

SNIA

STORAGE NETWORKING INDUSTRY ASSOCIATION

EDUCATION

Metropolitan and Wide Area Storage Networking

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MAN/WAN Storage Networking

Distance is essential to support business continuity, compliance, and consolidation. This session is targeted to Storage Networking Professionals who desire an overview of available techniques and technologies that overcome storage networking distance boundaries.

This session will demystify Metro/Wide Area Networking by providing participants with a working-level understanding of:

- Distance drivers, performance, protocols for Disk Mirroring (Synch/Asynch)/Clustering, remote disk and tape backup;
- Techniques that optimize throughput including flow control and data compression;
- Available transport technologies including SONET/SDH, CWDM, DWDM, IP, Metro Ethernet and dark fiber with the pro's and con's of each;
- Selecting the appropriate technology to meet different requirements with case studies

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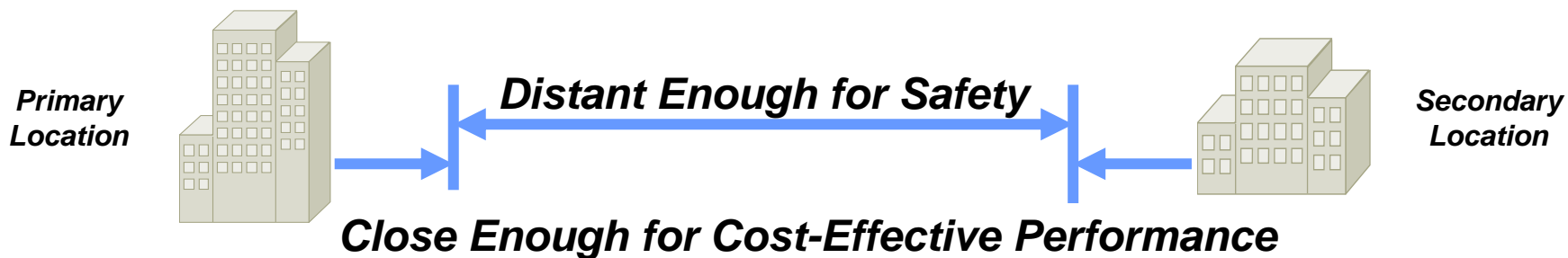
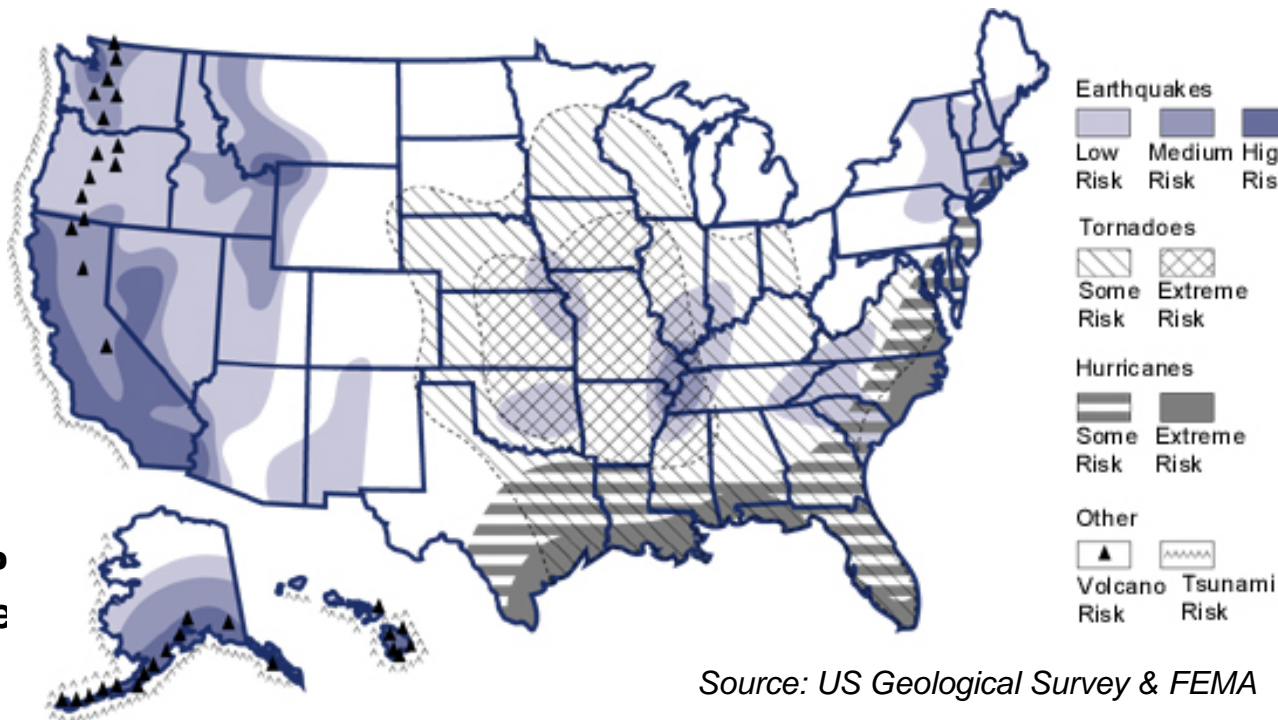
Agenda

- Drivers, Applications & Protocols
- Extension Optimizing Techniques
- Transport Technologies
 - WDM
 - SONET/SDH
 - Ethernet & TCP/IP
- Putting it all together
 - Case study

