Direct Attach Copper Cable Broad Market Potential

DAC is not Dead

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Outline

- Relative market size of Direct Attach Copper Cables (DAC)
- Challenges with current network use-case
- Network deployment options for 100G serial
- Challenges with 100G serial in current switch design
- Options for 100G serial switch design

Relative market size of DAC

Typically 10x larger than equivalent optical market

Interconnection Volume

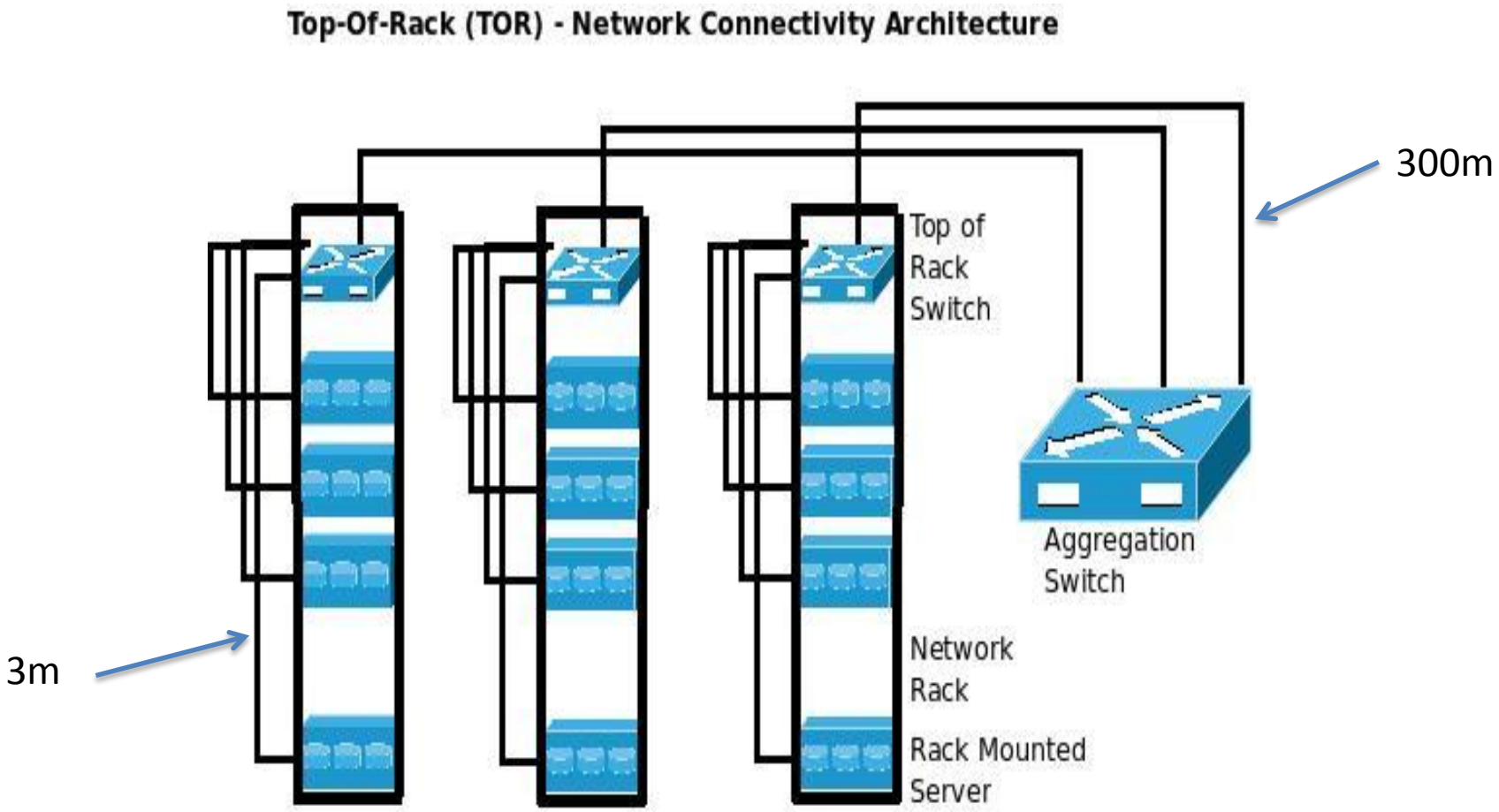
- Four sections per colo & multiple colos (≥ 4) per data center
- Volumes below are per section (except DCR to Metro)

A End	Z End	Volume	Reach (max)	Medium	Cost Sensitivity	Market Space
Server ǂ	TOR	10k – 100k	3 m	Copper	Extreme	LAN
TOR	LEAF	1k – 10k	20 m	Fiber (AOC)	High	
LEAF	SPINE	1k – 10k	400 m	SMF	High	
SPINE	DCR	100 – 1000	1,000 m	SMF	Medium	Campus
DCR	Metro	100 – 300	10 - 80 km	SMF	Low	WAN

