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| The International Teleocmmunication Union - Connecting the World. | **International telecommunication union****Telecommunication Standardization Bureau** |  |
|  | Geneva, 17 June 2019 |
| **Ref:** | **TSB Circular 179**SG15/HO | **To:**- Administrations of Member States of the Union |
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| **E-mail:** | tsbsg15@itu.int | **Copy to:**- ITU-T Sector Members;- ITU-T Associates;- ITU Academia; - The Chairman and Vice-Chairmen of Study Group 15;- The Director of the Telecommunication Development Bureau;- The Director of the Radiocommunication Bureau |
| **Subject:** | **Merger of Question 9/15 into Questions 10, 11 and 12/15** |

Dear Sir/Madam,

1 At the request of the Chairman of Study Group 15, *"Networks, Technologies and Infrastructures for Transport, Access and Home",* I have the honour to inform you that this Study Group, in its meeting in Geneva from 8 to 19 October 2018, agreed to merge Question 9/15 “Transport network protection/restoration” into Questions 10 “Interfaces, Interworking, OAM and Equipment specifications for Packet‑based Transport Networks”, Question 11 “Signal structures, interfaces, equipment functions, and interworking for optical transport networks“ and Question 12/15 “Transport network architectures” in accordance with the provisions of Resolution 1, Section 7, § 7.2.2, of WTSA (Hammamet, 2016), by reaching consensus among those present.

2 **Annex 1** provides an explanatory summary about the reason for the merger of Question 9/15 into Question 10, 11 and 12/15.

3 **Annexes 2, 3 and 4** give updated Questions 10, 11 and 12/15, respectively.

4 TSAG, in its meeting in Geneva from 10 to 14 December 2018, endorsed this merger of the Questions.

Yours faithfully,

*(signed)*

Chaesub Lee
Director of the Telecommunication
Standardization Bureau

**ANNEX 1
Reason for merger of Question 9/15 into Questions 10, 11 and 12/15**

For the last several study periods, Question 9/15 has been responsible for network protection and restoration. This was helpful when most packet-layer protection was in early development stages and often modelled after mature circuit protection mechanisms.

In recent years, the work in Question 9/15 has been declining as this work reaches maturity. In addition, work on circuit protection generally requires the involvement of experts from Question 11/15, and work on packet protection generally requires involvement of experts from Question 10/15, which has created scheduling difficulties during plenary meetings.

In addition, control-plane (ASON or SDN-based) restoration has been more naturally considered as an extension of the work done in Question 12/15 rather than the protection switching work of Question 9/15.

Therefore, SG15 has decided to merge Question 9/15 into Questions 10, 11 and 12/15 and distribute the remaining active responsibilities of Question 9/15 to Questions 10, 11 and 12/15.

**ANNEX 2
Updated text of Question 10/15**

# Question 10/15 – Interfaces, Interworking, OAM, protection and Equipment specifications for Packet‑based Transport Networks

(Update of Question 10/15 to include some of the work of Question 9/15)

## Motivation

The continued explosive growth of the Internet, the standardisation of Ethernet rates greater than 100Gbit/s (e.g., 200Gbit/s, 400Gbit/s), the emergent standardisation of additional Ethernet rates below 100 Gbit/s (e.g., 25 Gbit/s and 50 Gbit/s), accommodation of other packet‑based traffic, and the range of logical interfaces provided by FlexE that may or may not correspond to any existing Ethernet PHY rate, are key forces for packet transport network evolution. In order to ensure that packet‑based transport networks maintain carrier-class performance, it is essential that network protection techniques continue to evolve and relevant Recommendations are updated. Packet‑based transport networks must also continue to provide the Operation, Administration and Maintenance (OAM) capabilities that are essential to enabling carrier-class performance. Such networks are expected to support an increasingly wide variety of highly reliable and high‑quality services, which also require effective network control and management. Such factors will drive the need for the revision of existing Recommendations as well as the development of new Recommendations for packet‑based transport interfaces and equipment.

