Synchronous Ethernet

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History (1)

During the ITU-SG15 expert meeting September 2004

- Proposal to use the physical layer of Ethernet signals to transport a reference frequency, in the same way as it is done in SDH/SONET
- The rationale was that:
  - a large number of applications, that will be reached via G.8012 (Ethernet Equipments) will require G.811 traceability
  - Quality will be independant of traffic payload,
- Ethernet physical layer are able to transport a reference synchronization: this has been confirmed in ITSF Prague in 2006
- This was proposed to define an SSM channel to perform traceability
- It was proposed to thake G.781 as the basis to characterise the transport of reference frequency
- It was agreed that there is no conflict with IEEE frequency range specifications

Standard Objectives and achievements

Several recommendations will address the following points

G.8261 Definition and architecture

G.8262 Clocks, Jitter and wander

G.8264 SSM, in cooperation with IEEE

In addition ITU will update 2 existing recommendations

G.803, to be updated with Synchronous Ethernet as part of the network synchronization layer

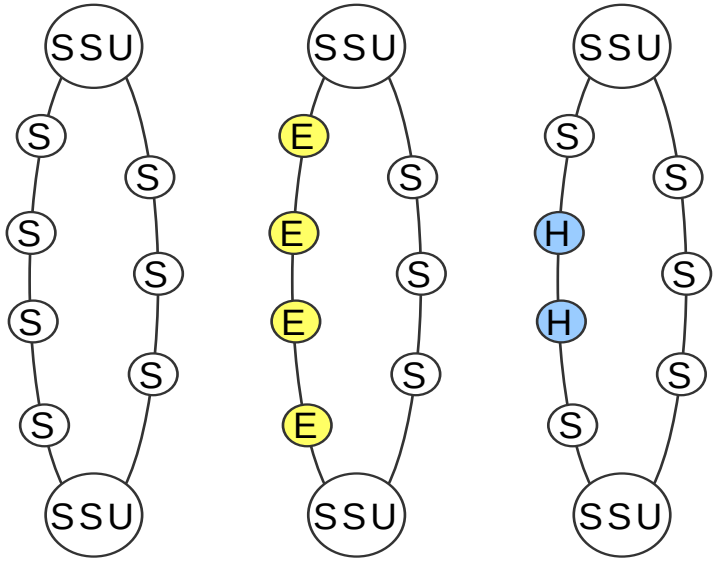
G.781, a few « atomic functions » will be added to define the Synchronous Ethernet ports

This should be achieved in February 2008 , end of study period

Architecture of Synchronous Ethernet

Synchronous Ethernet networks must interwork with existing SDH networks.

- A chain of 20 SDH Nes must be replaceable by a chain of 20 Sync-E NEs
- A reference chain of synchronous equipments as defined in G.803 can be done with a mix of SDH and Sync-E Nes
- It is possible that an NE has both STM-N and Sync-E ports



S: SDH
E:Eth
H:Hybrid

Source DT June 2006

Functions of a Synchronous Ethernet NE

-A Sync-Eth NE

- has a clock with a defined quality compatible with SDH/SONET
- is able to recover timing from one/several Ethernet signal
- is able to deliver timing to Ethernet signals
- can selects timing from several inputs for network protection
- provides timing traceability, via SSM (Synchronous Status Message)
- can be implemented within an SDH synchronization reference chain
- Independantly of synchronization, it has to be able to carry synchronous Ethernet ports and legacy ports

A Sync-Eth NE has a clock with a defined quality: G.813

-In order to interwork with the existing SDH synchronization network,

-In order to take advantage of all the work done to specify synchronous SDH networks and to fasten Synchronous Ethernet specification,

