

Welcome to the

2008 BICSI FALL CONFERENCE

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Modular Cassette-Based Fiber Optic Systems for Data Center Applications

Rudolph Montgelas



2008 BICSI Fall Conference, Las Vegas, Nevada

Modular Cassette-Based Fiber Optic Systems for Data Center Applications

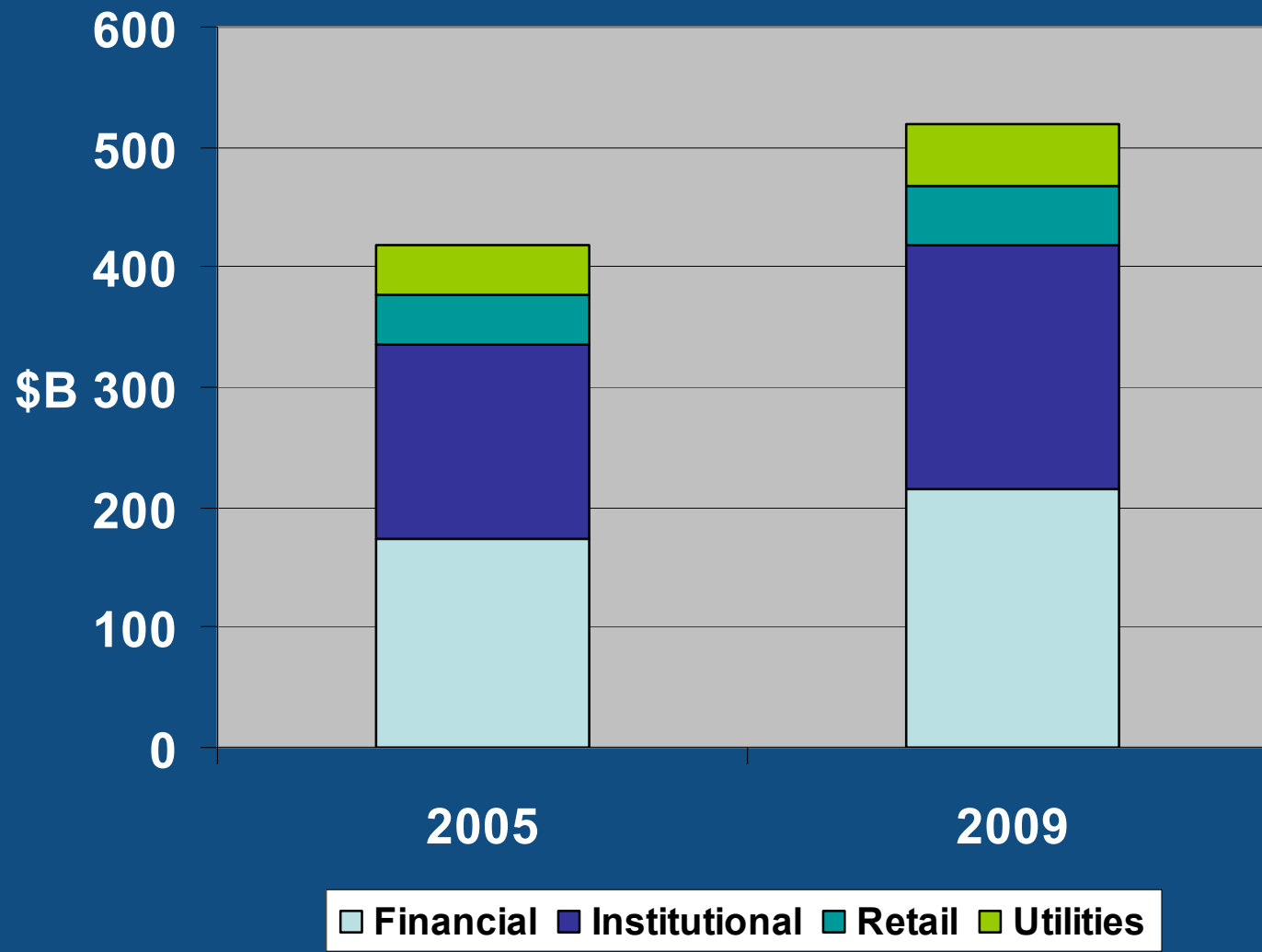
Rudy Montgelas
Senior Fiber Product Manager
Ortronics/Legrand



Topics

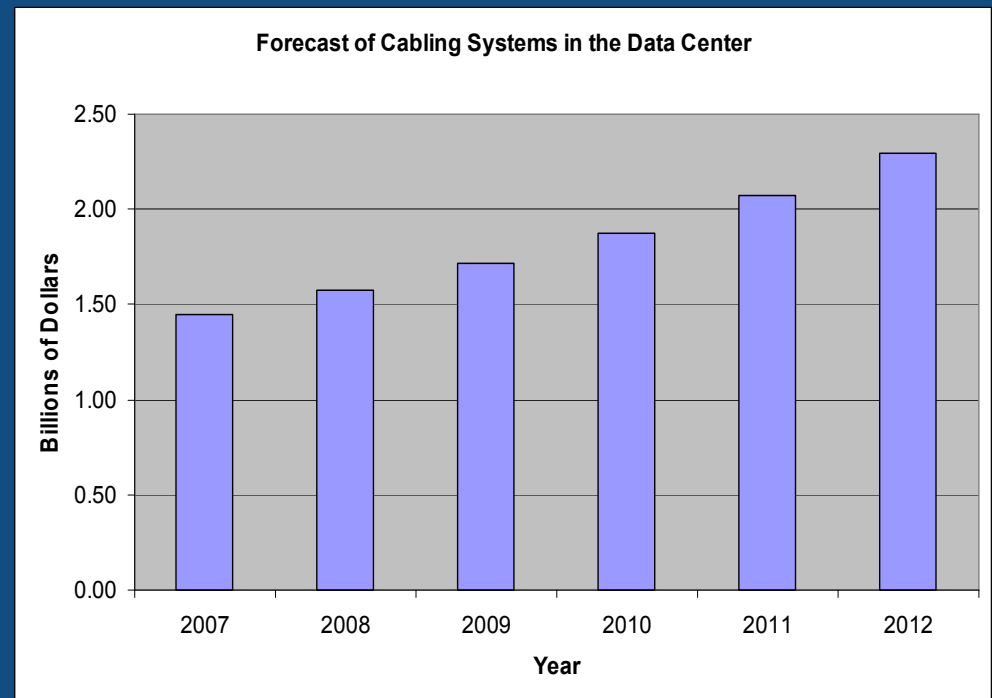
- Data Center Growth and Trends
- Standards & Topology
- Cabling Considerations
- Equipment Layout - Cooling
- Pre-terminated Fiber Systems
- Multi-fiber Array Polarity Considerations
- Summary
- Q&A

IT Spending on the Rise



Data Centers Key to Growth in Core Business

- Data Center annual growth continues at 10%
- More complex selling process, requiring Strategic Selling Skills
- Current trends include:
 - Focus on Sustainability issues
 - Increased focus on time to deploy projects
 - Emerging 'mega' sized Data Centers

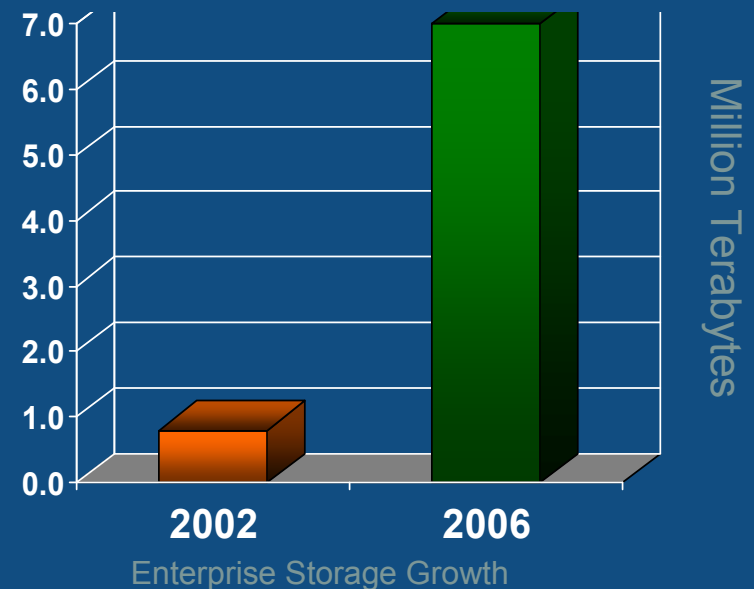


Source: Berk-Tek/ Ortronics analysis of BSRIA, Burroughs data

Why Are Data Centers and SANs Growing?

