

100 Gb/s SMF Standard Broad Market Potential Observations

Next Generation 100Gb/s Ethernet Optics Study Group
IEEE 802.3 Interim Session
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Chris Cole

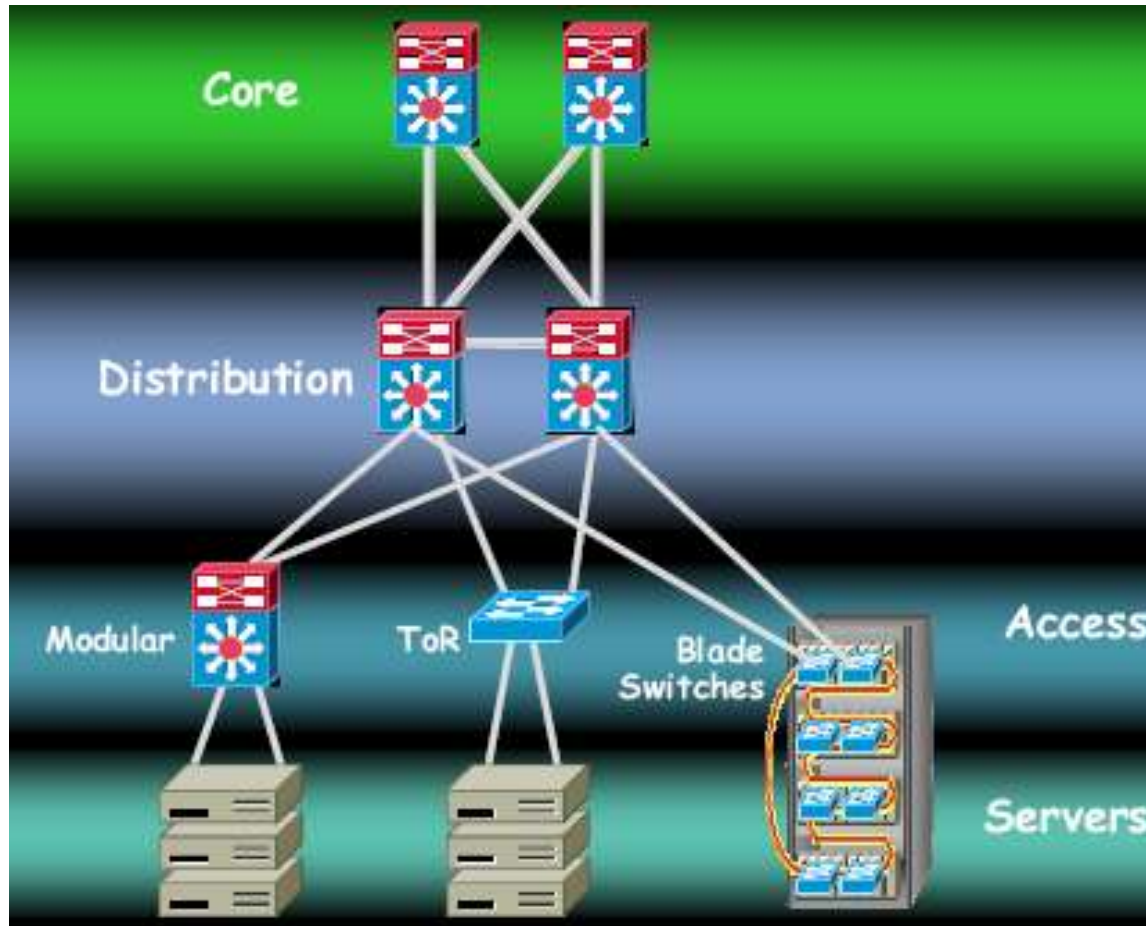
Outline

- Client Optics Applications Overview
- Switch Nomenclature Definition
- Broad Market Potential Approach
- 10G HSSG Results
- 100G HSSG Results
- Central Office Optics
- Internet Data Center Optics
- Observations

Client Optics Applications Overview

Client optics application & media type	High density data center parallel MMF	Structured data center duplex SMF	Carrier central office duplex SMF	General data center duplex SMF	Metro inter-data center duplex SMF
nominal reach	100m	1000m	2km	10km	20, 30, 40km
min. loss budget	2dB	2dB	4dB	6dB	11 to 21dB
bits/sec cost vs. volume curve	10G VCSEL	10G VCSEL	10G DFB laser	10G DFB laser	10G EML
10G standard	duplex MMF 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	proposed 40GE-ER4
100G standard	100GE-SR10 NG 100G OE 100GE-SR4	none NG 100G OE 100GE-nR4 ?	none NG 100G OE 100GE-nR4 ?	100GE-LR4 G.959.1 25G	100GE-ER4 G.959.1 25G