-In order to take advantage of all development and chips done for SDH,

-The clock of Sync-E Nes, G.8262 is based on G.813

G.813 specifies both Jitter and Wander

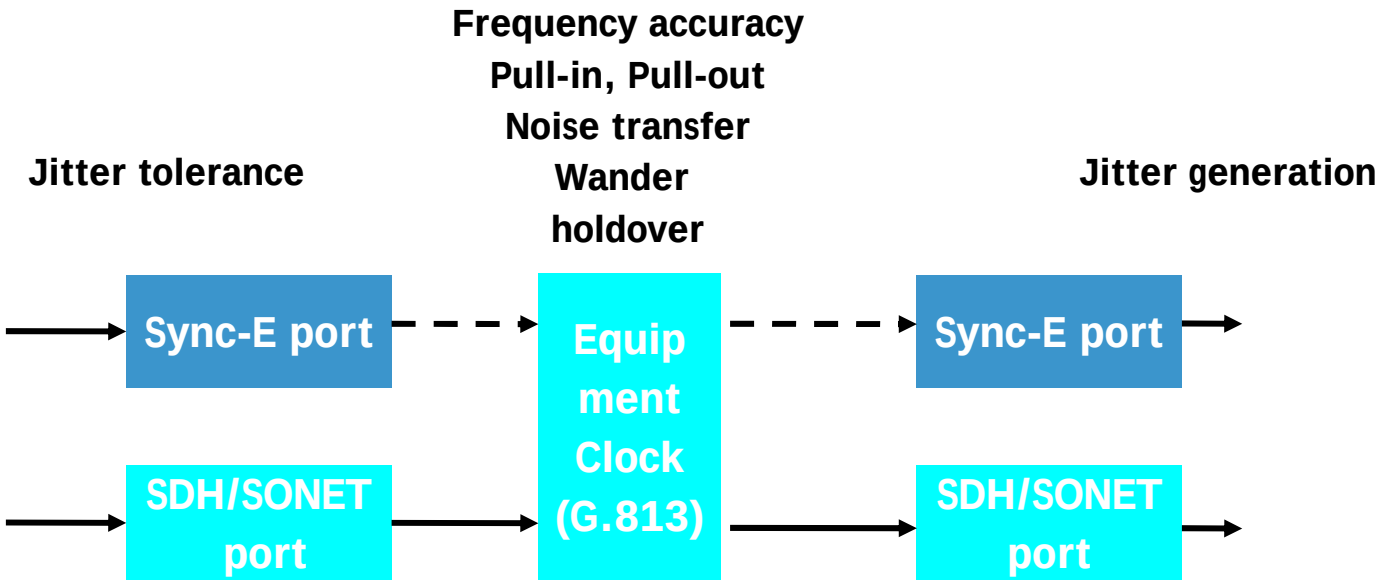
- Jitter is the key parameter for clock recovery
- Wander is the key parameter for noise accumulation over clocks in tandem

Compliance with G.813

Ethernet equipments use to extract the clock from the input signal and have a free run clock for the transmit port

