ICT solutions(including first order effects), and also addresses higher order effects such as rebound. By assessing how the use of ICT solutions impacts GHG emissions over time, it aims to provide a fair, transparent and comprehensive assessment of the GHG emissions induced by the use of one or more ICT solutions. Guidance is provided for the following types of assessments: Assessment of the second order effect of one or more ICT solution(s) implemented in a specific context by the user of an ICT solution while considering also higher order effects Assessment of the second order effect of one or more ICT solution(s) implemented at different levels, including at an organizational level (whether a private and public organizations), at a city level, at a country level or at worldwide level, while considering also higher order effects. Assessment of the second order effect one or more specific ICT solution(s) from the perspective of an ICT organization while considering also higher order effects. This includes Assessment of the aggregated effect of all ICT solutions provided by an ICT organization across all customers Assessment of the aggregated effect of one or several ICT solution(s) provided by an ICT organization across customers Assessment of the effect of a specific ICT solution implemented in an actual context for a specific customer.

**ITU-T L.1481 “Guidance on how to address Connect2030 targets on net abatement” (under approval)** provides guidelines on how to address the Connect 2030 greenhouse gas on net telecommunication/ICT-enabled Greenhouse Gas abatement. It is intended to be utilized by relevant stakeholders of the Connect 2030 ambitions, while considering the sustainable development goal (SDG) 13 and the objectives of the Paris Agreement and the Glasgow Climate Pact. It also presents examples of ICT solutions associated with a potential reduction of GHG emissions.

[**ITU-T L.1604 “Development framework for bioeconomy in cities and communities”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15032)**:** Bioeconomy deals with both sustainability and circularity and covers all biological resources. The aim of this Recommendation is to provide cities with a framework for bioeconomy’s development, especially under the lens of circularity and sustainability. The main elements examined in this document are: The definition and role of bioeconomy in cities, with a focus on circularity and sustainability. The determination of factors and KPIs that affect bioeconomy development in cities. The definition of a generic implementation framework for bioeconomy in cities.

[**ITU-T L.1610 “City Science Application Framework”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15033)**:** As urbanization continues to accelerate, urban governance is struggling to adapt to the environmental and sustainability challenges. The high degree of urban sprawl demands urban planning to be reinvented in order to improve land and resource allocations. This creates further tension between urban and peri-urban areas (locations of close proximity to cities) in terms of economic and environmental sustainability. This Recommendation proposes to analyse and solve these urban problems and challenges by using the city science method. It will demonstrate that by using empirical evidence such as data, the city science method provides the most reliable and consistent way for cities to tackle urban challenges.

[**ITU-T L.1620 “Guide to Circular Cities”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15034)**:** The Guide for Circular Cities contains a circular city implementation framework that is designed to improve circularity in cities and support stakeholders in implementing circular actions. The framework consists of a four-step methodology that provides a consistent method for assessing, prioritising and catalysing different circular actions. This deliverable is developed in response to the growing sustainability challenges that cities are facing and the emergence of the circular economy concept and its applicability and extension in the city setting. The Guide starts with an assessment of the main developmental and sustainability challenges that cities are facing and the ways in which the concept of circular economy can be extended beyond the economic sphere and be applied to different city assets. It further defines key components of the circular city implementation framework. These components include: city assets and products (i.e. various city infrastructures, city resources, city goods and services available for use in a city); circular city actions (i.e. outcome-orientated actions that can be applied to city assets and products); circular city outputs (i.e. the outputs of circular city actions applied to city assets and products); and circular city enablers (i.e. complementary activities which support or accelerate implementation of circular city actions). Each of these components contains different quality and potential for facilitating circularity in cities. The interactions between these components form the basis of the circular city implementation framework. Finally, the Guide explains the circular city implementation framework. This framework utilizes four different steps to assist city stakeholders in enacting circular actions. The first step is to establish a baseline for circularity. The second step is to determine the potential of circularity in different assets and to prioritize circular actions based on the availability resources. The third step is to apply city enablers to catalyse different circular actions. The last step is to evaluate the impacts of these actions. Cities are invited to use this Guide to identify a course of action for improving circularity. The Guide also includes practical recommendations for preparing circular city actions and their implementation. The Guide is complemented with 17 case studies that illustrate the application of the circularity concept based on experiences from cities around the world.

**[ITU-T L.Suppl.47 “Examples of resource-saving within the ICT Sector”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15084)**: In order to achieve sustainable growth under the constraints of the environment and resources, it is necessary to radically change conventional waste and recycling measures. Conventional waste countermeasures have mainly been recycling (reuse as a raw material), but in addition to this, reduction (control of waste generation) and reuse are also important. Since twisted pair cables, such as 4-pairs of unshielded twisted pair (UTP) or shielded twisted pair (STP) cables, are mainly used in various local area networks (LANs), a large amount of copper resources are still required to provide Internet services around the world. If fewer number of pairs can achieve the same communication performance as 4-pair type, the resource saving in the network can be realized. This Supplement provides various examples of resource saving in building systems, factories, plants and home applications due to the progress of resource saving within the ICT Sector, one of which is an example in the home network by using the Single-pair Ethernet (SPE) technology. Another example is related to semiconductor manufacturing technologies. Semiconductor dies (also known as chips) are currently mostly manufactured on disks (known as wafers) made of silicon, arsenide gallium or gallium nitride. Those chips have a rectangular shape which leads to losses on the edge of the wafer. The bigger the die the more important the losses. Some techniques used in the current industry are introduced for personal computer or server processors (CPU) and for graphics processing units (GPU) to reduce these losses.

[**ITU-T L.Suppl.48 “Data center energy saving: Application of artificial intelligence technology in improving energy efficiency of telecommunication room and data center infrastructure”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15085): Telecommunication Room and Data Center (DC) Infrastructure is containing a huge number of Information and Communication equipment. In order to keep the equipment running continuously and reliably, the room is necessarily equipped with air-conditioners to create a suitable environment for equipment operation. Nevertheless, it will cause a large amount of energy consumption and carbon emissions. This Supplement focuses on the application of AI technology and other emerging technologies such as digital twin, to improve the energy efficiency and reduce the carbon emissions of telecommunication room and DC infrastructures.

