ITU-T G.8265.1 - Frequency Profile

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Agenda

- IEEE-1588^{TM} Profile
- PTP Options and Configurable Attributes
- Unicast request mechanism
- Best Master Clock Algorithm (BMCA)
- G.8265. 1 Alternate BMCA
- Telecom Slave

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

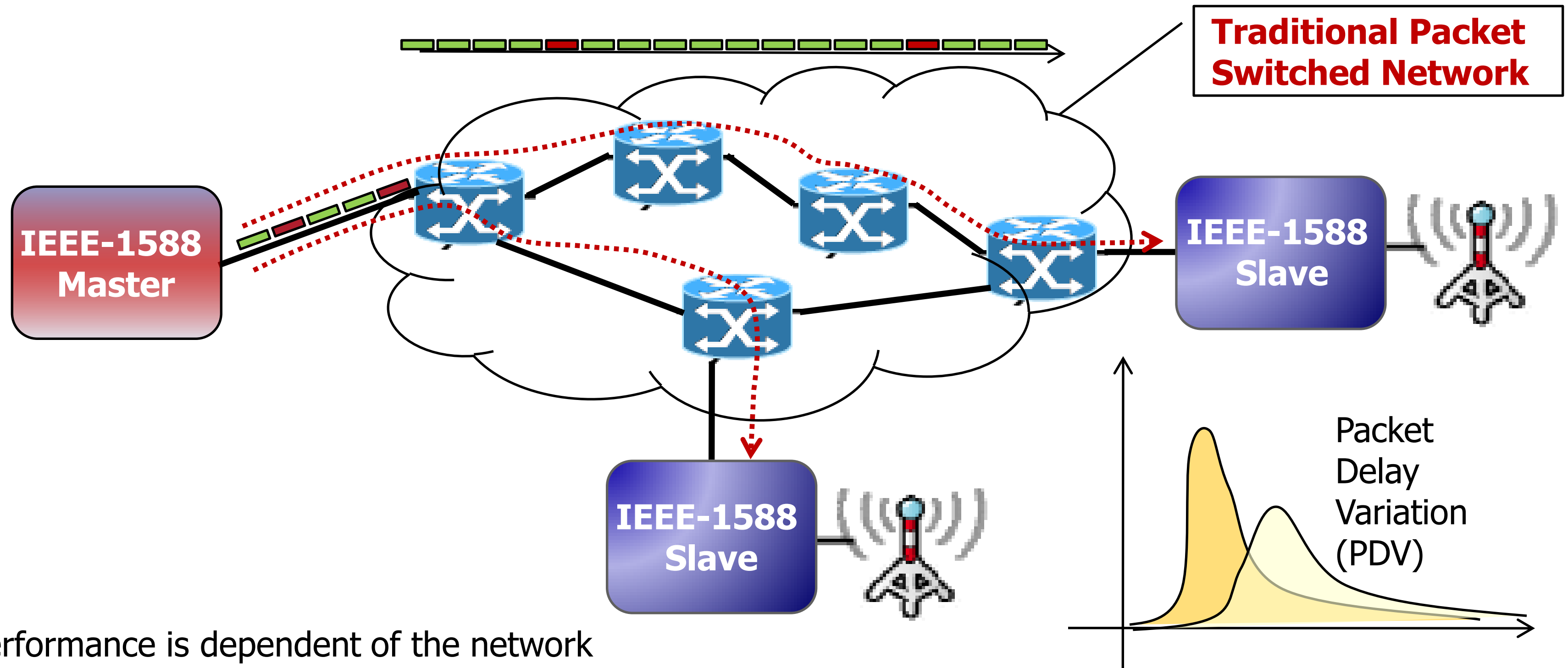
IEEE Std 1588™-2008 Frequency profile at ITU-T

- ITU-T G.8265.1 defines the PTP telecom profile for frequency synchronization, was consented in June 2010