Under the responsibility of this Question, Recommendations will be developed to provide the specifications for packet‑based equipment, OAM mechanisms, protection switching mechanisms, network interfaces, services, and domain interworking in packet transport networks. This activity will be conducted in close co-operation with related ITU-T Study Groups, IEEE, MEF, IETF and other SDOs as necessary.

Existing Recommendations may need to be enhanced to take into account transport network control and management paradigms, such as Automatically Switched Optical Network (ASON) and SDN control of transport networks.

The area of responsibility under this Question includes the specification of:

* Equipment functions related to packet layer networks, including equipment functions related to access networks.
* Equipment functions for transport of data/packet traffic (e.g., Ethernet, IP, ATM, MPLS, MPLS-TP, Data Center traffic).
* Power-saving mechanisms for packet transport network equipment in the wider context of ICTs (Information and Communications Technologies).
* Packet transport OAM structures and methods.
* Specification of all protection switching processes related to packet transport networks.
* Network interface characteristics for the packet transport network.
* Packet data transport supervision.
* A framework for defining network-oriented characteristics of Ethernet services in alignment with industry requirements.

Recommendations related to packet transport technologies used in the access environment and not covered by other Questions of ITU-T SG15 are also covered by this Question.

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

* G.8001/Y.1354, G.8011/Y.1307, G.8012/Y.1308, G.8012.1/Y.1308.1, G.8013/Y.1731, G.8021/Y.1341, G.8021.1/Y.1341.1, G.8031/Y.1342, G.8032/Y.1344, G.8101/Y.1355, G.8112/Y.1371, G.8113.1/Y.1372.1, G.8113.2/Y.1372.2, G.8121/Y.1381, G.8121.1/G.1381.1, G.8121.2/G.1381.2, G.8131/Y.1382, G.8132/Y.1383, I.610, I.630, Y.1710, Y.1711, Y.1712, Y.1713, Y.1714, Y.1720 and Y.1730.

## Question

What packet transport interfaces and equipment functions must be specified to enable compatible packet transport equipment in metro and long‑distance networks, including considerations regarding protection mechanisms and evolution of the optical transport network?

What characteristics should be recommended for equipment for the transport of packet‑based traffic such as Ethernet, MPLS-TP, MPLS, Data Center traffic?

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

* Specifications of Equipment functions necessary for the transport of packet‑based traffic such as Ethernet services, MPLS-TP, and Data Center traffic.
* Enhancements required to the packet transport equipment and network protection Recommendations in order to meet the needs, including support for disaster recovery, of:
	+ Access networks.
	+ Data Center networks.
	+ Cloud computing.
	+ Mobile networks including IMT-2020/5G.
	+ CBR clients.
	+ Future networks.
* Network protection Recommendations to provide enhanced survivability capabilities.
* Clarification and resolution of technical issues in published and draft Recommendations.
* What equipment functions should be specified to allow power savings within packet transport networks?
* Clarification of requirements and mechanisms of OAM for packet transport networks. This includes study on end-to-end OAM support for packet‑based ubiquitous networks. The OAM functions provide the capability for defect detection, defect localization, topology management and performance management. OAM functions should be able to be applied to point-to-point, point-to-multipoint and multipoint-to-multipoint networks.
* Clarification of generic OAM principles for connection-oriented packet-switched and connectionless packet switched networks.
* Clarification of generic OAM principles under interworking of different network technologies. This includes network interworking and service interworking scenarios.
* Continuation of work on the transport Ethernet OAM Recommendation G.8013/Y.1731 in cooperation with IEEE.
* Continuation of work on the MPLS-TP OAM Recommendations in cooperation with IETF.
* Continuation of work on the Ethernet services and Network Interfaces Recommendations in cooperation with MEF.

## Tasks

Tasks include, but are not limited to:

* Enhancements to, and refinements of, existing Recommendations on characteristics of packet transport network equipment functional blocks (G.8021/Y.1341, G.8021.1/Y.1341.1, G.8121/Y.1381, G.8121.1/G.1381.1, G.8121.2/G.1381.2).
* Enhancements to, and Refinements of, existing Recommendations on OAM mechanisms for packet transport networks (G.8013/Y.1731, G.8113.1/Y.1371.1, G.8113.2/Y.1371.2).
* Preparation of Recommendations on OAM mechanisms including defect localization functions and performance measurement functions.
* Enhancement and improvement of linear and ring protection switching Recommendations for packet-based technologies.
* Further development of Ethernet service characteristics (G.8011/Y.1307).
* Further development of packet transport network interface specifications (G.8012/Y.1308, G.8112/Y.1371).