Switch Nomenclature Definition



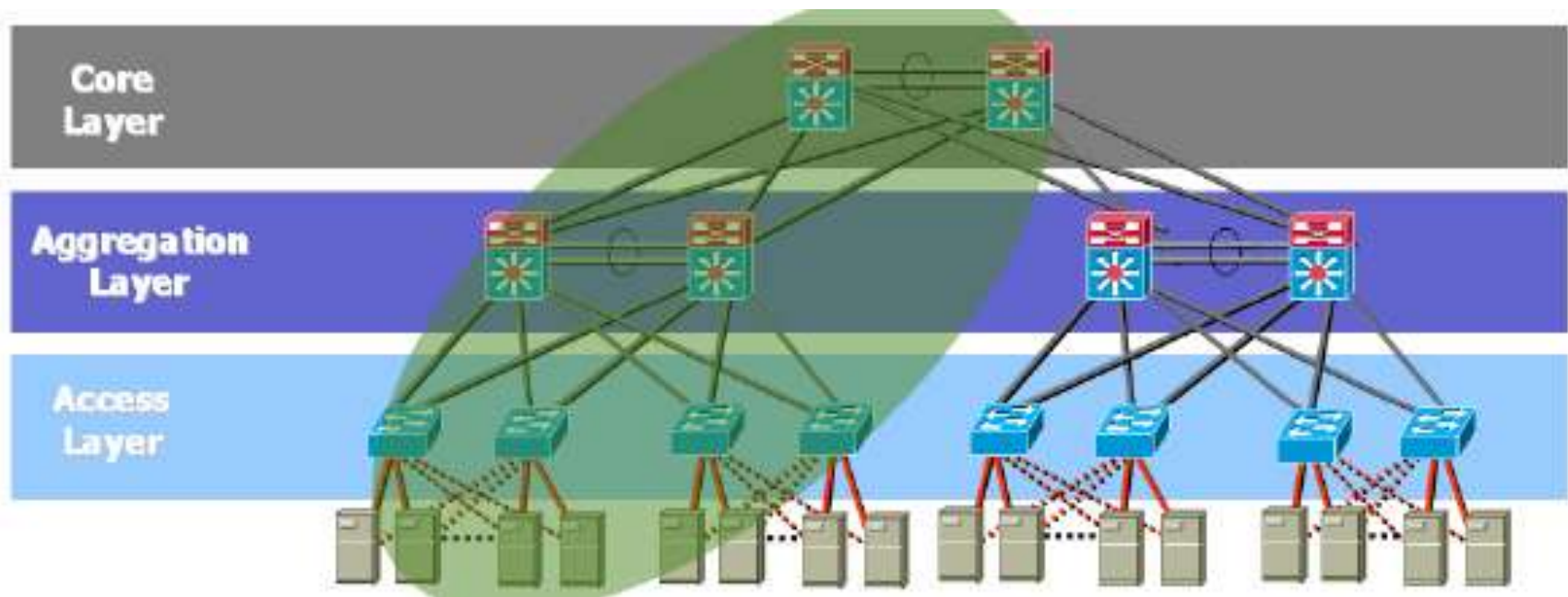
S3 = Core
(3rd level Switch)

S2 = Distribution
(2nd level Switch)

S1 = Access
(1st level Switch)

