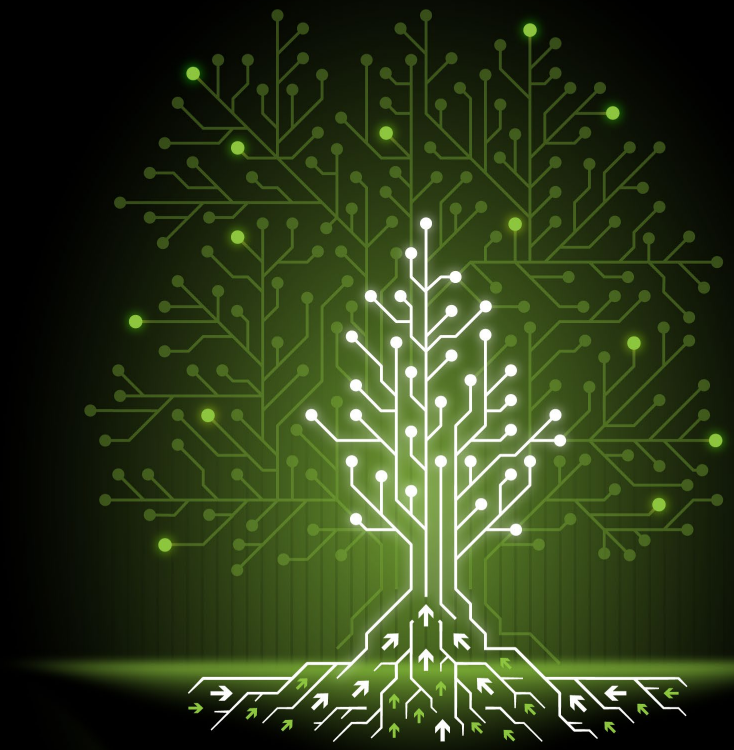
Standards for deploying synchronization in OCP

ITU-T SG15 Q13, Networks, Technologies and Infrastructures for Transport, Access and Home: Network synchronization and time distribution performance



Scaling Innovation Through Collaboration

OCP GLOBAL SUMMIT

OCTOBER 17-19, 2023
SAN JOSE, CA

TAP (Time Appliances Project)

TIME APPLIANCES

Standards for deploying synchronization in OCP

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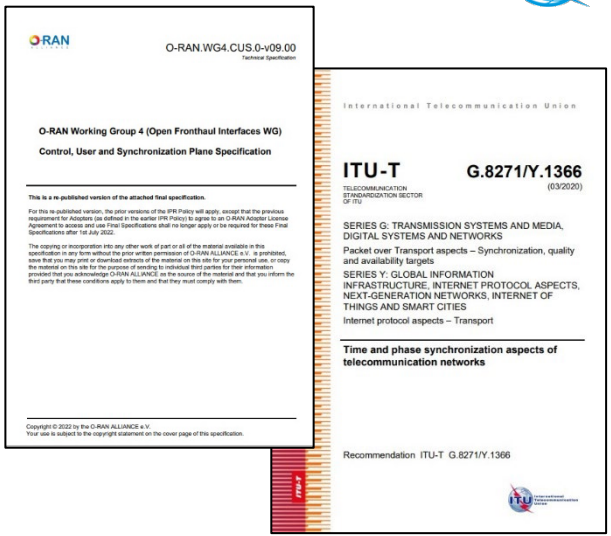
Contents

- Importance and value for the industry for standardized solutions
- How OCP TAP could take advantage of the work done in SG15/Q13
- Overview on SG15 and Q13
- How Q13 could make these standards suitable for Datacenter networks and other OCP TAP scenarios

Why develop standards?

