Transmitter power and penalty specs
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Methods of TX specification

- Separately specifying TX output power and TDP as in earlier PON standards makes the assumption that all TX have worst case transmitter and dispersion penalties.
  - Pro: Allows setting of output power without measuring penalty.
  - Con: Low-penalty transmitters must put out the same minimum power as transmitters with worst case penalties.
- Newer 802.3 draft standards now specify the TX in terms of a minimum value for output power minus penalties.
  - Enables low-penalty transmitters to launch less optical power and have lower power consumption.
  - Allows the same transmitter spec to apply to different channels independent of fiber dispersion.
  - Enables the use of multiple transmitter technologies for a wider vendor ecosystem and more differentiated optics.
    - EML, DML or Si Photonic based transmitters
    - Inclusion of analog or DSP techniques to reduce signal impairments
    - Cooled, semi-cooled or uncooled operation (as allowed by WL range)
  - The benefits of this method are independent of the specific metrics used, whether Pavg-TDP, OMA-TDEC or something else.
- NG-EPON has multiple channels, higher DP than 10G PON and no power margin to spare, and would benefit from using this method.

Applicability to NG-EPON

- Under the legacy method of separate Pavg and TDP specs, the two upstream wavelength plan of record (Motion #5, July'17) requires
  - 2dB higher worst-case DP for US0-A in 1300-1320nm than US0-B in 1260-1280nm (assuming DML transmitters)
  - 2dB higher Pavg for US0-A in 1300-1320nm than US0-B in 1260-1280nm.
- The proposed solution to restrict US0-A to ~1300-1305nm or shorter for all transmitters is needlessly restrictive.
  - Pre-supposes that DML transmitters will be used exclusively.
  - Artificially forces US0-A to have similar DP as US0-B so that both channels can share the same specs.
  - Pre-supposes that uncooled DMLs will never have sufficient output power to operate at 1320nm and all ONU transmitters will be cooled.
  - Potentially reduces laser chip yield due to tighter wavelength accuracy.
- Using the newer spec method, US0-A and US0-B share a single spec for TX minimum Pavg minus TPD (or similar metric), independent of transmitter technology or channel wavelength range.
  - Makes no assumptions about future technology: Chirp-managed or DSP-compensated DMLs, EMLs or Si Photonics transmitters with lower TP and/or DP can be used.
  - Allows cooled, semi-cooled or uncooled transmitter operation in commercial or industrial temperature environments.
  - Allows optics vendors to trade off chip technology, package design, assembly tolerances, CMOS IC capability, operating wavelength range, optical power and penalties to achieve the lowest cost ONUs over the life of each PON generation.

Example ONU TX specs

	Parameter	US0-B	US0-A (full)	US0-A (restricted)	Unit
	Wavelength range	1260 to 1280	1300 to 1320	1300 to 1305	nm
	OLT RX sensitivity, max	-24			dBm
	PR30 Loss budget	29			dB
Legacy Spec Method	ONU TX Pavg, min	7	9	7.5	dBm
	ONU TX TDP, max	2	4	2.5	dB
New Spec Method	ONU TX Pavg minus TDP, min (1)	5			dBm
	ONU TX TDP, max	4			dB

(1) Even if TDP is less than 0dB, Pavg minus TDP must be greater than this value.

- For this example, OLT RX sensitivity is assumed to be -24 dBm at BER = 1E-3.
- Maximum Transmitter Penalty is assumed to be 2dB to enable use of uncooled DMLs.
- Maximum Dispersion Penalty for DMLs is assumed to be 0dB for US0-B, 2dB for full US0-A and 0.5dB for US0-A restricted to 1305nm max.
- Using the new specification method the same transmitter specification applies equally to all channels regardless of transmitter technology or operating range.

Recommendations

- Transmitter power and penalties should be specified in terms of minimum transmitter optical power minus transmitter penalties.
  - Transmitter average power minus transmitter and dispersion penalty (TDP) is the preferred metric.
  - Other metrics such as minimum transmitter OMA minus TDEC can also be considered.
- The wavelength range for US0-A should be specified as 1300 to 1320nm for both 10Gb/s and 25Gb/s upstream per Motion#5 (July 2017).
  - The choice of whether to further restrict operating wavelength to limit dispersion penalty should be left to the implementer.