

27th Annual **Newport Conference**
on Optical Networking



Data Centers & Storage Area Networks

Trends in Fiber Optics & Cabling Systems

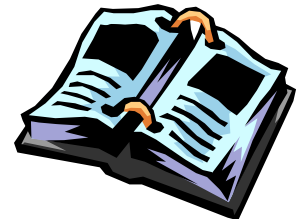
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Chairman, TIA Fiber Optics LAN Section (fols.org)
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Agenda

Data Centers & Storage Area Networks

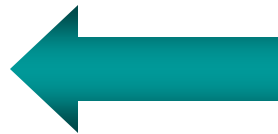
- Information generation & storage trends
- Data center & SAN market growth
- New fiber technology for data centers & SANs
- An emerging structured cabling system standard



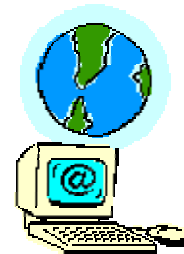
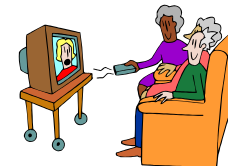
New Information Generation

Significant Annual Increases

- 2002 new information production: 5 exabytes
 - 1 exabyte – 1,000,000,000,000,000 bytes
 - Equivalent to 500 Libraries of Congress
- Four primary physical media
 - Print
 - Film
 - Magnetic
 - Optical
- 350% more information communicated than stored
- Four electronic channels (18 exabytes new content in 2002)
 - Telephone
 - Radio
 - Television
 - Internet



New information doubled in last 3 years



Source: "How Much Information 2003?", School of Information Management & Systems at University of California at Berkeley

Why Are Data Centers & SANs Growing?

Process & Store this Tidal Wave of Data

- Increased information generation
- Federal data warehousing legislation & recommendations
 - Patient record safeguarding:
 - Health Insurance Portability & Accountability Act (HIPAA)
 - Increased financial recordkeeping
 - Sarbanes-Oxley Act
 - U.S. Federal Reserve & U.S. Securities & Exchange Commission
 - Banks local & remote data centers 100 or more miles apart
- Basel Capital Accord (2006)
 - Financial institution's data backup strategy to be factored into credit rating
- Redundancy to protect against catastrophic loss



Definitions

Data Center & Storage Area Network

Data Center

- *ISP*: Specialized facility that houses web sites & provides data serving & other services for other companies
- *Enterprise*: Central data processing facility and/or the group of people who manage the enterprise's data processing & networks

Storage Area Network (SAN)

- High-speed special purpose network (or subnetwork) that interconnects different kinds of data storage devices with associated data servers on behalf of a larger network of users
- Usually located in Data Center

