IEEE 1588 Frequency and Time & phase profiles at ITU-T

Silvana Rodrigues, System Engineering, IDT , silvana.rodrigues@idt.com

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Agenda

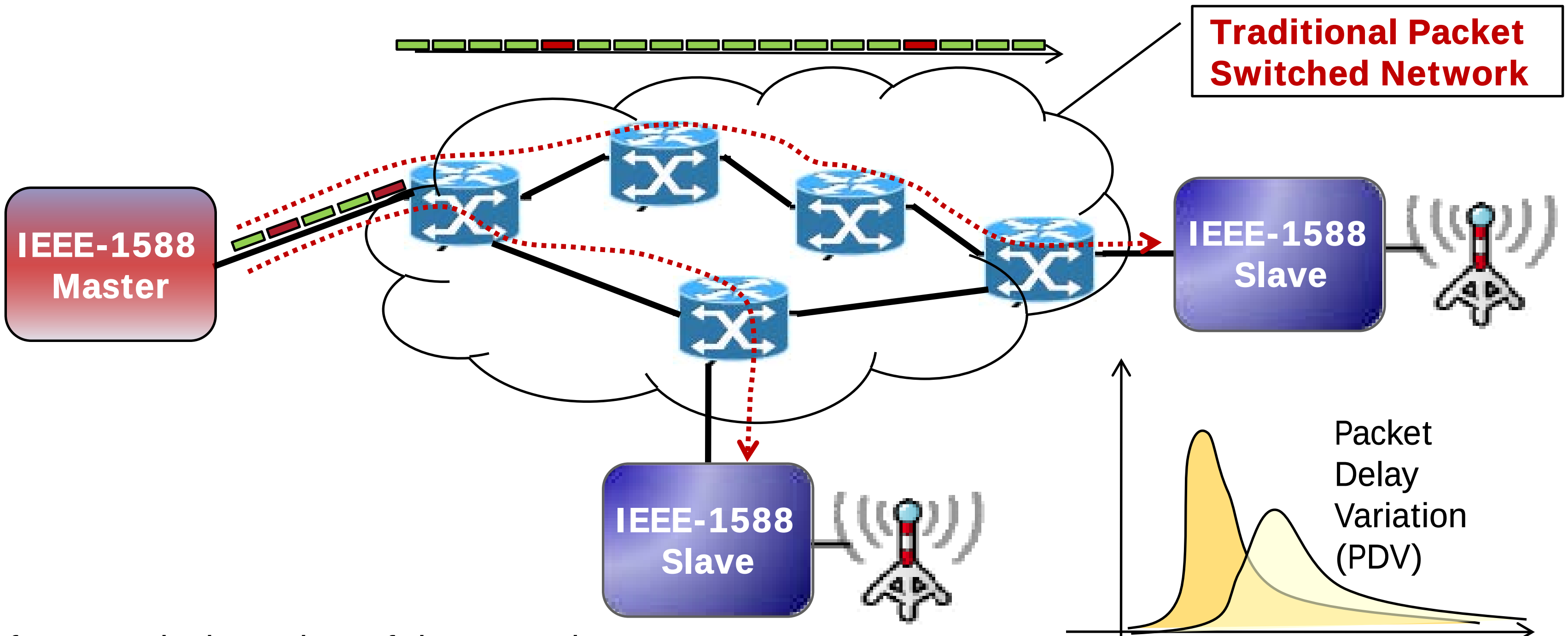
- IEEE-1588™ Profile
- ITU-T G.8265.1 – Frequency Profile
- ITU-T G.8275.1 – Time and Phase Profile
- ITU-T G.8275.2 – Time and Phase Profile with partial support from the network

IEEE-1588 Profiles

- IEEE-1588 defines profile as “The set of allowed Precision Time Protocol (PTP) features applicable to a device”
- “The purpose of a PTP profile is to allow organizations to specify specific selections of attribute values and optional features of PTP that, when using the same transport protocol, inter-work and achieve a performance that meets the requirements of a particular application.”
- A PTP profile should define
  - Best master clock algorithm options
  - Configuration management options
  - Path delay mechanisms (peer delay or delay request-response)
  - The range and default values of all PTP configurable attributes and data set members
  - The transport mechanisms required, permitted, or prohibited
  - The node types required, permitted, or prohibited
  - The options required, permitted, or prohibited

