Core Information Model (CoreModel)

TR-512.A.8 Appendix – Timing and Synchronization Examples

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Disclaimer

Open Networking Foundation
1000 El Camino Real, Suite 100, Menlo Park, CA 94025
www.opennetworking.org

Important note

This Technical Recommendations has been approved by the Project TST, but has not been approved by the ONF board. This Technical Recommendation is an update to a previously released TR specification, but it has been approved under the ONF publishing guidelines for 'Informational' publications that allow Project technical steering teams (TSTs) to authorize publication of Informational documents. The designation of '-info' at the end of the document ID also reflects that the project team (not the ONF board) approved this TR.

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Document History

Version	Date	Description of Change
		Appendix material was not published prior to Version 1.3
1.3	September 2017	Version 1.3 [Published via wiki only]
1.3.1	January 2018	Addition of text related to approval status.
1.4	November 2018	No changes.

1 Introduction

This document is an appendix of the addendum to the TR-512 ONF Core Information Model and forms part of the description of the ONF-CIM. For general overview material and references to the other parts refer to TR-512.1.

1.1 References

For a full list of references see TR-512.1.

1.2 Definitions

For a full list of definition see TR-512.1.

1.3 Conventions

See TR-512.1 for an explanation of:

- UML conventions
- Lifecycle Stereotypes
- Diagram symbol set

1.4 Viewing UML diagrams

Some of the UML diagrams are very dense. To view them either zoom (sometimes to 400%) or open the associated image file (and zoom appropriately) or open the corresponding UML diagram via Papyrus (for each figure with a UML diagram the UML model diagram name is provided under the figure or within the figure).

1.5 Understanding the figures

Figures showing fragments of the model using standard UML symbols and also figures illustrating application of the model are provided throughout this document. Many of the application-oriented figures also provide UML class diagrams for the corresponding model fragments (see TR-512.1 for diagram symbol sets). All UML diagrams depict a subset of the relationships between the classes, such as inheritance (i.e. specialization), association relationships (such as aggregation and composition), and conditional features or capabilities. Some UML diagrams also show further details of the individual classes, such as their attributes and the data types used by the attributes.

1.6 Appendix Overview

This document is part of the Appendix to TR-512. An overview of the Appendix is provided in TR-512.A.1.

2 Introduction to this Appendix document

This document provides a description of time and frequency synchronization in a telecommunications network and provides examples of the use of the CIM abstractions to model these synchronization functions.

The examples in this document extend the simple examples given in TR-512.11.

3 Network synchronization overview

The figure below shows an example of a (simple) synchronization network.

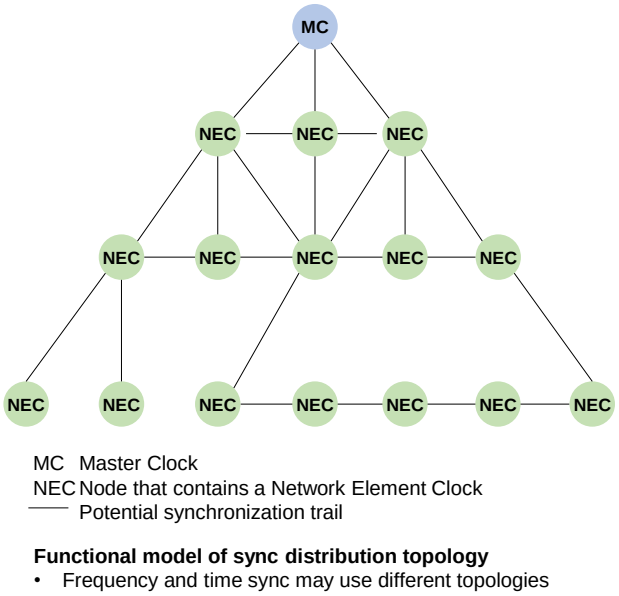
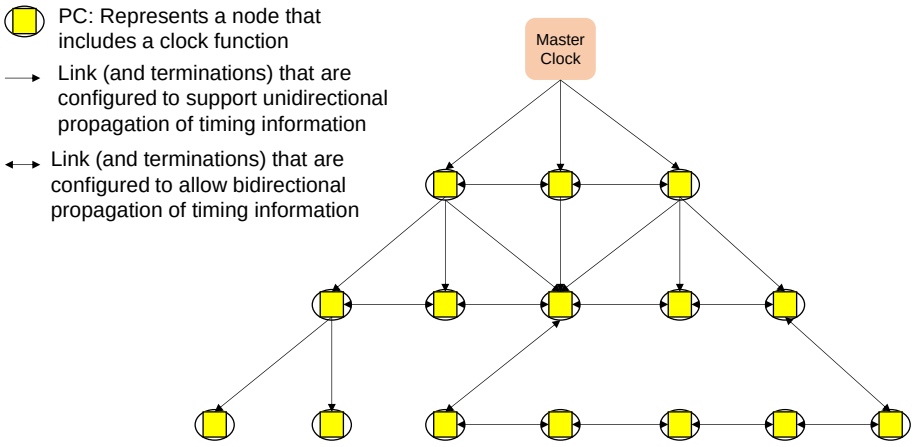