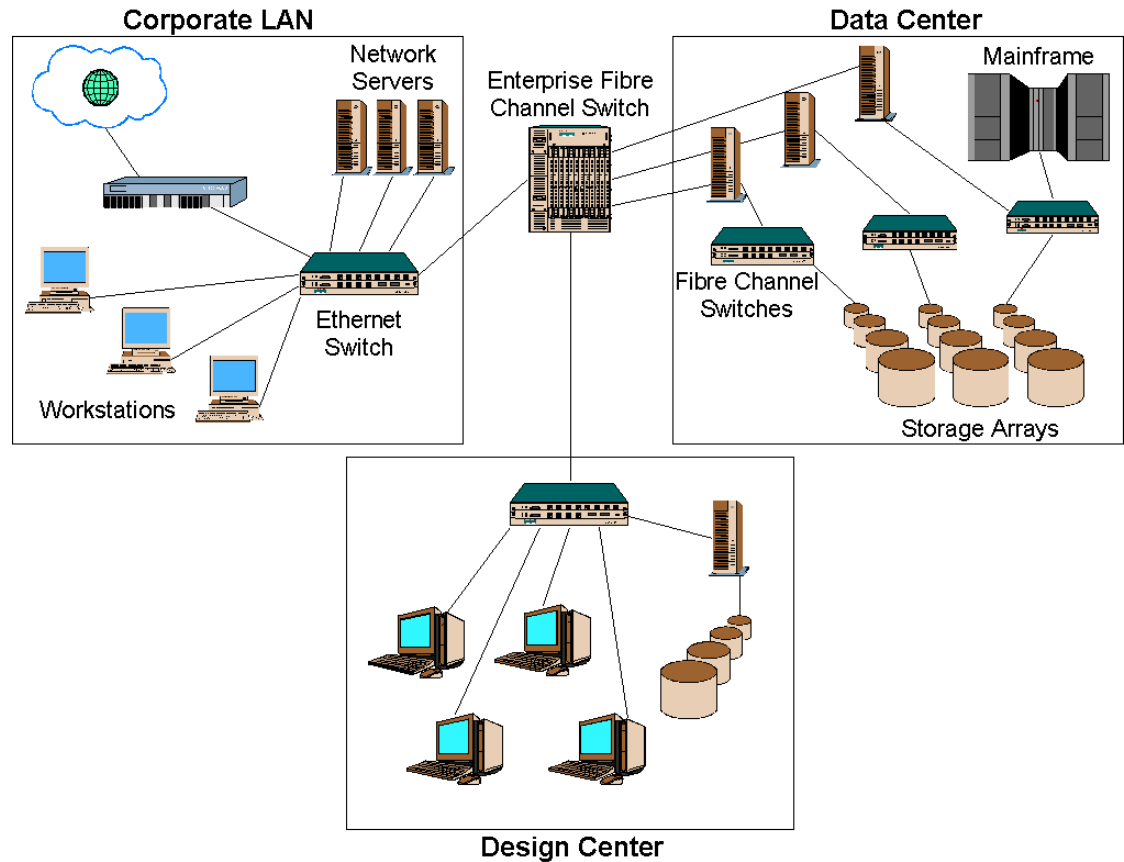


Source: *<http://www.whatis.com>

The Integrated Enterprise Network

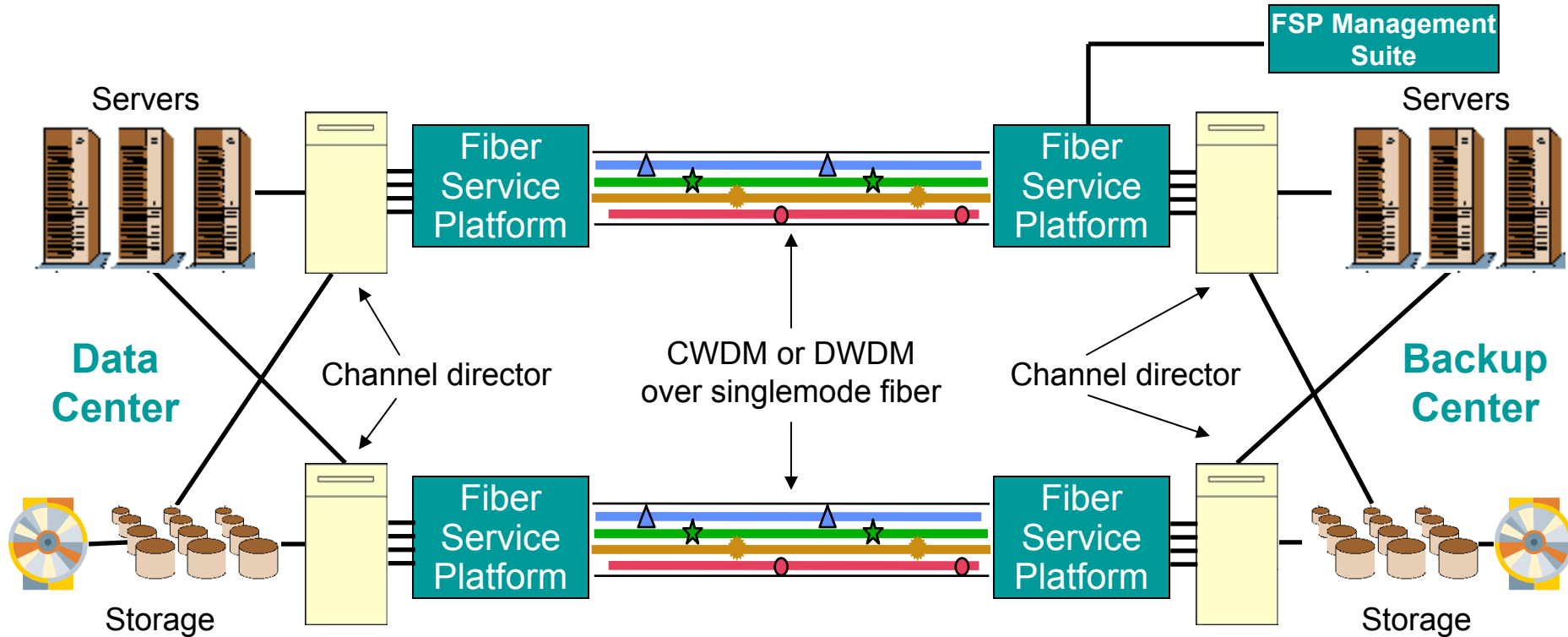
LAN, Data Center & SAN

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



Remote Data Centers & SANs

Cost-Effective with CWDM & DWDM Technology

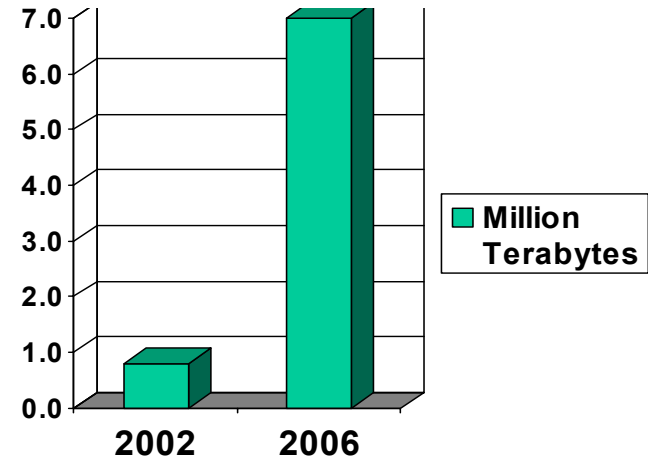


Source: *Lightwave*, January 2004, Todd Bundy, ADVA Optical Networking

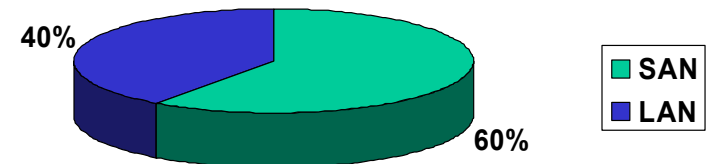
Enterprise Data Storage Growth

Rapid & Significant

- 30% annual growth
 - Last 3 years
 - Predicted for next 5 years
 - \$5.3 billion market by 2005
- Largest component of hardware budget
 - 18% of total I.T. budget
 - 60% of hardware budget
- Separate LAN/SAN spending strategies



Enterprise Storage Growth



Percent of Hardware Budget

Source: iSuppli Corporation Press Release, 1-04

Insufficient DC/SAN Infrastructure Investment

The Costs are Staggering

■ Ramifications

- Minimized customer transactions, interactions & sales volumes
- Decreased revenues

■ Network downtime estimates:

- Pay-per-view TV operator: \$125,000 per hour
- Credit card authorization company: \$2,600,000 per hour
- Retail brokerage: \$6,400,000 per hour



“Zerodowntime” the objective

Source: *Lightwave*, January 2004, Todd Bundy, ADVA Optical Networking

Why Do Data Center/SAN Managers Like Fiber?

Many Advantages

- More protocol choices
 - Fibre Channel
 - 10 Gbps Ethernet
 - ESCON/FICON
 - FCIP
- Smaller diameter cables
 - Light weight
 - Easier routing
 - Less congestion
 - Less cooling restriction
- Similar technology used in LANs
 - Installer familiarity
 - Lower testing costs
- Traditional fiber advantages
 - Higher bandwidth
 - Higher reliability
 - Immunity to EMI, RFI & crosstalk
 - Superior cable pull strength
 - Greater security



