

Standardization Trends Related to Environmental and Operations Technologies

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Abstract

To provide sustainable and stable information and communication technology (ICT) services, the NTT Group is addressing various issues, such as standardizing indicators for application service quality, promoting network services, protecting telecommunication equipment from electromagnetic interference and lightning surges, assessing the impact of ICT on climate change, and promoting a circular economy conducive to sustainable development. This article introduces the activities and standardization trends in each of the above fields.

Keywords: quality, operations and management, environment

1. Operation of application services

To efficiently operate (design, monitor, and manage) application services, it is important to develop indicators for quality of experience (QoE) and network quality of service (QoS). This section outlines the standardization trends of indicators used for application services.

1.1 Speech-quality estimation technology (ITU-T Recommendation G.107.2)

The International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) Recommendations G.107, G.107.1, and G.107.2 were standardized as quality-planning tools for Internet Protocol (IP) telephony services respectively for narrowband (300–3400 Hz), wideband (50–7000 Hz), and super-wideband (50–14000 Hz)/fullband (20–20000 Hz) and are widely used in the quality planning of domestic and international IP telephony services. Super-wideband speech services using Enhanced Voice Services (EVS) codecs have become the mainstream, and attention is being paid to G.107.2, which defines a mathematical algorithm

that uses a number of parameters related to speech quality as input. However, G.107.2 uses default values for some parameters. To cover background noise, burst packet loss, and delay, G.107.2 has been revised by modifying the algorithm for calculating the equipment impairment factor ($I_{e,eff}$), delay impairment factor (I_d), basic signal-to-noise ratio (R_o), and simultaneous impairment factor (I_s) by adding new parameters. This revision has made super-wideband and full-band E-models suitable under a variety of conditions.

1.2 Quality-estimation and degradation-factor-analysis technologies for adaptive bitrate streaming (ITU-T Recommendations P.1203, P.1204, and P.DiAQoS)

Adaptive bitrate streaming is a video-streaming technology. It varies the quality of video that the user receives depending on the network quality. The user's QoE varies greatly depending on the quality of the video received. In response to the use of adaptive bitrate streaming, P.1203 has been formulated to define a technology for monitoring the quality of high-definition video coded using H.264/AVC

(Advanced Video Coding), and P.1204.3, P.1204.4, and P.1204.5 have been formulated as technologies for monitoring the quality of 4K video coded using H.265/HEVC (High Efficiency Video Coding) or VP9. These recommendations are being revised in response to an increase in the use of a new coding scheme, AV1 (AOMedia Video 1). As mentioned above, ITU-T Study Group 12 (SG12) is extending quality-estimation technology in response to the development of various video-coding schemes.

Recommendations P.1203 and P.1204 have been formulated to define technologies for monitoring video quality. They express QoE on a scale of 1–5. Although quality degradation can be detected from the degree of drop in the quality value, it is not possible to identify the degradation factors (e.g., quality degraded due to encoding or a stalling event). To solve this problem, SG12 is studying P.DiAQoSE to define a method for analyzing quality-degradation factors. P.DiAQoSE calculates the degree to which quality parameters (bitrate, resolution, framerate, and stalling event information) that are input to one of the models in P.1203, P.1204.3, P.1204.4, or P.1204.5 reduce quality value (impairment value). Specifically, P.DiAQoSE calculates the degree of impairment of each quality parameter by distributing the difference between the current quality value (total degradation value) and maximum quality value that can be selected for a given viewing to quality parameters on the basis of Shapley theory. In addition to using conventional quality-monitoring technologies, knowing the degradation value for each quality parameter makes it easier to study how to improve quality.

1.3 Method for estimating the object-recognition rate in autonomous driving (ITU-T Recommendation P.obj-recog)

Europe and Japan have started providing autonomous driving services assuming that vehicles are monitored at remote monitoring centers. Video captured by a vehicle-mounted camera is encoded and sent to a monitoring center. At the monitoring center, a monitoring operator checks for obstacles on the road. The quality of the video transmitted from the onboard camera must be clear enough to enable the operator to recognize objects. To develop a technology for constantly monitoring whether the transmitted video is clear enough for object recognition, ITU-T SG12 launched a new work item (P.obj-recog). This technology will be developed on the basis of the results of subjective assessment experiments on object recognition using videos from onboard cameras.

1.4 Summary

Certain indicators are needed to operate application services efficiently. This section outlined the technologies that contribute to the operation of speech communication, video streaming, and autonomous driving services. For future services, it is important to develop indicators and use them in actual operations. Therefore, we need to keep abreast of the standardization trends in this field.

2. Standardization trends in TM Forum

2.1 What is TM Forum?

The original aim of TM Forum was to standardize the operations and management of telephone networks, ensuring stable provision of telephone services in each country. However, TM Forum has been working in cooperation with other industries on projects aimed at promoting network services. It has over 850 member companies mainly in the telecommunications and information technology (IT) industries.