Figure 3-1 Example synchronization distribution network

From a management perspective, the Master Clock can be represented by an instance of the clock and the node containing a network equipment clock can be represented by instances of Processing Construct (PC), that encompass LTP, FD and clock, with links to interconnect the nodes. Typically, only a subset of the links in a network are enabled, by management/control actions, to support the transfer timing information. Two types of information may be carried over these links: The timing information (frequency or time stamp) and (optionally) information about the source of the timing information. These links are typically used to carry both timing information and network traffic but some may be dedicated to synchronization. This is illustrated in the figure below.

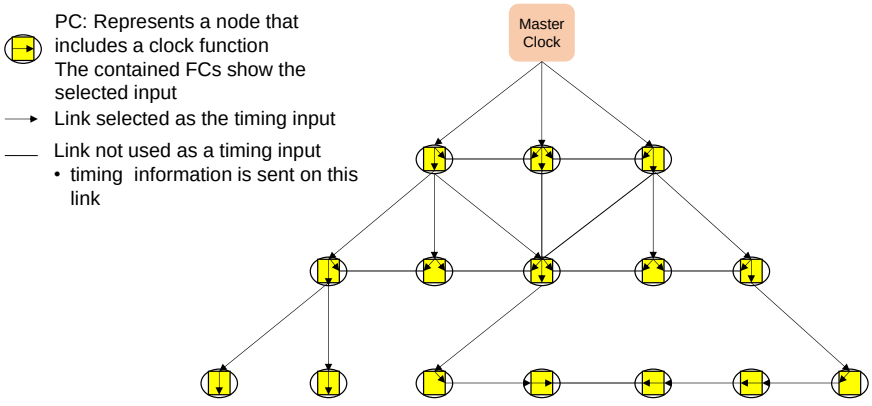


Full timing distribution topology before node input selection

- Frequency and time sync should use independent instances of the same base object classes (resulting in two independent distribution topologies)

Figure 3-2 Full timing distribution topology

The ensure the correct operation of the synchronization network each node will select one of the timing inputs and distribute the resultant timing information. This results in a pruned topology as illustrated below.



Selected timing distribution topology after node input selection

- A change in node input selection (e.g. caused by a link failure) will modify the topology
- Frequency and time sync should use independent instances of the same base object classes (resulting in two independent distribution topologies)

Figure 3-3 Reduced/pruned timing distribution topology

The pruned topology could be defined manually or: By allowing the nodes to be autonomously configured by PTP (using BMCA) or by Sync Status Messages (SSM) or: by some combination of manual and autonomous configuration. If some degree of autonomous control is permitted, then the selected topology will be updated when a failure occurs. Typically, a network operator would define the set of inputs that are used in the autonomous selection process and the priority assigned to each of these enabled inputs.

To ensure correct operation of the synchronization network the input used by the network element clocks should, when possible, be derived from the master clock. It is essential that, under fault conditions, the formation of timing loops is prevented.

Standard SSM messages only provide clock quality information which is insufficient to guarantee loop free operation under fault conditions so the links that are enabled to support timing information must be selected to avoid timing loops.

The PTP protocol provides both clock quality information and additional information about the clock source including its identity and domain membership. This allows the BCMA to select the best quality input, from those clocks within the timing domain, and avoid timing loops.

