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LIAISON STATEMENT

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Title: LS on ITU-T Q14/15 work on the management model for time and frequency synchronization

LIAISON STATEMENT

For action to: -

For comment to: -

For information to: IEEE 1588, IETF tictoc WG, ONF IMP

Approval: ITU-T SG15 meeting (Geneva, 15-26 February 2016)

Deadline: -

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ITU-T Q14/15 has initiated work on the development of a protocol neutral information model in UML to support the management of both time and frequency synchronization. Q14/15 also plans to map the UML model into a YANG data model for the management of time synchronization. This work does not cover time of day distribution (e.g., using NTP).

Management view of the synchronization network

A NE that supports a slave clock function (i.e. a local frequency or time reference) will terminate a number of interfaces that support trails and links in one or more layer networks. These link may support user traffic and/or synchronization information.

As described in Appendix A, the synchronization distribution trails will be present within some of these interfaces. The selection of the synchronization input and the distribution of the output of the slave clock are independent. For example at the edge of a network a NE may have two links that support an incoming synchronization signal but the output of the slave clock would not be distributed to other NEs. It is more convenient to describe and model synchronization using uni-directional constructs.

Simplified equipment model

Figures 1 and 2 below show a simplified equipment model for a network element that has an internal clock. The connection to an external clock (e.g. Stratum 2 for frequency synchronization or a boundary clock for PTP) is not show. The management abstractions required to represent an external clock are provided later in this document.

The model in figure 1 is based on G.781 [1] and the equipment model for time is shown in figure 2.

The figures includes numbers that show the flow of a synchronization signal from the input of the NE to the output of the NE.

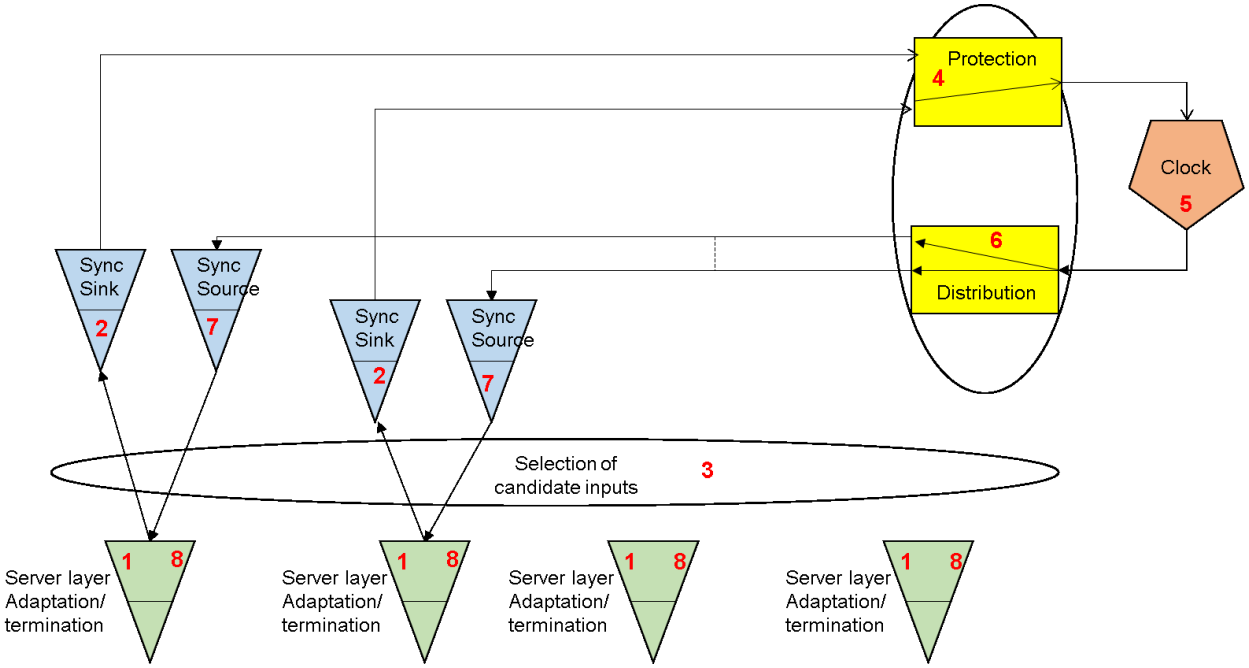

Figure 1 – Simplified frequency sync equipment model.