NOTE − An up-to-date status of work under this Question is contained in the SG15 Work Programme at: [http://www.itu.int/ITU-T/workprog/wp\_search.aspx?sg=15](https://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=15)

## Relationships

### Recommendations:

* G.800, G.805, G.806, G.808, G.808.1, G.808.2, G.808.3, G.872, G.8010, G.8051, G.8052, G.8110.1, G.8151, G.8152, G.7710, G.7711.

### Questions:

* Q4/15, Q11/15, Q12/15, Q13/15, Q14/15.

### Study Groups:

* ITU-T SG2 responsible for operational aspects.
* ITU-T SG12 responsible for Ethernet and MPLS performance, QoS and QoE.
* ITU-T SG13 responsible for future networks, with focus on IMT-2020, cloud computing and trusted network infrastructure.

### Standardization bodies, forums and consortia:

* MEF on Ethernet services and network interfaces issues.
* IEEE 802.1, 802.3 on Ethernet.
* IETF working groups on OAM, MPLS transport, PW transport.
* Broadband Forum.
* OIF on Flex Ethernet.

**ANNEX 3
Updated text of Question 11/15**

# Question 11/15 – Signal structures, interfaces, equipment functions, protection, and interworking for optical transport networks

(Update of Question 11/15 to include some of the work of Question 9/15)

## Motivation

The explosive growth of the Internet and other packet‑based traffic including data center connectivity, wireless networks such as IMT-2020/5G and new high definition video formats are the key drivers for the development of new transport network equipment and Network Node Interface (NNI) related standards for optical networks. This rapidly growing traffic will be supported by the anticipated standardization of new Ethernet interfaces for 25Gbit/s, 50Gbit/s, 200Gbit/s and 400Gbit/s with many other rates proposed, including the range of logical interfaces provided by FlexE. In addition, the development of Optical Transport Network (OTN) specifications provides the ability to dramatically increase the bandwidth, and thus traffic carrying capacity, of optical networks. Furthermore, the advent of the ODUflex and the Hitless Adjustment of ODUflex (HAO) has enabled efficient data traffic transport over flexible OTN interfaces with FlexO has enabled more efficient use of physical interfaces for higher bit rate clients. Circuit-based transport networks must also continue to provide the Operation, Administration and Maintenance (OAM) capabilities that are essential to enabling carrier-class performance. In order to ensure that circuit-based transport networks based on these new technologies maintain carrier-class performance, it is essential that network protection techniques continue to evolve and relevant Recommendations are updated. These and other enhanced capabilities, as well as the need to support any new management capabilities, have resulted in a need for the revision of existing equipment Recommendations as well as the development of new Recommendations for transport equipment. Increased utilization of OTN technology for a wider set of applications has driven the demand for support of new client signals, including high speed Ethernet, Storage Area Network (SAN) interfaces (such as Fibre Channel flows), as well as wireless network interfaces like Common Public Radio Interface (CPRI). Further work is expected to enhance the OTN Recommendations to carry future Ethernet and other data client interfaces.

The area of responsibility under this Question includes:

* Specification of transport signal structures, such as GFP, and OTN, SyncO, and FlexO.
* Specification of adaptations of client signals into server transport layers.
* Specification of interface characteristics for the transport and supervision of client signals.
* Specification of all protection switching processes related to OTN networks.
* Specification of all equipment functions, supervision related to the OTN networks including equipment functions related to access networks.
* Specification of fundamental transmission parameters and determination of the effect of various transmission impairments. This includes transmission error and availability performance objectives and allocation methods for efficient design of digital networks and associated transmission equipment.
* Specification of survivability capabilities and development of a strategy for multi-domain and/or multi-layer survivability interactions (including those where different transport technologies are used at different layers).
* Investigation of IMT-2020/5G mobile fronthaul and backhaul transport network requirements, including the emerging Next Generation Front Haul Interface (NGFI).
* Investigation of power saving mechanisms for transport network equipment in the wider context of ICTs (Information and Communications Technologies).
* Investigation and possible specification of OTN Services.