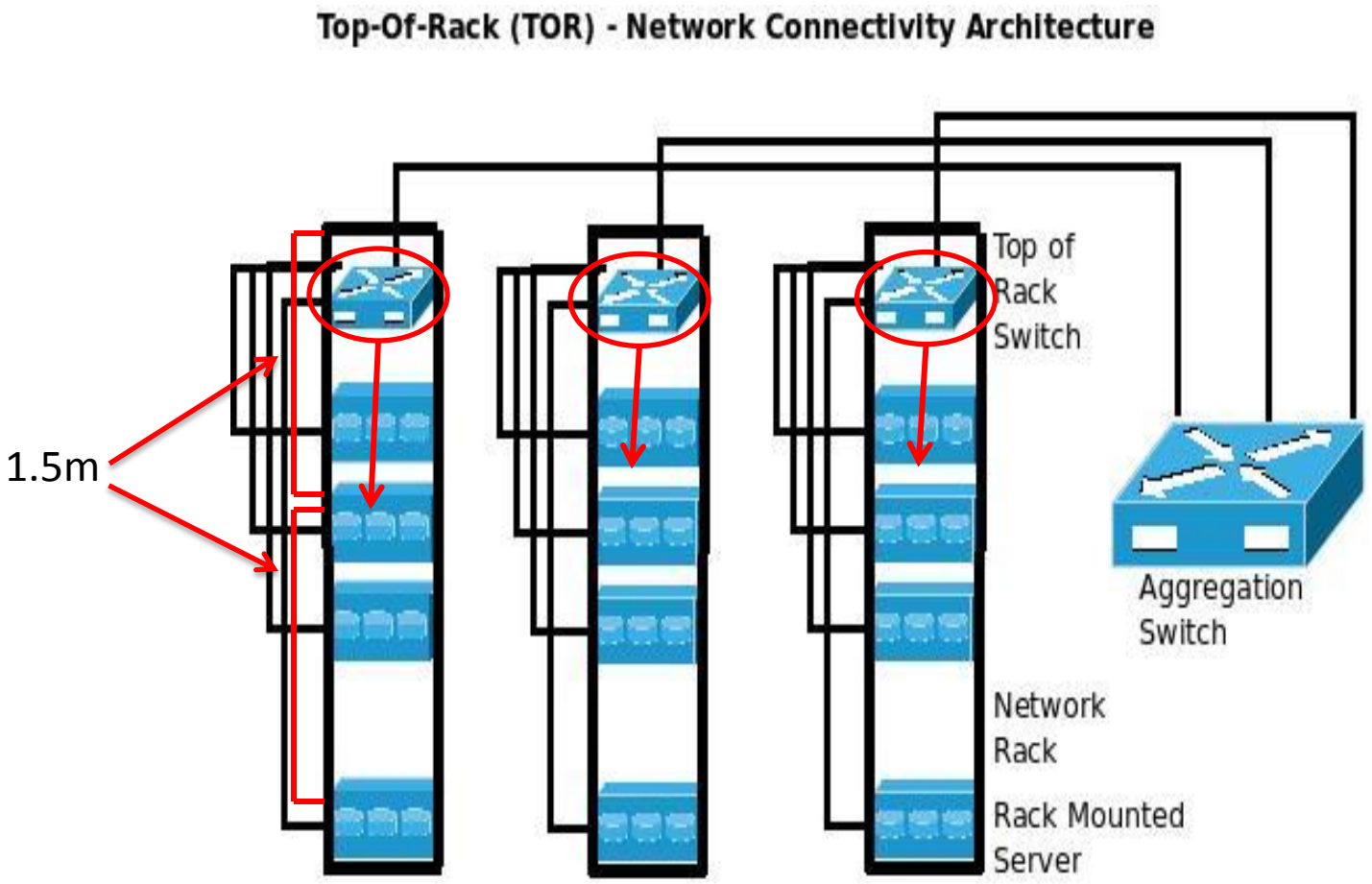
ǂ Server-TOR links may be served by breakout cables

