Standardization Activities on Future Networks in ITU-T SG13

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Abstract

ITU-T SG13 is one of the study groups of the Telecommunication Standardization Sector of the International Telecommunication Union, which is responsible for developing the concept of Future Networks. Its technical area includes, but not limited to, network slicing, machine learning, and quantum key distribution. This article introduces the history of Future Networks studies and recent topics.

Keywords: Future Networks, IMT-2020, quantum key distribution

1. Introduction

ITU-T SG13 is one of the study groups in the Telecommunication Standardization Sector of the International Telecommunication Union. It is responsible for developing the requirements and architecture of Future Networks. It has recently developed the recommendations on emerging network technologies such as network slicing and quantum key distribution. One of the unique features of SG13 is the diverse participation of experts around the globe, which includes not only Europe, North America, and Asia but also Africa, which promotes collaboration through SG13 Regional Group for Africa. Diverse views based on global participation are considered in creating recommendations. SG13 was well known as a place to develop a set of recommendations on Next Generation Networks (NGNs). However, as NGNs becomes mature, it is focusing more on academic subjects to try to attract more attention of industry experts. SG13 is going to play an important role in making such academic subjects more practical for industries.

2. Standardization history of Future Networks

Figure 1 shows a brief history of the standardization of Future Networks in ITU-T SG13. The study of Future Networks dates back to 2009. At that time, most standardization activities on NGNs had completed, and SG13 was considering a new vision of networks beyond NGNs. To promote this vision, SG13 established the Focus Group (FG) on Future Networks, which allows the participation of experts of non-ITU-T members including academic organizations. ITU-T Recommendation Y.3001 (objectives and design goal of Future Networks) was developed on the basis of the results of this activity. Y.3001 is not a technical specification that is implementable as a product or service but identifies four important aspects of Future Networks, i.e., service awareness, data awareness, environmental awareness, and socio/economic awareness. Instead of traditional standardization activities, it focuses on the vision and goal rather than implementable specifications to achieve interoperability among different components/devices/systems. This recommendation is referred to in various new network standardization activities due to this unique feature.

Non-radio parts of mobile networks have been an important study area in SG13 for many years. Contrary to FG Future Networks, which studied the high level concept of Future Networks, as mentioned above, FG IMT (International Mobile Telecommunication)-2020, which was established by SG13 to study non-radio parts of IMT-2020 (the ITU-defined generation of mobile networks corresponding to fifth-generation (5G)), studied more practical technical solutions such as network softwarization. To avoid potential overlap regarding study efforts with

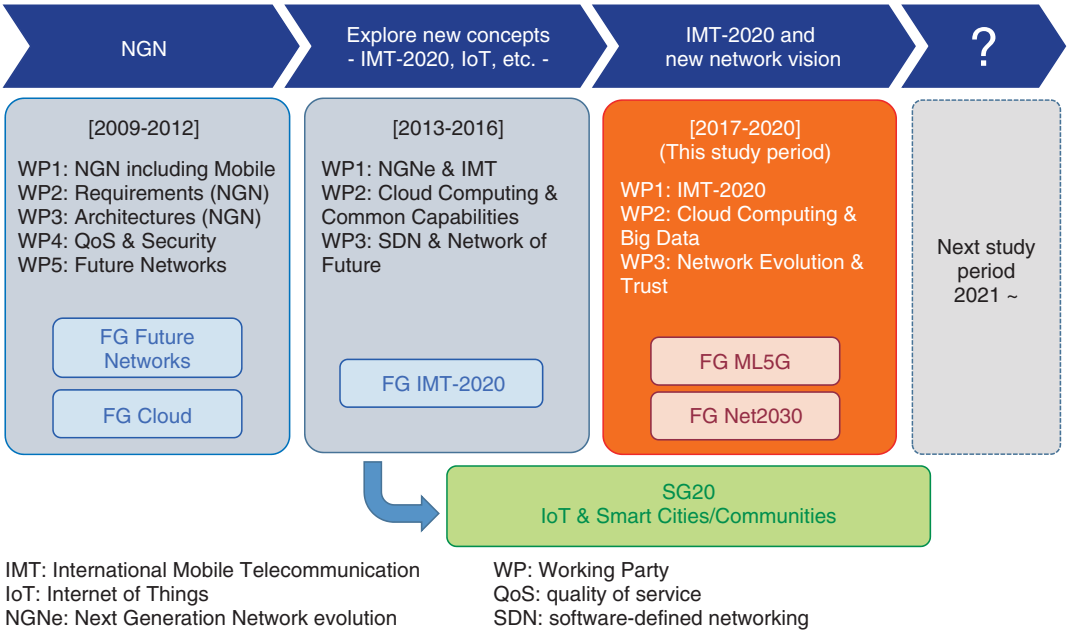


Fig. 1. History of study subjects in SG13.

the 3rd Generation Partnership Project (3GPP), which plays a central role in developing technical specifications for mobile networks to be implemented by industry players, FG IMT-2020 conducted a gap analysis to identify relevant areas before it started actual standardization. The results of this FG were transferred to the questions of Working Party (WP)1 of SG13, and a series of recommendations, such as Y.3150 (high level technical characteristics of network softwarization for IMT-2020), were produced.