A. Carter, A. Barbieri, Cisco, barbieri_01_0108, HSSG

Switch Nomenclature Definition



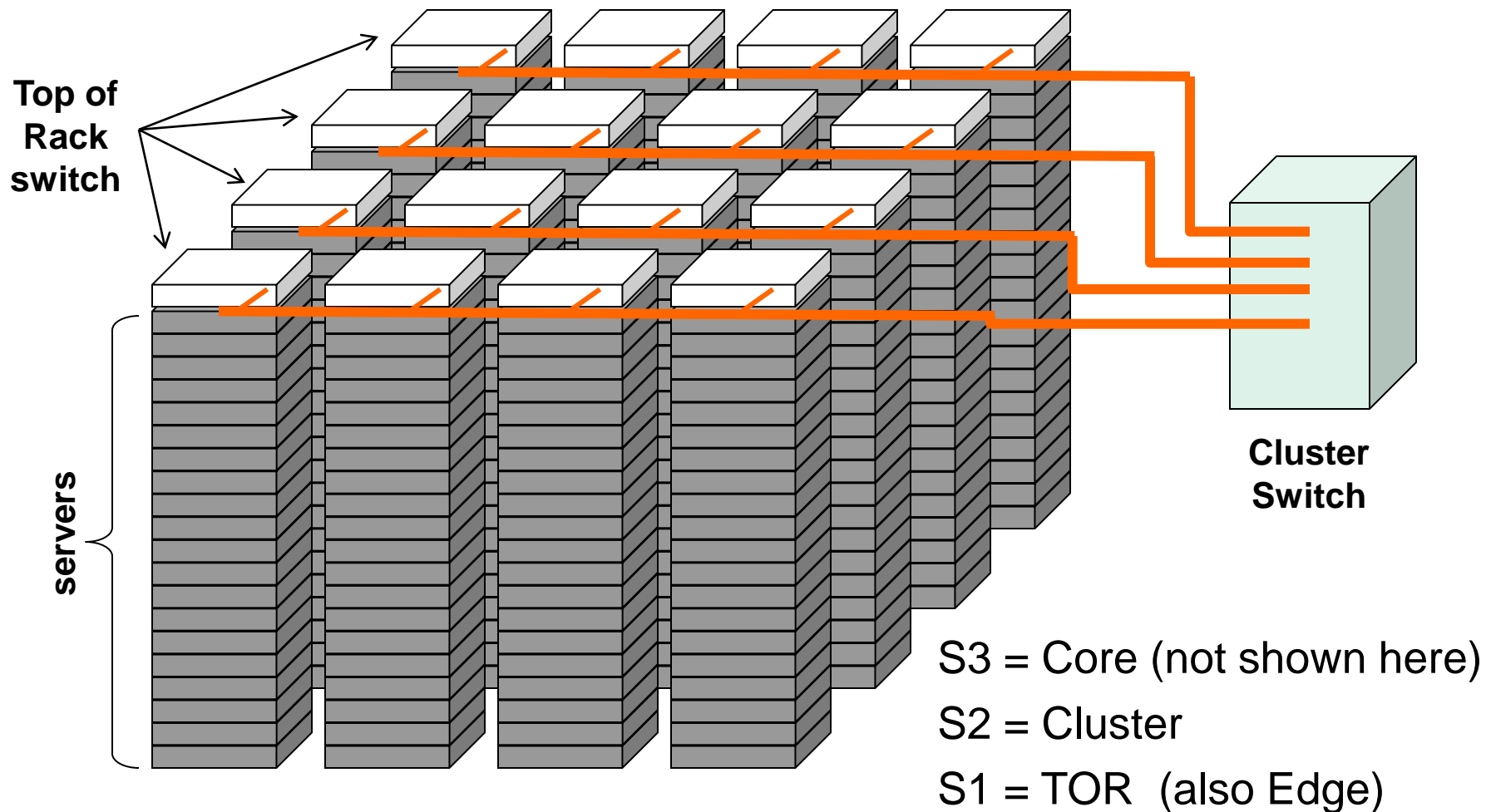
S3 = Core (3rd level Switch)

S2 = Aggregation (2nd level Switch)

S1 = Access (1st level Switch)

