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

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Study Group 15 (SG15) mandate

2022-2024 Study Period
SG15 is the Lead Study Group on :

- access network transport
- home networking
- optical technology

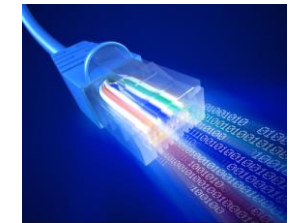✓ **The LARGEST and MOST PRODUCTIVE group in ITU-T with broad, global industry participation**

Home Networking

Smart Grid

High Speed Access

Transport Technologies

The Optical Transport Network

SG15 Working Parties (WPs)

- **WP1/15**: Transport aspects of access, home and smart grid networks

- **WP2/15**: Optical technologies and physical infrastructures

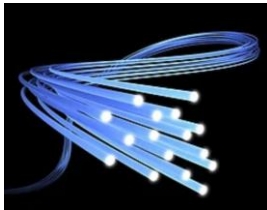- **WP3/15**: Transport network characteristics

WP1 – Broadband Access

G.fastback

Multi-Gigabit copper backhaul

MGfast

Next generation
copper access 5-10 Gbps

High speed
fibre-based in-premises
transceivers (G.fin)

Optical systems for access networks
Bidirectional P2P
XGS-PON, NG-PON2
50G-PON, WDM-PON

Free space optical
home networking

Continue collaboration with
broadband forum

Powerline
communication
(PLC)

G.RoF

PON support for mobile
front/backhaul, Radio over fiber

G.Hn and G.hn2 home
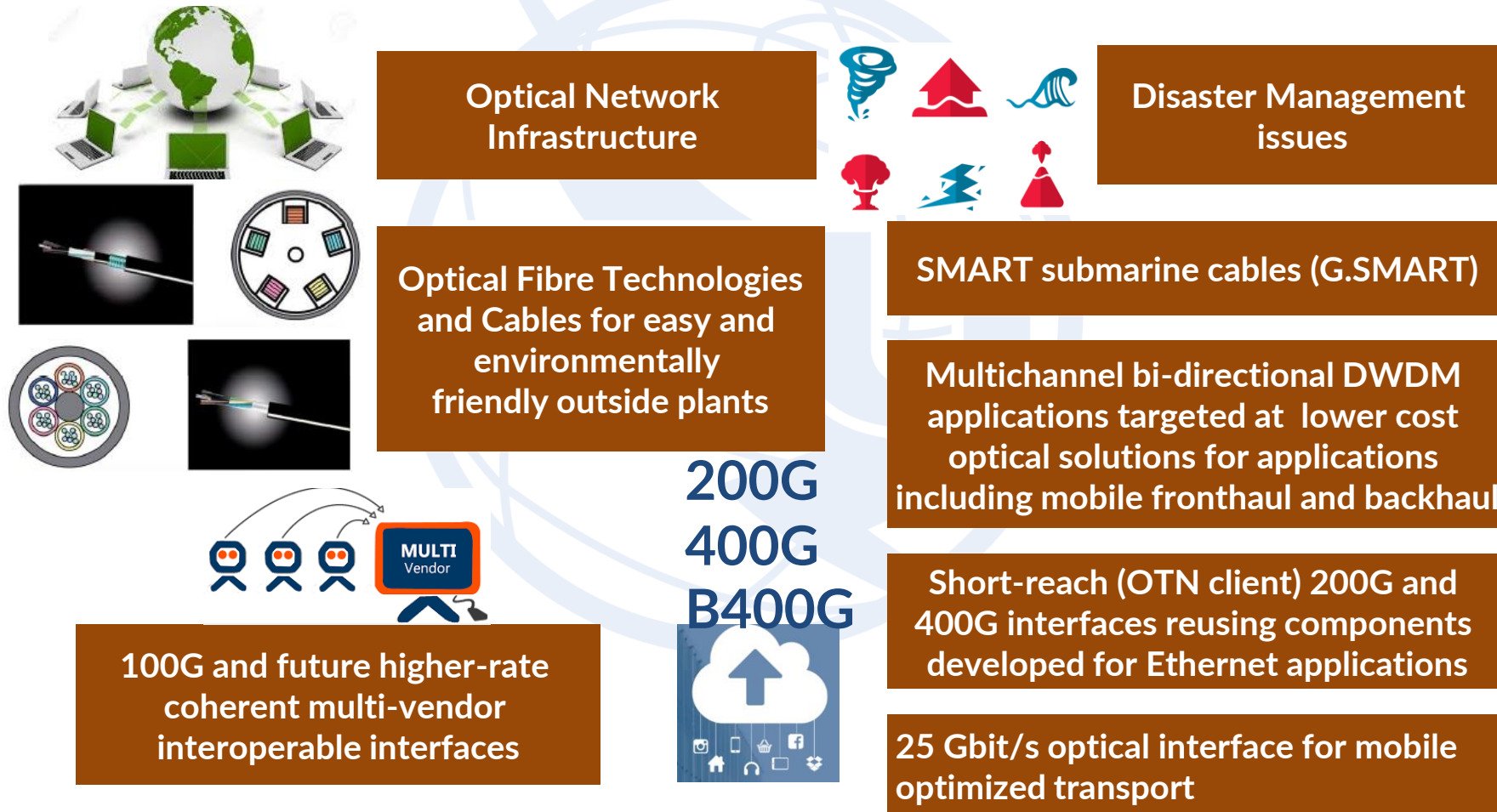networking over indoor
phone, power, and coax
wires >2 Gbps