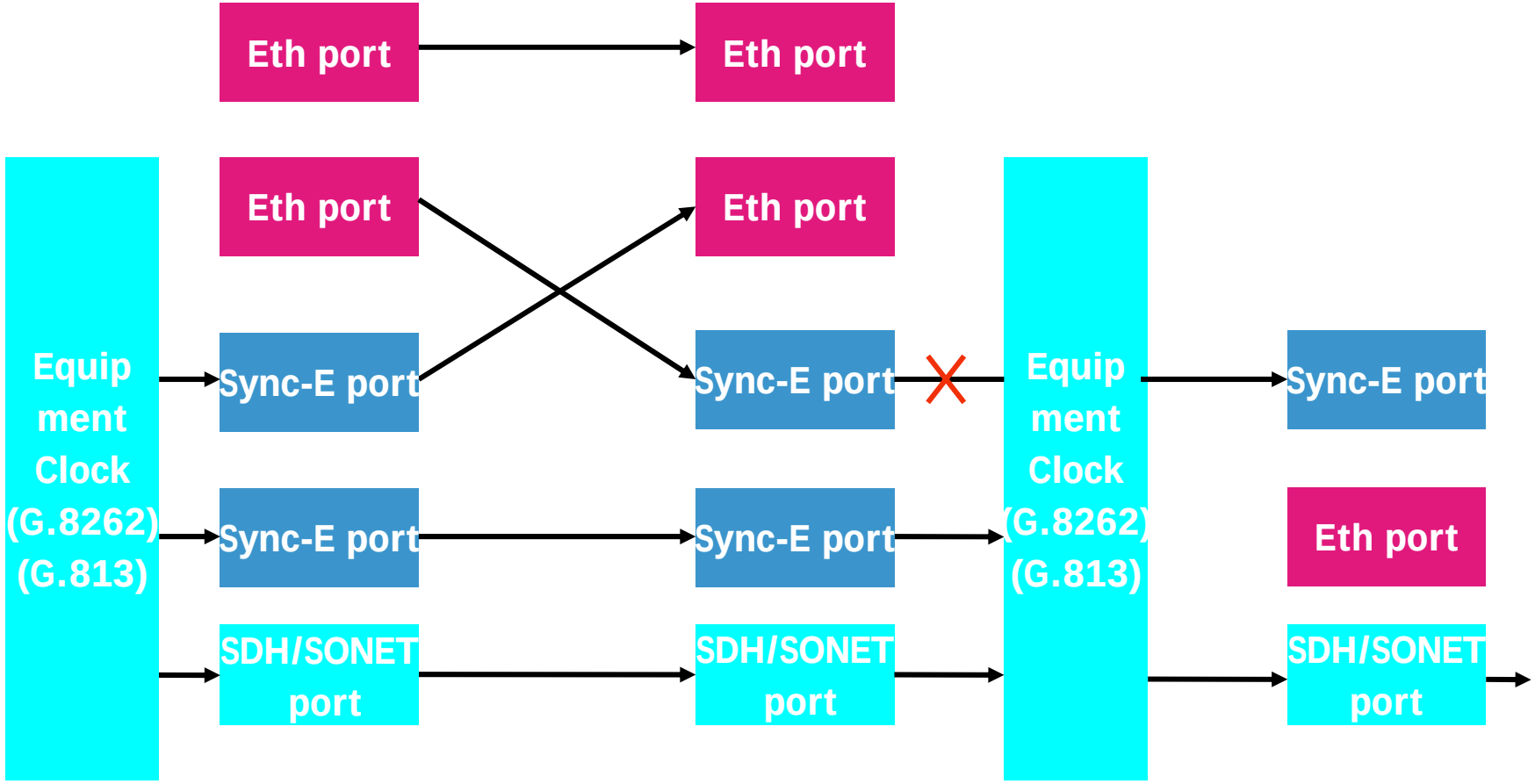
As in SDH, a synchronous-Ethernet equipment has to split clock requirements between port and an equipment clock

Eth and SDH/SONET ports belongs to the physical layer, the equipment clock is part of the synchronization layer, defined for SDH/SONET in ITU-T G.781



Jitter requirements and interworking with legacy equipments

Sync-E jitter requirements must comply with IEEE requirements in order to allow interworking between Sync-E and Eth ports