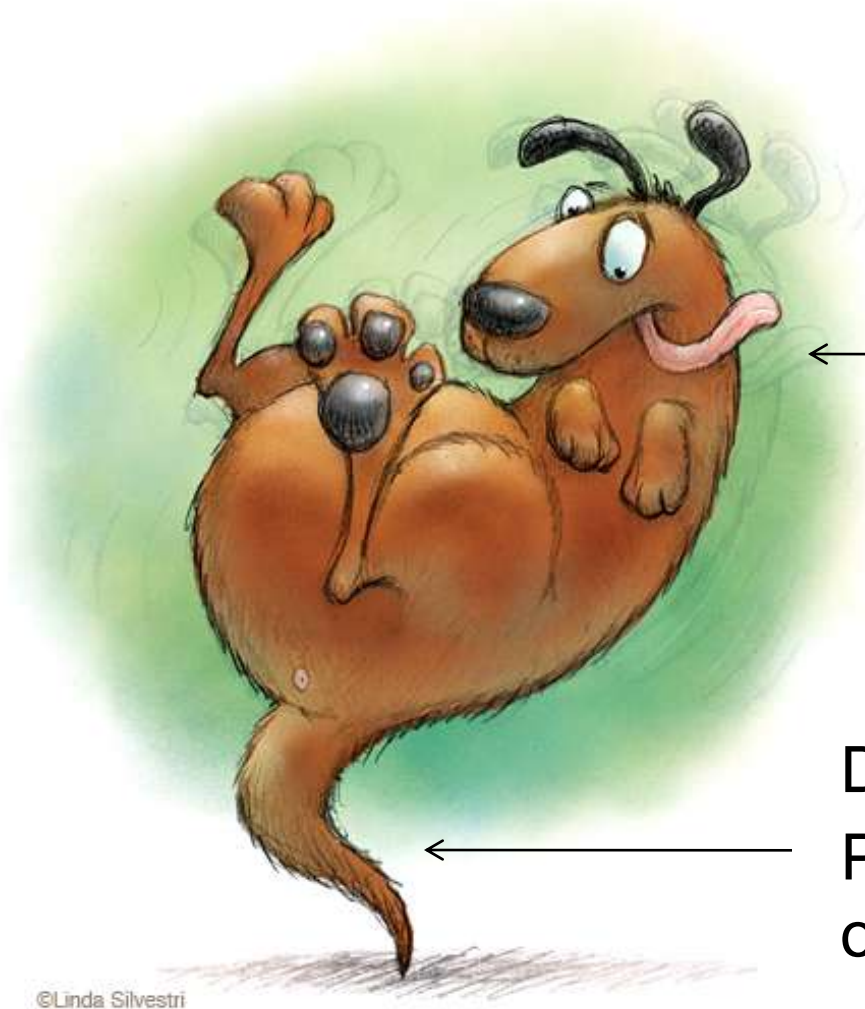
A. Carter, A. Barbieri, Cisco, barbieri_01_0108, HSSG

Switch Nomenclature Definition



C. Lam, H. Liu, Google, "Data Center Networking 101", OFC/NFOEC 2011, SC359

Broad Market Potential Approach



Base Broad Market Potential on majority of S1 ↔ S2 links and IDC S2 ↔ S3 links

Do not base Broad Market Potential on niche S1 ↔ S2 or traditional S2 ↔ S3 links

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10G HSSG SMF Reach Studies

- In addition to 10km, 6dB loss budget SMF standard, 10G HSSG considered 1km to 2km lower cost SMF standard:

http://www.ieee802.org/3/10G_study/public/june99/cornejo_1_0699.pdf

http://www.ieee802.org/3/10G_study/public/june99/dawe_1_0699.pdf

http://www.ieee802.org/3/10G_study/public/july99/nuss_1_0799.pdf

- 802.3ae Task Force adopted a single 10GE-LR standard
 - 10GE-SR 300m reach covered 99% of data center apps
 - No Broad Market identified for a 2km reach standard

100G HSSG SMF Reach Studies

- All IEEE 10G and 40G general optics deployed during the past decade have minimum 6dB loss budget and 10km SMF reach
- 802.3 HSSG extensively studied data center link reach
- Example HSSG study result (in 802.3ba email archives) summarizing responses from data center operators to proposal by optics suppliers to reduce 100G SMF reach objective from 10km to 3km or 4km
- >50% require 10km reach objective
 - 4km to 5km
 - 5km to 10km
 - <4km reach with 10km loss budget to support loss elements
- <50% require 3km or 4km reach objective
 - 500m to 1km
 - 1km to 2km
 - 2km to 4km
- There has been no new SMF reach study since HSSG

100G HSSG Broad Market Potential

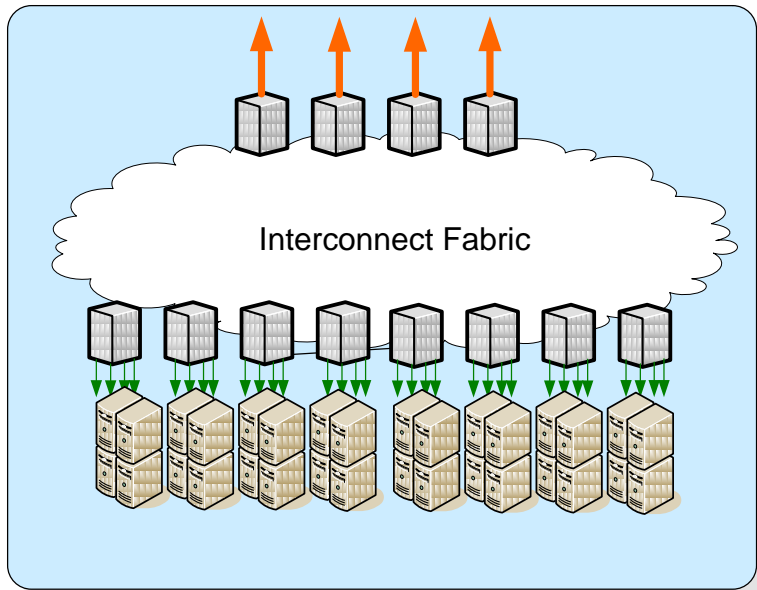
- Excerpt from the 100Gb/s HSSG Broad Market Potential response; part of the Project Authorization Request, Nov. 2007
“Given the topologies of the networks and intended applications, early deployment will be driven by key aggregation & high-bandwidth interconnection points. This is unlike the higher volume end system application typical for 10/100/1000 Mb/s Ethernet, and as such, the initial volumes of 100 Gb/s Ethernet are anticipated to be more modest than the lower speeds. This does not imply a reduction in the need or value of 100 Gb/s Ethernet to address the stated applications.”
- Translation
The 100Gb/s Market was S2 ⇔ S3 links, i.e. there was no Broad Market