- Standards provide the following benefits:
  - Standardized solutions
  - End-to-end interworking
  - Economy of scale
  - Lower TCO for both vendors and users



OCP TAP: synchronization and timing example

- Synchronization is increasingly important in datacenters:
  - Synchronized computers allows for faster decisions, i.e., decreased delays, lower power consumption
  - From 100 ms to 1 µs *and getting more stringent*
- Timing distributed within a datacenter using PTP from a Grandmaster (GM) to equipment clocks (ordinary clocks or OCs)
- For example, from Datacenter PTP Profile No. 1 Model 1 (OCP):
  - maximum time error between any two OCs must be < 5 µs
  - maximum time error between a GM and any OC must be < 2.5 µs
  - maximum time error generated by a Transparent Clock (TC) must be within ± 100 ns
- Timing between datacenters
  - Maximum time error between two datacenter GMs *must be established*

Source: How Datacenters can be more Efficient.pdf - Google Drive (2023 OCP Regional Summit)

Study Group 15 (SG15) mandate

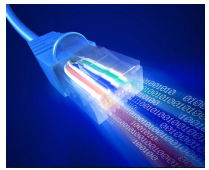
New Study Period started in March 2022.
SG15 is confirmed as Lead Study Group on :

- **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

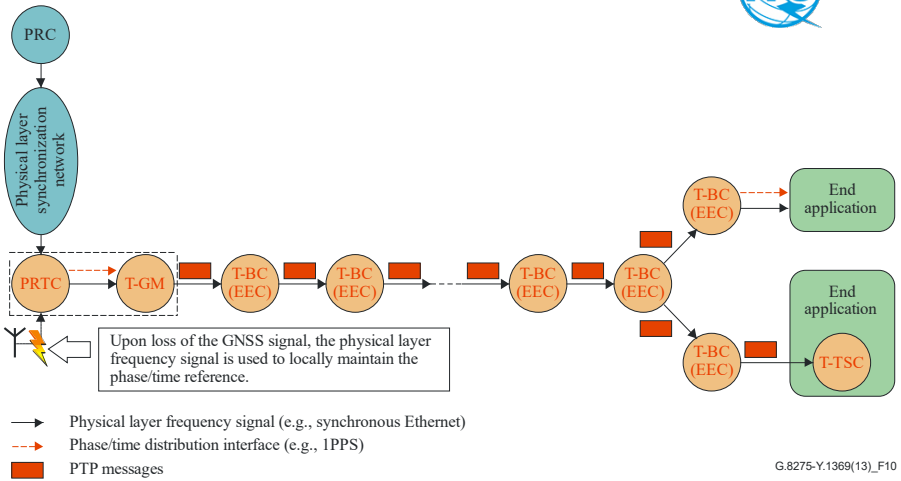


Transport Technologies

The Optical Transport Network

SG15/Q13: Scope of the Question

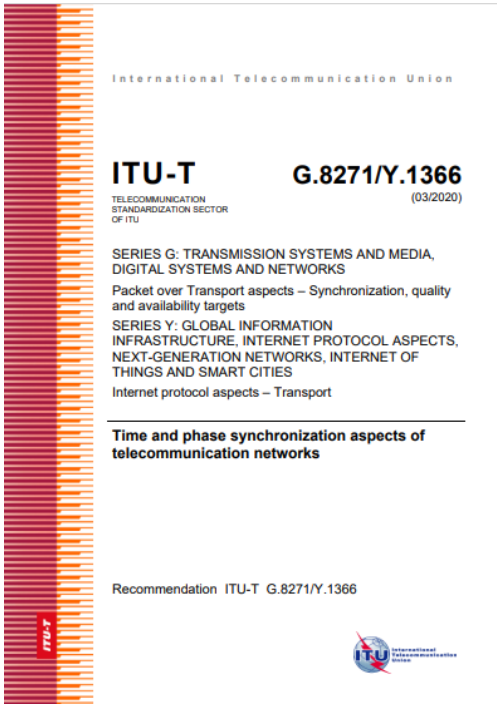
- Network synchronization and time distribution performance
  - Active since the 90s (sync for SDH in SG18)
  - Networks Timing Needs (e.g., OTN, MTN)
  - End Applications Timing Needs (e.g., Base Stations)
- **Distribution of Time-Phase and Frequency**
  - Methods (e.g., over physical layer, via packets,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

