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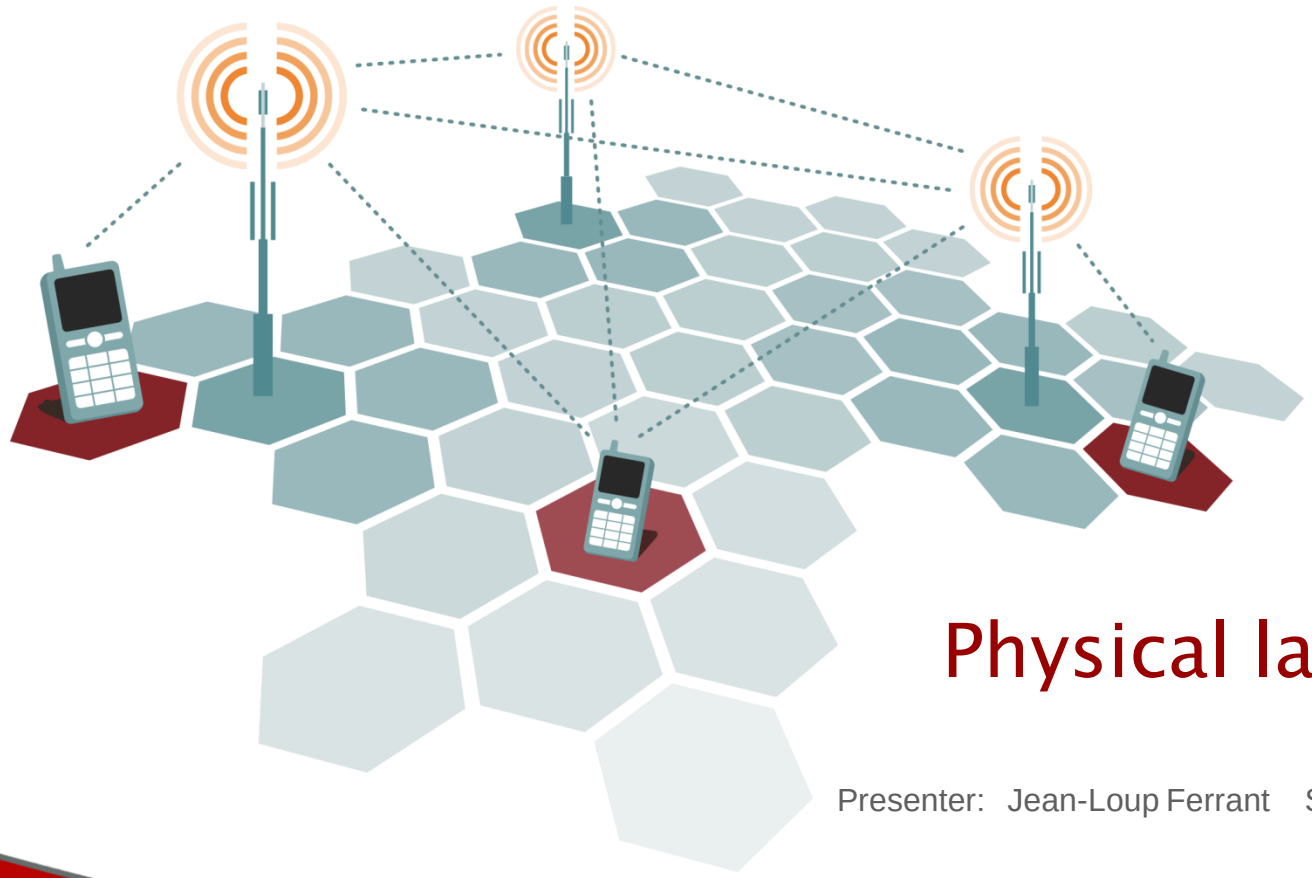


