Standardization in ITU-T Study Group 15 and Q13/15

Networks, Technologies and Infrastructures for Transport, Access and Home: Network synchronization and time distribution performance

Stefano Ruffini (Q13 Rapporteur)
Silvana Rodrigues (Q13 Associate Rapporteur)

WSTS 2024 (May 7-9 2024), San Diego (US)
Study Group 15 (SG15) mandate

2022-2024 Study Period
SG15 is the Lead Study Group on:
• access network transport
• home networking
• optical technology

✓ The LARGEST and MOST PRODUCTIVE group in ITU-T with broad, global industry participation
SG15 Working Parties (WPs)

- **WP1/15**: Transport aspects of access, home and smart grid networks
- **WP2/15**: Optical technologies and physical infrastructures
- **WP3/15**: Transport network characteristics
**WP1 – Broadband Access**

- **G.fastback**
  - Multi-Gigabit copper backhaul

- **MGfast**
  - Next generation copper access 5-10 Gbps
  - Optical systems for access networks
    - Bidirectional P2P
    - XGS-PON, NG-PON2
    - 50G-PON, WDM-PON
  - Continue collaboration with Next generation copper access 5-10 Gbps
  - PON support for mobile front/backhaul, Radio over fiber

- **G.RoF**
  - Powerline communication (PLC)
  - Free space optical home networking
  - High speed fibre-based in-premises transceivers (G.fin)
  - G.hn and G.hn2 home networking over indoor phone, power, and coax wires >2 Gbps

- **G.Hn**
  - MGfast support for mobile front/backhaul, Radio over fiber
WP2 – Optical Technologies

- Optical Network Infrastructure
- Optical Fibre Technologies and Cables for easy and environmentally friendly outside plants
- Disaster Management issues
- SMART submarine cables (G.SMART)
- Multichannel bi-directional DWDM applications targeted at lower cost optical solutions for applications including mobile fronthaul and backhaul
- Short-reach (OTN client) 200G and 400G interfaces reusing components developed for Ethernet applications
- 25 Gbit/s optical interface for mobile optimized transport
- 100G and future higher-rate coherent multi-vendor interoperable interfaces
- 200G
- 400G
- B400G
WP3 – Optical Transport Networks

- Transport and synchronization supporting 5G mobile fronthaul and backhaul
- G.83xx (metro transport network) for 5G optimized transport
- Architecture and other Transport SDN Aspects
- New “B400G” OTN interfaces, including the use of coherent G.698.2 interfaces
- Equipment & management specifications for OTN, Ethernet and MPLS-TP
- Synchronization of packet Networks, MTN and future OTN networks, e.g., beyond 400G
- Network survivability (protection and restoration)
- Management aspects of control and transport planes
- Core Information model enhancement for management of synchronization and optical media

BEYOND 400G
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Question title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/15</td>
<td>Coordination of Access and Home Network Transport Standards</td>
</tr>
<tr>
<td>2/15</td>
<td>Optical systems for fibre access networks</td>
</tr>
<tr>
<td>3/15</td>
<td>Technologies for in-premises networking and related access applications</td>
</tr>
<tr>
<td>4/15</td>
<td>Broadband access over metallic conductors</td>
</tr>
<tr>
<td>5/15</td>
<td>Characteristics and test methods of optical fibres and cables, and installation guidance</td>
</tr>
<tr>
<td>6/15</td>
<td>Characteristics of optical components, subsystems and systems for optical transport networks</td>
</tr>
<tr>
<td>7/15</td>
<td>Connectivity, Operation and Maintenance of optical physical infrastructures</td>
</tr>
<tr>
<td>8/15</td>
<td>Characteristics of optical fibre submarine cable systems</td>
</tr>
<tr>
<td>10/15</td>
<td>Interfaces, interworking, OAM, protection and equipment specifications for packet-based transport networks</td>
</tr>
<tr>
<td>11/15</td>
<td>Signal structures, interfaces, equipment functions, protection and interworking for optical transport networks</td>
</tr>
<tr>
<td>12/15</td>
<td>Transport network architectures</td>
</tr>
<tr>
<td>13/15</td>
<td><strong>Network synchronization and time distribution performance</strong></td>
</tr>
<tr>
<td>14/15</td>
<td>Management and control of transport systems and equipment</td>
</tr>
</tbody>
</table>
SG15 Meetings, 2022-24* Study Period

• Past meetings
  – Geneva, September 2022
  – Geneva, April 2023
  – Geneva, November 2023

• Future Meetings
  – Montreal, July 2024

• Interim Meetings, Correspondence activities, arranged by the Questions
  (on average 3 Interim meetings per year for Q13)

* Usually 4 years periods; it was adjusted this time due to impact from COVID-19
Q13: Scope of the Question

- Network synchronization and time distribution performance
  - Active since the 90s (sync for SDH in SG18)
  - Networks Timing Needs (e.g., OTN, MTN)
  - End Applications Timing Needs (e.g., 5G Base Stations)

- Distribution of Time-Phase and Frequency
  - Methods (e.g., over physical layer, via packets, GNSS)
  - Architectures
  - Clocks
  - PTP (IEEE 1588) profiles
  - Performance, Redundancy, Reliability, etc.

