A New Specification for Multi-Wavelength Optical Laser Sources for Advanced Integrated Optics

Chris Cole, Chair, CW WDM MSA, https://cw-wdm.org/

Market Focus, Wednesday, 15 September 2021, 12:05-12:35 CET

New technologies & systems, New markets, New packaging platforms

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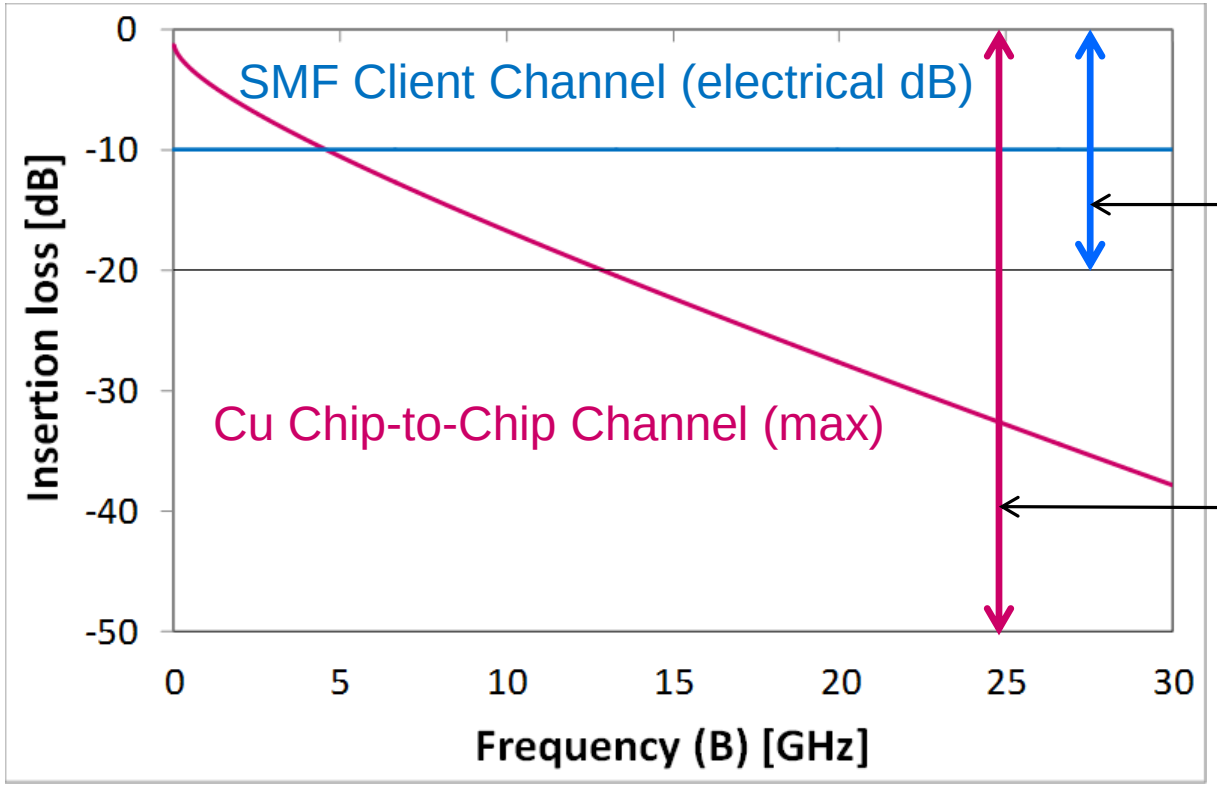
CW WDM MSA

Why a High-Count WDM Datacom Standard?

- Up to 10GbE: 1λ NRZ
- 40GbE and 100GbE: 4λ NRZ
- 200GbE, 400GbE, and likely 800GbE: 4λ PAM4
- ≥1.6TbE 4λ
  - 200Gbaud PAM4 IMDD (may not be feasible in the time frame of interest)
  - 50GBaud QAM16 Coherent
- ≥1.6TbE 16λ
  - 50Gbaud PAM4 IMDD
  - 100Gbaud NRZ IMDD
- High-count WDM is an alternative to higher order modulation and associated complexity

