IEEE 802.3 HSSG

Objectives Discussion
(i) MAC Data Rate Considerations (ii) Long Haul Objective

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HSSG Data Rate Considerations

- Wire speed Ethernet switching requirement
  - Uplink must be N x data rate of feeder ports (e.g. 80.0Gb/s or 100.0Gb/s)
- Fixed versus Scalable?
  - Scalable: Ports auto-negotiate to the lower rate supported
  - Benefit of Scalable: Do not burden every product with the cost of the maximum HSSG data rate support, if no need
  - But, do we want the increased complexity of a scalable solution?
- What is the highest data rate technically and economically feasible for MAC function and above?

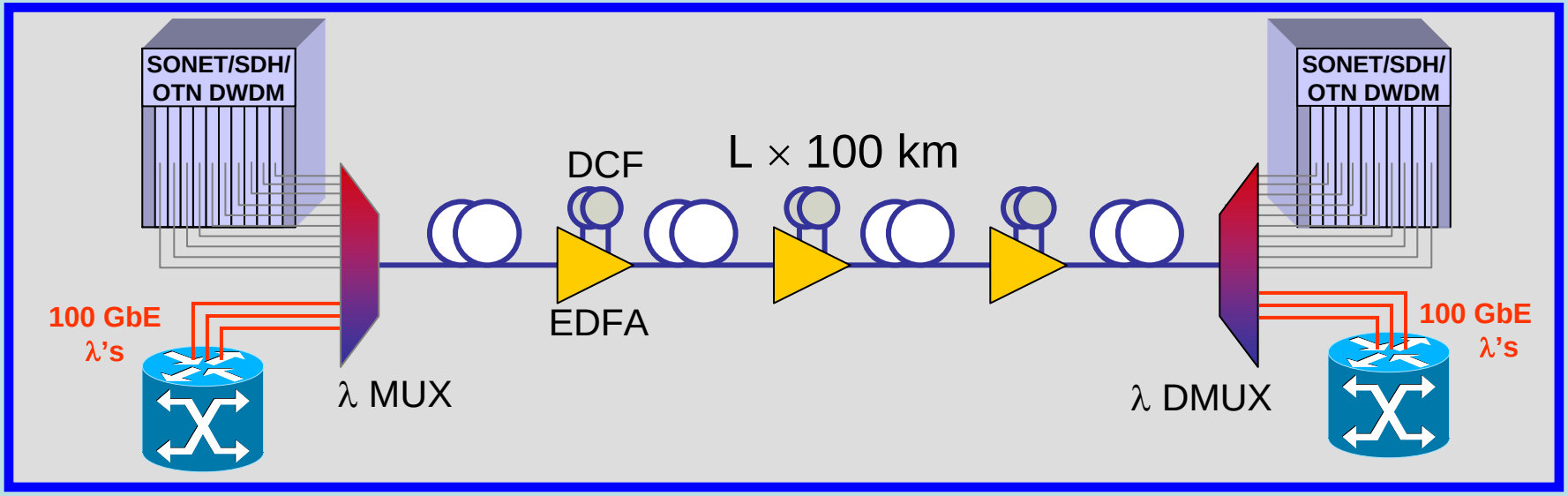
HSSG Data Rate Considerations

- Friendliness to transport over existing Long Haul networks (e.g. 95.846Gb/s instead of 100.0Gb/s)?
  - Run on top of existing 10G or 40G WAN links?
    - This is in conflict with the wire speed switching consideration
    - Which WAN speed: OC192/OC768, OPU2/OPU3 or OTU2/OTU3?
    - Difficult to address requirements of preamble and IPG transparency
    - See Addendum regarding relevant lessons learned in the 10G world
  - Specify HSSG LAN PHY and WAN PHY?
    - In the 10G world WAN PHY has not been widely adopted by users
    - Too many 10G PHY variants fragmented and slowed deployment
  - Specify an HSSG Long Haul PMD (X.00Gb/s MAC data rate; coexist with existing 10G and 40G waves by DWDM on unused spectrum)?
    - Strong FEC and perhaps different modulation than the LAN and MAN PMDs?
    - Carry SONET/SDH on top of HSSG link, if necessary and feasible?

A reasonable set of HSSG objectives?

