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**

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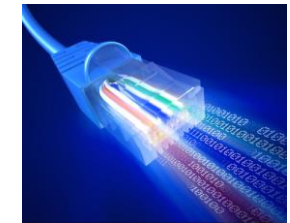
Home Networking

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

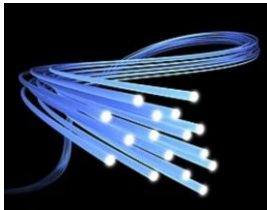- **WP3/15**: Transport network characteristics

WP1 – Broadband Access

G.fastback

Multi-Gigabit copper backhaul

MGfast

Next generation
copper access 5-10 Gbps

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

Continue collaboration with
broadband forum

G.RoF

PON support for mobile
front/backhaul, Radio over fiber

Fiber networking inside
the premises

Free space optical
home networking

Powerline
communication
(PLC)

G.Hn

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

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

200G 400G

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

5G MTN

BEYOND 400G

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

Optical Transport Networks

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

List of Questions

Question Number	Question title	Status
1/15	Coordination of Access and Home Network Transport Standards	Continued
2/15	Optical systems for fibre access networks	Continued
3/15 (former 18/15)	Technologies for in-premises networking and related access applications	Continued
4/15	Broadband access over metallic conductors	Continued
5/15	Characteristics and test methods of optical fibres and cables, and installation guidance	Continuation of Question 5/15 and part of Question 16/15
6/15	Characteristics of optical components, subsystems and systems for optical transport networks	Continued
7/15 (former 16/5)	Connectivity, Operation and Maintenance of optical physical infrastructures	Continuation of part of Question 16/15 and Question 17/15
8/15	Characteristics of optical fibre submarine cable systems	Continued
10/15	Interfaces, interworking, OAM, protection and equipment specifications for packet-based transport networks	Continued
11/15	Signal structures, interfaces, equipment functions, protection and interworking for optical transport networks	Continued
12/15	Transport network architectures	Continued
13/15	Network synchronization and time distribution performance	Continued
14/15	Management and control of transport systems and equipment	Continued

WP 3

SG15 Meetings, 2022-24* Study Period

- Past meetings
  - Geneva, 19-30 September 2022

- Future Meetings
  - Geneva, April 2023
  - 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
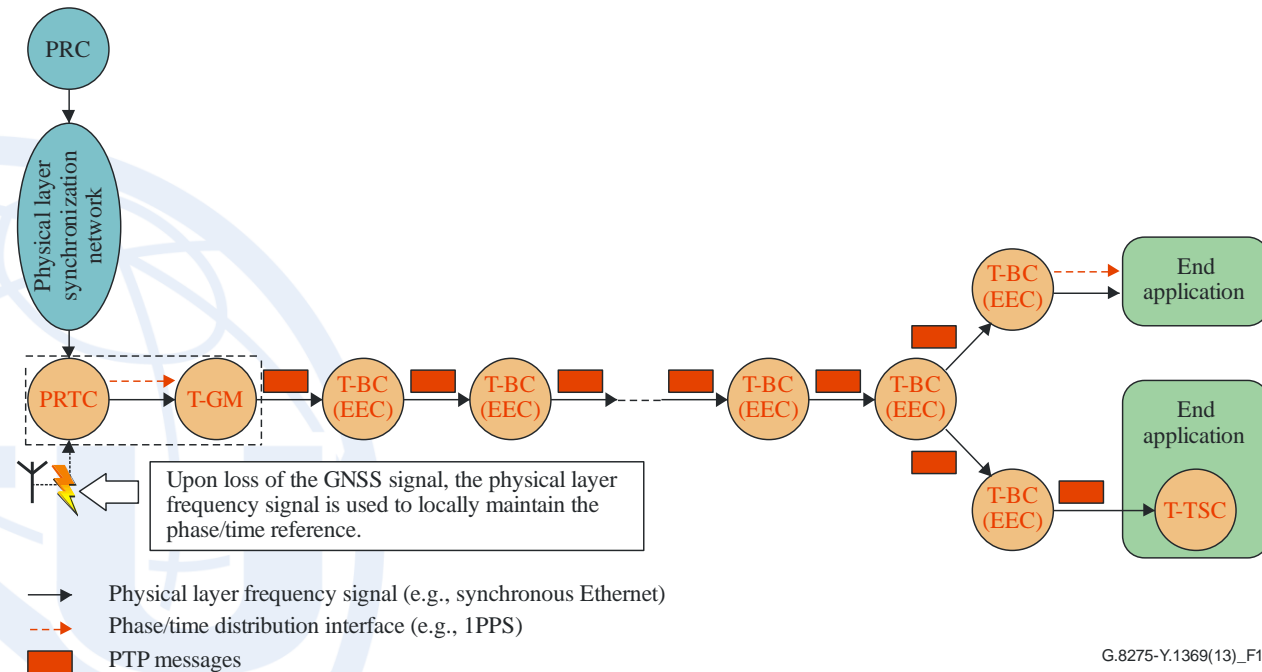
- **Network synchronization and time distribution performance**
  - Active since the 90s (sync for SDH in SG18)
  - Networks Timing Needs (e.g., OTN, MTN)
  - End Applications Timing Needs (e.g., 5G Base Stations)
- Distribution of Time-Phase and Frequency
  - Methods (e.g., over physical layer, via 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