- ITU-T Q13/15 is also worked on architectural requirements that are the basis for the definition of the PTP profiles
  - ITU-T G.8265, Architecture and requirements for packet-based frequency delivery, was consented in June 2010

- The PTP profile itself only consists of the protocol interoperability

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

Unicast request mechanism

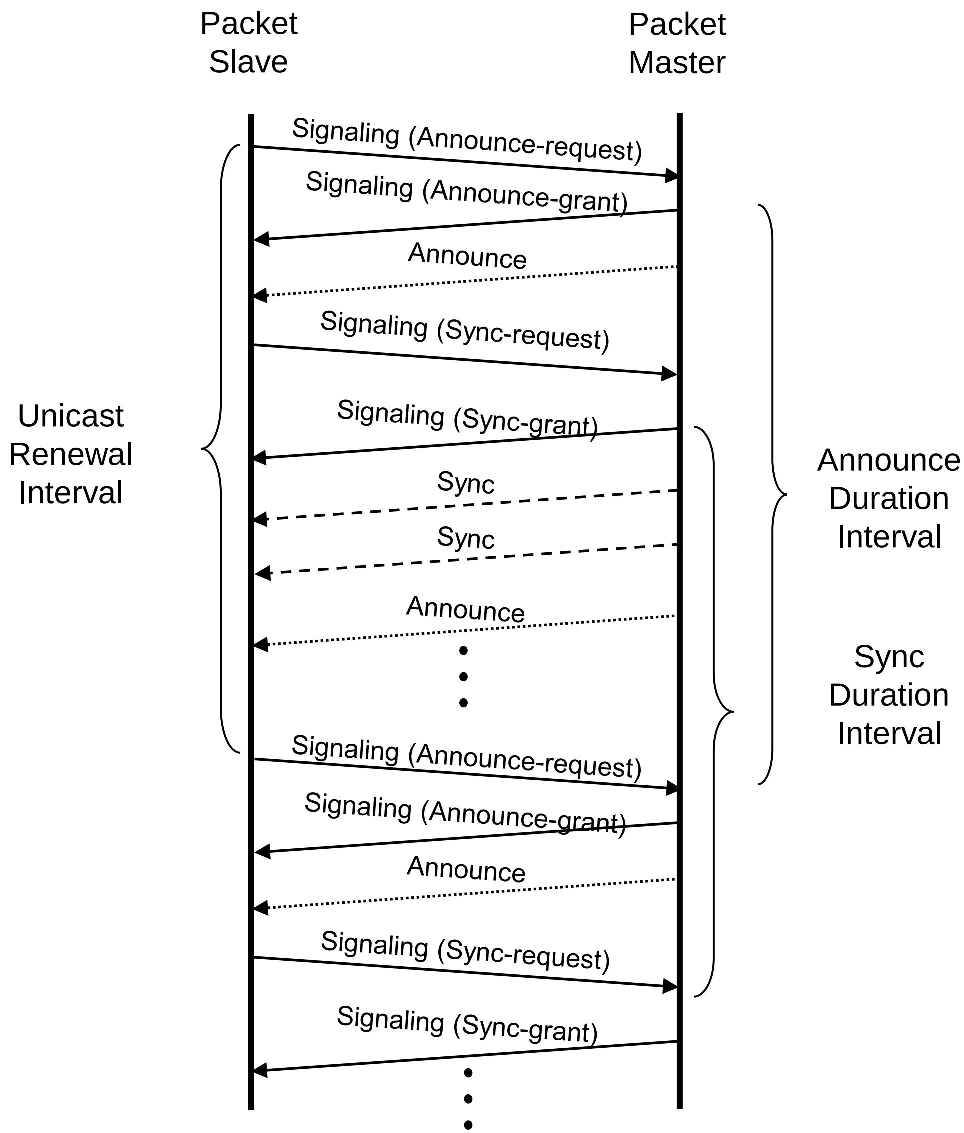


Figure 1/ITU-T G.8265.1: Unicast Negotiation Example

- In unicast mode, PTPv2 slaves request synchronization service by sending a PTPv2 Signaling message in unicast using the "unicast message negotiation"
- It allows unicast sessions between two nodes with agreed packet rates for Sync, Announce, and Delay_Req messages.
- The mechanism enables a "keep-alive" period, in order to detect the inactive slaves