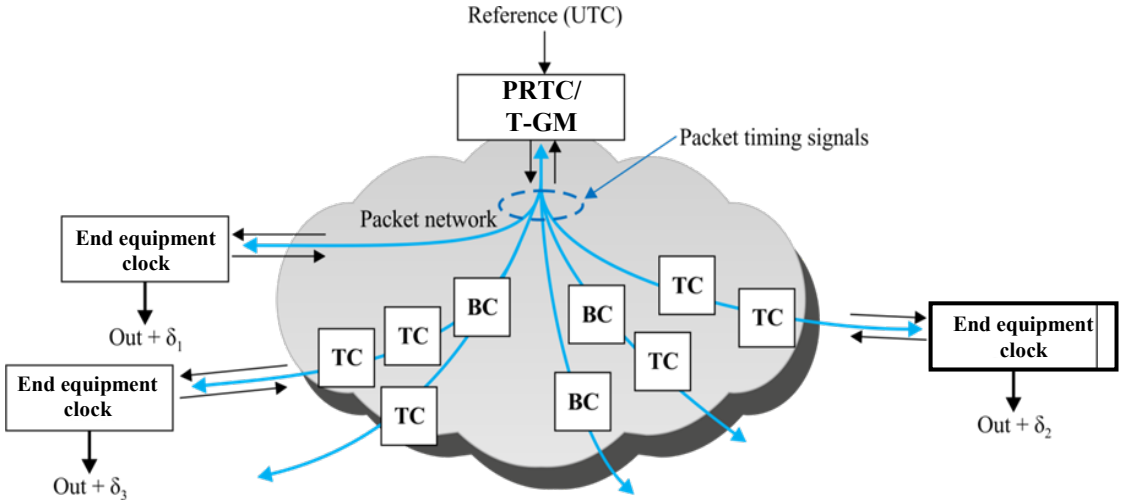
Outputs from Q13

- 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
- 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 (simulations on timing transport), G.Suppl68 (synchronization OAM requirements)
- **Technical Report:** GSTR-GNSS (Use of GNSS in Telecom)



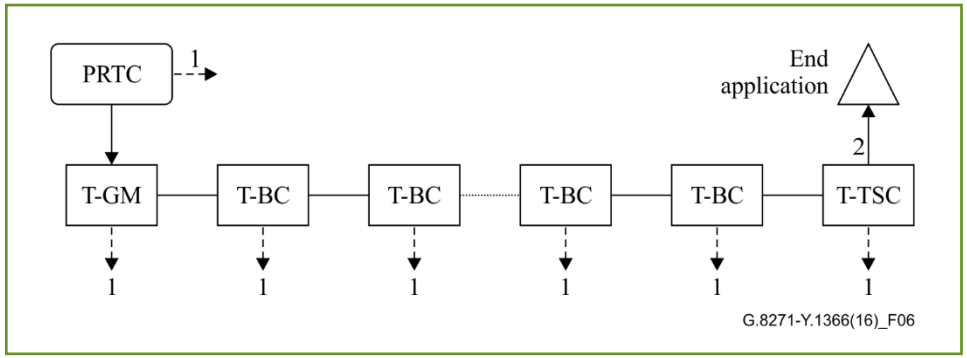
ITU-T G.8275.1
IEEE-1588 with full timing support (FTS) from Network

- Profile for applications that need very accurate phase/time synchronization
- Based on full timing support from the network (i.e., Telecom Boundary Clocks (T-BCs) or Telecom Transparent Clocks (T-TCs) are used in every node)
- Several ITU-T Recommendations, G.827x series, G.781.1, have been developed to address FTS phase/time synchronization
- Frequency synchronization is provided by the physical layer (SyncE)



