

100GE-nR4 (“MR4”) Parallel SMF PMD Economic Feasibility

Next Generation 40Gb/s and 100Gb/s
Ethernet Optics Study Group
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Outline

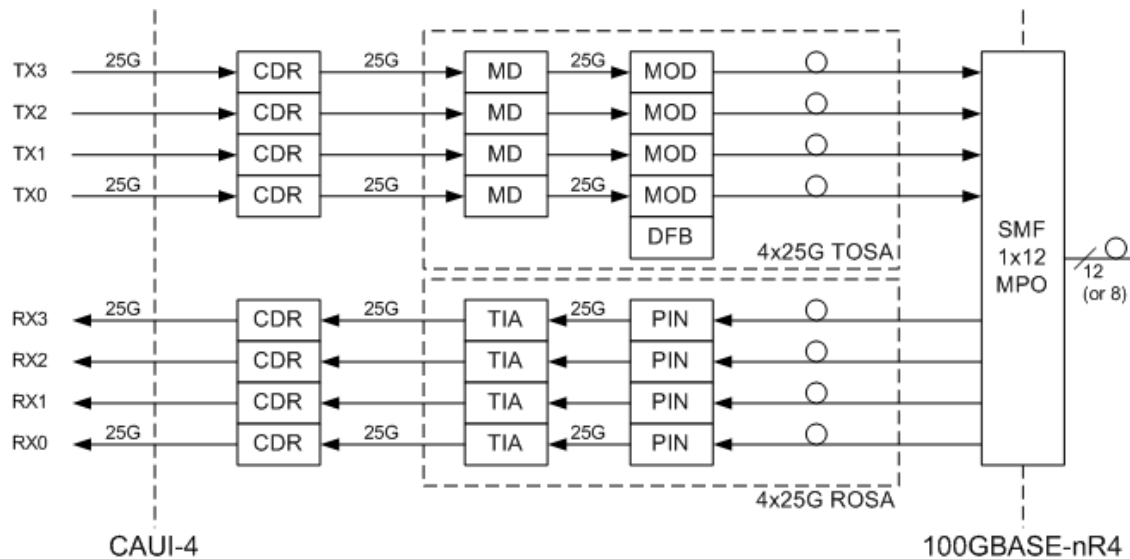
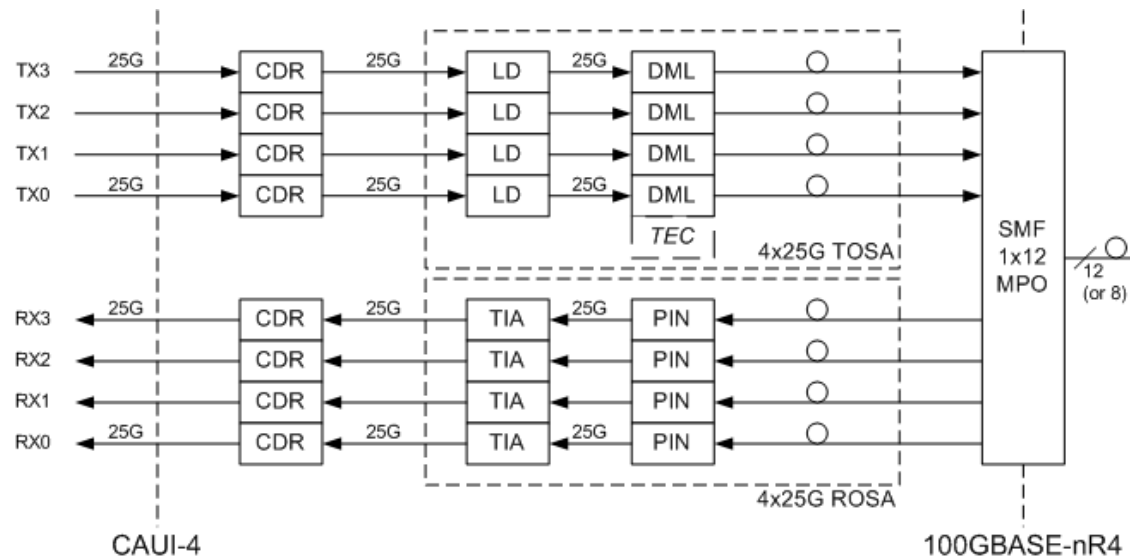
- Client Optics Overview
- 100GE-nR4 (“MR4”) Block Diagrams
- LR4/nR4 Total Link Cost Ratio Equations
- Feasible nR4 & LR4 Transceiver Costs
- Cabled Fiber Link Costs
- LR4/nR4 Total Link Cost Ratio Graphs
- 100GE-nR4 PMD Criteria
- Conclusions