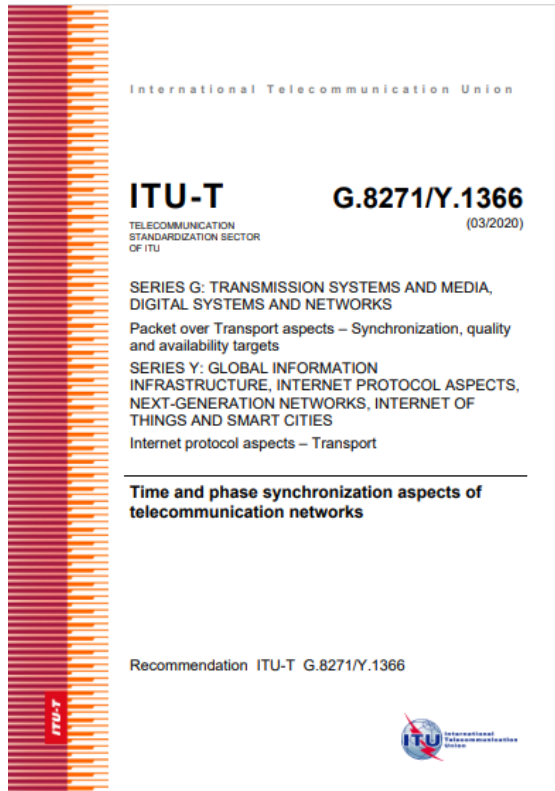G.8275-Y.1369(13)_F10

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
- Sync Layer Functions: G.781, G.781.1

International Telecommunication Union

ITU-T   **G.8271/Y.1366**

(03/2020)

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

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

**Time and phase synchronization aspects of
telecommunication networks**

Recommendation ITU-T G.8271/Y.1366

- G.826x series (distribution of **frequency synchronization**): Network requirements, Clocks, PTP Profiles

- G.827x series (distribution of **time synchronization**): Network Requirements, Clocks, PTP Profiles