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 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

IEEE-1588 Default BMCA

- All the clocks that are part of the same domain will organize themselves into a master-slave hierarchy based on the BMCA
- Announce messages are exchanged among potential grandmasters
- BMCA is run locally on each port
  - It compares its own data set with the data set that is received by Announce messages to determine which one is the better clock
- Two separate algorithms are part of the BMCA
  - Data set comparison algorithm
  - State decision algorithm

IEEE-1588 Default BMCA cont'd

- The data set comparison algorithm uses the attributes contained in the Announce messages with the following priority
  - Priority1 (defines clock priority, it is a user configurable designation)
  - clockClass (defines clock traceability)
  - clockAccuracy (defines clock accuracy)
  - offsetScaledLogVariance (defines clock stability)
  - priority2 (defines finer grained clock priority, it is a user configurable designation)
  - clockIdentity (defines clock unique identifiers, serves as a tie-breaker)
- The state decision algorithm determines the state of the port based on the results of the data set comparison algorithm
  - The ports states can be MASTER, SLAVE, or PASSIVE

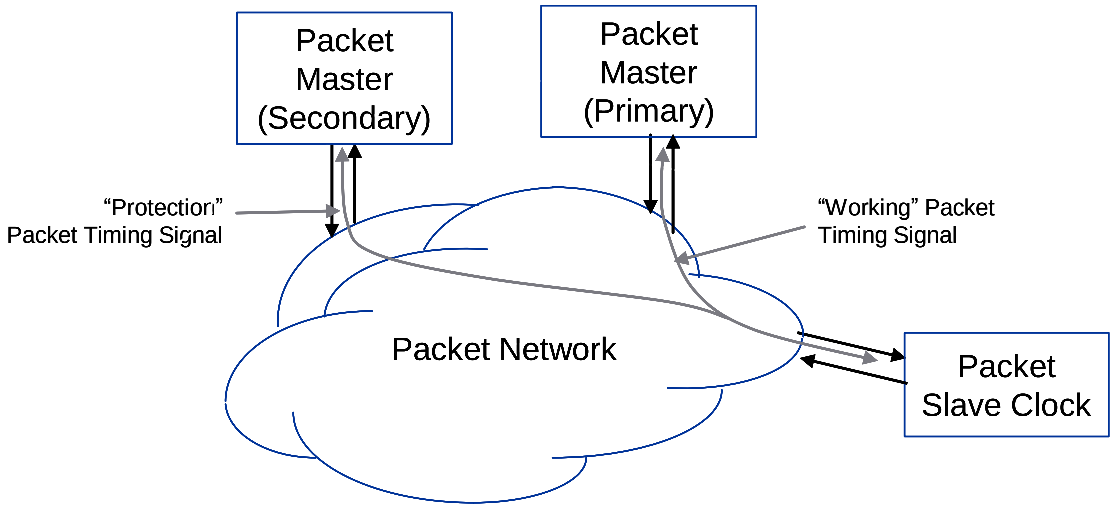


Figure 2/ITU-T G.8265.1: Packet network timing (frequency) protection

- Telecom architecture allows several masters delivering timing messages (e.g. Sync, Delay_resp) to slaves at the same time
- Slaves should have the possibility to switch from one primary master to a backup master in case of failure
- Different slaves must be able to select different masters
- The Master selection mechanism must be compatible with ITU-T Recommendation G.781 - Synchronization Layer Functions (SDH and Synchronous Ethernet)

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.