PRTC	Primary Reference Time Clock
BC	Boundary Clock
TC	Transparent Clock

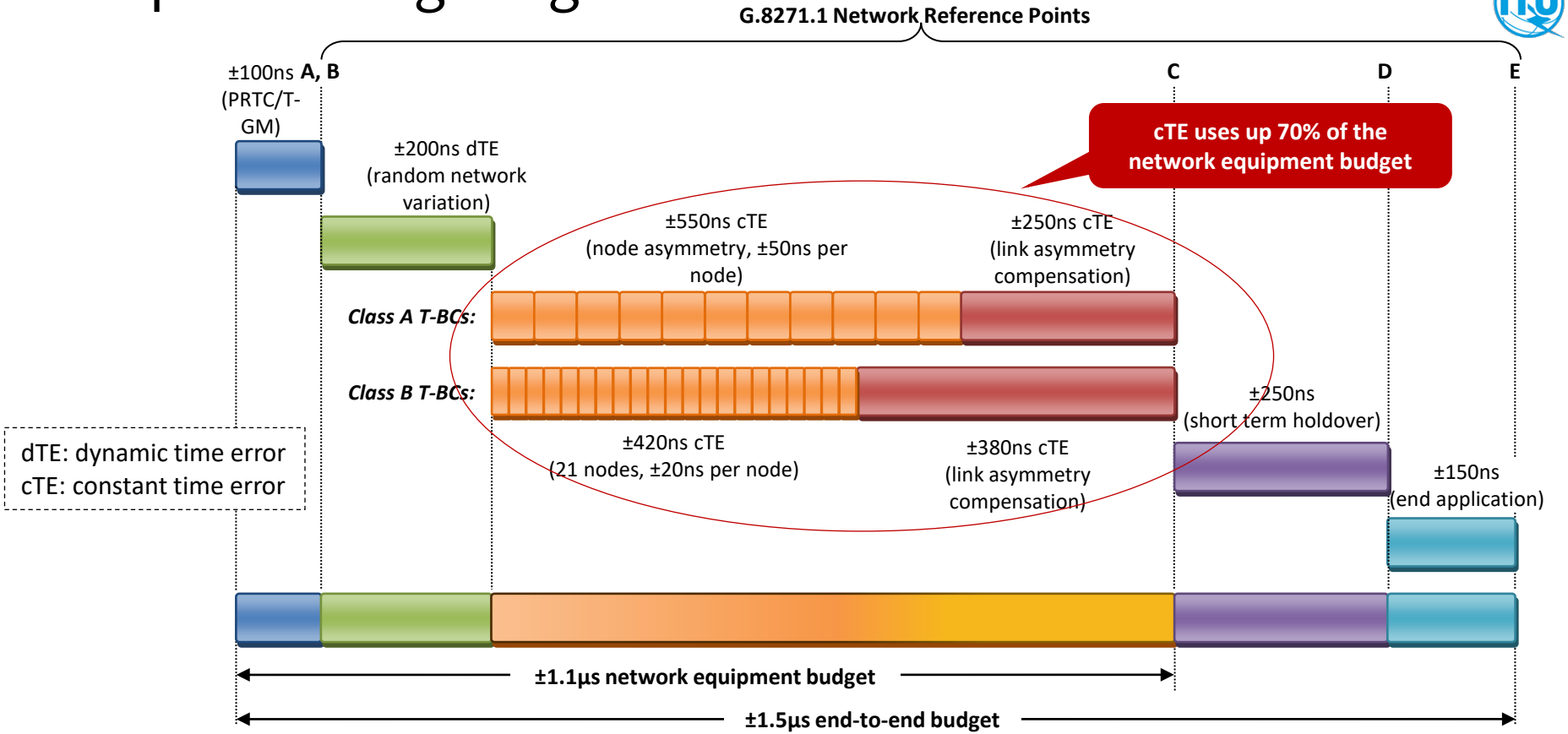
Example of Full Timing Support (ITU-T Rec. G.8275.1)



G.8271 Fig. 6

- Every device between the source (T-GM) and End Application is PTP-aware (Boundary Clock in this example). Network limits detailed in ITU-T Rec. G.8271.1.
- The model for a T-BC includes noise (time error) transfer from its input to its output and noise generation. ITU-T Rec. G.8273.2 covers T-BC (and T-TSC) and considers 4 classes of devices (A, B, C, D) with increasing stringency of performance requirements
- The noise accumulation over this hypothetical reference model (HRM) determines whether the chain is fit-for-purpose based on the End Application requirements