- MAC data rate of X.00Gb/s
  - 100.0 Gb/s if economic and technical feasibility proven (e.g. is MAC feasible?)
  - 80.0Gb/s would be acceptable if better economics (e.g. is 4 x 20Gb/s APL less expensive than 10x10Gb/s?)
  - In the new standard, give up the goal of transport over existing SONET/SDH/OTN Long Haul equipment
    - Proprietary solutions will likely evolve if there is market need
- Fixed data rate (as opposed to scalable)
  - Simplicity ->volume ->low cost
- Add a Long Haul (e.g. 1,000Km) PMD to the reach objectives
  - Coexist (DWDM) with existing SONET/SDH/OTN Long Haul transport on the ITU wavelengths grid
  - If we won't have a Long Haul PMD in HSSG, the industry will offer one anyway
    - Why not move the LH world from proprietary to standards?!
  - For those who want Ethernet to replace SONET/SDH everywhere – this is a great opportunity ☺

Long Haul PMD Concept



- Define a long haul DWDM PMD (pick the most appropriate APL approach among 10x10G or 5x20G or 4x25G or 1x100G) on ITU DWDM grid
- Define long haul modulation format and FEC
- MAC support of the larger inter-lane differential delay of LH (e.g. 1,000Km)
- Allows 100GbE Long Haul deployment as overlay on existing SONET/SDH/OTN DWDM networks
  - Network Core is a natural market for 100GbE
  - Increases the total market potential of 100GbE

Addendum

10Gb/s on the Long Haul Network

Lessons, Issues, Requirements, Solutions

Lessons from 10Gb/s Ethernet WAN Deployment

- 10GBASE-W (WAN PHY)
  - "Transport friendly"
  - Not widely adopted...why?
- 10GBASE-R (LAN PHY)
  - Not "transport friendly"
  - Widely adopted

10 GbE LAN PHY Mapping Issues

- Assume 10G or 40G (SONET/SDH or OTN) transport

Nominal payload rates	
OC-192/STM-64	9.5846 Gbps
OC-768/STM-256	38.338 Gbps
OPU2	9.995 Gbps
OPU3	40.150 Gbps

- LAN PHY rate (10.3125 Gbps) exceeds payload capacities of 10G SONET/SDH and OTN frames
- Problem scales when multiplexing 4x10 GbE to 40G
- VCAT is an option but adds complexity and lacks vendor support for 10G and 40G transport

10 GbE LAN PHY Mapping Schemes

- Standards-based schemes (G.7041 GFP, RFC 1662 Packet over SONET) do not transparently map 64B/66B encoding (including Ordered Sets), IPG, Preamble, SFD
  - Some customers require full bit-transparency of *entire 10.3125 Gbps signal* (security concerns, proprietary use of IPG and preamble, etc.)
  - → Standards-based mapping schemes not always acceptable
- MAC frame throughput not always 100% → Mapper must support flow control

MAC frame throughput	
LAN PHY → WAN PHY	92.9%
GFP-F → OC-192/STM-64	96% (9600B frame) to 100% (64B frame)
POS	Average 95% (9600B frame) to 100% (64B frame) but non-deterministic due to HDLC byte-stuffing
GFP-F → OTU2	100%

- <100% throughput unacceptable to many customers

Bit-Transparent Mapping

- Employs over-clocking of transport equipment to solve 10 GbE LAN PHY transparency and throughput problem
- Increase OPU2 payload capacity by over-clocking
  - Creates 10.3125 Gbps OPU2 payload capacity
  - Expanded “OTU2+” rate at 11.049 Gbps (w/o FS) +/-100 ppm
  - 100% bit transparent, no flow control, no packet loss
- Supported by multiple 10G component and system vendors
- But cannot interoperate with standards-based OTN equipment (data rate, clock tolerance)
- Difficulty multiplexing to 40G
  - G.709 ODTU23 multiplexing does not support +/-100 ppm 10G client clock tolerance (requires proprietary rate-adaptation)
  - Expanded “OTU3+” rate @ 44.5 Gbps incompatible with SONET/SDH clients
    - Inability to “mix and match” Ethernet clients easily with non-Ethernet → stranded bandwidth

Summary of 10GbE Transport Deployment

- Market evolved new solutions beyond IEEE and ITU standards
  - Data rate incompatibility with SONET/SDH and OTN because customers require transparency and/or no frame throughput reduction
  - 10 GbE WAN PHY finding much less acceptance than 10 GbE LAN PHY

Thank you!