- Networks
  - Ethernet, IP-MPLS, OTN, xPON, MTN ...

Cooperating with other Questions in SG15
- Q11: sync for/over OTN, MTN
- Q14: Sync Management
- Q2, Q4: Sync in the access
- Q6: sync over fibers

.. and SDOs (IEEE1588, 3GPP, O-RAN, etc.)
Outputs from Q13

• SDH and before packet timing:
  • G.803, G.810, G.811, G.812, G.813, G.823, G.824, G.825
• OTN: G.8251
• Enhanced Primary Reference Clocks: G.811.1
• Synchronization Layer Functions:
  • G.781, G.781.1
• Network requirements, Clocks, PTP Profiles
  • G.827x series (distribution of time synchronization)
  • G.826x series (distribution of frequency synchronization)
• Supplements:
  • G.Suppl65 (simulations on timing transport), G.Suppl68 (synchronization OAM requirements)
• Technical Report: GSTR-GNSS (Use of GNSS in Telecom)
Recent Results: ePRTC enhancements

- Enhanced PRTC is specified in G.8272.1. It can be implemented as a combination of a local atomic clock and a GNSS receiver.
- Target accuracy is 30 ns; Holdover characteristics are being improved.
  - 100 ns over 40 days Holdover
  - Parametric specification (holdover time vs. learning period)
Recent Results: cnPRTC

- cnPRTC (Coherent PRTC):
  - PRTCs network at the highest core or regional network level to maintain network-wide ePRTC time accuracy, even during periods of GNSS loss
  - Clock Recommendation (G.8272.2)
  - Network Requirements
  - Methods (high accuracy profile?)

| High-accuracy time transfer class | Maximum absolute time error – max|TE_L| (ns) |
|----------------------------------|----------------------------------|-----|
| A                                | 5 ns                             |
| B                                | 1 ns                             |
Recent Results: PTP Performance Monitoring Option

- **PTP Monitoring:**
  - options recently added to address various use cases
- **Network and clock monitoring:**
  - Support for IEEE 1588 standard Perf. Monitoring methodology (G.8275 Annex F)
  - When available measurements collected vs. a local GNSS receiver
Ongoing Studies: PTP Profiles evolution

• Use of the «Enhanced Accuracy TLV» for estimating accumulated Time Error, with potential definition of a modified Alternate BMCA

• PTP Security:
  • ongoing discussions (e.g., IEEE1588 Security TLV vs. MACsec)

• Network and clock monitoring
  • new TLV to carry GNSS-PTP time error

• Further enhancement to G.8275 Annex F to address new use cases

• Enhanced Partial Timing Support (“ePTS”)
  • Increased message rate (>128 packets per seconds)
  • Automatic asymmetry compensation via network management or local adjustments
Ongoing Studies: Timing delivery over 5GS

- Impact from integration of 5GS (5G System) with Industrial Automation application, and in general when timing is carried over 5GS
- Liaisons exchanged with 3GPP to understand the impact on current time sync architecture
- Examples being added in G.8271.1 based on new network limits (max|TE| < 600 ns)
Future Studies

• Synchronization continues to be a fundamental function as networks and applications evolve

• Among new items being studied or that may be considered in the future:
  • Emerging needs in mobile networks (e.g., 5G evolution) and connected applications
  • Support for enhanced synchronization network management and monitoring
  • High accuracy timing over optical pluggables
  • Support for enhanced security solutions
  • Continue to enhance robustness and reliability in the network synchronization solutions (e.g., as related to GNSS backup synchronization references)
  • Timing resiliency over 5G is a new item of interest
  • Enhanced Partial Timing Support
  • Needs of new applications with particularly stringent timing requirements (e.g., quantum key distribution (QKD) related applications have been mentioned)
  • Synchronization for Datacenters?
SG15 - Networks, technologies and infrastructures for transport, access and home (itu.int)
List of Questions and Rapporteurs (itu.int)
Getting involved in Q13

- Q13 meets periodically, generally face-to-face (3-4 times per year), with eMeetings as needed
- Next meeting: SG15 Plenary (Montreal, 1 - 12 July 2024), [4] Meeting of Study Group 15; Montreal, Canada, 1-12 July 2024 (itu.int)
- Where to find additional information (URL links):
  - SG15 Home Page: SG15 - Networks, technologies and infrastructures for transport, access and home (itu.int)
  - Q13/15 Terms of Reference: Text of the Question (itu.int)
  - How to become a member: Become a member- ITU/ UN Tech agency
- Contacts:
  - Hiroshi Ota (hiroshi.ota@itu.int) SG15 Advisor
  - Stefano Ruffini (Stefano.Ruffini@calnexsol.com) Q13 Rapporteur
  - Silvana Rodrigues (silvana.rodrigues@huawei.com) Q13 Associate Rapporteur