



Coherent solutions for 10 & 40km 800Gb/s objectives in 802.3dj

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IEEE P802.3dj

January Interim, 2023

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Overview

802.3dj includes the following 800Gb/s objectives that are suitable for a coherent optical solution

- over a single SMF in each direction with lengths up to at least 10 km
- over a single SMF in each direction with lengths up to at least 40 km

This contribution provides specifications for a coherent solution tailored to meet the 10km & 40km SMF applications

The solution presented for the 10 & 40 km objectives has no constraints on the G.652 fiber optical parameters

- A C band specification allows LR & ER interworking
- C band is optimal for 40 km reach
- 10 km reach can be met with either C band or O band

Fiber Optical Parameters

ITU-T G.652 (11/2016) defines parameters for a single-mode fiber

- Other fiber types (ITU-T G.657 & G.654) may also be used and should not be precluded.

G.652.B and G.652.D specifications are used to develop the 10km and 40km application

	G.652.B	G.652.D
Chromatic Dispersion (max)	18.0 ps/nm	18.6 ps/nm
Fiber Loss (C-Band)	0.35 dB/km	0.3 dB/km
PMDQ	0.2 ps/(km ^{.5})	0.2 ps/(km ^{.5})

O band attenuation of 0.43dB/km (1295 nm) has been used in previous 802.3 PMD's. The reduction in attenuation in the C band is useful for 800G SMF specifications

Note: The PMDQ definition in G.652 applies to longer fiber reaches with multiple segments. A DGD value of 8ps was used for 10km links in 802.3bs. Later analysis in 802.3cu reduced the DGD allocation to 5ps for 10 km links:

https://www.ieee802.org/3/cu/public/cu_adhoc/cu_archive/anslow_3cu_adhoc_051519.pdf

This DGD analysis is used in this contribution.

Coherent options for 10 & 40 km

OIF has two active projects that provide options for coherent 800GbE specs in IEEE 802.3dj:

- 800ZR uses GMP mapping of an Ethernet payload into a DSP frame with OFEC
 - Application is 80-100km DWDM/amplified
- 800LR uses a concatenated RS/BCH FEC
 - Application is unamplified ~10km reach

Either of these DSP implementations can be considered for 802.3dj SMF objectives:

- **Note: While the OIF application of 800ZR is an amplified link, mention of 800ZR for 802.3 applications does not imply the link is amplified – 800ZR is discussed only at the logical layer**

Key differences between these approaches:

- Baud
- Net Coding Gain
- Latency
- Timing variation
- Segmented vs Concatenated FEC support

800G Coherent: OIF 800ZR and 800LR

- **800LR**

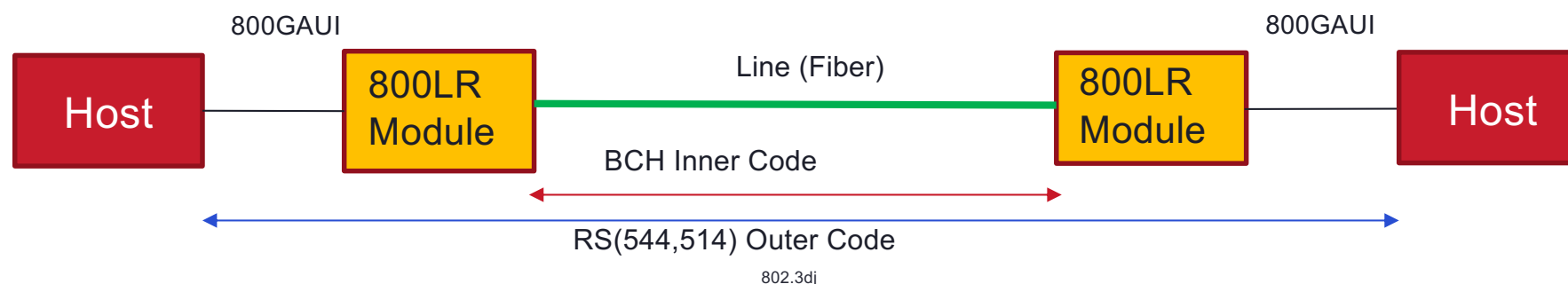
- Concatenated FEC support
 - Segmented architectural support if required
- Convolutional interleaver with direct mapping of RS FEC into BCH FEC
 - Timing certainty
- RS544+BCH(126,110) ~1.1% FEC Threshold
- Latency $\leq 250\text{ns}$ end to end (Concatenated)
- 123.7Gbaud 16QAM