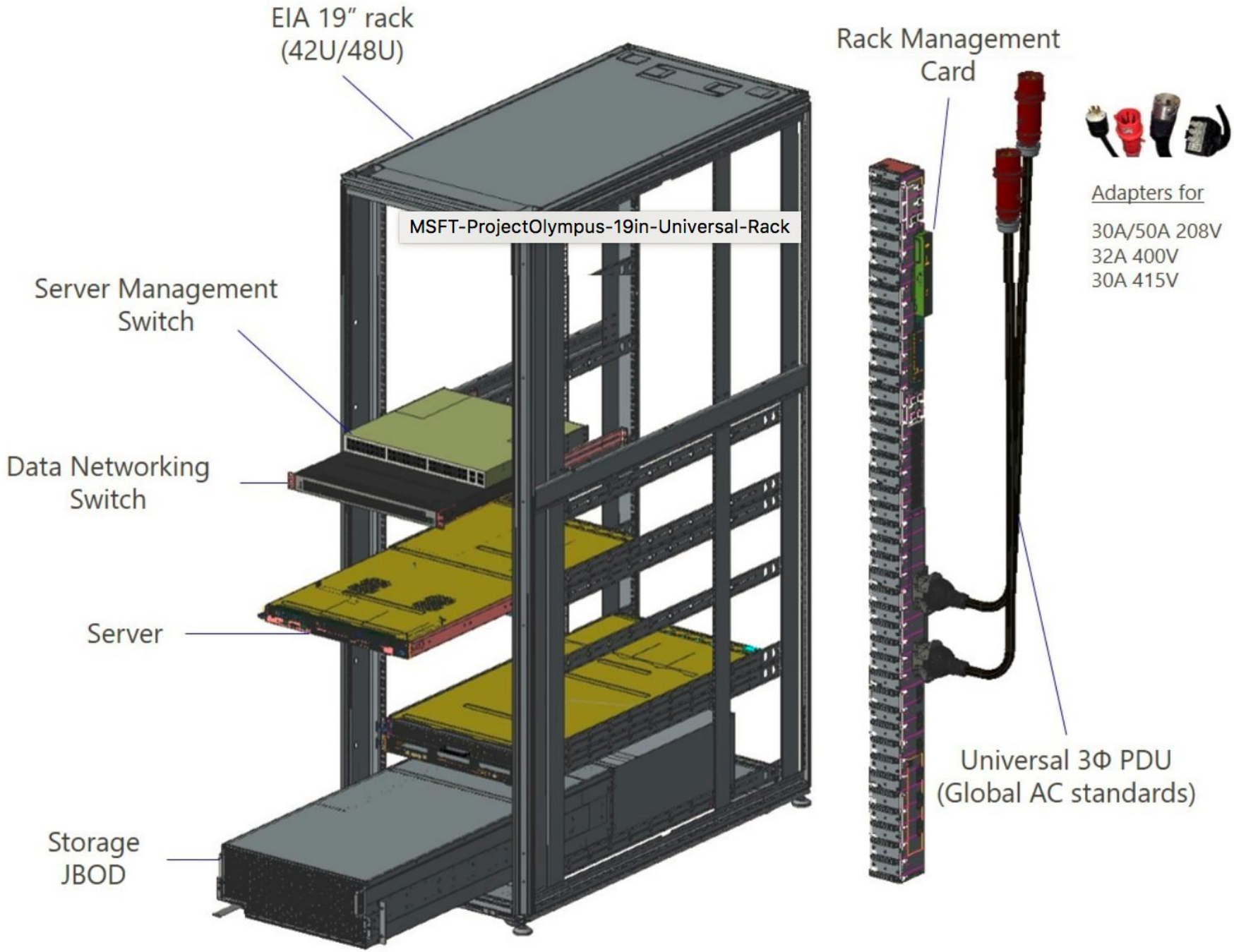
Source: Brad Booth, Microsoft http://www.ieee802.org/3/400GSG/public/13_11/booth_400_01a_1113.pdf

Current deployment use case has 3m DAC for TOR switch and 30-300m AOC for Aggregation switch

