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| ITU‑T Study Group 13 |
| Future networks, with focus on IMT-2020, cloud computing and trusted network infrastructures |
| Report of ITU-T SG13 to the World Telecommunication Standardization Assembly (WTSA-20), Part II: Questions proposed for study during the next study period (2022-2024) |

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| **Abstract:** | This contribution contains the text of the Study Group 13 Questions proposed for approval by the Assembly for the next study period. |
| **Contact:** | Mr Leo LehmannChairman ITU-T SG13Switzerland | Tel: +41 32 327 5752Email: Leo.Lehman@bakom.admin.ch |
| **Contact:** | Mr Yoshinori GotoActing Chairman ITU-T SG13NTT Japan | Tel: +81-422-59-6489Email: yoshinori.gotou.zr@hco.ntt.co.jp |

Note by the TSB:

The report of Study Group 13 to the WTSA-20 is presented in the following documents:

Part I: **Document 13** – General

Part II: **Document 14** – Questions proposed for study during the study period 2022-2024

# 1 List of Questions proposed by Study Group 13

| Question number | Question title | Status |
| --- | --- | --- |
| A/13 | Networks beyond IMT2020: Quality of service (QoS) mechanisms | Continuation of Q6/13 |
| B/13  | Networks beyond IMT-2020 and machine learning: Requirements and architecture | Continuation of Q20/13 |
| C/13 | Networks beyond IMT-2020: Network softwarization | Continuation of Q21/13 |
| D/13 | Networks beyond IMT2020: Emerging network technologies | Continuation of Q22/13 |
| E/13 | Networks beyond IMT2020: Fixed, mobile and satellite convergence | Continuation of Q2313 |
| H/13 | Future Networks: Deep packet inspection and network intelligence | Continuation of Q7/13 |
| I/13 | Future Networks: Requirements and capabilities for computing including cloud computing and data handling | Continuation of Q17/13 |
| J/13 | Future Networks: Functional architecture for computing including cloud computing and data handling | Continuation of Q18/13 |
| K/13 | Future Networks: End-to-end management, governance, and security for computing including cloud computing and data handling | Continuation of Q19/13 |
| L/13 | Applying Future Networks and innovation in developing countries | Continuation of Q5/13  |
| M/13 | Future Networks: Trustworthy and Quantum Enhanced Networking and Services | Continuation of Q16/13 |
| N/13 | Future Networks: Innovative service scenarios, including environmental and socio economical aspects | Continuation of Q1/13 |

# 2 Wording of Questions

DRAFT QUESTION A/13

Networks beyond IMT2020: Quality of service (QoS) mechanisms

(Continuation of Question 6/13)

## A.1 Motivation

A key characteristic of existing and emerging networks is the use of a smart transport including its softwarization/virtualization for supporting applications and services with varied QoS/QoE requirements, all of which must be supported by this smart transport. Appropriate mechanisms are needed to achieve the required levels of QoS/QoE, especially for applications that are latency- and loss-sensitive. Some applications may also require a large amount of bandwidth and strict quality assurance, which makes the support for QoS/QoE challenging, in particular under a softwarized/virtualised network environment.

To support QoS/QoE in a consistent, efficient, dynamic and secure fashion, considerations need to be given to the following:

– end-to-end qos/qoe assurance and application specific qos requirements

– use of varied types of transport technology in the core network, in the access network,
in endpoints and multiple administrative domains in an end-to-end path

– network resource optimization and orchestration for qos/qoe enablement

– use of ai/machine learning mechanisms

– application and qos/qoe mapping and its automation

– qos assurance mechanisms for vertical sector applications

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– ITU-T Y.3106, Y.3107, Y.3170, Y.3175

## A.2 Question

Study items to be considered include, but are not limited to:

– What new Recommendations or enhancements to existing Recommendations are needed to enable QoS/QoE support in the softwarized/virtualized networks, especially for performance-sensitive and bandwidth-demanding applications/services?

– What new Recommendations or enhancements to existing Recommendations are needed to enable QoS/QoE support in networks beyond IMT2020?

– What new Recommendations or enhancement to existing Recommendations are needed for AI/machine learning based QoS/QoE assurance mechanisms?

– What new Recommendations or enhancements to existing Recommendations are needed to support QoS assurance for vertical sector applications?

– What new Recommendations or enhancements to existing Recommendations are needed to support QoS assurance for QKDN?

– What new Recommendations are needed to provide optimal resource control and management for achieving end-to-end QoS in a heterogeneous environment involving different QoS mechanisms, network orchestrations, and multiple provider domains?

– What new Recommendations or enhancement to existing Recommendations are needed for QoS/QoE support for providing energy savings?

– What guidance is needed for ensuring that QoS/QoE matters raised by other Questions in Study Group 13 are addressed satisfactorily?

**NOTE −** Question will not overlap with existing works in SG12, SG16, SG20 and other SDO's (e.g. IETF and 3GPP)

## A.3 Tasks

Tasks include, but are not limited to:

– Maintenance and update of the Recommendations on QoS/QoE in SG13.

– Development of new Recommendations or enhancement to existing Recommendations on QoS/QoE support for resource control and management for softwarized/virtualized networks.

– Development of new Recommendations or enhancement to existing Recommendations on QoS/QoE support in networks beyond IMT2020.

– Development of new Recommendations or enhancement to existing Recommendations on AI/machine learning based QoS/QoE assurance mechanisms.

– Development of new Recommendations or enhancements to existing Recommendations which are needed to support QoS/QoE assurance for vertical sector applications.

– Development of new Recommendations or enhancement to existing Recommendations on QoS/QoE support in QKDN.

– Development of new Recommendations or enhancement to provide the optimal resource control and management for achieving end-to-end QoS in a heterogeneous environment involving different QoS mechanisms, network orchestrations, and multiple provider domains.

– Development of new Recommendations or enhancement to existing Recommendations on additional QoS parameters measurement and monitoring.

– Guidance and collaboration to/with other Questions on QoS/QoE matters, especially to a potential new Question(s).