- Supplements : G.Suppl65, G.Suppl68
- Technical Report: GSTR-GNSS

Ongoing Studies: PTP Profiles evolution

- Support for IEEE1588-2019 (all profiles) and details on Profile Interworking (G.8275) recently added
- Use of the «Enhanced Accuracy TLV» for estimating accumulated Time Error, with potential definition of a modified Alternate BMCA
- PTP Security: interest in adding an option for the security TLV
- PTP Monitoring: options recently added to address various use cases
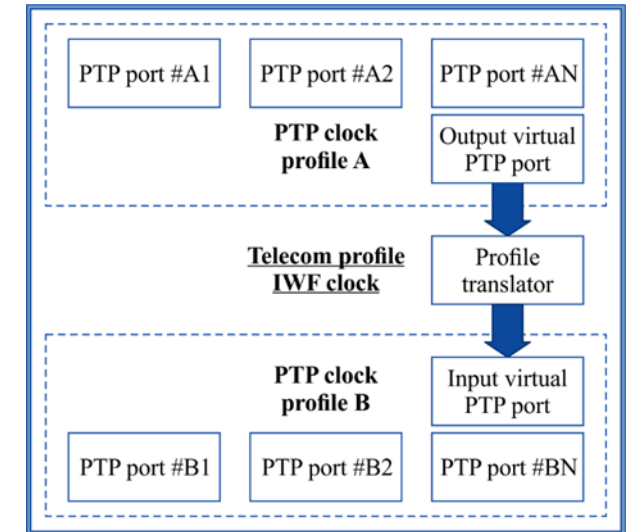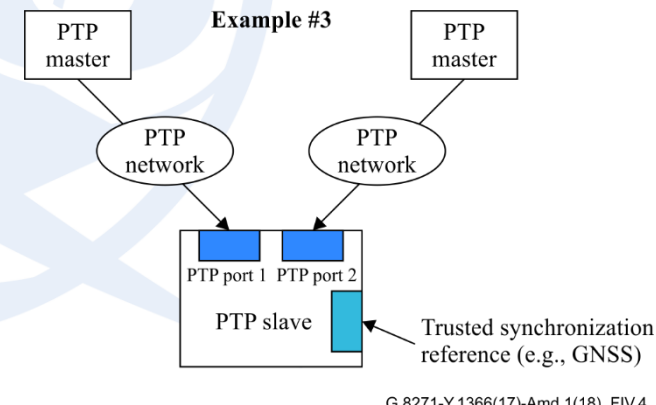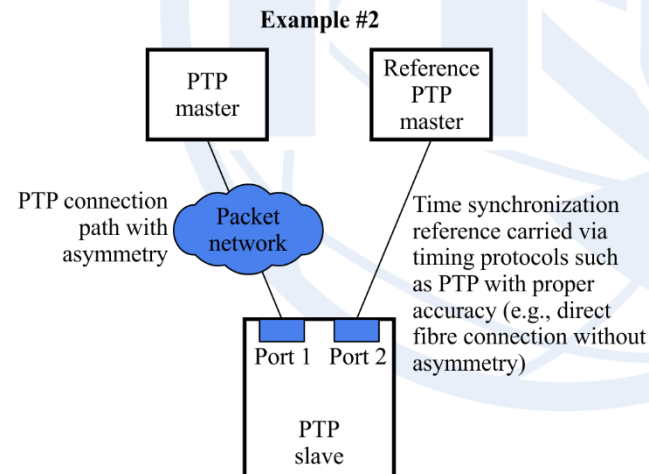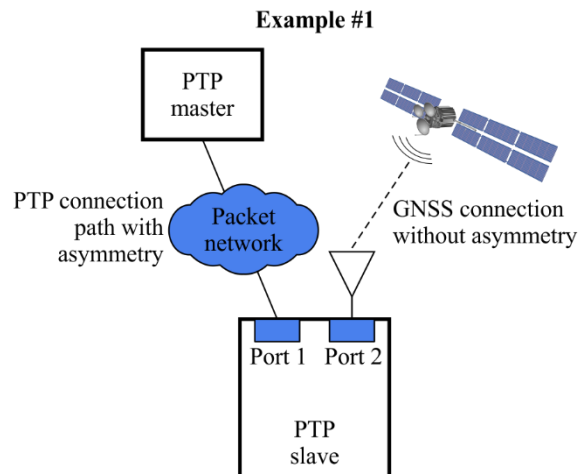
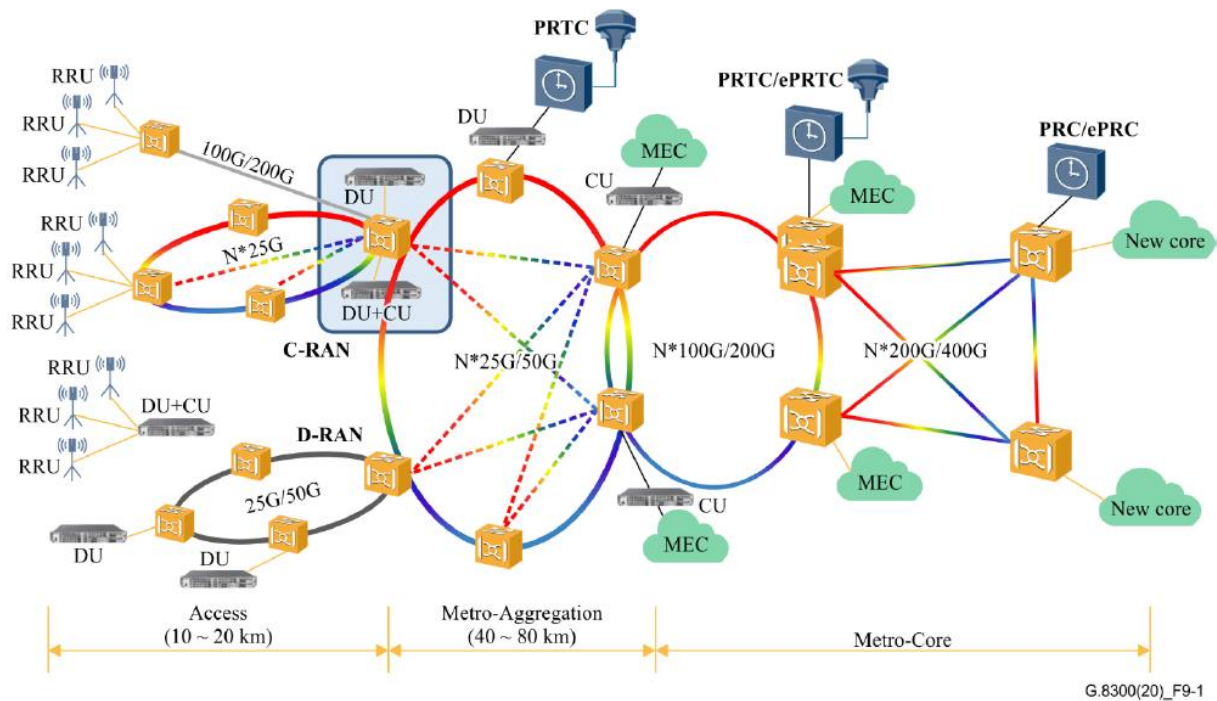- Network and clock monitoring: ongoing initiatives to include IEEE 1588 standard methodology (Annex J Performance Monitoring parameters) into the Telecom profiles