Most of the existing telecommunication room and DC infrastructures do not have the full ability to identify the distribution of indoor temperatures. Therefore, it is difficult to analyse the heat flow and the related power consumption in real-time and make appropriate adjustments timely. Consequently, it leads to unnecessary consumption of energy. This Supplement will address how AI-based power management can achieve the following capabilities:

• Data collections in telecommunication room and DC infrastructure;

• Real-time analysis of the historical power consumption and parameters of the target equipment room;

• The ability of training an intelligent model;

• Making reasonable adjustments dynamically to the air-conditioning and temperature, so as to achieve energy saving in the telecommunication room and DC infrastructure.

[**ITU-T L.Suppl.49 “Overview on Adaptation to Climate Change for ICT Networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15086) provides an updated overview of existing Recommendations and Technical Standards on the topic of Adaptation to Climate Change for ICT networks. In this context, adaptation has to be intended in a double meaning:

1) how ICT can help other areas (e.g. transports, buildings, …) to adapt to climate change challenges and effects;

2) how ICT networks themselves have to be designed/implemented in a more and more resilient way, in order to face climate change’s effects (e.g. flooding, stronger winds, …).

This Supplement takes into account also the work already done, on the topic of adaptation to climate change for ICT networks, from other workshops and Academia.

[**ITU-T L.Suppl.50 “Case Studies on Implementation of Cities' circular actions”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15087) contains circular city implementation framework that is designed to improve circularity in cities and support stakeholders in implementing circular actions. The framework consists of a four-step methodology that provides a consistent method for assessing, prioritising and catalysing different circular actions. The Recommendation is developed in response to the growing sustainability challenges that cities are facing and the emergence of the circular economy concept and its applicability and extension in the city setting. The Supplement aims to further support the circular city implementation framework by providing 17 case studies on cities implementing circularity in urban operations.

[**ITU-T L.Suppl.51 “Case studies on city science application framework”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15088): By employing scientific techniques and method used by the STI community, city science application framework provides a reliable and consistent way for cities to tackle the rising environmental and sustainability challenges. While Recommendation ITU-T L.1610 "City Science Application Framework" illustrates the methodology behind the application of city science, this Supplement provides success examples of cities that have already employed the city science approach to solve different challenges.

**ITU-T L.Suppl.52 “Guidelines on the Implementation of environmental efficiency Criteria for AI and Other Emerging Technologies” (under publication)** provides guidelines to policymakers, technologists, innovators, environmentalists, and other stakeholders from the technology industry, environmental sciences, and policy arena, on the topic of environmental efficiency criteria to assess the environmental impacts of artificial intelligence and other emerging technologies. These guidelines aim to serve as common factors, rather than a comprehensive list, for the above-mentioned stakeholders to consider while developing, deploying, and promoting any piece of technology into the market and society. While “emerging technologies” is a broad term, this Supplement identifies a few sample technologies through their accordant applications and areas of work in 16 applicable industry domains, which we hope our stakeholders can use as references to improve the environmental efficiency of their own technological products and/or services. When discussing environmental efficiency, this Supplement approaches environmental efficiency criteria from an adjusted model of Life Cycle Assessment of Product, with which three stages of environmental impacts – Materials, Use, and End of life – are examined. The Supplement provides both long-term and short-term strategies, which include not only specific examples for certain technologies addressing the three stages of environmental efficiency, but also an instrument to be used to localize such guidelines as well as to allow global benchmarking.

**ITU-T L.Suppl.53 “Computer processing, data management and energy perspective” (under publication)** proposes a set of good practices to improve the energy efficiency of cyber-physical applications – making use of IoT, AI, and Digital Twins. First, the Supplement introduces the cyber-physical paradigm, engineering reference framework, and a couple of system deployments models. Secondly, it defines three end-to-end use case typologies to be addressed (i.e. monitoring application using smart IoT systems and AI software; smart application using Edge computing and Cloud data center; and simulation applications using Digital Twin pattern). Energy efficiency practices are discussed adopting a circular value-chain model that consists of three main steps: Data Storage; Data Transfer/Move; and Data Processing/Analytics. Finally, this Supplement offers a set of recommended practices relating to each component of the three end-to-end use case typologies.

**ITU-T L.Suppl.54 “Guidance for assessing the GHG emissions consequences of the financial effects generated by ICT” (under publication)** describes a guidance for assessing the GHG emissions consequences of a financial effects (gains or losses) generated by ICT, separately considering the user and the vendor financial benefits or losses from the solution. It thus assesses the GHG impact of this common case of rebound effect due to changes in behaviour.

**ITU-T L.Suppl.55 “Environmental efficiency and impacts on United Nations Sustainable Development Goals of data centre and cloud computing” (under publication)**: As the role of data centre and cloud computing keeps increasing, so are the concerns over their energy use and energy cost, and the associated impacts on climate change and environment. In recent years, the data centre and cloud industry has made great progress in enhancing energy efficiency and adopting renewable energy sources. However, a sole focus on energy efficiency may cause burden shifting and overlook other relevant environmental impacts stemming from other parts of the data centres' life cycle and cloud computing value chain. Therefore, to support the development of sustainable data centres and cloud computing services, this Supplement aims to explore the environmental sustainability of data centres during their entire life cycle, factoring in a broad spectrum of energy and environmental aspects that needs to be addressed to achieve the relevant United Nations Sustainable Development Goals (SDGs). An integrated approach addressing both technical and implementation challenges will be applied to yield actionable insights to policy makers and industry experts.

**ITU-T L.Suppl.56 “Guidelines for connecting cities and communities with the Sustainable Development Goal” (under publication)** is based on the [U4SSC report on “Connecting cities and communities with the Sustainable Development Goals”](https://www.itu.int/en/publications/Documents/tsb/2017-U4SSC-Deliverable-Connecting-Cities/files/downloads/Deliverable-Connecting-Cities-and-Communities-422022.pdf) and provides an overview of how cities can use information and communication technologies (ICTs) to achieve the SDGs. It also maps the case studies to the various international agreements as well as the SDGs.

I.6.2 Electromagnetic fields

[**ITU-T K.20 (revised) “Resistibility of telecommunication equipment installed in a telecommunication centre to overvoltages and overcurrents”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15177) specifies resistibility requirements and test procedures for telecommunication equipment that is attached to or installed within a telecommunication centre. Overvoltages and overcurrents covered by Recommendation ITU-T K.20 include surges due to lightning on or near the line plant, short term induction from adjacent alternating current (AC) power lines or railway systems, earth potential rise due to power faults, direct contact between telecommunication lines and power lines, and electrostatic discharges (ESDs). The sources for overvoltages in internal lines, between equipment or racks, are mainly inductive coupling caused by lightning currents being conducted in nearby lightning strikes or lightning currents being conducted in nearby conductors. Major changes compared with Recommendation ITU-T K.20 (2017) include:

– DC insulation resistance test;

– revised test exemption for internal short cables;

– renaming of some test titles for clarity;

– screened cable exemptions;

– addition of test 7.10, a twisted pair port transverse/differential test, to Table 7.