The simple network example shows a single master clock, however, in a typical synchronization network additional (secondary) master clocks are present.

4 Processing of timing information in a node

To fully describe and manage the synchronization aspects of a node the PC describe above must be expanded to expose the internal details. This expansion, for a PTP clock, is shown in the figure below.

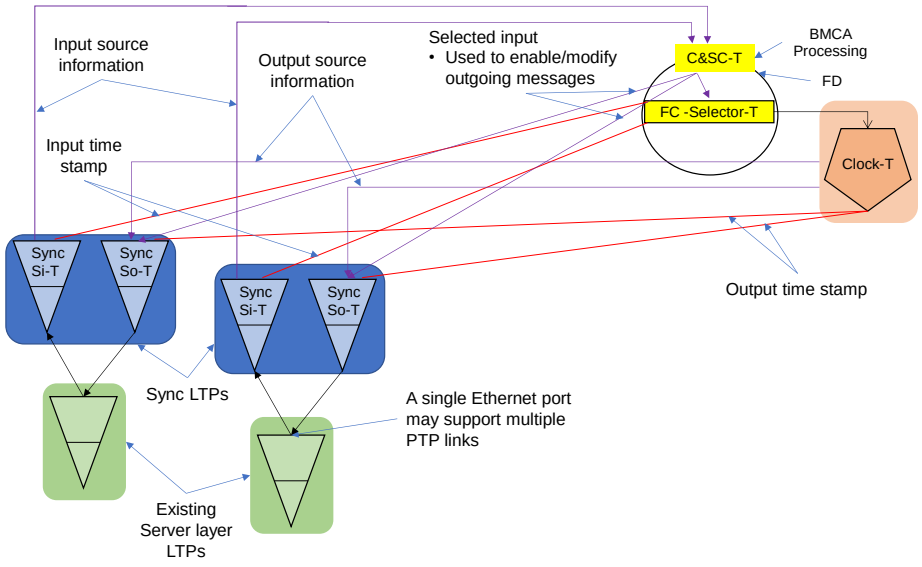


Figure 4-1 PTP node expansion

The termination of the trails carrying the timing information is represented with an LTP with the appropriate layer protocol(s). The extraction of the components of the timing information (time stamp and timing source information) is represented by a LTP with a layer protocol of synchronization (Sync LTP). The time stamp is forwarded to a FC, this FC has m inputs and one output. The timing source information is forwarded to a Configuration and switch controller (C&SC). The Sync LTP and the relationship to the FC and C&SC is only present for those inputs that have been enabled to support synchronization. The management/control system also assigns a selection priority to each input. The C&SC uses the timing source information together with the locally configured priority and any local commands to configure the FC to forward the time stamp from the selected input to the clock. If none of the inputs are selected the clock enters hold-over or free-run mode. The clock is an analog device that essentially integrates the time stamps and produces a smoothed output time stamp. The output time stamp is forwarded to all of the Sync LTP that have been enabled to support timing information. The clock source/quality information is also forwarded to these sync LTP. The C&SC informs the sync LTPs which input has been selected and the Sync LTPs modify the clock source/quality information.

The same abstraction, with the appropriate parameters, can be used for frequency synchronization.

Typically, a node will support redundant clocks. This is illustrated in the figure below.