Physical layer- SyncE

Presenter: Jean-Loup Ferrant Sponsored by Calnex Solutions

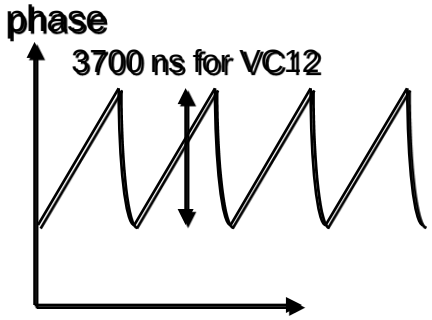
Physical layer

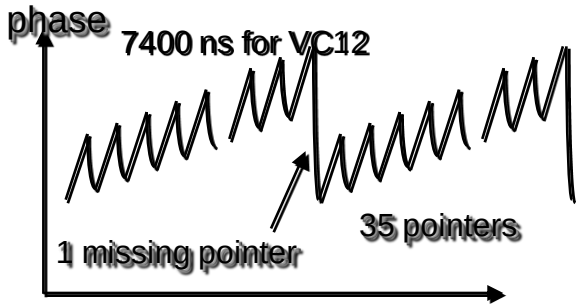
- It is possible to use the physical layer of a signal to transport a frequency reference.

- This has been used at the begining of digital networks with 2 Mbit/s lines carrying a 2048 kHz reference.
- But when the 2 Mbit/s was multiplexed into a higher PDH rate such as 34 or 140 Mbit/s, the 2 Mbit/s is not anymore transported by the physical layer
  - it passes through buffers that are not timing transparent
  - But the PDH hierarchy was designed so that the timing remain acceptable

Physical layer vs SDH mapping

- In SDH, the mapping of a 2 Mbit/s could result in a severe corruption of timing due to VC12 pointers





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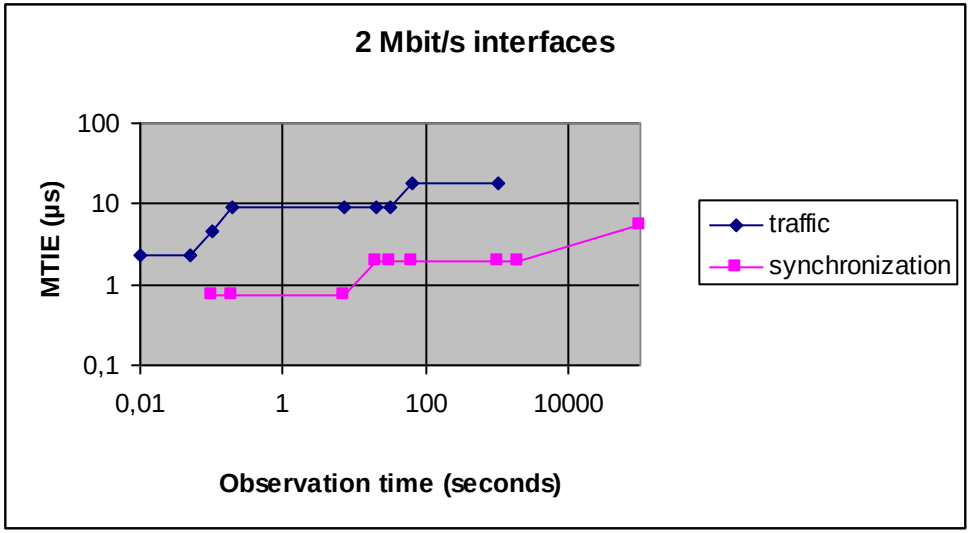
Performance of the physical layer

•When transported via a physical layer, the 2 Mbit/s can meet the template of a synchronization interface

•When it is mapped into a VC12, the output quality only meets the traffic interface template