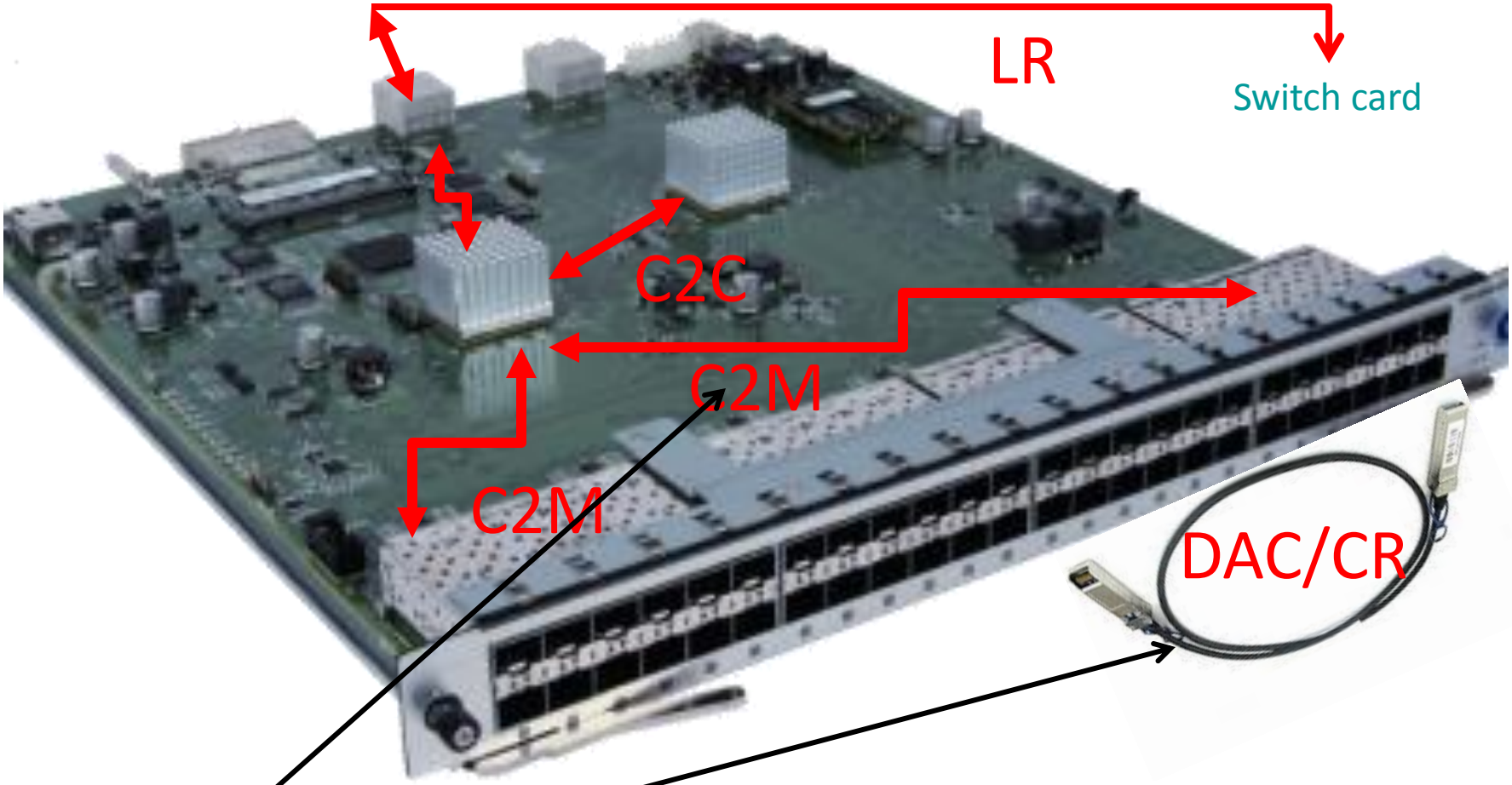


Improvement option 1: Move Switch to center of rack




EIA 19" rack
(42U/48U)
MSFT-ProjectOlympus-19in-Universal-Rack
Server Management
Switch
Data Networking
Switch
Server
Storage
JBOD
Rack Management
Card
Adapters for
30A/50A 208V
32A 400V
30A 415V
Universal 3Φ PDU
(Global AC standards)

Challenges for 100G serial with current switch design



C2M trace loss x2 and DAC insertion loss is too high to support 100G serial

56Gbps PAM4 Channel Link Budget (ball to ball)

Traditional
56 Gbps, f_0=14 GHz

Parameter	Loss
External 'raw' cable loss (3m)	9 dB
2 Host PCB trace (9" Megtron 6)	2 x 7.3 dB
2 Connectors	2 x 1.2 dB
2 Module PCB & capacitor	2 x 1.5 dB
Total channel loss	**29 dB**

Traditional
112 Gbps, f_0=28 GHz

Parameter	Loss
External cable loss (2m) (26 AWG)	10 dB
2 Host PCB trace (9" Meg 6)	2 x 14 dB
2 Connectors	2 x 2 dB
2 Module PCB & capacitor	2 x 2 dB
Total channel loss	**46 dB**

