Ethernet 301: 40/100GbE Fiber Cabling and Migration Practices

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(Panduit)
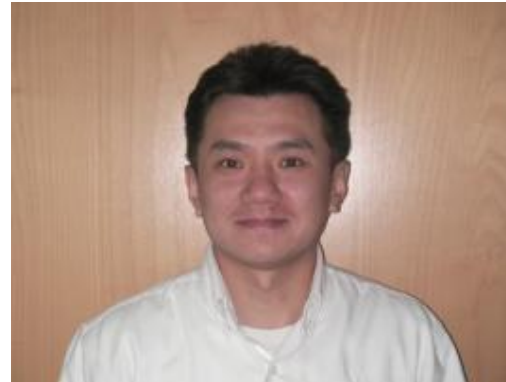
Frank Yang
(CommScope, Inc)

The Presenters

Robert Reid

- Sr. Product Development Manager at Panduit

Frank Yang

- Marketing Chair of Next Generation Ethernet Cabling
- Technical Marketing Manager at CommScope, Inc.

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THE VIEWS WE ARE EXPRESSING IN THIS PRESENTATION ARE OUR OWN PERSONAL VIEWS AND SHOULD NOT BE CONSIDERED THE VIEWS OR POSITIONS OF THE ETHERNET ALLIANCE.
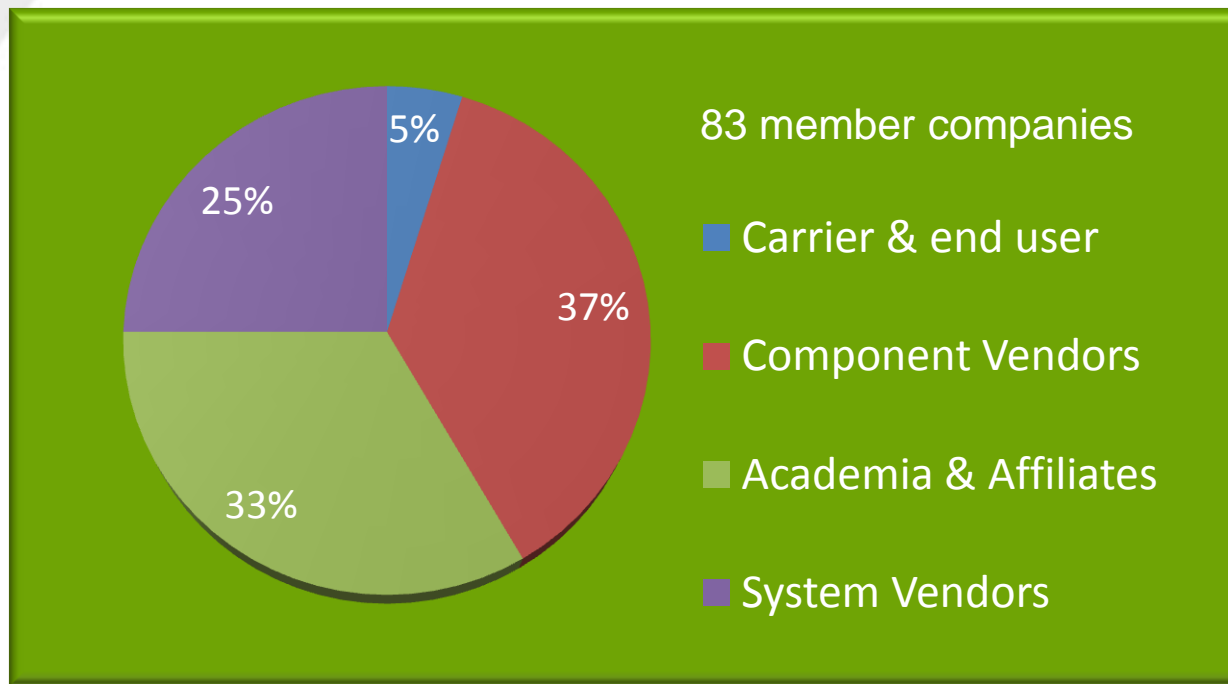
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Agenda

- Introduction of the Ethernet Alliance
- Data Center Trends and Their Impact on Cabling Infrastructure
- Fiber Cabling Migrations to 40/100GbE
- Link Power Budgets
- Design Considerations
- Conclusions

Who is the Ethernet Alliance?

- A global community of end users, system vendors, component suppliers and academia

- Representing the spectrum of the Ethernet industry

83 member companies

■ Carrier & end user

■ Component Vendors

■ Academia & Affiliates

■ System Vendors

5% / 25% / 37% / 33%

The Ethernet Alliance Strategic Vision

Expand Ethernet Ecosystem

- Facilitate interop testing
- Expand the market
- Go global

Support Ethernet Development

- Support consensus building
- Host Technology Exploration Forums (TEFs)
- Team with other orgs

Promote Ethernet

Marketing   Education

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University of Ethernet Curriculum

Completed and available online
Planned
Concept

Ethernet 101:
Introduction to Ethernet

Physical Layer x00 Series	Protocols x10 Series	Applications x20 Series	Products x30 Series
Ethernet 102: The Physical Layer Of Ethernet	**Ethernet 111:** 802.1:Protocols Of Ethernet	**Ethernet 121:** The Applications Of Ethernet	**Ethernet 131:** Ethernet Products
Ethernet 202: 10GBASE-T Revamped	**Ethernet 211:** Data Center Convergence	Ethernet 221: Data Center Applications	Ethernet 231: Ethernet Switches
Ethernet 301: 40/100GbE Fiber Cabling and Migration Practices	Ethernet 311: Congestion Notification	**Ethernet 321:** Industrial Applications	Ethernet 331: Ethernet Server Adapters

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What do you want to present?

Market Drivers for 40/100GbE

IDC
The number of deployed virtual servers has outnumbered deployed physical ones since 2009
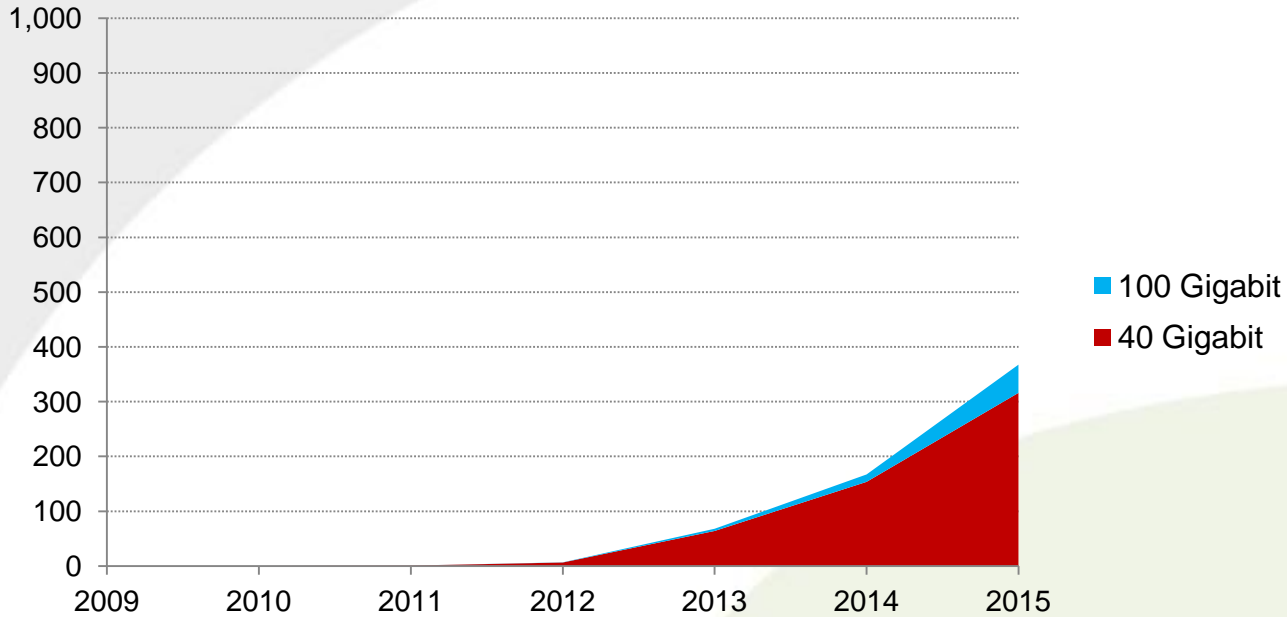
Gartner
Currently 28% of x86 workloads are running on virtual machines. That will jump to 50% by the end of 2012