WP2 – Optical Technologies

Optical Network Infrastructure

Disaster Management issues

Optical Fibre Technologies and Cables for easy and environmentally friendly outside plants

SMART submarine cables (G.SMART)

Multichannel bi-directional DWDM applications targeted at lower cost optical solutions for applications including mobile fronthaul and backhaul

200G 400G B400G

100G and future higher-rate coherent multi-vendor interoperable interfaces

Short-reach (OTN client) 200G and 400G interfaces reusing components developed for Ethernet applications

25 Gbit/s optical interface for mobile optimized transport

WP3 – Optical Transport Networks

Transport and synchronization supporting 5G mobile fronthaul and backhaul

Synchronization of packet Networks, MTN and future OTN networks, e.g., beyond 400G

G.83xx (metro transport network) for 5G optimized transport

Network survivability (protection and restoration)

Architecture and other Transport SDN Aspects

New "B400G" OTN interfaces, including the use of coherent G.698.2 interfaces

Management aspects of control and transport planes

Equipment & management specifications for OTN, Ethernet and MPLS-TP

Core Information model enhancement for management of synchronization and optical media

List of Questions

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

WP 3

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
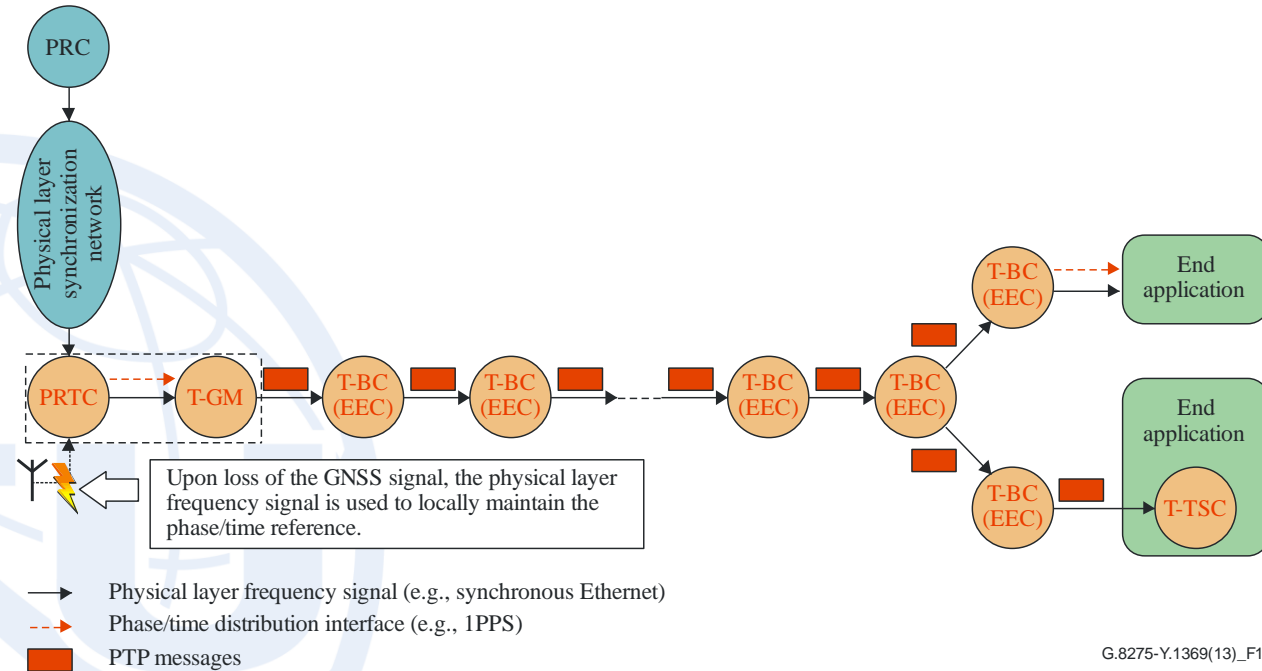
- **Network synchronization and time distribution performance**