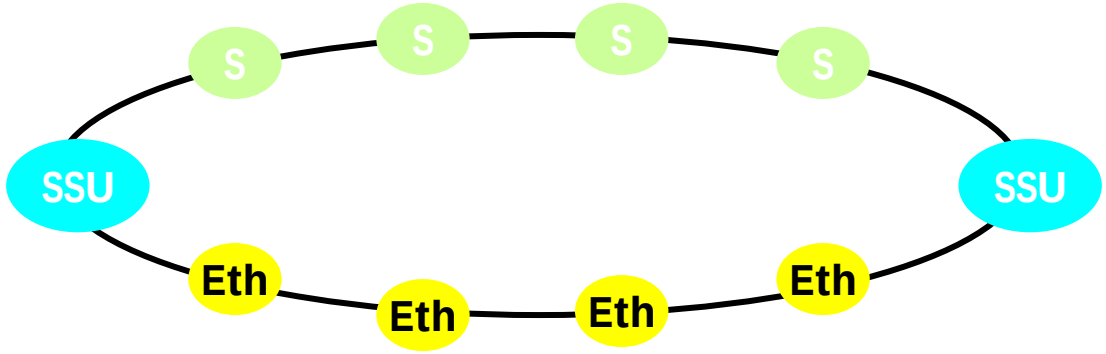


G.8262 and G.813 common specifications

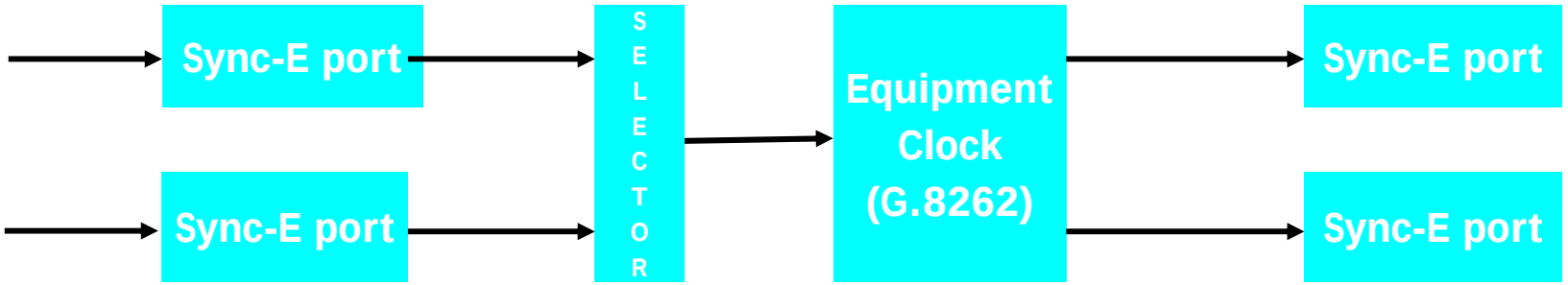
- Frequency accuracy 4.6 ppm
- Pull in range 4.6 ppm, Pull out range 4.6 ppm
- Wander tolerance
  - New to Ethernet equipments, since they had free running clock and no accumulation of wander
  - No impact on ports
- Noise transfer, wander generation
  - New to Ethernet equipments, since they had free running clock
  - Keep G.813 requirement because of noise accumulation in chains
- Holdover
  - Keep G.813 for compliance with G.803 SDH/SONET reference chain
- Transients
  - G.813 to be part of SDH/SONET chain
- List of interfaces compatible with Synchronous Ethernet
  - No list defined
  - Must be full duplex and send a continuous bit stream

A Sync-Eth NE participates to network protection

The Sync-Eth NE must have several synchronization Input ports, at least 2.



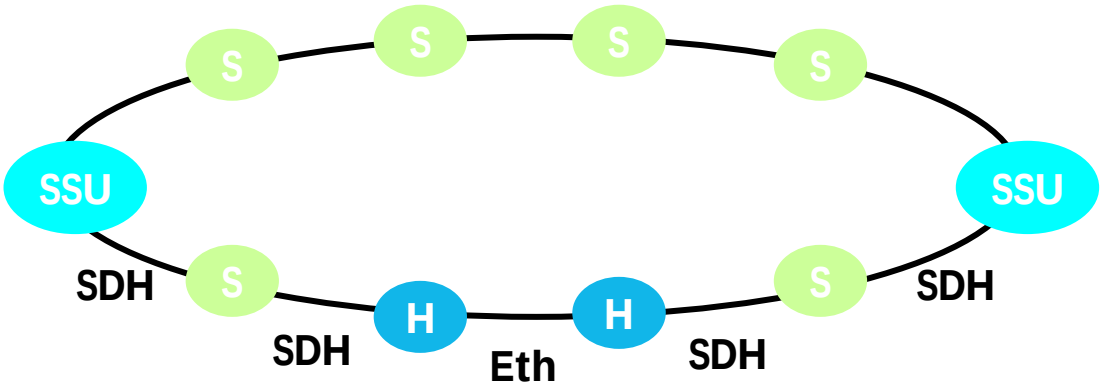
This leads to the clock diagram in Synchronous –Ethernet equipments