CIO Magazine
70% of enterprises will use cloud technology by 2012

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40 and 100 Gigabit Ethernet Switch Port Shipments (000s)

Source: Dell'Oro January, 2011

- **40 and 100 Gigabit Ethernet will be niche applications**
  - *Fiber solutions just starting to be commercialized*
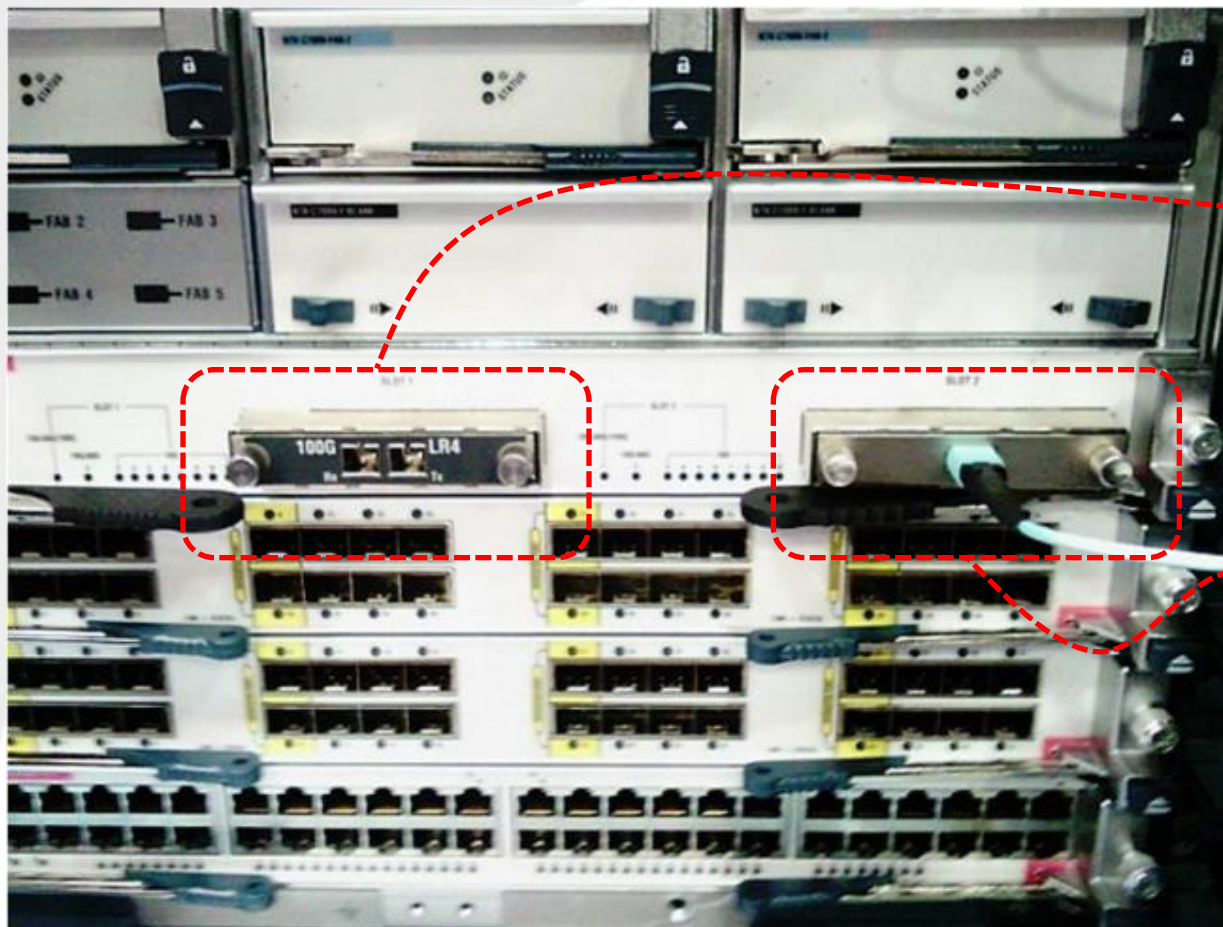 - *Multimode solutions for intermediate reach & Twinax copper for short reach*

The Big Picture: 40/100GbE Cabling Media and Reach

■ Planned for 1st Generation				■ Not Planned for 1st Generation	
Media	Reach	Data Rate	CFP	QSFP/QSFP+	CXP
Single-mode	10Km	100G			
		40G			
	40Km	100G			
Multimode (OM3)	100m	100G		Future?	
		40G			
Multimode (OM4)	150m	100G		Future?	
		40G			
Copper	3-7m	100G		Future?	
		40G			

Source: Chanda and Yang's white paper on 40GbE, Nov. 2010

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10

100G CFP Transceiver Solutions

100GBASE-LR4 CFP modules support 10 km links over duplex single-mode fiber

100GBASE-SR10 CFP modules support 100 meters of dual-ribbon Optical Multimode (OM3) fiber

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40G QSFP Transceiver and Cable Solutions

40GBASE-SR4 QSFP+ Module and Fiber Cables
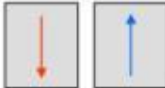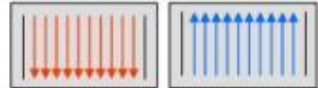

40GBASE QSFP+ to
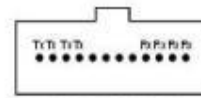Four 10GBASE SFP+ Breakout Cable

40GBASE QSFP+ to
QSFP+ direct-attach Cable

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Big Impact on Cabling Infrastructure
- From Duplex to Parallel

IEEE 802.3 Ethernet Channel Layout

Data Rate	10Gb/s	40Gb/s	100Gb/s
Laser Type	VCSEL	VCSEL Array	VCSEL Array
Fiber Type	OM3	OM3/OM4	OM3/OM4
Connector	LC x 2	12-fiber MPO	2x12f MPO or 1x24f MPO
# of Fibers	2	12	24
Schematic			

40GBASE-SR4

Single Port (recommended)
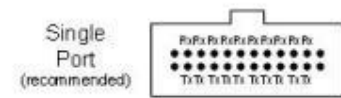
100GBASE-SR10
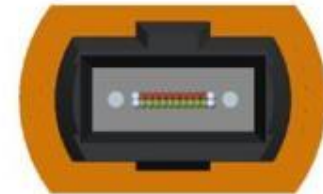
or

Side-by-Side Ports (alternative)

New 100G IEEE 802.3 Study Group

- Next Generation 100Gb/s Optical Ethernet Study Group

- New work impacts direction of future 100G MM PMDs

    - 4x25G instead of (10x10G)

    - Good for customers – reuse 40G cable plant

    - Research focused on direct modulation of VCSEL @ >25 G

- 100G SR4 will use 8 lanes (4 Tx/4 Rx), QSFP MSA & MPO

    - Preserves SR4 installations with OMx ribbon cable plant

- OIF group is developing CEI-28G-VSR common electrical interfaces for ANSI, IBTA & IEEE

