200 Gb/s 30m over OM4 Objective and Baseline link proposals

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IEEE 802.3 200 Gb/s per Wavelength MMF PHYs Study Group Interim Meeting

Supporters

- Chris Cole, Coherent,
- Roberto Rodes, Coherent
- Chris Kocot, Coherent
- Mike Dudek, Marvell, Supporters of the Objective

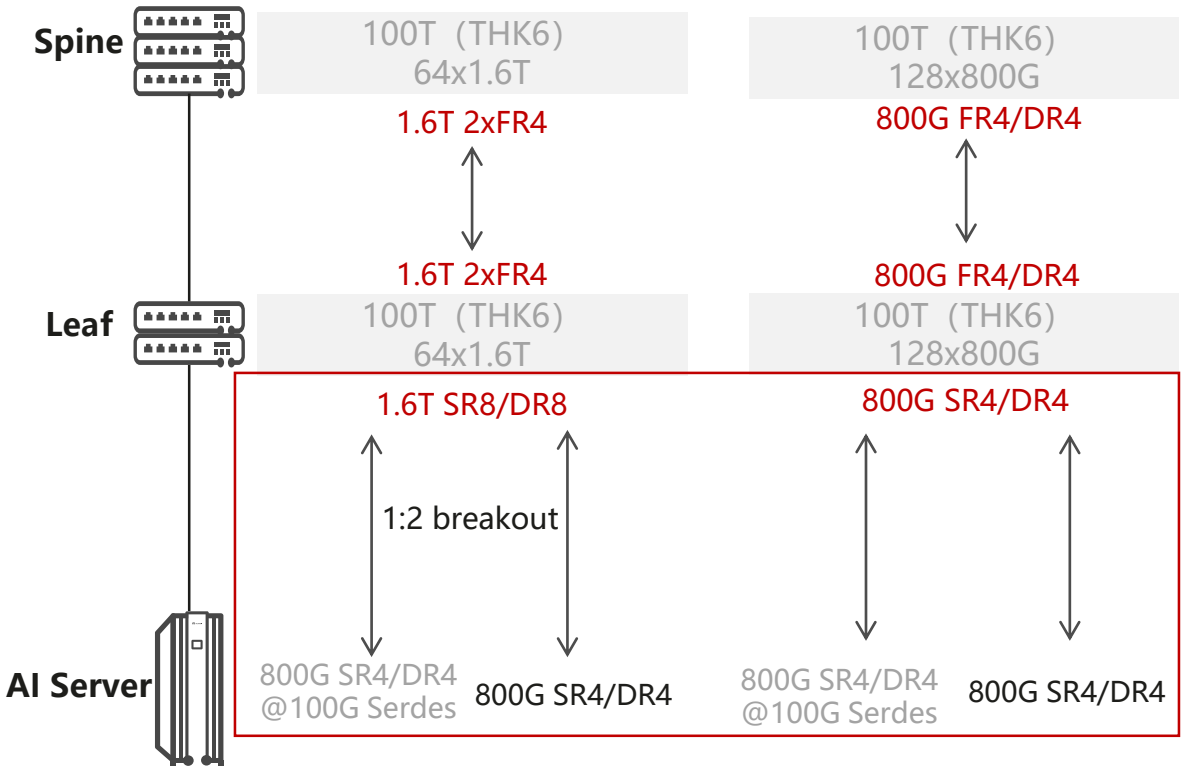
Overview

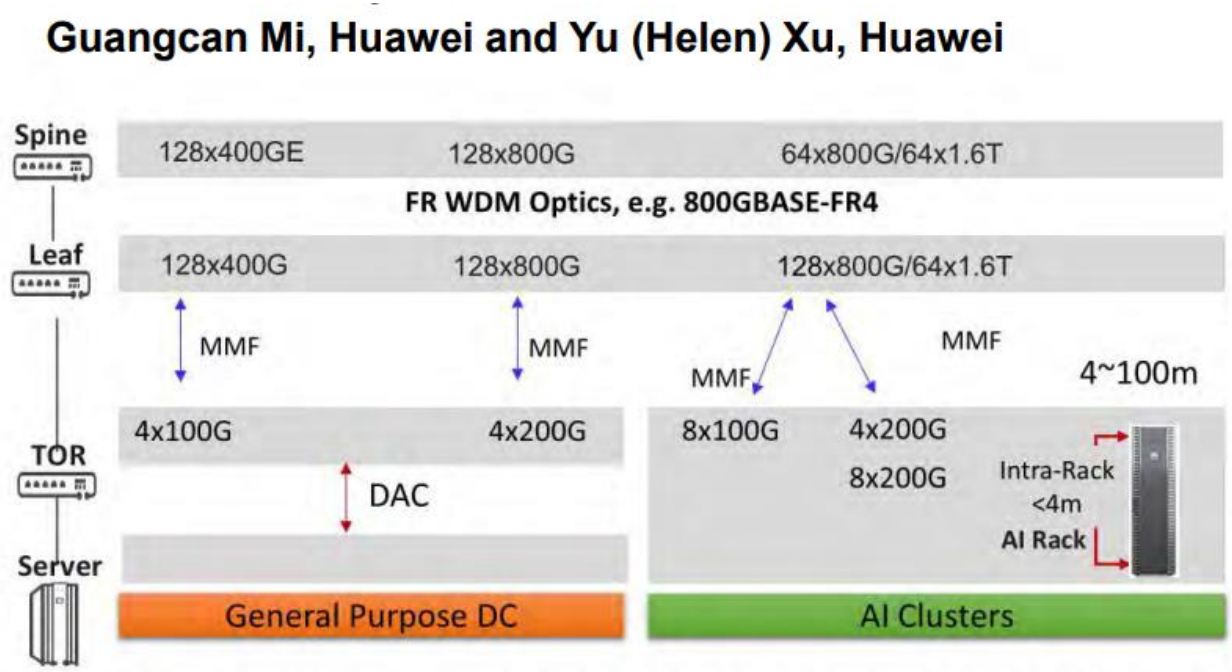
- Contribution in support of:
  - Objective(s) for 200 Gb/s operation over 30 m OM4