ITU-T FREQUENCY PROFILE

ITU-T G.8265.1 Frequency Profile
IEEE-1588 without support from Network



- Performance is dependent of the network
  - The clock recovery algorithm is adaptive in nature, therefore the performance is impacted by packet delay variation in the network
- The quality of the clock delivered to the application depends on several factors
  - The quality of the oscillator at the slave, the packet delay variation of the network, the number of timing packets per second
- ITU-T consented several Recommendations for IEEE-1588 for Frequency Synchronization targeting wireless backhaul applications
  - G.8265 (Architecture and requirements for packet-based frequency delivery), G.8265.1 (Precision time protocol telecom profile for frequency synchronization), G.8263 (Timing Characteristics of Packet based Equipment Clocks (PEC)), G.8261.1 (Packet Delay Variation Network Limits applicable to Packet Based Methods), and G.8260 (definition of PDV metrics)

G.8265.1 - PTP Options and Configurable Attributes

- One-way versus two-way mode
  - Both one-way and two-way modes are supported in the Frequency Profile
- Unicast versus Multicast mode
  - Only Unicast mode is allowed in the Frequency Profile
  - Unicast Message negotiation is used
- One-step versus two-step clock mode
  - Both one-step and two-step clocks are supported in the Frequency Profile
- PTP mapping
  - IEEE1588-2008 annex D - Transport of PTP over User Datagram Protocol over Internet Protocol Version 4 is supported in the Frequency Profile
  - IEEE1588-2008 annex E - Transport of PTP over User Datagram Protocol over Internet Protocol Version 6 is supported in the Frequency Profile
- PTP Message rates
  - Sync /Follow-up – min rate: 1 packet every 16 seconds, max rate: 128 packets per second
  - Delay_Request/Delay_Response – 1 packet every 16 seconds, max rate: 128 packets per second
  - Announce – min rate: 1 packet every 16 seconds, max rate: 8 packets per second, default: 1 packet every 2 seconds
  - Signaling messages – no rate is specified

Best Master Clock Algorithm (BMCA)

- PTP allows the following options for the BMCA
  - The default BMCA specified in the IEEE-1588 standards
  - An alternate best master clock algorithm specified in a profile
- PTP specifies the requirements for an alternate best master clock algorithm
  - Provision must be made to provide the states required for operation of the PTP state machines and state decision
  - The alternate best master clock algorithm may be dynamic or static
  - A static algorithm will simply configure the recommended state values on the ports of the node on which it is running.
  - The state decision codes for use in updating the data sets must be provided as an output of the alternate best master clock algorithm

G.8265.1 - Alternate BMCA

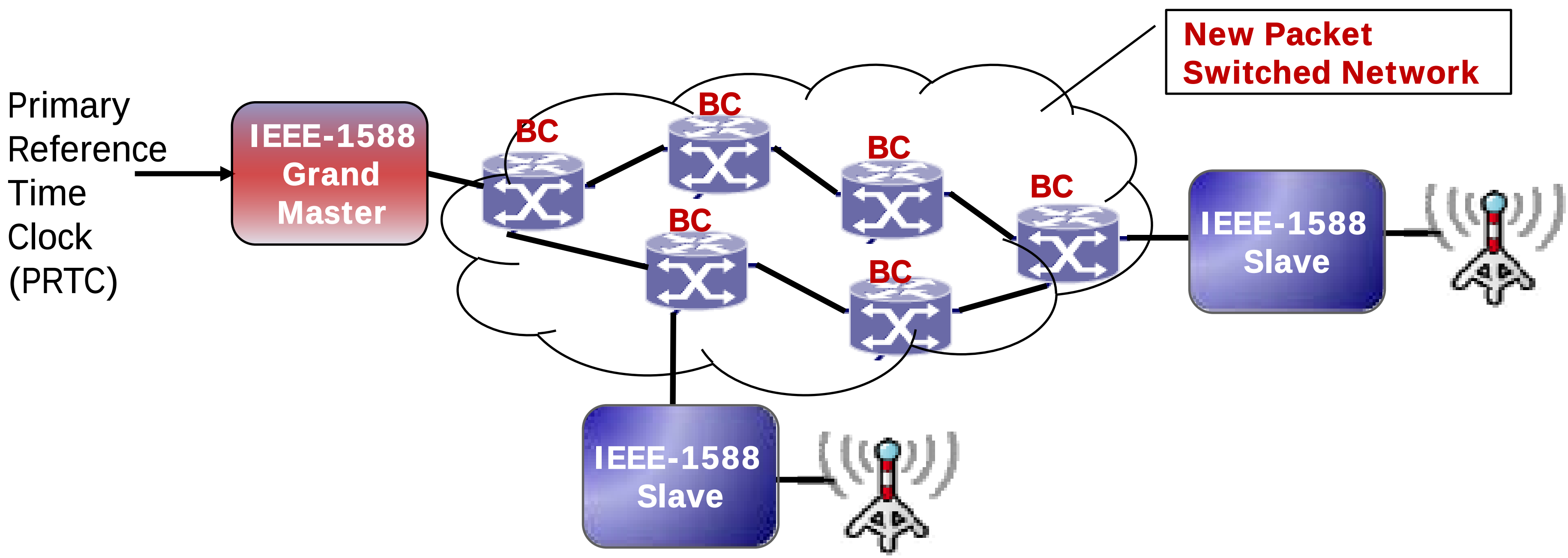
- For the alternate BMCA in G.8265.1, each master is isolated by a separated PTP domain that is done through the unicast communication
  - Grandmasters do not exchange Announce messages.
  - Masters are always active
  - Slaves are always slave-only clocks