- Fiber will have to be EXCELLENT to support upcoming 25Gb/s

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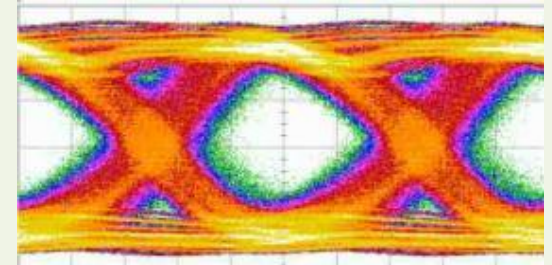
10G Ethernet – Conversion to 40G Cable Plant

10G Links   *Cassette-based equipment area distribution & cassette-based cross connect system for 10GBASE-SR channels*

MPO/MTP Backbone

MPO/MTP Backbone

LC Jumper

LC Jumper

LC Jumper
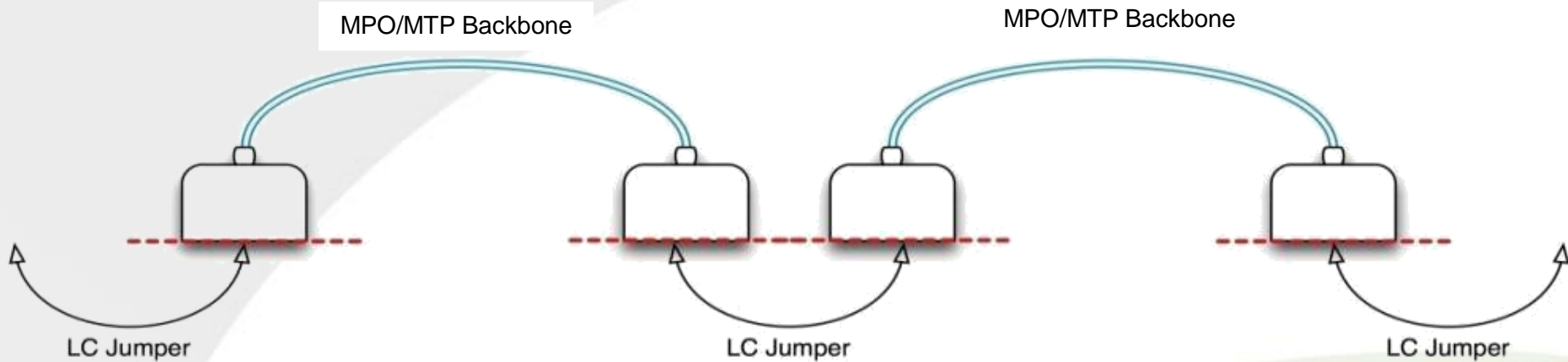
40/100G Links   *System above converted to 40GBASE-SR4 channels*

MPO/MTP Backbone

MPO/MTP Backbone

MPO/MTP
Coupler

MPO/MTP
Coupler

MPO/MTP
Coupler

MPO/MTP
Coupler

MPO/MTP Jumper

MPO/MTP Jumper

MPO/MTP Jumper

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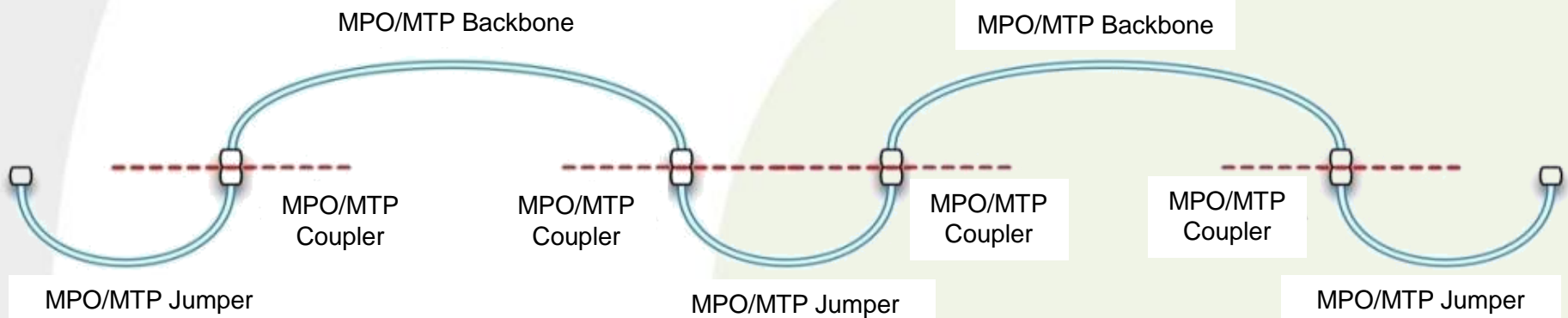
Design 1/10GbE Networks Today with the Standard Method Based Polarity Scheme

MM Fiber Trunk Cable

Switches with 10GbE ports

MM Fiber Fanouts

MM Fiber MPO/ MTP Connector

Or

MM Fiber Fanouts

Switches or servers with 10GbE ports

Fiber Module

Jumpers

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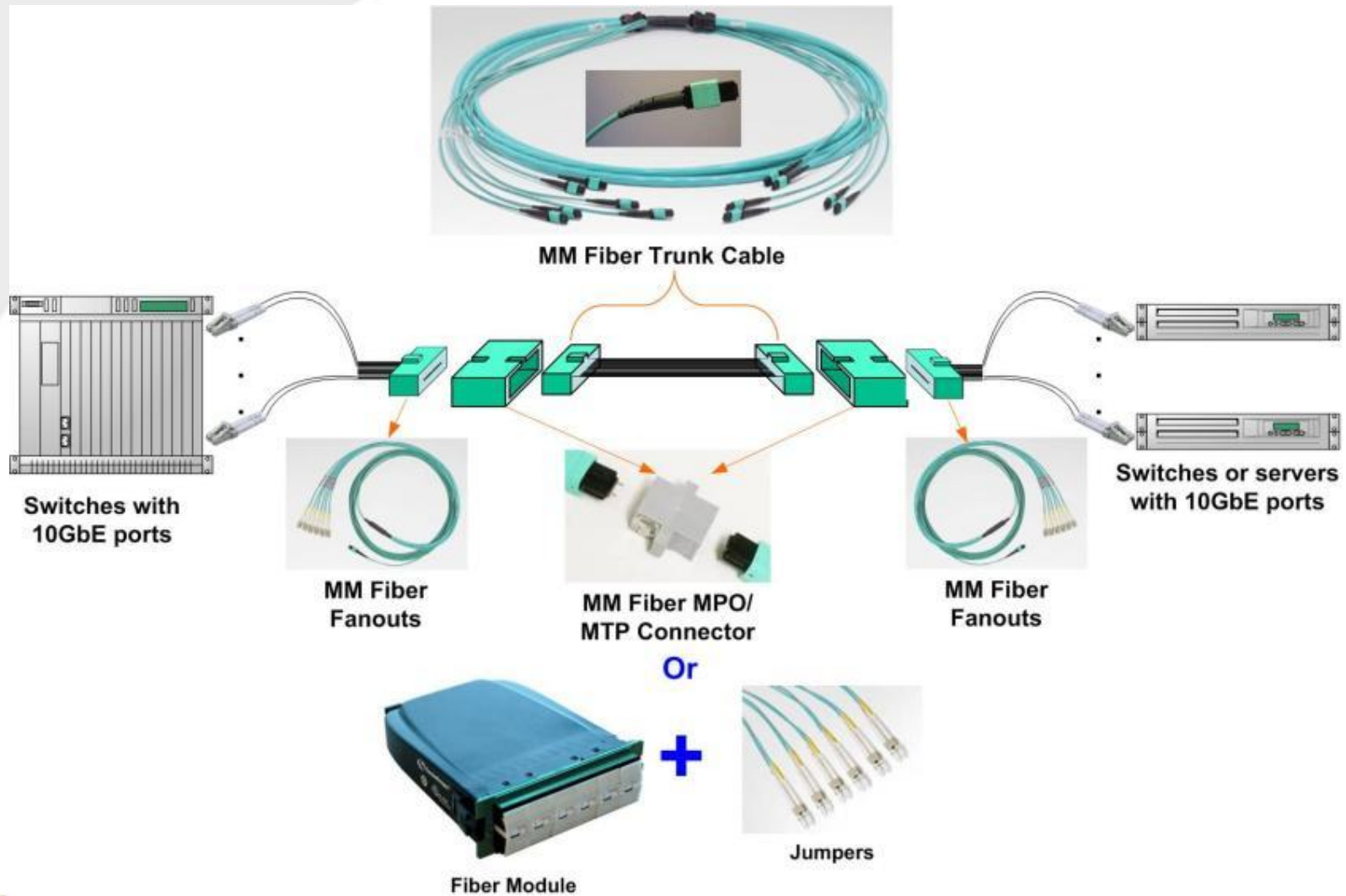
Investment Preservation: Reuse the Fiber Trunks for 40GbE or Next Gen 100GbE (4x25G) Networks Tomorrow

