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

New Study Period started in March 2022.
SG15 is confirmed as Lead Study Group on :

- **access network transport**
- **home networking**
- **optical technology**

Home Networking

Smart Grid

High Speed Access

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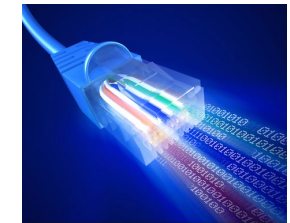
Transport Technologies

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

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

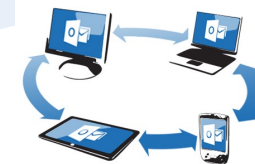Equipment & management specifications for OTN, Ethernet and MPLS-TP

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

5G MTN

BEYOND 400G

Optical Transport Networks

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

- Future Meetings
  - Geneva, November 2023
  - TBD, mid-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

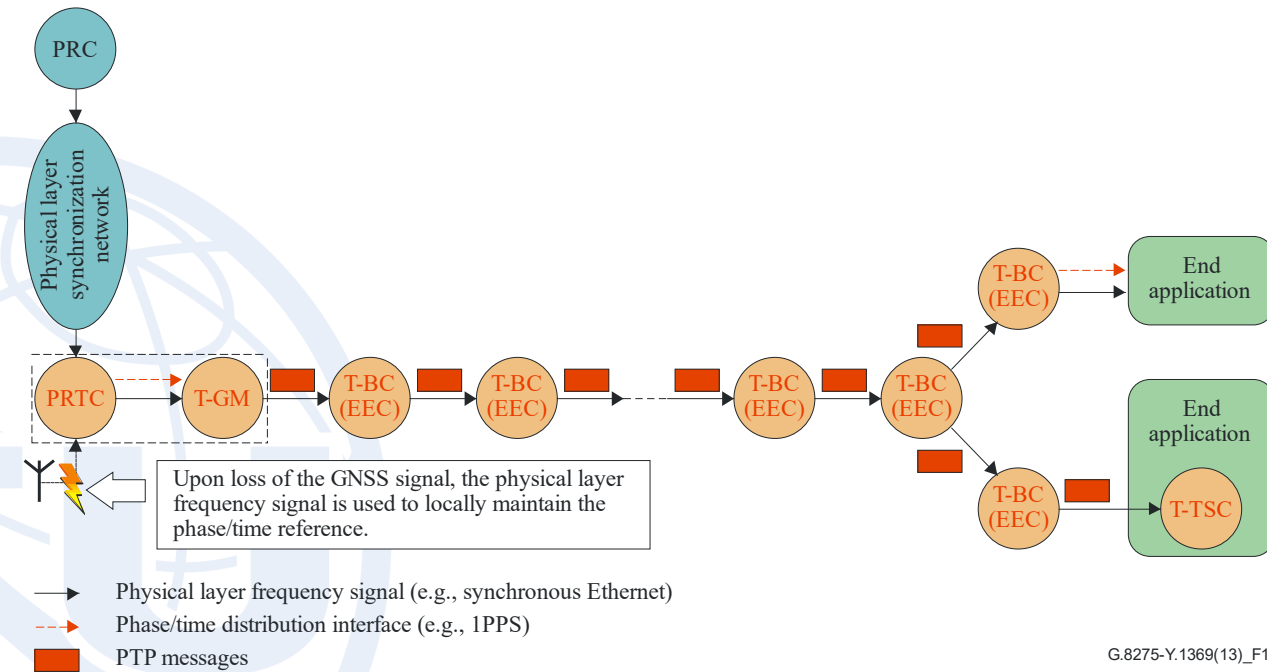- **Network synchronization and time distribution performance**
  - Active since the 90s (sync for SDH in SG18)
  - Networks Timing Needs (e.g., OTN, MTN)
  - End Applications Timing Needs (e.g., 5G Base Stations)
- Distribution of Time-Phase and Frequency
  - Methods (e.g., over physical layer, via 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

G.8275-Y.1369(13)_F10

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.)