[**ITU-T K.21 (revised) “Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15036) specifies resistibility requirements and test procedures for telecommunication equipment that is attached to or installed within a customer's premises. Overvoltages or overcurrents covered by this Recommendation include surges due to lightning on or near the line plant, short-term induction from adjacent alternating current (a.c.) power lines or railway systems, earth potential rise due to power faults, direct contact between telecommunication lines and power lines, and electrostatic discharges (ESDs). The sources for overvoltages in internal lines are mainly inductive coupling caused by lightning currents being conducted in nearby lightning strikes or lightning currents being conducted by nearby conductors.

[**ITU-T K.45 (revised) “Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15178) specifies resistibility requirements and test procedures for telecommunication equipment installed between telecommunication centres and between a telecommunication centre and the customer's premises. Overvoltages or overcurrents covered by this Recommendation include surges due to lightning on or near the line plant, short-term induction from adjacent AC power lines or railway systems, earth potential rise due to power faults, direct contact between telecommunication lines and power lines and electrostatic discharges. Changes compared with Recommendation ITU-T K.45 (2018) include:

• A DC insulation resistance test;

• a special requirements annex.

**[ITU-T K.76 (revised) “EMC requirements for DC power ports of telecommunication network equipment in the frequency range below 150 kHz”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15037)** specifies conducted emissions requirements for DC power ports of telecommunication network equipment in the frequency below 150 kHz. Furthermore, an immunity requirement specific to power ports of telecommunication network equipment with analogue voice interfaces is also defined.

[**ITU-T K.80 “EMC requirements for telecommunication network equipment in the frequency range 1 GHz-40 GHz”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15179)presents electromagnetic compatibility (EMC) requirements for all type of telecommunication equipment in the frequency range between 1 GHz and 40 GHz.

[**ITU-T K.83 (revised) “Monitoring of electromagnetic field levels”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14875) 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.87 (revised) “Guide for the application of electromagnetic security requirements – Overview”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15038)**:** General guidelines of information security management for telecommunications organizations are presented in Recommendation ITU-T X.1051, which is based on ISO/IEC 27002. In an information security management system (ISMS) based on Recommendation ITU-T X.1051, physical security is one of key issues, as shown for example in the following text presented in Recommendation ITU-T X.1051:

“a site whose environment is least susceptible to damage from the environment should be selected for communication centres – where a site is chosen that is vulnerable to environmental damage, appropriate measures should be taken against known hazards including: natural disasters [see e)] and temperature extremes;”

"a site whose environment is least susceptible to damage from strong electromagnetic field shall be selected for communication centres - where a site is chosen that is exposed to strong electromagnetic fields, appropriate measures should be taken to protect telecommunications equipment rooms with electromagnetic shields;"

When security is managed, the threat to equipment or site should be evaluated and mitigated. The threat is related to "vulnerability" and "confidentiality" in ISMS.

This Recommendation, Recommendation ITU-T K.87, outlines electromagnetic security risks of telecommunication equipment and illustrates how to assess and prevent those risks, in order to manage ISMS in accordance with Recommendation ITU-T X.1051. Major electromagnetic security risks addressed in this Recommendation are as follows:

• natural electromagnetic (EM) threats (e.g., lightning);

• unintentional interference (i.e., electromagnetic interference, EMI);

• intentional interference (i.e., intentional electromagnetic interference, IEMI);

• deliberate EM attacks via high-altitude electromagnetic pulse (HEMP);

• deliberate high-power electromagnetic (HPEM) attacks;

• information leakage from EM emanation (i.e., electromagnetic security, EMSEC).

Mitigation methods against electromagnetic security threats are also described in this Recommendation.

[**ITU-T K.91 (revised) “Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14876): 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.114 (revised) “Electromagnetic compatibility requirements and measurement methods for digital cellular mobile communication base station equipment”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15039) specifies the electromagnetic compatibility common requirements and test methods for digital cellular mobile communication base station equipment, repeaters and associated ancillary equipment which are independent of any kind of wireless access technologies, such as 2G, 3G, 4G, 5G or others. Test conditions for base stations used in variety modality are described, e.g., macro base station, distributed base station, micro base station, pico base station, integral antenna base station, active antenna base station and OTA active antenna base station. Performance criteria for immunity tests are also specified.

[**ITU-T K.123 (revised) “Electromagnetic compatibility requirements for electrical equipment in telecommunication facilities”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15040) describes the requirements for radiated and conducted emissions from electrical systems installed in telecommunication facilities. Electrical systems in the scope of this Recommendation include inverter driven electrical equipment including the air conditioners needed for the operation of telecommunication systems, personal computers, displays, printers, maintenance robots, and security systems including surveillance cameras. Their electrical systems include power conversion devices and electronic circuits which may generate conducted and radiated electromagnetic disturbances and cause degradation of the performance of nearby telecommunication systems.

[**ITU-T K.124 (revised) “Overview of particle radiation effects on telecommunication systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14933) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14934)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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14935) 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.136 (revised) “Electromagnetic compatibility requirements for radio telecommunication equipment”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15180) specifies the electromagnetic compatibility (EMC) requirements and the test method for radio telecommunication equipment and associated ancillary equipment.

[**ITU-T K.137 (revised) “Electromagnetic compatibility requirements and measurement methods for wireline telecommunication network equipment”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14936) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14937) 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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14938) 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.147 (revised) “Protection of networked information technology equipment” (under approval)** covers common one, two and four pair link implementations, their configurations, how surges are coupled into a system and what surge mitigation measures are used. Following this overview, the rationale for different surge and power fault test circuit approaches and when they are specified is given. Networked equipment can be subject to overvoltage and overcurrent transients. Both data and any powering services should be resistant to the expected environmental transients. Where equipment has multiple independent ports, such as central hubs, switches, or repeaters, then testing is required for inter-port resistibility. Resistibility testing needs to identify lightning transients coupled into a network by magnetic induction, earth potential rise, resistive coupling and transient coupling by a voltage-limiting operation of surge protective functions or flashover. Voltage limitation may convert common-mode surges into differential-mode surges in the signal path. It is also possible for alternating current mains power faults to couple into the network, which can necessitate the use of overcurrent protection.