MM Fiber Trunk Cable

Switches with 40GbE or future 4x25G ports

40GBASE-SR4 Or Future 4x25G

Switches or servers with 40GbE or future 4x25G ports

40GBASE-SR4 Or Future 4x25G

MM Fiber MPO/MTP Panel

Or

MM Fiber Extension Cord

MM Fiber 4x4 Module

MM Fiber Extension Cord

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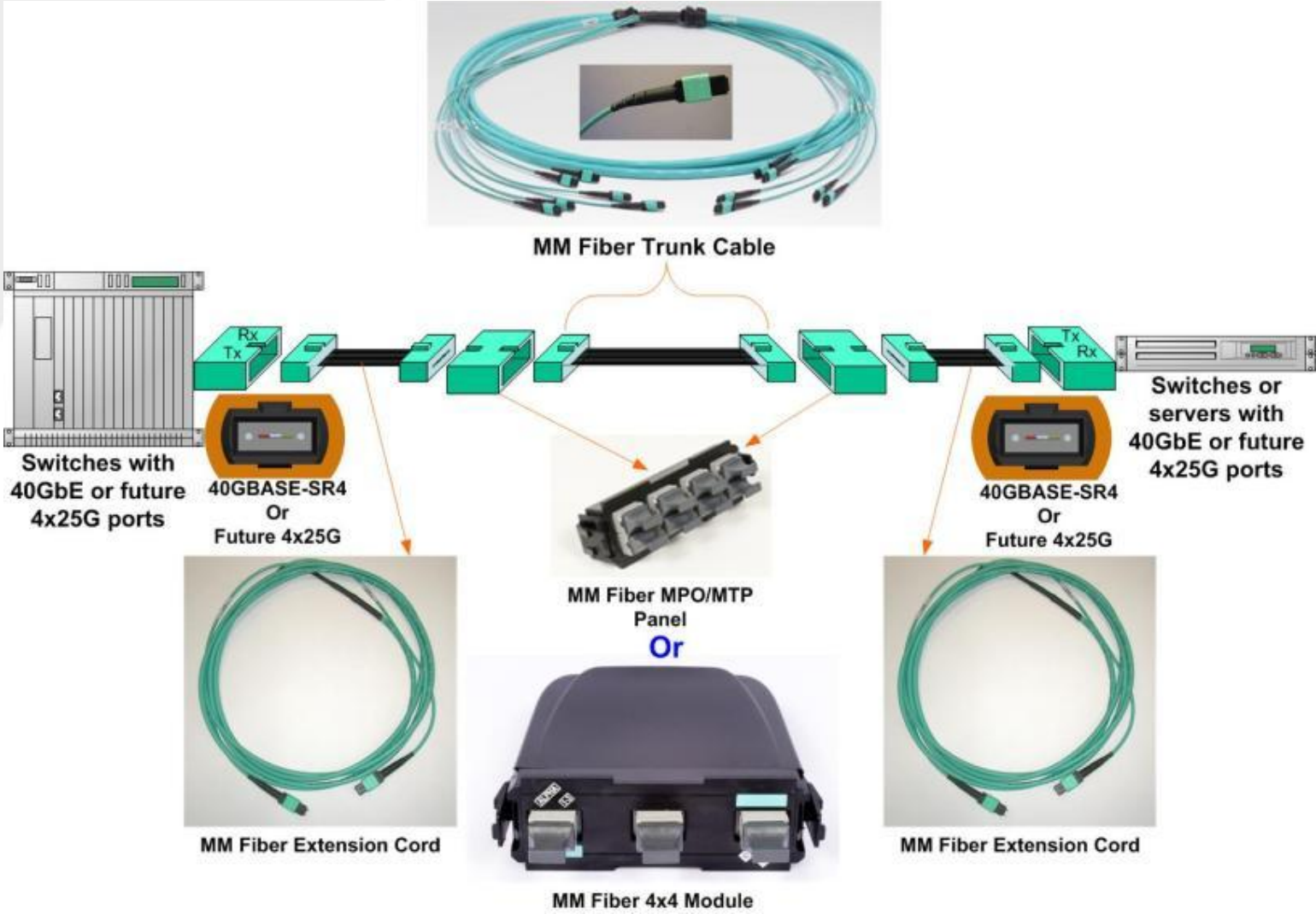
Investment Preservation: Reuse the Fiber Trunks for 100GbE Networks Tomorrow