The following major Recommendations, in force at the time of approval of this Question, fall under its responsibility: G.703, G.704, G.707/Y.1322, G.709/Y.1331, G.709.1/Y.1331.1, G.709.2/Y.1331.2, G.709.3/Y.1331.3, G.7041/Y.1303, G.7042/Y.1305, G.7043/Y.1343, G.7044/Y.1347, G.8023, G.8040/Y.1340, X.85/Y.1321, X.86/Y.1323, G.705, G.783, G.798, G.798.1, G.806, G.808, G.808.1, G.808.2, G.808.3, G.841, G.842, G.873.1, G.873.2, G.873.3, G.821, G.826, G.827, G.828, G.829 and G.8201.

## Question

Study items include, but are not limited to:

* What enhancements should be made to the existing NNI related Recommendations or what new Recommendations should be developed?
	+ For the networks employing Optical Transport Network (OTN) to accommodate new Ethernet clients?
	+ For OTN to enable OTN rates beyond 100Gbit/s such that they can be carried over single or multiple wavelength interfaces?
	+ For OTN support of the radio fronthaul / backhaul networks in line with IMT‑2020/5G mobile, network virtualization, high definition video (4K, etc.)?
	+ To reflect additional transport network applications and interworking scenarios?
	+ For networks optimized for transport of packet data?
	+ For WAN transport of emerging Optical Interworking Forum (OIF) flexible Ethernet (FlexE) over OTN for data center connectivity and other applications?
* Clarification of generic OAM principles for circuit-switched networks.
* Clarification of generic OAM principles under interworking of different network technologies. This includes network interworking and service interworking scenarios.
* What additional protection mechanisms for transport equipment should be recommended to provide enhanced survivability capabilities and a cohesive strategy for multi-domain and/or multi-layer survivability interactions?
	+ Network protection Recommendations to provide enhanced survivability capabilities and a cohesive strategy for multi-layer survivability interactions. This includes revisions to Recommendations G.808.x and G.873.x. These Recommendations will cover OTN, as well as multi-layer survivability, including consideration of the interactions with protection in packet layers.
	+ Multi-domain, multi-layer and multi-technology protection mechanisms for OTN.
	+ Enhancements required to the network protection Recommendations in order to meet the needs, including support of disaster recovery, of:
		- Access network.
		- Data Center networks.
		- Cloud computing.
		- Mobile networks including IMT-2020/5G.
		- Future networks.
* What transport equipment functions must be specified to enable compatible transport equipment in inter-office and long-distance networks, including evolution to the optical transport network?
* What transmission error performance parameters and objectives need to be recommended?
* What enhancements should be made to the existing equipment function Recommendations or what new Recommendations should be developed in order to meet the needs, including synchronization, of:
	+ Access networks.
	+ Data Center networks.
	+ Cloud computing.
	+ IMT-2020/5G.
	+ Future networks.
* What should be specified for the definition of new transport networks, while insuring transverse compatibility and interworking with previously specified technologies?
* What enhancements to existing Recommendations are required to provide energy savings directly or indirectly in Information and Communication Technologies (ICTs) or in other industries? What enhancements to developing or new Recommendations are required to provide such energy savings?