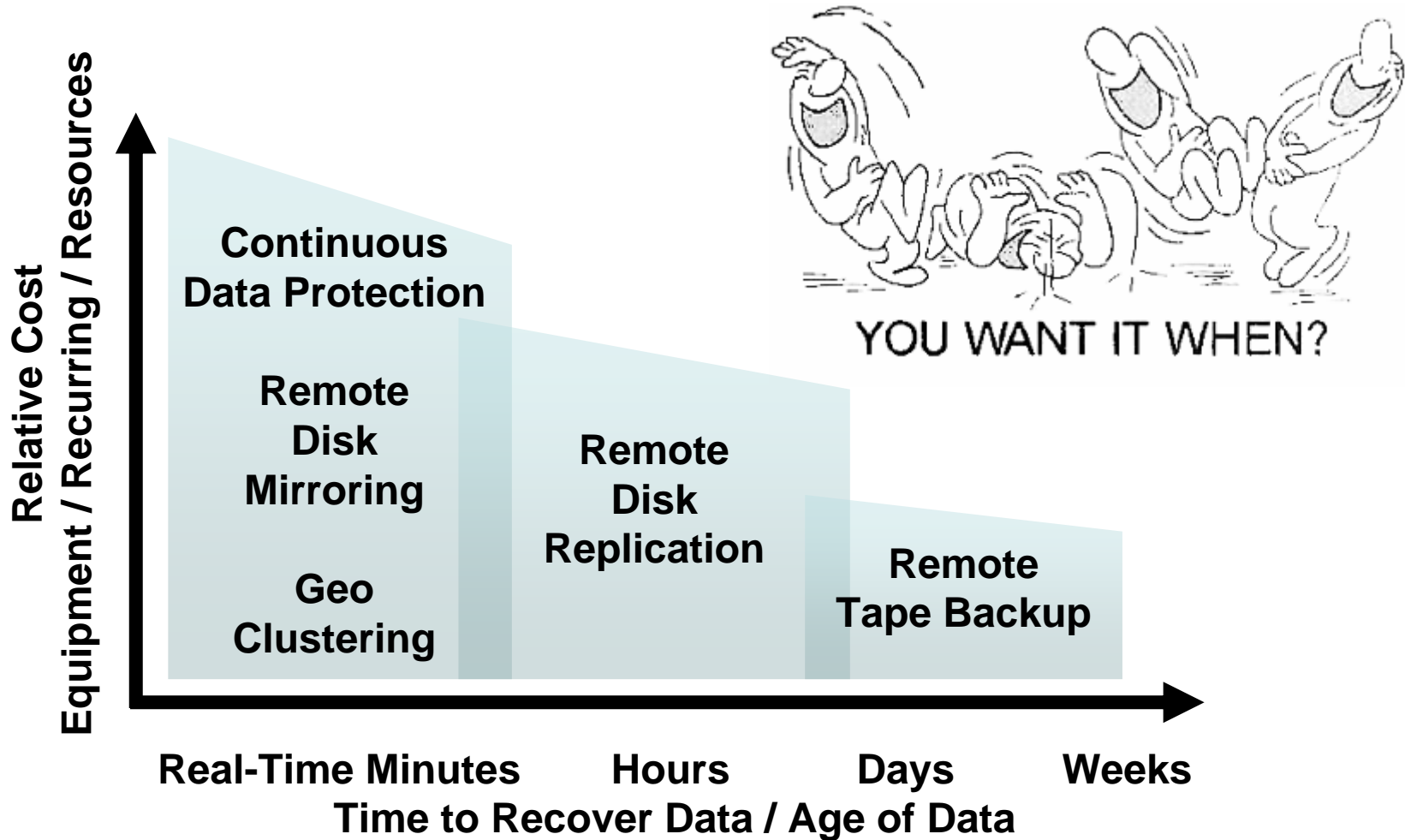
Drivers:

Why is Distance so Important?

- **BC/DR**
 - Human
 - HW/SW
 - Power Outages
 - Nature
- **Business**
 - Consolidation
 - Virtualization
 - Security
 - “Lost Tapes”
- **Regulatory**
 - Health Insurance (HIP)
 - Gov’t (Sarbanes-Oxle)



Applications: Driven by Business Requirements



Storage Protocols:

Built for high bandwidth and low latency

Fibre Channel - FC100 (1Gbps), FC200, FC400, FC1200 (10Gbps)

- Established SAN protocol; Eliminates parallel SCSI inefficiencies
- 10km protocol reach, Extended w/ flow control and optical networking

ESCON (200Mbps)

- Dominant protocol for Mainframe interconnect (1M+ ports deployed)
- Droop after 9km, 200km w/ optical networking

FICON (based on FC100, FC200 & now FC400)

- Utilizes Fibre Channel L2 → evolution of ESCON (8X)
- Droop after 120km, Extended w/ flow control and optical networking

FCIP, iSCSI, iFCP (Ethernet; 100Mbps, 1Gbps, 10Gbps variable)

- TCP/IP using Ethernet interface to servers and storage devices

Techniques to increase distance

Fibre Channel (& FICON) Buffer Credit Flow Control

- Compensates for FC Layer2 R_RDY wait times over long distance
- “FC droop” → 1 BB_Credit corrects for 2km of fiber delay (FC100)

FCP SCSI Write Acceleration

- Works at SCSI storage protocol layer to allow host to burst write data before remote disk responds with XFER_RDY over long distance pipe

iSCSI use of TCP Sliding Window and Congestion Control

- Multiple packets of data can be affirmed with a single acknowledgment

Tape Pipelining for Remote Tape Backup

- Provides buffering and error recovery to emulate local tape controller to offset latency effects of long distance