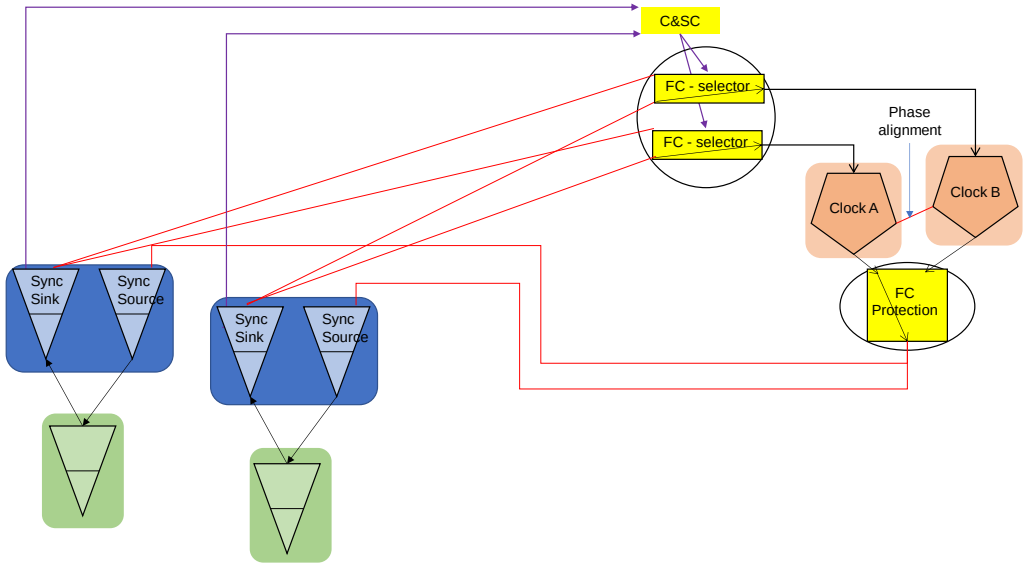


Figure 4-2 Node with redundant clocks

Both clocks receive the same time stamp input, one is selected as the master and provides a phase alignment signal to the slave. The FC protection selects the master clock and forwards the time stamp to the enabled sync LTPs. The clock source/quality information is also forwarded to these sync LTP by the FC protection. The master can be selected either automatically based on the status of the clocks, or by a local management inputs.

4.1 Refactoring the synch model

If visibility of the operation of the node is not required the sync model can be refactored into a Processing Construct that encompasses the Sync LTPs, FC-selector, C&SC, clock and FC protection. This is illustrated in the figure below.

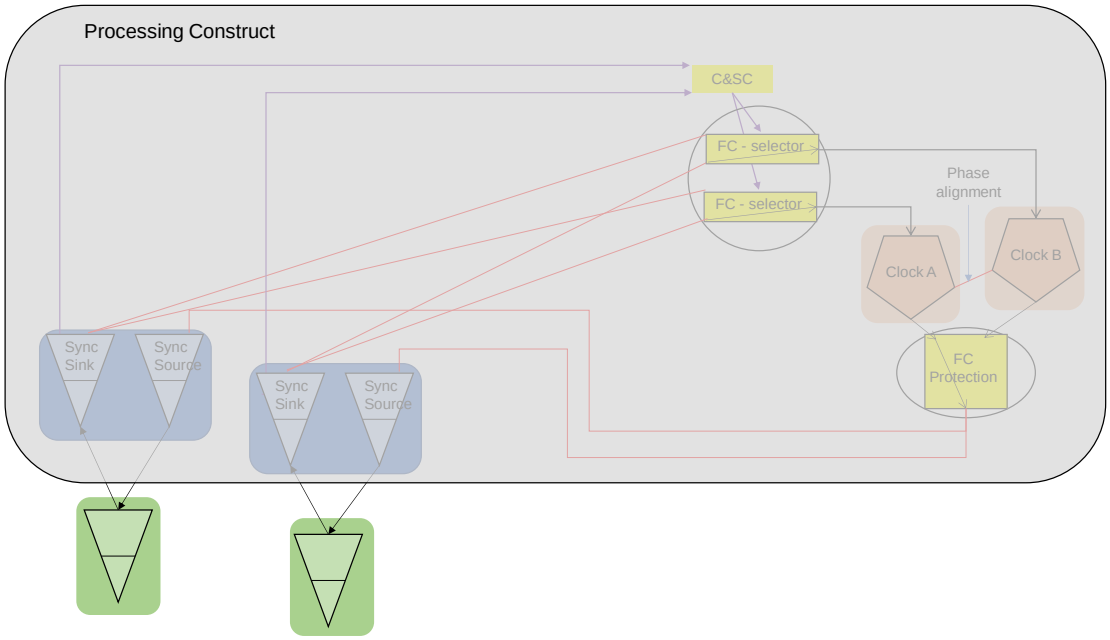


Figure 4-3 Node represented by a processing construct

In this case the Sync LTP attributes are reported against ports on the PC and the parameters of the clock are reported against the PC.

5 Synchronization model attributes

The attributes provided in this section[1] support frequency synchronization using SSM and time synchronization using the Telecom profile of [IEEE 1588]. These parameters need to be validated by ITU-T SG15, Q13/15 and Q14/15.