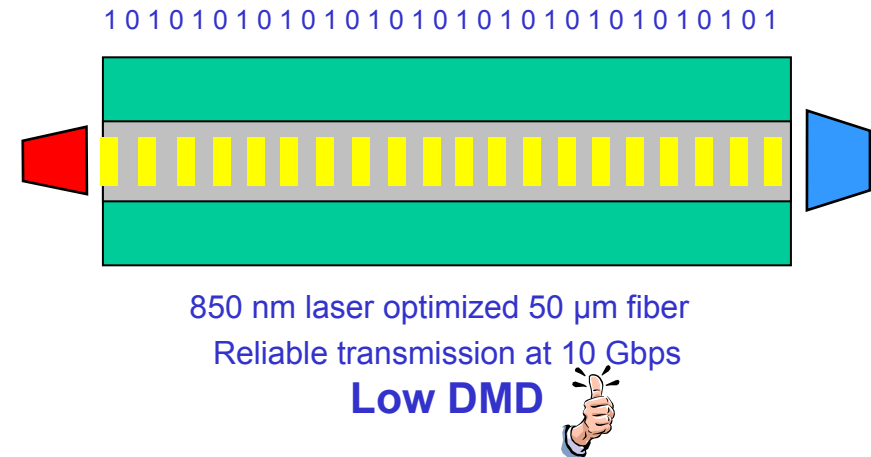
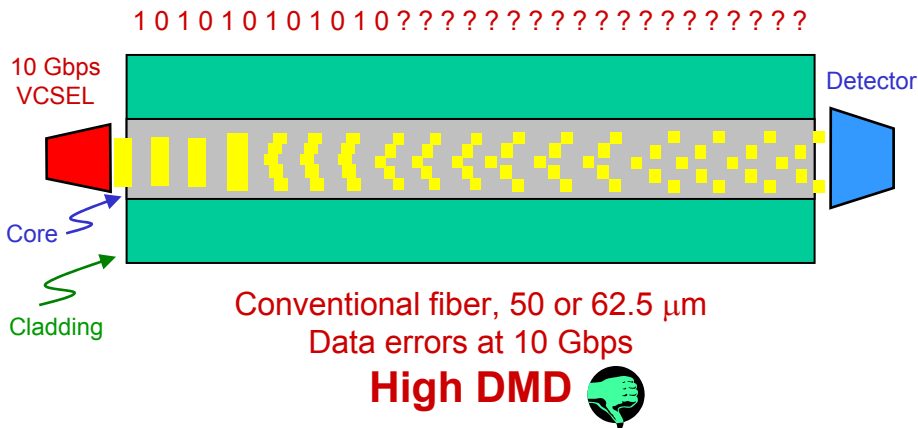
Key Elements of a Robust Data Center

To Support Increasing Network Traffic & Storage

- Reliable, high bandwidth networks required
- Optimal solution: systems engineered, manufactured & independently verified to exceed TIA/EIA requirements
- Fiber offers significant advantages over other media types
- Performance of individual fiber network elements critical
 - Fiber: low differential mode delay (DMD) & EMB_c
 - Electronics: fully qualified devices with high laser coupling efficiency
 - Cable: low attenuation
 - Apparatus: reduced insertion loss per mated pair

10 Gbps Performance Compared

Conventional vs. Laser Optimized 50 μm Fiber



- Conventional multimode fiber bandwidth: 200-500 MHz-km
- LOMF bandwidth: 2000 MHz-km & up
- Conventional multimode fiber 10 Gbps Ethernet support: 25-82 meters
- LOMF 10 Gbps Ethernet support: at least 300 meters

Fibre Channel Transceivers

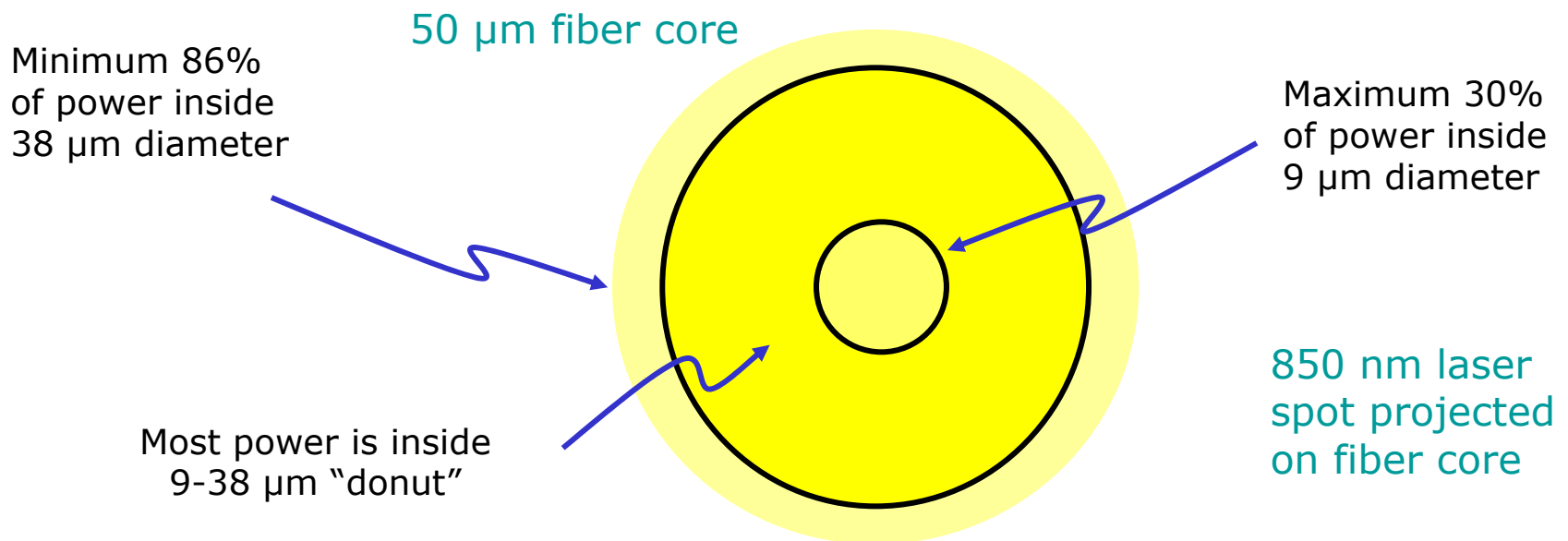
Short Wavelength VCSEL Technology Most Popular