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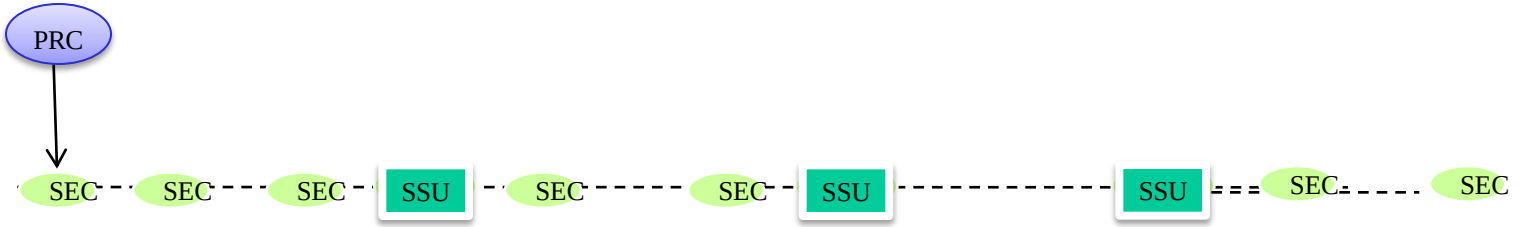
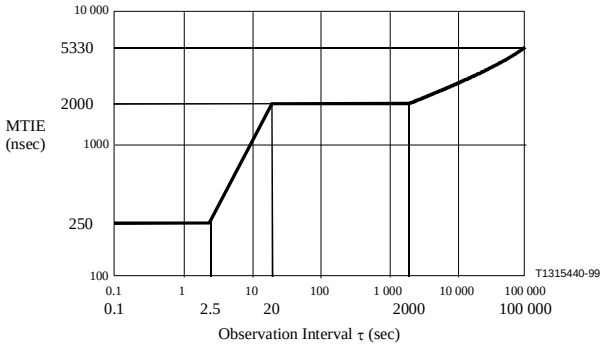
SDH, « the physical layer »

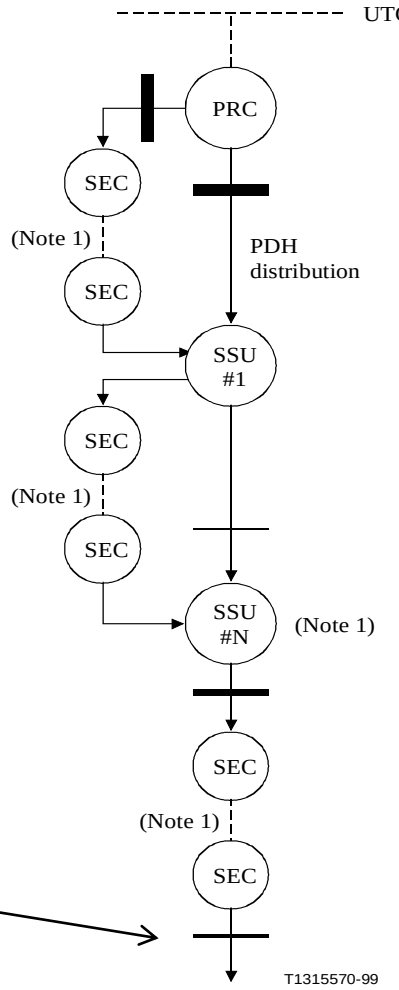
- The synchronization reference chain of SDH (G.803) specifies the maximum size of a SDH network able to transport a frequency reference over the SDH physical layer over 10 SSUs, 60 SECs and thousands of kms.
  - 2 MHz or 2 Mbit/s between PRC and SEC
  - Reference frequency carried by n*155.52 Mbit/s STM-n signal
  - The output timing meets the synchronization interface template

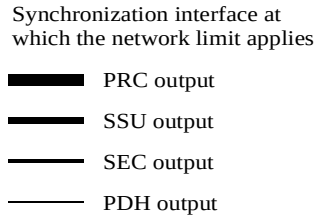


Clock hierarchy

- A clock hierarchy has been defined
  - PRC, SSU, SEC, (regenerator)
- The SSM has been defined for traceability
- The specification of this hierarchy required almost a decade