  - Active since the 90s (sync for SDH in SG18)
  - Networks Timing Needs (e.g., OTN, MTN)
  - End Applications Timing Needs (e.g., 5G Base Stations)
- Distribution of Time-Phase and Frequency
  - Methods (e.g., over physical layer, via packets, GNSS)
  - Architectures
  - Clocks
  - PTP (IEEE 1588) profiles
  - Performance, Redundancy, Reliability, etc.
- Networks
  - Ethernet, IP-MPLS, OTN, xPON, MTN ...

Upon loss of the GNSS signal, the physical layer frequency signal is used to locally maintain the phase/time reference.

→ Physical layer frequency signal (e.g., synchronous Ethernet)
⇢ Phase/time distribution interface (e.g., 1PPS)
▬ PTP messages

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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.)

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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)

ITUPublications
Recommendations

International Telecommunication Union
Standardization Sector

Recommendation
ITU-T G.8273/Y.1368 (06/2023)

SERIES G: Transmission systems and media, digital systems and networks

Packet over Transport aspects – Synchronization, quality and availability targets

SERIES Y: Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

Internet protocol aspects – Transport

**Framework of phase and time clocks**

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

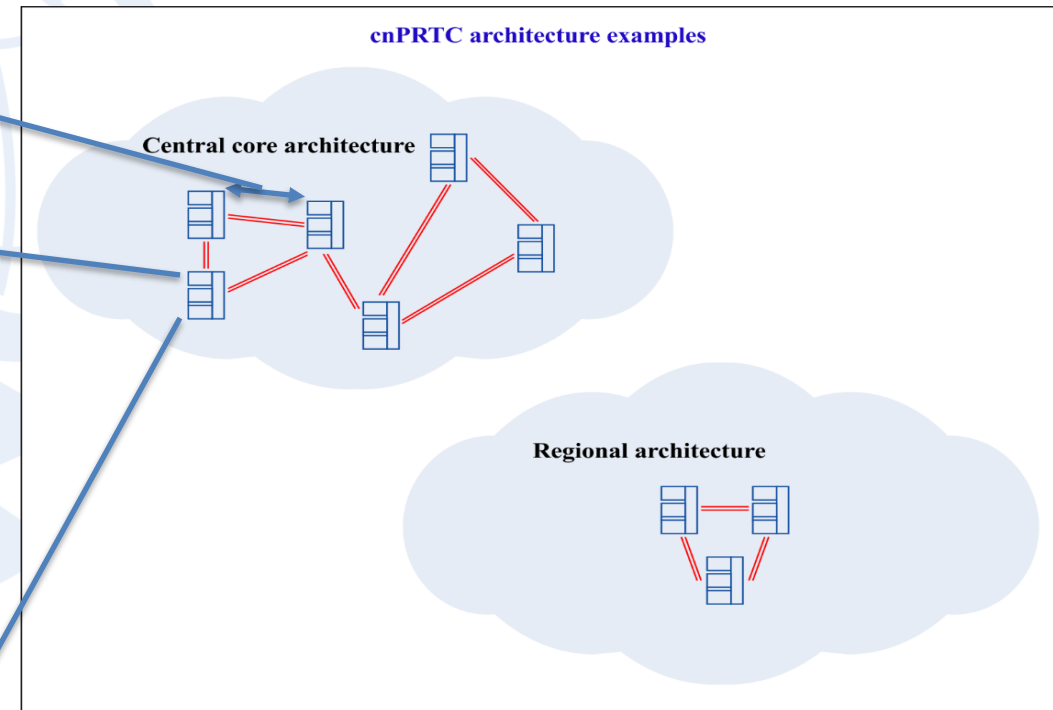 - Parametric specification (holdover time vs. learning period)