** Verify capabilities and performance with your service or solution provider*

Techniques to optimize MAN/WAN throughput

Content Compression

- Applications can't drive full port rates (5-80% average)
- Removal of idle characters ensures only user data is transported

Data Compression

- Lossless and low latency; LZS (Lempel Ziv Stac) standard algorithm
- 2.5x to 10x reduction in bandwidth based on compressibility of data

Bandwidth Sharing

- Allow multiple applications to flexibly share MAN/WAN bandwidth

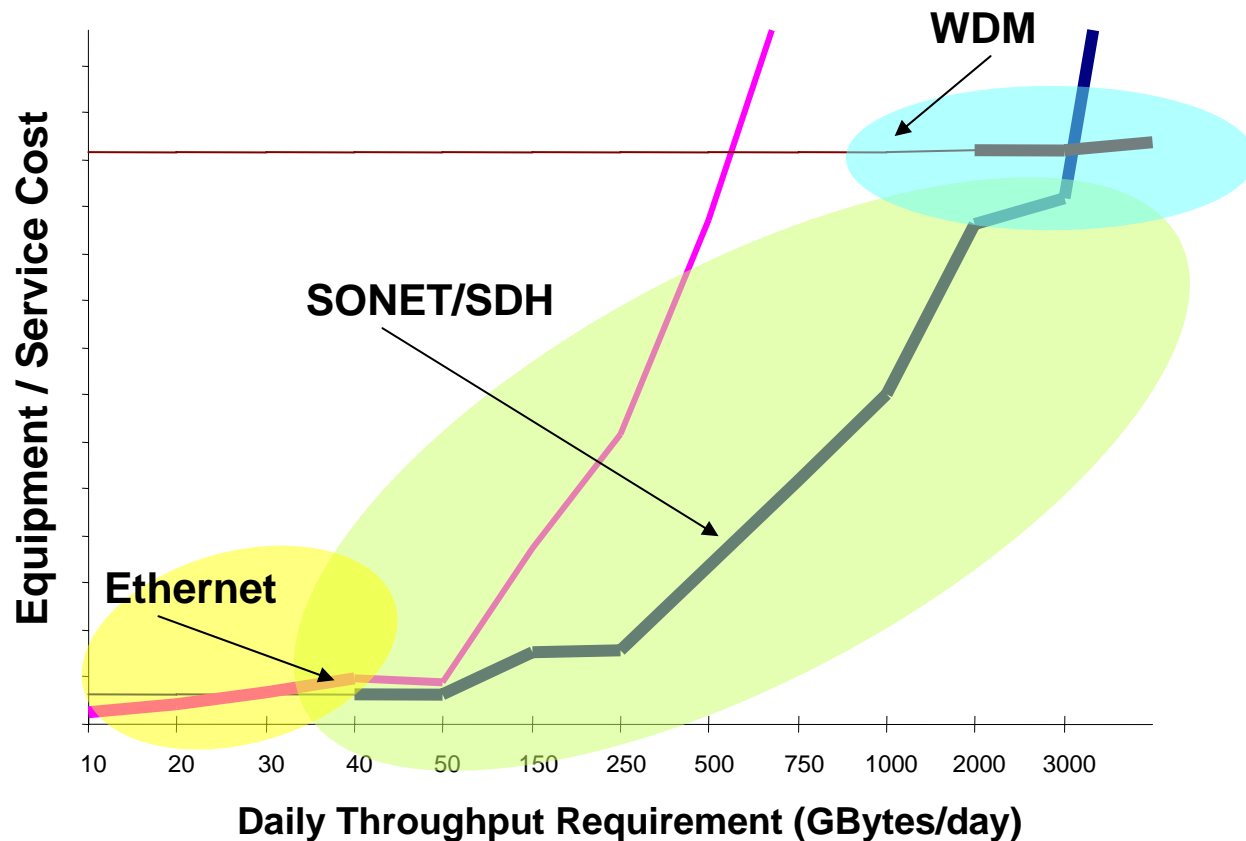
* *Verify capabilities and performance with your service or solution provider* 9

MAN/WAN Transport Options:

Relative Costs & Performance

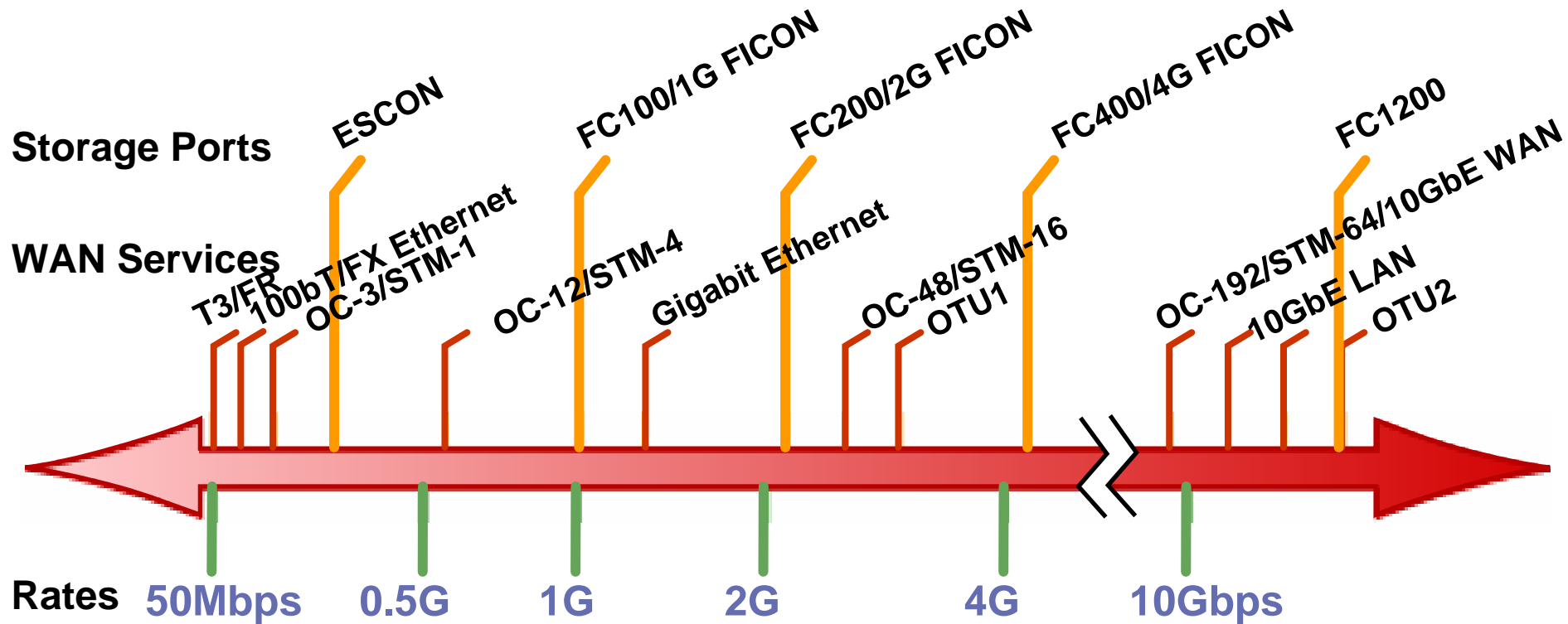
Many considerations:

- **Application**
- **Performance**
- **Latency**
- **Bandwidth**
- **Security**
- **Protection**
- **Distance**
- **Availability**
- **Cost**



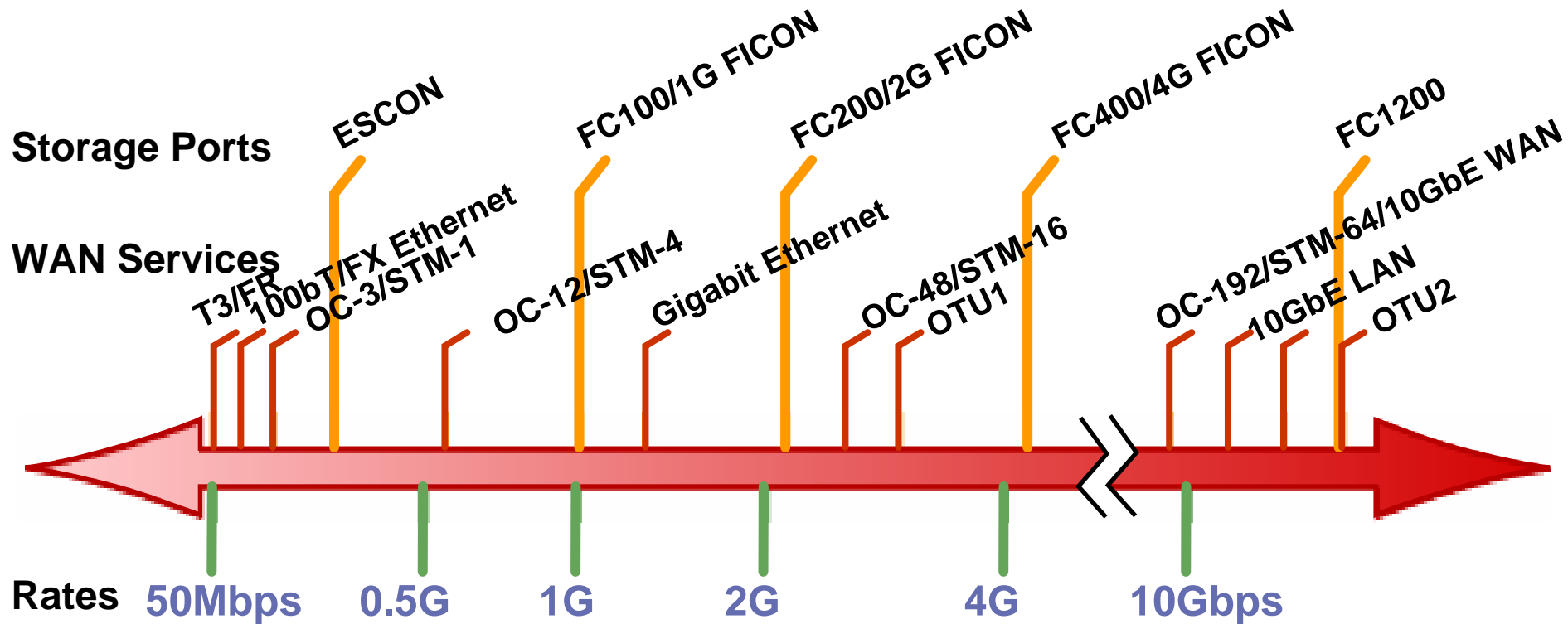
Storage Protocols

Don't Align Well with MAN/WAN Protocols



Storage Protocols

Don't Align Well with MAN/WAN Protocols



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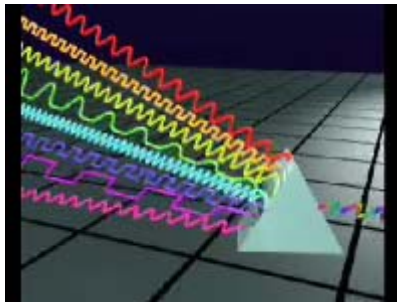
WDM MAN/WAN Networking