NOTE 1 – The maximum numbers of SSU and SEC clocks in these chains is defined in ITU-T Recommendation G.803.
NOTE 2 – PRC function is defined in ITU-T Recommendation G.811.
NOTE 3 – SSU function is defined in ITU-T Recommendation G.812 (Type I)
NOTE 4 – SEC function is defined in ITU-T Recommendation G.813 (Option 1)

Other types of physical layer

- Ethernet
  - 10 G WAN bit to bit identical to STM-64
  - Non synchronous, each switch generates the output Eth signals with its own free running oscillator
- OTN
  - Another non synchronous hierachy with a free running oscillator per NE

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Synchronous Ethernet

- It has been proposed in September 2004 to use the physical layer to transport a frequency reference in order to
  - Provide G.811 traceability to applications
  - Provide a timing quality independant of traffic payload

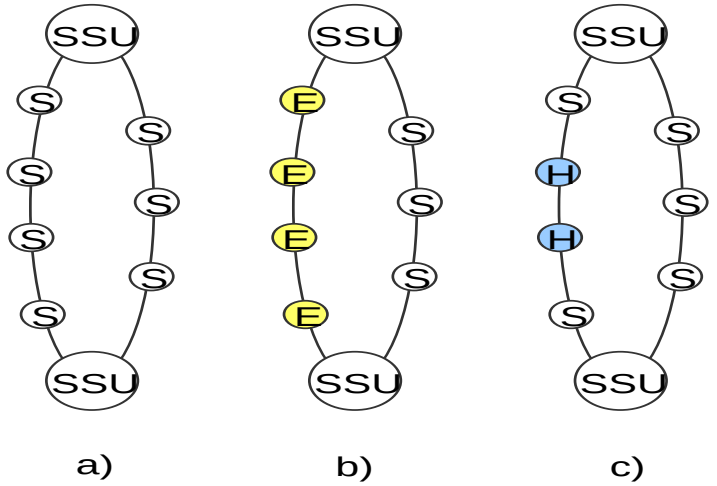
- It was decided to align SyncE on SDH
- to avoid defining a new synchronous hierarchy
- To allow mix of SDH and SyncE NEs in the G.803 reference chain

- In February 2008, the 3 recommendations defining Synchronous Ethernet were consented by ITU SG15
  - G.8261 for architecture and network limits
  - G.8262 for the definition of theclock
  - G.8264 for the definition of the SSM

Architecture of Synchronous ethernet

- In order to provide interworking between SyncE and SDH
  - A chain of 20 SDH NEs must be replaceable by 20 SyncE NEs
  - A chain of 20 NEs can mix SDH and SYNCE NEs
  - An NE can be equipped with both SDH and SyncE ports

- S:SDH
- E:Eth
- H:hybrid



SyncE requirements

- The SyncE NE
  - must have a clock compatible with SDH/SONET
  - Recovers timing from a synchronous Ethernet signal,with an SSM
  - Must be able to recover the data from an Ethernet signal
  - Must be able to provide traceablity via SSM

SyncE clock: G.8262

- Compliance with SDH implies that SyncE clocks are based on G.813
  - Jitter is related with clock recovery
    - It is a port function, to recover clock and data
  - Wander is related with noise accumulation on a chain of clocks.
    - It is a clock function
  - Frequency pull-in –range
    - Must be 100 ppm on the port so that data of legacy Eth can be processed
    - Must be 4.6 ppm at clock input to comply with SDH clocks

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Compliance with IEEE and SDH