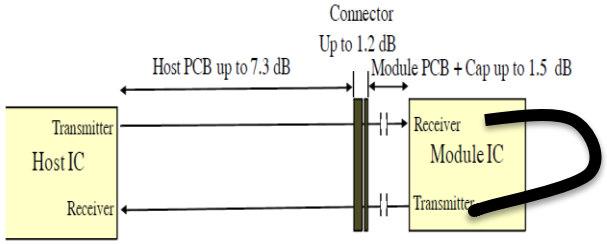
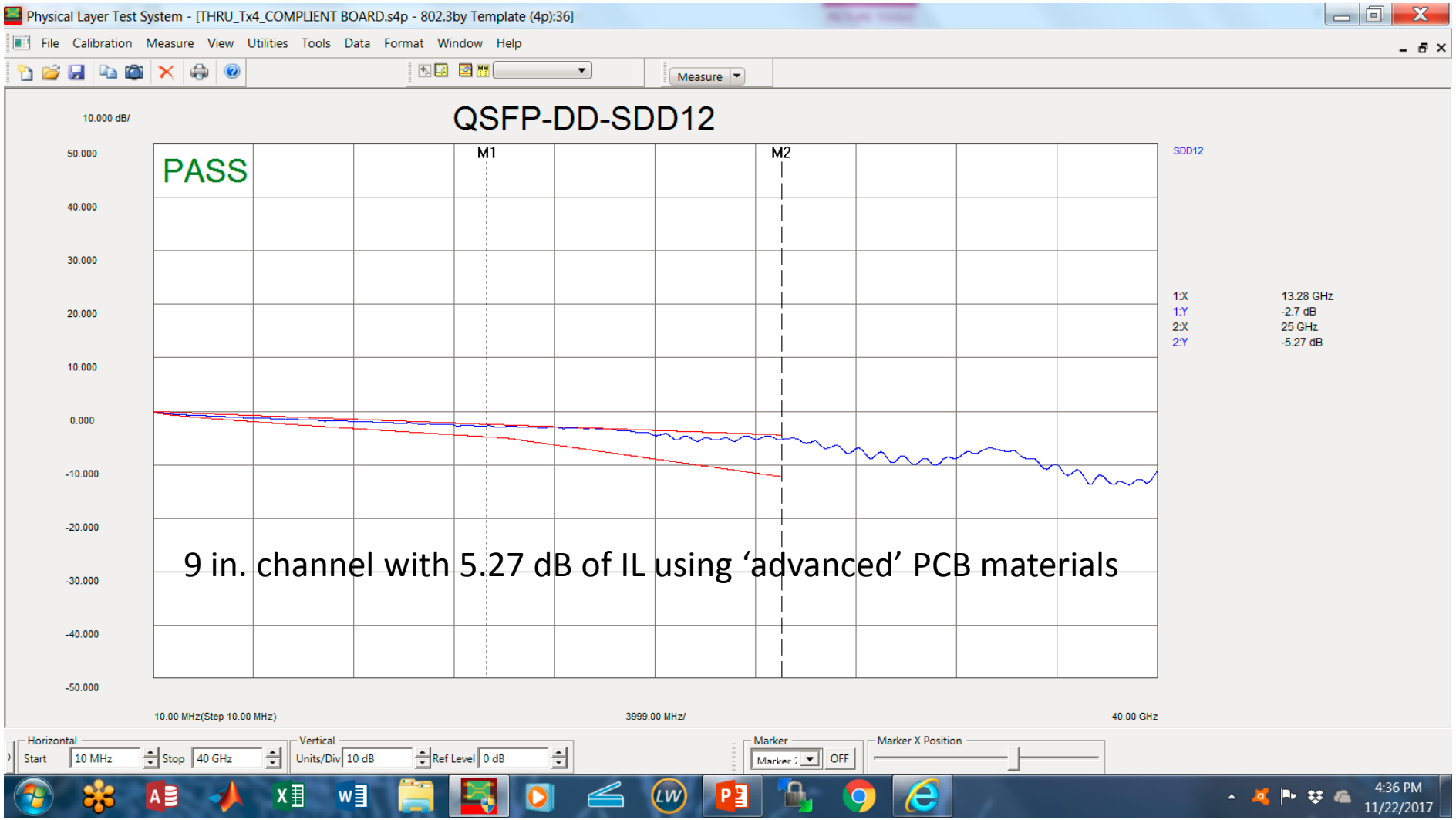