- 850 nm operating wavelength more cost effective
- Small Form Factor Pluggable (SFP) modules dominant
- Broad manufacturer availability
- Fully qualified products recommended
 - High reliability
 - Tested for all applications
 - Comprehensive environmental testing
 - High fiber coupling efficiency



High Fiber Coupling Efficiency

Laser & Fiber Specifications Complementary



850 nm laser optimized 50 micron multimode fiber

Fiber Loss Budgets Decreasing

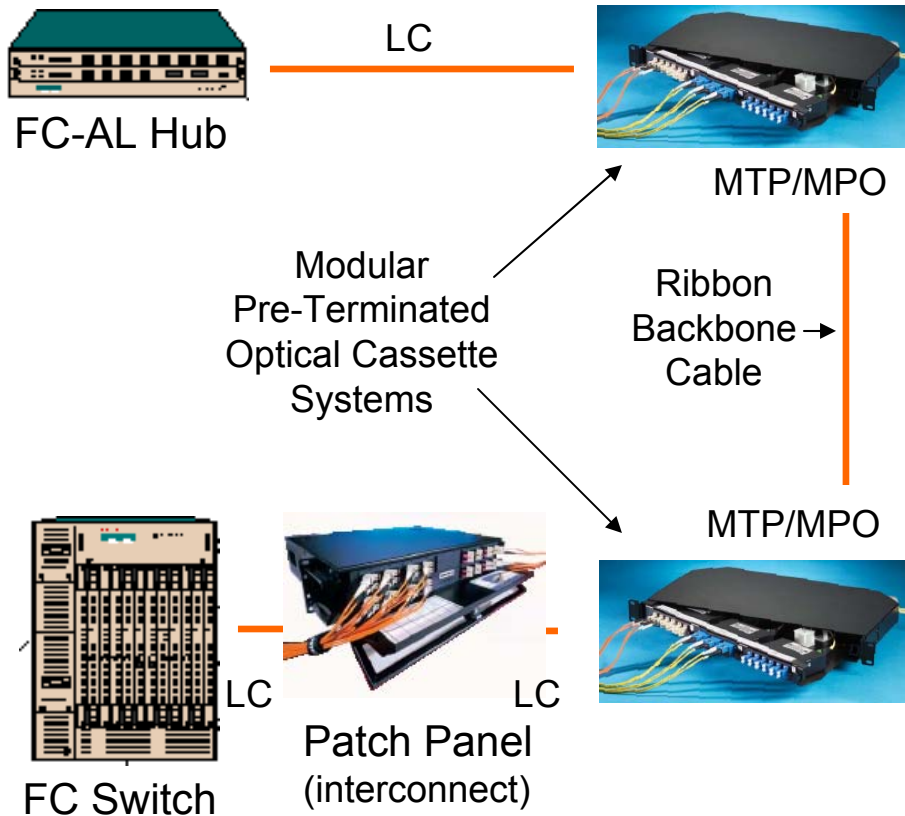
Due to Ever Increasing Speeds

Year	Application	Data Rate	Designation	Standard	Cable Plant Loss Budget (db)
Early 80's	Ethernet	10 Mbps	10BASE-FL	IEEE 802.3	12.5
Early 90's	Fast Ethernet	100 Mbps	100BASE-FX	IEEE 802.3	11.0
Late 90's	Short Wavelength Fast Ethernet	10/100 Mbps	100BASE-SX	TIA/EIA-785	4.0
2000	1 Gigabit Ethernet	1,000 Mbps	1000BASE-SX	IEEE 802.3z	3.56
2004	10 Gigabit Ethernet	10,000 Mbps	10GBASE-SR*	IEEE 802.3ae	2.60

