Question 13/15 – Network synchronization and time distribution performance

(Continuation of Question 13/15)

1 Motivation

Network synchronization performance specifications are essential for successful operation of digital transmission networks including the support of, for example, mobile networks. Network timing performance standards are necessary to define the feasibility and most effective means of implementing a time reference distribution service. This includes the distribution of both precision time and frequency.

Continuing effort needs to be put into the study of synchronization issues in packet-based and new TDM networks.

Requirements for the related OAM and Management functions need to be further studied.

Requirements from new network architectures and applications should be considered (e.g., as related to the IoT, IMT2020/5G, IMT-2020/5G evolution, new emerging applications that may require accurate timing such as support for enhanced security solutions, etc.). New applications with particularly stringent timing requirements may need to be considered (e.g., quantum key distribution (QKD) related applications).

Robust and reliable network synchronization solutions (e.g., as related to global navigation satellite system (GNSS) backup synchronization references) need to be addressed.

There is increased need to provide timing to support the needs of other industries (e.g., industrial automation) that may rely on the transport and synchronization solutions defined within this study group. SDN/NFV implications on the synchronization networks should also be studied. Enhancements drawing on and looking to enable artificial intelligence (AI) and machine learning (ML) should be studied.

The advances in network synchronization related technologies should be addressed.

New transmission technologies, services and facilities are regularly being introduced. Inter-operator links need to be efficiently installed, commissioned, brought into service and maintained. Test and measurement instrumentation is required for the installation, commissioning, bringing into service and maintenance of telecommunications equipment and networks. The measurement of the same parameter made with different measuring instruments should give reliable, repeatable and comparable results. Test equipment specification needs continuous review to take account of technology changes and improvements of jitter, wander and precision time measurement.

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

– Definitions and Architecture: G.781, G.810, G.8260, G.8264, G.8265, G.8275

– PTP Profiles: G.8265.1, G.8275.1, G.8275.2

– Network Performance: G.8251, G.822, G.823, G.824, G.825, G.8261, G.8261.1, G.8271, G.8271.1, G.8271.2

– Clocks: G.811, G.811.1, G.812, G.813, G.8262, G.8262.1, G.8263, G.8272, G.8272.1, G.8273, G.8273.2, G.8273.3, G.8273.4

– Test equipment: O.171, O.172, O.173, O.174 and O.182

– Supplements: G Suppl.65, G Suppl.68

– Technical Reports: GSTR-GNSS

2 Question

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

- What are the requirements for jitter and wander for the future OTN interfaces, e.g., beyond 100 Gbit/s?

- What is the network functionality required to provide real-time distribution of absolute time-of-day reference services and/or phase synchronization? What network capabilities are required to support the performance levels necessary to satisfy a selected set of time-of-day and/or phase synchronization user applications?

- How can network synchronization performance be enhanced through the use of synchronization status messages or other techniques?

- What network synchronization characteristics, for both normal and degraded mode, should be recommended for services carried over packet networks? What is the dependence on synchronization of performance of various methods of service clock recovery with respect to service requirements (e.g., jitter, wander, time error, etc.)?

- How can robust and reliable network synchronization solutions be provided (e.g., as related to GNSS back-up) the "coherent PRTC" concept is one option that may be considered: how can high-accuracy time synchronization be used in this context to back-up GNSS?

- What advances of the synchronization technologies (e.g., new type of clocks) should be considered in the overall network synchronization solutions?

- What network synchronization characteristics should be recommended for services carried over packet-based networks?

- What network synchronization characteristics should be recommended for services carried over Metro Transport Network (MTN) based networks?

- What jitter and wander requirements are needed for wireless network applications (e.g., radio relay, satellite)?

- Synchronization aspects related to supporting mobile network operations: what synchronization requirements are related to supporting the operation of the mobile network (e.g., backhaul and fronthaul) and of the related applications (e.g., LTE, LTE-A, IMT2020/5G)? What solutions are suitable to meet these requirements? How can the accuracy be improved?

- What jitter and wander requirements are needed for access networks (e.g., DSL, PON, Microwave)?