Client Optics Overview

Client optics application & media type(s)	High density data center duplex or parallel MMF	Structured data center duplex or parallel SMF	Carrier central office duplex SMF	General data center duplex SMF	Metro inter-data center duplex SMF
nominal reach	100m	500m	2km	10km	20, 30, 40km
min. loss budget	2dB	2dB	4dB	6dB	11 to 21dB
bits/sec cost baseline	10G VCSEL MMF	10G VCSEL MMF	10G DFB laser SMF	10G DFB laser SMF	10G EML SMF
10G standard	10GE-SR	none	OC-192 SR-1 G.693 10G	10GE-LR	10GE-ER G.959.1 10G
40G standard	40GE-SR4	none	40GE-FR G.693 40G	40GE-LR4 G.695 10G	NG 100G OE 40GE-ER4
100G standard	100GE-SR10 NG 100G OE 100GE-SR4	NG 100G OE 100GE-nR4 ?	NG 100G OE 100GE-nR4 ?	100GE-LR4 G.959.1 25G	100GE-ER4 G.959.1 25G

Oval designated box is the subject of this presentation

100GE-nR4 (“MR4”) Block Diagrams



LR4/nR4 Total Link Cost Ratio Equations

- LR4 total link cost =
2 * LR4 transceiver cost + cabled 2f OS2 fiber link cost
- nR4 (“MR4”) total link cost =
2 * nR4 transceiver cost + cabled 8f OS2 fiber link cost
- LR4/nR4 total link cost ratio =
LR4 total link cost / nR4 total link cost

Feasible nR4 & LR4 Transceiver Costs

- 100GE-nR4 ("MR4") / SR10 estimates
 - "MR4"/SR10 = 3 to 5 (Anderson, Cole, Petrilla)
 - "MR4"/SR10 = 1.2 ??? (Palkert)
 - 100GE-SR4 cost = 1.2 * SR10 cost
 - [petrilla_02a_0112](#), [petrilla_01a_0312](#), confirmed Apr'12
- 100GE-LR4/SR4 near and mid-term estimates
 - Near-term: LR4 (CFP2) / SR4 (CFP4) = 6.7
 - 100GE-SR4 cost = 1.2 * SR10 LC 2012 projection
 - Mid-term: LR4 (CFP4) / SR4 (CFP4) = 4.5 to 5
 - [cole_02a_0312](#)
- 100GE-LR4/SR4 long-term estimate
 - Long-term: LR4/SR4 (CFP4) = 4
 - 100GE-SR4 cost \approx 40GE-SR4 LC 2012 projection