- **OIF 800ZR Framing**

- Segmented FEC
- Asynchronous GMP mapping of 257b blocks into DSP frame
- OFEC ~2% FEC threshold
- Latency $\leq 2\text{ us}$ end to end
- 118.2 Gbaud 16QAM
- Power ~2W higher than LR

800LR supports sufficient coding gain for a single digital solution 800G 10km & 40km
→ It is preferred due to its technical advantages in latency, power, and timing certainty

→ https://www.ieee802.org/3/df/public/22_07/maniloff_3df_01b_2207.pdf



802.3dj 10km & 40 km Objectives

The 10km solution is defined to support a 6.3dB loss budget consistent with existing 802.3 10km specifications

- Fiber attenuation in C band is < O band, however the 10km loss budget is maintained to support loss-limited applications

The 40km solution is defined based on worst-case G.652 fiber loss

- For G.652.D 2 dB is allocated for patch panels.

C band operation allows multiple technology solutions to meet a higher Tx output power for 40km reach

- Mature EDFA and SOA technologies in modules can boost Tx power to meet 40km link loss

A coherent solution allows definition of a specification resulting in interoperable 10km and 40km interfaces

- In this scenario, the C band is used in both applications

If interoperability between 10 & 40km is not considered critical, separate bands for each application can be selected based on market potential

- 10km can be designed as an O band solution, with 40km designed as a C band solution

800GBASE-LR1 and 800GBASE-ER1 Link parameters

	800GBASE-LR1	800GBASE-ER1	
Maximum Reach	10	40	km
Fiber Loss	3.5	12	dB [1]
Additional Loss	2.8	2	dB [2]
Chromatic Dispersion Max	200	800	ps/nm [3]
Chromatic Dispersion Min	0	0	ps/nm
DGD	5	10	ps

Note 1: 800GBASE-ER1 Loss specification for G.652.D fiber attenuation. G.652.B fiber maximum attenuation results in a 14dB maximum loss.

Note 2: 800GBASE-ER1 on G.652.B fiber is an engineered link, with no allocations for additional patch panel loss.

Note 3: Chromatic Dispersion is allocated based on G.654 maximum CD value, which is greater than the worst-case G.652 CD

LR Specs are for C band, O band would maintain the same loss budget with Chromatic Dispersion range reduced

800GBASE-LR1 and 800GBASE-ER1 Tx Parameters

	800GBASE-LR1	800GBASE-ER1	
Modulation Format	DP-16QAM	DP-16QAM	
Baud	123.7	123.7	Gbaud
Optical Frequency	193.7	193.7	THz [1]
FEC	RS(544,514,10) +BCH(126,110)	RS(544,514,10) +BCH(126,110)	
Average Launch Power (Max)	-4	2	dBm [2]
Average Launch Power (Min)	-10	-2	dBm [2]
Optical Frequency Accuracy	±3	±3	GHz

Note 1: C band is assumed here, LR frequency changed for O band

Note 2: Average launch power Min/Max define the limits of a compliant transmitter.
Tunable transmit power is not required

800GBASE-LR1 and 800GBASE-ER1 Rx Parameters

	800GBASE-LR1	800GBASE-ER1	
Optical Frequency	193.7	193.7	THz [1]
Optical Frequency Tolerance	±3	±3	GHz
Sensitivity at TP2	-16.8	-17	dBm
Sensitivity at TP3	-16.3	-16	dBm
Optical Power (Max)	-4	2	dBm [2]
Allocation for Penalties	0.5	1	dB

Note 1: C band is assumed here for both LR & ER. LR frequency is changed for O band

800GBASE-LR1 and 800GBASE-ER1 are compliant over the 10km link specifications if both are designed in the C band. A 6 dB minimum loss is required between an ER transmitter and an LR receiver

Note 2: Including a 6dB minimum loss specification for ER should be considered

Summary

A coherent solution for the 802.3dj 10 & 40 km SMF objectives is presented based on a concatenated RS544/BCH FEC code

The proposed specification can fully meet fiber parameters defined in ITU G.652, as well as G.657 and G.654

10 and 40km specifications using the same framing and compatible optical specs provide the possibility of an interoperable 10 & 40km 800GbE implementation

While C band is optimal for the 40km application, either C band or O band is applicable to 10 km

The task force should consider whether 10 km should be implemented in C or O

- Alignment between 10 & 40km and broad market potential are important considerations



Thanks!