OTN Support for Beyond 10km Optical PHYs

Steve Trowbridge

Nokia

Background

- "Provide Appropriate Support for OTN" has become an "Apple Pie" objective for high-rate optical projects, appearing in P802.3ba, P802.3bm, P802.3bs, P802.3by, P802.3cc, P802.3cd projects
- Brief reminder about what this has come to mean:
  - Mapping of Ethernet with a given MAC rate over OTN fits into the expected transport network capacity
  - All PMDs with a given MAC rate can be mapped over OTN in the same way (e.g., with a canonical mapping format)
  - Where PMDs correspond to an OTN rate, pluggable Ethernet optical modules can be reused for OTN client applications

Mapping of Ethernet with a given MAC rate over OTN

- 10G was problematic – 10GBASE-R has a bit rate of 10.3125 Gb/s ±100ppm which didn't fit the OPU2 payload capacity

- 40G might have been problematic – 40GBASE-R has an aggregate bit-rate of 41.25 Gb/s ±100ppm, while the OPU3 container size is ~40.150519 Gb/s ±20ppm. But the warning note under Figure 82-5 assures that only the 11 listed control block types are valid, which permits the OTN mapping to use 1024B/1027B transcoding to fit 40GBASE-R into OPU3.

- 100G, 200G, 400G we developed concurrently in IEEE and ITU-T, so the corresponding Ethernet rates map efficiently into their respective OTN line rates.

- 25GBASE-R has a bit-rate of 25.78125 Gb/s ±100ppm, always mapped in the PCS format, which fits into 20 (of 80) tributary slots of an OPU4. So you get four 25GbE into a 100G line interface as expected

- 50GBASE-R will be mapped in the PCS format without FEC (trans-decoded to 66B), so 51.5625 Gb/s ±100ppm, which fits into 40 (of 80) tributary slots of an OPU4. So you get two 50GbE into a 100G line interface as expected

All PMDs with a given MAC rate can be mapped over OTN in the same way

- You want the flexibility to use a different PMD type at the OTN ingress and egress

- All 50GBASE-R PMDs must use the same 50GBASE-R PCS (over-clocked 40GBASE-R PCS per clause 82)

- If later added to the project, all 100GBASE-R PMDs must use the same Clause 82 100GBASE-R PCS per clause 82. Note that the interfaces adding a Clause 91 FEC sublayer still map back to the same PCS, and the PCS format without FEC is what is mapped over OTN, and any future 100GbE signal format must do the same

- Future 200GbE and 400GbE PHYs must preserve the OTN mapping reference point described in the NOTE at the end of Clause 119.2.4.1

Where PMDs correspond to an OTN rate, pluggable client modules can be reused for OTN client applications

- N/A for 50GbE, as there is currently no defined 50G OTN rate

- For 200GbE and 400GbE:
  - The objective would be met in a straightforward way if new beyond 10km optical PHYs use the same end-to-end RS(544,514) FEC lane format as P802.3bs-defined PMDs
  - As the FlexO (ITU-T G.709.1) frame format for operating over 200GbE and 400GbE Ethernet pluggable modules intends to use RS(544,514) FEC with a similar lane format and markers as 200GbE and 400GbE, if new beyond 10km optical PHYs use the XS to connect to logic in the module implementing a stronger FEC but retaining the 257B transcoding, it <u>may</u> be possible that the same logic in the module could be used (at a slightly higher bit-rate) for an OTN-framed signal as for an Ethernet-framed signal to substitute the stronger FEC for RS(544,514).

Where PMDs correspond to an OTN rate, pluggable client modules can be reused for OTN client applications – 100G scenarios (if added) page 1/2

- Three frame formats for Ethernet operation across 100GbE optical modules:
  - No FEC, bit-interleaved PCSLs consisting of 66B blocks
  - RS(528,514) FEC (P802.3bm, CWDM4 and ER4-lite, etc.)
  - RS(544,514) FEC (P802.3cd PMDs)
- Two frame formats for OTN operation across 100GbE optical modules:
  - OTL4.4 with RS(255,239) FEC for OTU4 over 1st generation (non-FEC) 100GbE optical modules such as 100GBASE-LR4
  - FlexO (possibly multiple bonded 100GbE PHYs supporting an OTUCn) uses RS(544,514) FEC.
- None of the existing 100G Frame formats are designed with the assumption of FEC in the module.

Where PMDs correspond to an OTN rate, pluggable client modules can be reused for OTN client applications – 100G scenarios (if added) – Page 2/2

- Two alternatives if a new beyond 10km 100G optical PHY is specified:
  - The new 100GbE optical PHY uses an Annex 135E 100GAUI-4 C2M interface with RS(544,514) FEC on the host board intended to protect the end-to-end link, there is a high probability that the currently defined FlexO interface works without change
  - If a new 100GbE optical PHY uses a new FEC expected to be in the pluggable module, this would be based on a new (explicit or implicit) 100G XS. If the 100G XS is based on an RS(544,514) FEC and the new FEC retains 257B trascoding, it <u>may</u> be possible that the same logic in the module can work for both Ethernet and OTN frame formats. If the AUI C2M interface is based on no FEC or RS(528,514) FEC, new modules would require different logical modes of operation for Ethernet and OTN applications

Proposal

- The Beyond 10km Optical PHYs Study Group should adopt the following objective:

Provide Appropriate Support for OTN