Shannon Capacity Theorem Modulation Guidance

$C = B \log_2 (1 + S/N)$

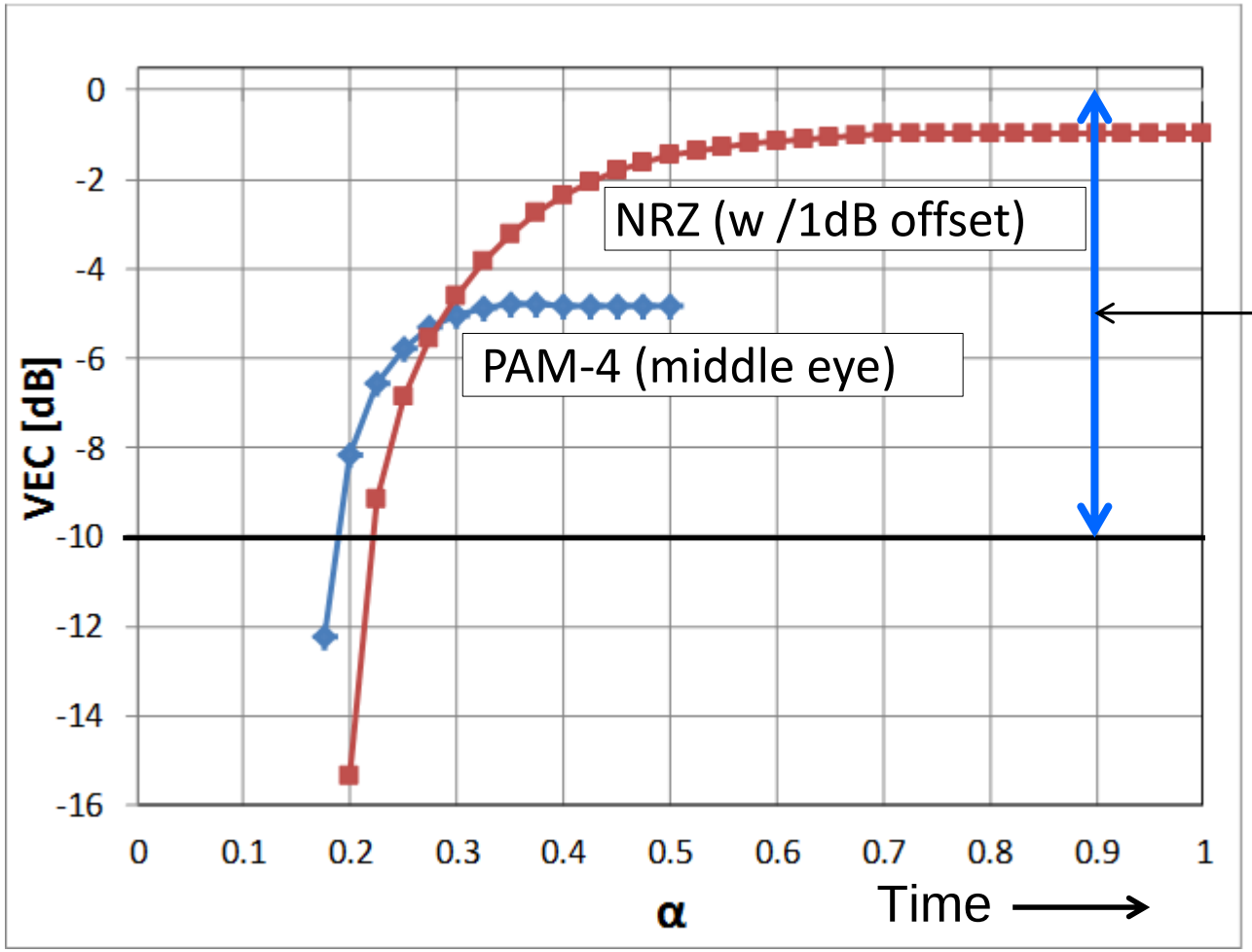


TRX S/N type*	Channel Freq (B)	TRX S/N	Shannon guidance
SMF	High	Low	NRZ
Cu (SerDes)	Low	High	PAM4

*BTB, no FEC

Cole, IEEE 802.3bs presentation, 12 Mar 2015

~3dB NRZ SNR Advantage over PAM4



TRX S/N
SMF

- BTB, no FEC
- noise penalty offsets VEC by ~1dB (B_{NRZ}/B_{PAM-4} dependent)
- α = B / bit-rate

Why PAM4 Optics?