Note that the candidate selection shown above can select an input from any suitable server layer adaptation/termination function. This is normally preconfigured by management.

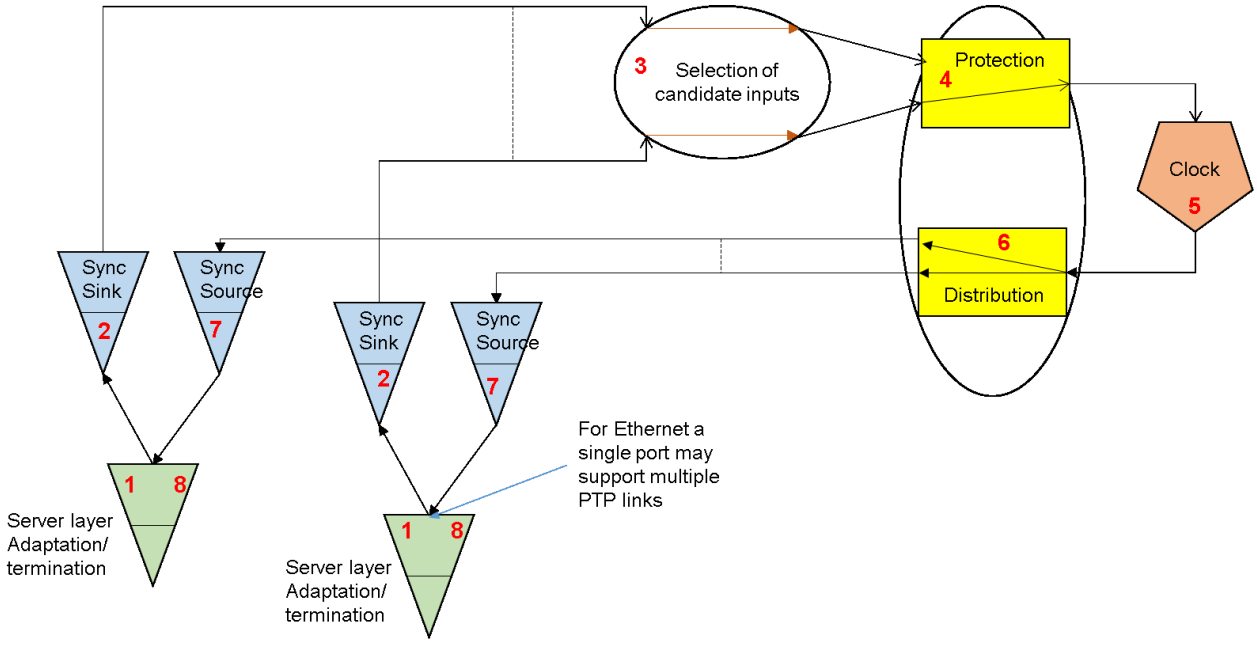

Figure 2 – Simplified PTP equipment model.

The processes associated with these functions are outlined below.

1. Terminate the server layer
   1.1. Specification provided in Recommendations under the responsibility of Q10 (e.g. G.8021) or Q11 (e.g. G.798)
2. Synchronization sink function extracts the Synchronization information[1] from the sync links (identified by the management plane) as "potential" sync inputs and forwards it to (3)
   2.1. Report the content of the status of the synchronization trail including the contents of the ssm/PTP messages to management
3. Selects a sub-set of the "potential" inputs as candidates to provide the synchronization information to the protection process (4)
   3.1. Management plane configures this process
4. Protection
   4.1. Based on the quality of the synchronization inputs (ssm/PTP) and priorities provided by the management plane the protection process selects one of the candidates and forwards it to the clock function (5)
5. Clock function processes the input sync information (frequency and ssm or time stamp and PTP messages) and provides the modified sync information to the sync distribution function (6)
   5.1. If none of the inputs meet the quality defined by the management plane the clock may enter a hold-over or free run mode. The status of the clock will be reported to the management system.
6. Distribute the synchronization information from the clock to the output ports via (7)
   6.1. The management system must define which outputs are intended to carry the synchronization information.
   6.2. The ssm/PTP messages sent by the sync source that is bound to the server layer adaptation/termination that is currently used as the sync input to the clock may be different from the ssm/PTP messages sent by the other sync source. For example for frequency sync the clock quality message ssm from the clock will be replaced with "do not use for synch" to avoid timing loops.
7. Encodes the synchronization information provided by the clock function to allow it to be carried by the server layer
8. Terminate the server layer
   8.1. Specification provided in Recommendations under the responsibility of Q10 (e.g. G.8021) or Q11 (e.g. G.798)

Management abstractions

For the purposes of management, the functions (and/or processes) described above will be represented as described below. Note that these are described in terms of instances of the LogicalTerminationPoint (LTP) or ForwardingConstruct (FC) classes from Recommendation ITU-T G.7711 (ONF TR-512) that represent the specific synchronization function. These are described in terms of uni-directional instances since this simplifies the description. Bidirectional instances may be used.