Wavelength Division Multiplexing

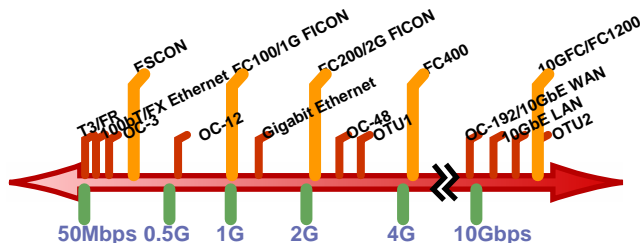


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A “LASER” shoots light through a single fiber optic strand...



...it is split into several wavelengths...



...with each wave carrying up to 2.7-10.7Gbps of “full-rate” throughput...

WDM

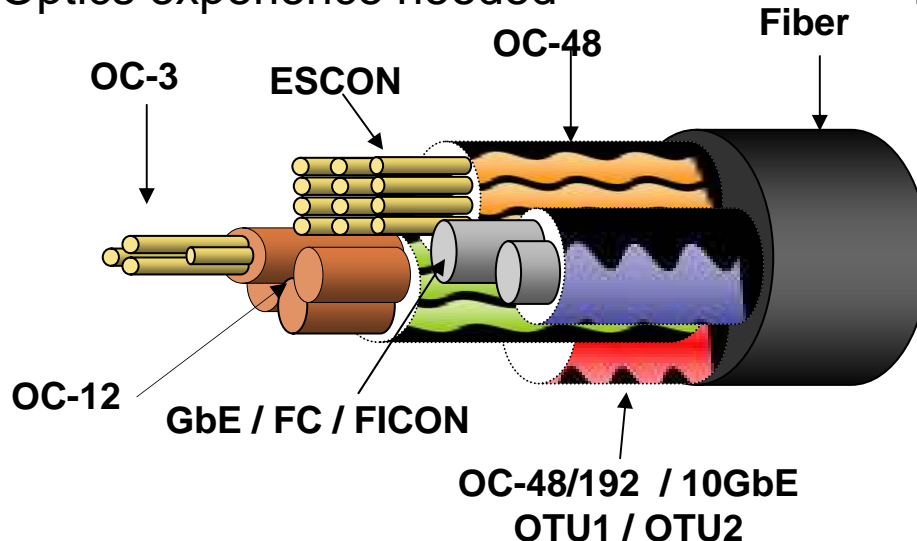
Flavors and Features

DWDM: Dense WDM

- 8-40+ waves per fiber
- 500mile reach with amplification
- 2.5Gbps & 10Gbps common
- Optical protection
- Optics experience needed

CWDM: Coarse WDM

- 4-8 waves per fiber
- 50mile reach
- 2.5Gbps
- Optical protection
- Lower cost with passive optics



Each wave (aka lambda) can utilize its full bandwidth capacity for multiple services

New WDM solutions offer mixed C/DWDM, mixed services per wavelength and service changes with no hardware changes

WDM

Deployment Notes

Work with service provider / solution vendor:

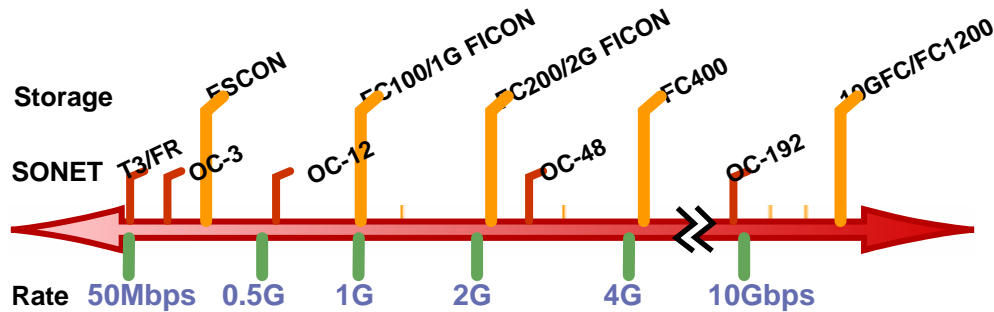
- Analyze requirements (protocols, bandwidth, latency, protection)
- Consolidate other applications (IT, TDM as well as mainframe, SAN)
- Compare alternatives (C/DWDM, service aggregation, management, visibility)

Acquire dark fiber: *Optical fiber in place but not used (i.e. unlit)*

- Local Carrier (e.g. AT&T, Qwest, Verizon)
- Dark Fiber Providers:
 - 360Networks, AboveNet, ACSI, Aerie, Broadwing, C2C, Caprock Communications, Dedicated Fiber Solutions, Enkido, Evolution Networks, Fiber Technologies, Fiberworks, Florida Fiber Networks, Global Crossing, Global Metro Networks, Level 3, Looking Glass Networks, PFNet, Phonoscope, Qwest, WCI Cable, Williams, ... *just to name a few ...*
- Utilities:
 - American Fiber Networks, AEP Communications, Allegheny Communications, AVISTA, CFW Communications, First Energy, GPU Telecom Services, City Of Los Angeles, Con Edison, Dominion Telecom, Espire Communications, FPL Fibernet, Los Angeles Department of Water, NeesCom, Neon, City of Palo Alto Utilities, R&B Communications, Progress Telecom, Sierra Pacific, Telergy, Touch America, ... *just to name a few ...*
- Brokers, consultants, solution vendors, internet search