- The Master selection process is based on the Quality Level (QL)-enabled mode per ITU-T Recommendation G.781
  - Quality Level (QL)
    - The Clock Class attribute in the Announce messages in PTP is used to carry the SSM QL value
    - Master with the highest Quality Level that is not in a failure condition will be selected
    - In case of Masters with similar QL, the Master with the highest Priority is selected.
  - Priority
    - Each master has a priority value that is locally maintained in the Telecom slave.
  - Packet Timing Signal Fail (PTSF)
    - PTSF-lossSync, PTSF-lossAnnounce, PTSF-unusable

- G.8265.1 introduces the concept of a Telecom Slave
  - Consists of multiple PTP slave-only clock instances.

ITU-T TIME/PHASE PROFILE G.8275.1

G.8275.1- ITU-T Time/Phase Profile IEEE-1588 with support from Network



- Boundary Clocks (BCs) and Transparent Clocks (TCs) can be used to overcome the performance issue
- The quality of the clock delivered to the application is dependent on the quality of the oscillator at each BC/TC and at the slave nodes
  - Synchronous Ethernet will be used in conjunction with BC for the first version of the profile
- The work on TC is just starting at ITU
- ITU-T is working on several recommendations (G.827x) to address time and phase applications

G.8275.1 PTP Options and Configurable Attributes

- On-going work on the usage of the PTP Options and configurable attributes for phase and time profile
- Two types of Ordinary clocks: T-GM (Telecom Grand master, master clock only) and T-TSC (Telecom Slave clock, Slave-Only Ordinary Clock)
- Boundary clock will be used on the first profile
- One-step and two-step clocks are allowed
- PTP mappings
  - The default mapping for the Time/phase profile is agreed to be IEEE1588-2008 annex F - Transport of PTP over Ethernet
  - IEEE1588-2008 annex D - Transport of PTP over User Datagram Protocol over Internet Protocol Version 4 is for further study
  - IEEE1588-2008 annex E - Transport of PTP over User Datagram Protocol over Internet Protocol Version 6 is for further study
- Unicast versus Multicast mode
  - For the Ethernet mapping, both the forwardable multicast address 01-1B-19-00-00-00 and the non-forwardable multicast address 01-80-C2-00-00-0E must be used for all PTP messages'
  - The default Ethernet multicast address to be used depends on the operator
- PTP Message types and rates
  - Sync message, Follow-up, Announce, Delay_Request, and Delay_Response
  - Fixed packet rate of 16 packets per second for Sync, Delay_Req and Delay_Resp messages for the case where physical layer frequency support (e.g. Synchronous Ethernet) is used
  - The message rate for Announce message needs to be defined

G.8275.1 - Alternate BMCA

- The alternate BMCA in G.8275.1 is based on the default BMCA specified in IEEE 1588
- The alternate BMCA allows
  - Multiple active Grand Masters
  - Per-port Boolean attribute notSlave.
    - notSlave is TRUE -> the port is never placed in the SLAVE state
    - notSlave is FALSE -> the port can be placed in the SLAVE state
  - Per-port attribute localPriority to be used as a tie-breaker in the dataset comparison algorithm
  - the clock attributes priority1, clockAccuracy, offsetScaledLogVariance, and priority2 are static