MM Fiber Trunk Cable

Switches with 100GbE ports

100GBASE-SR10

Switches or servers with 100GbE ports

100GBASE-SR10

MM Fiber MPO/MTP Panel

MM Fiber Y Cord

MM Fiber Y Cord

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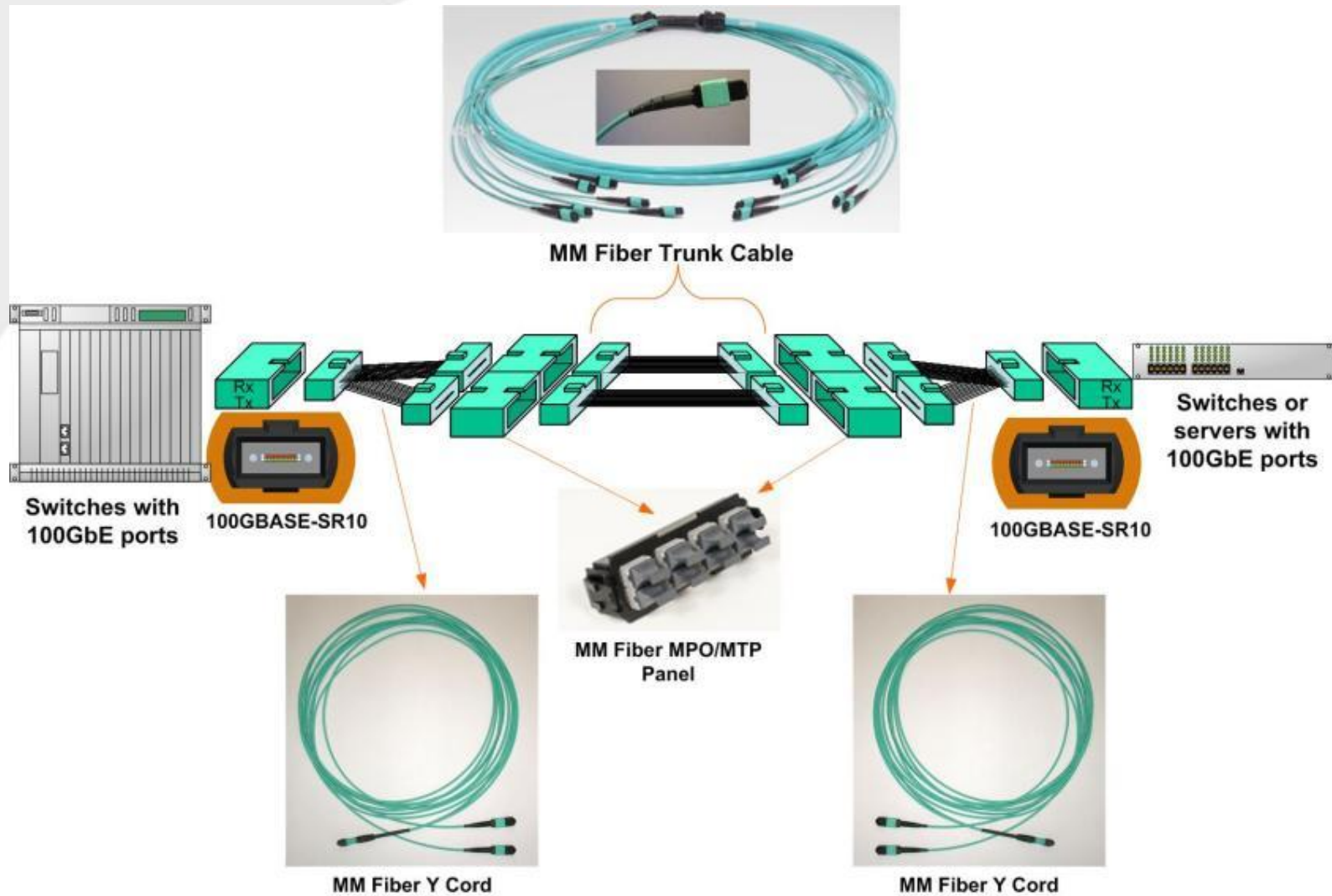
Peace of Mind: With the Standard Based Polarity Scheme, Cabling Infrastructure Can be 40/100GbE Ready
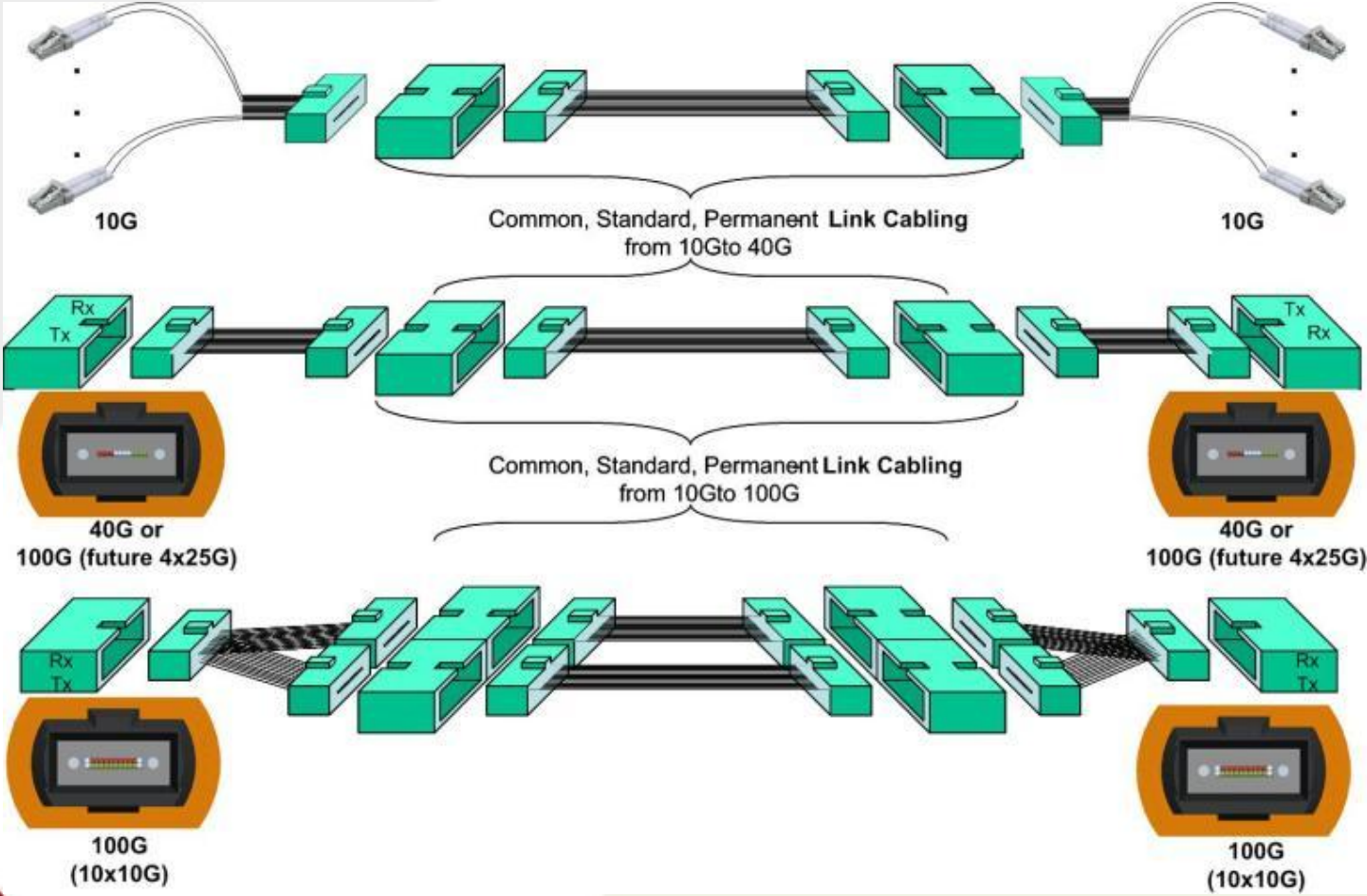
40G Cable Plant 'Dark Fiber' Migration Cassette

10G/40G "Conversion Cassettes"

40G QSFP

40G QSFP

40G QSFP

40G QSFP

40G QSFP

40G QSFP

Center four fibers from trunk assemblies routed to 3rd (new) MPO/MTP on cassette front. 4 transmit from trunk 'A' and 4 receive from trunk 'B'

