IEEE 802.3 Access projects summary, and the use of fiber loss statistics

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IEEE 802.3ca 50G-EPON

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Approved 802.3ca Objectives

- Support subscriber access networks using point-to-multipoint topologies on optical fiber
- Provide Physical Layer specifications that
  - Operate over a single SMF strand
  - Support symmetric and/or asymmetric MAC data rates of:
    - 25 Gb/s in downstream and 10 Gb/s or 25 Gb/s in upstream (25G-EPON)
    - 50 Gb/s in downstream and 10 Gb/s, 25 Gb/s, or 50 Gb/s in upstream (50G-EPON)
  - Have a BER better than or equal to 10^{-12} at the MAC/PLS service interface (or the frame loss ratio equivalent)
  - Support coexistence with select legacy PON technologies
    - Optical power budgets to accommodate channel insertion losses equivalent to PR20 and PR30, as defined in Clause 75.
    - Wavelength allocation allowing concurrent operation with 10G-EPON, XG-PON1, and XGS-PON PHYs (1575nm-1580nm downstream, 1260nm-1280nm upstream)
    - Wavelength allocation allowing concurrent operation of 25G-EPON and G-PON reduced wavelength set (1480nm-1500nm downstream, 1290nm-1330nm upstream) PHYs

Enhancements to 50G-PON

- WDM coexistence with GPON, XG-PON1, XGS-PON
- Envelope frame structure[1], [2]
- Separation of physical ID from service flow IDs[1]
  - User Link ID (ULID), Physical Link ID (PLID), Management Link ID (MLID), Group Link ID (GLID)
- Improved efficiency with reporting and granting[1]
  - Single message for reporting or granting for multiple logical links
- Frame fragmentation allowed[1]
- Flexible scheduling in multi-channel system[2]
- Channel bonding[2]

[1] ***PON TC/MAC layer specification comparison***, Duane Remein
- https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20180127/Documents/3.%20Duane%20Remein.pdf

[2] ***802.3ca channel bonding and skew remediation***, Glen Kramer
- https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20180127/Documents/4.%20Glen%20Kramer.pdf

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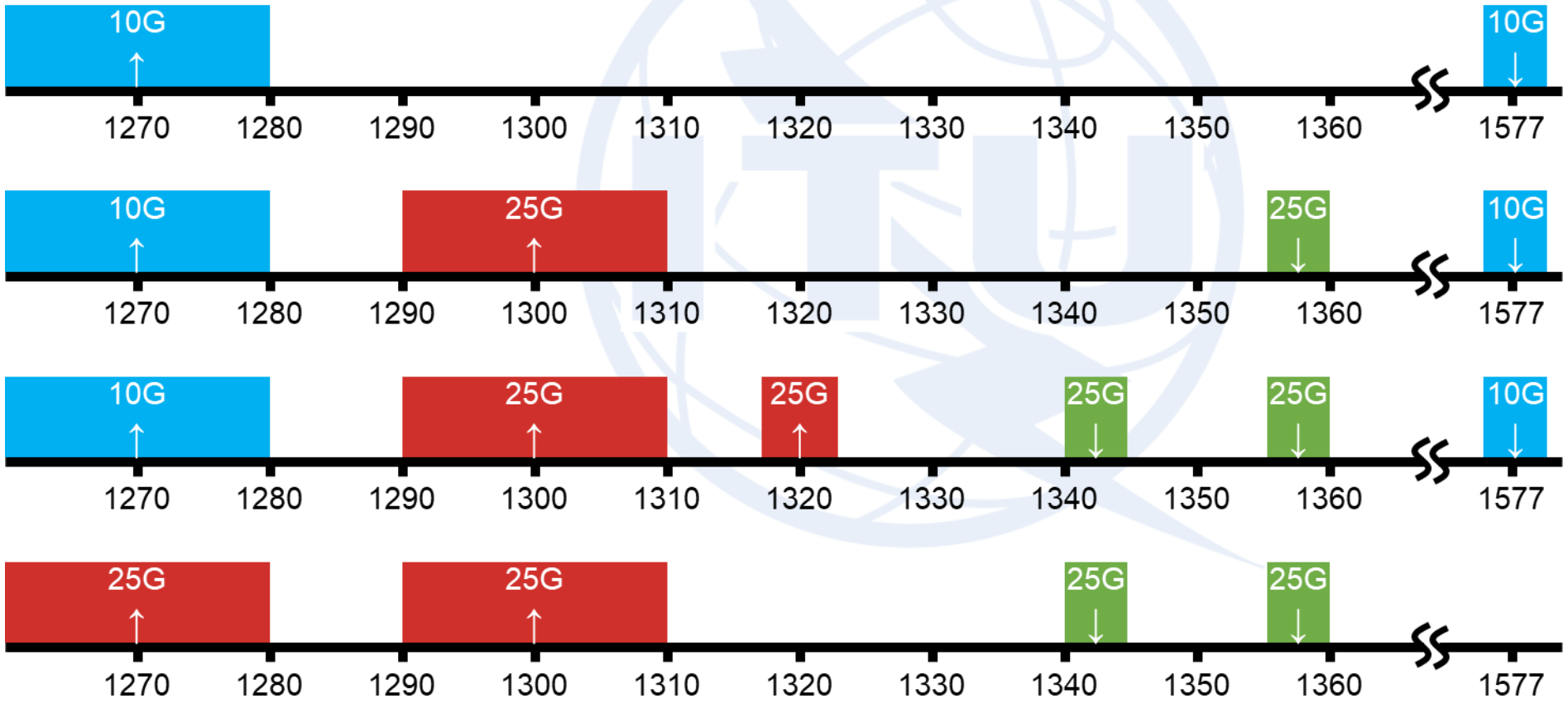
Wavelength Plan



