Brief Overview of Work in ITU-T Q13/15 on Transport of Time via PTP

Geoffrey M. Garner
Consultant

IEEE 802.1 AVB TG
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gmgarner@alum.mit.edu

Caveat

- This presentation is current as of the date of its preparation
- As Q13/15 is meeting the weeks of September 10 and 17, 2012, aspects described here can change

Structure of Recommendations for Transport of Frequency and Phase/Time via PTP (adapted from [1]) - 1

Category	Frequency	Time/Phase
Definitions/Terminology	G.8260: Definitions and terminology for synchronization in packet networks	
Basics and network requirements	G.8261/Y.1361: Timing and synchronization aspects in packet networks (frequency)	G.8271: Time and phase synchronization aspects in packet networks
	G.8261.1: PDV network limits applicable to packet based methods (frequency synchronization)	G.8271.1: Network requirements for time/phase (09-2012)
	SyncE network level jitter/wander: included in G.8261 (may be in a G.8261.2 in future)	G.8271.2: may be needed for future

agreed ongoing options (possible in future)

Structure of Recommendations for Transport of Frequency and Phase/Time via PTP (adapted from [1]) - 2

Category	Frequency	Time/Phase
Clocks	G.8262/Y.1362: Timing characteristics of a synchronous Ethernet equipment slave clock (frequency)	G.8272: PRTC (primary reference time clock) timing characteristics (09-2012)
	G.8263: Timing characteristics of packet based equipment (PEC)	G.8273: Packet time/phase clocks: Framework and clock basics (09-2012)
		G.8273.1: Packet master timing characteristics (09-2012)
		G.8273.2: T-BC timing characteristics (07-2013)
		G.8273.x: T-TC timing characteristics
		G.8273.y: T-TSC timing characteristics (tbd)

agreed ongoing options (possible in future)

Structure of Recommendations for Transport of Frequency and Phase/Time via PTP (adapted from [1]) - 3

Category	Frequency	Time/Phase
Methods	G.8264/Y.1364: Distribution of timing information through packet networks	G.8275: Packet – architecture for time/phase (07-2013)
	G.8265: Architecture and requirements for packet based frequency delivery	
PTP profiles	G.8265.1: PTP telecom profile for frequency synchronization	G.8275.1: PTP profile for time and phase synchronization
	G.8265.2: PTP telecom profile #2	G.8275.2: PTP profile ToD /phase #2 (Note: Q13/15 agreed to work on a second profile for time/phase for the case of partial on-path support in June 2012, but G.8275.1 takes priority)

agreed ongoing options (possible in future)