1. Termination of the server layer
   1.1. 

Sink part of a bi-directional server layer LTP instance as defined in G.874.1 (OTN), G.8052 (Ethernet), Draft G.8152 (MPLS-TP).

[1] Synchronization information includes: For frequency synchronization the frequency and synchronization status messages, and for precision time the time stamp and PTP messages.

2. Synchronization sink function
   2.1. Sync Si LTP Sink part of a client layer LTP object instance that supports uni-directional Synchronization Sink function[2]
   2.2. Server layer specific optional packages may be required to allow management of the adaptation/termination processes.
3. Selection of candidate inputs for the protection process (3)
   3.1. For frequency synchronization
   Creation/removal of the relationship between an instance of the server layer LTP and an instance of the client layer Sync LTP
   3.2. For PTP:
   Creation/removal of the relationship between an instance of the client layer Sync LTP and an instance of the Sync Protection FC (4)
4. Protection process:
   4.1. Sync Prtn FC New object instance uni-directional Sync protection ForwardingConstruct
5. Clock function:
   5.1. Clock LTP New object instance uni-directional Clock LTP.
6. Clock distribution
   6.1. Sync Dist FC New object instance uni-directional sync distribution ForwardingConstruct.
7. Synchronization source function
   7.1. Sync So LTP Source part of a client layer LTP object instance that supports uni-directional Sync Source function
   7.2. Server layer specific optional packages may be required to allow management of the adaptation/termination processes.
8. Terminate server layer
   8.1. LTP Source part of a bi-directional server layer LTP instance as defined in G.874.1 (OTN), G.8052 (Ethernet), Draft G.8152 (MPLS-TP).

Object construction

Object instances of LTP, FC, ForwardingDomain (FD) are used to represent the synchronization functions and are constructed from the base classes using composition. This aligns with the approach taken in G.7711 (ONF TR-512) and avoids the creation of specialized object classes. A sketch of the relationships for the synchronization LTP instances is provided below in figure 3.

[2] For all of the object instances representing "Sync" separate conditional packages will be defined for frequency and precision time. The objects will be constructed from the base class using composition (as defined in G.7711).

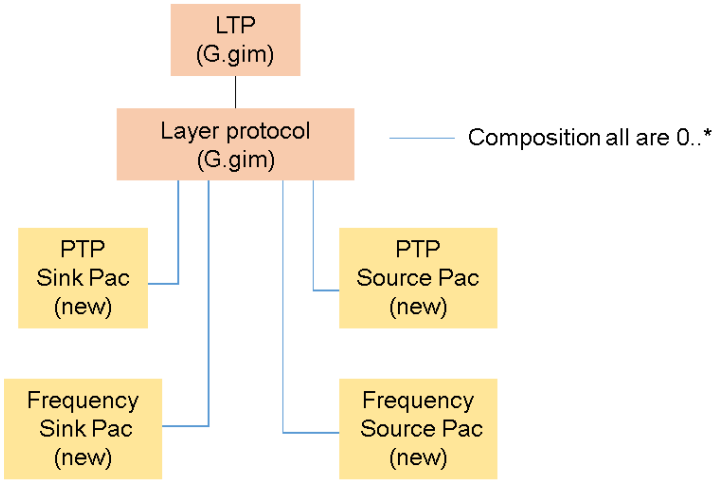

Figure 3: Synchronization LTP construction

Additional (technology specific) optional packages may be required to describe any server specific properties.

The clock function is represented by an instance of LTP constructed as shown in figure 4.

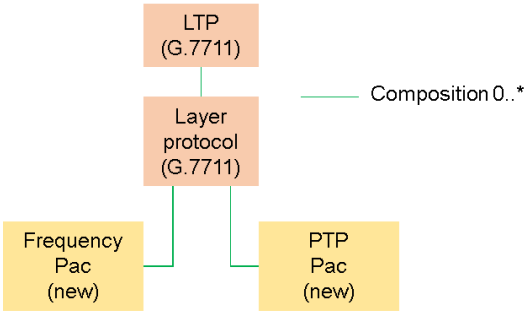

Figure 4: Clock LTP construction

Additional (technology specific) optional packages will be required to describe clocks with different quality levels or functions (e.g. transparent clock, boundary clock, stratum 2 clock etc.).