An up-to-date status of work under this Question is contained in the SG13 Work Programme:
<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=6/13>

## A.4 Relationships

Recommendations:

– Y-series in SG13

– G-series in SG12

Questions:

– All Questions involved with networks beyond IMT2020

Study groups:

– All Study Groups involved with networks beyond IMT2020

Other bodies:

– 3GPP

– ATIS CSF, IIF, PTSC and PRQC

– Broadband Forum

– ETSI NFV ISG

– ETSI INT AFI

– IEEE 802 LAN/MAN

– IETF

– ODL

– ONF

– ONOS

WSIS Action Lines

– C2

Sustainable Development Goals

– 9

DRAFT QUESTION B/13

Networks beyond IMT-2020 and machine learning: Requirements and architecture

(Continuation of Q20/13)

## B.1 Motivation

The objective of this question is to study the requirements, architecture and use of technologies including artificial intelligence (AI)/machine learning (ML) to realize networks beyond IMT-2020, in order to address the anticipated needs of network and application services in the upcoming years.

Network requirements and architecture for IMT-2020 networks have been baselined and successful deployments have been reported since its inception in the early 2010s. The next generation of IMT networks (following IMT-2020 networks) is already under study in many countries. Considering that a new generation network is commercialized around every 10 years, the next generation of IMT networks is expected to be deployed around 2030. It is the right time to study the requirements and architecture of networks beyond IMT-2020.

IMT-2020 has gone through several major paradigm shifts in network technologies such as the adoption of network slicing and service-based architecture. However, there are still many aspects to improve in the current architecture. An evolutionary approach can be sought on the current generation of IMT networks to address some remaining issues. A network is not a simple packet delivery system anymore; it is becoming a neural system of our society. To meet the requirements and derive necessary architecture enhancements, consideration should be given to key aspects of networks beyond IMT-2020.

Integration of AI/ML applications is also regarded as one of the key architectural aspects to consider for networks beyond IMT-2020. The complexity coming from distributed architecture and heterogeneous nature of use cases makes it imperative to study the service requirements and overheads related to the AI/ML applications. A comprehensive study of the impact, KPIs and evaluation of AI/ML applications is a must for the design of network architecture. The study should also include test methodologies and deployment guidelines for AI/ML applications in the networks.

In summary, this question focuses on the study of the requirements, architecture and use of technologies including AI/ML to realize networks beyond IMT-2020.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– Y.3100, Y.3101, Y.3102 and Y.3104

– Y.3172, Y.3173 and Y.3174

## B.2 Question

Study items to be considered include, but are not limited to:

– What are the key requirements and capabilities of networks beyond IMT-2020 including AI/ML based on the emerging service scenarios?

– What framework and architecture are required to realize networks beyond IMT-2020 including AI/ML based on the identified requirements and capabilities?

– What key technologies related to networks beyond IMT-2020 including AI/ML are required to realize the networks?

– How to incorporate network intelligence from AI/ML into networks beyond IMT-2020?

– How to build and/or guide the ecosystem on networks beyond IMT-2020 including AI/ML taking into account business models and use cases?

– How to utilize and guide the open source software activities related to networks beyond IMT-2020 and AI/ML to meet the requirements of the networks?

## B.3 Tasks

Tasks include, but are not limited to:

– Development of Recommendations on the requirements and capabilities for networks beyond IMT-2020 including AI/ML based on the emerging service scenarios.

– Development of Recommendations on the framework and architecture design of networks beyond IMT-2020 including AI/ML, based on, not limited to, the above identified requirements, capabilities and gap analysis identified by Focus Group on Machine Learning for Future Networks including 5G.

– Development of Recommendations and other relevant documents on overall requirements and functional architecture of networks beyond IMT-2020 including AI/ML.

– Development of Recommendations on the interworking of networks beyond IMT-2020 with current networks including IMT-2020 networks.

– Study of potential utilization and guide of open source software activities in networks beyond IMT-2020 and AI/ML.

– Development of Recommendations on ecosystem aspects taking into account business models and use cases.

An up-to-date status of work under this Question is contained in the SG13 Work Programme.
<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=20/13>

## B.4 Relationships

Recommendations:

– Y-series in SG13

Questions:

– All SG13 related Questions, including Q6/13, Q16/13, Q21/13, Q22/13, Q23/13

Study Groups:

– ITU Study Groups involved with IMT-2020 studies

Other bodies:

– ITU-R

– 3GPP

– NGMN

– IETF

WSIS Action Lines

– C2

Sustainable Development Goals

– 9

DRAFT QUESTION C/13

Networks beyond IMT-2020: Network softwarization

(Continuation of Question 21/13)

## C.1 Motivation

The recent continuous change of digital technologies on networking closely influence on various aspects of human life (e.g., industrial control, self-automated driving, time critical and high reliability communications, and cloud-based services). New types of networks are emerging or becomes closer to practical usage with trend of the times.

Network softwarization is an overall approach for the design, deployment, control, management and orchestration of network components by software, and exploits flexibility, dynamicity and rapidity of networking. The characteristics of network softwarization have high affinity with the realization of new scenarios and requirements in various business and social fields.

Key technologies include SDN/NFV and data plane programmability supporting network slicing and orchestration, and have been studied in Y.3000, Y.3100 and Y.3300 series.

The Recommendations that specifies framework, service scenarios, requirements, and architecture of network softwarization in networks beyond IMT-2020 fall under the responsibility of this Question.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– ITU-T Y.2242, Y.2305, Y.3110, Y.3111, Y.3112, Y.3150, Y.3151, Y.3152, Y.3153,Y.3154, Y.3324.

## C.2 Question

Study items to be considered include, but are not limited to:

– What are the requirements and architecture of SDN/NFV and data plane programmability to support functions such as network virtualization and network slicing necessary for exploding and diversifying services taking into account traffic controlling, time sensitivity, scalability, reliability, security and distribution of functions?

– What are the requirements and architecture of management and orchestration, related management-control continuum capability of softwarized networks and network slices, taking into account operational efficiency, energy saving, high efficient resource utilization and others?