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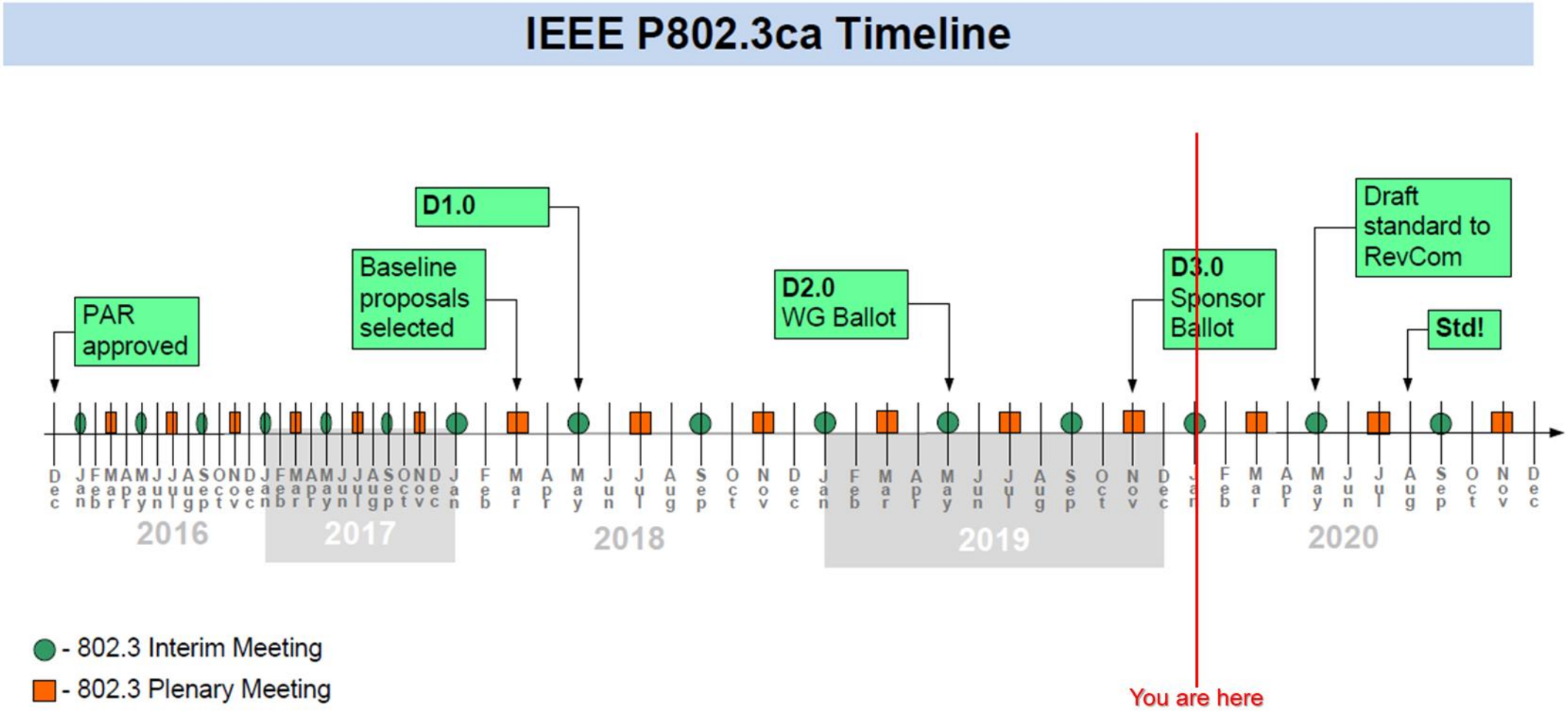
802.3ca Timeline