Existing "Day One" 12 fiber MPO/MTP trunks

"Day Two" 8 fiber MPO/MTP patch cords

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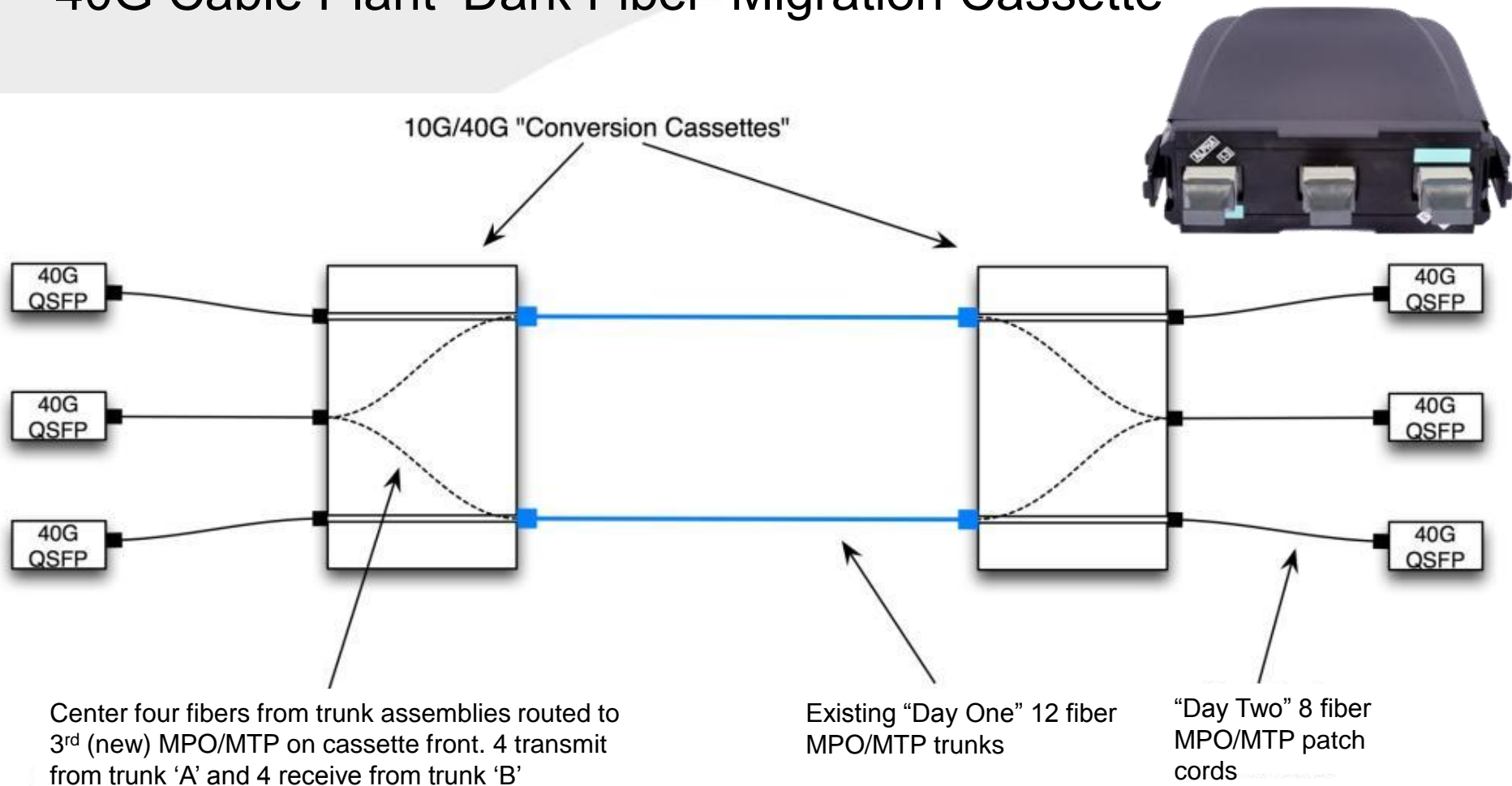
40/100G Cable Plant Design/ Link Power Budgets

- Data Centers are architected on the basis of 100m (minimum) channels
- Designers value the structured cabling model (flexibility, troubleshooting, modularity) - many different designs!!!
- The use of a structured cabling system (SCS) is strongly recommended (even for small installations) – many designers prefer the flexibility offered by an "any to any" cross connect (Centralized Patching Location)
- A SCS provides a protected solution that serves current requirements as well as allows for easy expansion
- 10G systems meant to be "future-proofed" for 40/100G must be carefully designed not to exceed power budgets

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40GBASE-SR4/100GBASE-SR10 Channel Budget

Power
Budget
(8.3dB)
100 meter
Channel

Channel Insertion Loss (CIL) = 1.9dB

**= 1.5dB (connectors) + 0.4dB (fiber)**

Parameter	OM3	OM4	Unit
Effective modal bandwidth at 850 nm	2000[a]	4700[b]	MHz•km
Power budget (for maximum TDP)	8.3		dB
Operating distance	0.5 to 100	0.5 to 150	m
Channel insertion loss[c]	1.9	1.5	dB
Allocation for penalties (for maximum TDP)[d]	6.4	6.5	dB
Unallocated margin	0	0.3[e]	dB
Additional insertion loss allowed	0		dB

Source: IEEE

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Link Power Budgeting for Cabling
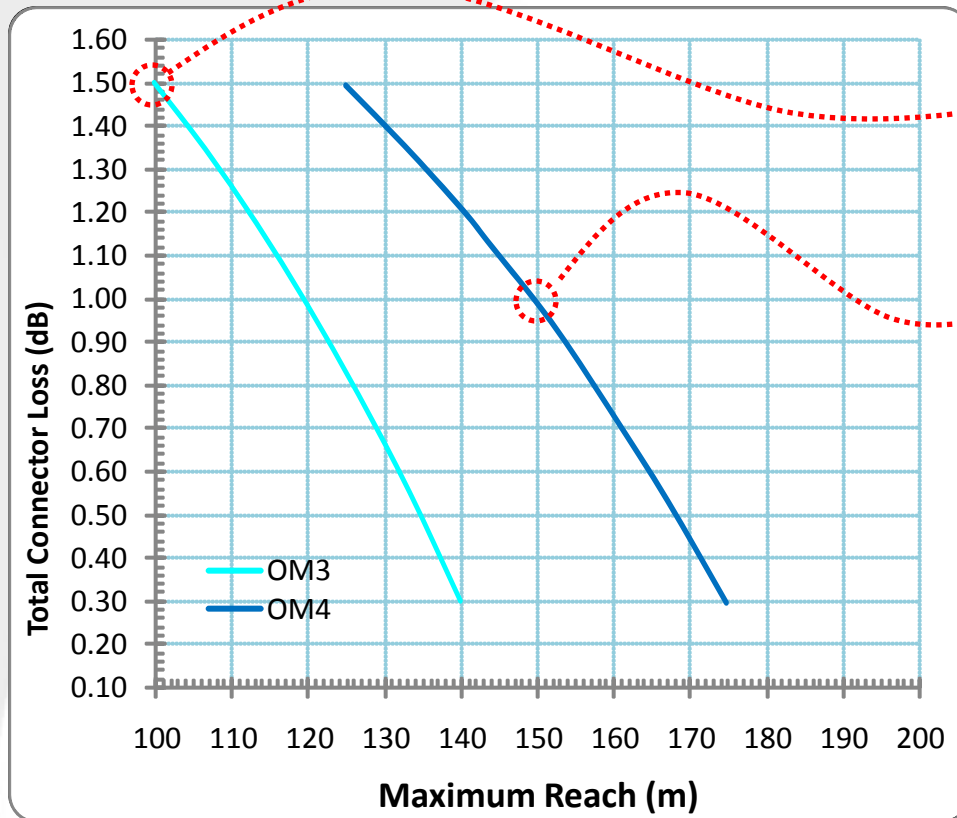
100 meter OM3 channel with two 0.75dB (Max.) connectors (1.5dB connector insertion loss total)