[**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”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14846) 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.152 “Electromagnetic compatibility requirements for power equipment in telecommunication facilities”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15022) describes the requirements for radiated and conducted emissions from power equipment installed in telecommunication facilities. Power equipment in the scope of this Recommendation include rectifiers that supply direct current (DC) voltages of up to 400 V, power conditioning systems (PCSs) including grid connected power converters (GCPCs), uninterruptible power supplies (UPSs). The power equipment usually includes power conversion devices and may generate conducted and radiated electromagnetic disturbances and cause degradation of the performance of telecommunication systems and this Recommendation aims to prevent.

**ITU-T K.Suppl.16 (revised) “Electromagnetic field compliance assessments for 5G wireless networks” (under publication)** provides guidance on the radio frequency electromagnetic field (RF-EMF) compliance assessment considerations for IMT 2020 wireless networks also known as 5G. Given that the 5G technical standards have just been finalised and commercial 5G networks are now lunched in many countries.

[**ITU-T K.Suppl.24 (revised) “Rationale for setting resistibility requirements of telecommunication equipment installed in a telecommunication centre against lightning”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15089)provides the technical information (rationale) for setting the resistibility requirements against lightning in [ITU-T K.20]. This information should be referred to for any revision of [ITU-T K.20]. The rationale described in this Supplement is mainly quoted from past contributions and other documents discussed in ITU-T SG5 during the establishment and revision of [ITU-T K.20]. Also, this Supplement intends to include any rationale for the revision of [ITU-T K.20] in case it is revised.

[**ITU-T K.Suppl.27 to ITU-T K.44 “The 100 kHz ring wave generator”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15081): Some regional standards offer the ring-wave generator as an alternative test procedure. Surges in AC mains branch circuits have been found to show a damped ring wave. This supplement looks at the history of ring waves, the ring wave generator and its parameters. For most purposes the 1.2/50-8/20 generator is sufficiently adequate for surge testing without using a 100 kHz ring wave generator.

[**ITU-T K.Suppl.28 “Electric shock and related terms and definitions”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15082): An electricity supply voltage classified as extra-low voltage (ELV) has a low probability of causing a hazardous electrical shock. It is important to realise that the actual ELV value is not absolute, but depends on the electrical shock event circumstances. This Supplement covers established definitions, insulation types, equipment classes, electric shock physical reaction levels, electric shock event factors and circuit configuration examples.

[**ITU-T K.Suppl.29 “EMF strength inside and outside of electric vehicle using wireless power transfer (WPT) technology”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15083): The electric vehicle could be the type of transportation system to be used most frequently by the general public in the near future. EMF exposure levels from electric vehicles causes some concern to the general public so they should be assessed for the different type of vehicles. This particular electric vehicle uses dynamic wireless power transfer (WPT) technology to charge its battery with the power delivered from the coils installed underground. In this case, passengers and drivers can be exposed to electromagnetic field (EMF) inside and outside of the vehicle when it is stationary or moving. In each case, two different EMF measurement protocols need to be applied to evaluate the human exposure levels to EMF. This Supplement 29 to ITU-T K-series Recommendations includes the evaluation results of EMF exposure levels based on the exposure limits inside and outside of the electric vehicles known with the commercial name of OLEV (on-line electric vehicle), developed in Korea.

**ITU-T K.Suppl.30 “ITU-T K.118 - Requirements for lightning protection of fibre to the distribution point equipment – Overview” (under publication):** Telephone lines are constantly being repurposed for digital use. This document looks at the lightning threats that repurposing for digital G.fast (Fast Access to Subscriber Terminals) may bring. Since the publication of Recommendation ITU-T K.118, 2016, Requirements for lightning protection of fibre to the distribution point equipment, the system, often called G.fast (fast access to subscriber terminals) with RPF (reverse power feed), has had extensive deployment. This supplement provides the subsequent informative references and materials that have appeared since the publication of ITU-T Recommendation K.118. The conventional telephone twisted pair connecting wire, termed the link (transmission path between two cabling system interfaces, including the connections at each end), between the Distribution Point Unit (DPU) and the Customer Premises Equipment (CPE) usually has a maximum length of up to 300 m. Electrical lightning stresses on the connected equipment at the link ends are considered to arise from the lightning disturbances on the CPE powering source, differential EPR (earth potential rise) of the link ends and possibly magnetic induction to the link cable. This supplement mainly concerns itself with the differential EPR values between the link ends.

**ITU-T K.Suppl.31 “ITU-T K.118 - Requirements for lightning protection of fibre to the distribution point equipment – Modelling earth potential rise (EPR)” (under publication):** Since the publication of Recommendation ITU-T K.118, 2016, Requirements for lightning protection of fibre to the distribution point equipment, the system, often called G.fast (fast access to subscriber terminals) with RPF (reverse power feed), has had extensive deployment. This supplement provides an assessment earth potential rise (EPR) levels at the cabling link ends to the Distribution Point Unit (DPU) and the Customer Premises Equipment (CPE). Electrical lightning stresses on the connected equipment at the link ends are considered to arise from the lightning disturbances on the CPE powering source, differential EPR (earth potential rise) of the link ends and possibly magnetic induction to the link cable. This supplement mainly concerns itself with the link end EPR values.

**ITU-T K.Suppl.32 “Case Studies of RF-EMF Assessment” (under publication)**: The RF-EMF exposure levels are varying depending on the environment in which they are taken and type of radio communication systems that are in operation. This Technical Report presents results of case studies of 5G RF-EMF exposure levels taken in different conditions and areas. All results of assessment delivered by ITU-T members and include calculations and measurements of the 5G RF-EMF exposure levels in vicinity of different radio communication systems. The results included in this new Supplement provide information concerning the 5G RF-EMF exposure levels in real situations. The EMF exposure assessments are included in succeeding appendixes. This new Supplement is mainly to solve the problem of EMF compliance assessments of 5G base station systems through the typical case studies including computation evaluation and measurement evaluation, and also provides the case support on implementation of the ITU-T K.Supplement 16 and IEC62232.