A few slides describing 802.3cp

A task force that goes both ways!

Frank Effenberger

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The unique aspects of Optical Access

- Using optical fiber in access presents unique challenges. In particular, the fiber cost per user is much higher, because there are fewer users on each fiber
  - This is the fundamental motivation for PONs
- However, some applications need larger and more dedicated bandwidth than a PON can provide
  - Examples include high capacity business services and wireless fronthaul
- In these cases, the use of Bidirectional optical transmission can reduce the required number of fibers by 50%
- Bidirectional operation also avoids the possibility of crossing the fibers, so less operational difficulties

Basic design approach

- The 802.3 standard has a large number of very successful two-fiber optical PHYs
- The basic approach of the 802.3cp task force is to reuse these PHYs to the maximum extent possible
- What needs to change?
  - There needs to be two wavelengths instead of one
  - The loss budget needs to meet the needs of the access network

Bidirectional wavelengths and loss budgets

	10 Gb/s		25 Gb/s		50 Gb/s	
	Down	Up	Down	Up	Down	Up
BR10 (similar to LR types) 10km reach, 0 to 6.3 dB loss	1320 to 1340 nm	1260 to 1340 nm	1320 to 1340 nm	1260 to 1340 nm	1320 to 1340 nm	1260 to 1340 nm
BR20 (covers most users) 20km reach, 0 to 15 dB loss	1320 to 1340 nm	1260 to 1340 nm	1306 to 1322 nm	1281 to 1297 nm	1306 to 1322 nm	1281 to 1297 nm
BR40 (similar to ER types) 40km reach, 5 to 18 dB loss	1320 to 1340 nm	1260 to 1340 nm	1306 to 1322 nm	1281 to 1297 nm	1306 to 1322 nm	1281 to 1297 nm
BR40+ (Extra loss for access) 40km reach, 10 to 23 dB loss	1320 to 1340 nm	1260 to 1340 nm	1306 to 1322 nm	1281 to 1297 nm	1306 to 1322 nm	1281 to 1297 nm