- 50Gb/s PAM4 adopted for ASIC SerDes (50G Cu lanes) in 2012
- 50Gb/s PAM4 adopted for optics in 2015:
  - Enabled reuse of 50G PAM4 SerDes technology
  - Reduced the cost & time to market of initial shipments
  - Chosen despite 50G NRZ being the technically better long-term solution
- Predictably optical component bandwidth increased
  - 50GBaud technology is now mature and shipping in volume
  - PAM4 3dB SNR, power and cost penalty is permanently locked-in
- PAM4 optics technology remains the best choice for the Ethernet ecosystem
- Emerging applications with own ecosystem can use alternatives like high-count WDM

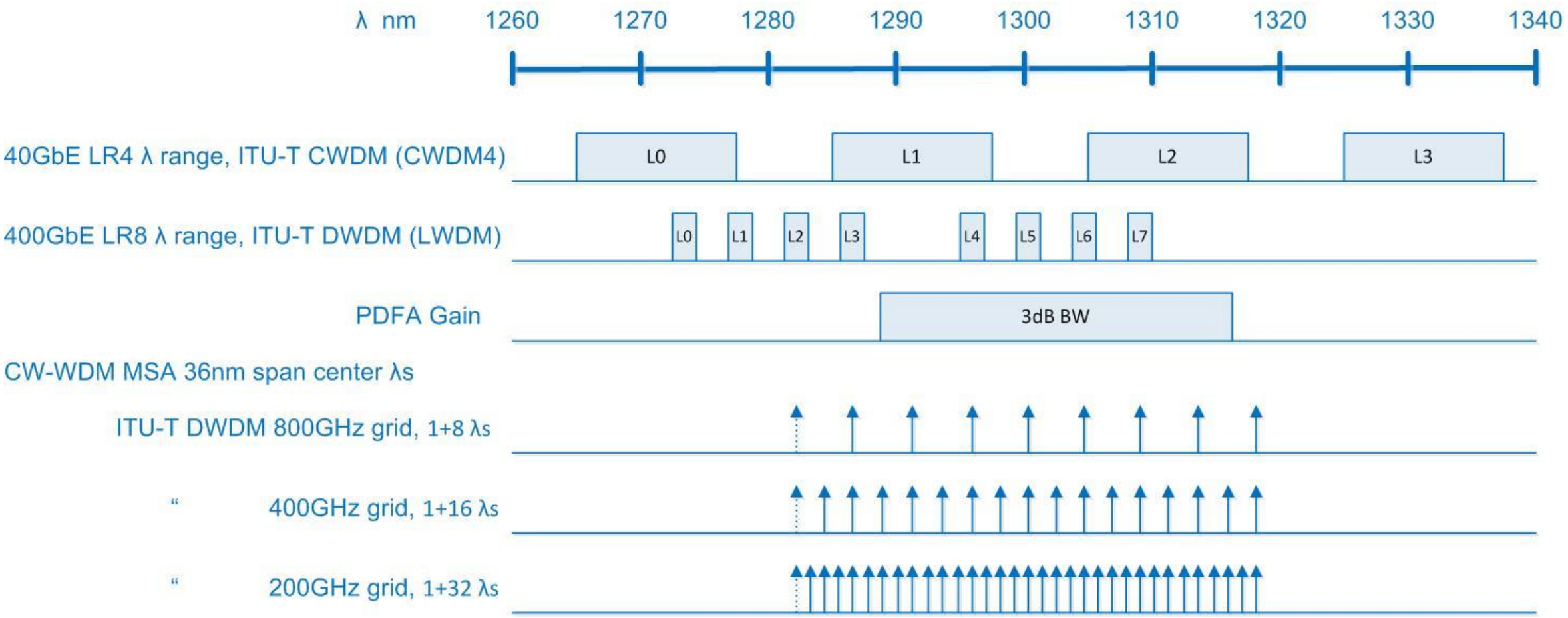
CW WDM MSA Overview

- Objective: develop high-count WDM laser source spec for emerging applications
- Formed: April 2020
- Website: https://cw-wdm.org/
- Chair: Chris Cole, II-VI
- Editor: Matt Sysak, Ayar Labs
- Associate Editors: John Johnson, Broadcom, David Lewis, Lumentum
- Marketing: Kristine Raabe, Ayar Labs
- Rev. 1.0 Spec. published: June 2021
- 11 Promoter Members
- 36 Observer Members