TM Forum has set five key themes: Cloud Native IT & Networks, Data & AI, Autonomous Operations, Ecosystems, and People & Planet and is currently working on the following 18 projects:

- End-to-end ODA Project
- Information Systems Architecture Project
- Components and Canvas Project
- Open APIs Project
- AI Governance Project
- Data Governance Project
- Autonomous Network Project
- AI Closed Loop Automation Project
- AI Operations (AIOps) Project
- Measuring and Managing Autonomy Project
- Digital Twin for Decision Intelligence Project
- Business Architecture Project
- Business Assurance Project
- Digital Ecosystem Management Project
- Standardizing Wholesale Broadband - Fibre Access (BFA) Project
- Digital Maturity Model Project
- Customer Experience Management Project
- TechCo Organizational Design Project

NTT is pursuing digital transformation (DX) and IOWN (Innovative Optical and Wireless Network)/Cognitive Foundation. We believe that the key drivers in these efforts are speeding up service provision by using business support systems (BSS) and operation support systems (OSS) that comply with standards, providing network services on the basis of abstract customer requirements, and creating organizations,

including staffing, that are suitable for the DX era. From these perspectives, this section describes trends in the following four projects.

2.2 Components and Canvas Project

Conventional BSS/OSS architectures assume a telephony service. To develop architectures and frameworks capable of supporting various forms of business, TM Forum is discussing Open Digital Architecture (ODA) and Open Digital Framework (ODF). Specifically, TM Forum is defining an ODA that can support collaborations with other business partners, diversification of customer experience (CX), and dramatic enhancement of operations using artificial intelligence (AI), etc. This ODA has the following functions:

- **Engagement Management:** management designed to support the functional part that serves as points of contact with customers and operators and to enhance CX.
- **Party Management:** management of relationships with stakeholders, such as personnel involved and procurement partners in the B2B2X (business-to-business-to-x) business model.
- **Core Commerce Management:** management of customers and products (corresponding to the BSS domain).
- **Production:** management of end-to-end services and resources, including networks (corresponding to the OSS domain).
- **Intelligence Management:** management domain for AI technology, etc. to achieve a closed loop in each management domain.

TM Forum is currently studying the ODF, which uses tools and maturity models, as a framework to achieve the ODA. Specifically, TM Forum is studying the utilization and mapping of business processes (enhanced Telecom Operations Map (eTOM)), applications (Telecom Application Map (TAM)), and an information model (Shared Information/Data Model (SID)), which it has specified earlier. eTOM is used as business requirements for constructing ODF systems, SID as information systems, and TAM as transformation tools.

2.3 Autonomous Network Project

The Autonomous Network Project aims to achieve autonomous/automated operations of networks. In collaboration with organizations, such as the 3rd Generation Partnership Project (3GPP), the European Telecommunications Standards Institute (ETSI),

Zero Touch Network and Service Management (ZSM), and Experiential Networked Intelligence (ENI), TM Forum is discussing the implementation architecture and model and application programming interfaces (APIs) for autonomous/automated operations of networks. TM Forum aims to enable an autonomous network by dividing the overall architecture into a business-operation layer, service-operation layer, and resource-operation layer and link the management layers of these three layers. It seeks to achieve an autonomous network step by step by defining levels of automation achieved from L0 to L5. The level of automation can be raised from manual to automatic from different aspects, such as execution, cognition, analysis, and decision making. In addition, the definition of the level of automation is conceived in such a way that autonomous/automated operations are achieved by stepping up each of the intent and application aspects from manual to automatic. One of the project's latest discussion topics is the study of a tool for quantitatively evaluating the level achieved of each company's autonomous network. The architecture of the autonomous network is designed in such a way that a closed loop is created in each of the business, service, and resource operations layers. The aim with this architecture is to automate each management layer in an optimal manner and achieve globally optimized autonomous operations by linking the closed loops of the three layers. The goal with the closed loop of each layer is defined as "intent," and the intent is used as the key to link the layers of the autonomous network. Using the intent in this manner is now attracting attention. There are intense discussions on the required APIs and information models and many documents are being compiled in preparation for standardization.

2.4 Digital Ecosystem Management Project

Connectivity as a Service (CaaS) is defined as a form of service in which users of a network service specify only the starting and ending points and the network characteristics they require, and the service is provided using network slicing, etc. Users of CaaS may not have specific requirements regarding the routes in the network or may have no knowledge about routes in the network. CaaS is implemented by defining such user requirements, some of which may be ambiguous, as the intent, deriving a specific network configuration by combining the available services, then providing the service. The API for CaaS is being studied with the aim of compiling a document that summarizes the API requirements by the end of

FY2023. To provide CaaS, it is necessary to derive a specific service from the user's order that includes ambiguous requirements. Therefore, this project is studying a method for incorporating elements of the intent being studied for the Intent Management API and a method for using the intent as a means of providing network slicing.