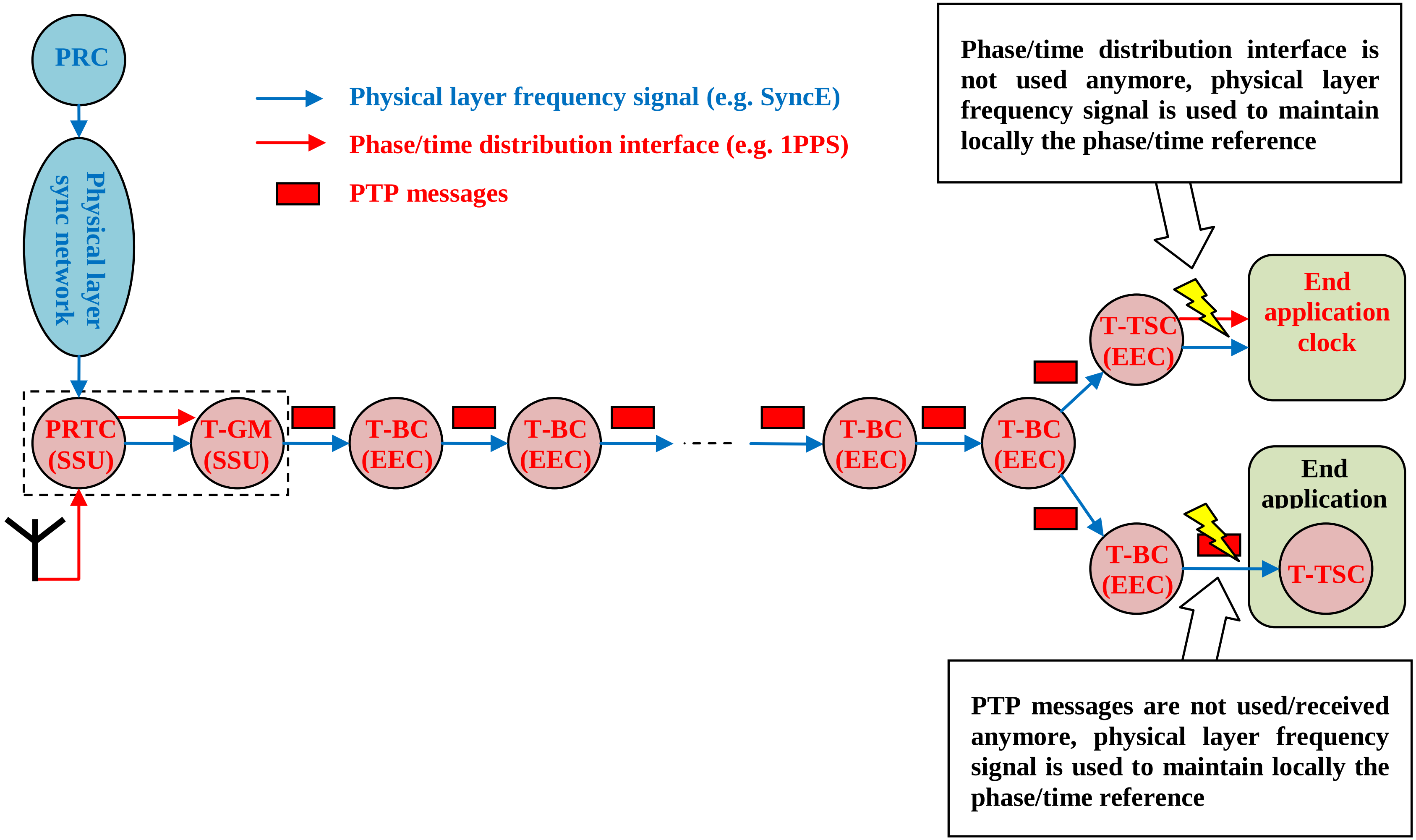
Dataset member	Default value
defaultDS.priority1	128
defaultDS.clockQuality.clockAccuracy	26 (hex)
defaultDS.clockQuality.offsetScaledLogVariance	8000 (hex)
defaultDS.priority2	128