As the study on IMT-2020 becomes mature, the study focus has shifted to more advanced features based on the network architecture of IMT-2020. SG13 established two FGs, FG ML5G (Focus Group on Machine Learning for Future Networks including 5G) and FG-Net2030 (Focus Group on Technologies for Network 2030), which are, for example, working on possible applications of artificial intelligence/machine learning (AI/ML) and a new network vision for 2030.

3. Recent study subjects

The following topics are being studied in SG13.

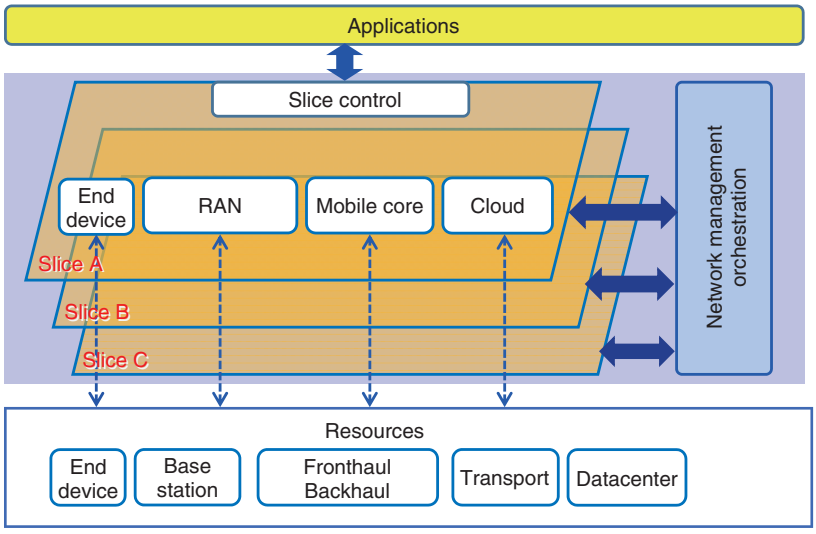
3.1 Network softwarization and IMT-2020

Network softwarization is a technical approach for designing, implementing, deploying, managing, and maintaining network equipment and/or network components by using software programming. As **Figure 2** shows, a typical use case of network softwarization is to virtualize various network components, such as base station fronthaul and mobile core, and produce a network slice collecting these virtualized components. SG13 produced a basic concept of network slicing to be applied to IMT-2020, while 3GPP studied network slicing to create a set of implementable specifications.

The domestic discussion of network softwarization for preparing the contributions for SG13 was conducted in 5GMF (The Fifth Generation Mobile Communications Promotion Forum). Japanese experts play a leading role in the study of network softwarization including the responsibility as rapporteur for Question 21, which is mandated to address this issue. A series of recommendations, such as Y.3150 mentioned above, Y.3151 (software-defined networking parts including fronthaul), and Y.3154 (resource pooling for network slice management), have been produced.

3.2 Cloud computing

The study on cloud computing was started by FG Cloud (Focus Group on Cloud Computing) established in 2020. Historically, so-called de facto standards prevailed over de jure standards including



RAN: Radio Access Network

Fig. 2. Concept of network softwarization.

ITU-T recommendations in the computing industry. Therefore, particular consideration should be made in terms of standardization strategy for ITU-T to have influential outcomes. SG13 has been attempting to establish a collaborative relationship with other standard bodies that are more influential than ITU-T. Even though the influence of de jure standard bodies is limited, ITU-T could play a role in specific issues such as terminology and reference architecture. SG13 established two collaborative teams with ISO/IEC JTC1* Subcommittee 38 Working Group 3 to jointly address these issues. The outcomes of this collaboration resulted in ITU-T Recommendations Y.3500 (terminology of cloud computing) and Y.3502 (reference architecture of cloud computing).

Japanese experts focus on the system called "inter-cloud," which combines cloud computing and a wide area network connecting different datacenters. An overview of the inter-cloud is given in ITU-T Recommendation Y.3511 (framework of inter-cloud) to which Japanese experts contributed and played a leading role.