The uni-directional synchronization protection FC instance will be based on one of the G.7711 [2] protected FCs and the uni-directional synchronization FC instance will be derived from a point-to-multi-point FC from G.7711 [2].

Example use of the model

An example of the instantiation of the model for a NE with an internal clock is provided below in Figure 5.

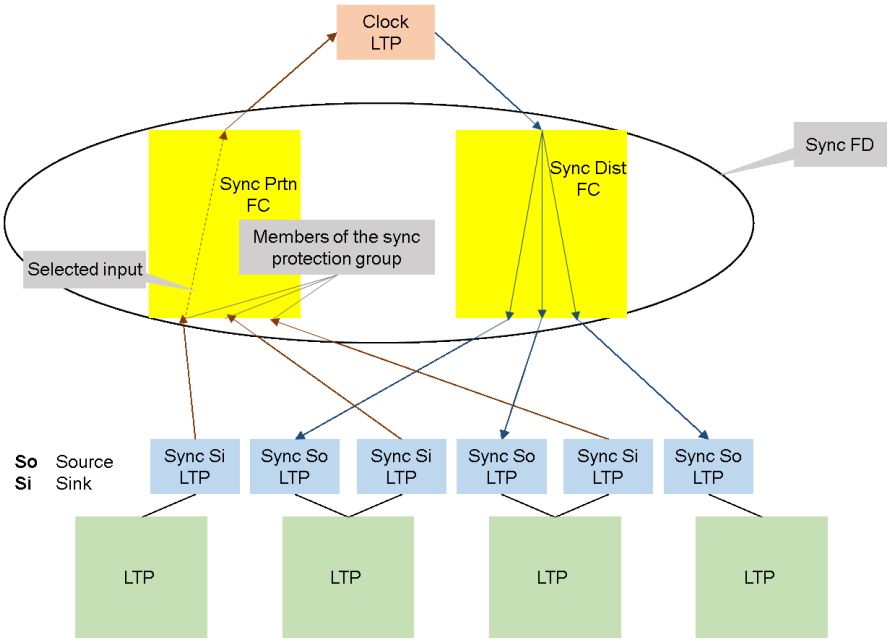

Figure 5: Example of the use of the synchronization management model

Notes for figures 5 and 6

- Each green LTP is an instance of the LTP class that represents the termination of the server layer.
- Each blue LPTs is an instance of the client layer LTP class that represent the sync function.
- Each yellow FC is an instance of the FC class that represents the sync selection or distribution functions.
- The Peach LTP is an instance of the LTP class that represents the NE clock function.

This set of managed object will be used to manage the (frequency or time) synchronization functions of the network element with an internal clock. Typically the server layer LTPs would also terminate user traffic. Also the NE will normally support additional LTPs and FDs/FCs in multiple layer networks to support the management (termination and/or connectivity) of user traffic.

The rules for the instantiation of the Sync Source LTP and Sync Sink LTP instances depend on the capabilities of the hardware and the policy of the network operator. At least the following options for the behaviours should be supported by the model:

1. Created by management action: The management system explicitly creates (and deletes) the sync LTP instances
   1.1. The management system also creates/breaks the associations between the Sync LTP instances and the Sync FC (for time) instance or server layer LTP instances (for frequency).
2. Auto created: The NE instantiates the Sync LTP instances when sync status messages or PTP messages are detected.
   2.1. The relationship between the Sync LTP instances and the Sync FC (for time) instance or server layer LTP instances (for frequency) is initially “null” and must be configured by the manager
   2.2. The relationship between the Sync LTP instances and the Sync FC (for time) instance or server layer LTP instances (for frequency) is automatically created when the Sync LTP instances are created.
      2.2.1. The Sync protection priority should be set to “low” and may be reconfigured by management or PTP protocol actions.

Note that the same set of managed object classes (with different pacs to reflect the different clock quality and capability) could be used to represent for example a boundary clock NE or a stratum 2 clock

An example of the instantiation of the model of a transport NE connected to a standalone external clock is provided in figure 6.