SONET/SDH MAN/WAN Networking

aka TDM – Time Division Multiplexing



- Well established and widely available
- Metro to Wide area reach
- Connection based with predictable low latency
- Highly reliable with path protection
- New advances increase interoperability and flexibility*
 - FC, FICON, ESCON as well as Ethernet (full & sub-rate)
 - Generic Framing Procedure (GFP) & Virtual Concatenation (VC)
 - Flow control & data compression

* *Verify capabilities with your service or solution provider*

Check out
SNIA Tutorials:



- Networking Technologies:
Concepts in Internal and External
Networked Storage

SONET/SDH

Deployment Notes

Understand your actual throughput needs:

- SONET/SDH can be expensive to transport at full protocol rates
- Changed data size ÷ by backup window = data rate

Work with carriers & fiber providers:

- Services may be tarified differently by local or out of region carriers
- Some have hosting and storage extension transport services leveraging SONET with lower equipment costs and simpler management

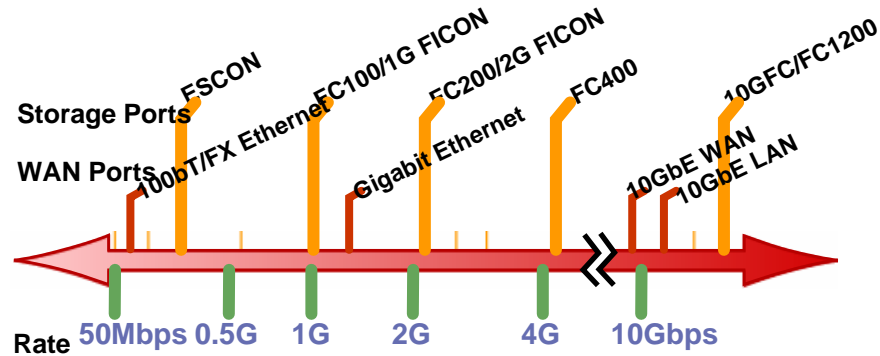
Consider storage extension platforms utilizing SONET/SDH:

- Combine multiple applications into a single SONET/SDH service
- Provide greater storage protocol visibility and priority management
- Optimize service with data compression
- Extend application reach with flow control and write acceleration

Notes:

- Don't expect your transport sales guy to know much about storage
- Ask about their enterprise professional services or storage/service bundle offers

Ethernet & TCP/IP MAN/WAN Networking



- TCP/IP *hops* across the network
- For MAN/WAN it *rides* over SONET, WDM or native Ethernet
- Extensive reach and availability
- Well understood and accepted in IT world
- Low service cost points for *best-effort* services
 - Short-term bursty, file-based, small “packets”, connectionless
 - Congestion common, retransmits, variable/high latency
- Better-effort services becoming more available
 - Ethernet Private Line, MPLS, RPR, Carrier Ethernet

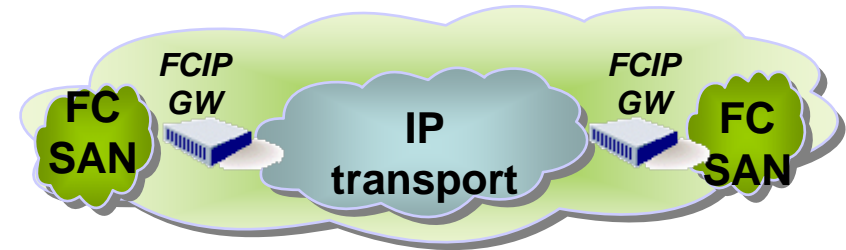


Know your application's performance requirements!

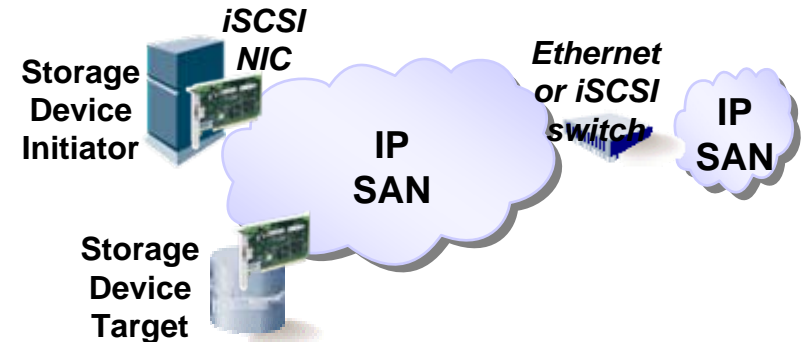


Ethernet and TCP/IP for Storage Networking

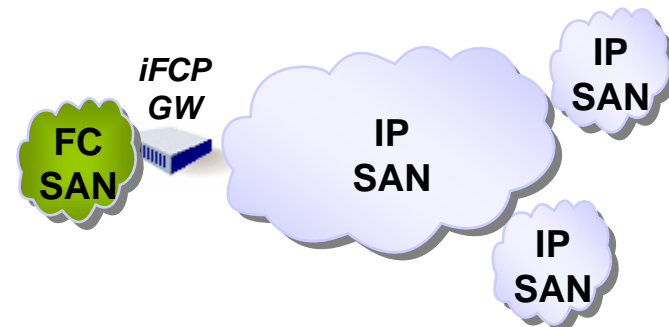
- **FCIP - FC over TCP/IP**
 - IP transport extends single SAN
 - FC devices & fabric services
 - Gateway devices connect FC SANs