Days of Holdover
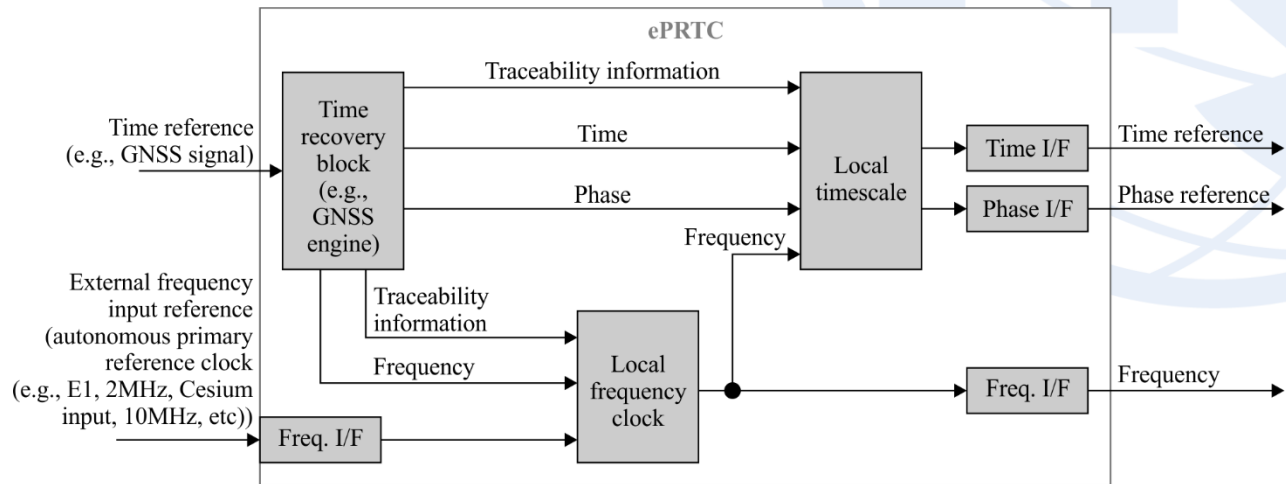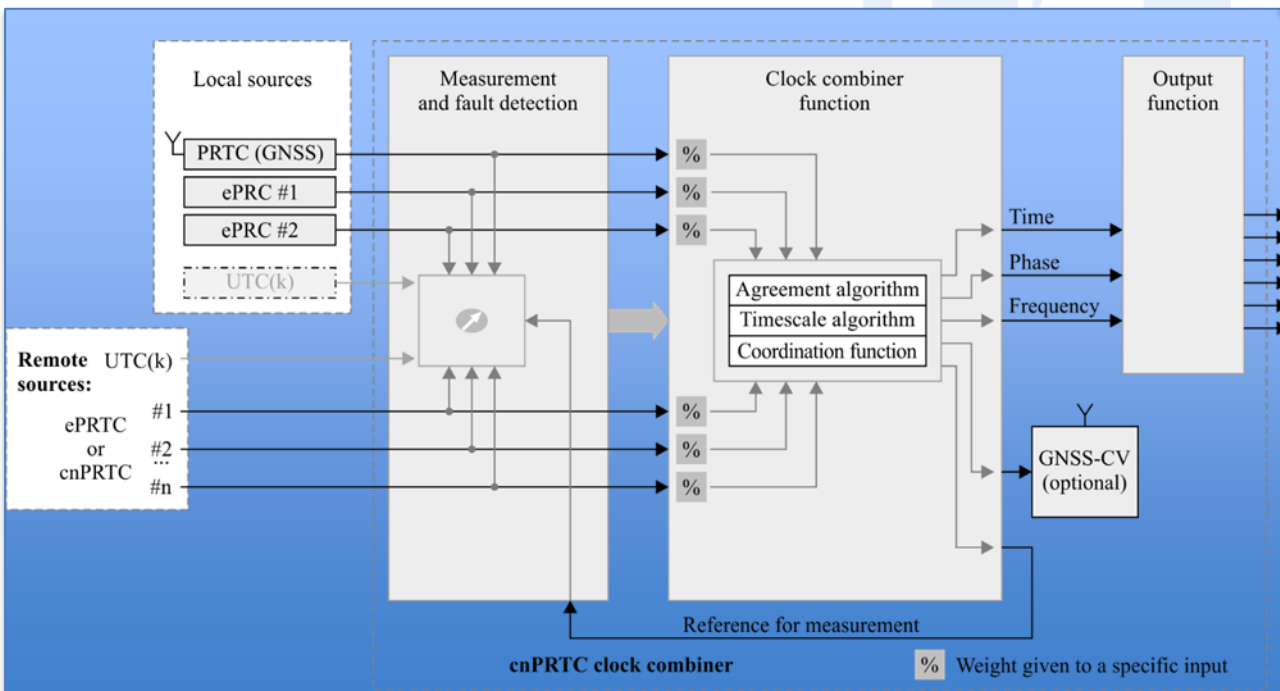