– What are the gaps in standardization effort for network softwarization as well as in open source activities?

– What are key technology enablers to enhance network softwarization in both public telecommunications including satellite communications and private communication networks (e.g., private 4G/5G network) specific to vertical industry services or applications?

– How to enhance network softwarization by using AI techniques to support network automation?

– What new business models are available with the advent of digital transformation by using techniques of network softwarization, network management and orchestration?

– How to handle, evaluate and measure network parameters for softwarization including network slice to guarantee a measurable service level over homogeneous or heterogeneous networks？

## C.3 Tasks

Tasks include, but are not limited to:

– Considering open source activities, development and maintenance of Recommendations on requirements, functional architecture and mechanisms for network softwarization including generic SDN and their profiles for intent-based networking, network virtualization, network slicing, NFV and virtualized network applications supporting service requests over versatile kinds of networks;

– Development of Recommendations on the management and orchestration of homogenous/heterogeneous types of softwarized infrastructure in both public and private networks;

– Development of Recommendations on the capability in support of network softwarization by using enhanced APIs and AI-assisted functionalities;

An up-to-date status of work under this Question is contained in the SG13 Work Programme: <https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=21/13>

## C.4 Relationships

Recommendations

* Y-series in SG13

Questions

* All Questions relating to network softwarization

Study Groups

* ITU-T and ITU-R Study Groups involved in the IMT-2020 network and networks beyond IMT-2020 studies

Standardization bodies

* ETSI
* ONF
* 3GPP
* IETF/IRTF
* TMF
* BBF
* GSMA
* 5GSA
* Open-source activities involved in SDN including network virtualization, network slicing and orchestration studies

WSIS Action Lines:

* C2

Sustainable Development Goals:

* 9

DRAFT QUESTION D/13

Networks beyond IMT2020: Emerging network technologies

 (Continuation of Question 22/13)

## D.1 Motivation

The objectives of this Question are: (1) to study the enhancement of data-aware networking (DAN) including information-centric networking (ICN), and future packet-based network (FPBN) including public telecommunication data network (PTDN), (2) to study the application and deployment of DAN/ICN, FPBN/PTDN, and other emerging network technologies for network services, such as Industrial networks, in networks beyond IMT-2020.

The volume and diversity of data generated by network and application services are expected to continuously increase in the coming years. The handling of these generated data by networks beyond IMT-2020 will impose diverse network requirements such as high data rates, low latency, and low energy consumption. Given that these requirements are difficult to be supported using conventional host-centric, location-based and client-server architectural approaches [ITU-T Y.3001], DAN/ICN and FPBN/PTDN appear to be promising candidate solutions to be studied. During the study of these DAN/ICN and FPBN/PTDN solutions, consideration will also be given to how existing or emerging technical means as distributed ledger /blockchain, or network slicing and orchestration can be taken into account.

In summary, this Question focuses on the study of the enhancement and application of DAN/ICN and FPBN/PTDN.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– ITU-T Y.3001, Y.3031, Y.3032, Y.3034, Y.3071-Y.3076, Y.2611-Y.2621, Y.sup47,Y.sup48

## D.2 Question

Study items to be considered include, but are not limited to:

– What extensions are required in DAN/ICN and FPBN/PTDN to incorporate in-network computing, big data analysis, distributed ledger technology/blockchain, machine learning and artificial intelligence (ML/AI) for satisfying requirements of high throughput, low latency, low energy consumption, and high network efficiency?

– How DAN/ICN and FPBN/PTDN network functions can be configured and deployed by applying software-defined networking, network function virtualization, service function chaining, network slicing and orchestration?

– What are the requirements, framework and functional architectures of emerging networking technologies such as digital twin of networks and industrial networking?

## D.3 Tasks

Tasks include, but are not limited to:

– Development of Recommendations including scenarios, use cases, requirements, framework and functional architecture on the extension of DAN/ICN and FPBN/PTDN with the component technologies of in-network computing, big data analysis, DLT/blockchain, ML/AI.

– Development of Recommendations on deployment and configuration of DAN/ICN and FPBN/PTDN network functions by applying software-defined networking, network function virtualization, service function chaining, network slicing and orchestration.

– Development of Recommendations on ICN functional architecture and component technologies including data object naming, name resolution, information discovery, transport, routing, mobility, caching, interworking of heterogeneous smart application domains, security, billing and charging, and emerging use cases.

– Development of Recommendations on ICN use-case specific mechanisms and bridging technologies for applying ICN in networks beyond IMT2020.

– Study and standardization of other relevant emerging network technologies such as digital twin of networks and industrial networking.

An up-to-date status of work under this Question is contained in the SG13 Work Programme <https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=22/13>

## D.4 Relationships

Recommendations

– DAN/ICN and FPBN/PTDN related Recommendations: ITU-T Y.3031, Y.3032,
Y.3034, Y.3071, Y.3072, Y.3073, Y.3074, Y.3075, Y.3076, Y.2601, Y.2611, Y.2612,
Y.2613, Y.2614, Y.2615, Y.2616, Y.2617, Y.2618, Y.2619, Y.2620, Y.2621, Y-series Supplements (Supp. 47 and 48)

– IMT-2020 and Future Networks related Recommendations such as ITU-T Y.3001,
Y.3101, Y.3102

Questions

– Networks beyond IMT-2020 related Questions

Study Groups

– ITU-T Study Groups involved with Networks beyond IMT-2020 and Future Networks studies

Other bodies

– ISO/IEC JTC1 SC 6

– IETF

– ONF

– ETSI’s relevant ISGs

– TM Forum

– Linux Foundation relevant open source projects

WSIS Action Lines

– C2

Sustainable Development Goals

– 9

DRAFT QUESTION E/13

Networks beyond IMT2020: Fixed, mobile and satellite convergence

(Continuation of Question 23/13)

## E.1 Motivation

Current usages of different access technologies provide users with different user experiences, such as broad bandwidth, low time delay, massive connections, and high security. The main purpose of fixed, mobile and satellite convergence for multi-access network is to federate all means of access technologies including fixed, mobile and satellite accesses, providing users with the capability to access the network ubiquitously and enjoy the best service experience under the circumstance. Users and operators benefit from network convergence of fixed, mobile and satellite, in the aspects of seamless service, connection reliability, service continuity, network efficiency, load balancing, disaster recovery, etc.