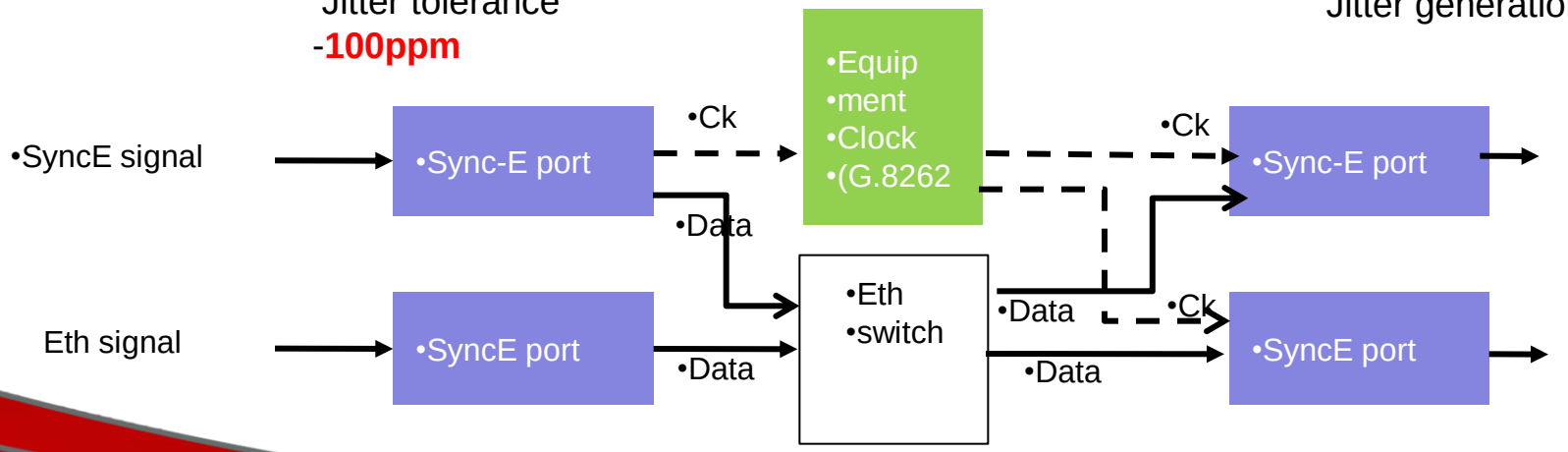
- SyncE ports must recover synchronous and non synchronous Eth signals
- SyncE signals are characterized by a SSM

•Comply with G.813

•Frequency accuracy
•Pull-in, Pull-out, **4.6ppm**
•Noise transfer
•holdover
•Wander

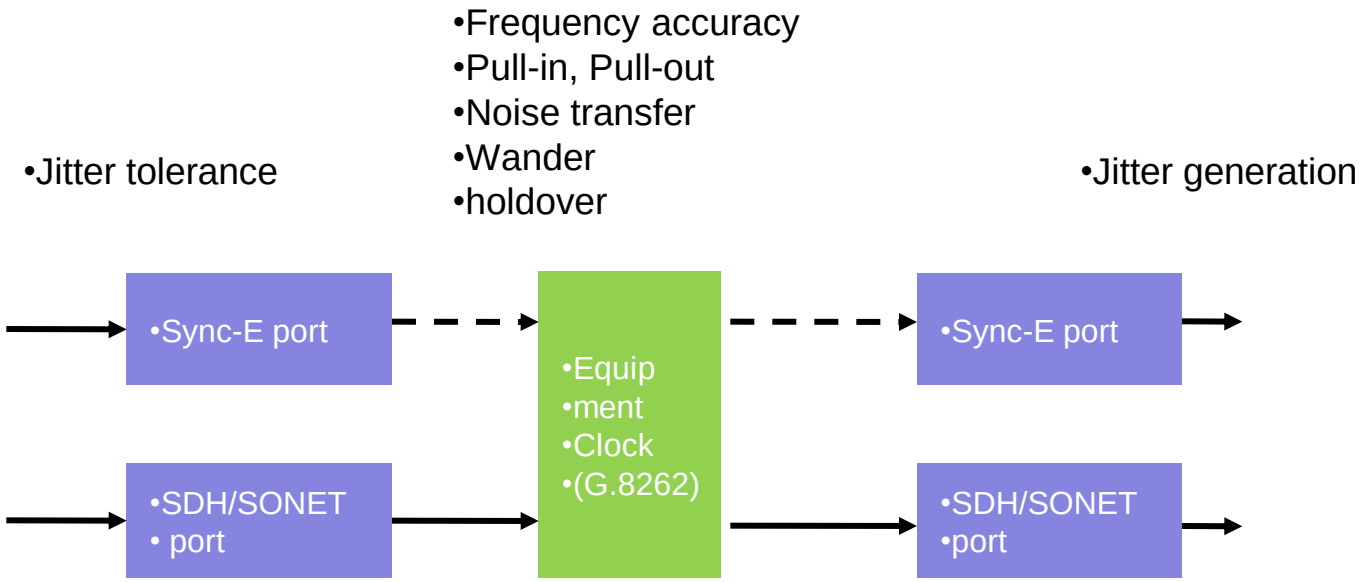
-**Comply IEEE**
Jitter tolerance
-**100ppm**