Phase/time traceability information

- Three clockClass values have been agreed

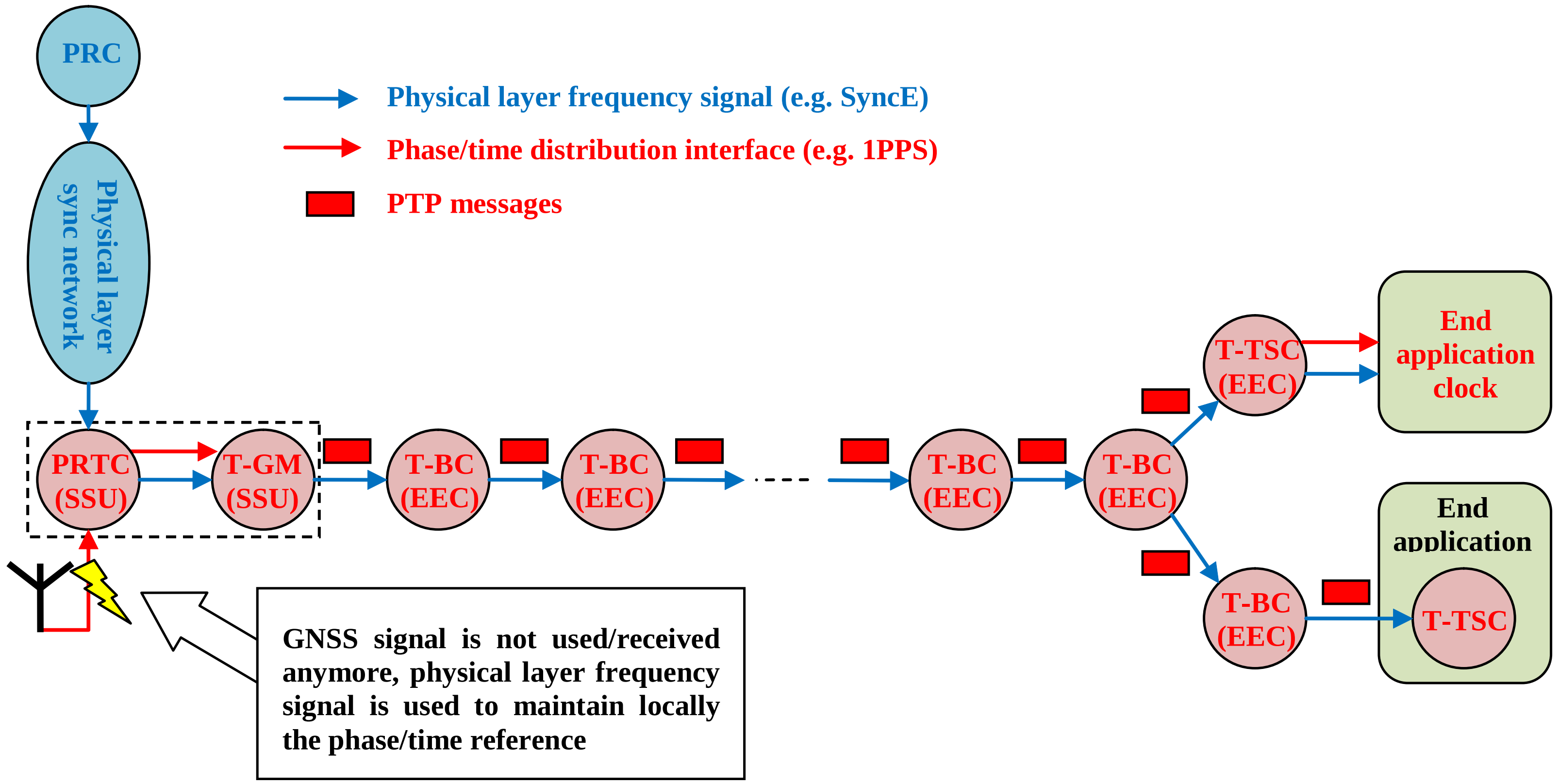
clockClass	Phase/time traceability description
6	PTP clock traceable to PRTC in locked mode (e.g. PRTC traceable to GNSS)
7	PTP clock within holdover specification
247	PTP clock outside holdover specification