# Ongoing Studies: MTN (Metro Transport Network)

- Metro Transport Network:
Layer one transport network for 5G
Transport technology specified in the G.83xx series

G.8300(20)_F9-1

G.8310(20)_FA.1
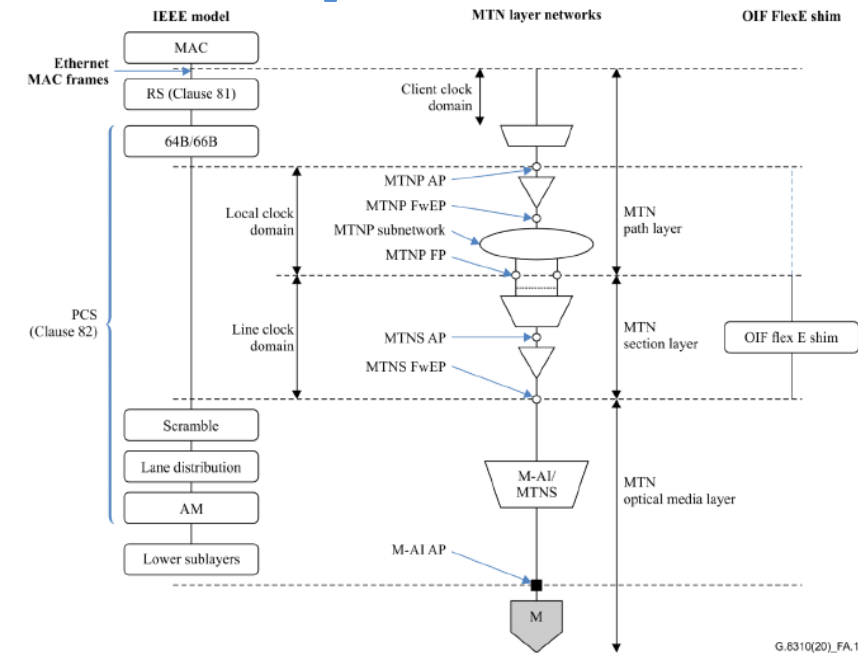
- *G.mtn-sync* under development, to address the related Sync aspects :
  - Sync Requirements
  - Sync Architecture
  - PTP and syncE distribution
  - Clocks
- Reference to existing Q13 Recommendations as applicable
(e.g., PTP profile based on G.8275.1)