A Sync-Eth NE can be part of a SDH synchronization reference chain

Sync-Eth NEs may be part of an SDH synchronization reference chain

- This reinforce the requirement of G.813 clocks
- This can be achieved with « hybrid » NEs in which are implemented both SDH and Ethernet ports
- MSTP are typical examples of « hybrid « NEs

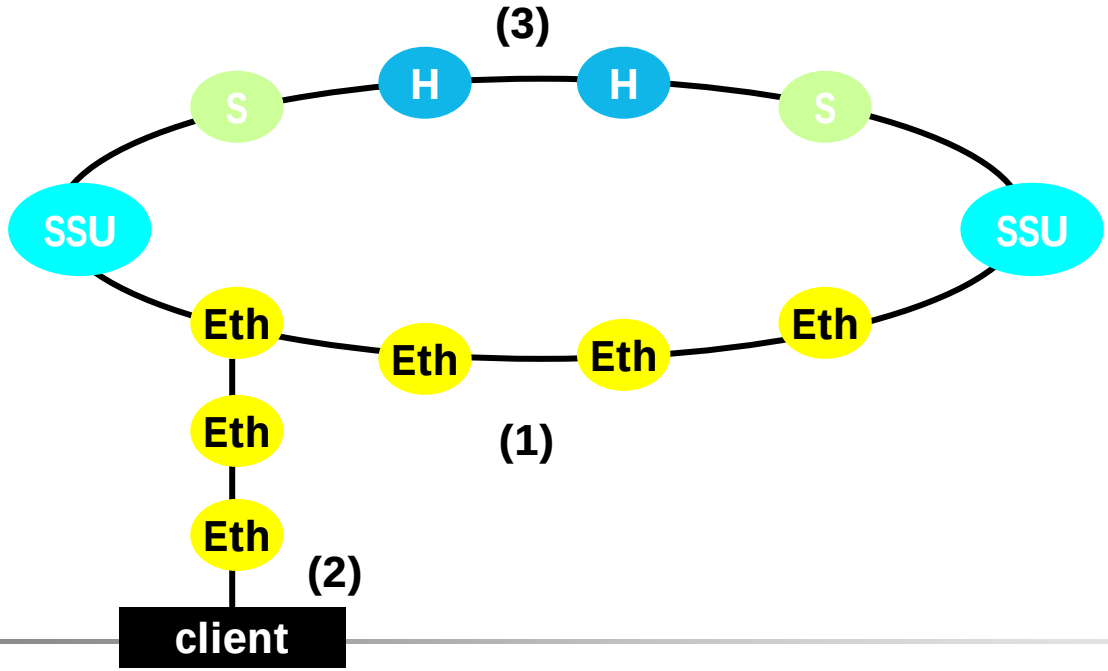


A Sync-Eth NE provides timing traceability

Traceability is required to provide automatic network protection

- In order to avoid timing loops (1)
- In order to prevent delivery of a wrong signal to a client (2)
- In order to interwork with SDH networks (3)