## Tasks

Tasks include, but are not limited to:

* Enhancement to relevant Recommendations for transport networks (including G.709, G.709.1 and G.798) to increase network transport capacity and accommodate greater than 100 Gbit/s Ethernet services.
* Enhancement to Recommendations for transport networks to support access applications, including IMT-2020/5G mobile radio fronthaul / backhaul applications.
* Enhancements to OTN protection mechanisms, for example nested protection schemes and M:N ODUk SNC.
* Enhancement and improvement of linear and ring protection switching Recommendations for OTN.
* Clarification of relationships between survivability function of circuit-based transport and survivability function in other layers or other transport technologies (e.g., SDH, OTN, etc.).
* Clarification of interworking between different protection schemes within a layer network (e.g. interworking linear and ring protection).
* Maintain and update, as necessary, OTN equipment Recommendation G.798.1.
* Maintain and update, as necessary, the error performance Recommendations G.821, G.826, G.827, G.828, G.829 and G.8201.
* Maintain and update, as necessary, PDH, SDH, OTN, FlexO and LAPS Recommendations.
* Evolution of GFP, LCAS, and HAO related Recommendations.
* Further development of the OTN Interface Recommendation.

NOTE − An up-to-date status of work under this Question is contained in the SG15 Work Programme at: [http://www.itu.int/ITU-T/workprog/wp\_search.aspx?sg=15](https://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=15)

## Relationships

### Recommendations:

* G.784, G.825, G.7710, G.693, G.694, G.695, G.698, G.800, G.805, G.872, G.957, G.959.1, G.8010, G.8021, G.8080, G.8110, G.8110.1, G.8121, G.8251, G.8261, G.8262, G.8264, and G.993.x.

### Questions:

* Primary (repeated below): Q6/15, Q10/15, Q12/15, Q13/15, and Q14/15.
* Q2/15, Q4/15, Q6/15, Q7/15, Q10/15, Q12/15, Q13/15 and Q14/15.

### Study Groups:

* ITU-T SG2 on network maintenance.
* ITU-T SG13 responsible for future networks, with focus on IMT-2020, cloud computing and trusted network infrastructure.

### Standardization bodies, forums and consortia:

* MEF on Ethernet services and Ethernet interfaces, Layer 1 services.
* IEEE 802.1, 802.3 on Ethernet.
* T11 on SAN flows transport.
* Optical Interworking Forum (OIF) on flexible Ethernet (FlexE).
* Broadband Forum (BBF).

 **ANNEX 4
Updated text of Question 12/15**

# Question 12/15 – Transport network architectures

(Update of Question 12/15 to include some of the work of Question 9/15)

## Motivation

Transport network architecture Recommendations (G.800, G.805 and G.809) and technology specific network architecture Recommendations (G.803, G.872, G.8010, G.8110, G.8110.1 and I.326) have been established and are widely used. As operating experience is gained with employing current transport network technologies and new technologies evolve (e.g., variable size packets, high-speed transport networks), new Recommendations, or enhancements to existing Recommendations need to be developed, in close cooperation with the standardization activities on transport network systems and equipment. The operational aspects of networks, including the use of ASON or SDN for restoration, are becoming more important. The operational aspects of combined packet and circuit switched optical networks should be considered to ensure that they are addressed in a way that is architecturally sound and minimizes divergent approaches.

Software Defined Networking (SDN) is an architectural approach to managing transport network resources. Its architecture needs to be understood in the context of the management control continuum that includes the Architecture of the Automatically Switched Optical Network (G.8080). Commonality and differences with existing architectures requires study as it is applied to various transport layers. Requirements for enhanced control interfaces to and within the transport network, for example to support network slicing, need to be studied. Interfaces to configure and control programmable hardware are needed. Interfaces that enable clients to request network services beyond basic connectivity are needed.

Network Functions Virtualisation (NFV) is an architectural approach in which some network functions are implemented as a programme on a generic compute platform. There are strong synergies between SDN and NFV especially in the goal of providing automated control. This drives the need for compatible enhanced control interfaces. This suggests the need for strong compatibility between the functional modelling currently used for the transport network and the functional model for NFV.

The continued evolution of transport networks and the services they support such as, the Internet, IMT-2020/5G, datacentre-based services, and higher definition video, have resulted in drastic changes in the demands placed on transport networks. Transport networks need to continuously evolve to meet these changing demands and provide a converged transport network. This rapidly evolving situation led us to recognise the need for a coordination and communication activity among the involved Questions (primarily Questions 2, 6, 7, 9, 10, 11, 12, 13, and 14/15) in order to avoid duplication of work and facilitate the most efficient completion of the work. Also, a standardization work plan for new optical transport network activities (the Optical Transport Networks and Technology Standardization Work Plan (OTNT SWP)) needs to be maintained. In addition, some general aspects such as terminology, need to be captured.