  - CSD:
    - Broad Market Potential
    - Technical Feasibility
    - Economic Feasibility
  - Baseline Proposal for a 30 m link over OM4
  - Considerations of timeline in the choices of objectives

200 Gb/s/Lane application scenarios

The network architecture of general-purpose DC and AI clusters will gradually upgrade to 1.6 Tb/s.

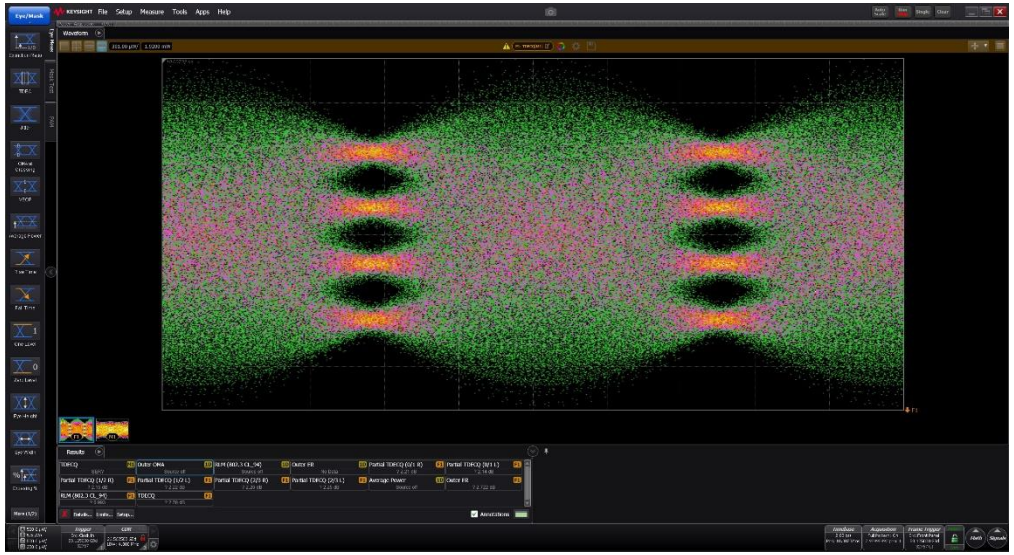
VCSEL are an excellent choice for SR due to low cost and low power consumption characteristics.