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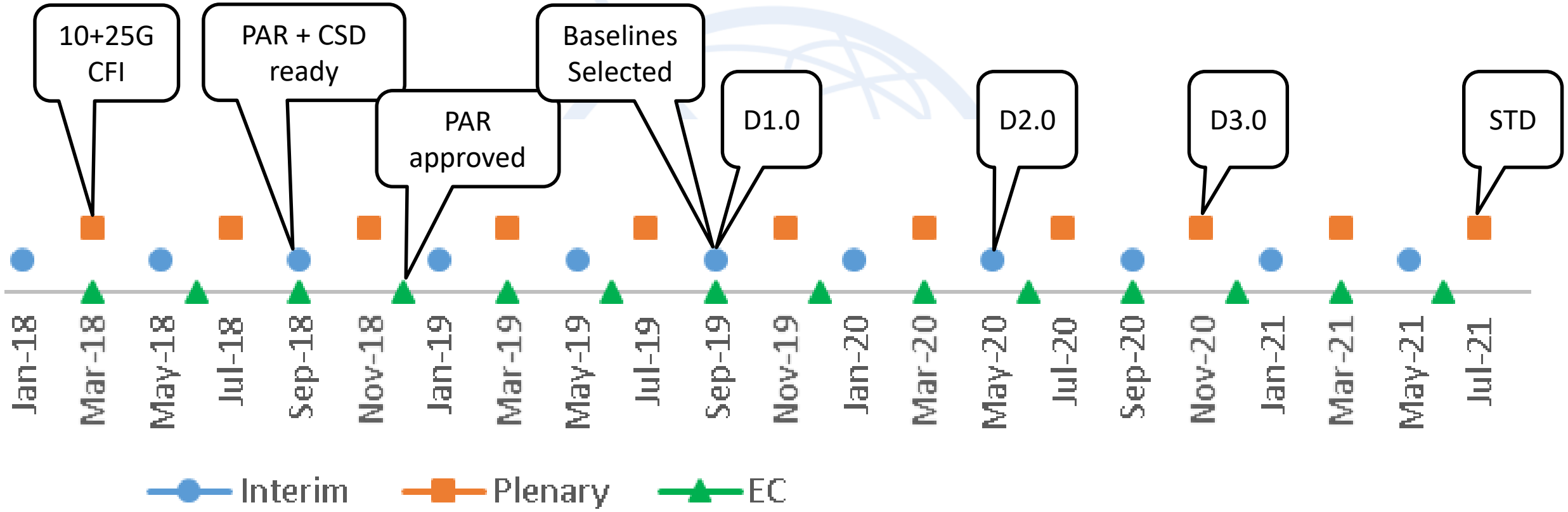
Task force timeline



Working to align the G.9806 draft recommendation to 802.3cp
Ideally, the same optic can satisfy both ITU and IEEE specs

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IEEE 802.3cs Super-PON

Claudio DeSanti

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IEEE 802.3cs Objectives

- Provide Physical Layer specifications that:
  - Preserve the Ethernet frame format utilizing the Ethernet MAC
  - Support a BER of better than or equal to 10^{-12} at the MAC/PLS service interface (or the frame loss ratio equivalent)
  - Support a passive point-to-multipoint ODN with a reach of at least 50 km with at least 1:64 split ratio per wavelength pair
  - Support at least 16 wavelength pairs for point-to-multipoint PON operation
  - Support the MAC data rate of 10Gb/s downstream
  - Support the MAC data rates of 2.5Gb/s and 10Gb/s upstream
  - Leverage existing EPON PCS and PMA to support the above MAC data rates
  - Support tunable transmitters