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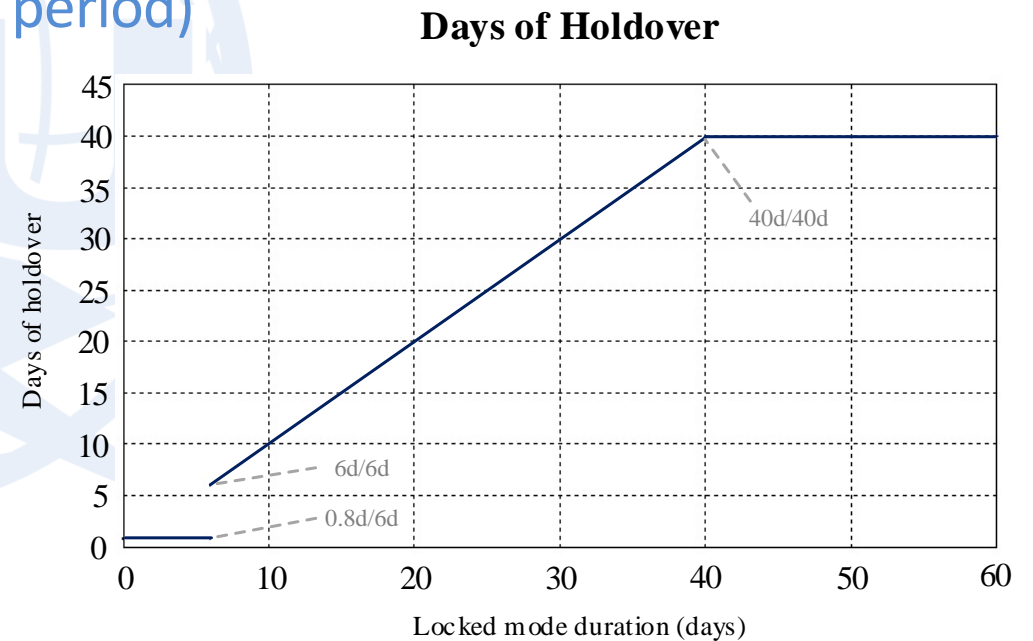
Recent Results: cnPRTC

- 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

cnPRTC architecture examples

Central core architecture

Regional architecture

G.8275-Y.1369(17)-Amd.1(18)_FVI.1

Local sources

Measurement and fault detection

Clock combiner function

Output function

PRTC (GNSS)

ePRC #1

ePRC #2

UTC(k)

Remote sources:
UTC(k)

ePRTC or cnPRTC
#1
#2
...
#n

Agreement algorithm
Timescale algorithm
Coordination function

Time

Phase

Frequency

GNSS-CV (optional)