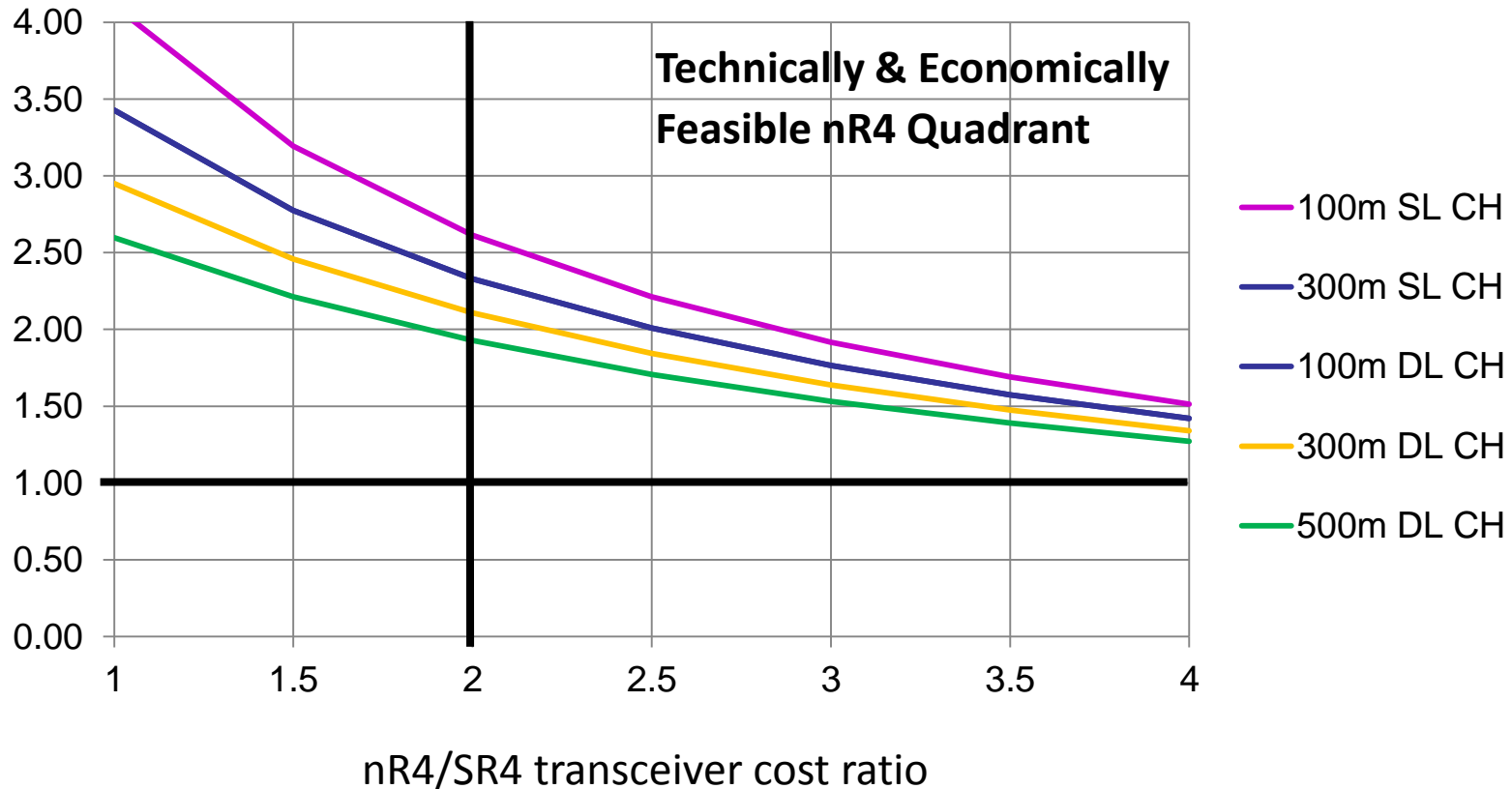
Cabled Fiber Link Costs

Channel Type	Single-link		Double-link		
Fiber Type	100m	300m	100m	300m	500m
2f OS2 SMF	1	1.5	1.5	2	2.5
8f OS2 SMF	4	6	6	8	10

- Fiber connectivity cost ratios only (no transceivers) from [cole_01_0512](#) (Abbott, Cole, Coleman, Kolesar, Swanson)
- 100m 8f OM3 MMF cost average of several sources used as 100m 8f OS2 SMF cost with above ratios to calculate cabled fiber link costs