9

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

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)

- PTP Monitoring:
  - options recently added to address various use cases

- Network and clock monitoring:
  - Support for IEEE 1588 standard methodology (Annex J Performance Monitoring parameters) in the Telecom profiles (New Annex F in G.8275)
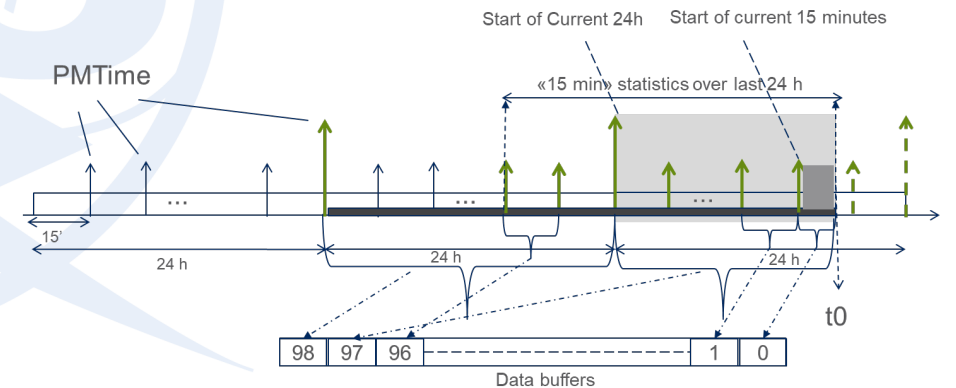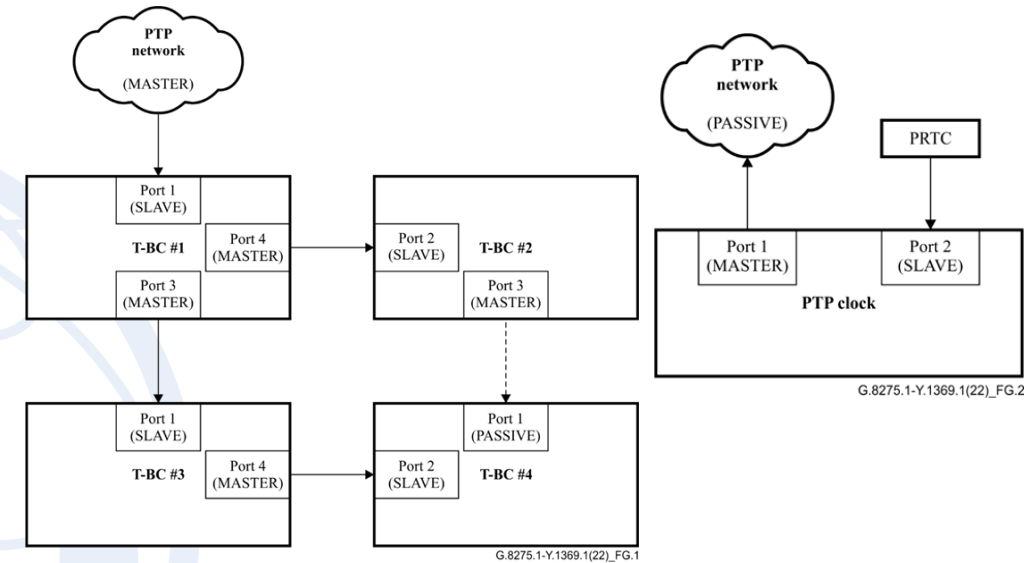
Ongoing Studies: ePRTC enhancements