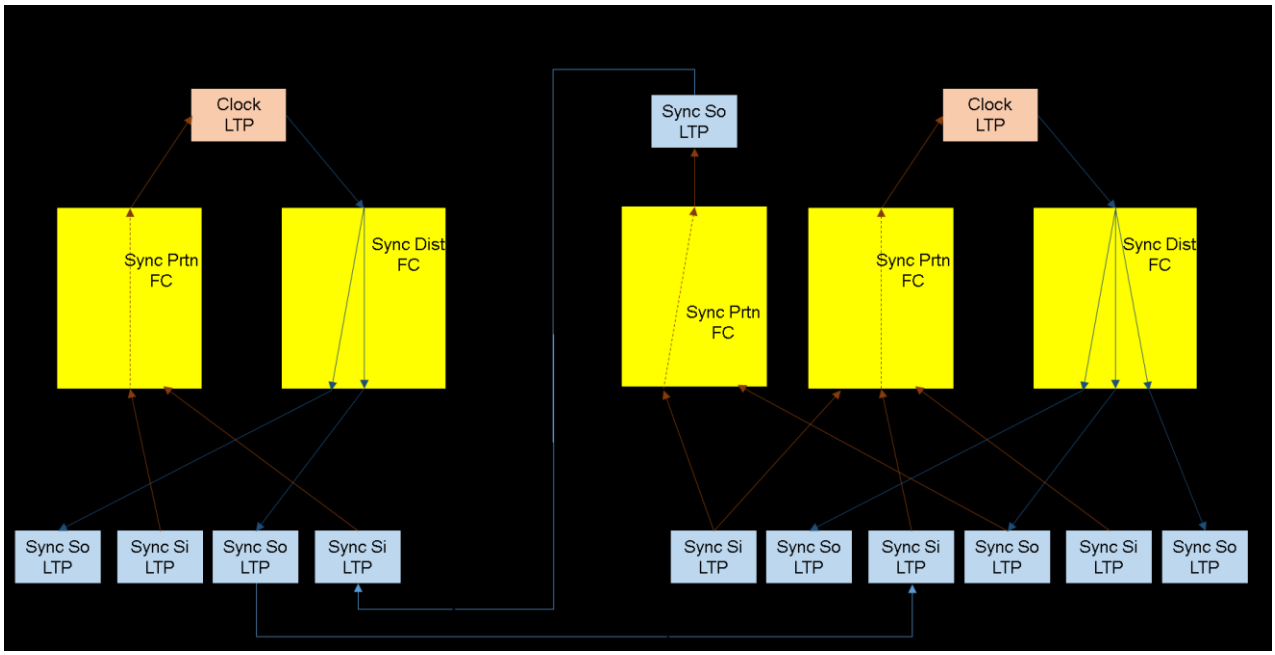

Figure 6: External clock and Transport NE

To avoid adding clutter in the figure the server layer LTP instances and the FD instances are not shown in figure 6. The standalone external clock could be a boundary clock (for time) or a stratum 2 clock (for frequency). Other configurations are possible, for example the output from the transport NE could be provided by the NE clock.

Attributes

This section provides an initial high level overview of the types of attributes that should be included in the Sync managed objects in addition to the "normal LTP/FC attributes" such as name, operational state, administrative state etc. The actual parameters and values should be defined by Q13/15.

Note that contributions were submitted to this SG15 meeting proposing more detail for the attributes. These attributes will be added during further work.

1. Sync sink LTP
   1.1. Received ssm/PTP messages
   1.2. Input to Sync protection enabled (Use Administrative state?)
2. Sync source
   2.1. Sync output enabled (Use administrative state?)
   2.2. Transmitted ssm/PTP message (is this needed?)
3. Sync Protection FC
   3.1. List of inputs
   3.2. Selected input
   3.3. Priority list
   3.4. Controls (e.g. Override automatic selection)

4. Clock
   4.1. Clock status
   4.2. Quality level alarm (e.g. input quality is less than a defined value)
   4.3. Performance parameters
5. Sync Distribution FC
   5.1. List of output

References

[1] ITU-T Recommendation G.781 “Synchronization layer functions”

[2] ITU-T Recommendation G.7011 (ex G.gim) “Generic protocol-neutral management Information Model for transport resources”

