

Investigation Topics

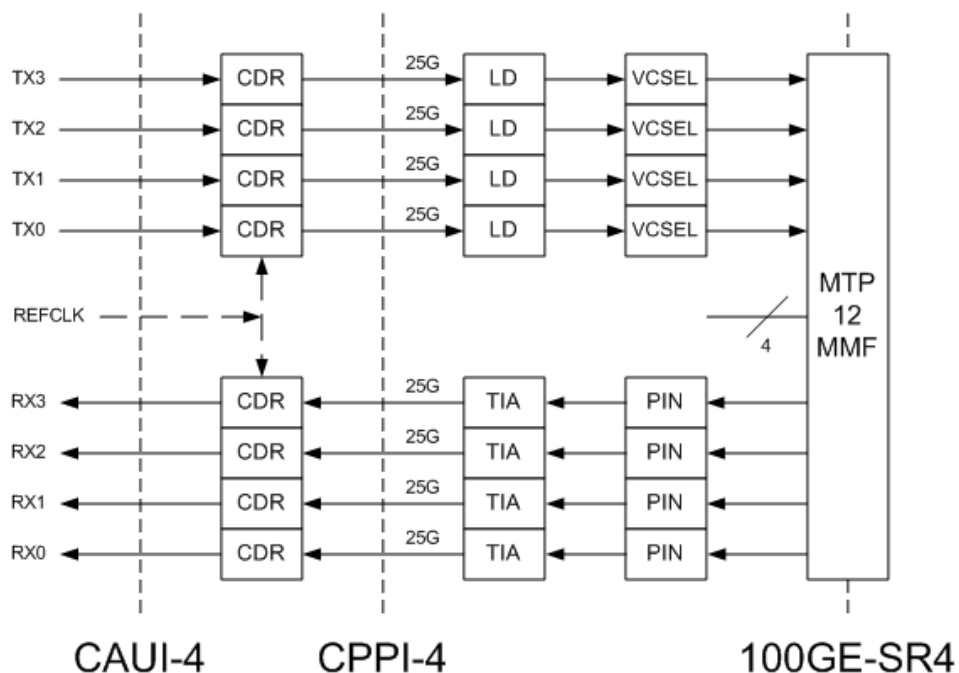
Next Generation 100GbE Study Group
IEEE 802.3 Interim Meeting
Chicago, Illinois
12-15 September 2011
Chris Cole

Existing and Next Gen 100G Optics

Optics designation	100m	1000m	2km to 10km
primary application	high density data center	structured inter-net data center	carrier & general data center
~loss budget	2dB	2.5dB	6dB*
~link budget = loss + penalties	8dB	3dB	8.5dB
bit/sec cost & power target	~10GE-SR	~10GE-SR	~10GE-LR
volume laser technology	VCSEL PIC	TBD	DFB PIC
fiber	parallel MMF	duplex SMF	duplex SMF
Existing standard	100GE-SR10	none	100GE-LR4
Next Gen standard	100GE-SR4	100GE-nR4 ???	none

* 2km dedicated optics loss budget is 4dB

100m High Density Optics



- **100m high density optics should be a NG 100G SG investigation**
- Investigation should include determining the best 4x25G electrical I/O:
 - CAUI-4; w/ & w/o FEC
 - CPPI-4; w/ & w/o FEC, w/ & w/o EDC
- Discussed in detail in other NG 100G SG presentations

1000m Structured IDC Optics

- Majority of 10G data center interfaces are 10GE-SR
- 10GE-SR VCSEL technology has significantly lower cost & power than 10GE-LR DFB laser technology
- 10GE-SR 300m reach covered 99% of data center links when adopted in 2002, and still covers majority of links today
- Since 2002, because of appearance of Internet Data Centers (IDCs), there is a new 10G structured link application:
1000m > reach >300m @ ~10GE-SR bit/sec cost
- Similar link applications exist or will exist at 40G and 100G
- 100GE-SR10 and 100GE-SR4, using parallel VCSEL Array and MTP connector technology, are not practical for >300m link applications
- 100GE-LR4, using DFB PIC technology, exceeds 10GE-SR bit/sec cost & power
- Large difference between structured 1000m and general 10km optics link budgets (>6dB) offers opportunities for new technologies

1000m Structured IDC Optics

- **1000m structured IDC optics should be a NG 100G SG investigation**
- Optics technologies TBD
 - 100GE-LR4 WDM cooled 4x25G DFB PIC (reference baseline)
 - un-cooled CWDM DFB PIC (unlikely to be compelling)
 - Si modulator PIC
 - InP modulator PIC
 - Long Wave VCSEL PIC
 - others
- Market potential and volume timeline TBD
- Exact reach TBD
- **Caution:** No justification may be found in NG 100G SG for 1000m duplex SMF optics standard, either because of insufficient market volume or immature optics technology