Comply IEEE
Jitter generation



Hybrid network

- Has both SyncE and SDH ports



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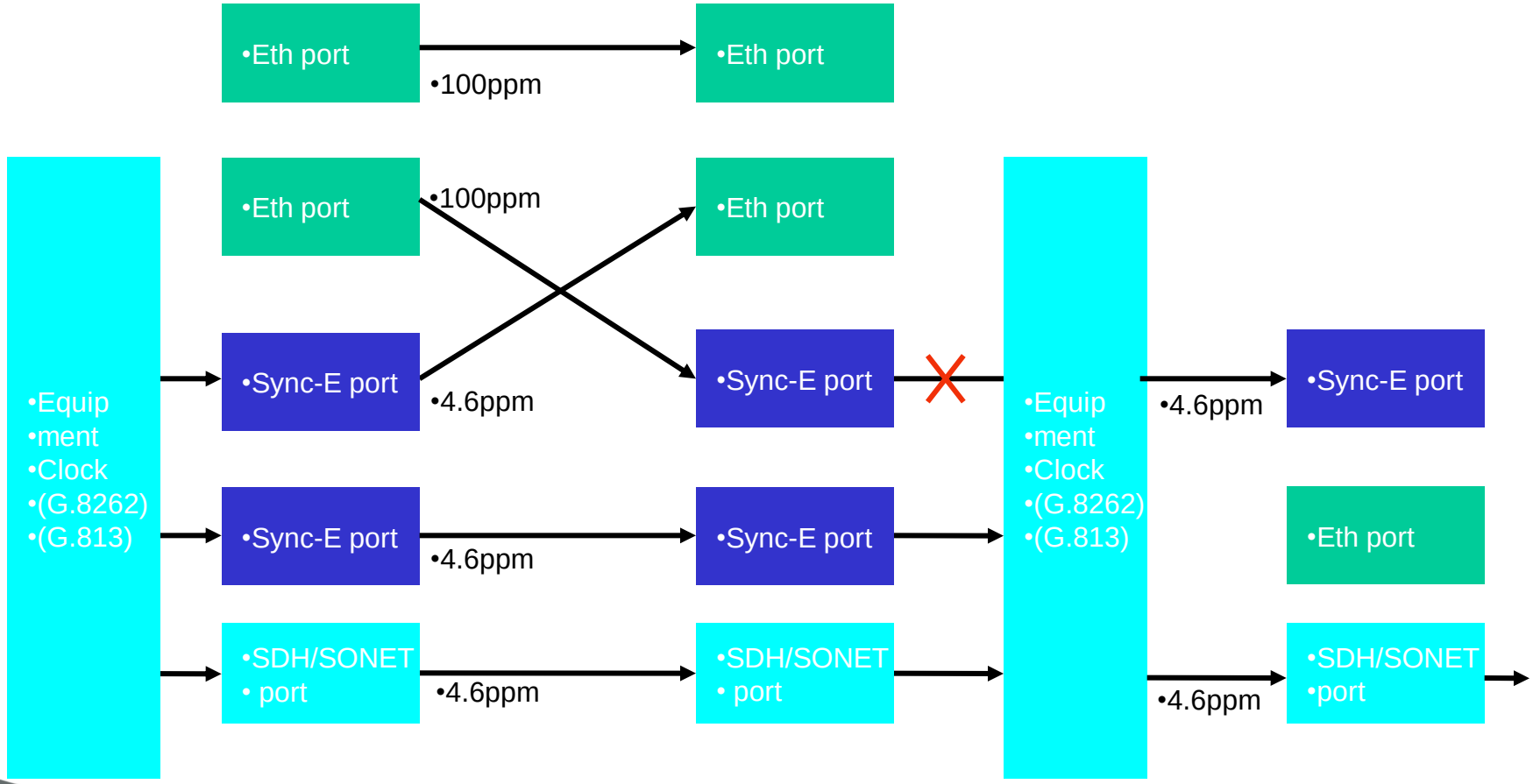
Interworking with legacy equipments