The cloud study in SG13 is moving to big-data-related subjects running on clouds rather than the cloud itself. The current structure of big data in the industry is the silo type structure in which dominant players collect and manage their own big data. The model studied in SG13 is more horizontally federated among different players with specific roles. A set of recommendations of the Y.3600 series describe this issue.

3.3 AI/ML

AI/ML is one of the hottest topics in this industry. SG13 started AI/ML-related activities through FG ML5G, which was established to consider possible applications of AI/ML in networks. The initial target of AL/ML study was automation of network management. Similar activities are being conducted in the European Telecommunications Standards Institute (ETSI) (e.g. ZSM-ISG (Industry Specification Group (ISG) Zero Touch Network and Service Management), and SG13 liaises with these groups. FG ML5G, which was established in 2018, concluded its activities in June 2020 and submitted the deliverables to SG13. Further discussions including development of ITU-T recommendations will progress in relevant questions such as Question 20.

The basic architecture of ML studied in FG ML5G is described in ITU-T Recommendation Y.3172 (architecture framework for machine learning in future networks including IMT-2020). The architecture in Y.3172 contains two different environments, i.e., sandbox in which an ML algorithm learns using a simulator and pipeline in which the algorithm is applied in an actual management task (**Fig. 3**).

* ISO/IEC JTC1: International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1

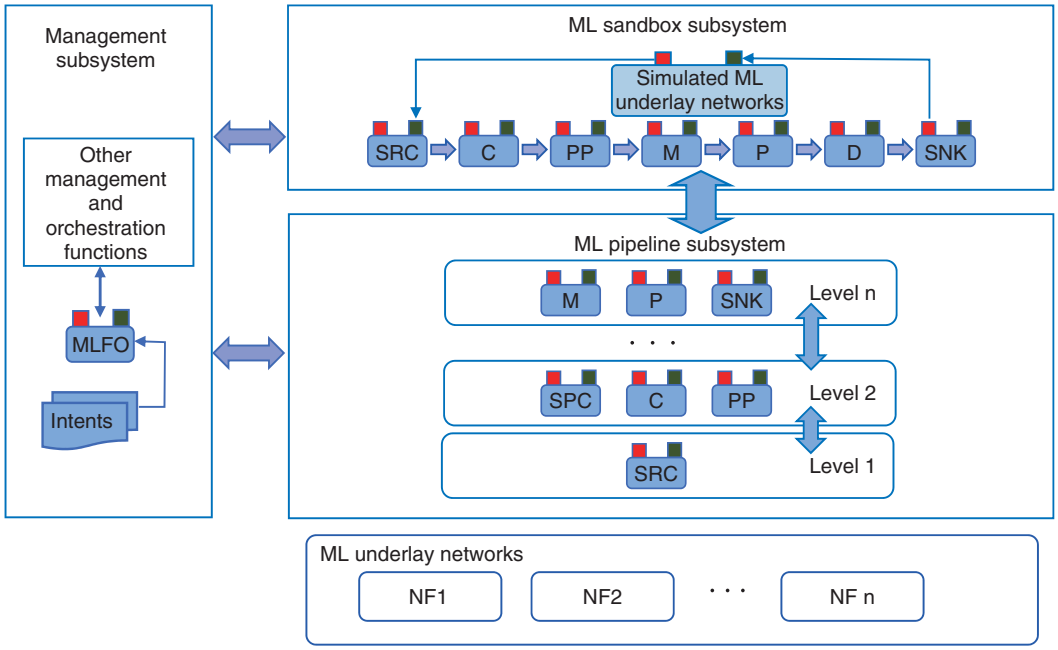


Fig. 3. Machine learning architecture in Y.3172.

Big data, which is being studied in SG13 in the context of cloud computing, would be applicable to AI/ML. Questions 17, 18, and 19 working on big data will join the AI/ML-related activities.

3.4 Quantum key distribution

Quantum key distribution is a system to distribute encryption keys to remote nodes in a secure manner by using quantum physics. Quantum key distribution is becoming mature for small-scale deployment including commercial services for specific applications. Question 16 has been working on networks for quantum key distribution since 2018.

It is not possible to provide quantum key distribution over a long-distance fiber network due to attenuation of optical signals on the fiber. The distance between nodes of quantum key distribution is not more than 100 km, even with the latest techniques. This imposes constraints on the design of large-scale networks such as nation-wide and global networks. The architecture being studied in SG13 introduces intermediate nodes that are placed in secure locations such as central offices of a telecom carrier (**Fig. 4**). This allows the provision of long-distance key distribution beyond the limitation of quantum key distribution without intermediate nodes.