Process & Store Massive Amounts of Data

- Data Policy Directive (DPD) – European Union (E.U.)
- Basel Capital Accord (2006)
- HIPAA (U.S.), PIPEDA (Canada)
- Sarbanes-Oxley Act (U.S.)
- Securities & Exchange Commission (U.S.)
- Redundancy to protect against catastrophic loss



Data Center - Trends

- More and more bandwidth required – IP Convergence
 - More cables and connections – cabling congestion critical
- Equipment densities increasing
 - More blade servers in each rack or cabinet
 - Cooling requirements increasing
 - Efficient power delivery and power backup is essential
- Redundancy and data backup
- Increased need for data storage - SANs
- Elevated security requirements



Data Center Equipment Growth

	Early Stages	Today
Applications	100Base -T	10G Base - F
Computing Equipment	3U & 4U Servers	Blade Servers
Servers/cabinet or rack	3 to 6	30 to 40
Data Storage	Tape & Disc	Tape, Disc, Silicon
Cabinet power dissipation	200W - 1kW	3kW - 12kW
Current service to cabinet	15A	60A to 100A
Supporting Equipment	Displays	Displays
	Keyboards	Keyboards
	UPS	UPS
		Asset Management
		Cooling Equipment

Today's 10G Market

Data Centers – 2008 Typical Installations

Facility	Purpose	Typical Data Rates	Typical # of Racks	Typical Business
TR	Cross-Connections & Switches	10/100 Mbps	< 5	All
Small DC (Reduced)	Servers, CPU, UPS, Switches	1 Gbps	5 - 20	Small Financial Hospitals
Medium DC (Basic)	Servers, CPU, UPS, POE, Local SAN, Switches	1 - 10 Gbps	20 - 100	Banks Drug Co. Universities
Large DC (Distributed)	Servers, CPU, UPS, POE, Local & Remote SANs, Switches, Asset Management	1 - 10 Gbps	> 100	Large Financial Retail Insurance Large Research Labs

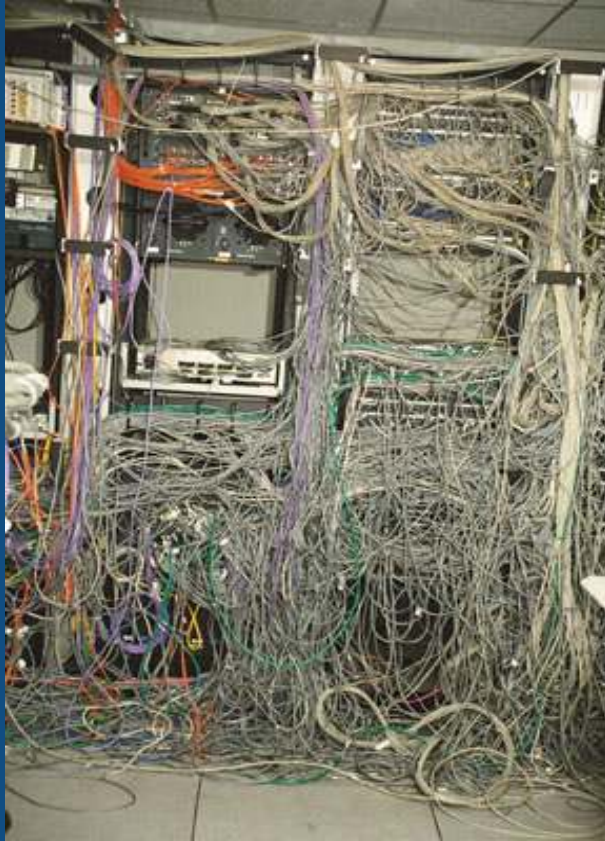
Data Center Cabling Standards

Structured Cabling Systems for Data Centers and SANs

- TIA-942 - April 2005
 - “Telecommunications Infrastructure Standard for Data Centers”
- ISO/IEC
 - Future ISO/IEC 24764 “Generic Cabling for Data Centers”

How Do Standards Help?

They
Help
Us Go
From
This



To
This!



TIA-942 Data Center Standard

Objective

- Requirements and guidelines for the design and installation of a data center or computer room
- Intended for use by designers needing thorough understanding of data center design
- Comprehensive document

Cabling

Network Design

Location

Access

Architectural design

Environmental design

Electrical design

Fire protection

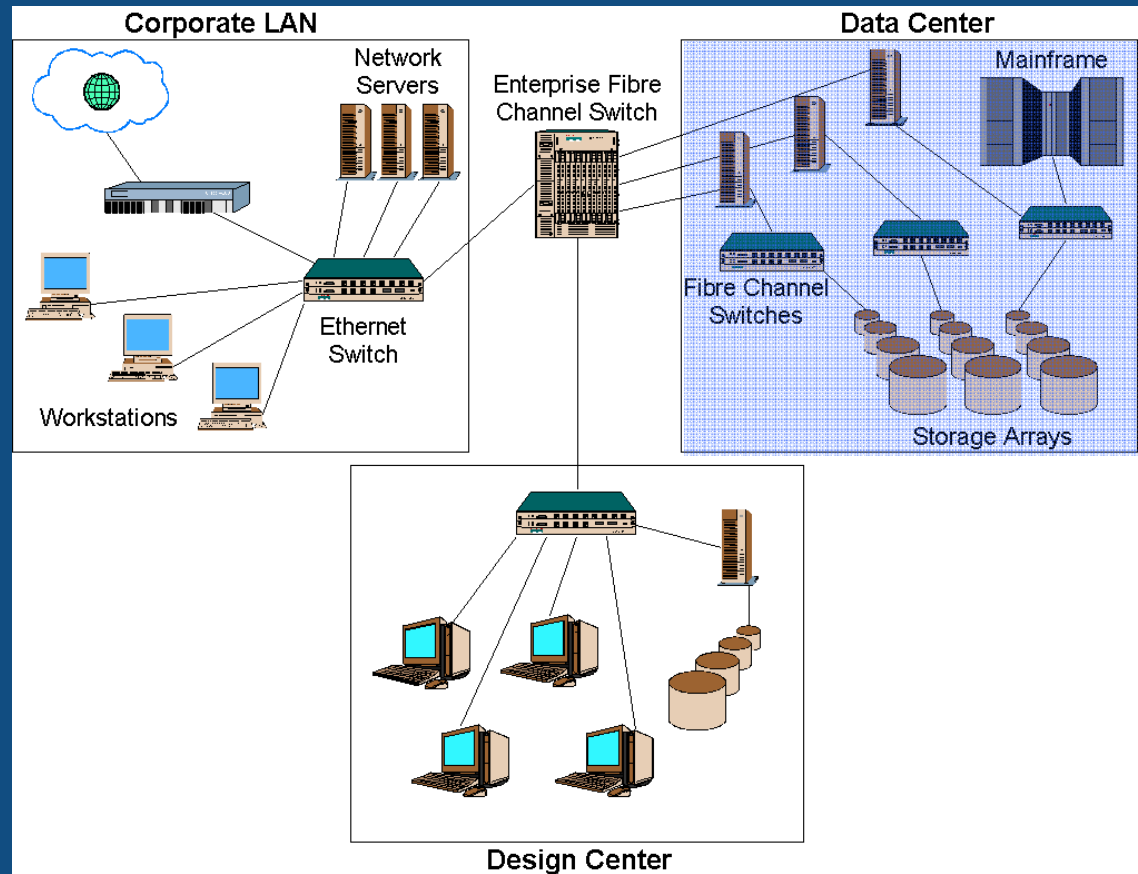
Water intrusion

Redundancy

The Integrated Enterprise Network

LAN, Data Center and SAN

- Physical layer
 - Copper & optical fiber cabling subsystems
- Interconnect devices
 - Hubs, switches & directors
- Translation devices
 - Host bus adapters
 - Routers
 - Gateways
 - Bridges