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

  - the latest agreement is for maintaing 100 ns over 30 days Holdover

  - Ongoing discussion for a parametric specification (holdover time vs. learning period)
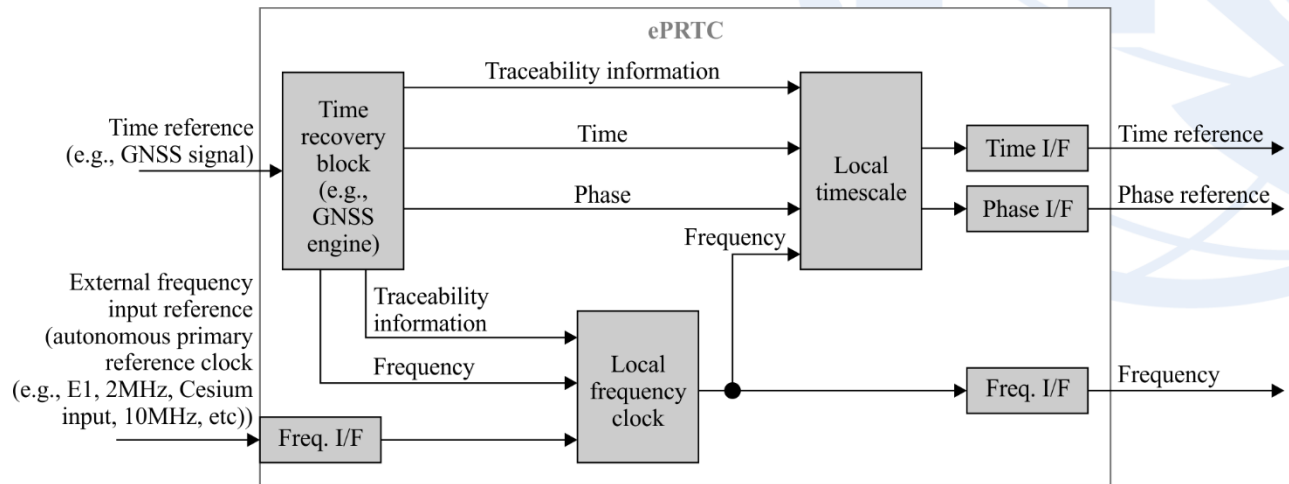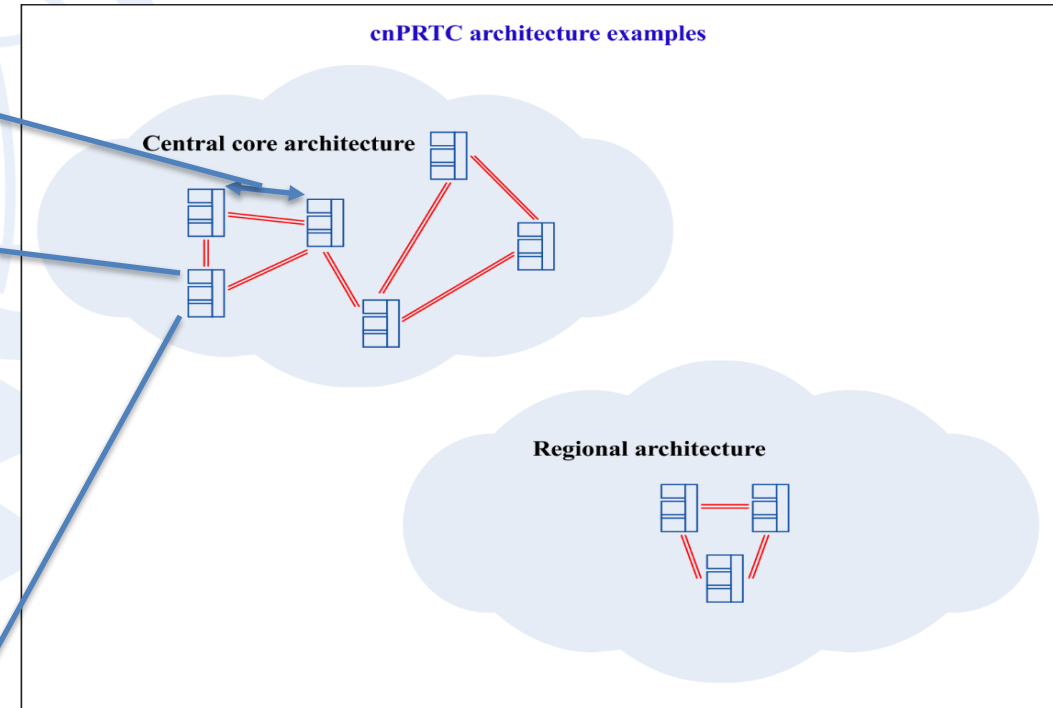