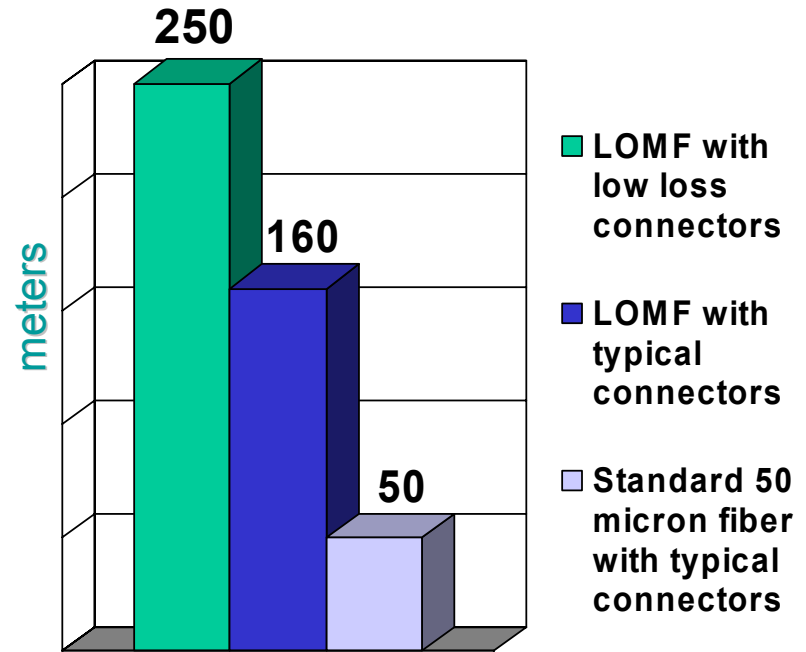
Short wavelength most cost-effective 10 Gbps Ethernet & Fibre Channel solutions

Plug & Play Data Center Systems

Fibre Channel Example: 2 MTP®/MPOs & 3 LC Connections



10 Gbps Fibre Channel @ 850 nm
(10G FC 1200 M5)



LOMF low loss system enables plug & play system to 250 meters with margin

MTP is registered trademark of U.S. Conec, Ltd.

Data Center Fiber Cabling

Reduced Diameter & Armored Cables Now Available

- Backbone subsystem
 - Backbone cables
 - Main cross-connects
 - Horizontal cross-connects
 - Mechanical terminations
 - Patch cords
- Horizontal subsystem
 - Horizontal cables
 - Mechanical terminations
 - Patch cords
 - Zone outlet or consolidation point (optional)



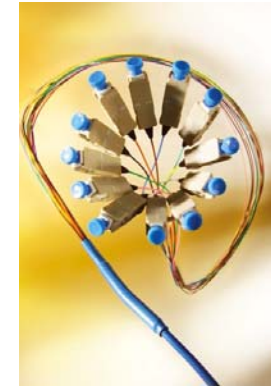
Pre-Terminated Trunk Cable Assembly

Time & Labor Saving Backbone Cable Designs

Definition: Backbone cable with factory installed connectors extending from rear of adapter panel to mating end of another adapter panel in another rack

- Commonly available fiber counts to 144
- Reduced on-site labor costs
- Optical performance guaranteed
- Distribution, armored, or reduced diameter dry plenum indoor/outdoor designs available
- Facilitates cable routing & dressing in and between rack & fiber enclosure

Lower loss than ribbon backbone cables



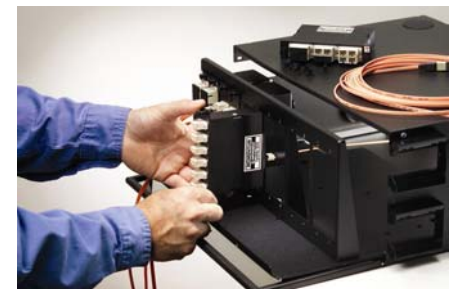
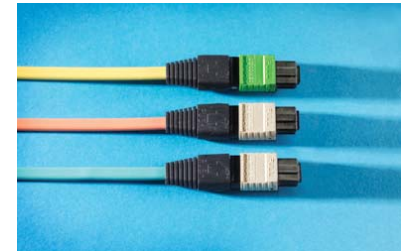
Ribbon Backbone Cable