- **iSCSI - SCSI over TCP/IP**
 - IP SANs for small/med+ enterprises
 - IP devices over IP fabric services (no FC)
 - iSCSI NIC or Gateway used



- **iFCP - Internet-Fibre Channel Protocol**
 - Multiple separate SANs based on IP
 - FC devices over IP fabric services
 - Gateway devices create IP SANs



Ethernet and TCP/IP Deployment Notes

Identify your application's performance requirements:

- Latency, throughput, tolerance for packet loss
- Ask your extension application software vendor

Balance cost savings with performance issues

- Good for low performance, non-real time backup applications
- TCP/IP windowing technique provides flow control
- Congestion, packet loss, round trip delay, timeouts, retransmissions and TCP/IP stack overhead result in "IP Droop"

Get the highest performance Ethernet service available

- 99.99% packet delivery ratio agreement (IP VPNs are 99.95 or less)
- Deterministic (non-routed → over SONET or Ethernet Private Line)

Consider storage extension platforms using Ethernet/IP WAN:

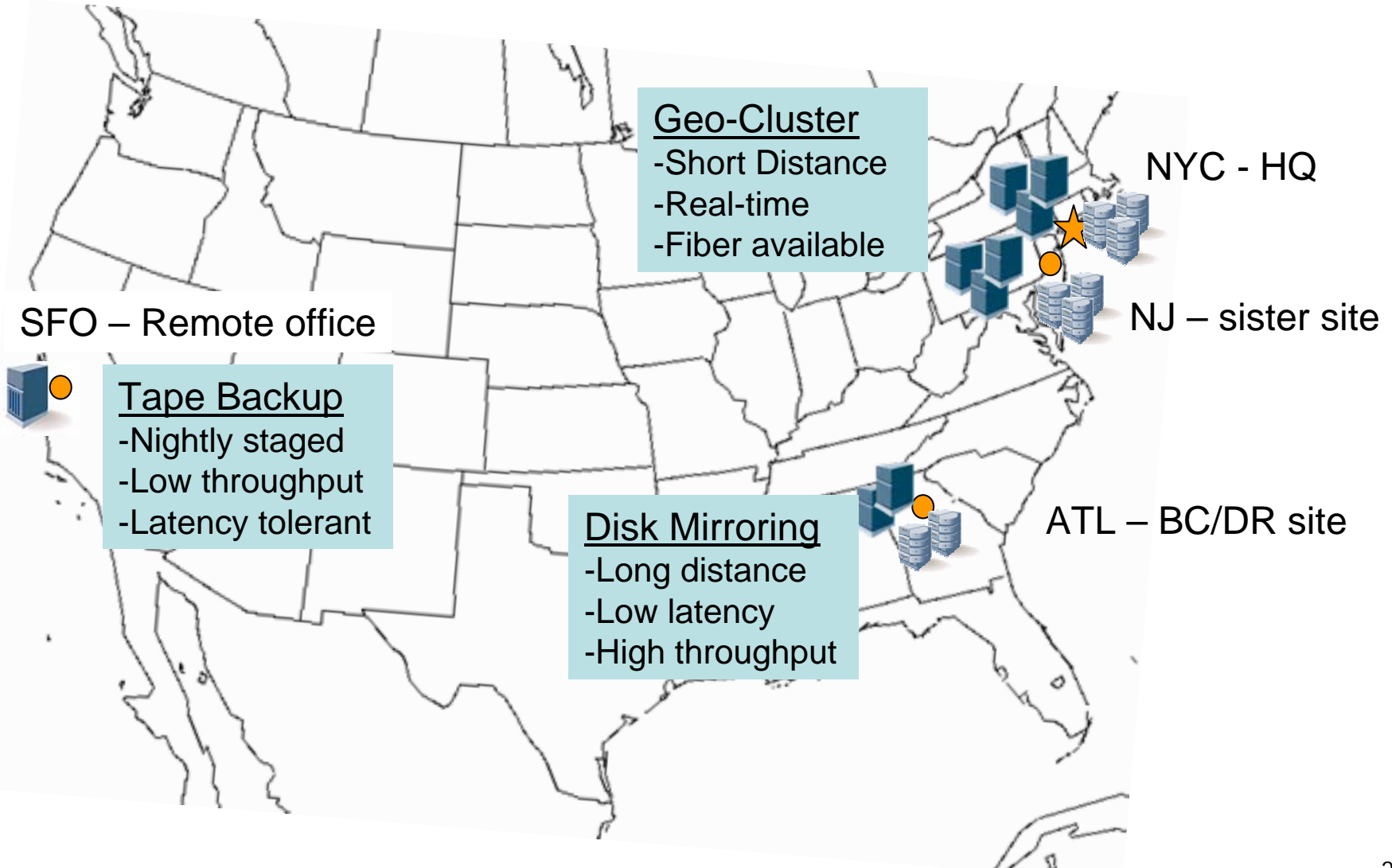
- Combine multiple applications w/ visibility & management
- Optimize service with data compression
- Extend application reach with flow control and write acceleration