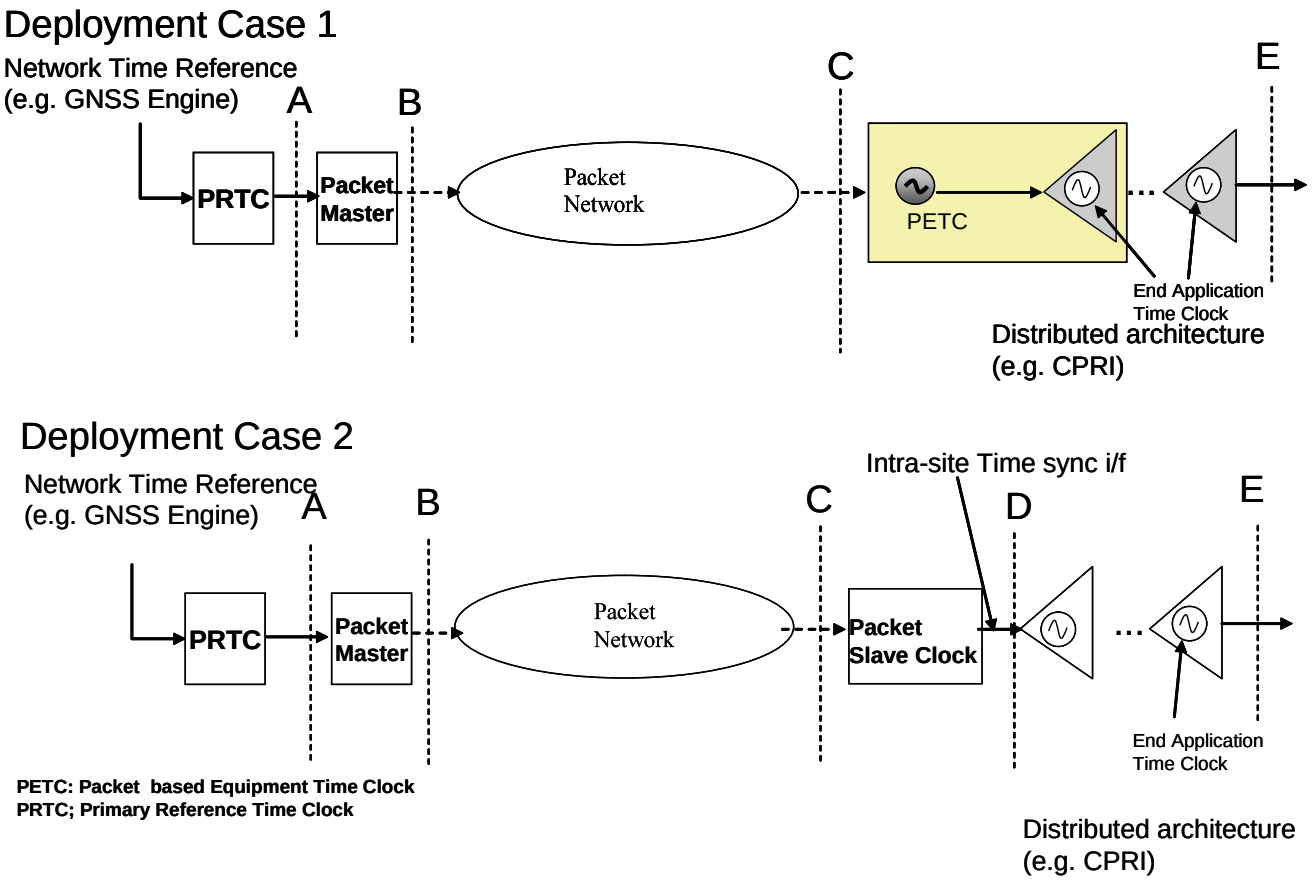
Structure of Recommendations for Transport of Frequency and Phase/Time via PTP (adapted from [1]) - 4

Category	Frequency	Time/Phase
Supplements		G.supp: Simulation of transport of time over packet networks (07-2013 (note that [1] lists this as 09-2012, but it will not be completed then))

agreed ongoing options (possible in future)

Network Reference Model Deployment Cases

From Latest Draft G.8271.1 [2]



Other Related Assumptions for Initial Work

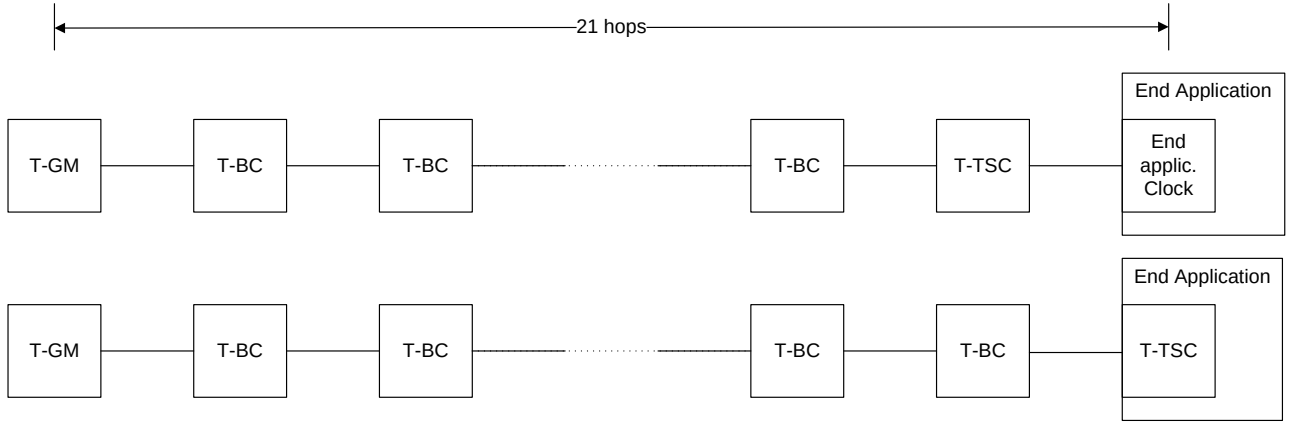
- Initial work (G.8275.1) assumes all nodes are PTP-capable (i.e., every node is either a telecom grandmaster (T-GM), telecom boundary clock (T-BC), or telecom time slave clock (T-TSC)
  - Recent agreement to work on 2nd PTP time profile for case of partial on-path support (i.e., where some nodes would not be PTP-capable), but case of full on-path support takes priority
- Within G.8275.1, initially have been working on case where time is transported via PTP and frequency via SyncE (case of SyncE assist)
  - Work is getting started on case where both time and frequency are transported via PTP (pure PTPcase)
    - This case is most analogous to AVB/802.1AS, though it will be seen there will very likely be differences