2.5 TechCo Organizational Design Project

The TechCo Organizational Design (TCOD) Project is studying ways to ensure that the culture and skills of an organization and its operators continuously evolve along with the progress of DX. This project is compiling documents that describe the Digital Talent Maturity Model and TechCo Organizational Design. Therefore, it is important not only to discuss systems, such as BSS and OSS, as has been done conventionally, but to also ensure that communication service providers continuously and appropriately evolve their organizational culture. The TCOD Project aims to standardize best practices and guidelines that are based on the above perception.

2.6 Summary

In parallel with the above projects, TM Forum focuses on assessing the effectiveness of standard specifications and creating new requirements and businesses through a proof of concept and a technical demonstration called "Catalyst Project." TM Forum accelerates the use of standardization in actual business through both discussions on standard documents and technical demonstration.

3. Standardization trends related to environment, climate change, and circular economy

ITU-T SG5 aims to develop standards that contribute to enhancing the reliability of telecommunication services and reducing the environmental impact of business activities by protecting telecommunication facilities from electromagnetic interference and lightning surges, evaluating the impact of ICT on climate change, and addressing issues surrounding a sustainable circular economy. For these purposes, SG5 created three Working Parties. Working Party 1 focuses on electromagnetic compatibility (EMC) and electromagnetic exposure. Working Party 2 considers eco-efficiency, e-waste, circular economy, and sustainable ICT networks. Working Party 3 is focused on adaptation to and mitigation of climate change, e-waste, and net zero emissions.

3.1 EMC, lightning protection, and human-body exposure to electromagnetic fields

SG5 Question 1 investigates requirements for protecting telecommunication systems against lightning strikes and overvoltage to ensure electrical protection, reliability, safety, and security of ICT systems. Question 1 also considers revisions to the existing recommendations and supplementary documents related to soft errors in telecommunication equipment caused by particle radiation. This Question aims to develop recommendations for ensuring electromagnetic security in telecommunication equipment, including methods for protecting equipment against high-altitude electromagnetic pulse and high-power electromagnetic attacks as well as methods for evaluating and reducing risk of information leakage via electromagnetic waves. Question 2 examines requirements for protecting telecommunication systems against overvoltage and overcurrent as well as protective devices to protect equipment and devices against lightning and other electrical events. Question 3 examines procedures, calculation methods, and measurement methods for estimating the electromagnetic field strength around antennas to protect the human body from electromagnetic radiation fields emitted by mobile phones and wireless systems. Question 4 studies EMC issues in ICT environments, including the development of EMC standards for new telecommunication equipment, telecommunication services, and wireless systems.

3.2 Eco-efficiency, e-waste, circular economy, and sustainable ICT networks

Question 6 identifies the environmental efficiency requirement of digital and frontier technologies. It focuses on studying technical solutions, enhancements, metrics, key performance indicators, and related accurate measurement methods and reference values for different type of technologies. Question 7 seeks to address the e-waste challenges by identifying the environmental requirements of digital technologies including Internet of Things, end-user equipment, and ICT infrastructures or installations on the basis of the circular economy principles and improving supply-chain management. Question 13 aims to develop recommendations, supplements, and/or technical reports identifying requirements and providing guidance, innovative frameworks, and tools for the use and operation of digital technologies (i.e., AI, 5th-generation mobile communication systems (5G), etc.) in cities and communities that support the transition to a circular city. It also aims to develop

metrics and key performance indicators that establish a baseline scenario of circular cities and communities.

3.3 Adaptation to and mitigation of climate change, and net zero emissions

Question 9 aims to develop assessment methodologies and guidance that allow the objective, transparent, and practical assessments of the sustainability impact of digital technologies, including ICT, AI, and 5G, to align their developmental trajectories with the Paris Agreement and United Nations Sustainable Development Agenda. Question 11 seeks to develop standards, guidelines, and measurement frameworks that support the development of a smart energy system and applying smart energy solutions to achieve a low-carbon economy. This Question aims to develop recommendations, supplements and/or technical reports on real-time energy service and control solutions for more effective and efficient energy management through ICT and digital technologies. Question 12 aims to develop recommendations, supplements, and/or technical reports that support the deployment

of digital technologies in accelerating climate-adaptation actions. This Question would improve the efficiency of power and cooling systems in ICT networks, support the development of energy-efficient ICT architectures such as up to 400 VDC power feeding systems, add energy saving features to ICT equipment and applications, improve air-flow-controlling technology, cooling technology and renewable energy systems, and more.

3.4 Summary

The subjects that are attracting attention in the field of ICT in ITU include electromagnetic effects of solar flares, methods for improving and evaluating energy efficiency at datacenters and 5G base stations, and supply-chain management and digital passports for achieving a circular economy. More general environmental management systems and environmental impact assessment are being studied by the International Organization for Standardization (ISO), and energy management systems and environmentally conscious design are being studied by the International Electrotechnical Commission (IEC).



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