I.6.5 Naming, numbering, addressing and identification

**Recommendation ITU-T E.118.1 "ITU-T management of the allocation of globally assigned Issuer Identifier Numbers (IINs)" (under approval)** specifies the criteria by which the TSB shall allocate and manage the globally assigned IIN, as well as the specific resources that will be managed.

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

**ITU-T D.608R “OTT Voice Bypass” (under approval)**: OTT voice bypass is now widely recognised as a form of traffic bypass and a growing source of losses for international inbound voice revenues. The regional Recommendation will focus on national and regional collaboration between member states and operators to deal with the OTT voice bypass issue.

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

[**ITU-T E.803 (revised) “Quality of service parameters for supporting service aspects”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15000)deals with the quality of service (QoS) parameters that could be of primary interest and concern to the customers and users of ICT services who wish to compare performances of service providers (SPs) of ICT services during the non-utilization stages of such services and secondarily to regulators and service providers.

[**ITU-T G.191 (revised) “Software tools for speech and audio coding standardization”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15001) provides source code for speech and audio processing modules for narrowband, wideband and super-wideband telephony applications. The set includes codecs, filters, noise generators. This edition introduces changes to Annex A, which describes the ITU-T Software Tools (STL) containing a high-quality, portable C code library for speech processing applications. This release of the STL, also known as STL2022, incorporates:

• An implementation of ESDRU (energy-based spatial distortion reference unit) as described in ITU-T P.811.

• An implementation of the loudness measurement algorithm as in ITU-R Rec. BS.1770-4.

Recommendation ITU-T G.191 includes an electronic attachment containing STL2022 and manual.

[**ITU-T G.1023 “Framework for capacity assessment of packet data services in mobile networks”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15008) provides a framework for capacity assessment of packet-data services in mobile networks. Mobile-network capacity is an underlying factor in all QoS aspects of a packet-data based mobile network due to the shared-resource properties of such networks. It is therefore desirable to achieve a basic understanding of related properties and corresponding performance indicators. Measuring network capacity takes, however, significantly more effort and resources, in the sense that a direct measurement of capacity requires a massive effort in terms of resources, which practically creates the requirement to use assessments. This Recommendation therefore provides a systematic approach to describe and characterize methods for assessment of packet-data based mobile networks, and presents the respective framework. Spatial resolution is an important element of this framework, i.e. the recognition that network capacity is not a quantity which is uniform over the entire network, or large areas of it. Rather, due to the cellular nature of such networks, capacity, and therefore also QoS and QoE properties, are spatially different.

[**ITU-T G.1036 “Quality of experience (QoE) influencing factors for augmented reality (AR) services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15009) lists typical use cases of augmented reality services and identifies the key QoE factors in it, and also gives a suggested scheme for AR QoE assessment in future works.

[**ITU-T G.Suppl.77 “Influencing factors on quality of experience (QoE) for video customized alerting tone (CAT) and video customized ringing signal (CRS) services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14997) describes video customized alerting tone (CAT) and video customized ringing signal (CRS) services and helps to identify the QoE key factors of video CAT and CRS.

[**ITU-T P.64 (revised) “Determination of sensitivity/frequency characteristics of local telephone systems”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15002) is mainly concerned with the electro-acoustical measurements required for supplying sensitivity/frequency characteristics suitable for use in calculating loudness ratings, or estimating other subjectivity-determined quantities. For this purpose, measurements under real conditions must form the basis. Artificial mouths and artificial ears must be used with due regard to obtaining good agreement between these measurements and those from real mouth and ear determinations. Measurements under real conditions are complicated, time-consuming and not reproducible with great precision. This Recommendation describes measurement methods using recommended forms of artificial mouths and artificial ears (see Recommendations ITU-T P.51 and P.57). This Recommendation applies mainly to local telephone systems (LTSs) with handset telephones; however, the principles also apply to other types of telephones. Annexes D, E and F define handset positions to be used with the head and torso simulator (HATS) according to ITU-T P.58 and P.57 type 3.3, 3.4, 4.3 and 4.4 artificial ears. Allowance is given to placing the handset in a way which best represents its intended use. Annex G describes the correspondence between measurements using the loudness rating guard-ring position (LRGP) and the HATS position.

[**ITU-T P.380 (revised) “Electro-acoustic measurements on headsets”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15003) provides testing methods for headsets using the head and torso simulator. The Recommendation addresses the following topics: selection of artificial ears, classification of headsets, positioning of headsets on HATS, test repeatability and contents of the measurement report.

**[ITU-T P.Imp565 “Implementer's Guide for Recommendation ITU-T P.565”](https://www.itu.int/rec/T-REC-P.Imp565-202206-I)** provides information about the handling of the wide-band modes of voice codecs EVS and Opus at coding rates above 20 kbits/s by Recommendation ITU-T P.565. This document contains all updates submitted up to and including those at Study Group 12 meeting in June 2022. This document was agreed by ITU-T Study Group 12 on 17 June 2022 and is the initial version of this implementer's guide for Recommendation ITU-T P.565.

[**ITU-T P.Imp565.1 “Implementer's Guide for Recommendation ITU-T P.565.1”**](https://www.itu.int/rec/T-REC-P.Imp565.1-202206-I) provides information about the handling of the wide-band modes of voice codecs EVS and Opus at coding rates above 20 kbits/s by Recommendation ITU-T P.565.1. This document contains all updates submitted up to and including those at Study Group 12 meeting in June 2022. This document was agreed by ITU-T Study Group 12 on 17 June 2022 and is the initial version of this implementer's guide for Recommendation ITU-T P.565.1.

[**ITU-T P.581 (revised) “Use of head and torso simulator for hands-free and handset terminal testing”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15004) covers hands-free (including speakerphone, loudspeaking and headset) and handset terminals and includes clauses for the calibration and use of the head and torso simulator (HATS) for handset and headset terminals. This Recommendation specifies the use of the HATS for speakerphone terminal subjective and objective evaluations (e.g., Recommendation ITU T P.340). It defines the test arrangements, the mouth calibration, the binaural equalization and loudness summation, as well as the method for headphone calibration to be applied for subjective third-party listening tests as described in Recommendation ITU-T P.832.

[**ITU-T P.852 “Subjective quality evaluation of text-based chatbots”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15078) describes methods and procedures for conducting subjective evaluation experiments for services which are based on text-based chatbots. Such chatbots enable a natural language-based dialogic interaction via text, and are used to offer customer care self-services, service selling, or alike. The set-up and running of appropriate interaction experiments is described, and questionnaires for quantifying the relevant quality dimensions perceived by the user are given.