Example of budgeting

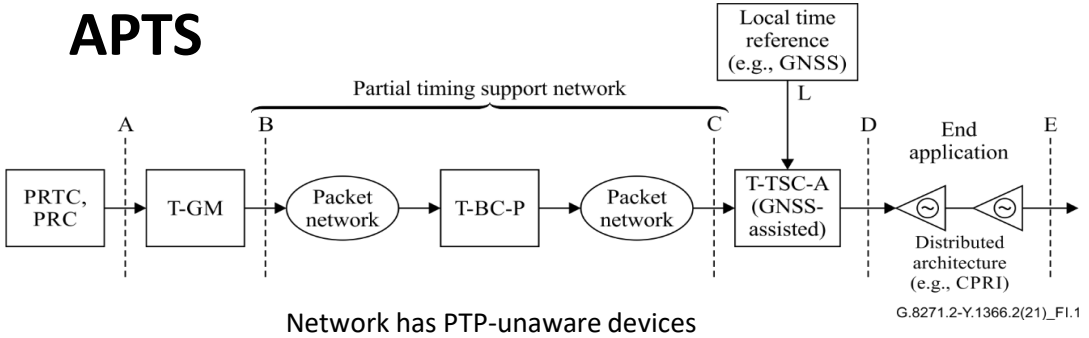


ITU-T G.8275.2
IEEE-1588 without timing support from Network

- Assisted Partial Timing Support (APTS) – GNSS is co-located with the T-TSC-A
  - PTP is used as a **backup** for GNSS failures
- Partial Timing Support (PTS) – without the GNSS co-located with T-TSC-P
  - **Only** PTP is used for timing
- Several ITU-T Recommendations, G.827x series, G.781.1, have been developed to support phase/time synchronization for PTS/APTS

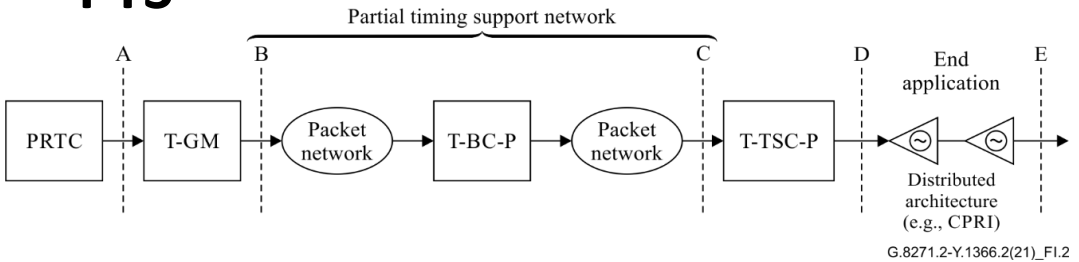
PRC	Primary Reference Clock
T-GM	Telecom Grandmaster
T-BC-A	Telecom Boundary Clock – Partial Support
T-BC-P	Telecom Boundary Clock – Partial support
T-TSC-A	Telecom Time Synchronous Clock – Assisted