- 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
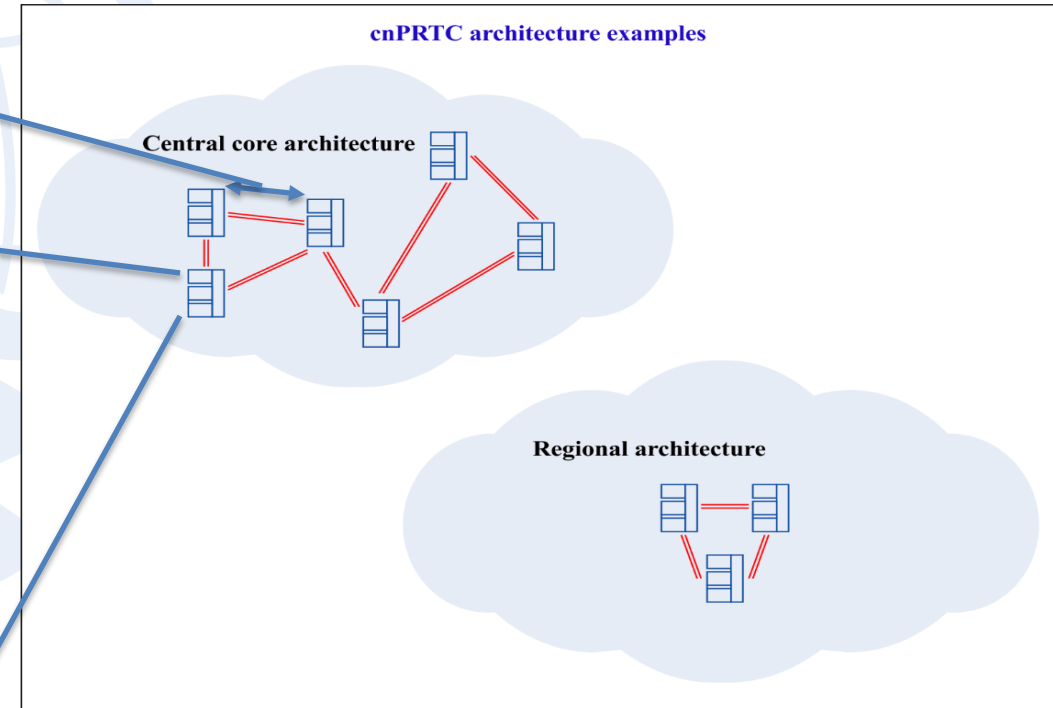 - Parametric specification (holdover time vs. learning period)