Highly Modular Time-Saving Option for DCs & SANs

Definition: Ribbon backbone cable terminated with MPO (multi-fiber push on) connectors designed to interface with optical cassette system

- Utilizes MTP/MPO 12-fiber connector technology
- Cassette support for 24 fibers
- Factory certified performance
- Integrated system
- Significant time & cost savings during installation & maintenance

Generally higher loss than trunk cable assemblies



Small-Form-Factor Fiber Connectors

High Density Critical for Space-Limited Data Centers



VF-45



OptiJack



LX.5



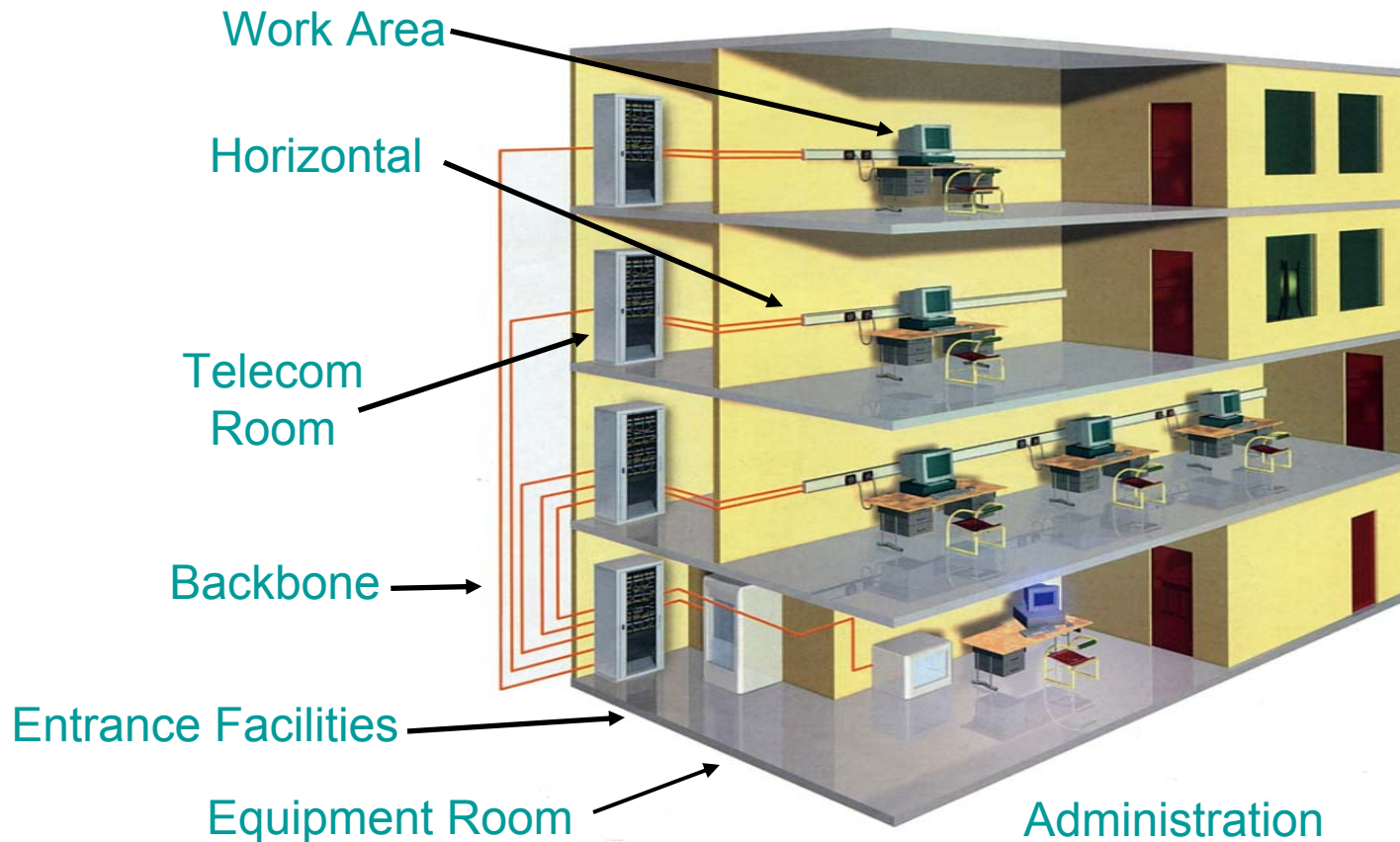
MT-RJ



LC

Premises Structured Cabling System

TIA/EIA-568-B Defines 7 Subsystems



Data Center Cabling Standard

Under Development

- Telecommunications Infrastructure Standard for Data Centers
- SP-3-0092 (to become TIA/EIA-942)
- Draft 5.0a, August 2, 2004