- What jitter and wander specification requirements are needed in the evolution of OTN and in MTN?

- Synchronization aspects (frequency, phase and time) of packet networks, e.g., Ethernet, MPLS, IP networks.

- What mechanism can be used to add security to the transport of timing?

- Synchronization aspects related to new applications, e.g., as related to the Internet of things (IoT) and security mechanisms that depend on accurate timing?

- Synchronization aspects with regard to transport via satellite networks?

- What are the synchronization related requirements for OAM and Management functions?

- What is the implication of SDN/NFV concepts to the synchronization network architectures and requirements?

- Use of AI and ML in synchronization networks?
- What manual and automatic test and measurement instrumentation and techniques to assess transmission performance need to be specified by ITU-T and what should be the specifications?

– The following are examples of instrumentation and techniques which may be studied:

- measurement and evaluation of error performance parameters and objectives;
- test instrumentation and techniques associated with various technologies (e.g., PON, OTN PNT, submarine systems and beyond 100 Gbit/s);
- test instrumentation and techniques associated with Layer 1 Transmission technologies for metallic and optical media like 1G access, beyond 100 Gbit/s;
- jitter and wander test instrumentation and techniques associated with various technologies (e.g., PON, OTN, PNT and beyond 100 Gbit/s);
- test instrumentation and techniques associated with optical phase modulations (e.g., ODB, DQPSK and DP-QPSK);
- keeping O-Series Recommendations up to date.

3 Tasks

Tasks include, but are not limited to:

– Continue development of recommendations related to the transport of frequency through packet networks, G.826x-series including G.8260, G.8261, G.8261.1, G.8262, G.8262.1, G.8263, G.8264, G.8265, G.8265.1, and G.8266.

– Continue development of recommendations related to the transport of phase and time through packet networks, G.826x- and G.827x-series including G.8260, G.8271, G.8271.1, G.8271.2, G.8272, G.8272.1, G.8273, G.8273.1, G.8273.2, G.8273.3, G.8273.4, G.8275, G.8275.1, G.8275.2.

– Revision and enhancements of the related supplements and technical reports: G Suppl.65, G Suppl.68, GSTR-GNSS.

– Revisions and enhancements to Recommendations G.825 and G.8251.

– Maintenance and enhancement of G.81X-series.

– Continue work on the transport of clients through OTN (e.g., PTP, etc.).

– Consider need for new Recommendation on jitter and wander instrumentation for packet-based networks (O-series), e.g., O.175.

– Consider need for new Recommendation on physical layer test instrumentation associated with Optical Phase modulations (ODB, DQPSK and DP-QPSK).

– Work on Recommendation for frequency and time synchronization layer functions (G.781, G.781.1).

– Work on sync in metro transport network (MTN).

An up-to-date status of work under this Question is contained in the SG15 work programme (https://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=15).

4 Relationships

Recommendations:

– Q.551, G.703, G.709, G.783, G.798, G.800, G.805, G.80XX series, G.81XX series, G.83XX series

– G.783

Questions:

– Q2/15, Q4/15, Q6/15, Q8/15, Q10/15, Q11/15, Q12/15, Q14/15, and Q18/15

Study Groups:

– ITU-T SG2 on telecommunication management

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

– ITU-T SG9 on broadband cable and tv

– ITU-T SG17 on security

– ITU-T SG20 on IoT, smart cities and communities

– ITU-R SG4 on satellites

– ITU-R SG5 on terrestrial services

– ITU-R SG6 on broadcasting service

– ITU-R SG7 on science services

Other bodies:

– ATIS SYNC

– IETF TICTOC

– IETF NTP

– MEF on circuit emulation over Ethernet and frame delay measurements

– MEF mobile backhaul/fronthaul

– MEF on transport services for mobile networks

– IEEE 1588

– IEEE 802.3

– IEEE 802.1

– IEEE 802.16 (Wireless MAN)

– 3GPP RAN, SA

– Broadband Forum

– IEC TC86

– Optical Interworking Forum (OIF)

– ETSI

– ONF

– O-RAN WG4, WG5, WG9

– CPRI