Application Requirement and Budget

- Currently focusing on wireless backhaul application
  - Class 4 of Table 1/G.8271 (UTRA-TDD,LTE-TDD (small cell)
  - 1 – 1.5 μs time accuracy (maximum absolute value time error)
- Budget components (values have been discussed, but no final agreement yet)
  - Link and PHY asymmetry
  - PRTC accuracy
  - Random noise (includes SyncE rearrangements)
  - End application
  - Holdover (i.e., time holdover)
  - Intra-site distribution (deployment case 2 only)
- Budget discussions have been based on 1.5 μs time accuracy limit

Hypothetical reference models - 1

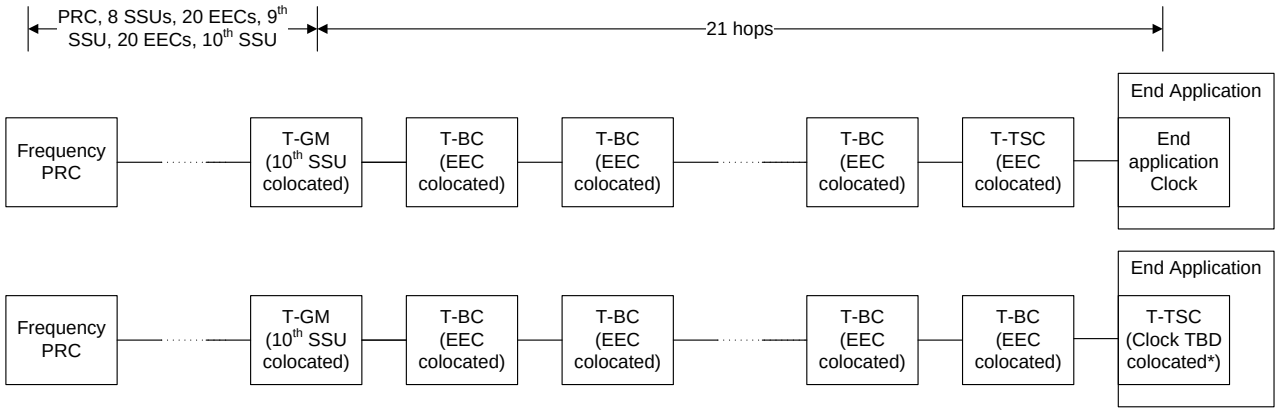
- HRM – 1 (no SyncE support for frequency transport, i.e., pure PTP case)



- 1 T-GM, 19 T-BC, 1 T-TSC and the end application clock for the case of a T-TSC external to the end application (1st case)
- 1 T-GM, 20 T-BC and 1 T-TSC for the case of a T-TSC embedded in the end application (2nd case)

Hypothetical reference models - 2

- HRM – 2 (with SyncE support for frequency transport, i.e., pure PTP case)
- Congruent scenario