[**ITU-T P.863.2 “Extension of P.863 for multi-dimensional assessment of degradations in telephony speech signals up to full-band”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15010) describes a set of models for predicting perceptual dimensions of degradations linked to the overall speech quality from narrowband (NB) (300 to 3 400 Hz) to full-band (FB) (20 to 20 000 Hz) telecommunication scenarios. The predictions target user judgments on four perceptual dimensions, as obtained in a subjective test described in Annex I to this Recommendation. The models described in this Recommendation are partially based on internal parameters of the model given in ITU-T Rec. P.863. This Recommendation presents a detailed description of all model parts which are not contained in ITU-T Rec. P.863. A conformance testing procedure is also specified in Annex B to allow a user to validate that an alternative implementation of the models is correct.

[**ITU-T P.Imp863 “Implementer's Guide 3 for Recommendation ITU-T P.863”**](https://www.itu.int/rec/T-REC-P.Imp863-202206-I) provides information about the handling of the wide-band modes of voice codecs EVS and Opus at coding rates above 20 kbits/s by Recommendation ITU-T P.863. This document contains all updates submitted up to and including those at Study Group 12 meeting in June 2022 except for those already published in the earlier Implementer’s Guides from 05/18 and 12/19. This document was agreed by ITU-T Study Group 12 on 17 June 2022.

**[ITU-T P.910 (revised) “Subjective video quality assessment methods for multimedia applications”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15005)** describes non-interactive subjective assessment methods for evaluating the one-way overall video quality for multimedia applications, such as videoconferencing, storage and retrieval applications, as well as telemedical applications. 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. Recommendation ITU-T P.910 also outlines the characteristics, like duration, kind of content and number of sequences, of the source sequences to be used.

[**ITU-T P.1140 (revised) “Speech communication requirements for emergency calls originating from vehicles”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15006) defines use cases, requirements and associated test methods for speech communication for emergency call communications originating from vehicles using a dedicated emergency call system covering built-in emergency call systems (manufacturer installed) as well as after-market emergency call kits. This Recommendation contains an electronic attachment containing the set of freely-available test signals referred to within the Recommendation.

[**ITU-T P.1204.4 (revised) “Video quality assessment of streaming services over reliable transport for resolutions up to 4K with access to full and reduced reference pixel information”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15007) describes the reduced-reference and full-reference video quality estimation model for Recommendation ITU-T P.1204 for monitoring the video quality for streaming using reliable transport (e.g., hypertext transfer protocol- (HTTP-) based adaptive streaming (HAS) over the transmission control protocol (TCP), quick user datagram protocol internet connections (QUIC)). The estimate is validated for videos encoded with H.264, H.265, video payload type 9 (VP9), or AOMedia Video 1 (AV1) codecs at any resolution up to 4K/ultra-high definition (UHD) (3 840 × 2 160) resolution for personal computer (PC) monitors and television (TV) and up to 2 560 × 1 440 for smartphone and tablet displays. The ITU-T P.1204 series of Recommendations provides sequence-related (between 5 s and 10 s) and per-1-second video-quality estimation. In principle, the per-one-second outputs of these video-quality models can be used together with an audio model for integration into audiovisual quality and, together with information about initial loading delay and media playout stalling events, further into a final per-session model output, an estimate of integral per-session quality (see e.g., Recommendations ITU-T P.1203, ITU-T P.1203.2, ITU-T P.1203.3). Recommendation ITU-T P.1204.4 was developed in collaboration with the Video Quality Experts Group (VQEG).

[**ITU-T P.1320 “QoE assessment of extended reality (XR) meetings”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15011) advises on aspects of importance for QoE assessment of telemeetings with extended reality elements. The goal is to define the human, context, and system factors that affect the choice of the QoE assessment procedure and metrics when extended reality telemeeting systems are under evaluation.

[**ITU-T P.1402 “Guidance for the development of machine learning based solutions for QoS/QoE prediction and network performances management in telecommunication scenarios”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15012) introduces Machine Learning techniques and their application for QoS/QoE prediction and network performance management in telecommunication scenarios. Especially, the design of training and evaluation data is described and means to avoid overtraining for Machine Learning models. It is also discussed the relation to classical model or algorithm development and differences are described. This recommendation gives best practice guidance for the successful development and evaluation of models based on Machine Learning but does not describe concrete models or algorithms for a dedicated purpose.

[**ITU-T Y.1545.2 “QoS metrics for continuity-of-performance of packet data based services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15013) defines spatially resolved metrics for packet-data based services and a methodology for their computation, using the same conceptual framework as Recommendation ITU-T G.1034. The metrics are covering the QoS and QoE aspects of a wide range of applications used in motion, i.e. during travel. A taxonomy of application categories is provided, taking into account their absolute data rate requirements and, in particular, their sensitivity against temporary drops in available data rates which are caused by motion through an environment which is characterized by spatial variation of network performance, i.e. available data rate or latency. The methodology defines a way to create a description of such spatial distributions of performance, termed route profiles, and a way to use route profiles to create predictions of QoS and QoE of application usage. It also defines a new entity to describe local network performance which provides an abstraction and thereby a versatile way to express performance requirements.

[**ITU-T Y.3117 “Quality of service assurance-related requirements and framework for smart education supported by IMT-2020 and beyond”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15052) specifies the quality of service (QoS) assurance-related requirements and framework for smart education supported by the international mobile telecommunications 2020 (IMT-2020) and beyond. Recommendation ITU-T Y.3117 (Y.IMT2020-qos-req-se) first provides an overview of smart education supported by IMT2020 and beyond. It then specifies the QoS assurance-related requirements and a framework. Finally, the QoS consideration for smart education services are described in Appendix I.

[**ITU-T Y.3118 “Requirements and framework for jitter guarantee in large scale networks including IMT-2020 and beyond”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15053) specifies the requirements and framework for an effective and efficient solution of jitter guarantee for dynamic traffic with arbitrary input patterns in large-scale networks including IMT-2020 and beyond. The framework in this Recommendation is composed of the time-stamping and the buffering functions at the network boundary. It is scalable and does not rely on time synchronization or slot scheduling.