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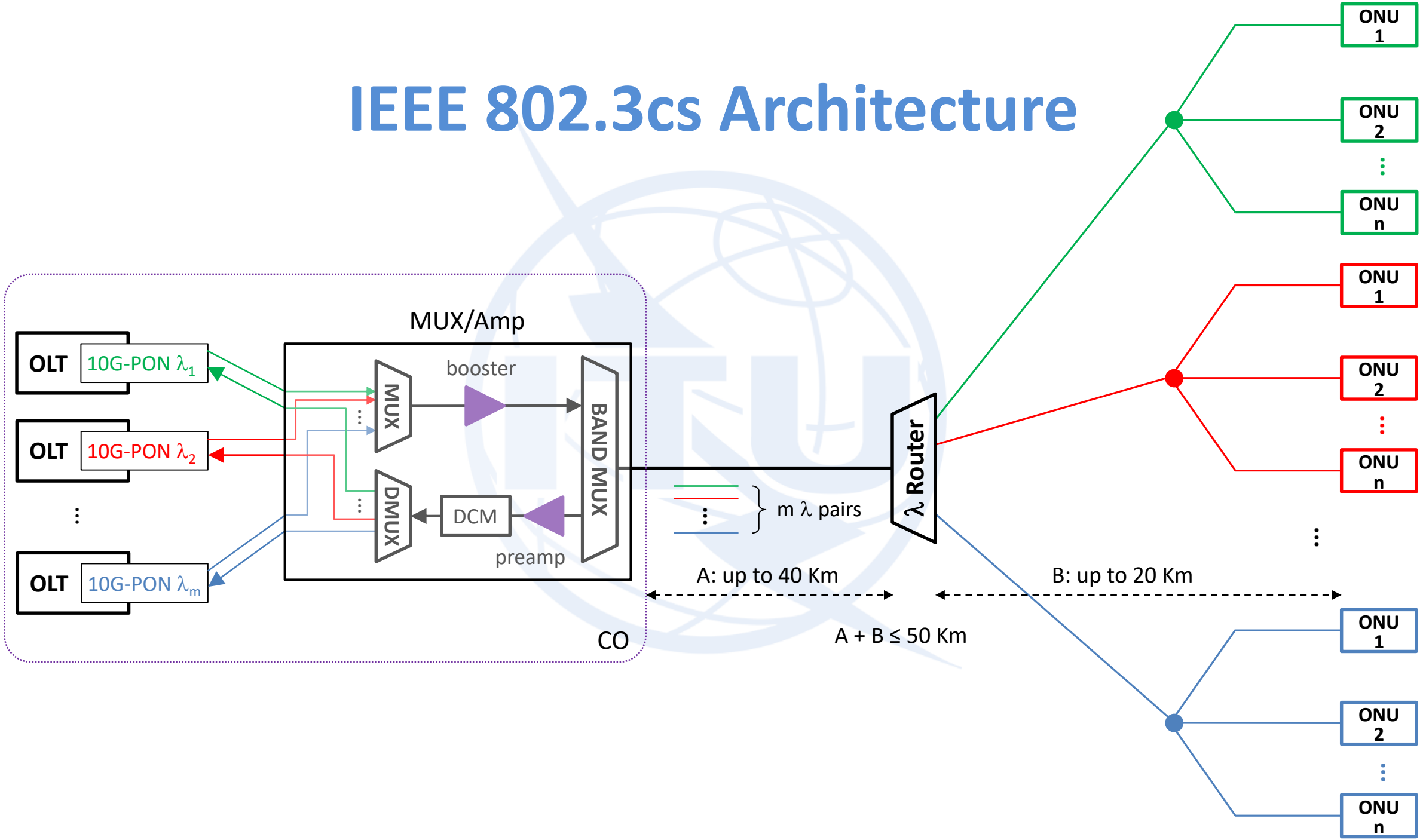