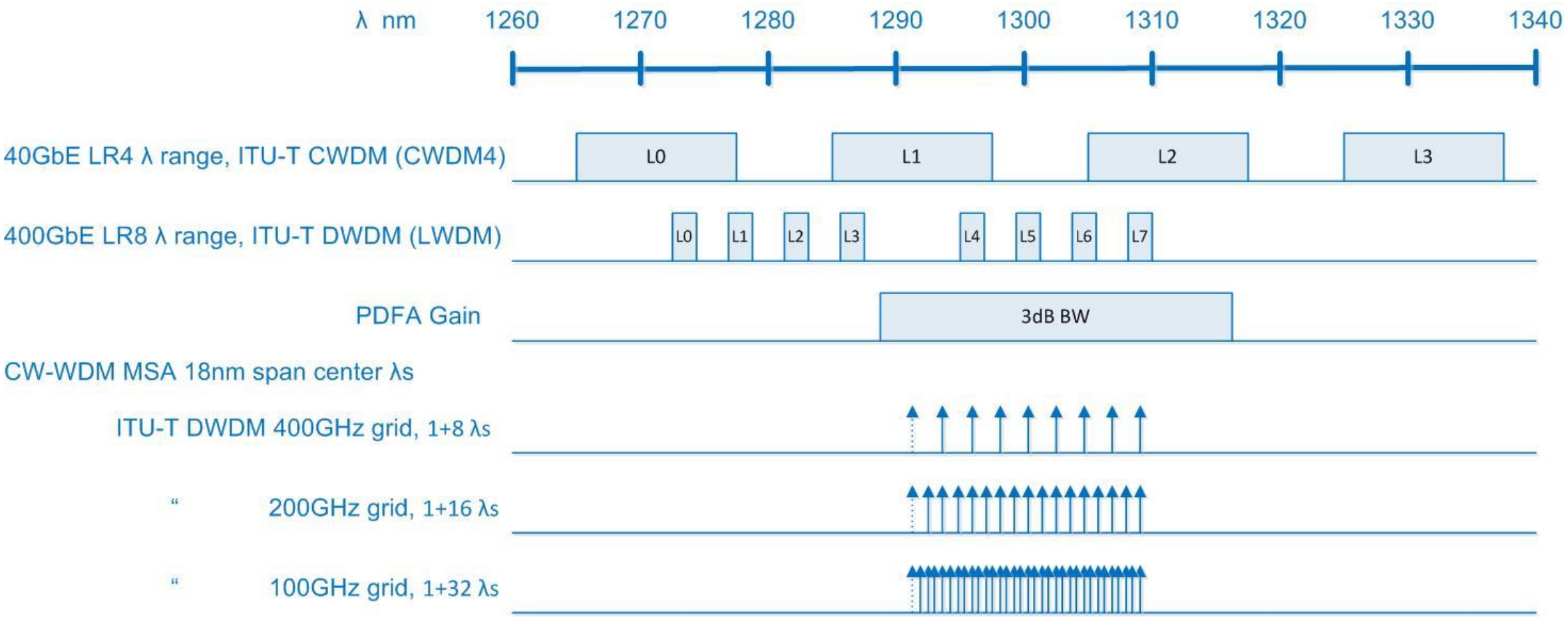
Promoter Members

Observer Members

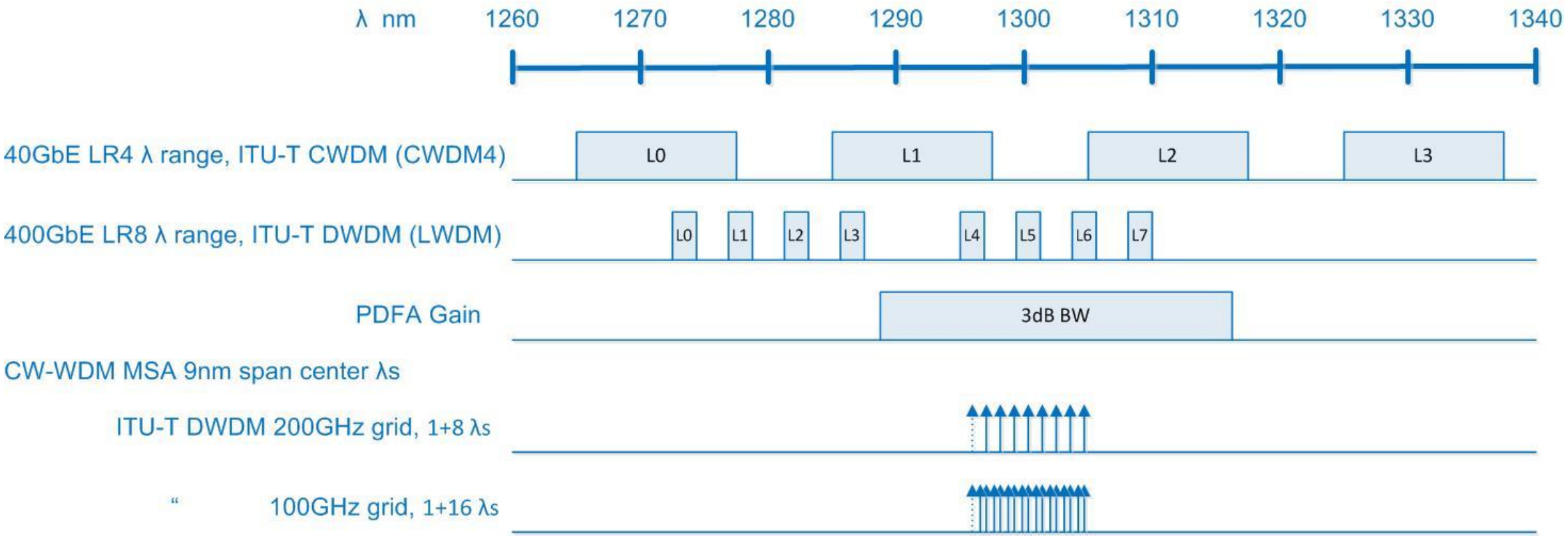
CW WDM MSA 36nm Span Center λs, 200GHz Grid, 1+32 λs



CW WDM MSA 18nm Span Center λs



CW WDM MSA 9nm Span Center λs



Power limits per fiber (sum of all wavelengths)

Output Power class	9 nm span AOP (max)	18 nm span AOP (max)	36 nm span AOP (max)	Units
Type 1 Eye Safety Limit	20	20	14	dBm
Type 2 Eye Safety Limit – 6dB	14	14	8	dBm
Type 3 Eye Safety Limit + 6dB	26	26	20	dBm

AOP: Average Optical Power

Wavelength Accuracy

Source Type	Center wavelength offset range	Center wavelength variation range	Units
Type I (multiple Grid Spacings)	± 5.0	± 4.0	nm
Type II (fraction of a Grid Spacing)	± 0.5	± 0.5	nm

New ITU-T SG15 Q6 12λ O-band Mobile Standard: G.owdm

- Mobile is a very cost sensitive application with its own ecosystem
- Lowest cost solution like low modulation order 12λ WDM can be considered
- Leverages high-volume lasers used for IEEE Ethernet LWDM and CWDM optics
- One of the proposals is 800GHz spaced 12λs, common with CW-WDM MSA 36nm span 800GHz spaced λs
- Major issue for 800GHz spacing is 12λ four-wave-mixing (FWM) penalty
- CW-WDM MSA Associate Editor John Johnson analyzed FWM for Rev. 1.0 Spec
- He presented his FWM analysis in Q6
- Q6 has provisionally decided to use 800GHz spacing for 10km application
- A lot of work is left to be done, and FWM requirements may be too hard to meet
- In that case, a wider spaced 12λ WDM proposal will be considered

CW WDM MSA Status

- Rev. 1.0 Specification Published
- Provides framework for high-count WDM laser sources
- Does not specify link parameters
- Next step is for industry to develop products using the MSA Specification
- MSA will promote the standard and facilitate industry collaboration
- Successful solutions will be standardized in future MSA Specifications

A New Spec for Multi-Wavelength Optical Laser Sources

Thank You!