G.8275 – Protection scenario 1.1 at the T-TSC



From WD111 (Huawei, France Telecom, Iometrix, and China Mobile), San Jose

G.8275 – Protection scenario 1.2 at the PRTC / T-GM



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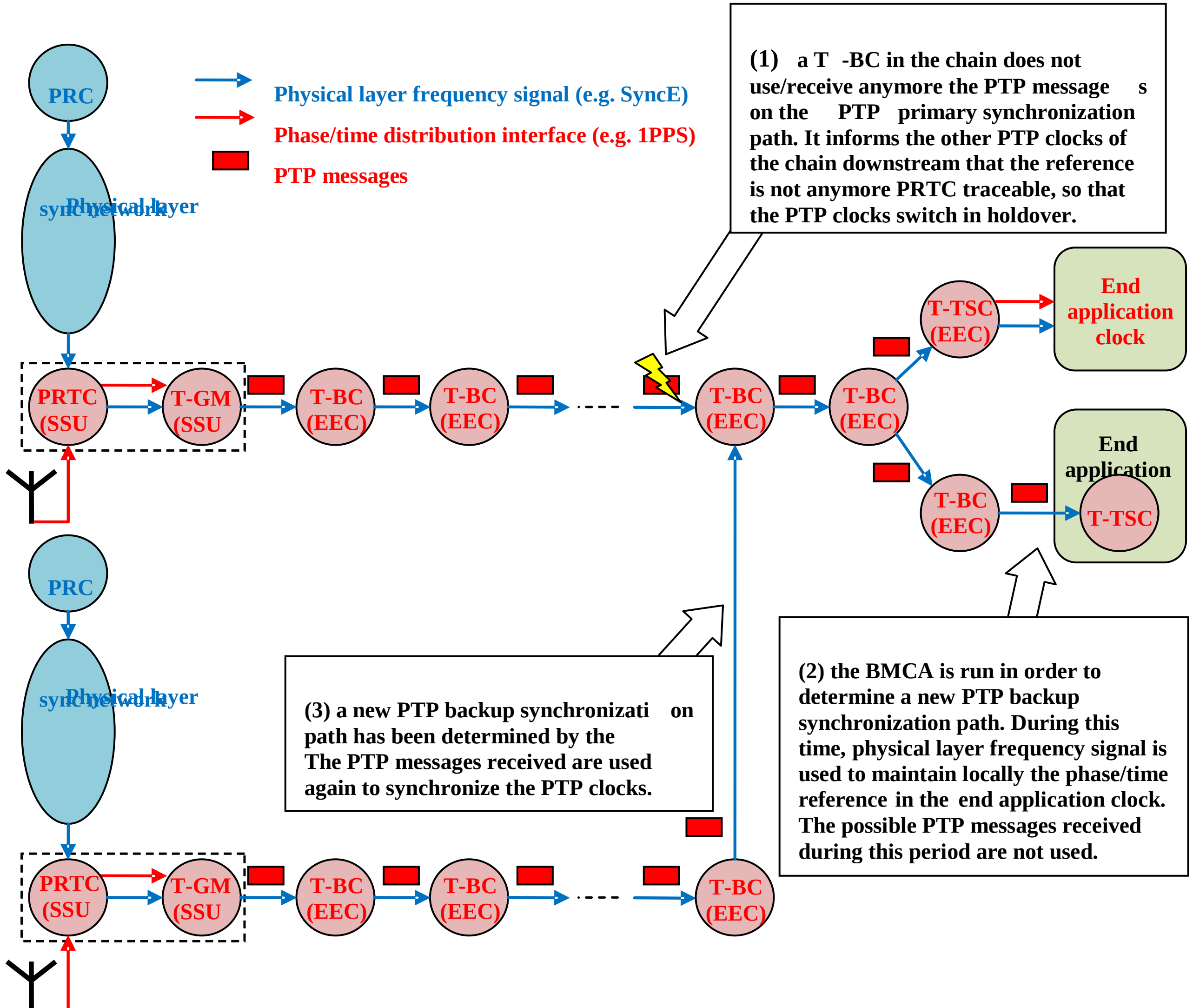
G.8275 – Protection scenario 2