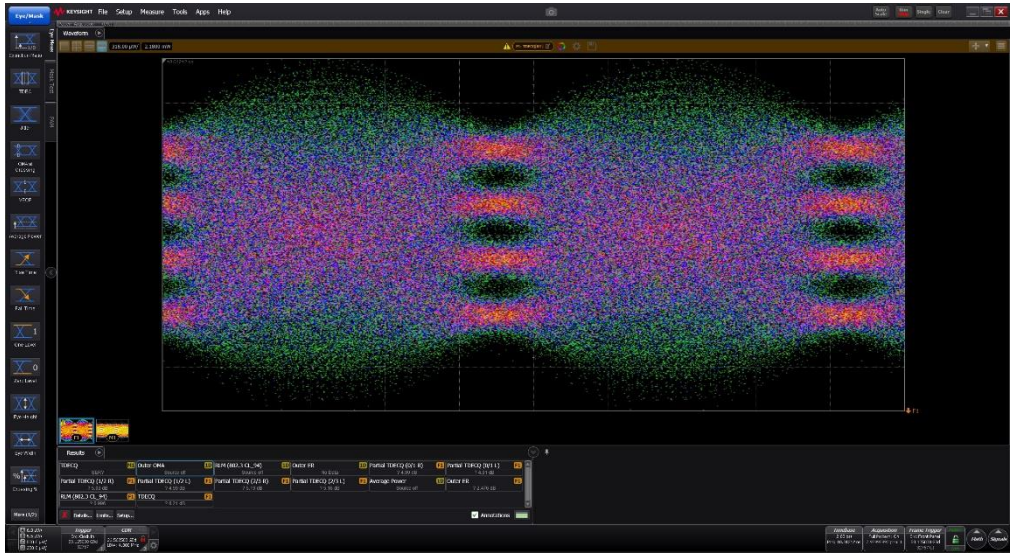


VCSEL Transmission @200 Gb/s over 30m

106G baud with PRBS13



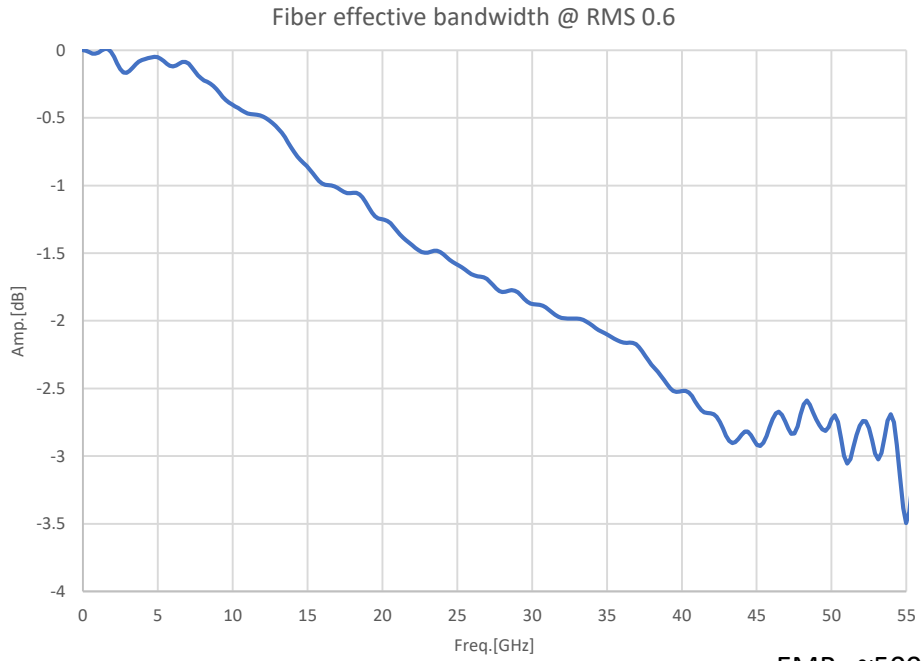
Back-to-Back (~TP2)