In some use cases of networks beyond IMT2020, fixed access network, mobile access network, and satellite access network interwork to form a converged network. A converged access-agnostic core network, which integrates fixed, mobile and satellite core network, also assisted by AI/ML and other innovative technologies, is envisioned as a direction of evolution of networks beyond IMT2020. Therefore, this Question focuses on the study of requirements, use cases, network capabilities, innovative technologies, and service enhancements to support fixed, mobile and satellite convergence, ensuring a seamless user experience within the fixed, mobile and satellite domains for the target of full connectivity for various types of user equipment. Subjects on fixed mobile convergence in networks beyond IMT2020 without satellite access are also in the scope of this Question. The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– ITU-T Y.3130, Y.3131, Y.3132, Y.3133, Y.2029 Amd.1, Y.2041, Y.2255, Y.2814, Y.2815

## E.2 Question

Study items to be considered include, but are not limited to:

– What requirements and network capabilities are needed to support fixed, mobile and satellite convergence in networks beyond IMT2020?

– How to achieve seamless service, connection reliability, service continuity, load balancing, and disaster recovery in networks beyond IMT2020 with the introduction of fixed, mobile and satellite convergence?

– What are the impacts and effects of fixed, mobile and satellite convergence for networks beyond IMT2020?

– What innovative network and IT technologies are required for fixed, mobile and satellite convergence in networks beyond IMT2020? How to apply innovative technologies to enhance fixed, mobile and satellite convergence?

– What are needed to enhance fixed, mobile and satellite convergence from the perspective of network efficiency (network management, resource orchestration, energy savings, etc.) in telecommunications, information and other industries?

– What new use cases and services would be available with the advent and development of fixed, mobile and satellite convergence? What new capabilities can be exposed with fixed, mobile and satellite convergence?

– What are needed to achieve full connectivity for various types of user equipment?

## E.3 Tasks

Tasks include, but are not limited to:

– Develop Recommendations based on the study of fixed, mobile and satellite convergence in networks beyond IMT2020, using fixed, mobile and satellite accesses and their network capabilities in the context of the questions above.

– Determine requirements and use cases for fixed, mobile and satellite convergence to support multimedia and data services.

– Develop network capabilities to support fixed, mobile and satellite convergence in networks beyond IMT2020, focusing on user experience, service support, and network efficiency.

– Study the application of innovative network and IT technologies in fixed, mobile and satellite convergence in networks beyond IMT2020, such as land and satellite convergence, AI/ML, DLT, quantum information technologies, etc.

– Study the enhanced interfaces and procedures in support of fixed, mobile and satellite convergence, focusing on the reference points between UE and converged network, and between application and converged network.

– Study the new services and exposed capabilities with the advent and development of fixed, mobile and satellite convergence.

– Develop Recommendations on full connectivity for various types of user equipment.

An up-to-date status of work under this Question is contained in the SG13 work programme <https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=23/13>

## E.4 Relationships

Recommendations

– Y-series in SG13

– Q-series in SG11

Questions

– All Questions related to networks beyond IMT2020

Study Groups

– ITU Study Groups involved with networks beyond IMT2020 studies

Standardization bodies

– ITU-R

– 3GPP

– ETSI

– BBF

– IEEE

– IETF

WSIS Action Lines

– C2

Sustainable Development Goals

– 9

DRAFT QUESTION H/13

Future Networks: Deep packet inspection and network intelligence

(Continuation of Q7/13)

## H.1 Motivation

Deep packet inspection (DPI) is beneficial to network operators in many areas such as service/application awareness, quality of service (QoS) assurance, network management and so on.

In order to provide better service and make full use of the network resources, network operators and service providers need to sense the network timely and accurately. By combination with big data, artificial intelligence and machine learning related technologies, network awareness can be further enhanced.

Based on deep packet inspection and intelligent network-awareness, operators can improve QoS and quality of experience (QoE) of the network, they can also make efficient use of network resource, reduce costs and capital investment.

Deep packet inspection and intelligent network-awareness can also be the generic core technologies and common building blocks for some application technologies which depend on deep packet inspection and intelligent network awareness tightly such as big data driven networking (bDDN).

It should be emphasized that studies on big data and machine learning related technologies are out of scope for this Question.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– ITU-T Y.2770, Y.2771, Y.2772, Y.2773, Y.2774, Y.2775;

– ITU-T Y.3650, Y.3651, Y.3652.

## H.2 Question

Study items to be considered including, but are not limited to:

– What enhancements to existing Recommendations are needed to enable
services/applications identification/awareness/visibility, to enable traffic and resource
optimization based on deep packet inspection in future networks?

– What new Recommendations are needed to provide new mechanism, architecture for
deep packet inspection in future networks from the perspective of emerging application
context?

– What new Recommendations are needed to support functional requirements, functional
architecture, mechanism and application scenarios of intelligent network-awareness in
future networks from the perspective of emerging application context?

– What new Recommendations are needed to provide functional architecture,
requirements and mechanism for big data driven networking?

– What new Recommendations are needed to provide framework, requirements and
architecture for networking scenarios which use deep packet inspection and intelligent
network-awareness in order to support capabilities like environment awareness,
self-awareness, self-learning and thinking, self-decision, self-operation,
self-restructuring, self-optimization and self-protection?

– What new Recommendations are needed for other application based on deep packet
inspection and intelligent network-awareness?

## H.3 Tasks

Tasks include, but are not limited to:

– Enhancements of ITU-T Y.2770 , Y.2771, Y.2772, Y.2773, Y.2774, Y.2775 in future networks.

– Development of new Recommendations on new DPI requirements, architecture, mechanism and methods for future networks in the emerging application context.