Reference for measurement

cnPRTC clock combiner

% Weight given to a specific input

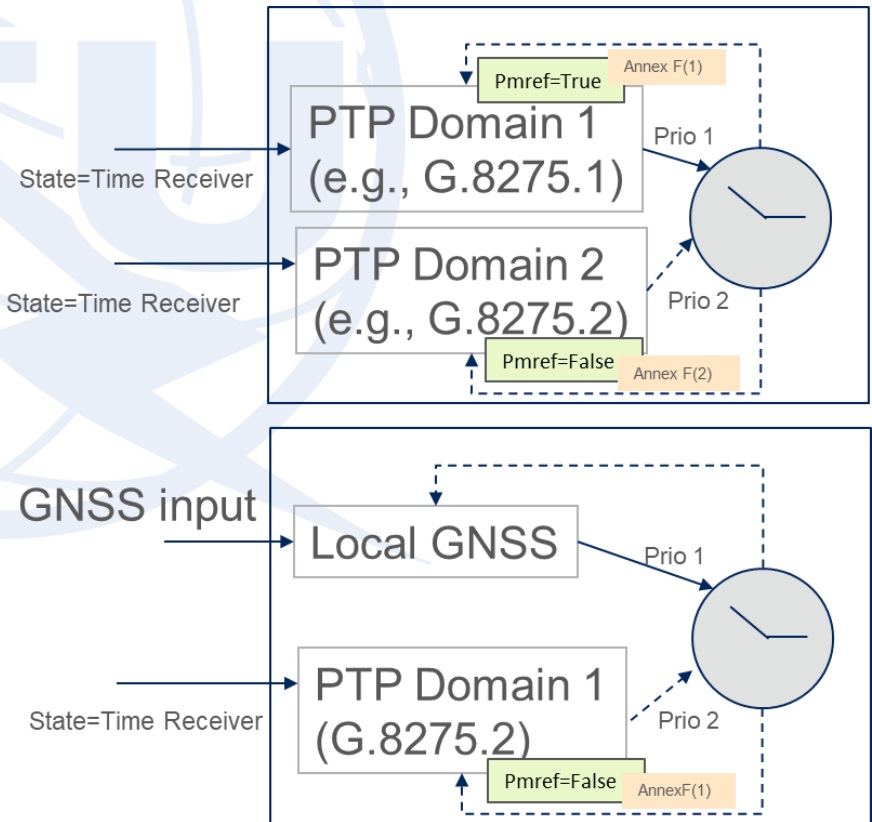G.8275-Y.1369(17)-Amd.2(19)_FVI.3

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
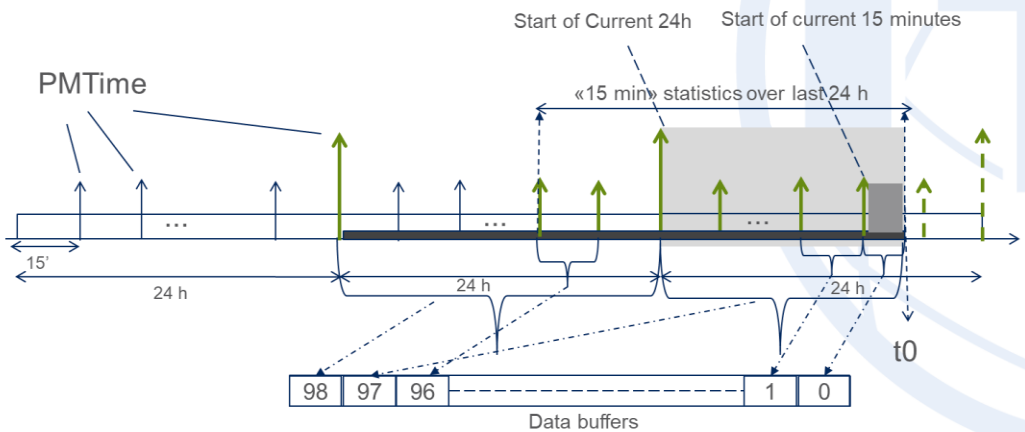
Ongoing Studies: PTP Profiles evolution