Optical eye diagram after 30m fiber transmission

- After 30m of OM4 fiber transmission, we obtained a relatively clear eye diagram.
- There are several ways to further improve the system performance
  - ✓ Optimize TX, tighten the RMS of VCSEL... Those are early results.

OM4 Fiber effective bandwidth



EMBc ~5000 MHz.km

- We tested one 30m OM4 fiber, the effective bandwidth is 55 GHz, which is 0.53x of Nyquist frequency.
- By tightening RMS of VCSEL, the EMB of the MMF can be further increased.

Objective Recommendation

1- Broad application for MMF links in AI clusters and in datacenters
2- OM4 Fiber has adequate bandwidth to support 30m of transmission at 200 Gb/s
3- VCSEL technology at 200 Gb/s is mature and make the links possible
4- Technology exist is widely available leading itself to a “rapid” transition to standard.

Recommendation is for Objectives:

- Define a physical layer specification that supports 200 Gb/s operation over 1 pair of MMF with lengths up to at least 30 m
- Define a physical layer specification that supports 400 Gb/s operation over 2 pairs of MMF with lengths up to at least 30 m
- Define a physical layer specification that supports 800 Gb/s operation over 4 pairs of MMF with lengths up to at least 30 m
- Define a physical layer specification that supports 1.6 Tb/s operation over 8 pairs of MMF with lengths up to at least 30 m

Illustrative Baseline Preview

Illustrative Transmitter Specifications

Description	200GBASE-SR1 400GBASE-SR2 800GBASE-SR4 1.6TBASE-SR8	Unit
Signaling rate, each lane (range)	TBD	GBd
Modulation Format	PAM4	
Lane wavelengths (range)	844~863	nm
Side-mode suppression ratio (SMSR), (min)	30	dB
RMS spectral width	TBD	nm
Average launch power, each lane (max)	TBD	dBm
Average launch power, each lane (min)	TBD	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(max)	TBD	dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane(min) for TDECQ < 1.8 dB for 1.8 dB ≤ TDECQ ≤ TDECQ (max)	TBD TBD TBD	dBm dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	TBD	dB
TECQ (max)	TBD	dB
Average launch power of OFF transmitter, each lane (max)	-30	dBm
Transmitter power excursion, each lane (max)	TBD	dB
Extinction ratio, each lane, (min)	TBD	dB
Transmitter transition time (max)	8	ps
Transmitter over/under-shoot (max)	TBD	%
RIN_xOMA (max)	TBD	dB/Hz
Optical return loss tolerance (max)	TBD	dB
Encircled flux	≥86% at 19 um ≤30% at 4.5 um	dB

Illustrative Receiver Specifications

Description	200GBASE-SR1 400GBASE-SR2 800GBASE-SR4 1.6TBASE-SR8	Unit
Signaling rate, each lane (range)	TBD	GBd
Modulation Format	PAM4	
Lane wavelengths (range)	844~863	nm
Damage threshold, each lane	TBD	dBm
Average receive power, each lane (max)	TBD	dBm
Average receive power, each lane (min)	TBD	dBm
Receive power, each lane (OMA_{outer}) (max)	TBD	dBm
Receiver reflectance (max)	TBD	dB
Receiver sensitivity (OMA_{outer}), each lane (max) for TECQ < 1.8dB for 1.8 dB ≤ TECQ ≤ SECQ	 TBD TBD	 dBm dBm
Stressed receiver sensitivity (OMA_{outer}), each lane (max)	TBD	dBm
Conditions of stressed receiver sensitivity test:		
SECQ	4.4	dB
OMA_{outer} of each aggressor lane[c]	3.5	dBm