Near-Term LR4/nR4 Total Link Cost Ratio

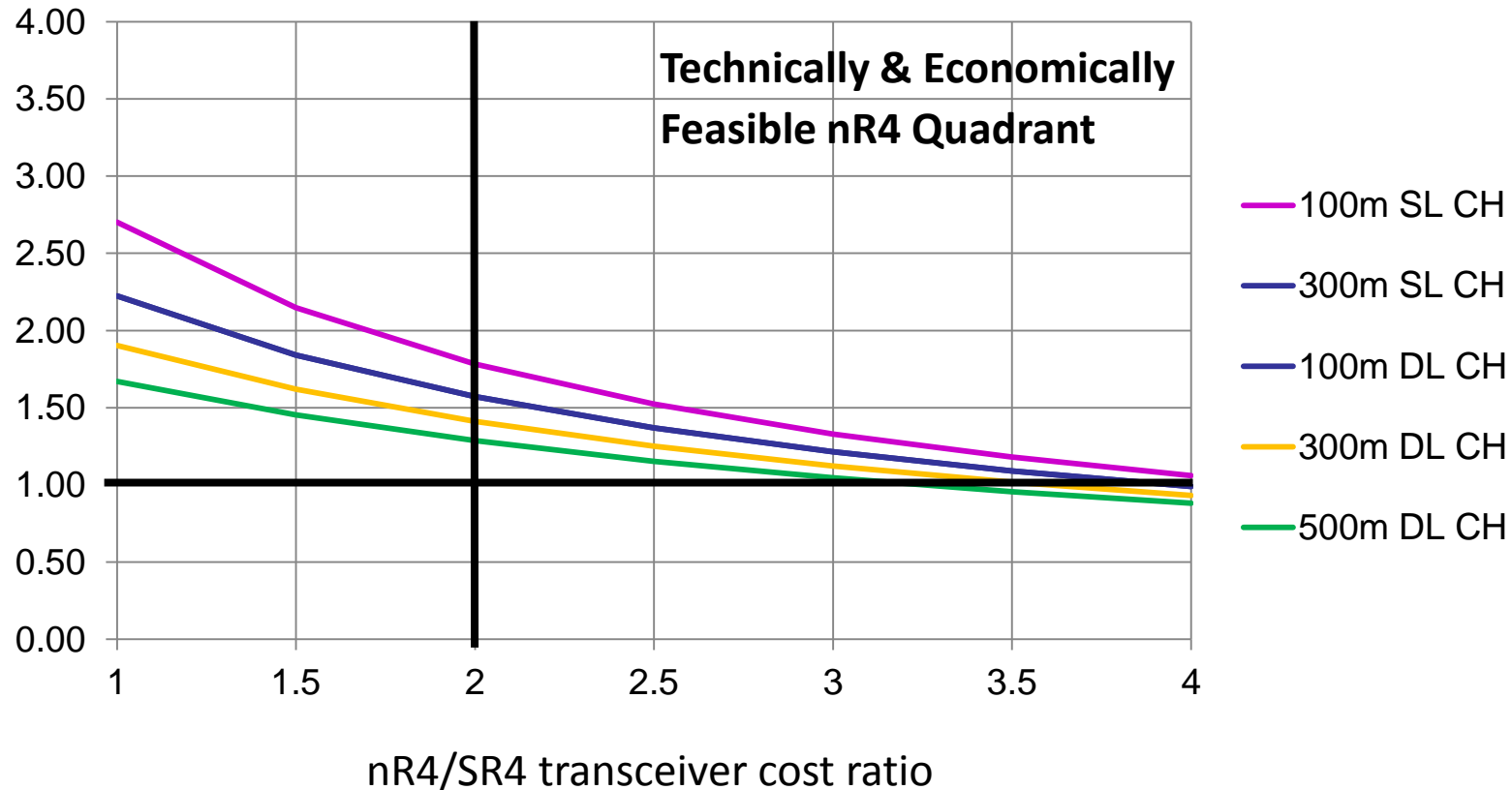
LR4/nR4 total link cost ratio



- LR4/SR4 transceiver cost ratio = 7
- SR4 transceiver cost = 1.2 * SR10 LC 2012 projection