– Development of new Recommendations on requirements, architecture, mechanism and method related to intelligent network-awareness for future networks in the emerging application context.

– Development of new Recommendations on functional architecture, requirements and new mechanism of big data driven networking.

– Development of new Recommendations on framework, architecture and requirements for networking scenarios which use deep packet inspection and intelligent network-awareness in order to support capabilities like environment awareness, self-awareness, self-learning and thinking, self-decision, self-operation, self-restructuring, self-optimization and self-protection.

– Development of new Recommendations on other application based on deep packet inspection and intelligent network awareness.

An up-to-date status of work under this Question is contained in the SG13 Work Programme:
<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=7/13>

## H.4 Relationships

Questions:

– All big data related Questions.

– All artificial intelligent and machine learning related Questions.

– All future networks related Questions.

– All OAM related Questions

Study groups:

– All big data related study groups.

– All artificial intelligence and machine learning related study groups

– All future networks related study groups.

– All OAM related study groups

Other bodies:

– IETF

– ISO

– 3GPP

– ETSI NFV

– IEC

– IEEE

– ONF

WSIS Action Lines

– C2, C3

Sustainable Development Goals

– 9

DRAFT QUESTION I/13

Future Networks: Requirements and capabilities for computing including cloud computing and data handling

(Continuation of Question 17/13)

## I.1 Motivation

Digital transformation is the strategic adoption of new, fast and frequently changing technology to improve process and productivity, manage risk, reduce cost, etc. Competitiveness of digital transformation depends on evolving technology, that is, its ability to quickly adapt to future computing technologies. In particular, cloud computing and big data are driving digital transformation. In addition, future computing technologies take into account artificial intelligence including machine learning, distributed computing, edge computing, data-centric computing, memory-centric computing, quantum cloud computing and computing aware networking. Therefore, the telecommunication industry has an important role to play in the fields of future computing and furthermore, the integration and development of future computing technologies in Future Networks will drive a rapid move towards a digital transformation.

Cloud computing is a model for enabling service user's ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services), that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Data is of high value to build applications and services based on future computing. For this reason, not only the big data capabilities, but also technologies and standards to support data usage, processing, analysing, exchanging, sharing, and data quality assessment are essential in terms of data handling.

The primary focus of this Question is to provide the necessary overall frameworks, definitions, and ecosystems including requirements, capabilities related to the integration or support of future computing including cloud computing and data handling in telecommunication ecosystem.

This Question is intended to develop new Recommendations for:

– definitions, overview, ecosystem, and use cases for future computing (including cloud computing and data handling);
requirements, and capabilities for future computing;

– interoperability, data portability, and exchange information in future computing;

– application of future computing in vertical domains;

– relationship among future computing technologies.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– ITU-T Y.3500, Y.3501, Y.3503, Y.3504, Y.3505, Y.3506, Y.3507, Y.3508;

– ITU-T Y.3600, Y.3601.

## I.2 Question

Study items to be considered include, but are not limited to:

– What new Recommendations should be developed for future computing (including

– cloud computing and data handling) definitions, ecosystem, use cases, and capabilities from telecommunication perspectives?

– What new Recommendations should be developed for requirements and capabilities?

– What new Recommendations should be developed for requirements for future computing interoperability and data portability between service providers that are appropriate and achievable for use cases?

– What new Recommendations should be developed for future computing ‘as a Service’?

– What new Recommendations should be developed for the application of future computing in vertical domains?
What collaboration is necessary to minimize duplication of efforts with other SDOs?

## I.3 Tasks

Tasks include, but are not limited to:

– Developing Recommendations for future computing (including cloud computing and data handling) definitions, overview, ecosystem, use cases, business roles and benefits from telecommunication perspectives;

– Developing Recommendations for future computing requirements and capabilities;

– Developing Recommendations for future computing interoperability and data portability as well as the applications of future computing in vertical domains;

– Providing the necessary collaboration for the work in the Question with relevant SDOs, consortia and fora;

– Maintenance and enhancement of the Recommendations for which the Question is responsible.

An up-to-date status of work under this Question is contained in the SG13 Work Programme:
<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=17/13>

## I.4 Relationships

Recommendations

– Other relevant Y-series recommendations, in particular in Y.3500 and Y.3600 series

– Y-series and Cloud computing and data handling related Recommendations in the M, Q and X series Recommendations

Questions

– Cloud computing and data handling related Questions

– Other relevant Questions with networking aspects

Study Groups

– ITU-T Study Groups and ITU-D Study Groups involved in cloud computing and data handling related studies

Other bodies

– ISO/IEC JTC 1/SC 27, 32, SC38 and SC42

– National Institutes of Standards and Technology (NIST)

– Distributed Management Task Force (DMTF)

– Storage Networking Industry Association (SNIA)

– Cloud Security Alliance (CSA)

– ETSI ISG NFV

– Open Computing Project (OCP)

– Linux Foundation projects

– Organization for the Advancement of Structured Information Standard (OASIS)

– World Wide Web Consortium (W3C)

WSIS Action Lines:

– C2, C3, C10

Sustainable Development Goals:

– 9

DRAFT QUESTION J/13

Future Networks: Functional architecture for computing including cloud computing and data handling

(Continuation of Question 18/13)

## J.1 Motivation

Digital transformation is the strategic adoption of new, fast and frequently changing technology to improve process and productivity, manage risk, reduce cost, etc. Competitiveness of digital transformation depends on evolving technology, that is, its ability to quickly adapt to future computing technologies. In particular, cloud computing and big data are driving digital transformation. In addition, future computing technologies take into account artificial intelligence including machine learning, distributed computing, edge computing, data-centric computing, memory-centric computing, quantum cloud computing and computing aware networking. Therefore, the telecommunication industry has an important role to play in the fields of future computing and furthermore, the integration and development of future computing technologies in Future networks will drive a rapid move towards a digital transformation.

Cloud computing is a model for enabling service user's ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services), that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Data is of high value to build applications and services based on future computing. For this reason, not only the big data capabilities, but also technologies and standards to support data usage, processing, analysing, exchanging, sharing, and data quality assessment are essential in terms of data handling.