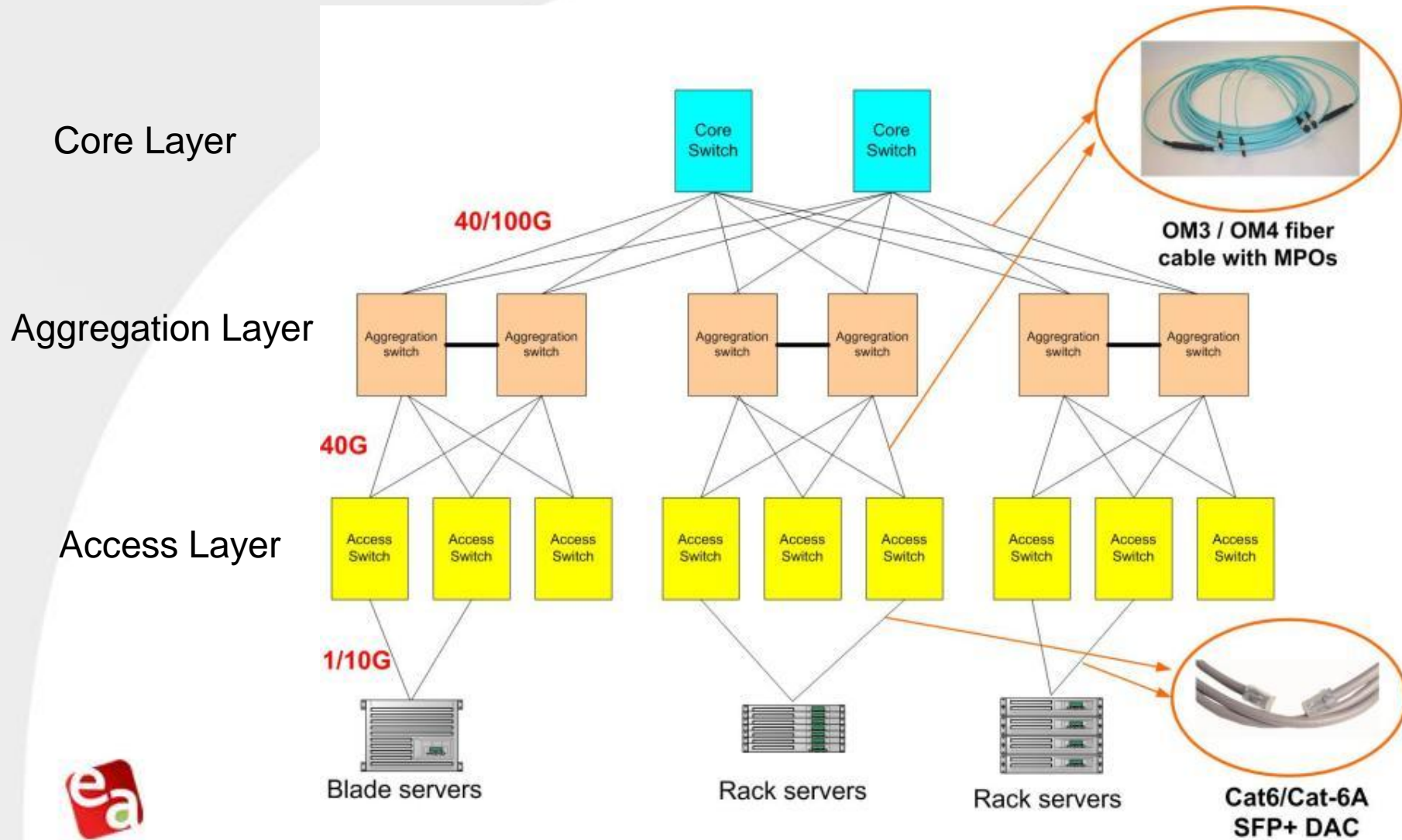150 meter OM4 channel with two 0.50dB (Max.) connectors (1.0dB connector insertion loss total)

"Engineered Link" (explain this a little bit more what it means)
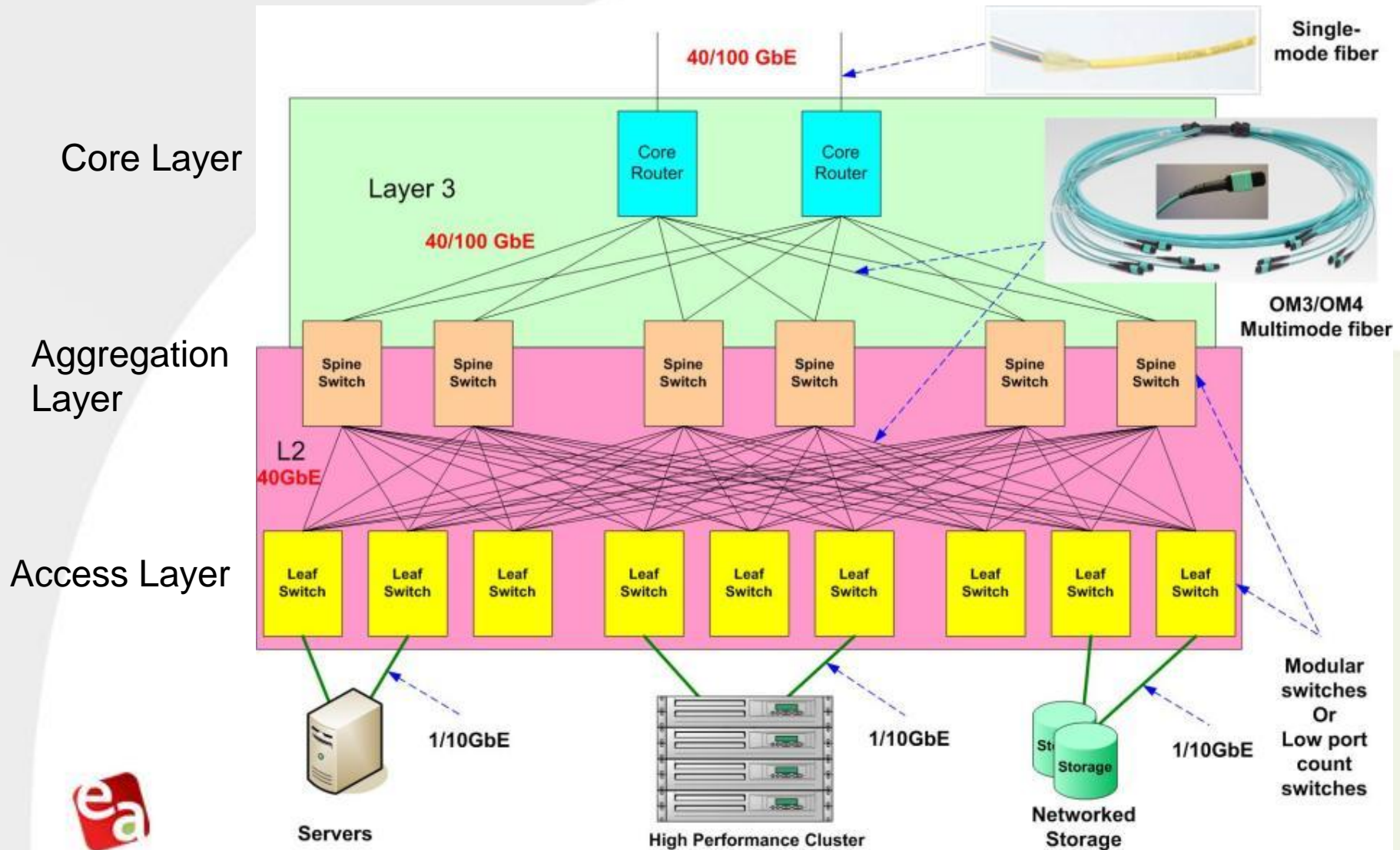
Source: Panduit extrapolation from IEEE model