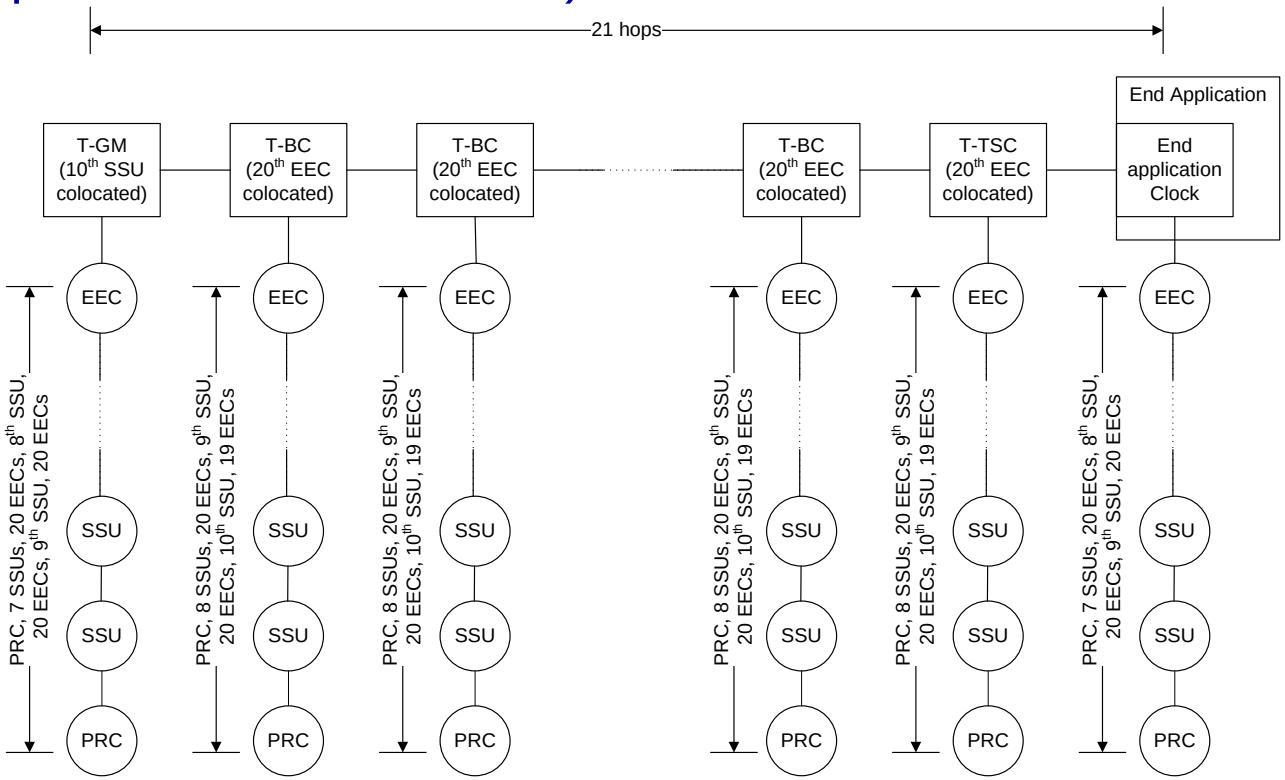


* The initial assumption is that the type of oscillator is assumed to be equivalent to an SSU, but other characteristics may differ.

- 1 T-GM, 19 T-BC, 1 T-TSC and the end application clock for the case of a T-TSC external to the end application (1st case)
- 1 T-GM, 20 T-BC and 1 T-TSC for the case of a T-TSC embedded in the end application (2nd case)