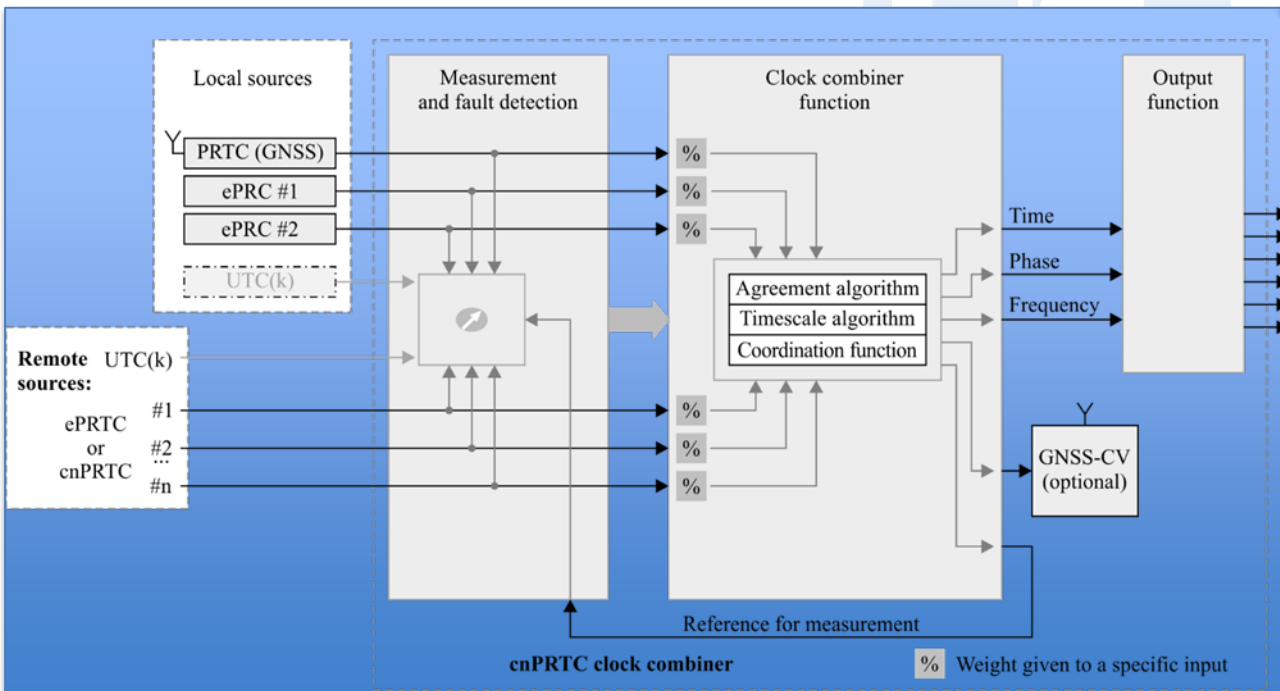G.8272.1-Y.1367.1(16)_FI.1

Days of Holdover
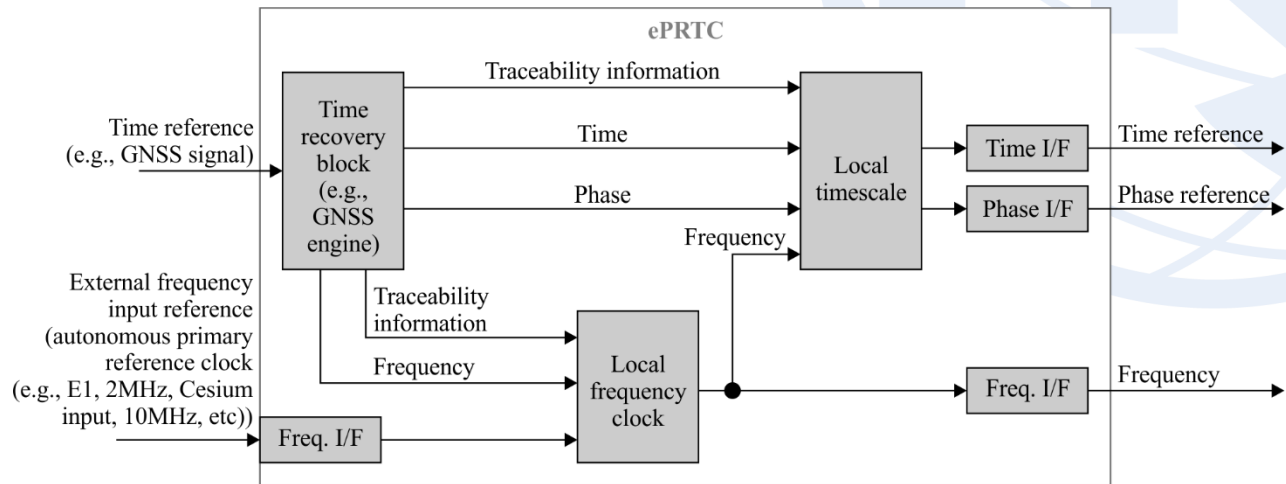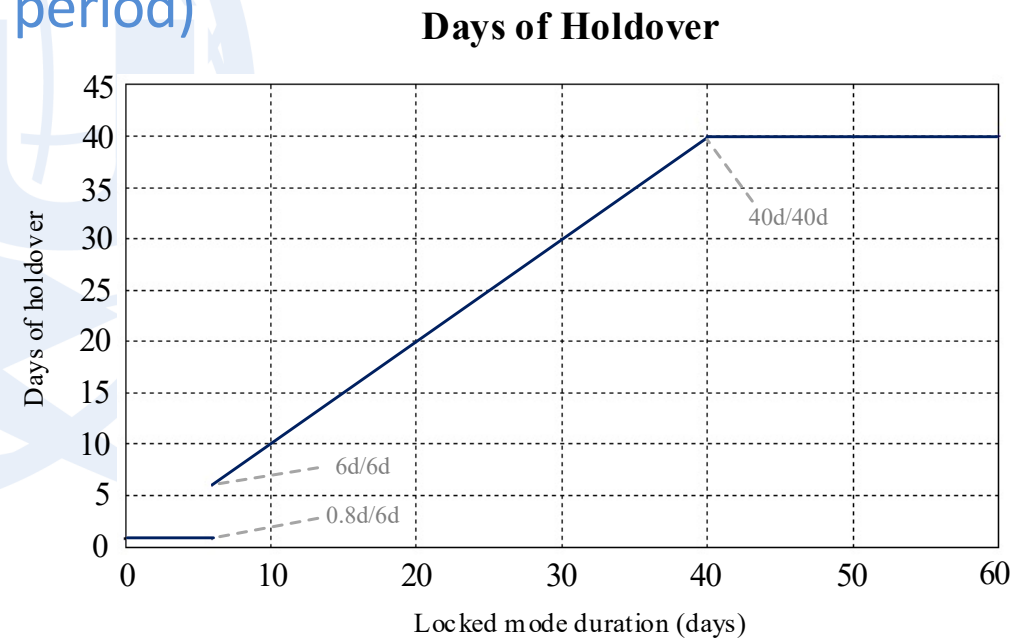
Ongoing Studies: cnPRTC