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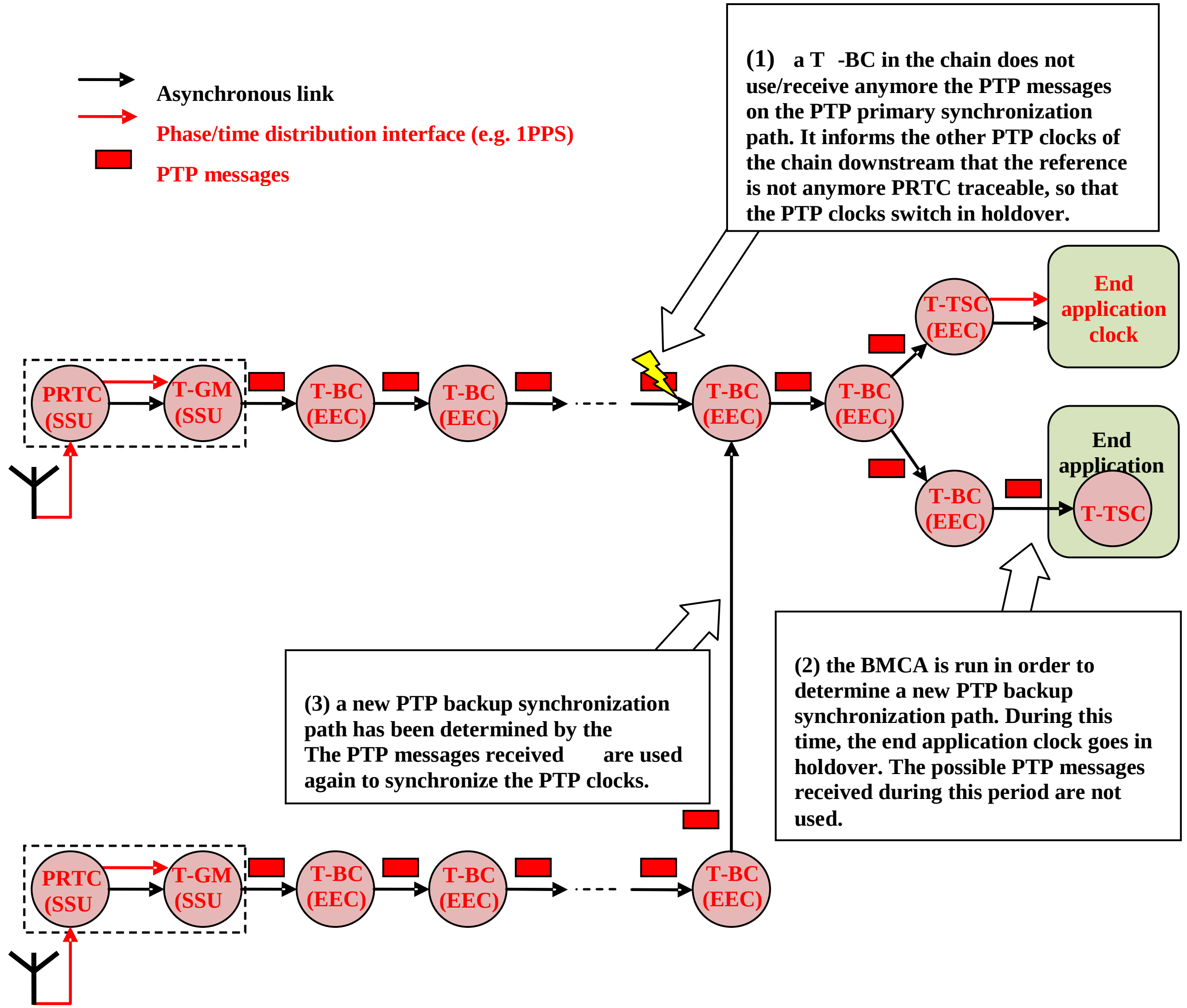
G.8275 – Protection scenario 3



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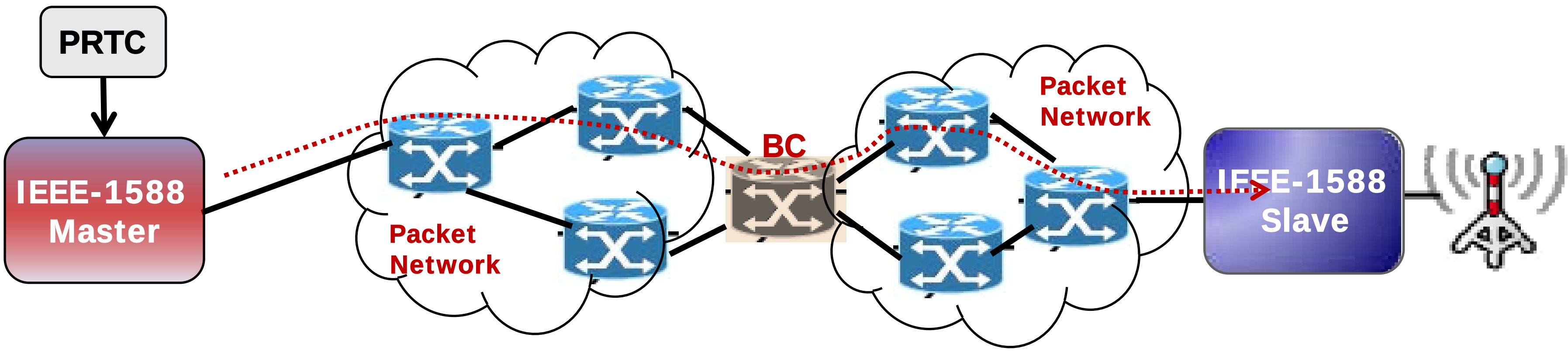
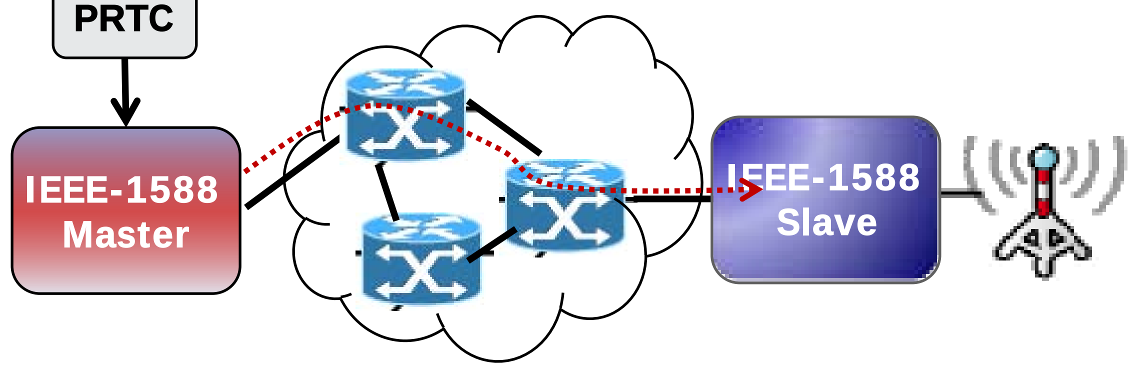
ITU-T TIME/PHASE PROFILE G.8275.2