The primary focus of this Question is to provide the architectures, infrastructures and networking views related to the integration and support of the future computing (including cloud computing and data handling) in telecommunication ecosystems.

This Question is intended to develop new Recommendations for:

– functional architectures in support of future computing based services and applications future computing functional architectures supporting interworking requirements,

– distributed computing, edge computing and other emerging forms of computing; future computing infrastructures including networking aspects (e.g. for the support of network slicing);

– future computing functional architectures of in support and applied in vertical domains; data handling functional architectures including data handling interworking functional architecture and future computing based data handling architecture;

– functional architectures and mechanisms supporting the integration and convergence of future computing technologies in networking.

This Question is also intended to develop Reports; Handbooks; Guidelines for practice, assessment, evaluation; etc. as appropriate on studies and implementations for above functional architectures and related functions.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility: Y.3502, Y.3504, Y.3509, Y.3511, Y.3515, Y.3516, Y.3519.

## J.2 Question

Study items to be considered include, but are not limited to:

– What new Recommendations should be developed regarding the future computing functional architectures, including the specification of corresponding functions, functional components, and their inter relations?

– What new Recommendations should be developed regarding the infrastructures and networking aspects of future computing?

– What new Recommendations should be developed for the data handling architectures, including data exchange and interoperation functional architectures?

– What new Recommendations should be developed for the functional architectures of future computing in support of vertical domains?

What collaboration is necessary to minimize duplication of efforts with other SDOs?

## J.3 Tasks

Tasks include, but are not limited to:

– Developing Recommendations for future computing functional architectures (including interworking), covering the identification of architectural functions, functional components, and their inter-relation required to provide future computing based services.

– Developing Recommendations for future computing infrastructures and networking aspects, covering the identification of functions, functional components for computing, storage and networking.

– Developing Recommendations for future computing based data handling functional architecture, data exchange and interoperation functional architecture.

– Developing Recommendations for the functional architectures of future computing in vertical domains.providing the necessary collaboration with external SDOs, consortia and forums.maintenance and enhancement of the Recommendations for which the Question is responsible.

An up-to-date status of work under this Question is contained in the SG13 Work Programme:
<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=18/13>

## J.4 Relationships

Recommendations:

– Other relevant Y-series recommendations, in particular in Y.3500 and Y.3600 series

– Y-series and Cloud computing and data handling related Recommendations in the M, Q and X series Recommendations.

Questions:

– Cloud computing and data handling related Questions

– Other relevant Questions dealing with networking aspects

Study Groups:

– ITU-T Study Groups and ITU-D Study Groups involved in cloud computing and data handling related studies

Other bodies:

– ISO/IEC JTC 1/SC 38 and SC42

– ISO TC307

– IETF

– IEEE

– ETSI including ISG MEC and ISG NFV

– Open Computing Project (OCP)

– Linux Foundation projects

– Organization for the Advancement of Structured Information Standard (OASIS)

– World Wide Web Consortium (W3C)

– Metro Ethernet Forum (MEF)

– Distributed Management Task Force (DMTF)

– Storage Networking Industry Association (SNIA)

– National Institute of Standards and Technology (NIST)

WSIS Action Lines:

– C2, C3, C10

Sustainable Development Goals:

– 9

DRAFT QUESTION K/13

Future Networks: End-to-end management, governance, and security forcomputing including cloud computing and data handling

 (Continuation of Question 19/13)

## K.1 Motivation

Digital transformation is the strategic adoption of new, fast and frequently changing technology to improve process and productivity, manage risk, reduce cost, etc. Competitiveness of digital transformation depends on evolving technology, that is, its ability to quickly adapt to future computing technologies. In particular, cloud computing and big data are driving digital transformation. In addition, future computing technologies take into account artificial intelligence including machine learning, distributed computing, edge computing, data-centric computing, memory-centric computing, quantum cloud computing and computing aware networking. Therefore, the telecommunication industry has an important role to play in the fields of future computing and furthermore, the integration and development of future computing technologies in Future Networks will drive a rapid move towards a digital transformation.

Cloud computing is a model for enabling service user's ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services), that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Data is of high value to build applications and services based on future computing. For this reason, not only the big data capabilities, but also technologies and standards to support data usage, processing, analysing, exchanging, sharing, and data quality assessment are essential in terms of data handling.

The primary focus of this Question is to develop standards on end-to-end management, governance, and security for future computing including cloud computing and data handling from the perspective of telecommunication. The novel methods based on artificial intelligence and machine learning are essential to handle complexity of future computing management and optimally orchestrate its operation and lifecycle management.

This Question aims to provide new Recommendations in the following areas:

– End-to-end service management and orchestration of future computing (including cloud computing and data handling);

– End-to-end resource (including software infrastructure) management and orchestration of future computing;

– Data management of future computing;

– Security mechanisms and methods of future computing.

It should be noted that the term "end-to-end" is used here in information technology context, and does not refer to the management of endpoints or user devices, as it would have otherwise been implied if the telecommunication technology context were used. The term end-to-end refers to multi-layer, multi-component and multi-domain in future computing for telecommunications environment, which is in the scope of this Question.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– Y.3514, Y.3517, Y.3518, Y.3520, Y.3521, Y.3522, Y.3523 and Y.3524

– Y.3604

## K.2 Question

Study items to be considered include, but are not limited to:

– What new Recommendation should be developed for end-to-end service management and orchestration of future computing, including but not limited to Development and Operation (DevOps), continuous integration / continuous delivery (CI/CD), distributed/edge computing, computing aware networking and other cloud native related technologies?

– What new Recommendation should be developed for end-to-end resource (including software infrastructure) management and orchestration of future computing?

– What new Recommendation should be developed for data management of future computing including but not limited to data analytics, data management, data preservation as well as lifecycle management of data?
What new Recommendation should be developed for specific identity, access and security mechanisms that enable effortless trusted access to future computing?

– What collaboration is necessary to minimize duplication of efforts with other SDOs?