Data Center Structured Cabling System

9 Elements Comprise TIA-942

1. Computer room
2. Telecommunications room
3. Entrance room
4. Main distribution area
5. Horizontal distribution area
6. Zone distribution area
7. Equipment distribution area
8. Backbone cabling
9. Horizontal cabling

Spaces



Data Center

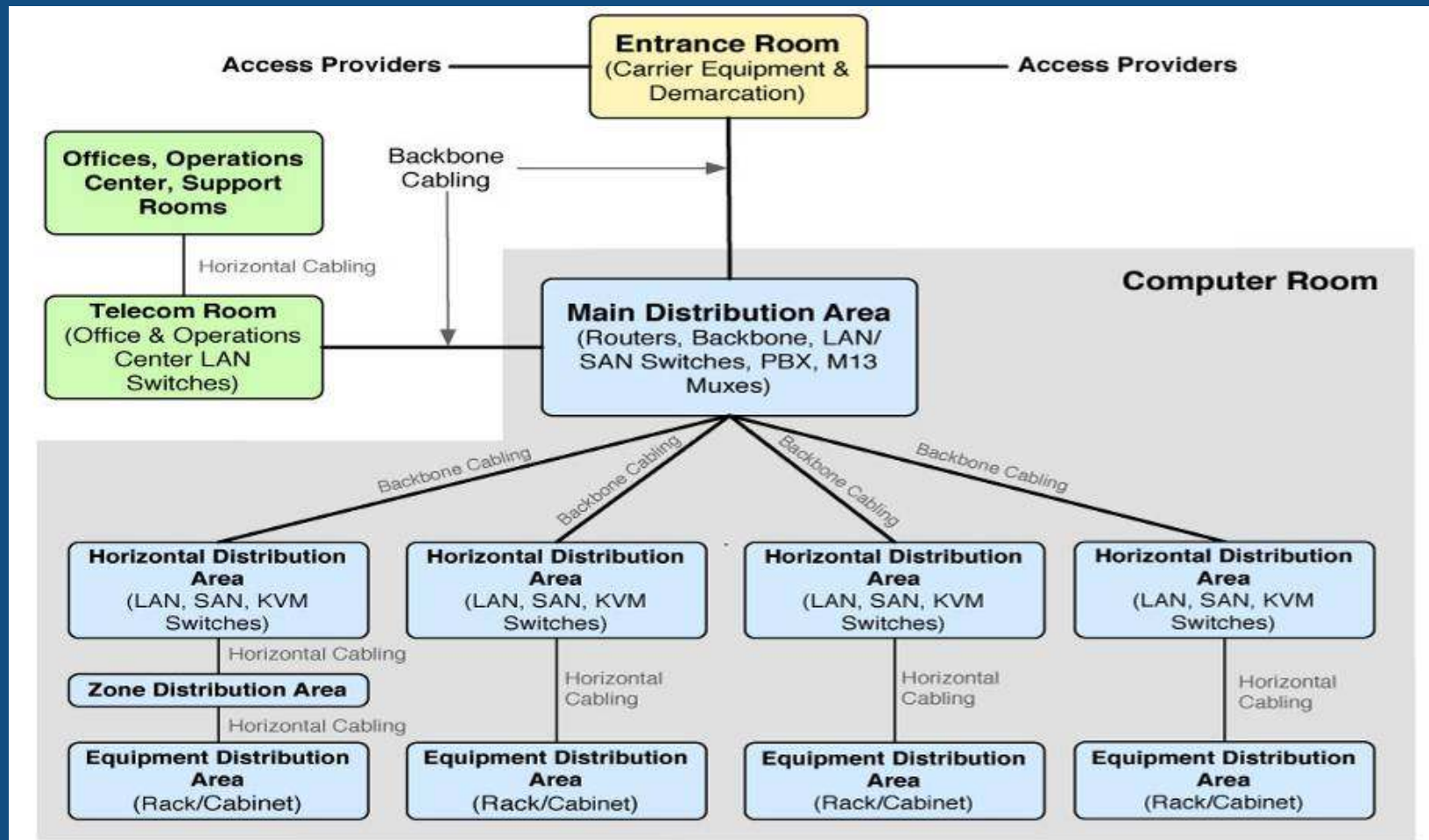
Cabling subsystems



Premise LAN

Basic Data Center Topology

And TIA/EIA-568-B Counterparts



Data Center Cabling Recommendations

Transmission Media – Normative “Required”

- 100-ohm twisted-pair copper cable
 - Category 3 or 5e
 - Category 6 recommended
- Multimode fiber optic cable
 - 62.5/125 μm or 50/125 μm
 - 50/125 μm 850 nm laser optimized multimode fiber recommended
- Singlemode optical fiber cable
- 75-ohm coaxial cable
 - Type 734 & 735 cable
 - Type T1.404 coaxial connector





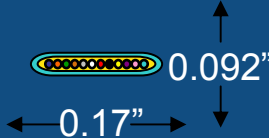
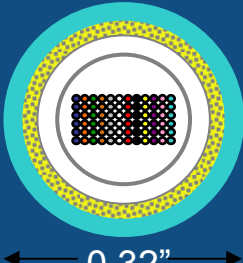

Per TIA-942

Data Center Cabling Considerations

- Reduced Diameters
 - Better Fill Ratios
 - Improved Air Flow for Cooling
 - Increased Termination Densities
- Armoring
 - Protection from Damage
 - More Cost Effective than Conduct
 - Easy to Install



Common Data Center Cabling Options

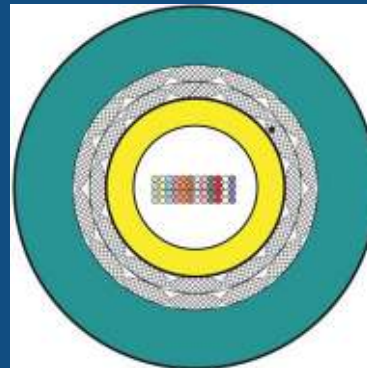
				
UTP	10G UTP	12F Ribbon Cable	72 F Multi-Ribbon Cable	72 F Loose Tube Cable
Cat 6	Cat 6A	50/125 LOMF	50/125 LOMF	50/125 LOMF
1 channel	1 channel	12 fibers	72 fibers	72 fibers
40 lbs/kft	47 lbs/kft	6 channels	36 channels	36 channels
7 lbs/kft	28 lbs/kft	68 lbs/kft	Max 10G length: <55m	Max 10G length: 100m
Max 10G length: <55m	Max 10G length: 100m	Max 10G length: 600m	Max 10G length: 600m	Max 10G length: 600m
Install load: 25 lb	Install load: 25 lb	Install load: 160 lb	Install load: 200 lb	Install load: 600 lb

Reduced Diameter Loose-Tube Fiber Cabling

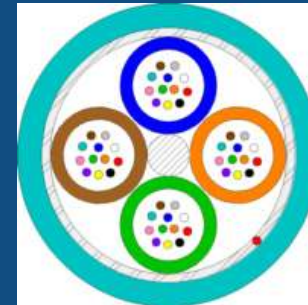
- Developed specifically for data centers
- Optimized for use in pre-terminated assemblies
- Easy to install, easy to terminate
- 50% smaller than ribbon cables
- No preferential bending



Reduced diameter
48F Loose-Tube
Cable (0.231" OD)