**ITU-T Y.3121 “QoS requirements and framework for supporting deterministic communication services in local area network for IMT-2020” (under approval)** specifies QoS requirements and framework for supporting deterministic communication services in a local area network (LAN). First, it presents the concept and benefits of deterministic communication services in a LAN consisting of heterogeneous network technologies. Then it specifies a high-level model and associated QoS requirements for inter- technology domain deterministic communication services in LAN. Based on the identified QoS requirements, it identifies a framework and an example operational procedure. Finally, it provides three scenarios and associated use cases as informal material in appendixes.

**ITU-T Y.3183 “Framework for network slicing management assisted by machine learning leveraging QoE feedback from verticals” (under approval)** provides a framework for machine learning assisted network slicing management, leveraging vertical end users’ feedback on QoE, which can help achieve run-time optimisation of user perceived performance. The overall architecture, components, workflow and related APIs of this framework are specified with respect to the high-level requirements identified. A use case is provided in appendix to show an application example of this framework. Example implementations of the key APIs are also provided.

[**ITU-T Y.3137 “Technical requirements for supporting application addressing in edge computing for future networks including IMT-2020”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15054)**:** Application addressing is the process to discover the IP address of the server which the application running on when UE intends to access the application. This Recommendation specifies the technical requirements for supporting application addressing in edge computing for future networks including IMT-2020, and also proposes new requirements towards fixed mobile convergence (FMC) architecture for future networks including IMT-2020.

[ITU-T Y.3807 “Quantum Key Distribution networks – QoS parameters”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14864) 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.3811 “Quantum key distribution networks - Functional architecture for quality of service assurance” (under approval)** specifies a functional architecture of QoS assurance for the quantum key distribution networks (QKDN). This recommendation first provides an overview of the functional architecture of QoS assurance for the QKDN. It then describes the functional architecture of QoS assurance which includes functional entities such as QoS data collection, data processing, data storage, data analytics, QoS anomaly detection and prediction, QoS policy decision making, and enforcement and reporting. Based on the functional entities described in the functional architecture, this Recommendation specifies a basic operational procedure of QoS assurance for the QKDN.

[**ITU-T Y Suppl.60 (revised) “Interpreting Y.1540 Maximum IP-Layer Capacity Measurements”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14999) to the ITU-T Y-series Recommendations provides information on interpreting ITU-T Y.1540 maximum IP-layer capacity measurements as described in Annex A and Annex B of the Recommendation. This Supplement also provides useful information for those who measure various technologies. Much has been learned as part of extensive testing campaigns thus far, and there is more to learn. Therefore, this Supplement may be updated frequently, and readers are encouraged to ensure that they are using the most recent version.

[**ITU-T Technical Report ESTR-KPI-RAN “Key performance indicators (KPIs) for radio access mobile networks”**](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-QOS-2022) presents a framework that stakeholders can use as benchmarking when defining key performance indicators (KPIs) for radio access mobile networks.

[**ITU-T Technical Report GSTR-5GQoE “QoE requirements for real-time multimedia services over 5G networks”**](https://www.itu.int/pub/publications.aspx?lang=en&parent=T-TUT-QOS-2022-1) defines a scope for the analysis of QoE in 5G services and several use cases where this scope is applicable. Such use cases are: Tele-operated Driving, Wireless Content Production, Mixed Reality Offloading, and First Responder Networks. Addressing this set of use cases is challenging for three different reasons:

- Their requirements and Quality of Experience (QoE) expectations may be different from the ones typically present in most QoE-related research and Recommendations, which typically address communication services for consumer-type users (e.g., telephony, videoconference, video delivery / streaming, gaming, etc.).

- The experience and expectations of the use case owners may not be applicable to cellular wireless networks, even when QoS policies are applied. E.g., a wireless content production studio will not have the same channel capacity as a wired network, neither from bandwidth nor from reliability points of view. Therefore, totally new impairments or artifacts may appear when moving the use case from wired links to 5G.

- Professional and vertical markets applications typically have less users than the video consumer market ones (there are fewer content producers than content consumers), or the video transmission is just one of the pieces of a much more complex ecosystem (as in the automotive industry).

For each of the services, the document describes:

- Its main characteristics and reference architecture.

- The relevant QoE indicators to be considered on the service.

- A reference implementation, including the order-of-magnitude values of the service Key Performance Indicators, and

- An analysis of the key factors to evaluate the QoE of the service.

I.9 Conformity, interoperability and testing

[ITU-T Q.5024 “Protocol for providing intelligent analysis services in IMT-2020 network”](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14926) 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.9.8 Testing Internet of things

[**ITU-T Q.4069 “Testing requirements and procedures for Internet of Things based green data centres”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15046)specifies testing requirements and procedures for Internet of Things based green data centres. This Recommendation introduces testing requirements including interoperability testing requirements between platform, systems and IoT devices, functional testing requirements(e.g. testing requirement of analysis of IoT devices status) and self-optimization testing requirements (e.g. testing requirement of data quality audit), and testing procedures including interoperability testing procedure, functional testing procedure, and self-optimization testing procedure for IoT based green data centres.

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

[**ITU-T L.1034 “Adequate assessment and sensitisation on counterfeit ICT products and their environmental impact”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15023) provides awareness and guidance on counterfeit ICT products' health and environmental impacts. The intention is to create awareness and sensitisation on human health and environmental risks and measures implemented in different countries for risk mitigation.

I.12 Signalling Protocols

[**ITU-T Q.3061 “Signalling requirements for service function paths load balancing traceroute in service function chaining”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14850) 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.3406 “Signalling requirements for telemetry of virtual broadband network services”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15044) specifies the signalling requirements for telemetry of virtual broadband network services, by architecturally adding the dedicated functional component and the corresponding interfaces in NFV framework.

[**ITU-T Q.3631 “Interworking between ISDN and the IP Multimedia (IM) Core Network (CN) subsystem”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14921) 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.3646 “Framework and protocols for signalling network analyses and optimization in VoLTE”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14922): Signalling network includes the network entities and the signalling exchange which are related to telecommunications services. Analyses and optimization on signalling network are important methods for network and service-related management and operation. This Recommendation specifies the framework, interfaces, protocols, service procedures, AI/ML-assisted functions, and security considerations of signalling network analyses and optimization in the context of VoLTE network.

[**ITU-T Q.3721 “Procedures for Programming Protocol-Independent Packet Processors (p4) Switch-based vBNG”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15045) specifies the architecture, interfaces, and procedures for Programming Protocol-Independent Packet Processors (p4) Switch-based vBNG.