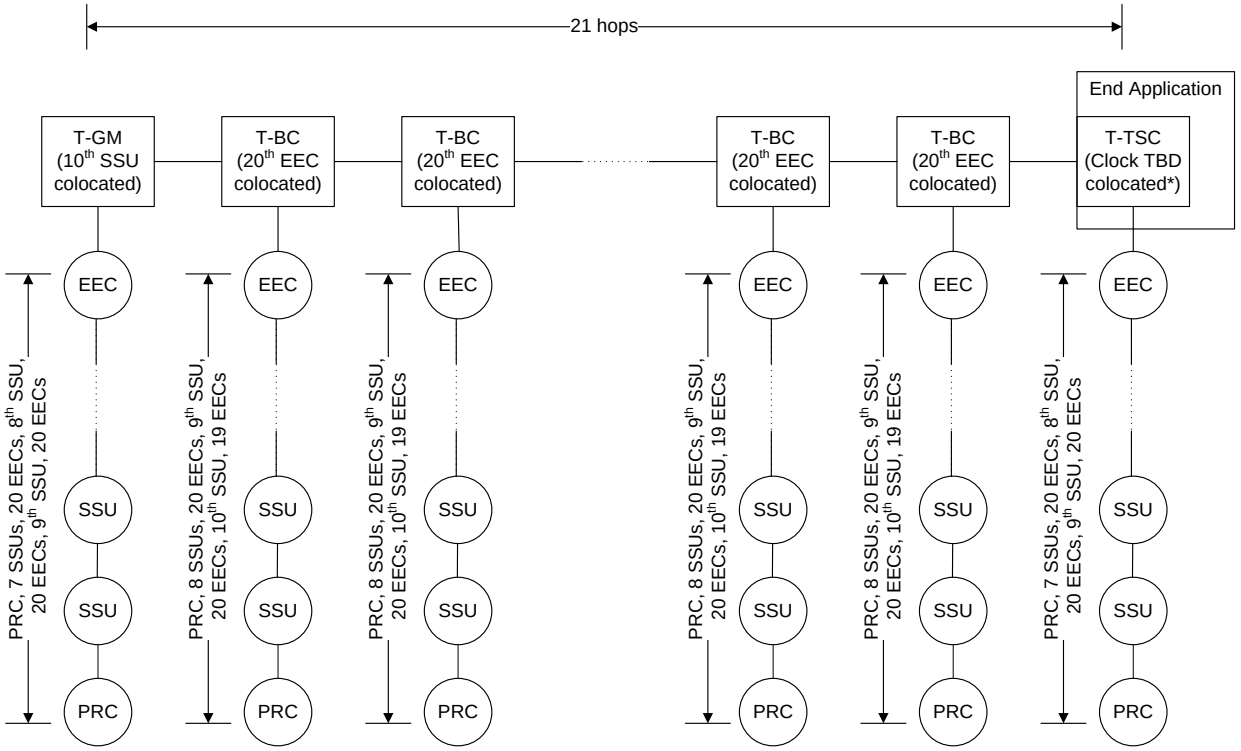
Hypothetical reference models - 3

- HRM – 3 (with SyncE support for frequency transport, i.e., pure PTP case)
- Non-congruent scenario, case 1 (T-TSC separate from end application, and 19 T-BCs)