## K.3 Tasks

Tasks include, but are not limited to:

– Developing Recommendations for overview, framework, high level and functional requirements and capabilities, data models for end-to-end service management and orchestration of future computing, including but not limited to Development and Operation (DevOps), continuous integration / continuous delivery (CI/CD), distributed/edge computing, computing aware networking and other cloud native related technologies.

– Developing Recommendations for overview, framework, high level and functional requirements and capabilities, data models for end-to-end resource (including software infrastructure) management and orchestration of future computing.

– Developing Recommendations for data management of future computing including but not limited to data analytics, data management, data preservation as well as lifecycle management of data.

– Developing Recommendations for specific identity, access and security mechanisms that enable effortless trusted access to future computing.

– Providing the necessary collaboration with external SDOs, consortia and forums working on future computing to minimize duplication of efforts.

An up-to-date status of work under this Question is contained in the SG13 work programme <https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=19/13>

## K.4 Relationships

*(The relationship of this Question to other activities is listed against the following four categories)*

Recommendations

– Other relevant Y-series recommendations, in particular in Y.3500 and Y.3600 series;

– Y-series and Cloud computing and data handling related Recommendations in the M, Q and X series Recommendations.

Questions

– Cloud computing and data handling related Questions

– Artificial intelligence and machine learning (AI/ML) related Questions and Focus Group

Study Groups

– ITU-T Study Groups and ITU-D Study Groups involved in cloud computing and data handling related studies

Other bodies

– IEEE

– IETF

– ISO/IEC JTC 1/SC 27, SC38, SC40 and SC42

– Distributed Management Task Force (DMTF)

– Linux Foundation Edge

– Linux Foundation Networking (LFN)

– Metro Ethernet Forum (MEF)

– Storage Networking Industry Association (SNIA)

– TM Forum

– OASIS

– 3GPP

– ETSI ISG NFV

– ETSI ISG ZSM

– ETSI ISG ENI

– ETSI ISG MEC

– OpenStack

– Open Network Automation Platform

– Open Network Operating System

WSIS Action Lines:

– C2, C3, C5

Sustainable Development Goals:

– 9

DRAFT QUESTION L/13

Applying Future Networks and innovation in developing countries

(Continuation of Question 5/13)

## L.1 Motivation

The importance of future networks, which include capabilities like cloud computing, trust, big dataSDN or Artificial Intelligence for developing countries will continue to grow for the foreseeable future. New technologies are of critical importance to developing countries as they continue to make networks more accessible, more efficient, more cost effective, more adaptive and more versatile.

This question will aim at reducing the standardization gap in the scope of SG13 activities by being the channel through which developing countries can follow, contribute and implement international standards as appropriate to their context.

The activities of this question will mainly focus on producing Technical Papers and Supplements, which study the needs of the eco-system as a whole of developing country telecom networks in terms of applying IMT-2020, cloud computing, big data, trust and other emerging technologies.

This Question will address work items of specific interest to developing countries with the aim of producing corresponding specific Recommendations of specific interest to developing countries.

This Question provides a highly useful forum for developing countries to describe their infrastructure circumstances, their needs, and thus form a basis for work in other SG13 Questions as well as in relevant organizations within and outside ITU toward meeting their needs.

It has been sensed that there is a desire from the least developed countries to be more involved and to help steer the work towards better meeting their needs, but that it is difficult for them to find a suitable home for such inputs.

This work would feed relevant organizations within and outside ITU whose aim would be to meet the identified needs.

This Question could be promoted and exploited as an easier and automatic entry in SG13 work, for developing countries new to SG13.

This work should be conducted in close cooperation with relevant organizations within and outside ITU.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility:

– Y Suppl. 46 (11/2017) ITU-T Y.3500-series – Requirements and challenges regarding provision and consumption of cloud computing services in developing countries.

## L.2 Question

Study items to be considered include, but are not limited to:

– What scenarios and requirements in terms of services and deployments are needed for applying future networks, NGN, cloud computing, Trust, big data, SDN and so on and other emerging technologies in Developing Countries telecom networks?

– What are the standardization requirements of developing countries, in relation with SG13’s hot topics and what challenges that could be addressed with standards;

– What enhancements to existing Recommendations are required to provide energy savings

– directly or indirectly in Information and Communication Technologies (ICTs) and services or in other industries?

## L.3 Tasks

Tasks include, but are not limited to:

– Prepare gap analysis on the current status and trends of IMT-2020, future networks, cloud computing, trust in ICT, big data, SDN, AI, ML and any other new technologies, from a view point of developing country telecom networks.

– Develop requirements and use cases in terms of services and deployments for applying IMT-2020, future networks, NGN, cloud computing, Trust, big data, SDN, AI, ML and any other new technologies in Developing Country telecom networks.

– Produce Supplements and Technical Papers on how best developing countries can implement emerging technologies or migrate to emerging technologies.

– Study of the impact of SG13’s hot topics on telecom networks in developing countries and SDG’s achievement.

– Study of the impact of the implementation of ITU recommendations in developing countries.

– Produce and promote work items for study by Question 5/13.

– Produce and promote work items for study by SG13 Questions, relevant to the specific needs of developing countries.

– Develop recommendations of specific interest to the needs of developing countries.

An up-to-date status of work under this Question is contained in the SG13 Work Programme: <https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=5/13>

## L.4 Relationships

Recommendations

– Y Series ITU-T Recommendations

Questions

All Questions of SG13

Study Groups:

– All ITU-T related study groups

– ITU-D Study Groups 1 and 2

– ITU-R WP 5D

Other bodies

– 3GPP

– 3GPP2

– APT

– IEEE

– IETF

WSIS Action Lines

– C

Sustainable Development Goals

– 9

DRAFT QUESTION M/13

Future Networks: Trustworthy and Quantum Enhanced Networking and Services

(Continuation of Question 16/13)

## M.1 Motivation

Considering future ICT infrastructures and services, trust is becoming important and essential. For supporting the necessary network intelligence for handling complexity and uncertainty/risks in future ICT infrastructures and services, it’s necessary to make better use of knowledge about the status of environments and trust for creation, dissemination and utilization of knowledge in an open and collaborative manner as well as for taking into account trustworthy autonomous networking and services.