G.8275.2- ITU-T Time and Phase Distribution over a Packet Network providing Partial Timing Support at the Protocol Level

- Development of a new PTP Profile for Time/Phase Distribution (G.8275.2)
- Architectures are being discussed at ITU-T

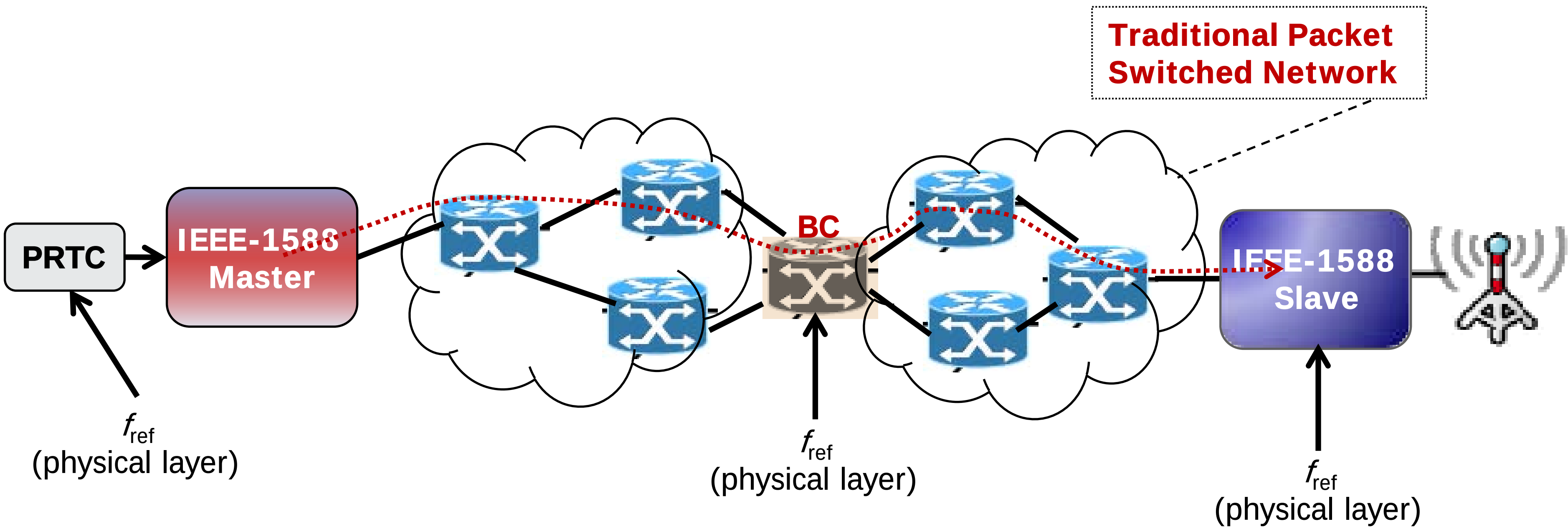


Segmented Architecture (Boundary cCock to break down the network into smaller segments)



Distributed architecture (Packet Master Clock near to Packet Slave Clock)

- The use of physical layer support (e.g. Synchronous Ethernet)
  - May improve stability and performance of the boundary clock
  - Can be used to provide protection in case of packet timing signal failure



THANK YOU!