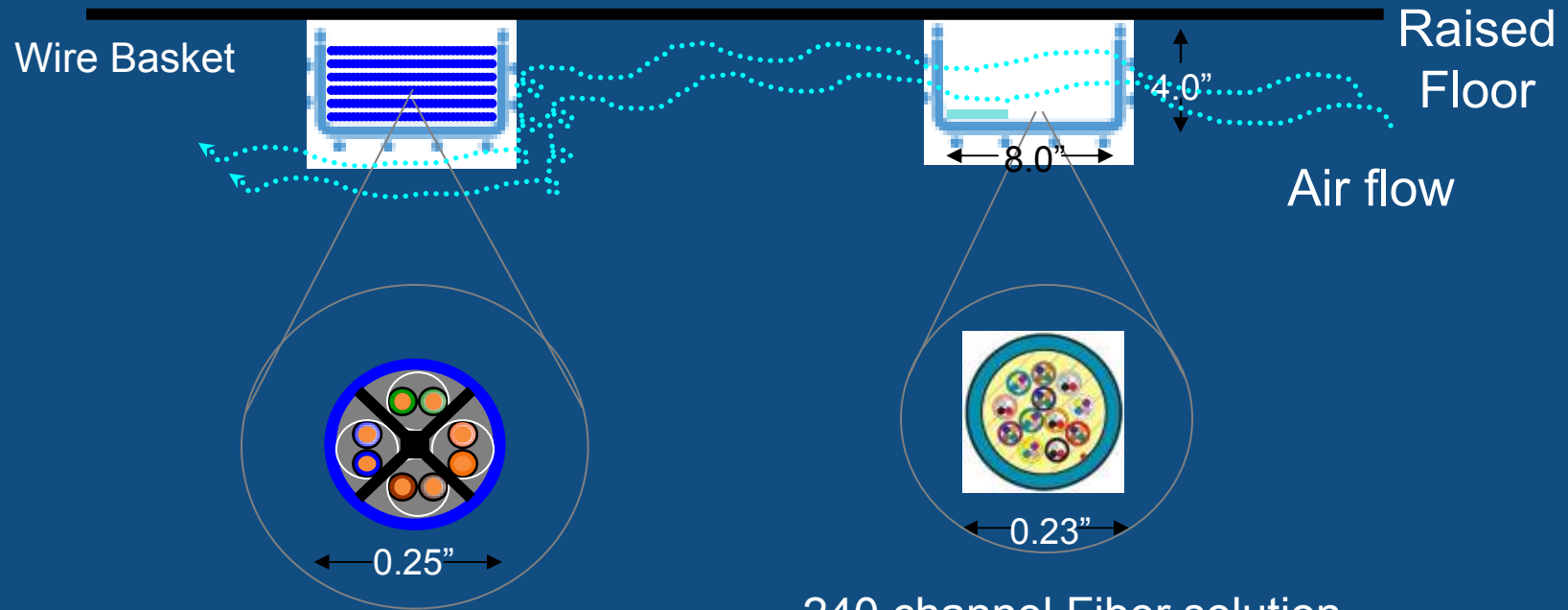


48F Stacked Ribbon
Cable (0.520" OD)



48F Loose-Tube
Plenum Cable
(0.370" OD)

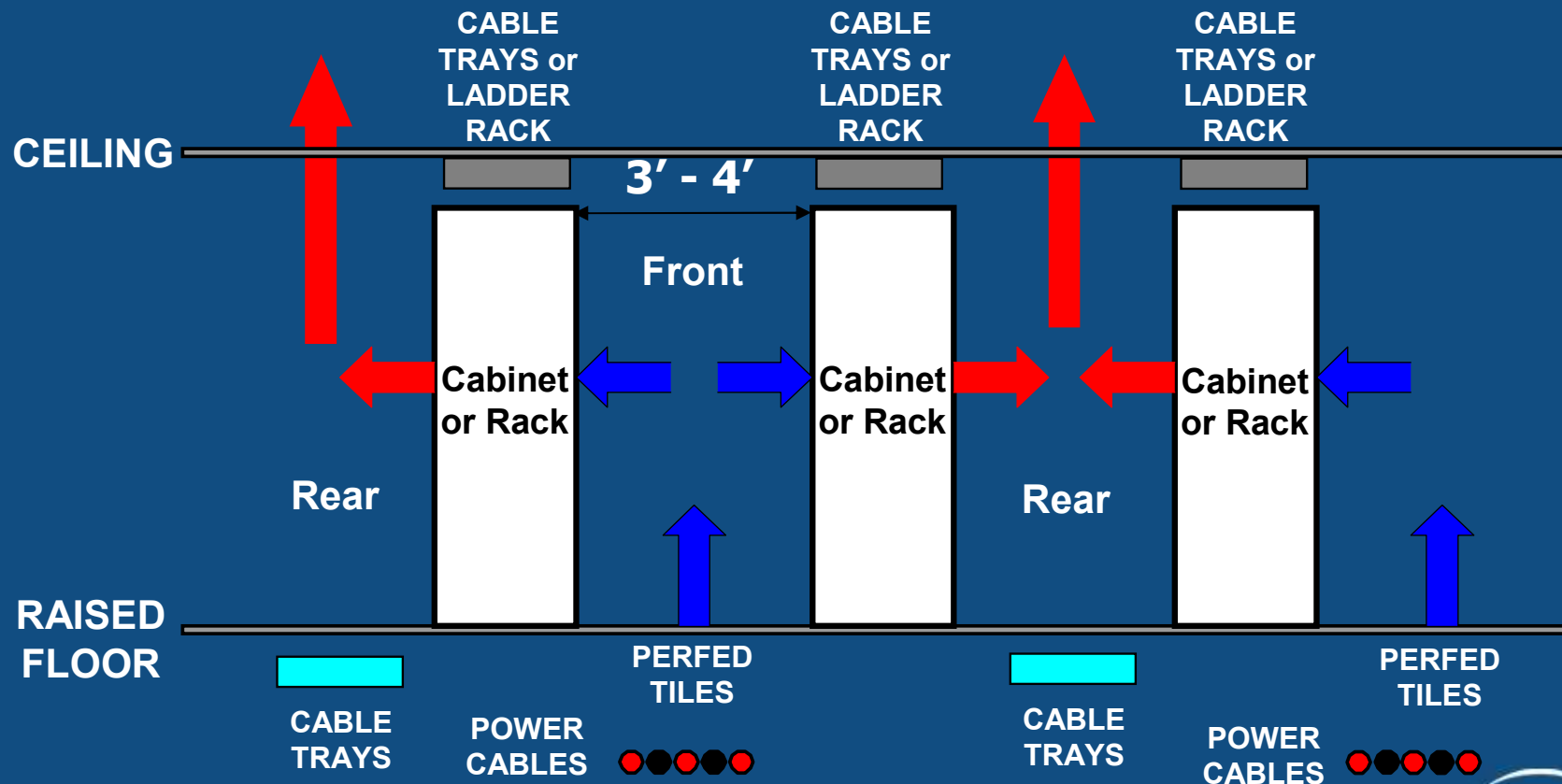
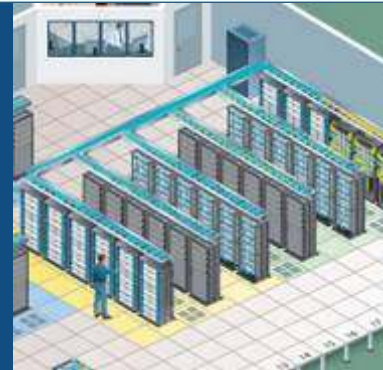
Size Matters for Airflow and Density: CAT 6 versus Compact 48-Fiber Loose-Tube Cable



242 channel Cat 6 UTP solution
242 cables at 50% Fill Ratio

240 channel Fiber solution
50/125 LOMF Loose-Tube
10 cables, Fill Ratio < 1 %
(Channels include 2 fibers)