This question will investigate such importance of trustworthy networking and services and identify requirements and functions to support building of trusted ICT infrastructures in a decentralized manner with various enabling technical solutions like blockchain for enhanced security challenges covering privacy, safety, resilience and reliability.

Furthermore, this question will continue to develop key solutions for quantum key distribution (QKD) networks and consider quantum enhanced networks covering a broad range of quantum information technology (QIT) while supporting user networks for cryptographic applications.

In addition, interworking aspects between different networks and services should be studied, and this study should be focused on the interworking between other networks whenever necessity of interworking is identified.

Thus, the focus of this Question will include activities related to trustworthy networking and services including interworking. The work to specify the procedure, requirements, properties, and mechanisms for supporting trusted ICT infrastructures is the responsibility of this question. In addition, this Question will include activities related to quantum enhanced networks with QIT (e.g., QKD, quantum internet, etc.), and their services and applications as one of challenging items on trust.

Recommendations under responsibility of this Question include:

– Y.2070, Y.2072, Y.2281, Y.2291, Y.3043, Y.3041, Y.3044, Y.3045, Y.3051, Y.3052, Y.3053, Y.3054, Y.3800

## M.2 Question

Study items to be considered include, but are not limited to:

– What new Recommendations should be developed for trustworthy networks, including their ability to support specific applications/services?

– What new Recommendations should be developed to support trustworthy services with enabling technologies like blockchain?

– What enhancements to the existing Recommendations should be made to enable interworking between other networks including end user networks (e.g., customer premises networks)?

– What new Recommendations should be developed for quantum enhanced networks with QIT and their services and applications while supporting user networks based on core Recommendations on QKD networks?

## M.3 Tasks

Tasks include but are not limited to:

– Development of new Recommendations related to trustworthy networking and services;

– Development of new Recommendations related to enabling technical solutions for trusted ICT infrastructures;

– Development of new Recommendations related to interworking between other networks (including specific networks, e.g., networks for vehicular, smart grid and healthcare, etc.) and services considering heterogeneous and constraint networking environments in end user side;

– Development of new Recommendations related to end user networks and their specific applications/services in end users’ perspective (e.g., enhancement of home networks, personal area networks, etc.);

– Development of new Recommendations related to quantum enhanced networks with QIT (e.g., QKD, quantum internet, etc.);

– Development of new Recommendations related to user networks interacting with quantum enhanced networks;

– Development of new Recommendations related to deployment, scenarios and business models of the above networks and services

An up-to-date status of work under this Question is contained in the SG13 Work Programme:
<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=16/13>

## M.4 Relationships

Recommendations

– I-, Q-, X- and Y-series

Questions

– All future networks, trusted network infrastructures, home network and quantum enhanced networks related Questions

Study Groups

– All future networks, trusted network infrastructures, home network and quantum enhanced networks related study groups

Other bodies

– FG-QIT4N

– ISO/IEC JTC 1/SC 6, SC 27, SC 39 and AG4

– IETF/IRTF

– ETSI

– ETSI ISG-QKD

– ETSI TC Cyber

– IEEE-SA

– Online Trust Alliance (OTA)

– Trusted Computing Group (TCG)

– ONF

– 3GPP

– Broadband Forum

– Open Mobile Alliance (OMA)

WSIS Action Lines

– C1, C2, C3, C5, C7, C10, C11

Sustainable Development Goals

– 9, 11

DRAFT QUESTION N/13

Future Networks: Innovative service scenarios, including environmental and socio economical aspects

(Continuation of Q1/13)

## N.1 Motivation

Innovative service scenarios with support of information technologies are preparing opportunities for new services to be created in various environments demanding ICT support. For example, risk mitigation service features related to the effects of the climate on the environment form nowadays services scenarios of quickly increasing importance.

It is important to consider not only the potential application services (described by use cases) that may be developed, but also the anticipated operating service scenarios and the implementations of service models (described by service deployment models). These considerations can be applied to assist the application service planning and may possibly even accelerate the availability and automation of application services in future Networks. Service deployment models based on future network technologies can be designed to enable service providers’ business innovation.

The use cases should be initiated from the user perspective and the service deployment models should take into account the service providers’ perspective.

In the context of these studies, this Question will also consider environmental and socio-economic aspects with the objective to minimize the environmental impact as well as to reduce the barriers to entry for the various actors involved in the network ecosystem

Recommendations under responsibility of this Question include:

– Y-series Recommendation

## N.2 Question

Study items to be considered include, but are not limited to:

– Use cases and service scenarios for innovative application services in Future Networks;

– Service deployment models for innovative application services in Future Networks;

– Support of environmental awareness (e.g., for energy saving) in the context of innovative application services in Future Networks;

– Support of socio-economic awareness in the context of innovative application services in Future Networks.

## N.3 Tasks

Tasks include, but are not limited to, the development of documents as appropriate, for:

– Use cases, service scenarios and service deployment models for innovative application services in Future Networks, such as smart farming, smart learning, smart industries, smart energy control, smart logistics, UAV (Unmanned Aerial Vehicle) based services;

– Environmental awareness for energy consumption reduction and energy efficiency management in the context of innovative application services in Future Networks;

– Socio-economic awareness in the context of innovative application services in Future Networks.

Question produces and progresses work items through, or in coordination with, other related Questions, if necessary.

An up-to-date status of work under this Question is contained in the SG13 work programme
<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=1/13>

## N.4 Relationships

Recommendations

– Y-series Recommendations

Questions

– All Questions of SG13

Study groups

– ITU-T Study Groups 5, 11, 16, 17, 20

– ITU-D Study Groups 1 and 2

Other bodies

– ISO, IEC, ANSI, ETSI

– IEEE, IETF, OMA, W3C

– APT, GS1, FAO

WSIS Action Lines

– C2, C7 e-environment

Sustainable Development Goals

– 8, 9, 12, 13

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