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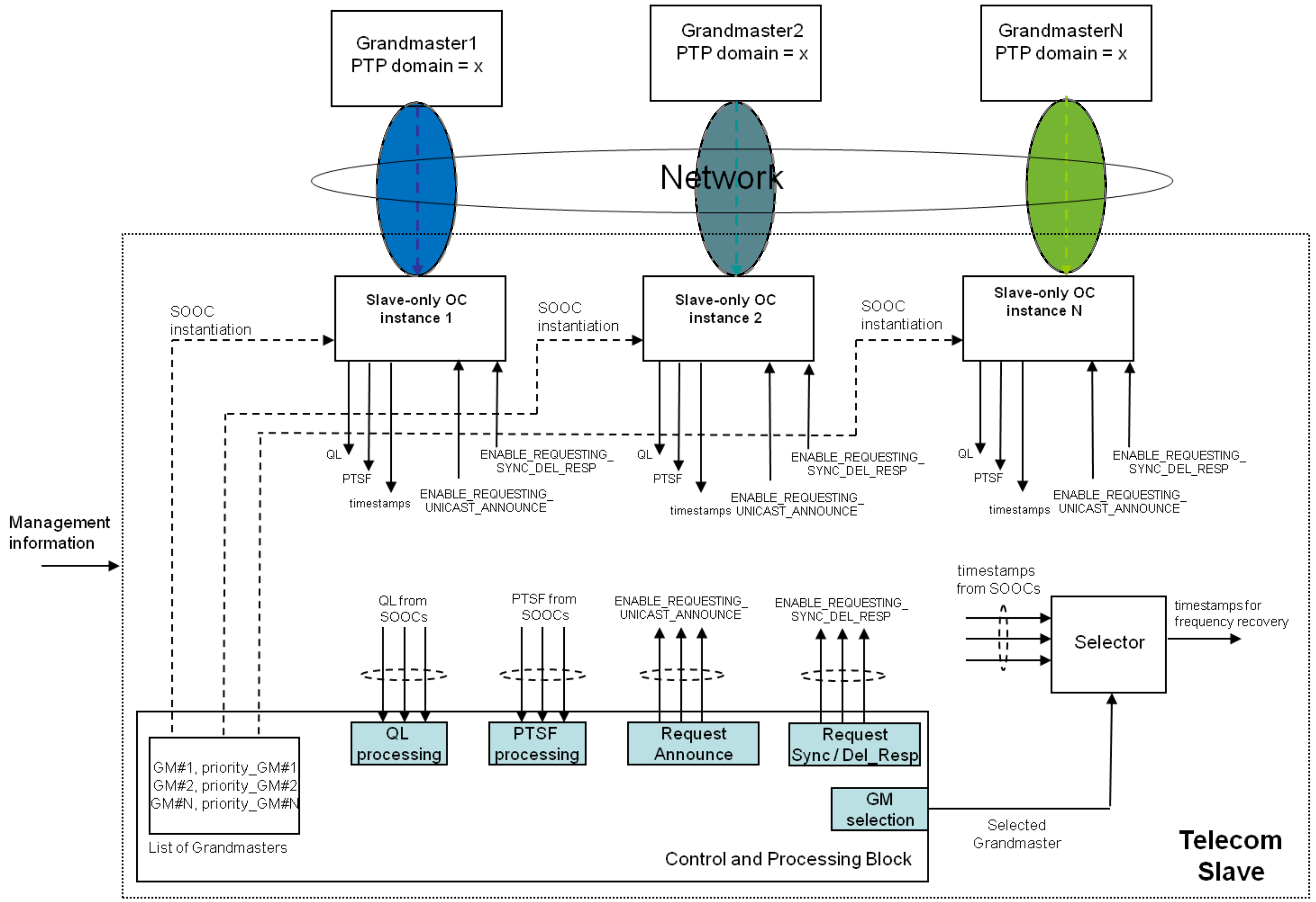

Figure 3/G.8265.1: Telecom Slave Model

THANK YOU!