Data Center Equipment Cooling and Cabling Layout



Optical Networking Equipment Heat Load Power Dissipation in Watts – Typical Rack

Cisco Product	Fiber Solution	Copper Solution
WS-C6509-E-FAN (Chassis and Fan Tray)	188	188
WS-X6K-SUP1A-2GE (Supervisor Engine)	89	89
WS-X6748-XXXXX (48-port GigE)	$280 \times 7 = 1960$	$377 \times 7 = 2827$
WS-X6708-10G-3C (10G w/modules)	555	555
Total Switch Power Consumption	2792	3659
Watts per network port	8.1	10.6

XXXXX = SFP for Fiber Solution, GE-TX for Copper Solution



Cassette-Based Optical Cabling System

Main Distribution Area (MDA)



Rack Mount Patch
Fiber Cabinet



Duplex Jumper Cable
50µm, LOMF

Cable Management Rack



Optical Cassette, 1U
50µm, LOMF



Backbone Cable

Ribbon Cable with 50µm, LOMF



Horizontal Distribution Area (HDA)

Cable Management Rack



Rack Mount Patch
Fiber Cabinet

Optical Cassette, 2U
50µm, LOMF



Duplex Jumper Cable
50µm, LOMF

Cassette-Based DC/SAN Solution

Ribbon Backbone or Ribbonized Fiber Cable

Reduced diameter loose tube or ribbon backbone cable terminated with MPO connectors designed to interface with an optical cassette system



Advantages of Cassette Based Fiber Connectivity Solutions

- Reduced
 - Labor costs
 - Congestion in cable pathways and spaces
 - On-site installation time
 - Security risk
- Increased
 - Optical port density
 - Component modularity
 - Optical performance and reliability
 - System interoperability

What's inside a fiber cassette?



- Plastic or metal housing
- Built-in bend radius limiter
- Precision-polished front panel SC or LC fiber connections
- 12-Fiber ribbon harness
- Precision-polished rear panel 12-fiber MPO connections

What to look for in a cassette

- **Low Insertion Loss**
 - Greater flexibility for zone cabling applications, cross connects and patching
- **Compatibility with Low-DMD Fibers**
 - Maximum compatibility with cabling systems – allows reallocation of ISI penalty to the channel insertion loss budget
- **Internal Fiber Management**
 - Reduces excessive bending and kinking during manufacture
- **Performance Documentation Affixed to Cassette**
 - Prevents loss of factory insertion loss test results
- **Protected MPO Connections**
 - Reduces the chance that critical optical connections could be inadvertently bumped or damaged
- **Choice of front panel patch cord connectors**
 - Flexibility to match the optical ports on the electronics. Shuttered adapters

Link Loss Budget Comparison

- Cable and Connector Loss only concerns
- Channel Insertion Loss

- ~3.5 dB/km for cable
- 0.75 dB per mated pair for connectors
- Standards Based Channel Examples