- 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
- Network Requirements
- Methods (high accuracy profile?)
- Clock Recommendation (G.8272.2)

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

PRTC (GNSS)
ePRC #1
ePRC #2
UTC(k)

Measurement and fault detection

Clock combiner function

Agreement algorithm
Timescale algorithm
Coordination function

Output function

Time
Phase
Frequency

Remote sources:
UTC(k)
ePRTC or cnPRTC #1 #2 ... #n

GNSS-CV (optional)

Reference for measurement

cnPRTC clock combiner

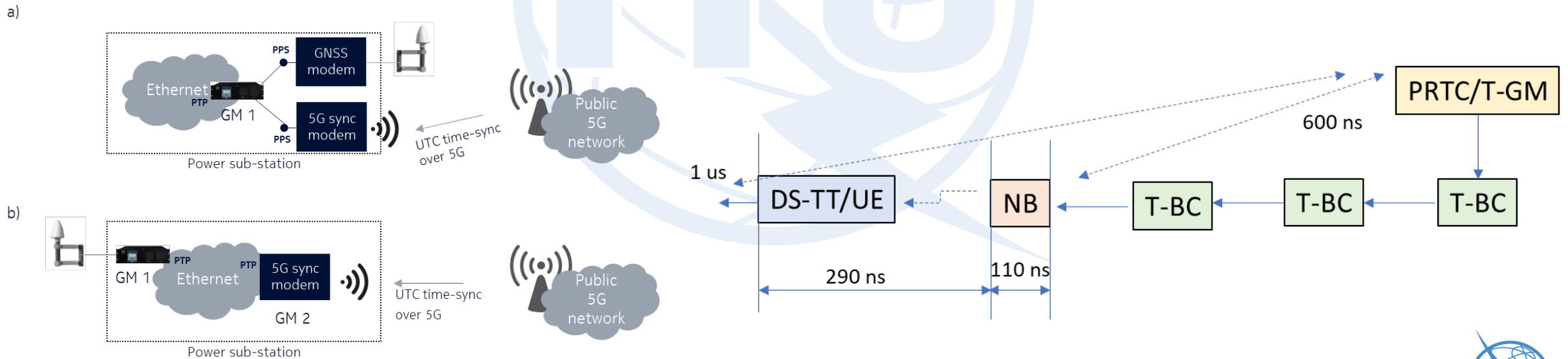% Weight given to a specific input

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

New Studies:
Timing delivery over 5GS

- Q13 is starting to consider the impact from integration of 5GS (5G System) with Industrial Automation application, and in general when timing is carried over 5GS
  - Liaison exchanged with 3GPP last year 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)

a)

Ethernet
PTP
GM 1

PPS
GNSS modem

5G sync modem
PPS

Power sub-station

UTC time-sync over 5G

Public 5G network

b)

GM 1
PTP
Ethernet
PTP
5G sync modem
GM 2

Power sub-station

UTC time-sync over 5G

Public 5G network

1 us

DS-TT/UE

NB

T-BC

T-BC

T-BC

PRTC/T-GM

600 ns

290 ns   110 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
  - "Time Transfer Overlay Network" ? (new timing technique for a partial timing support via very high rate for the timing messages, including automatic asymmetry control)
  - 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 (Geneva, 20 November - 1 December 2023), [3] Meeting of Study Group 15; Geneva, 20 November - 1 December 2023 (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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