Figure 13-20. CEI-28G-VSR full Channel Reference Model

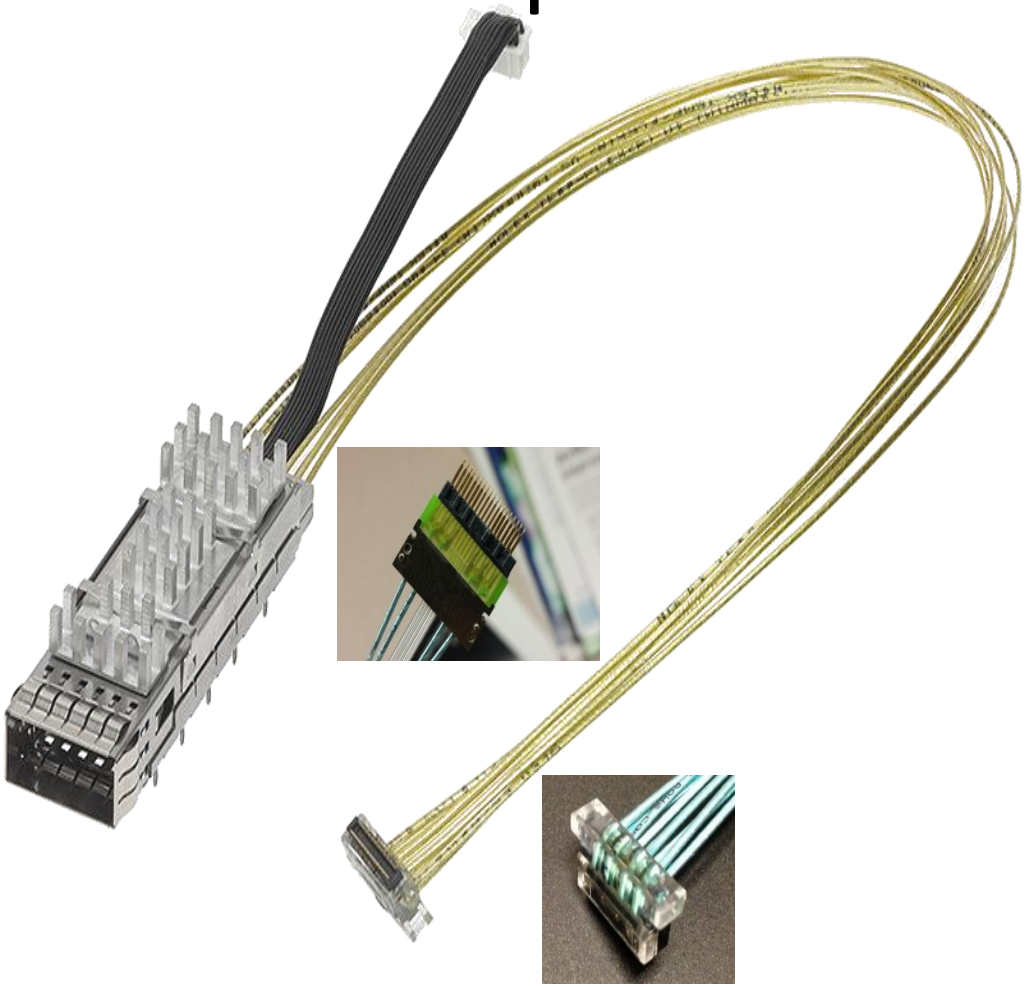
Improvement option 2: Low Loss PCB

Low loss switch channels can be achieved with ‘advanced’ PCB materials



See: diminico_100GEL_01_0118

Improvement option 3: internal cables replace PCB traces

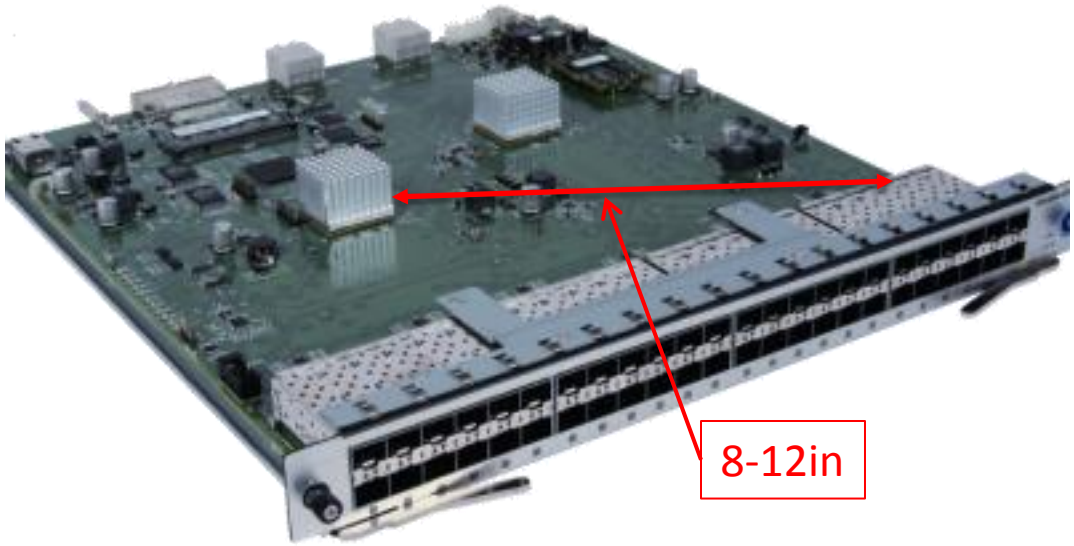


Key Benefits:

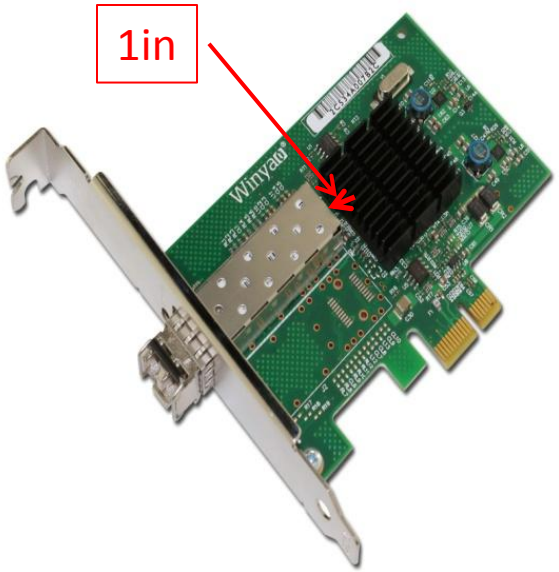
- **Lower System-Level Costs:**
  - **Eliminate the need for costly PCB materials (Nelco, Megtron, Tachyon, etc)**
  - **Eliminate the use of additional DFE or retimer chips to drive long traces**
  - **Improved thermal performance with 1x1 cages (air-cooled)**
- **Architectural Flexibility:**
  - **Freedom to locate ASIC anywhere (eg. further from backplane)**
  - **Enable lower power ASIC**
  - **Extended reach from ASIC to I/O**
  - **Enable longer external copper I/O cables**
  - **Cool the ports and the ASIC better**
- **New ways to handle power integrity to large ASICs**

