Physical layer – SyncE

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Physical layer

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

• This has been used at the beginning 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
  o it passes through buffers that are not timing transparent
  o 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.
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.
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
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 independent 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 the clock
  - 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 traceability 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
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 with IEEE
  - Jitter tolerance -100ppm

- Data

- Equip
  - Clock
  - (G.8262)

- Ck

- SyncE signal

- Sync-E port

- Eth
  - switch

- Sync-E port

- Data

- Ck

- Sync-E port

- Sync-E port

- Data

- Ck

- Sync-E port

- Data
Hybrid network

• Has both SyncE and SDH ports

• Jitter tolerance
  • Frequency accuracy
  • Pull-in, Pull-out
  • Noise transfer
  • Wander
  • Holdover

• Jitter generation
  • Sync-E port
  • SDH/SONET port
  • Equipment
  • Clock
  • (G.8262)
  • SDH/SONET port
Interworking with legacy equipments

- Eth port
- 100ppm
- Sync-E port
- 4.6ppm
- SDH/SONET port
- 4.6ppm

- Equip
-ment
-Clock
-(G.8262)
-(G.813)

- Sync-E port
- 4.6ppm

- Equip
-ment
-Clock
-(G.8262)
-(G.813)

- Eth port
- Sync-E port
- 4.6ppm
- SDH/SONET port
- 4.6ppm

- Sync-E port
- 4.6ppm

- Eth port
- SDH/SONET port
- 4.6ppm
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
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
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
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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