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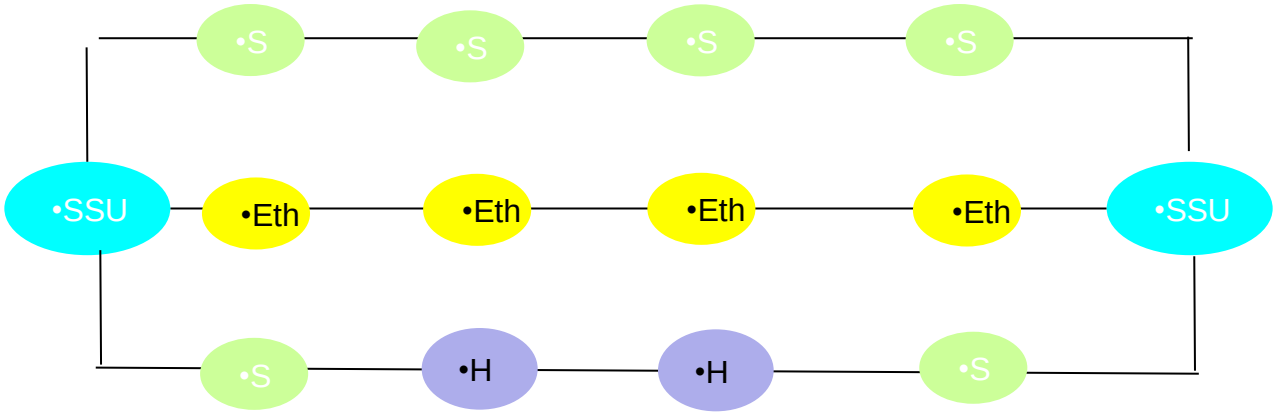
Need for a SSM in SyncE equipments

- SSM is needed on all kinds of chains, SDH, SyncE and hybrid
  - to provide automatic protection of a chain of NE
  - To avoid timing loops



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SSM in SyncE

- 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 to use an Organization Specific slow Protocol as defined in G.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

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SSM transport

- The SSM is transported in the ESMC Ethernet Synchronization Messaging Channel
- Two types of messages are transmitted
  - An event message sent immediately in case of SSM change
  - A heartbeat message
    - Sent at a rate of about 1 Hz
    - No message for 5 seconds means ESMC failure

- Quality Level data is mapped into a TLV format
- Future information might be mapped according TLV format