Improvement option 4: Define asymmetric switch to server connections

Define end to end budgets that take advantage of short NIC traces

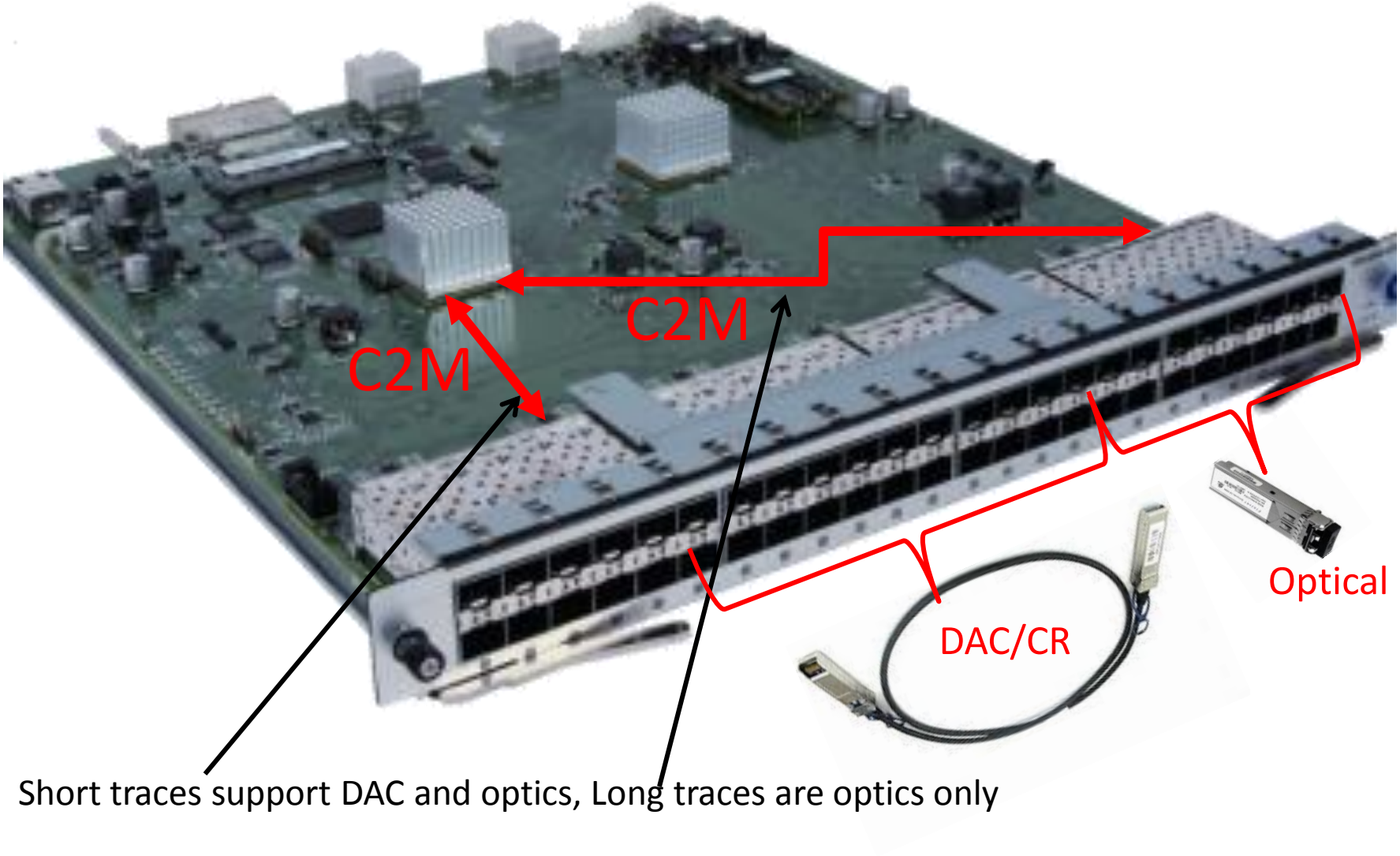


Switch ports require long host to module traces



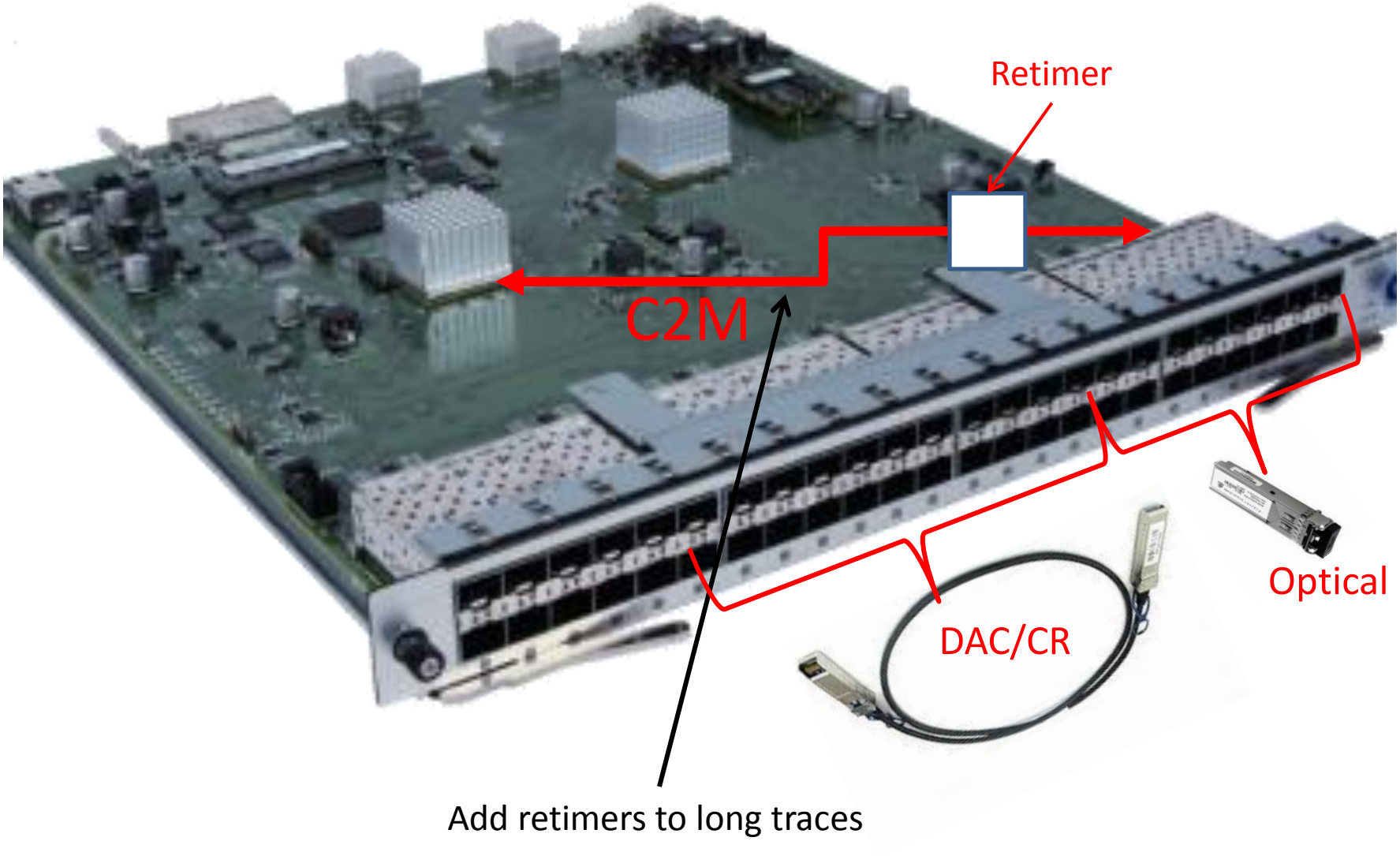
Server ports have very short host to module traces

Improvement option 5:
Switch chip to port optimization



Short traces support DAC and optics, Long traces are optics only

Improvement option 6: Add retimers



Summary:

- DAC is not dead
  - Copper variants are prevalent and economically critical in the market today because of the cost/performance tradeoff they provide
    - Most cost effective intra rack connection
    - 10x larger market size vs optics
  - Multiple options exist to enable 100G serial DAC to provide the cost benefits demanded by end users