Traceability is provided via SSM in SDH networks

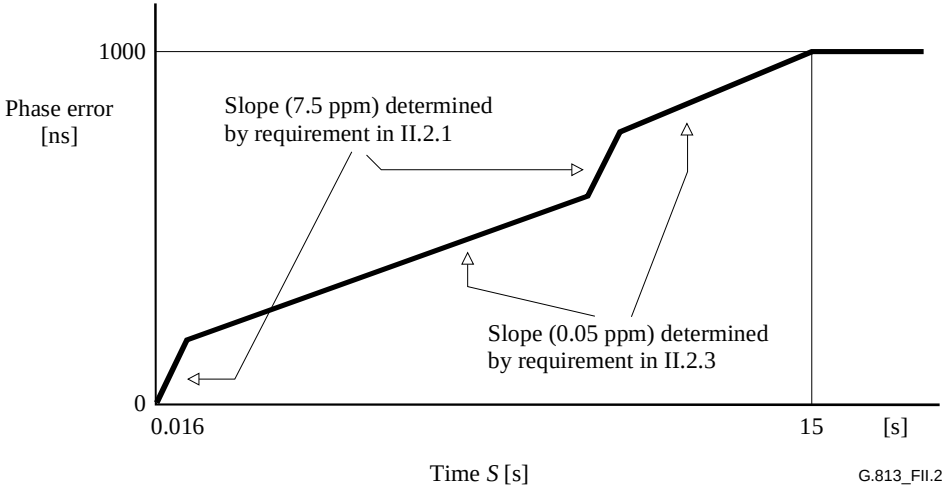


SSM in SDH networks

SSM is transported in the E1 byte of the SOH section of an SDH frame

- The SSM value is sampled at the frame rate, i.e. 8kHz
- To prevent undue reconfigurations, an SSM value is accepted if
  - received with the same value in 3 consecutive frames (G.781-option 1, ETSI)
  - received in at least 8 consecutive samples (G.781-option 2, US)

- In order to keep phase error within network limits (1µs)
  - The reconfiguration of a chain of up to 20 NEs must be performed within 15 seconds