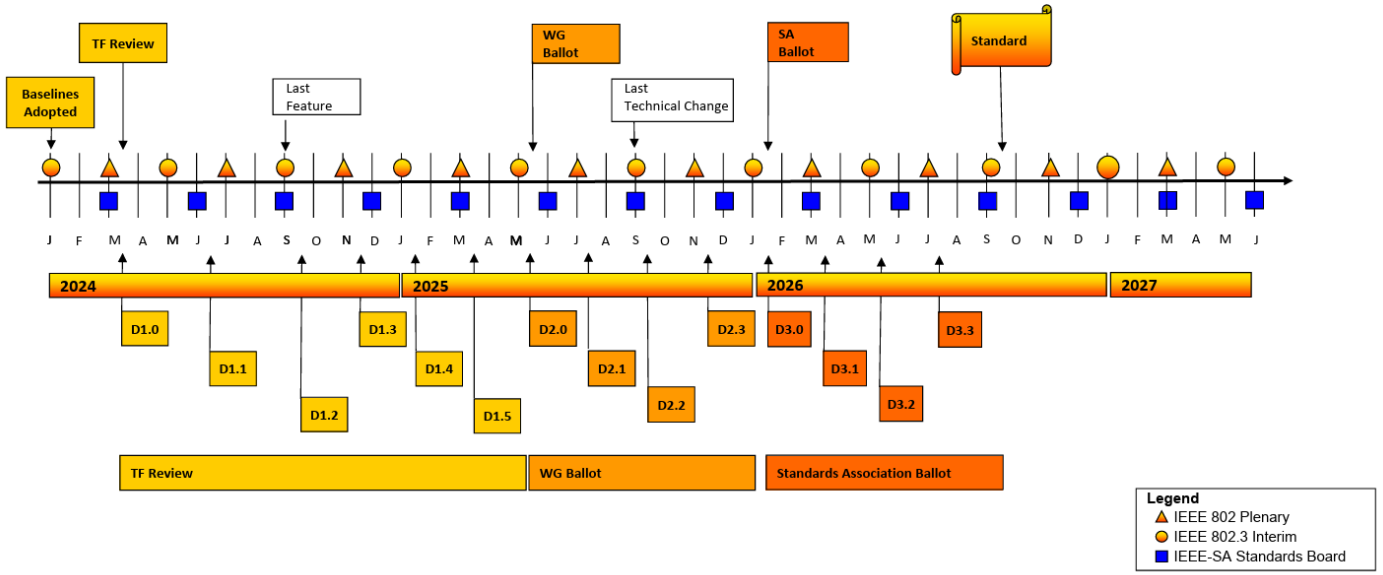
Illustrative Link Budget

Description	200GBASE-SR1 400GBASE-SR2 800GBASE-SR4 1.6TBASE-SR8	Unit
	OM4	
Effective modal bandwidth at 850 nm	4700	MHz.km
Power budget (for max TDECQ)	TBD	dB
Operating distance	0.5 To 30	m
Channel insertion loss	TBD	dB
Maximum discrete reflectance	-35	dB
Allocation for penalties (for max TDECQ)	TBD	dB
Additional insertion loss allowed	TBD	dB

Consideration

Timeline

Adopted IEEE P802.3dj Timeline (14 Nov 2024)



-802.3dj (200Gb/s/Lane over SMF) is tracking for a fall 2026 availability.
-For a 200Gb/s/Lane over MMF to be relevant it cannot lag far behind

Summary

1- Broad application for MMF links in AI clusters and in datacenters
2- OM4 Fiber has adequate bandwidth to support 30m of transmission at 200 Gb/s
3- VCSEL technology at 200 Gb/s is mature and make the links possible
4- Technology exist is widely available leading itself to a “rapid” transition to standard.

5- There is a strong opportunity for broad consensus on supporting objectives for 200 Gb/s over 30 m OM4.
6- While rapid progress is possible, significant technical work remains to be done.

7- The key is to define a scope wide enough to be meaningful yet narrow enough to ensure rapid development, with room for future extensions.

Appendix

Illustrative Link Budget