2km Dedicated Optics

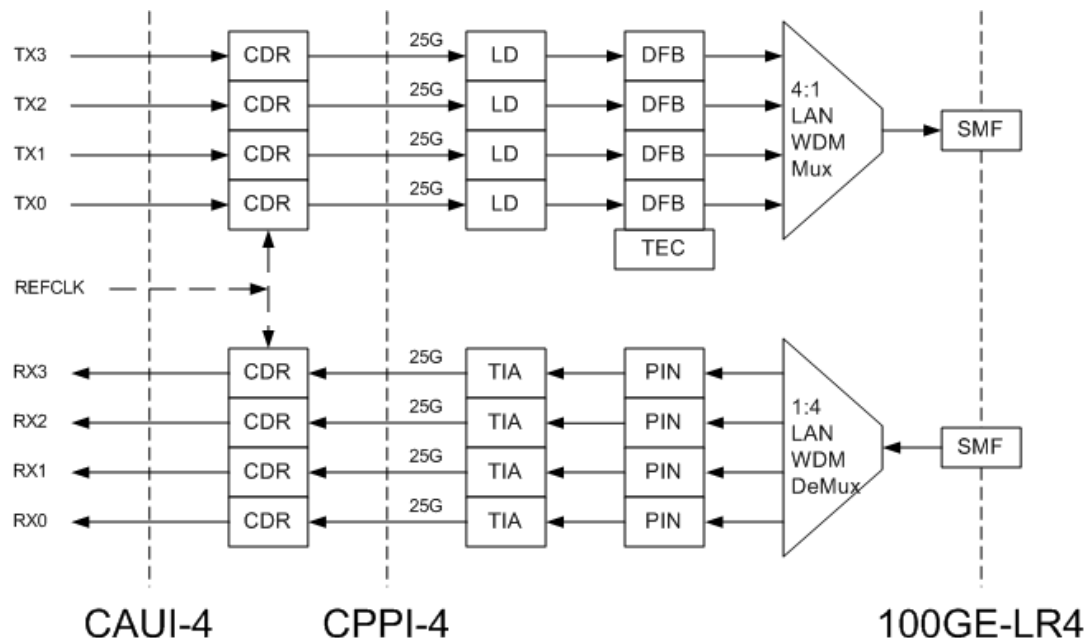
Carrier 40G optics link budget	ATT	China Telecom	Deutsche Telekom	NTT	Sprint	Verizon
6dB deployed (4dB loss budget)	Yes	Yes	Yes	Yes	Yes	Yes
7dB preferable (5dB loss budget)	Yes	Yes	Yes	Yes	Yes	Yes
4dB sufficient for all links	No	No	No	No	No	No

- Source: “100Gb/s SMF Client Reach Specs” presentation during NG Optical PMD CFI Discussion, 11/8/10, Dallas, TX
- All deployed 10G and 40G 2km optics support min 4dB loss budget
- Carrier 100G 2km optics application is the same as at 40G
- 100G cost target: ~10GE-LR bit/sec

2km Dedicated Optics

- Data centers use 10GE-LR requiring 10km budget support
- Central offices use OC-192 SR-1 requiring 2km budget support
- Volume of the two 10G applications is similar
- Early SR-1 single rate 300-pin modules have been replaced by pluggable dual rate modules which meet both specifications
- Despite large link budget difference, lower cost of 2km budget does not justify dedicated SR-1 single rate 10G pluggable modules
- 40G is the same; LR4 WDM tri-rate modules are the lowest cost solution for 40GE, STM-256 and OTU3 client applications
- 100G is also the same; LR4 WDM dual-rate modules will be the lowest cost solution for 100GE and OTU4 client applications
- Split in volume and extra OpEx cost of supporting two different SMF interface types wipes any out cost savings of dedicated 2km modules
- **Market & technology shows that 2km dedicated optics should NOT be a NG 100G SG investigation**

2km to 10km General Optics



- **100GE-LR4 will be the lowest cost 2km to 10km optics solution**
- NG 100G SG investigation should determine best 4x25G electrical I/O to support 100GE-LR4 optics:
 - CAUI-4; w/ & w/o FEC
 - CPPI-4; w/ & w/o FEC, w/ & w/o EDC

Next Gen 100G Optics Scenario Example

Electrical I/O type	MMF	SMF
Baseline	100GE-SR4	100GE-LR4
Extended (ex. w/ FEC)	100GE-SR4+	100GE-LR4 reduced cost

- Baseline I/O (ex. CAUI-4) supports standard specifications
- Extended I/O (ex. FEC) can be used to:
 - extend electrical and optical performance
 - reduce cost through simplified design and testing (ex. no low BER specifications and measurements)
- Auto Negotiation can be used to revert to baseline performance

Recommendations

- The following are recommended for NG 100G SG optical investigation:
 - 100m high density optics
 - 1000m structured IDC optics
- The following are recommended for NG 100G SG electrical investigation:
 - CAUI-4; w/ & w/o FEC
 - CPPI-4; w/ & w/o FEC, w/ & w/o EDC
- The following are not recommended for investigation:
 - 2km dedicated optics
(best supported by 2km to 10km general optics)