- 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
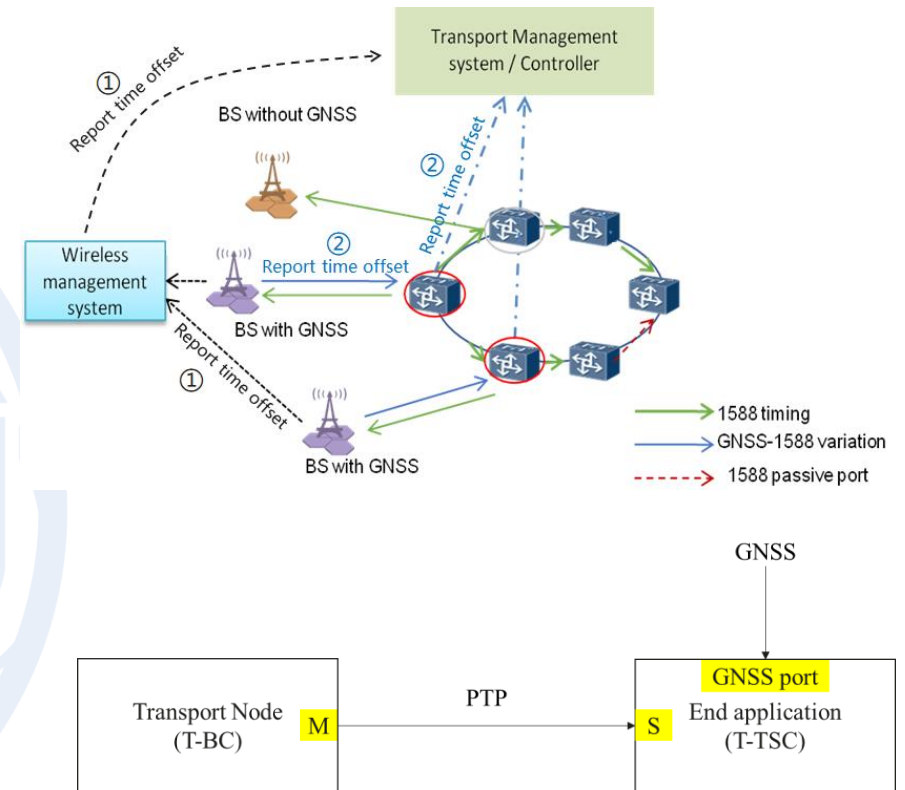
Ongoing Studies: Timing delivery over 5GS