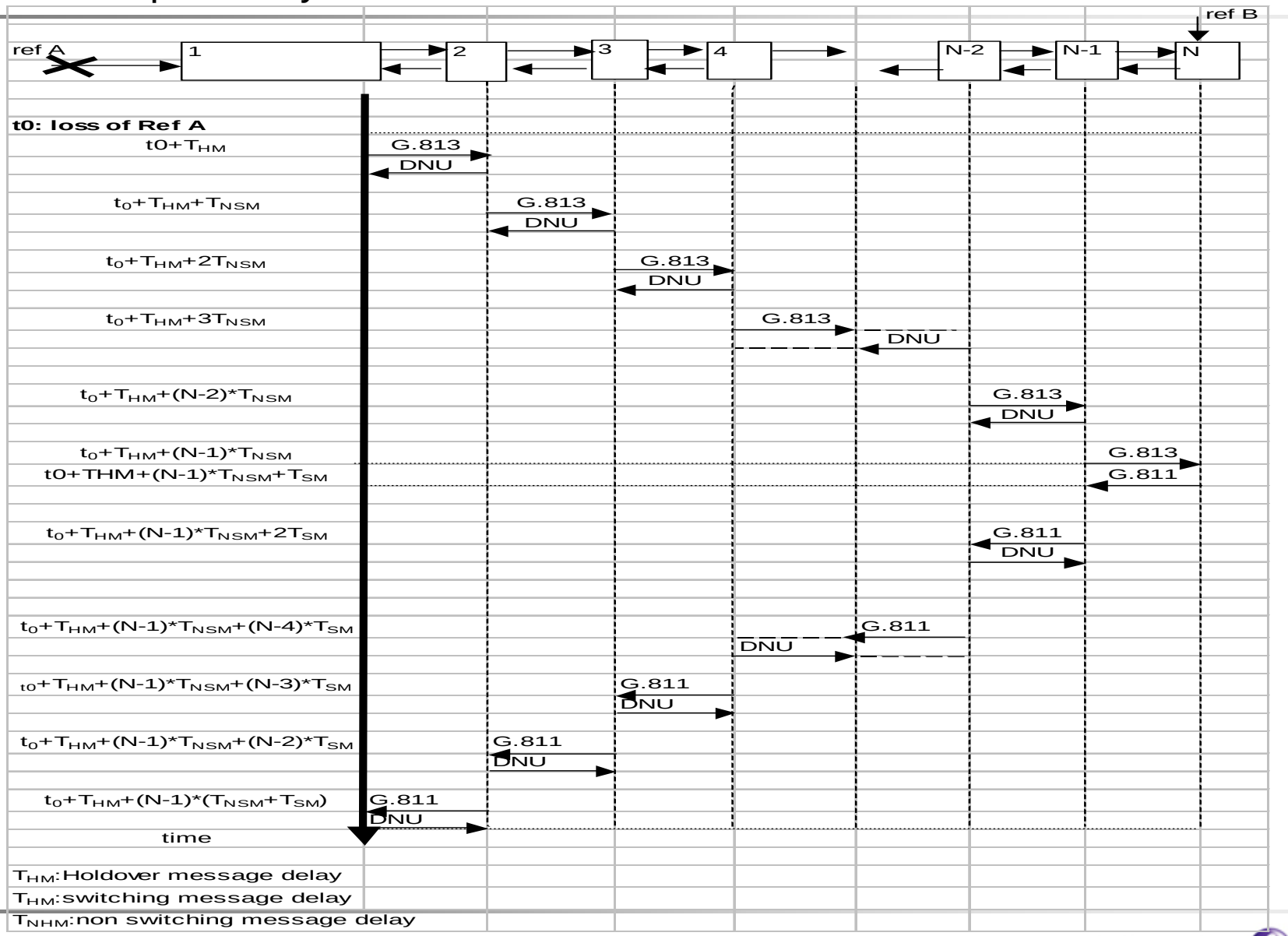
Delay times defined in G.781

These delays are specified for option 1 (SDH) and tyhe case of option 2 is « for further study »

- Holdover message delay T_{HM}
  - This delay applies when the SEC shall enter holdover because of loss of signal of the input reference and lack of any other available reference. When this event occurs, the SEC goes immediately into holdover but changes the output SSM to the holdover code after a delay which has been defined to be between 500 ms and 2000 ms.
- Non-switching message delay T_{NSM}
  - This delay applies when the QL of the selected synchronization source changes but no switchover to another source is performed. The outgoing SSM/TM follows this change at the input within a time defined to be less than 200 ms.
- Switching message delay T_{SM}

  This delay applies when a new synchronization source is selected. The output SSM change, if any, is done after a delay that has been defined to be between 180 ms and 500 ms.

Use of SSM to protect synchronization in a linear chain



Definition of SSM in Synchronous ethernet

Synchronous Ethernet must meet all SSM delays of SDH

- since these values depend on network limits and G.813
- Since the timing performance are required to be similar to SDH

Transport of SSM messages has been defined by a cooperation between IEEE and ITU SG15

- IEEE proposed ITU SG15 an OSSP Organization Specific Slow Protocol
  - No more than 10 messages per second per application
  - No delay due to bandwidth for critical messages
- IEEE defined the OSSP in a revision of G.802.3 clause 57, 802.3ay

ITU-T Q13/15 has defined a new SSM protocol

- that requires less than 10 messages per second per OAM application
- that does not require large calculation time from the equipment
- that meets the G.781 timing requirements

IEEE OAMPDU slow protocol

The new process is based on the transmission of a message only when the QL value of the equipment clock changes

- This message is protected against transmission errors by the FCS
- This message is duplicated to protect transmission against packet loss

The process must be guaranteed against failure of the SSM transmission channel

- In case of QL change, the timing might be degraded, e.g. holdover
- 10 seconds is the maximum time to reject a timing delivered by a holdover

A heartbeat will resend periodically an SSM message with the QL

- a periodicity of 1 to 3 seconds is conidered as acceptable
- It does not overload processors

G.781 update

A few new functions need to be added

- the ETYn layer clock
  - It provides the clock for the generation of Synchronous Ethernet signals
- The ETY or ETH adaptation functions, So ans Sk
  - As in SDH these functions are in charge of the SSM process