[**ITU-T Q.5003 “Signalling requirement and architecture for federated multi-access edge computing”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14925): 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.

I.13 Formal Languages and Identification

[**ITU-T X.672 | ISO/IEC 29168-1 (revised) “Information technology – Open systems interconnection – Object identifier resolution system”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=14780) specifies the object identifier (OID) resolution system (ORS). This enables (arbitrary) information to be associated with any ORS-supported OID node (of the international object identifier tree defined in Rec. ITU-T X.660 | ISO/IEC 9834-1). This associated information is identified by an application specification that may have a requirement for instances of that application (running on any computer system) to obtain the associated information by an ORS search, using an ASN.1 OID-IRI value to identify the node. Currently defined application information for a node includes the canonical form of an international object identifier, child node information, registration information about the owner of the node, a reference to an ASN.1 module identified by the node, information supporting tag-based applications, and information supporting cybersecurity.

[**ITU-T Z.161 (revised) “Testing and Test Control Notation version 3: TTCN-3 core language”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15091) defines Testing and Test Control Notation 3 (TTCN-3) intended for specification of test suites that are independent of platforms, test methods, protocol layers and protocols. TTCN-3 can be used for specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of Common Object Request Broker Architecture (CORBA) based platforms and application programming interfaces (APIs). The specification of test suites for physical layer protocols is outside the scope of this Recommendation. This revision of the Recommendation contains amendments, clarifications, corrigenda and editorial corrections.

[**ITU-T Z.161.1 (revised) “Testing and Test Control Notation version 3: TTCN-3 language extensions: Support of interfaces with continuous signals”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15092) defines the "continuous signal support" package of TTCN 3. TTCN 3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of Common Object Request Broker Architecture (CORBA) based platforms, testing of application programming interfaces (APIs), etc. TTCN 3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of this Recommendation.

[**ITU-T Z.161.2 (revised) “Testing and Test Control Notation version 3: TTCN-3 language extensions: Configuration and deployment support”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15093) defines the configuration and deployment support package of TTCN-3. TTCN-3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of Common Object Request Broker Architecture (CORBA) based platforms, application programming interfaces (APIs), etc. TTCN-3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of this Recommendation.

[**ITU-T Z.161.3 (revised) “Testing and Test Control Notation version 3: TTCN-3 language extensions: Advanced parameterization”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15094) defines the advanced parameterization package of TTCN-3. TTCN 3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of Common Object Request Broker Architecture (CORBA) based platforms, application programming interfaces (APIs), etc. TTCN-3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of this Recommendation.

[**ITU-T Z.161.4 (revised) “Testing and Test Control Notation version 3: TTCN-3 language extensions: Behaviour types”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15095) defines the behaviour types package of TTCN 3. TTCN 3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of Common Object Request Broker Architecture (CORBA) based platforms, application programming interfaces (APIs), etc. TTCN 3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of this Recommendation.

[**ITU-T Z.161.5 (revised) "Testing and Test Control Notation version 3: TTCN-3 Language extensions: Performance and real time testing"**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15096) defines the real-time and performance testing support package of TTCN-3. TTCN-3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of OMG CORBA based platforms, APIs, etc. TTCN-3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of this Recommendation.

[**ITU-T Z.161.6 (revised) “Testing and Test Control Notation version 3: TTCN-3 language extensions: Advanced matching”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15097) defines the support of advance matching of TTCN-3. TTCN-3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of OMG CORBA based platforms, APIs, etc. TTCN-3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of the present document.

[**ITU-T Z.161.7 (revised) “Testing and Test Control Notation version 3: TTCN-3 Language Extensions: Object-Oriented Features”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15098) defines the support for object-oriented features in TTCN-3. TTCN-3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of OMG CORBA based platforms, APIs, etc. TTCN-3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of the present document.

[**ITU-T Z.165 (revised) “Testing and Test Control Notation version 3: TTCN-3 runtime interface (TRI)”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15099) provides the specification of the runtime interface for TTCN-3 (Testing and Test Control Notation 3) test system implementations. The TTCN-3 Runtime Interface (TRI) provides the recommended adaptation for timing and communication of a test system to a particular processing platform and the system under test, respectively. This Recommendation defines the interface as a set of operations independent of target language.

[**ITU-T Z.165.1 (revised) “Testing and Test Control Notation version 3: TTCN-3 language extensions: Extended TRI”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15100) defines the extended TRI package of TTCN 3. TTCN 3 can be used for the specification of all types of reactive system tests over a variety of communication ports. Typical areas of application are protocol testing (including mobile and Internet protocols), service testing (including supplementary services), module testing, testing of CORBA based platforms, APIs, etc. TTCN 3 is not restricted to conformance testing and can be used for many other kinds of testing including interoperability, robustness, regression, system and integration testing. The specification of test suites for physical layer protocols is outside the scope of this Recommendation.

[**ITU-T Z.166 (revised) “Testing and Test Control Notation version 3: TTCN-3 control interface (TCI)”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15101) specifies the control interfaces for Testing and Test Control Notation 3 (TTCN-3) test system implementations. The TTCN-3 control interfaces (TCIs) provide a standardized adaptation for management, test component handling and encoding/decoding of a test system to a particular test platform. This Recommendation defines the interfaces as a set of operations independent of a target language. The interfaces are defined to be compatible with the TTCN-3 standards (see clause 2 of ETSI ES 201 873-6 V4.12.1). The interface definition uses the Common Object Request Broker Architecture (CORBA) Interface Definition Language (IDL) to specify the TCI completely. Clauses 8, 9 and 9.7 of ETSI ES 201 873-6 V4.12.1 present language mappings for this abstract specification to the target languages Java and ANSI C. This revision of the Recommendation contains amendments, clarifications, corrigenda and editorial corrections.

[**ITU-T Z.167 (revised) “Testing and Test Control Notation version 3: Using ASN.1 with TTCN-3”**](https://www.itu.int/ITU-T/recommendations/rec.aspx?id=15102) defines a normative way of using ASN.1 as defined in Recommendations ITU-T X.680, ITU-T X.681, ITU-T X.682 and ITU-T X.683 with TTCN-3. The harmonization of other languages with TTCN-3 is not covered by this Recommendation. This revision of the Recommendation contains amendments, clarifications, corrigenda and editorial corrections.