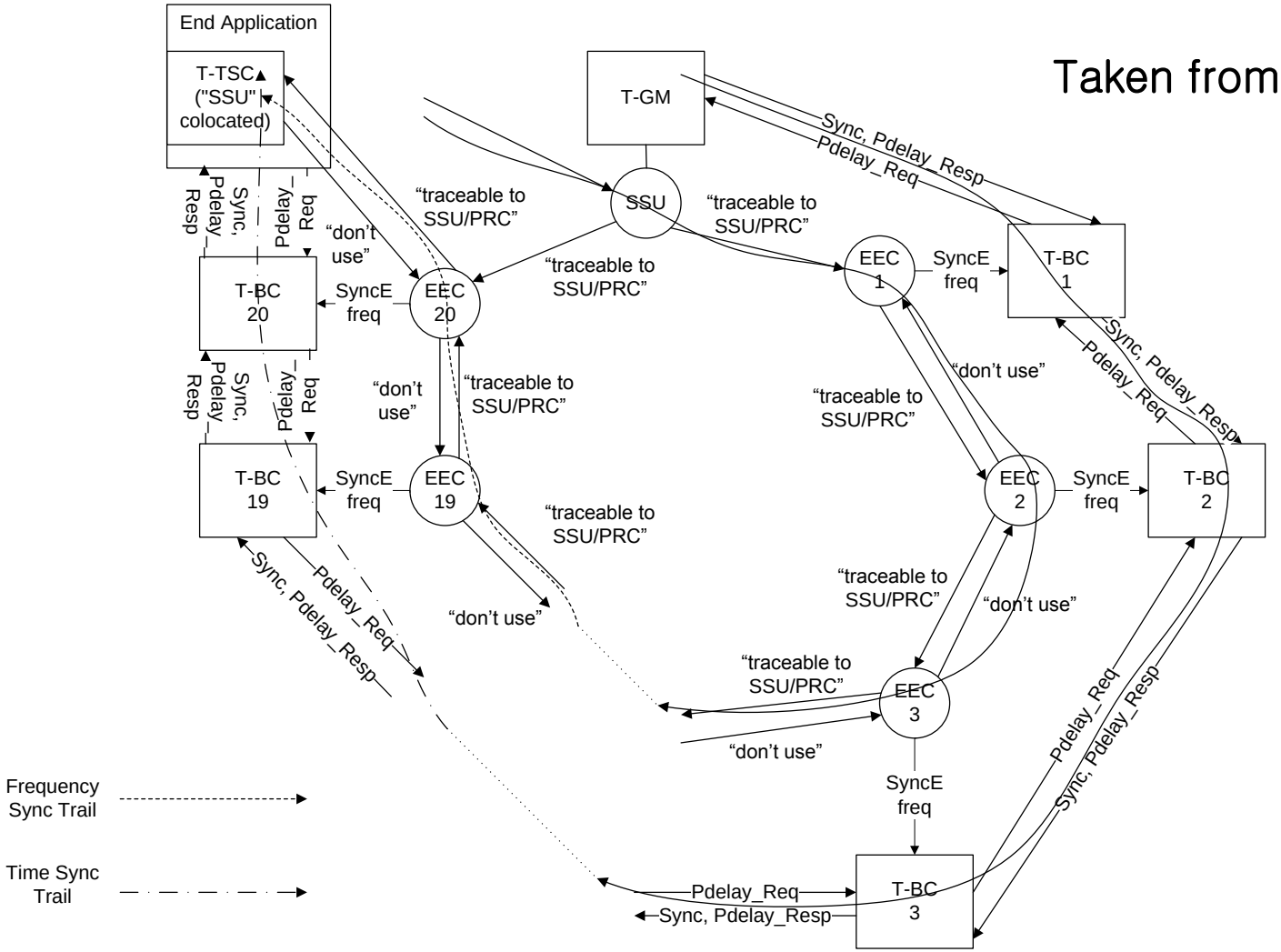
Hypothetical reference models - 4

- HRM – 3 (with SyncE support for frequency transport, i.e., pure PTP case)
- Non-congruent scenario, case 2 (T-TSC collocated with end application, and 20 T-BCs)



* The initial assumption is that the type of oscillator is assumed to be equivalent to an SSU, but other characteristics may differ.

Illustration of HRM-2 for case of ring, with collocated T-TSC and end application



Requirements related to PTP profile – 1

- G.8275.1 will include T-GM (note that PRTC supplies timing to T-GM, but is outside PTP), T-BC, and T-TSC
  - Recent discussions and agreement to develop a second PTP telecom time profile for case of partial on-path support, but case of full on-path support takes priority
  - Support for T-TC will be in future work
- Both one-step and two-step clocks supported
- Path delay mechanism: Delay_Req/Resp (favored mainly because it is already used in frequency profile, and argument was made that code can be re-used)
- Ethernet transport mechanism (1588 Annex F) is required
  - Some participants also want IPv4 (Annex D) included, for backward compatibility with the telecom frequency profile

Requirements related to PTP profile - 2

- Current decision to use, for Ethernet transport, the address 01-80-C2-00-00-0E
  - Some support to also allow 01-1B-19-00-00-00
- BMCA will most likely be an alternate BMCA
  - Discussion on degree to which best master selection should be fully automatic, versus manual configuration
  - This discussion concerns whether best master selection should be based on “ITU-T G.781 [5] principles”, which use
    - Clock quality level (QL) (could be mapped to clockClass)
    - Local port priority (new attribute)

Requirements related to PTP profile – 3

- BMCA (cont.)
  - An alternate BMCA that uses these attributes could be created; however, some questions (list below is not exhaustive) to be decided are
    - Should there be a single GM or multiple GMs (multiple synchronization spanning trees?
    - Should the alternate BMCA break timing loops if QLs and local priorities are not configured properly (G.781 does not)
    - Should the alternate BMCA be completely within PTP, or should the bulk of it be outside PTP as in the frequency profile (see G.8265.1)?

Requirements related to performance

- Note that some of the items below are not fully decided, but it has been indicated they can be used for simulation purposes
- T-BCs will do filtering, with 0.1 Hz bandwidth and 0.1 dB gain peaking (basic assumption for simulations)
- Mean Sync message rate: 16 messages/s
- Mean Delay_Req rate not decided; likely will be less than Sync rate
- 1 ms turnaround time (time between receipt of Sync and sending of Delay_Req, when Delay_Req is sent) (initial assumption for simulations)
- 8 ns timestamp granularity (not an official requirement, but will be used to derive other requirements; the requirement will be specified in terms of performance)

Requirements related to performance - 1

- Agreement in June for T-BC to slow down SyncE phase transients to mitigate their effect on maximum time error in HRM2; however, new simulation results to be presented at current meeting indicates this is not effective unless the transients are slowed down by a factor of 150 or more (which may not be practical)

References - 1

[1] Helmut Imlau, Q13/15 NGN Synchronization Requirements Structure, Deutsch Telekom Contribution to ITU-T Q13/15, Boulder, CO, USA, 12 – 16 March 2012.

[2] Latest Draft G.8271.1, *Network Limits for Time Synchronization in Packet Networks, ITU-T SG 15*, TD 734 (WP3/15), ITU-T, Geneva, September, 2012.

[3] ITU-T G.8271, *Time and phase synchronization aspects of packet networks*, ITU-T, Geneva, February, 2012.

[4] Geoffrey M. Garner, Lv Jingfei, Sebastien Jobert, Michel Ouellette, and Han Li, Potential Mitigation of the HRM2b Transient, Huawei, France Telecom Orange, Iometrix, and China Mobile Communications Corporation contribution to ITU-T Q13/15, Helsinki, Finland, 4 – 8 June 2012, WD71.

[5] ITU-T Rec. G.781, *Synchronization layer functions*, ITU-T, Geneva, 2008.