The updated G.781 model

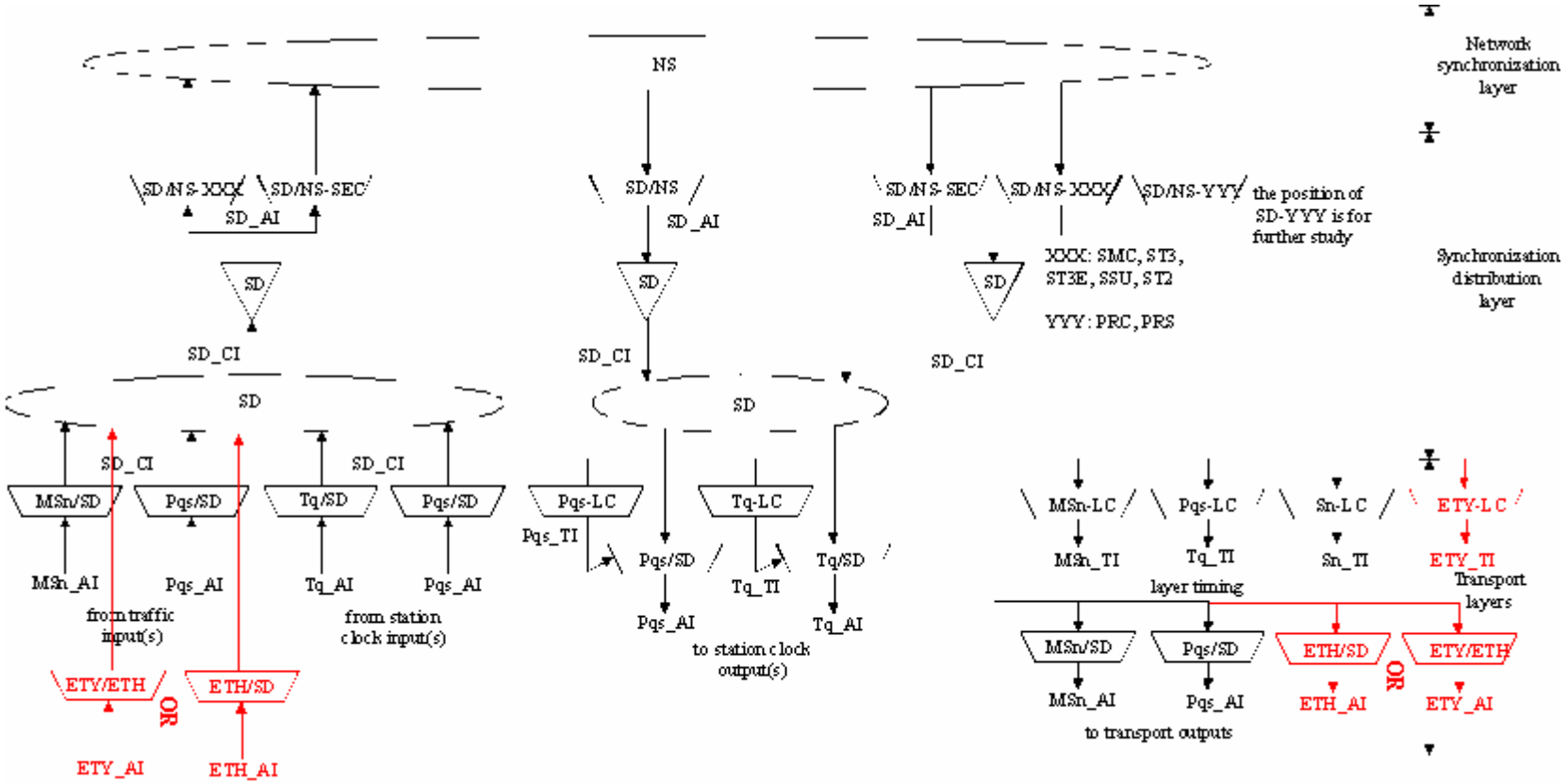


Figure 17/G.781 – Synchronization Distribution and Network Synchronization layer atomic functions

G.803

Synchronous Ethernet will be added to SDH in the synchronization layer definition

Specific warnings will be added against following situations

- NE transparent to timing, but not passing SSM
- NE passing the SSM but not the timing

conclusion

Synchronous Ethernet will provide same high quality frequency reference as SDH did for more than 10 years

Synchronous Ethernet does not transport time

Synchronous Ethernet might transport phase, this is under discussion in ITU-T Q13/15

But a chain of Ethernet NEs can propagate timing only if all Ethernet NEs of the chain are Synchronous Ethernet NEs

1588 and Synchronous Ethernet will be 2 complementary methods for the transport of timing through packet networks

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