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Data Center “Spaces”

And Their TIA/EIA-568 Counterparts

Entrance Room

- Analogy: “Entrance Facility”

Main Distribution Area (MDA)

- Analogy: “Equipment Room”

Horizontal Distribution Area (HDA)

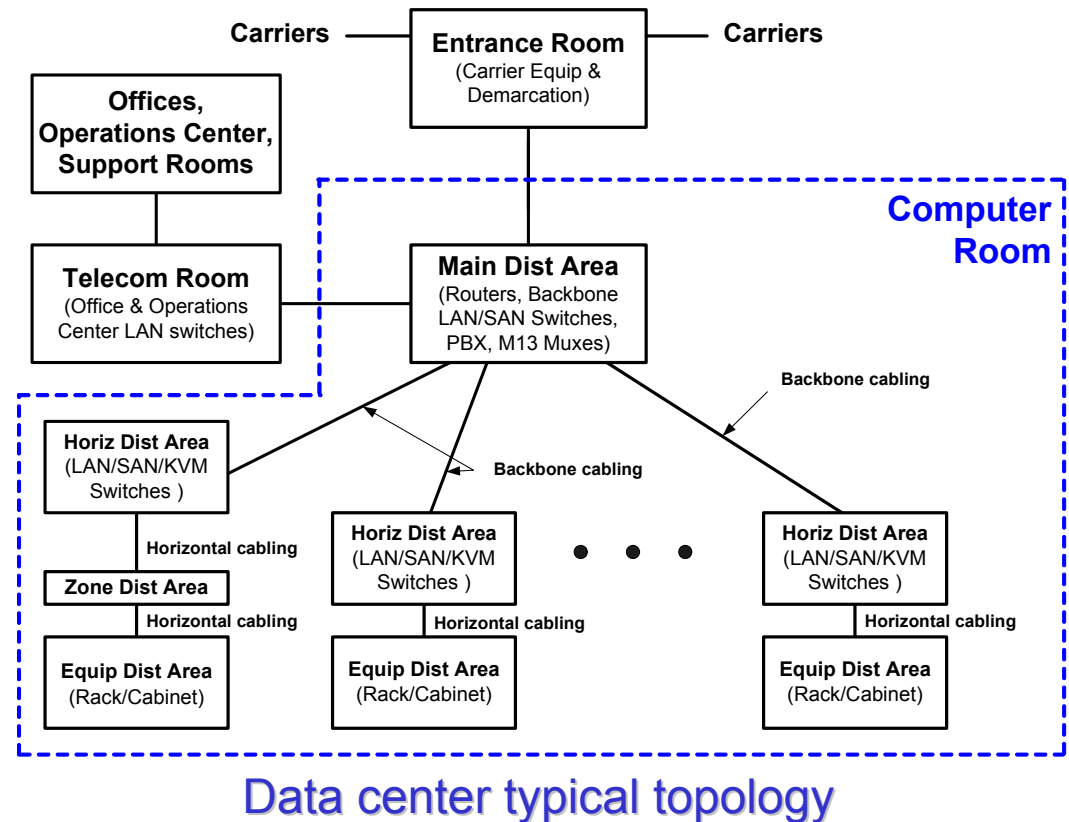
- Analogy: “Telecom Room”

Zone Distribution Area (ZDA)

- Analogy: “Work Area”

Equipment Distribution Area (EDA)

- Location of cabinets & racks

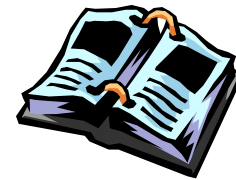


50/125 μm 850 nm laser optimized multimode fiber recommended

Summary

Data Centers & SANs Growing Rapidly

- Vast amounts of new information being created, communicated & stored
- Legislation & other business priorities impacting data center & storage area network growth
- Informed fiber technology decisions critical to customer satisfaction
- Structured cabling system principles now being applied to Data Centers & SANs to better handle growth, interoperability & customer choice





Thank you for your attention