2km Carrier Central Office Optics

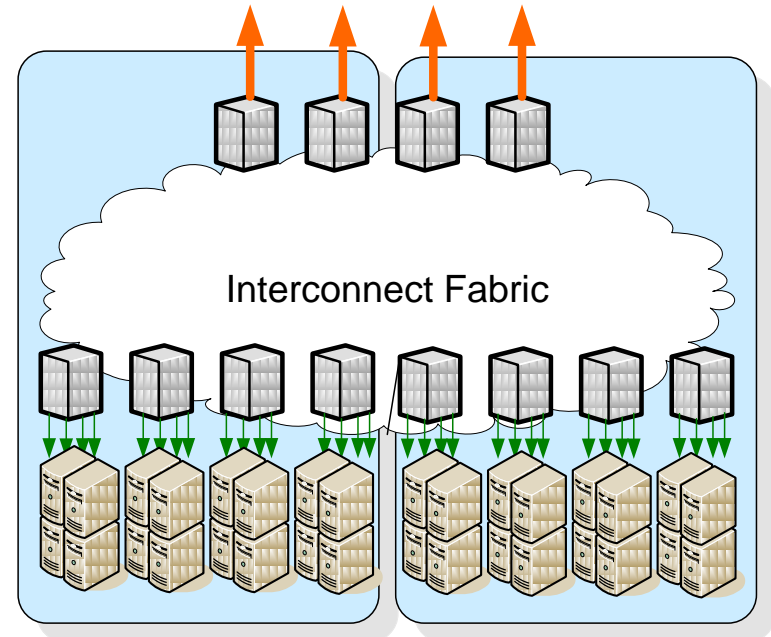
40G 2km telecom optics loss budget	ATT	China Telecom	Deutsche Telekom	NTT	Sprint	Verizon
4dB deployed	Yes	Yes	Yes	Yes	Yes	Yes
5 dB preferred	Yes	Yes	Yes	Yes	Yes	Yes
4dB <u>link</u> budget sufficient for all links	No	No	No	No	No	No

- Source: “100Gb/s SMF Client Reach Specs” presentation during Next Gen Optical PMD CFI Discussion, 11/8/10, Dallas, TX
- All IEEE and ITU-T 10G and 40G 2km optics deployed during the past decade have minimum 4dB loss budget and link budget penalties supporting minimum 2km SMF reach.

Internet Data Center Optics Example



Single Building



Multi-Building

- Campus Scale Datacenter network fabric optics requirements
 - 10m to 1km reach for intra-building
 - 1km to 2km for inter-building (small fraction of all links)
 - 5dB loss budget
- Fiber rich, ultra-large capacity

C. Lam, H. Liu, Google, "Data Center Networking 101", OFC/NFOEC 2011, SC359

Observations

- Data to support Broad Market Potential for a new SMF standard (in addition to 100GE-LR4) has not been shown in the NG 100G OE SG.
- What has been presented is the desire for significant cost reduction of 100G optics
- Broad Market for the existing 100Gb/s standard is still developing, but we are now proposing to partition it, which will degrade economies of scale
- A real 2x or 4x cost reduction over 100GE-LR4 DFB laser PIC based optics (i.e. cost comparable to 100GE-SR4) will be compelling in the Market, but so far no convincing subset of 100GE-LR4 specifications has been identified
- To propose a 100G SMF Objective requires more study as discussed in cole_02_1111_NG100GOPTX.pdf