5.1 Existing NE object

Attribute Name	Description	Type
Sync_Support_freq	Indicate whether the NE has the capability to support frequency synchronization.	Enumeration – Read only: [ITU-T G.813]; [ITU-T G.812]; etc.

[1] NE sync status has not been fully covered in this release.

Attribute Name	Description	Type
Freq Sync support enabled	Allows the frequency sync functions to be deactivated	Boolean – Read/Write: Default: enabled
Sync_Support_time	Indicate whether the NE has the capability to support time synchronization.	Enumeration – Read only: Boundary clock (BC); Transparent clock (TC) etc.
Time Sync support enabled	Allows the time sync functions to be deactivated	Boolean – Read/Write: Default: enabled

5.2 Clock

5.2.1 Frequency sync (SSM) pac

Attribute Name	Description	Type
system clock ID	The ID of the SyncClock_Frequency object.	Object ID frequ and PTP could use a common attribute definition Object ID – read only
associated node ID	The SyncClock_Frequency object is associated with the NE of this node ID.	Object ID frequ and PTP could use a common attribute definition Object ID – read only
run-mode	The run-mode of the frequency system clock, such as freerun, locked, and holdover.	Enumeration - Read only; Freerun; locked; holdover frequ and PTP could use a common attribute definition Enumeration – read only
internal clock SSM	The SSM quality level of internal clock of the NE.	Enumeration - Read only [ITU-T G.813]; [ITU-T G.812]; ??? frequ and PTP could use a common attribute definition Enumeration – read only

5.2.2 Time Sync (PTP) pac

Attribute Name	Description	Type
PTP system clock ID	The ID of the SyncClock_Time object.	Object ID frequ and PTP could use a common attribute definition Object ID – read only
associated node ID	The SyncClock_Time object is associated with the NE of this node ID.	Object ID frequ and PTP could use a common attribute definition Object ID – read only
PTP enable status	Indicate whether the NE enables PTP function or not.	Boolean – read/write? Boolean – read/write
run-mode	The run-mode of the PTP system clock, such as tracing and non-tracing.	Enumeration - Read only: Freerun; locked; holdover frequ and PTP could use a common attribute definition Enumeration – read only
PTP domain	The PTP domain number of the NE.	Integer or string – Read/write? Integer – read/write
PTP device-type	Three PTP device types are included: boundary clock (BC), transparent clock (TC), and ordinary clock (OC).	Enumeration - Read only boundary clock (BC), transparent clock (TC), and ordinary clock (OC). frequ and PTP could use a common attribute definition with different enumerations Enumeration – read/write
PTP slaveonly	Indicate whether the NE can only be used as PTP slave or not.	Boolean - Read only? Boolean – read/write

Attribute Name	Description	Type
PTP source dataset	The PTP status dataset of current tracing source.	Ordered list - Read only: grandmasterIdentity – Object ID – Read only, parent ID – Object ID – Read only, priority 1 – Integer – Read only, priority 2 – Integer – Read only, clockClass – Integer – Read only, accuracy – Integer – Read only, offsetScaledLogVariance – Integer – Read only, timesource – Enumeration – Read only, stepsRemoved – Integer – Read only, currentUtcOffset – Integer – Read only, ptpTimescale – Enumeration – Read only, timeTraceable – Boolean – Read only, frequencyTraceable – Boolean – Read only, [IEEE 1588] protocol version – Integer – Read only,, current absolute time – Integer – Read only.

Attribute Name	Description	Type
PTP default dataset	The PTP status dataset of internal clock of the NE	Ordered list – Read/Write: CLK ID – Object ID – Read/Write, priority 1 – Integer – Read/Write, priority 2 – Integer – Read/Write, clockClass – Integer – Read/Write, accuracy – Integer – Read/Write, offsetScaledLogVariance – Integer – Read/Write, timesource – Integer – Read/Write, stepsRemoved – Integer – Read/Write, [IEEE 1588] protocol version – Integer – Read/Write.

5.3 Sync LTP

5.3.1 SSM in band pac

All of the attributes that report/manage SSM quality level can use a common enumeration.