Mid-Term LR4/nR4 Total Link Cost Ratio

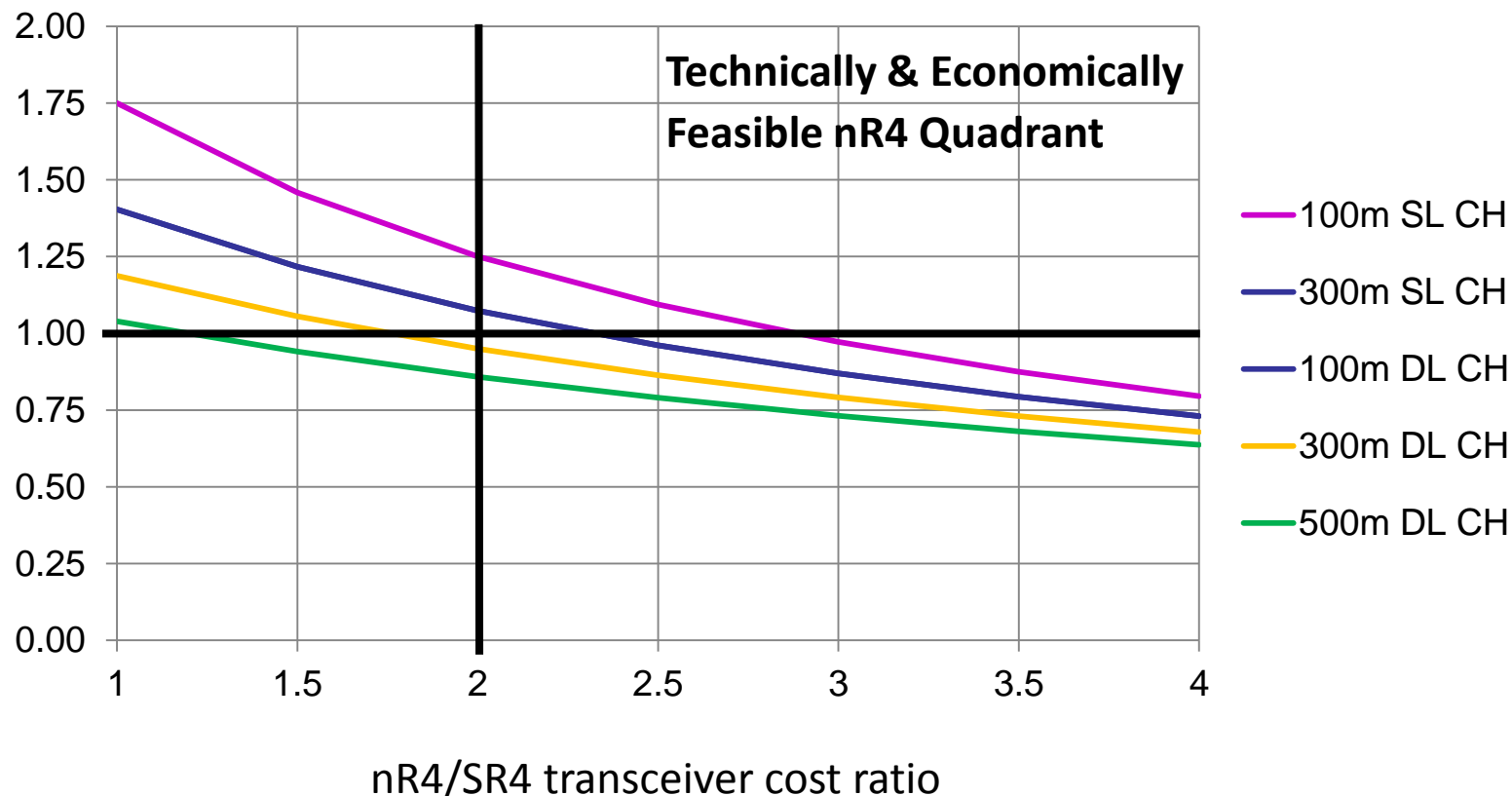
LR4/nR4 total link cost ratio



- LR4/SR4 transceiver cost ratio = 5
- SR4 transceiver cost = SR10 LC 2012 projection

Long-Term LR4/nR4 Total Link Cost Ratio

LR4/nR4 total link cost ratio



- LR4/SR4 transceiver cost ratio = 4
- SR4 transceiver cost = 40GE-SR4 LC 2012 projection

100GE-nR4 Parallel SMF PMD Criteria

- Economic Feasibility
 - In the near and mid-term, parallel SMF offers a modest total link cost advantage over LR4
 - This does not include the effect of split volume
 - In the long-term, parallel SMF has no cost advantage over LR4, same as 40GE today
- Broad Market Potential (discussed at prior meetings)
 - Some IDC operators have interest in parallel SMF as a primary structured data center client optic
 - Other IDC operators and Central Office (Telecom) operators have no interest in parallel SMF, except for isolated low-volume applications

Conclusions

- Economic Feasibility and Broad Market Potential case for 100GE-nR4 parallel SMF IEEE standardization is underwhelming
- 100GE-nR4 specifications written this year will not be optimal as there is no industry experience with parallel SMF transceivers
- IEEE standardization now may not be the best first step for the development of parallel SMF transceiver technology
- High density port expansion may be the best first step for parallel SMF transceivers to complement parallel MMF transceivers used for this application