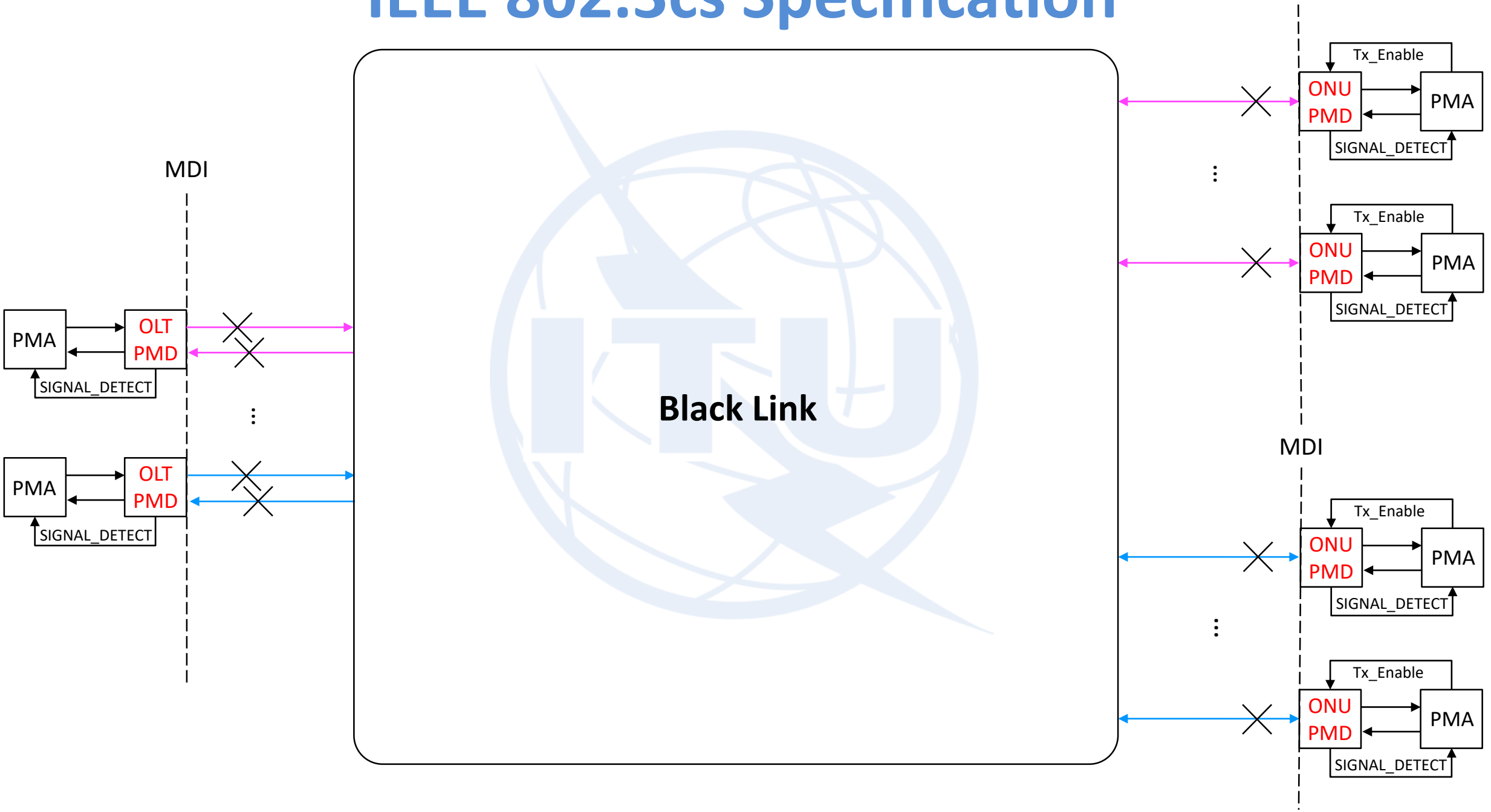
IEEE 802.3cs Architecture