In principle, quantum key distribution provides the capability of sharing only a small amount of data, such as an encryption key, rather than a huge volume of data such as audio, video, and text. Therefore, quantum-key-distribution networks are assumed to provide enhanced security for communication applications on traditional networks. How quantum key distribution networks and traditional networks work together is an important subject of standardization, and SG13 is working on this issue.

There are other areas of quantum-related information and communication technologies such as quantum computing. ITU-T established FG QIT4N (Focus Group on Quantum Information Technology for Networks) to promote studies in these areas.

3.5 Network 2030

FG Net2030, which was proposed by a Chinese company, was established to promote study on the network vision called “Network 2030,” which will be achieved in 2030. Network 2030 supports emerging applications, such as holographic-type communications and tactile internet, which will not be available for current network technologies. In this work, a new

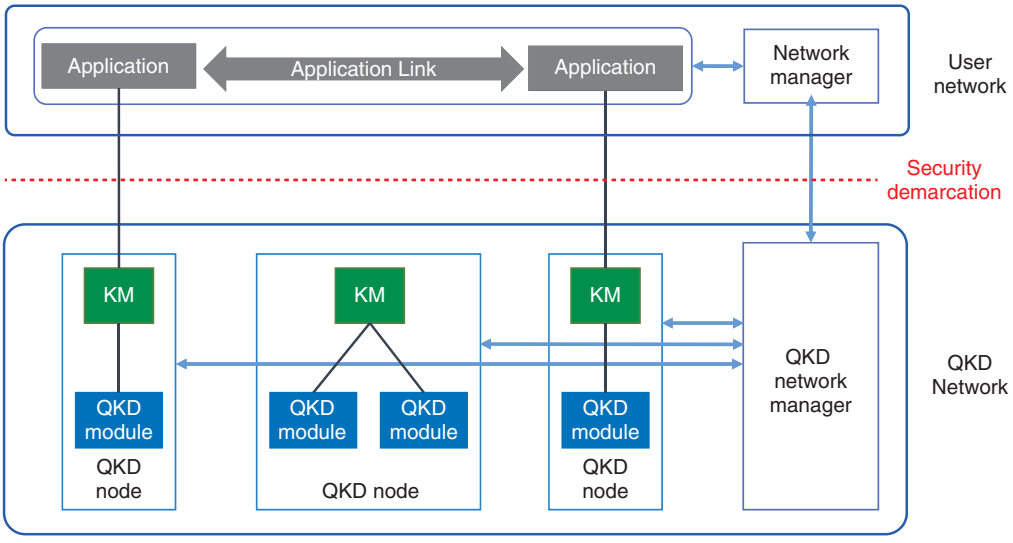


Fig. 4. Conceptual structure of quantum key distribution network.

network technology called "New IP" was proposed. Although the relationship of New IP and a set of Internet Protocol (IP)-based network technologies is not yet clear, this stimulated a significant political discussion on whether ITU-T should handle IP-related technologies. One party of the discussion expressed their concern of New IP, stating that IP-related technologies should be discussed using the multi-stakeholder approach and that the Internet Engineering Task Force (IETF) rather than ITU-T should be responsible for this study. The proponent responded that the proposed study items do not overlap with the current work items in IETF, and ITU-T can conduct the proposed study items. The proponent also proposed to change the name from "New IP" to "Future Vertical Communication Networks" to avoid misunderstanding. The discussion on this new study subject is still continuing.

4. Conclusion

SG13 played a central role in the standardization of NGN architecture. It is now exploring new areas for Future Networks, such as network slicing, AI/ML, and quantum key distribution. Although the role of SG13 as an organization to produce implementable standards for the telecommunication industry is becoming weak, it is still developing emerging network technologies and concepts. We, the management team of SG13, wish to make SG13 a place of bridging academic study and industrial standardization, which is a unique role in the global standardization community.

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He received a B.E. and M.E. in applied physics from Tohoku University, Miyagi, in 1992 and 1994. He joined NTT Basic Research Laboratories in 1994 and has been researching and developing cable television systems, Internet protocol television (IPTV), and machine-to-machine technology. He has been engaged in the standardization of IPTV in ITU-T as a member of the IPTV Focus Group and Global Standards Initiative since 2006. He has also served as Rapporteur of Question 11 of ITU-T SG9, Questions 5 and 25 of ITU-T SG13, and Question 21 of ITU-T SG16. He has been a vice-chair of ITU-T SG13 since 2013. He is a member of the Institute of Electronics, Information and Communication Engineers.