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Updated G.781 model

- With addition of the ETY and ETH layers for SyncE needs

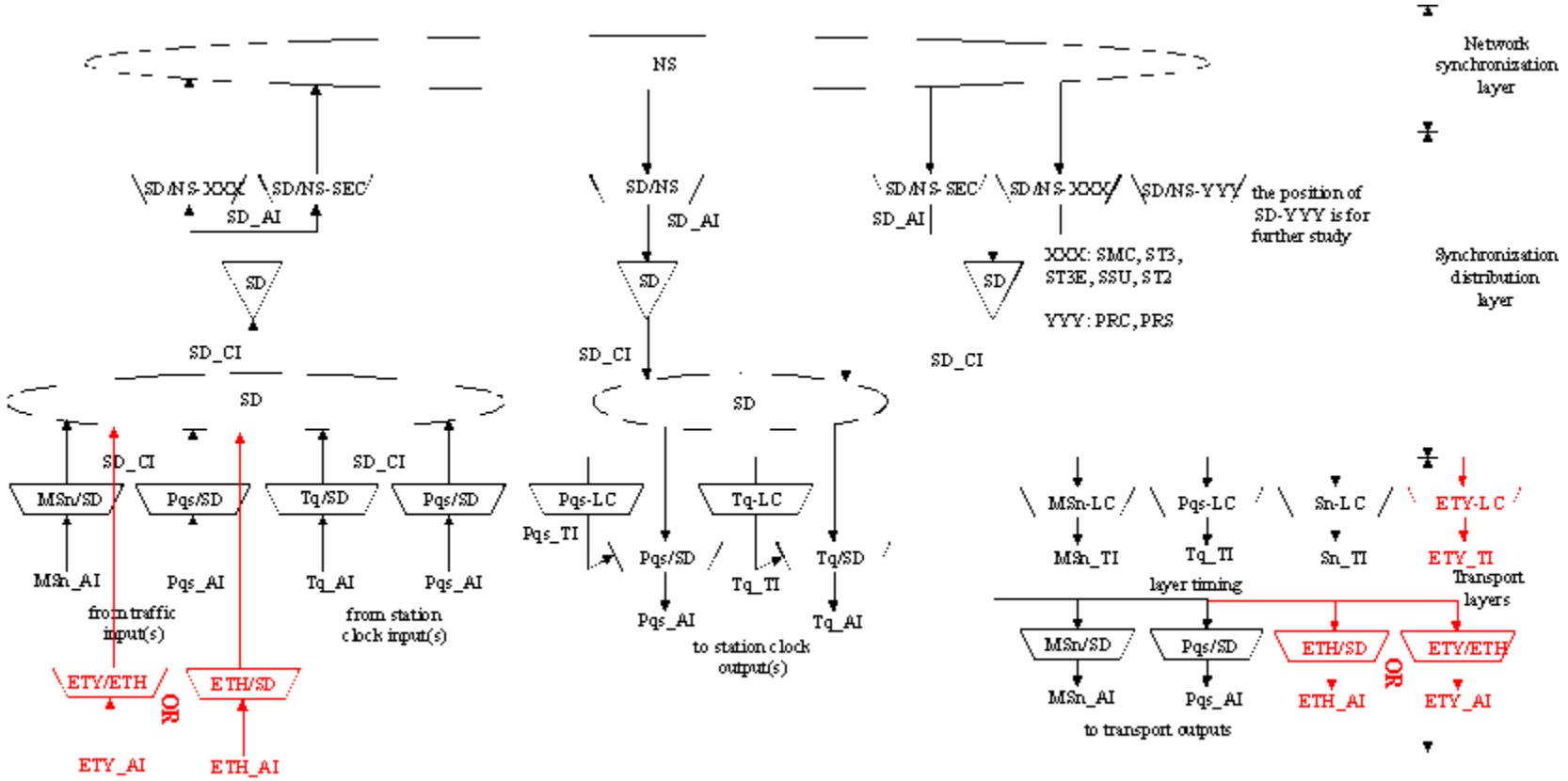

Figure 17/G.781 – Synchronization Distribution and Network Synchronization layer atomic functions

Conclusion

- Synchronous Ethernet provides the same quality transport of timing as SDH.
- Synchronous Ethernet does not provide transport of time, although it has been agreed that the use of ESMC might allow it.

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Calnex Paragon Sync