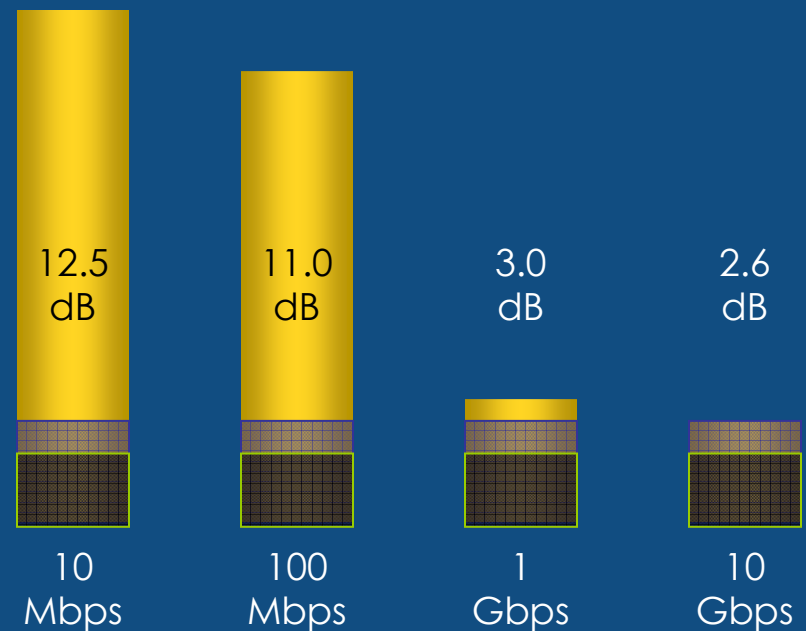
- 100 m cable
- 2 mated connector pairs

$.1\text{km} * 3.5 \text{ dB} + (2 * 0.75 \text{ dB}) = 1.85 \text{ dB}$



- 3 mated connector pairs

$.1\text{km} * 3.5 \text{ dB} + (3 * 0.75 \text{ dB}) = 2.60 \text{ dB}$

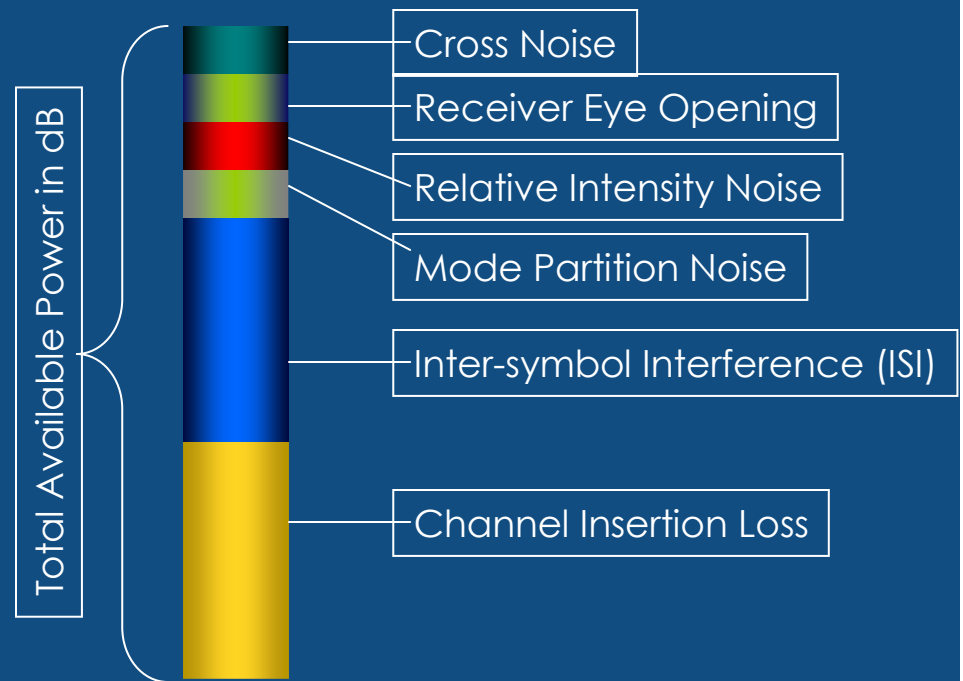


IEEE Loss Budget Allocation

- IEEE considers many elements when designing power budgets for active devices

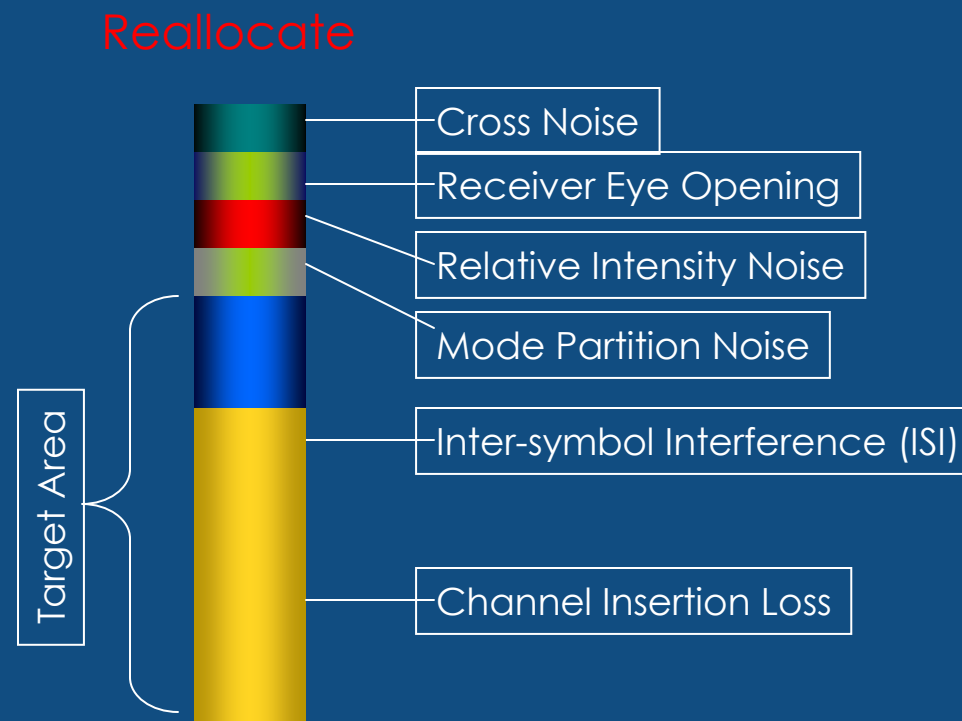
~75% of Total Budget

- Inter-symbol Interference (ISI)
- Channel Insertion Loss
- Cross Noise
- Receiver Eye Opening
- Relative Intensity Noise
- Mode Partition Noise



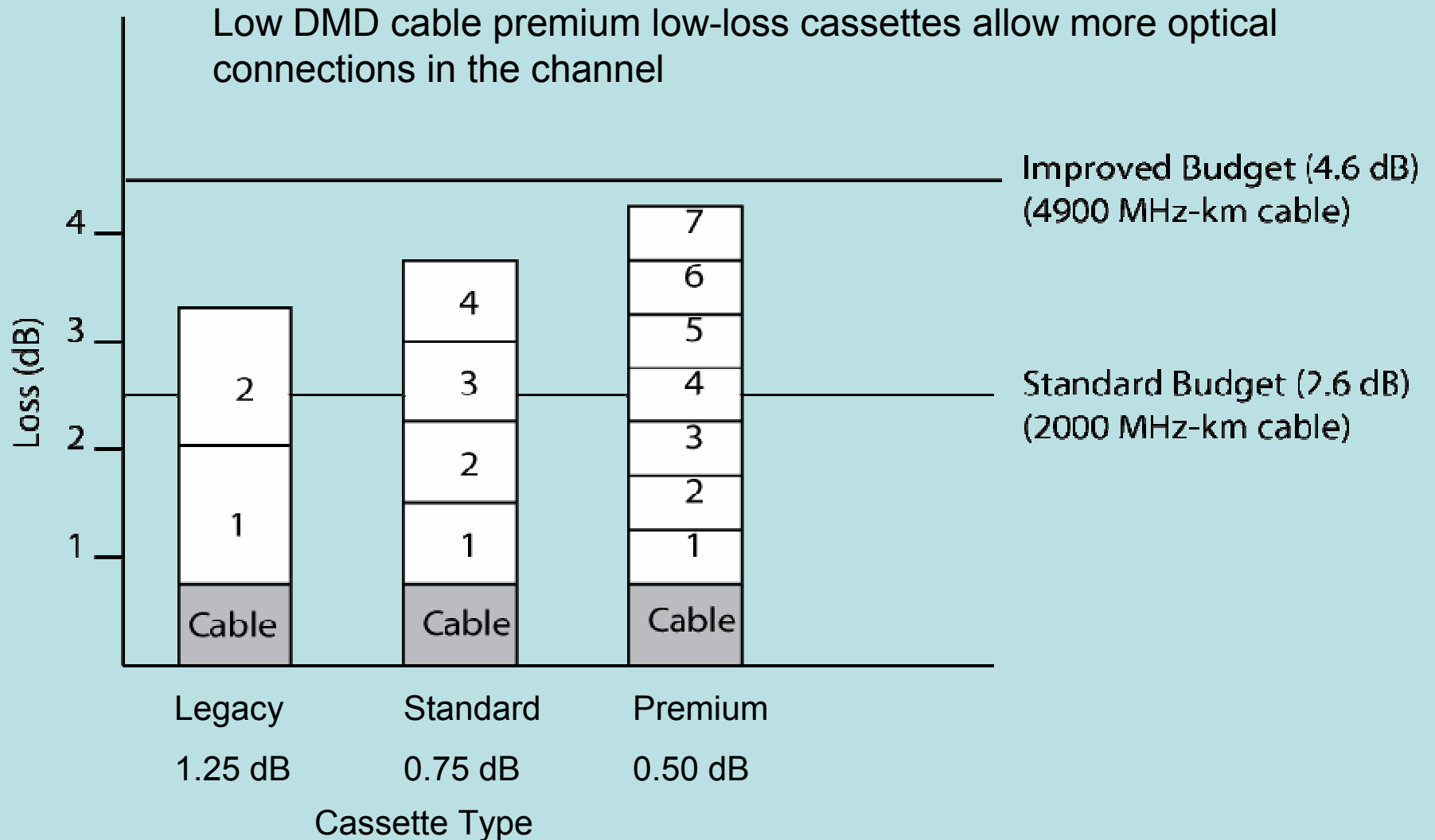
Low DMD Fiber “Re-allocation”

- The system designer is currently working with a 2.6dB optical power budget over 300m with OM3 fiber
- With low DMD (4900 Mhz-km EMB) fiber cables, it is possible to reduce the ISI penalty and reallocate power to channel loss
 - Creating an effective cable plant budget increase of up to 2.0 dB when compared with standard 50/125 fiber
 - The amount of additional cable plant loss budget is dependent upon fiber DMD and channel length