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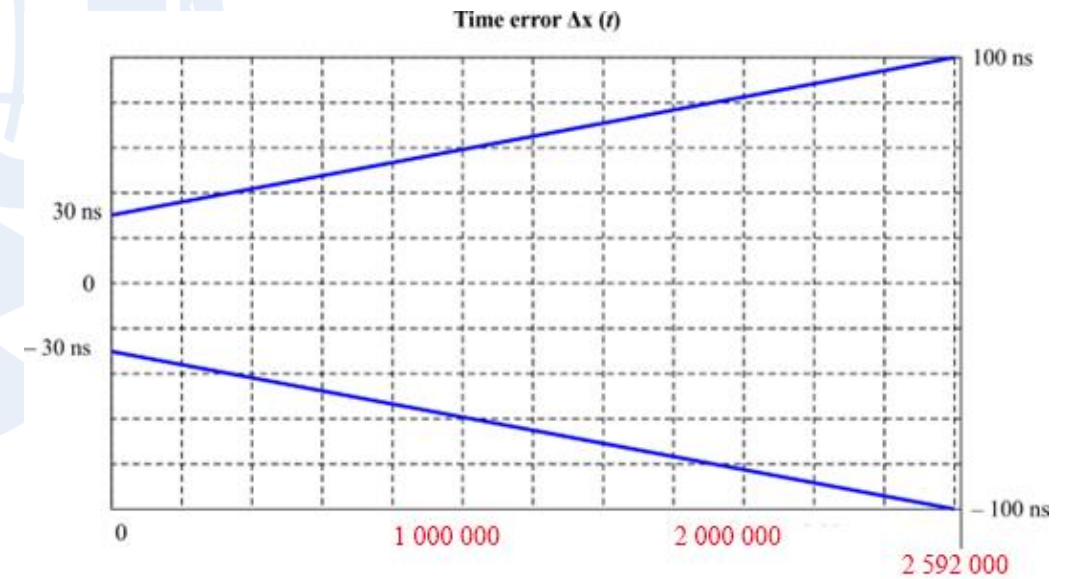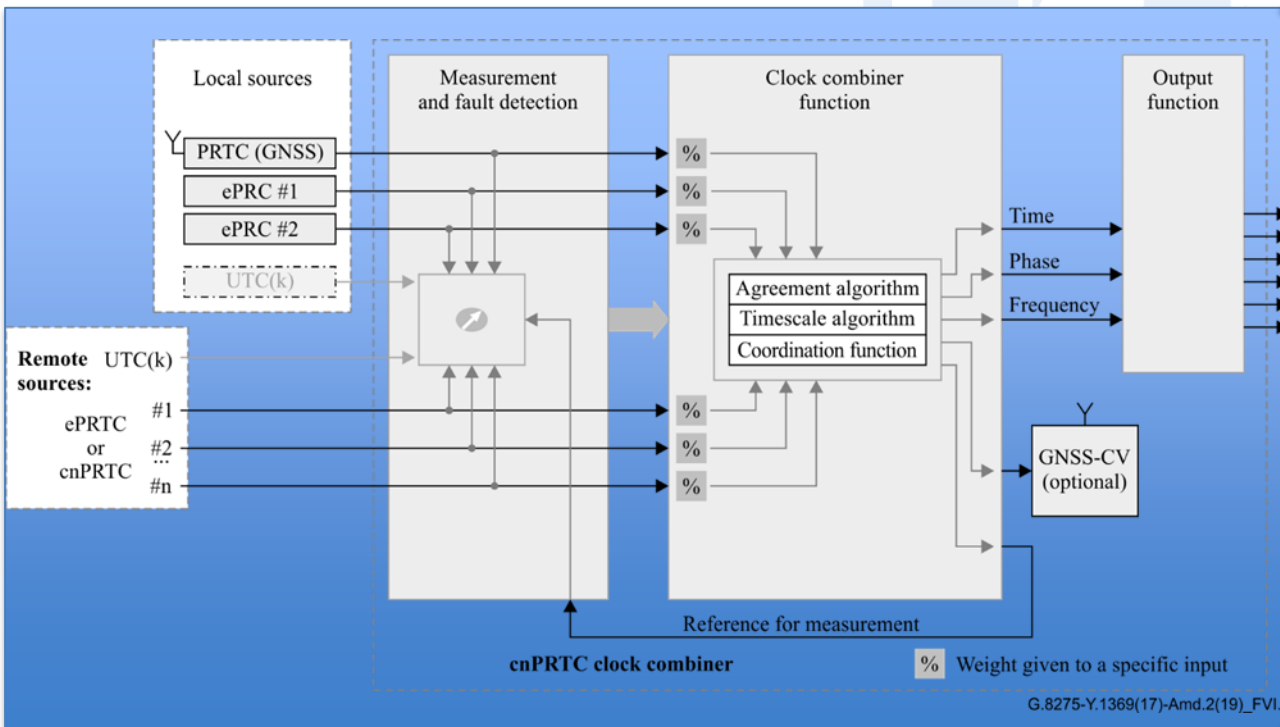

G.8272.1-Y.1367.1(16)_F03

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

Measurement and fault detection

Clock combiner function

Output function

PRTC (GNSS)

ePRC #1

ePRC #2

UTC(k)

Remote sources:

Remote 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

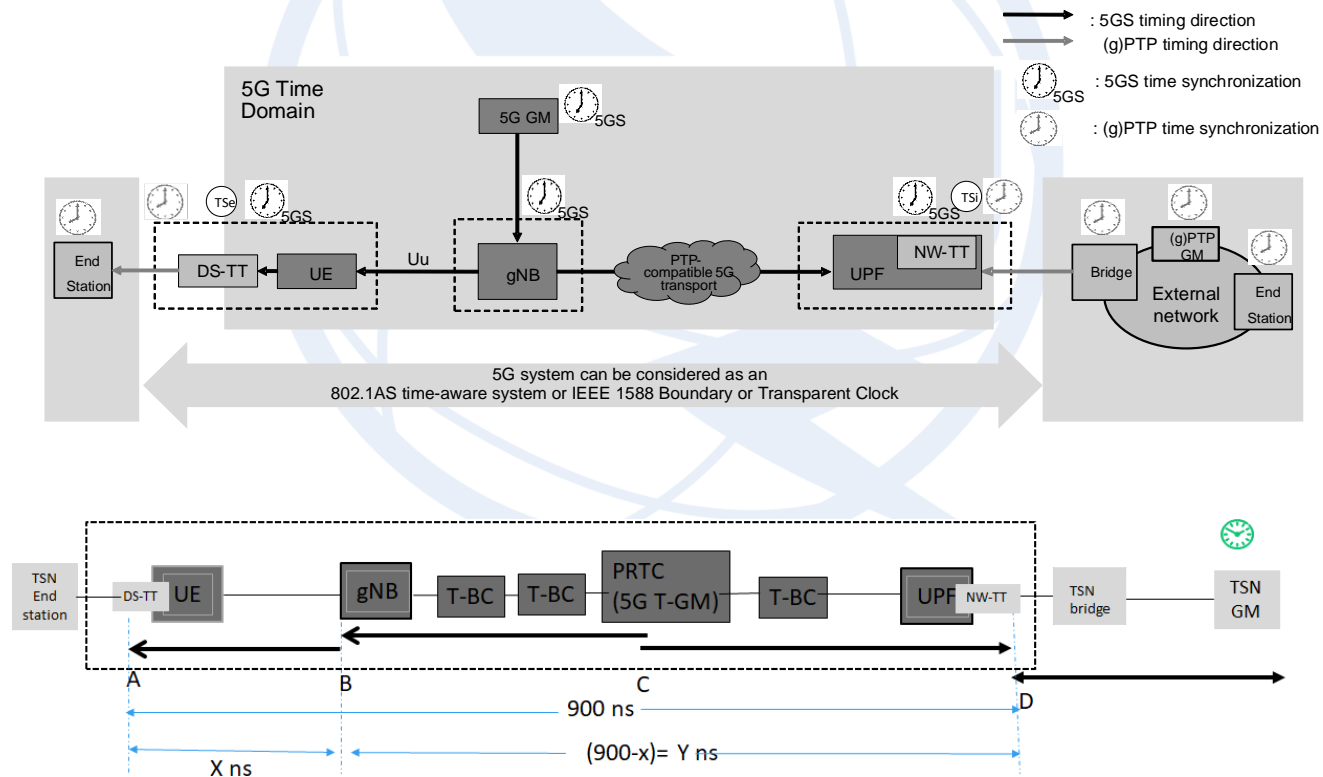% Weight given to a specific input

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

New Studies:
5G integration with Industrial Automation ?

- Q13 is starting to consider the impact from integration of 5G with Industrial Automation application
  - Liaison exchanged with 3GPP last year to understand the impact on current time sync architecture

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)
  - Needs of new applications with particularly stringent timing requirements (e.g., quantum key distribution (QKD) related applications have been mentioned)

SG15 - Networks, technologies and infrastructures for transport, access and home (itu.int)
List of Questions and Rapporteurs (itu.int)