APTS



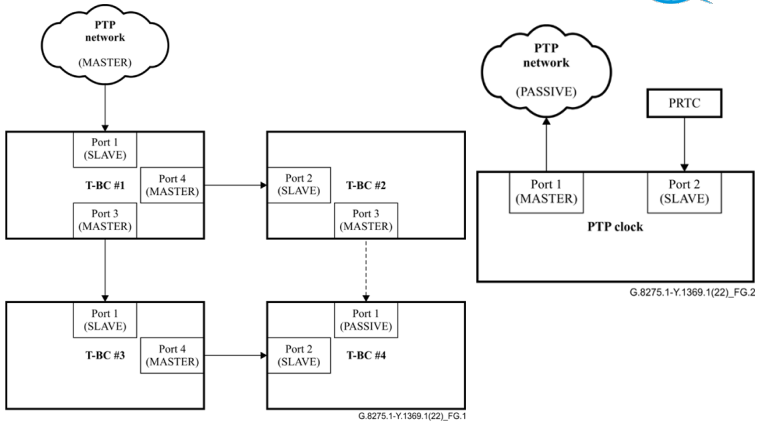
Network has PTP-unaware devices

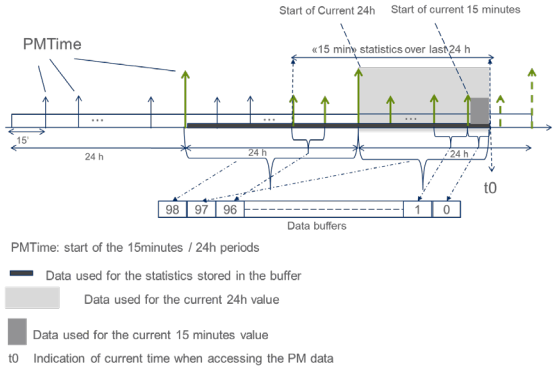
PTS



Ongoing Studies: PTP Profiles evolution

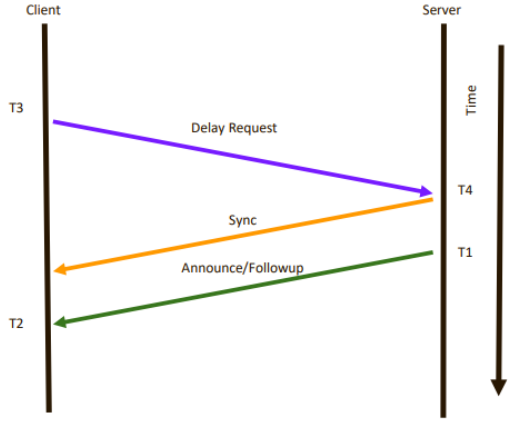
- Use of the «Enhanced Accuracy TLV» for estimating accumulated Time Error, with potential definition of a modified Alternate BMCA
- PTP Security: interest in adding an option for the security TLV
- PTP Monitoring: options recently added to address various use cases
- Network and clock monitoring: ongoing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





Simple PTP vs Telecom Profiles

- PTP Profile for datacenter: [TAP PTP Profile – OpenCompute]
  - Unicast with full timing support
  - Based on timing distribution across TC chain
- Simpler PTP option has practically been proven efficient and suitable for data center application
  - Reduced signaling, e.g.,
    No need for unicast negotiation (load balancing is not an issue)
  - No state on server side
  - Client constantly receives time sync data from multiple GMs
  - the plan is for evolving the profile towards the simpler version that best suits the datacenter needs.



Source: Simpler PTP - Optimized Precision Time Protocol (PTP) for Datacenters.pdf - Google Drive (2023 OCP Regional Summit)

- What is different from 8275.1/.2? What can be reused?
  - Unicast as per G.8275.2, but the simplified version calls for a new profile (G.8275.3?)

Future Studies in Q13

- 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)
  - **Synchronization for Datacenters**

Call For Action:

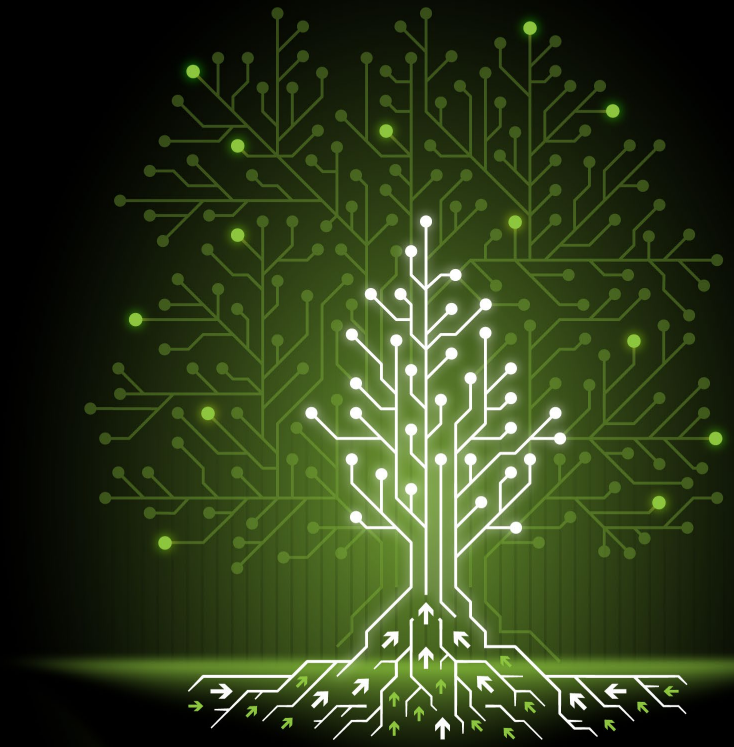
Collaboration between OCP-TAP and Q13

- How can Q13 contribute? What can be reused? What needs development?
  - Basic Principles, concepts, metrics, etc.: G.810, G.8260
  - End to end network requirements for the delivery of sync in Datacenters could be addressed in G.8271
  - HRMs and network limits for OCP applications added in G.8271.1
  - PTP profile in G.8275.x
  - Clocks (possible new class if needed):
    - T-TSC: G.8273.2
    - T-TC: G.8273.3
  - Testing guidelines : G.8273

Getting involved in Q13

- Q13 meets periodically , generally face-to-face (3-4 times per year), with remote calls 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:
    - 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

Thank you!



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