Appendix A

Synchronization distribution network example

The architecture of frequency synchronization is provided in G.781 [1]. The synchronization distribution network is described as a layer network. In normal operation, the frequency of the primary reference clock is distributed over synchronization trails to a NE clock function in a network element. This NE clock behaves as a slave clock that is synchronized to the input frequency and output from that slave clock is distributed over (new) synchronization trails to other downstream NE clock functions. Status messages are distributed with the synchronization signal to indicate the quality level of the synchronization signal (e.g. PRC). In normal operation a slave clock has one or more synchronization inputs. The NE's that contains a clock must be configured to use (only) the synchronization signals defined by the management system. The selection criteria (e.g. priority) for each of the candidate synchronization signals must be configured by the management system. The synchronization function in the NE uses the synchronization quality level (in the status messages) and the configured priorities to select one on the candidate input synchronization signals as the input to the NE clock function. In the absence of a suitable input synchronization signal the NE clock enters a "hold over" mode and becomes a secondary master clock for all of the downstream NE clocks. Note that the management system must define the candidate inputs and priorities in a way that prevents timing loops.

The synchronization signal is delivered to the NE clock function by a server layer trail. This server layer trail may dedicated to synchronization distribution or it may also be used to carry client traffic.

The same architecture can also be used to describe the distribution of time information, this allows the same information model to be used for both. In the (typical) case where both frequency and time synchronization are used the synchronization distribution for frequency and time it should be possible to manage them as two separate layer networks.

A simple example of a synchronization distribution network is shown below in figure 1.

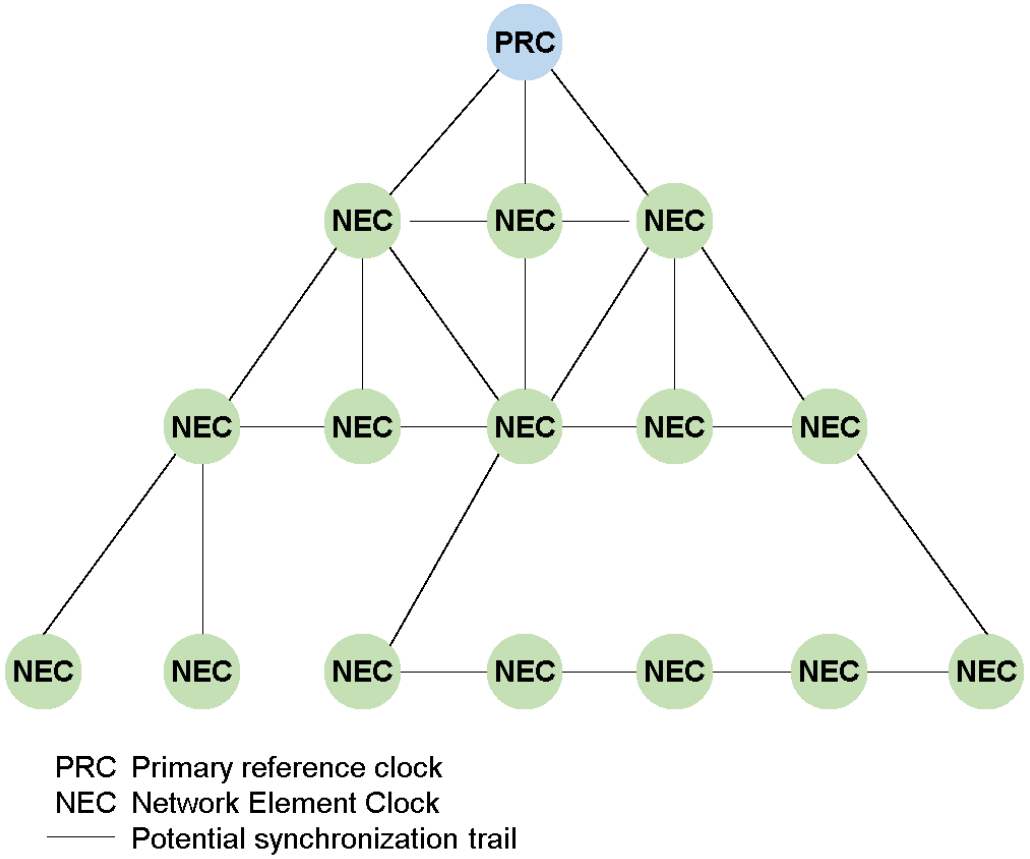

Figure 1: Example synchronization distribution network

The synchronization trails exist between the PRC and the adjacent NE clocks and between each pair of adjacent NE clocks. The synchronization functions in each NE act independently to select one on the candidate input synchronization signals as the input to the NE clock function. If all of the NE clocks in the example were allowed to select any of the potential inputs then a failure of the PRC could result in a timing loop.

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