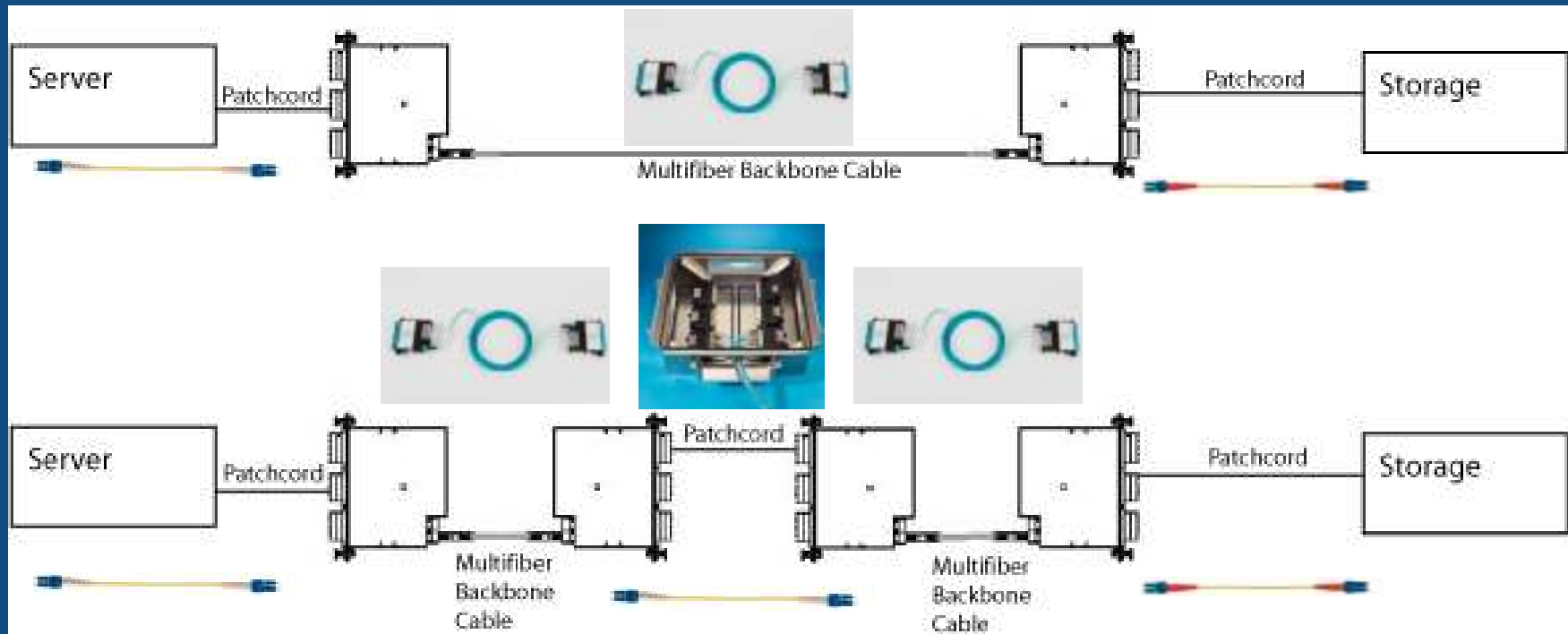


IEEE 10 Gig Cassette Power Budget Options

Low DMD cable premium low-loss cassettes allow more optical connections in the channel



Multiple Cassette Connections



Increasing the number of connections for zone cabling or additional cross-connects

Optical Fiber System Considerations

- Type of Data Center installation
 - SAN, backbone or horizontal application
 - True end-to-end solution that is available today
- Environment
 - 300 meter operation using OM3 fiber at 10 Gbps
 - Minimum 2000MHz-km EMB (effective modal bandwidth)
 - Future:
 - “OM4” fiber at 10 Gbps (Minimum EMB 4700MHz-km)*
 - “OM4+” fiber at 10 Gbps (Minimum EMB 4900MHz-km)*
 - Minimum of 100m at 40/100 Gbps for future parallel optical networks*
- Lifespan/Longevity
 - Ability to support higher speeds without significant changes to the infrastructure

* Standards have not been agreed upon at this time



Cost Comparison Summary

Connection type	Port cost	Materials: Horizontal cable, patch cords, connectivity	Installation labor * per channel	Total per channel cost
SM Fiber:				
Field Terminated	11,000.00	178.59	45.07	\$11,223.66
SM Fiber:				
Pre-Terminated	11,000.00	188.03	6.25	\$11,194.28
LOMF:				
Field Terminated	5,500.00	156.70	34.67	\$5,691.36
LOMF:				
Pre-Terminated	5,500.00	217.64	6.25	\$5,723.89
UTP Copper	2,198.00	184.12	46.75	\$2,428.87
F/UTP Copper	2,198.00	191.52	52.35	\$2,441.87

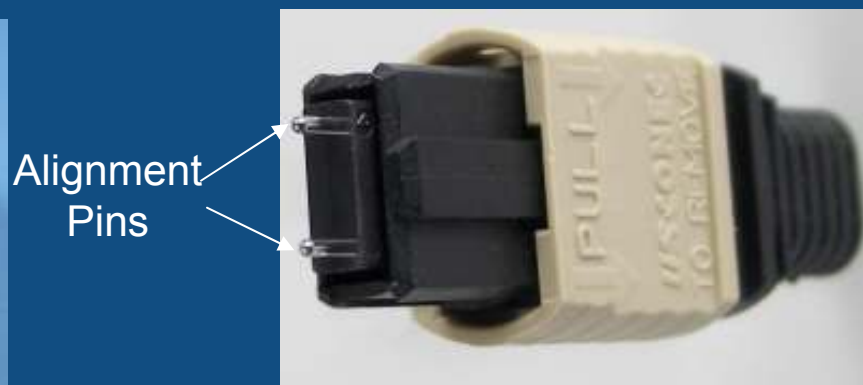
- * Cost per channel based on:
- 8-port 10-GigE blade with X2 modules
 - Distribution pricing
 - Two meter patch cords
 - Installation labor rate of \$60 per hour
 - Assumes no reworks for field terminations



MPO Fiber Backbone Cables and Connectors



MPO-to-MPO ribbon backbone cable with dust caps



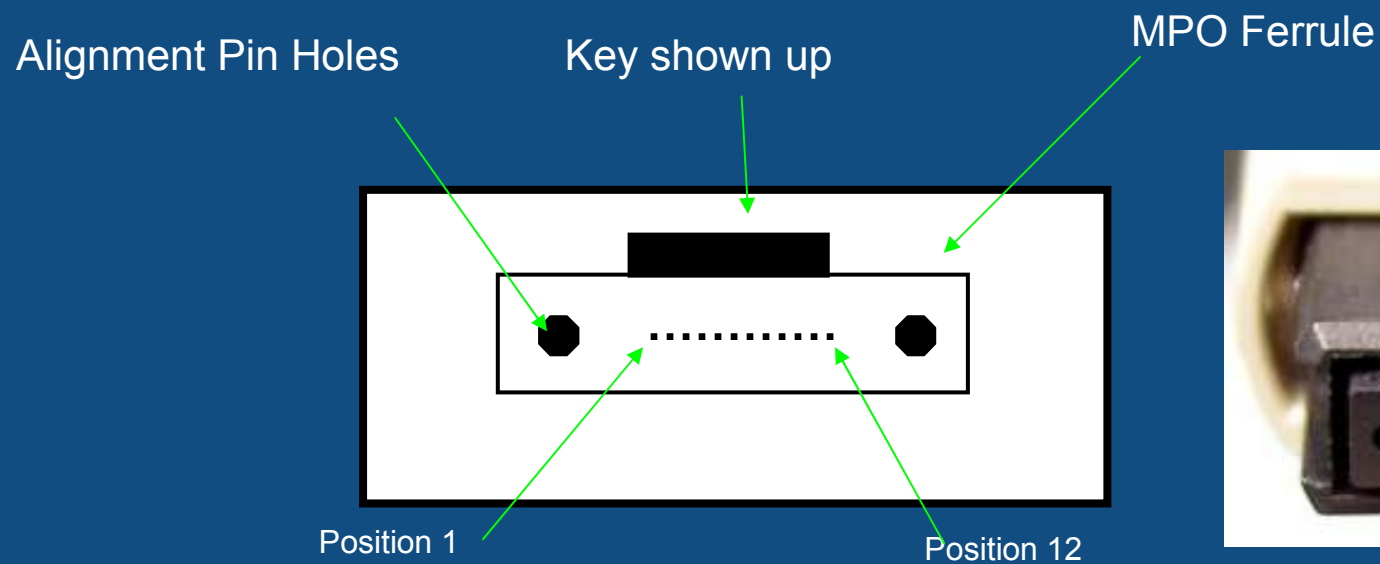
Alignment
Pins

MPO connector with pins installed



MPO adapter shown with connector installed inside the cassette

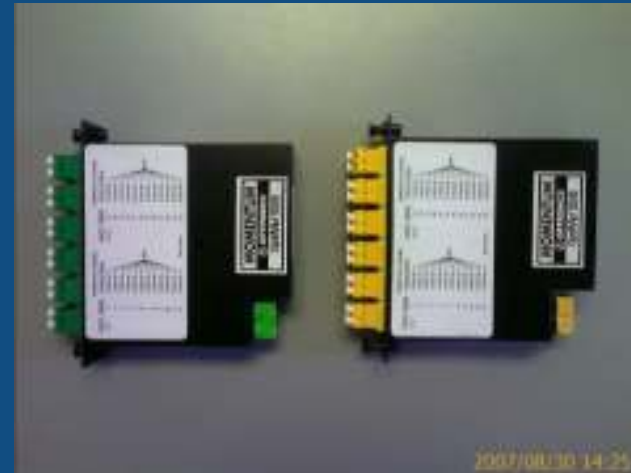
Fiber Position on an MPO Connector



MPO plug fiber positions shown looking at the end of ferrule with the key up

Secure/Keyed Pre-terminated Modular Systems

- Typically used for multiple networks in the same secure government or military facility
 - Keyed/color-coded front-panel adapters and patch cords provide physical separation for multiple network cross-connections
 - Keyed/color-coded rear-panel MPO adapters and backbone cables provide physical separation for multiple backbone network connections



