Proposed laser specification baseline for 800GBASE-LR1

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Supporters

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Introduction

- kota_3dj_01a_2311 proposed the use of relaxed laser frequency accuracy specifications for 800GBASE-LR1

- 800GBASE-LR1 can benefit from such a specification methodology by allowing more options for implementors to lower complexity of coherent module designs
  - For e.g., simple DFB lasers with TEC in non-hermetic packaging would be a possible implementation choice

- This presentation explores the interoperability implications of these specifications

Goals of the proposed laser specifications

- Laser Types
  - Type 1: Traditional etalon wavelocker based laser design
    - Able to achieve tight accuracy (for e.g. ±1.8GHz) over life without DSP assist
  - Type 2: Simpler DFB laser with TEC without wavelocker
    - Requires use of factory calibration of each laser to ensure relaxed accuracy (for e.g. ±10GHz) over life
    - Module firmware with DSP assist can achieve tighter relative accuracy (for e.g. ±0.9GHz) at startup and over life of link
    - Optionally use simpler non-hermetic packaging
- Provide maximum flexibility in choice of lasers for the module designer
  - Either Type 1 or Type 2 available for module design
  - Single shared laser for TX/RX allowed for either laser type
  - Allow use of separate lasers for TX/RX if TX uses Type 1 lasers
    - For interoperability reasons, the use of separate lasers is excluded when TX uses a Type 2 laser
- Peer-to-peer mechanism (i.e. no out-of-band handshake is required)

TX and RX Laser Characteristics

Description		800GBASE-LR1	Unit
Transmitter Operating Frequency (absolute accuracy)		228675±10	GHz
Laser Relative Frequency tracking accuracy (max)		±0.9	GHz
Laser linewidth (max)		1	MHz
Rate of laser frequency change (max) (100ns averaging)		1	THz/s
Side-mode suppression ratio (SMSR) (min)		30	dB
Laser RIN	Average	-145	dBc/Hz
	Max	-140	

1311nm to match nominal frequency of multiple prior clauses (e.g. 200GBASE-LR4) near the center of the zero-dispersion window

Laser absolute accuracy over life for either Type 1 or Type 2 lasers

Relative frequency offset accuracy achieved through laser frequency adjustments by modules using Type 2 lasers for transmit

Module Startup Procedure for shared TX/RX Type 2 laser

- Module starts up and transmits signal with a laser frequency accurate to ±10GHz based on factory calibration settings
- Receiver DSP has ability to provide an estimate of the relative LO offset to module firmware
- Module firmware makes small adjustments to transmit laser frequency in the direction which reduces the relative LO offset. Laser frequency changes cannot be faster than the specified rate.
- The frequency adjustment stops when the relative LO offset is within a pre-determined threshold chosen by the module designer (for e.g. ±0.25GHz)
- Use a “dead-zone” to avoid un-necessary laser frequency adjustments
- Periodic re-adjustments if the relative LO offset exceeds the dead-zone chosen by the module designer (for e.g. ±0.4GHz) with some margin to the worst case relative offset specification of ±0.9GHz
- Any laser adjustments need to stay within the limits required to ensure absolute accuracy (±10GHz)

Laser Interop Requirements for Module

- Case 1: Module uses laser with wavelocker for TX
  - Module ensures (by design) that the transmit signal is accurate to ±1.8GHz over life. Therefore, no need to adjust transmit laser frequency in response to the link partner
  - RX needs to handle the case that the remote signal at startup can be ±10GHz from the nominal frequency. However, this will eventually be adjusted by the link partner to within the ±0.9GHz relative to your transmit signal. This will ensure that remote signal will have ±2.7GHz absolute accuracy after startup.
  - If module chooses to use a dual-laser architecture, the RX requirements are set by the particular design choices made by the module designer regarding the LO laser.
- Case 2: Module uses a DFB laser+TEC without wavelocker for TX
  - Module uses factory calibration settings to ensure ±10GHz initial accuracy of transmit signal
  - TX signal is adjusted during link startup to reduce relative offset to ±0.9GHz
  - RX needs to handle the scenario that the remote signal can initially be ±10GHz from the nominal frequency (i.e. ±20GHz relative offset). Module laser frequency adjustments will ensure relative offset is less than ±0.9GHz after initial startup.
  - Dual-laser architecture is not possible if we want to keep the etalon based designs simple

Interop Scenarios (1/2) – Type 1 DUT

DUT Type	Link Partner Type	DUT TX Accuracy (Initial)	DUT TX Accuracy (After linkup)	LO Offset at DUT RX (Initial)	LO Offset at DUT RX (After linkup)
Type 1 laser for TX Shared-laser	Type 1 laser for TX Shared-laser or non-shared	±1.8GHz	±1.8GHz	±3.6GHz	±3.6GHz
	Type 2 laser for TX Shared-laser	±1.8GHz	±1.8GHz	±11.8GHz	±2.7GHz
	Type 2 laser for TX Separate laser	±1.8GHz	±1.8GHz	±11.8GHz	±11.8GHz

Interop Scenarios (2/2) – Type 1 DUT

DUT Type	Link Partner Type	DUT TX Accuracy (Initial)	DUT TX Accuracy (After linkup)	LO Offset at DUT RX (Initial)	LO Offset at DUT RX (After linkup)
Type 1 laser for TX Separate RX laser with ability to adjust upto ±10GHz	Type 1 laser for TX Shared-laser or non-shared	±1.8GHz	±1.8GHz	±3.6GHz	±0.9GHz
	Type 2 laser for TX Shared-laser	±1.8GHz	±1.8GHz	±11.8GHz	±0.9GHz
	Type 2 laser for TX Separate laser	±1.8GHz	±1.8GHz	±11.8GHz	±0.9GHz

Interop Scenarios (1/2) – Type 2 DUT

DUT Type	Link Partner Type	DUT TX Accuracy (Initial)	DUT TX Accuracy* (After linkup)	LO Offset at DUT RX (Initial)	LO Offset at DUT RX (After linkup)
Type 2 laser for TX with ability to adjust upto ±10GHz Shared-laser	Type 1 laser for TX Shared-laser or non-shared	±10GHz	±2.7GHz	±11.8GHz	±0.9GHz
	Type 2 laser for TX Shared-laser	±10GHz	±10GHz	±20GHz	±0.9GHz
	Type 2 laser for TX Separate laser	±10GHz	±10GHz	±20GHz	±0.9GHz

* Absolute accuracy

Interop Scenarios (2/2) – Type 2 DUT

DUT Type	Link Partner Type	DUT TX Accuracy (Initial)	DUT TX Accuracy* (After linkup)	LO Offset at DUT RX (Initial)	LO Offset at DUT RX (After linkup)
Type 2 laser for TX Separate RX laser with ability to adjust upto ±10GHz	Type 1 laser for TX Shared-laser or non-shared	±10GHz	±10GHz	±11.8GHz	±0.9GHz
	Type 2 laser for TX Shared-laser	±10GHz	±10GHz	±20GHz	±0.9GHz
	Type 2 laser for TX Separate laser	±10GHz	±10GHz	±20GHz	±0.9GHz

* Absolute accuracy

Conclusions

- There is an opportunity to innovate on the laser specifications for 800GBASE-LR1 coherent modules
- For interoperability reasons, we will need to drop support for one of the following module types:
  - Module designs with Type 2 TX with separate TX/RX lasers or
  - Module design with Type 1 TX with shared TX/RX lasers
- Next step is offline consensus building around the approach and specifications

Thank you!