The following major Recommendations, in force at the time of approval of his Question, fall under its responsibility: G.800, G.803, G.805, G.809, G.872, G.7701, G.7702, G.8010/Y.1306, G.8080/Y.1304, G.8081/Y.1353, G.8110/Y.1370, G.8110.1/Y.1370.1 and I.326.

## Question

What new or modifications to existing Recommendations are required to:

* Refine and enhance the specification of Transport Network Architecture, including enhancements to G.800, G.872, G.7701, G.7702, G.8010, G.8080, G.8110 and G.8110.1, including use of ASON or SDN for network restoration, operational aspects and implications of the evolution of photonic technologies to support additional flexibility within the transport network?
* Define the architecture for SDN control of transport networks?
* Understand the commonality and differences between SDN and Automatically Switched Optical Network (ASON) architectures?
* Explore the relationship between the Transport Network Architecture and applications such as computing and storage, including NFV?
* Explore the implications of multi-technology and multi-layer integration, the potential for network simplification and the consequent impact on the network architecture and existing standards?
* Develop the architecture of media networks as the manner in which information layers use them is evolving?
* Explore the relationship between SDN and ASON functions, and how control functions are related to the information models developed in Q14/15?
* Explore enhancements to the architecture of transport networks to address emerging requirements of IMT-2020?
* Specify requirements for enhanced control interfaces to and within the transport network? Interfaces to configure and control programmable hardware are needed.
* Define interfaces that enable clients to request network services beyond basic connectivity?
* Explore for SDN control of transport networks, the implications of the centralized vs distributed control architectures (the management/control continuum)?
* Reflect synchronization (as studied in Q13/15) in architecture Recommendations?

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

* Transport networks that offer circuit switching capability including photonic switching technology.
* Transport networks that offer packet switching capability, including packet switching in the photonic layer.
* Converged multi-technology and multi-layer transport networks.
* The architecture of the media layer and new ways that information layers can be supported over media.
* Support of point-to-multipoint and multipoint-to-multipoint transport services.
* The dynamic behaviour of resources in the network (e.g. link speed change).
* The relationship with functional modelling required for NFV.
* The Software Defined Networking (SDN) architectural approach and its role in providing more flexible control.
* Use of ASON or SDN for network restoration.
* What enhancements to OTNT SWP or what new Recommendation(s) or mechanisms are necessary to capture, within this framework, new or evolving aspects of optical transport networks, their general terminology, and reliability/availability characteristics?

## Tasks

Tasks include, but are not limited to:

* Maintenance of Recommendations I.326, G.803, and G.805.
* Refinement and enhancement of Recommendations G.800, G.872, G.7701, G.7702, G.8010, G.8080, G.8110 and G.8110.1.
* Investigate the use of ASON or SDN for network restoration and clarify the relationship between protection switching and restoration techniques.
* Facilitate discussion among questions during SG15 meetings to coordinate work on Optical Transport, including the harmonization of terminology.
* Develop, maintain, and regularly distribute a work plan that documents the work and time schedules of all major new optical transport network activities (OTNT SWP).

NOTE − An up-to-date status of work under this Question is contained in the SG15 Work Programme at: <http://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=15>

## Relationships

### Recommendations:

* None.

### Questions:

* Q2/15, Q6/15, Q7/15, Q10/15, Q11/15, Q13/15 and Q14/15.

### Study Groups:

* ITU-T SG2 on telecommunication management.
* ITU-T SG13 working on SDN and IMT-2020/5G.
* JCA-IMT-2020 on 5G.
* ITU-T SG20 requirements from IoT.

### Standardization bodies, forums and consortia:

* IETF on Control Plane Issues.
* IEEE 802 on Ethernet Issues.
* OIF on Optical Control Plane and FlexEthernet.
* ONF on SDN.
* ETSI ISG NFV.
* 3GPP on IMT-2020/5G.
* BBF on IMT-2020/5G .

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