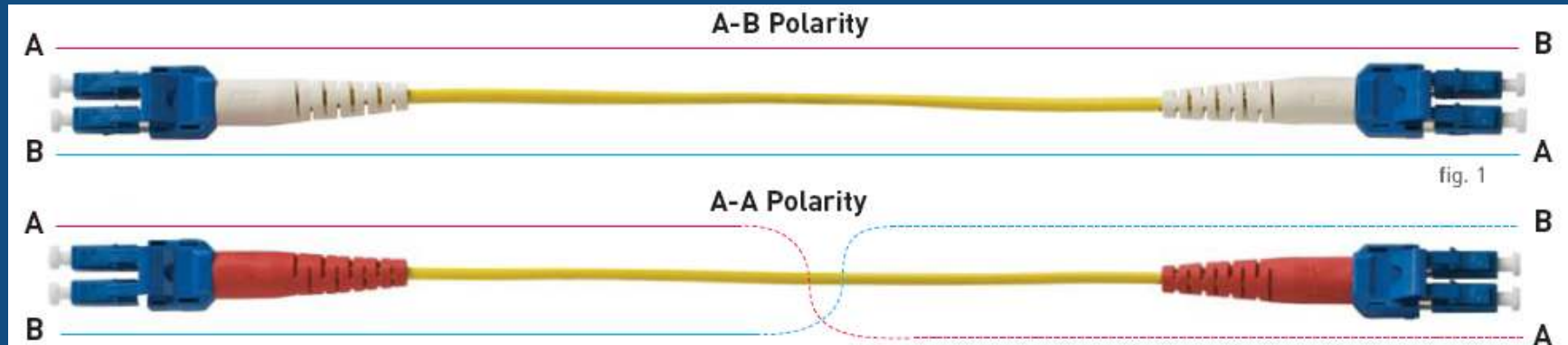
24 Fiber MTP*/MPO Connections

- 24-Fiber MTP/MPO connections can significantly reduce pre-terminated connection costs and increase connection densities
- No standards on polarity at this time
- TIA and IEEE are considering for the future



* MTP is a registered trademark of US ConneC

Types of Fiber Patch Cords

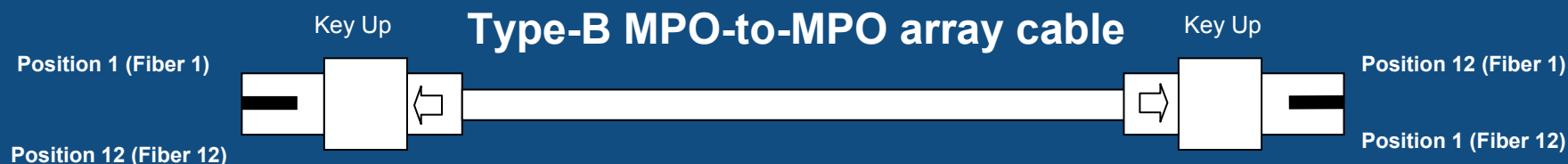


Single round duplex jacketed patch cord

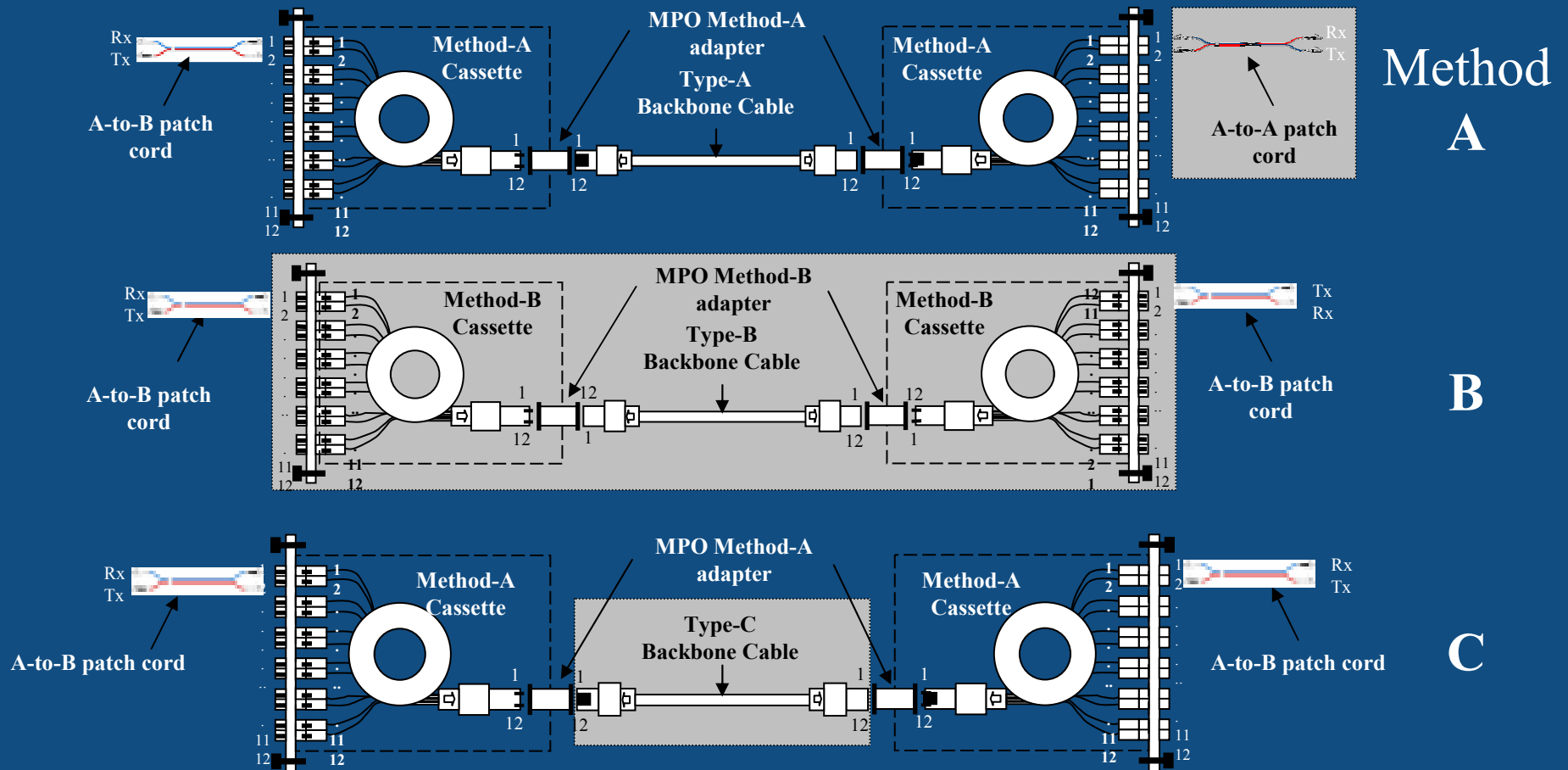


Zip cord jacketed patch cord

Types of MPO Backbone Cables



Modular Cassette Connectivity Methods Per TIA-568 Addendum 7



Summary

- New technology for fiber based pre-terminated cassettes and MPO multi-fiber cables is here today
 - low loss/high bandwidth system performance for today's DC/SAN installations
- It is important that the installer, system designer and end-user consider the optical performance of ALL critical components in the link
 - Patch cords and MPO backbone cables, (in addition to the cassettes)
 - The optical loss performance of the link is the summation of the loss of all the components in the link
 - The polarity implications of connecting a particular component into a full duplex fiber link should be fully understood
- Selecting modular fiber systems that comply with TIA standards can help to prevent costly troubleshooting and rework of the installed fiber cable plant

Thank you for your
attention

Questions?

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