Attribute Name	Description	Type
clock port ID	The ID of the SyncLTP_In_Band_Clock object.	Object ID – read only
associated port ID	The SyncLTP_In_Band_Clock object is associated with the physical port LTP of this port ID.	Object ID – read only
SSM output enable status	Indicate whether to send SSM messages or not.	Boolean – read/write
SSM information	Current input and output SSM quality levels used by the port. The SSM quality level can be set manually or automatically.	Enumeration – Read/Write e.g: PRC, SSU-A, SSU-B, QL-SEC, DNU, etc.

Attribute Name	Description	Type
SSM mode	Indicate whether to use manual or automatic input and output SSM quality levels.	Enumeration– Read/Write: Manual or Automatic
SSM configuration	The input and output SSM quality levels set manually.	Enumeration – read/write

5.3.2 SSM external clock

Attribute Name	Description	Type
external port ID	The ID of the SyncLTP_External_Clock object.	Object ID – read only
external port enable status	Indicate whether to enable this external port or not.	Boolean – read/write
bits-type	The type of this port, such as 2048kb/s or 2048kHz.	Enumeration read only
SSM sa-bit	Indicate which sa-bit bits are used for carrying input and output SSM quality levels.	Enumeration – read/write
SSM out-threshold	The external port stops transmitting when the SSM quality level is lower than the threshold.	Enumeration – read/write
SSM information	Current input and output SSM quality levels used by the port. The SSM quality level can be set manually or automatically.	Enumeration – read only
SSM mode	Indicate whether to use manual or automatic input and output SSM quality levels.	Enumeration– Read/Write: Manual or Automatic
SSM configuration	The input and output SSM quality levels set manually.	Enumeration – read/write

5.3.3 PTP pac

Attribute Name	Description	Type
PTP port ID	The ID of the SyncLTP_PTP object.	Object ID – read only

Attribute Name	Description	Type
associated port ID	The SyncLTP_PTP object is associated with the physical port LTP of this port ID.	Object ID – read only
PTP port enable status	Indicate whether to enable this PTP port or not.	Boolean – read/write
PTP port state	The current PTP state of the PTP port, such as master, slave, passive, initializing, listening, premaster, uncalibrated, and faulty.	Enumeration – read only
PTP asymmetry-correction	The asymmetry correction value of this PTP port.	Integer, nano seconds – read/write same as external time port delay compensation? Integer – read/write
PTP clock-step	Indicate whether one-step or two-step mechanism is adopted.	Enumeration – read only
PTP udp-egress configuration	The configuration of PTP UDP encapsulation, including source IP address, destination IP address and IPv4/IPv6 protocol.	Ordered list – Read/Write: source IP address – String – Read/Write, destination IP address – String – Read/Write, IPv4/IPv6 protocol – Enumeration – Read/Write.
PTP mac-egress configuration	The configuration of PTP MAC encapsulation, including source MAC address, destination MAC address and VLAN configuration.	Ordered list – Read/Write: source MAC address – String – Read only, destination MAC address – String – Read only, VLAN configuration – String – Read/Write
PTP announce-interval	The sending interval of PTP announce message.	Integer: milli seconds – read/write
PTP announce receipt-timeout	It is used for fault detection of PTP announce messages.	Integer: milli seconds – read/write
PTP sync-interval	The sending interval of PTP Sync message.	Integer: milli seconds – read/write

Attribute Name	Description	Type
PTP min-delayreq-interval	The sending interval of PTP Delay_req message.	Integer: milli seconds – read/write

5.3.4 PTP 1PPS + ToD pac

Attribute Name	Description	Type
external port ID	The ID of the SyncLTP_External_Time object.	Object ID – read only
external time port status	Indicate whether this external time port is used as an input or output port.	Boolean - read only
external time port dataset	The status dataset of this port	Ordered list – Read/Write: grandmasterIdentity – Object ID – Read/Write, priority 1 – Integer – Read/Write, priority 2 – Integer – Read/Write, clockClass – Integer – Read/Write, accuracy – Integer – Read/Write, offsetScaledLogVariance – Integer – Read/Write, timesource – Integer – Read/Write, stepsRemoved – Integer – Read/Write, currentUtcOffset – Integer – Read/Write.
external time port delay compensation	The delay compensation value of this external port.	Integer, nano seconds – read/write Same as PTP asymmetry-correction? Integer – read/write

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