IEEE 802.3cs Specification



802.3cs Annex: Statistical Link Design Attenuation

- Link loss design can be challenging over longer link lengths
- In determining link loss for a concatenated series of optical cables in a link, methods other than maximum attenuation coefficient can be used
- ITU-T G.652D appendix 1 provides guidance on using statistical modeling to develop economic design models
- Further study across the 1470 nm to 1625 nm window across multiple G.652 and G.657 fiber distributions resulted in a Link Design Attenuation (LDA) of 0.24 dB/km for links over 40 km (1)
- The 802.3cs Task force has added an Annex describing this model and results.

(1) *Information about cabled fiber link attributes used for system design*

http://www.ieee802.org/3/cs/public/202001/20200121-Ferretti_3cs_01.pdf

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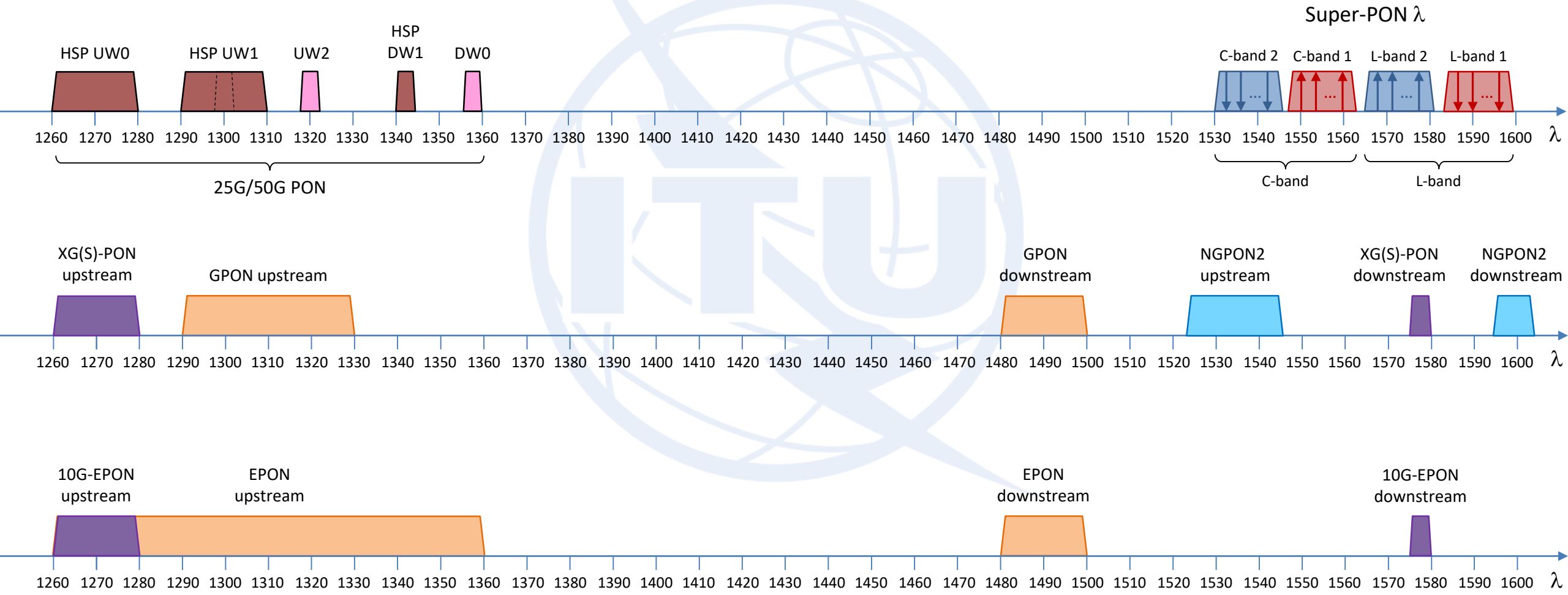
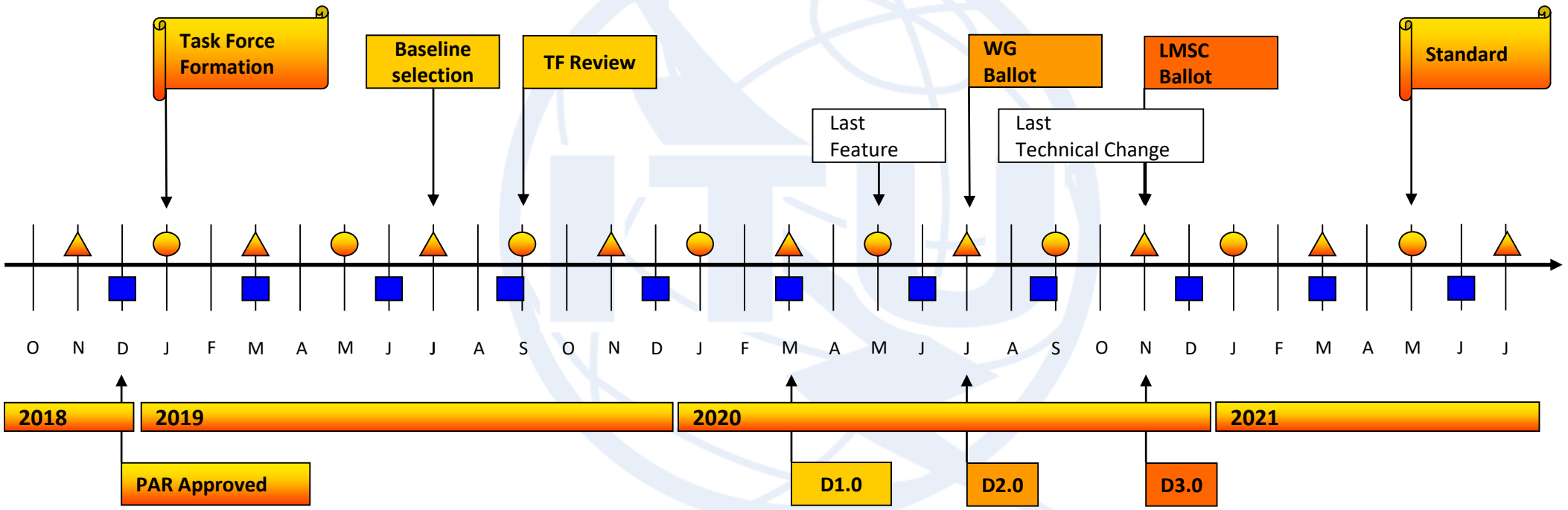
IEEE 802.3cs Wavelengths



IEEE 802.3cs Timeline



Legend
- IEEE 802 Plenary
- IEEE 802.3 Interim
- IEEE-SA Standards Board

Working to align the ITU-T G.9807.3 activity with IEEE 802.3cs
Ideally, the same optic should satisfy both ITU-T and IEEE specs

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