- 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)
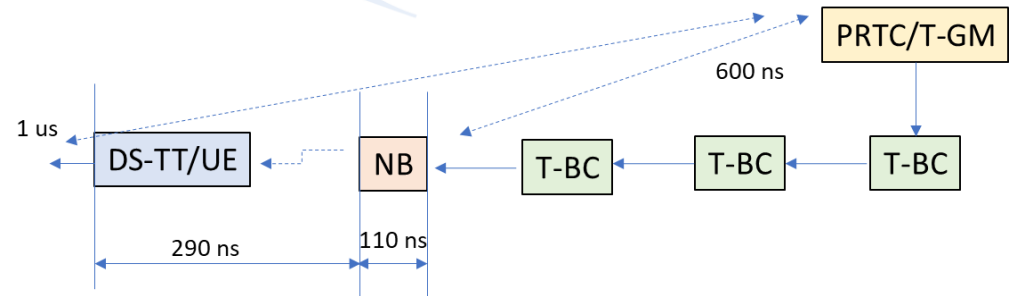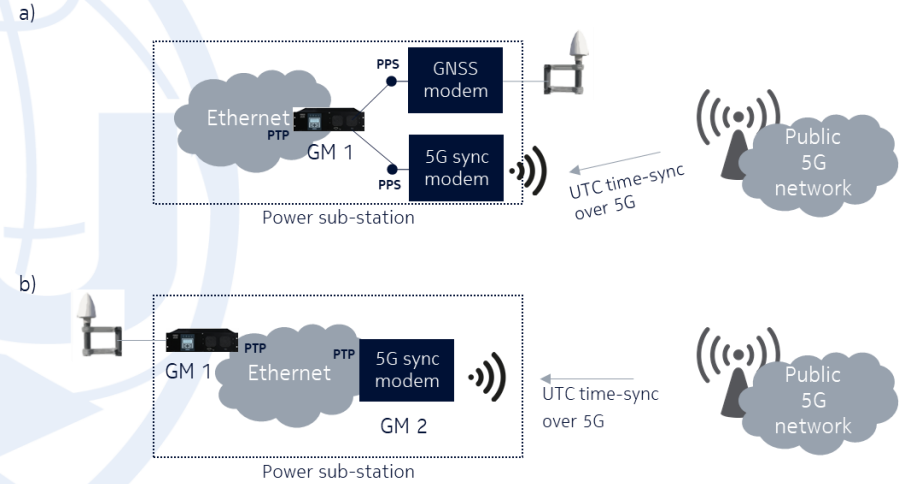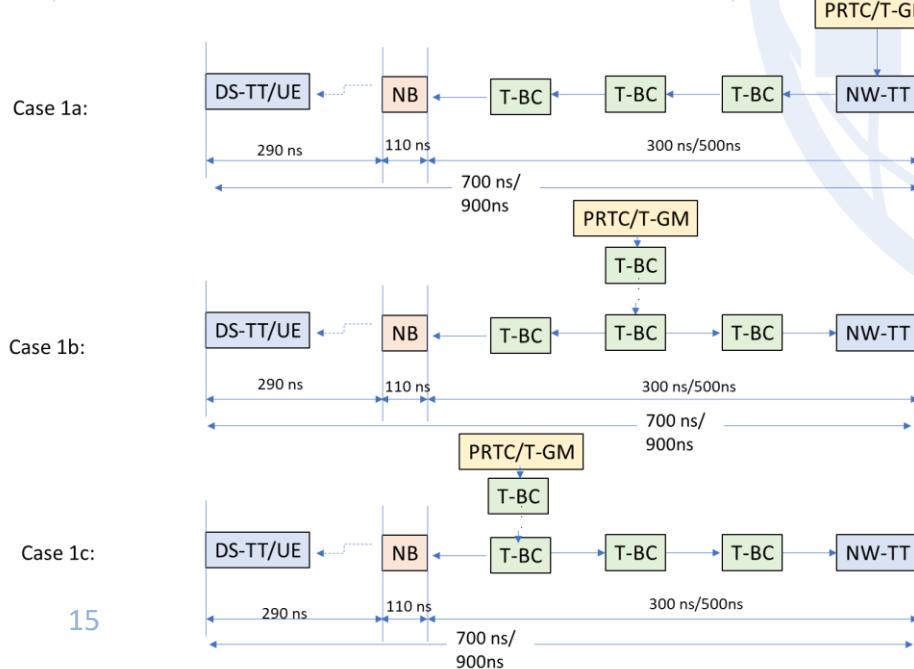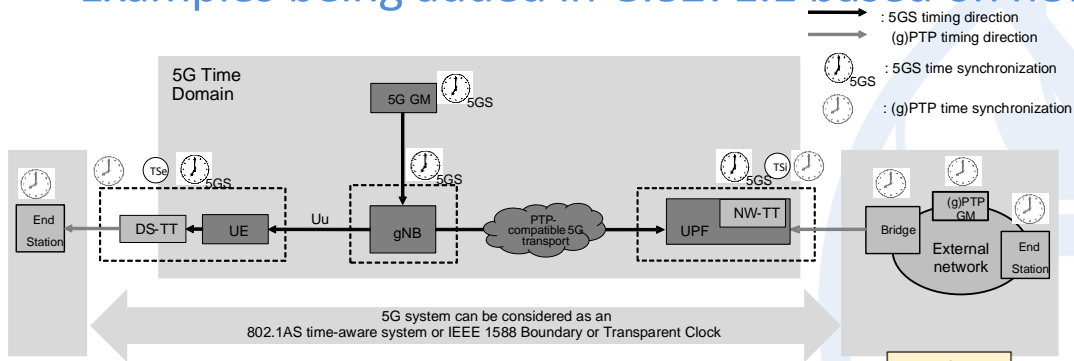
Future Studies

- 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:

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