Trade-off between SCS 'wants' and IEEE requirements

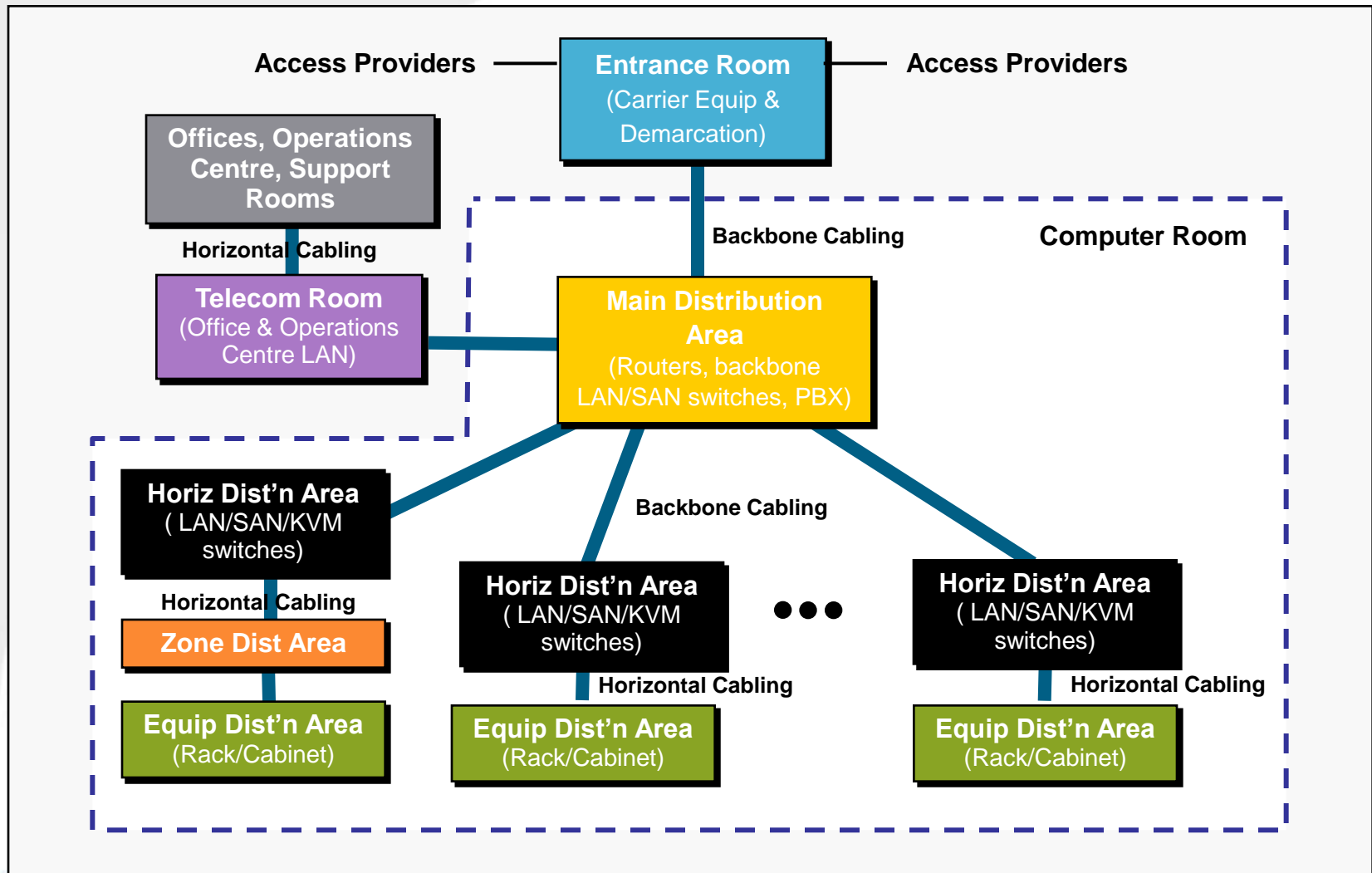# Deploy 40/100GbE in the Traditional Data Center Multi-tier Architecture

Deploy 40/100GbE in the Emerging Data Center Fabric Architecture

Basic Data Center Topology
Source - TIA-942

Server Row Aggregation Switching Design

Legend:
- ●--● Laser Optimized MM Structured Cabling
- ●--● Category Copper Cabling
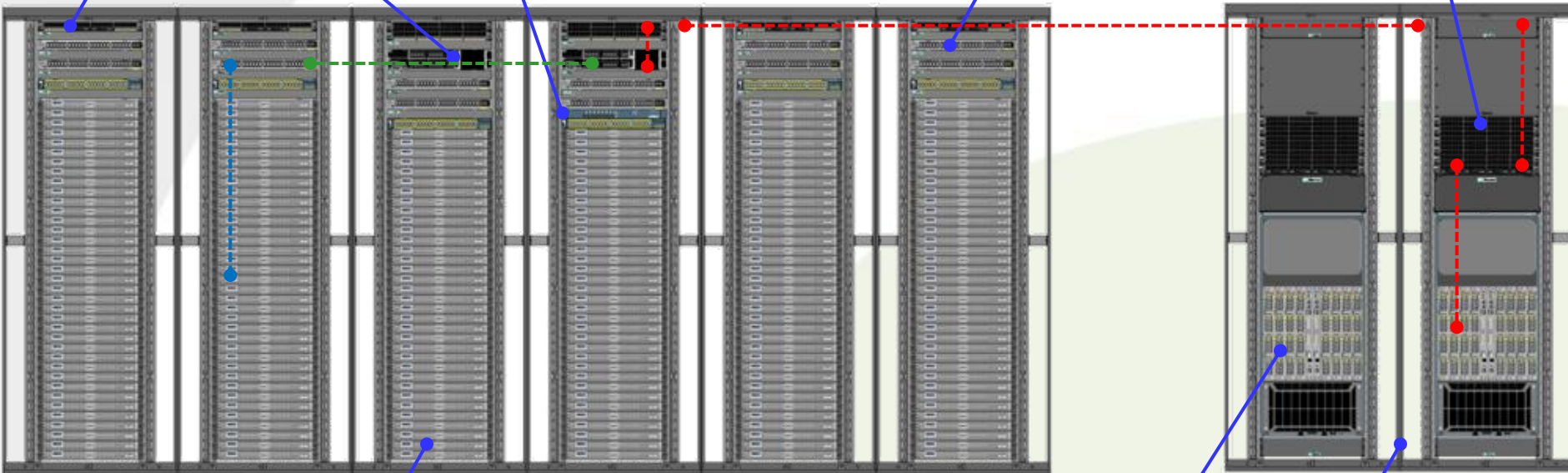- ●--● SFP+ Twin-Ax Copper

Labels:
- Fiber/Copper Patching (includes FC network)
- Aggregation Switch
- Console Server
- Access Switch
- Fiber Patching
- Server Row Equipment Distribution Area
- Core Switch
- Core Switch Main Distribution Area

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Server Row Aggregation Switching 40G Cabling Migration

Cabling Segment	Day "One" (10G delivered to access, 10G @ Core)	Day "Two" (More 10G delivered to access, 40G @ Core)
Aggregation to Core	SFP+ 10GbE fiber module transceivers & OM3/4 fiber cable	QSFP+ 40GbE fiber modular transceivers & OM3/4 fiber cable
Access to Aggregation	SFP+ fiber or TwinAx	More SFP+ fiber or TwinAx
Server to Access	CAT-5e thru CAT-6A for 1000BASE-T	SFP+ Direct attach 10G copper or Cat-6a for 10GBASE-T

Core Aggregation Co-location Design Layout

Laser Optimized MM Structured Cabling

Category Copper Cabling

SFP+ Twin-Ax Copper

Fiber/Copper Patching
(includes FC network)

Access Switch

Console Server

Fiber & Copper Patching

Aggregation Switch

Core Switch

Server Row Equipment Distribution Area

Core Switch
Main Distribution Area

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Core Aggregation Co-location 40G Cabling Migration

Cabling Segment	Day "One" (10G delivered to access, 10G @ Core)	Day "Two" (More 10G delivered to access, 40G @ Core)
Aggregation to Core	SFP+ TwinAx or SFP+ 10GbE fiber module transceivers & OM3/4 fiber cable	QSFP+ 40GbE direct attach copper
Access to Aggregation	SFP+ 10GbE fiber modular transceivers & OM3/4 fiber cable	More SFP+ 10GbE fiber modular transceivers & OM3/4 fiber cable
Server to Access	CAT-5e thru CAT-6A for 1000BASE-T	SFP+ Direct attach 10G copper or Cat-6a for 10GBASE-T

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Summary

- High bandwidth demanding applications are driving 40/100 GbE networks

- 40/100 GbE technologies have big impact on fiber cabling infrastructure – from duplex to parallel

- The polarity, gender and power budgets of Fiber cabling for 40/100 GbE must be carefully considered in order to migrate the infrastructure smoothly

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Ways to Get Involved In EA

- Become A Member
- Attend A Plugfest
  - Data Center Bridging
  - High Speed Ethernet
  - Higher Speed Modular IO
  - Energy Efficient Ethernet

  Join A Subcommittee
- Participate In An EA Booth At Trade Shows
  - OFC/NFOEC
  - Carrier Ethernet Congress
  - Interop
  - Supercomputing
  - European Conference on Optical Communication (ECOC)

- Participate In EA Sponsored Webinars

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Discussion and Q&A