Agenda

- Drivers, Applications & Protocols
- Extension Optimizing Techniques
- Transport Technologies
 - WDM
 - SONET/SDH
 - Ethernet and TCP/IP
- **Putting it all together**
 - Case study

Case Study:

Putting it all together

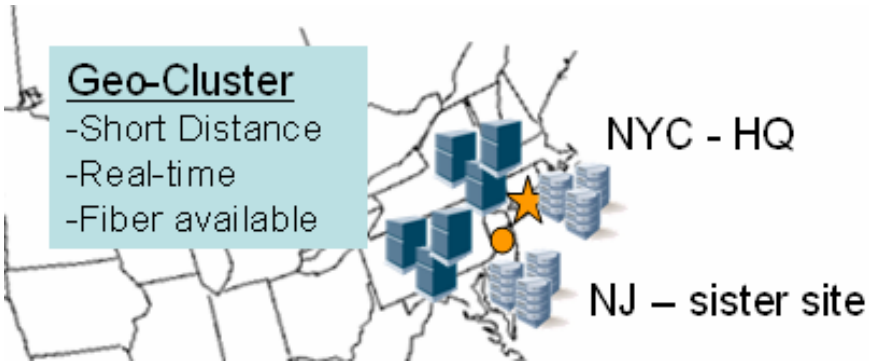


Case Study

Recommended option (NYC-NJ)

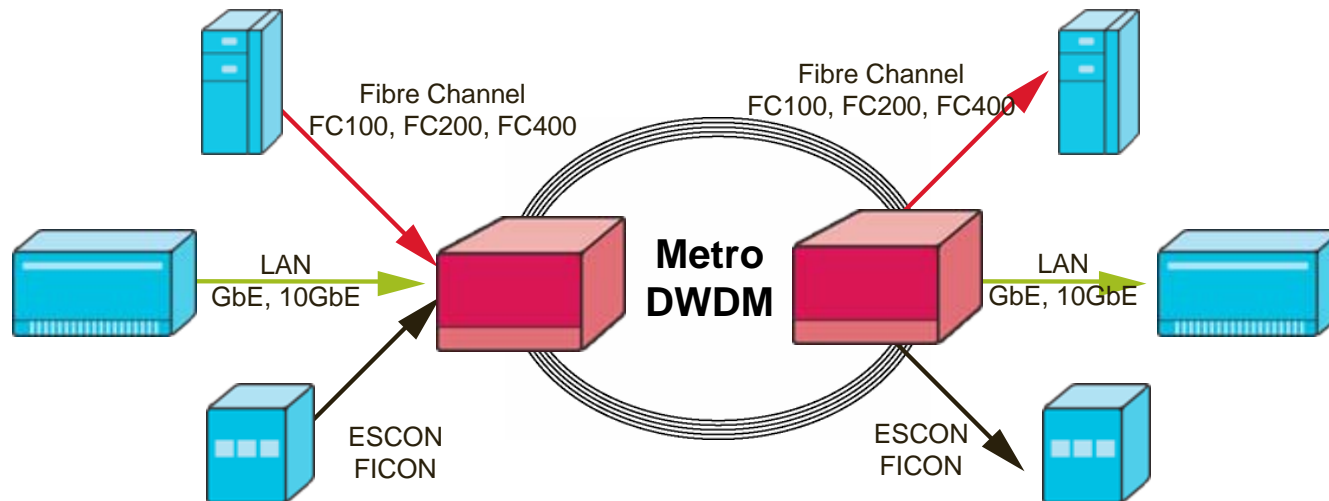
Geo-Cluster

- Short Distance
- Real-time
- Fiber available



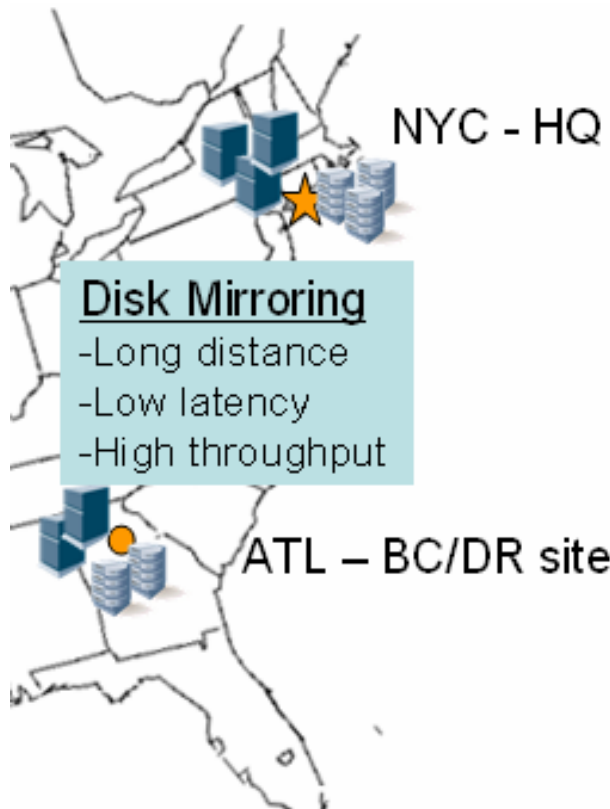
WDM CPE Equipment at each site

- Lease one pair of dark fiber
- Consolidate all applications transparently
- Fiber protection
- Future-proof (apps, protocols & bandwidth)



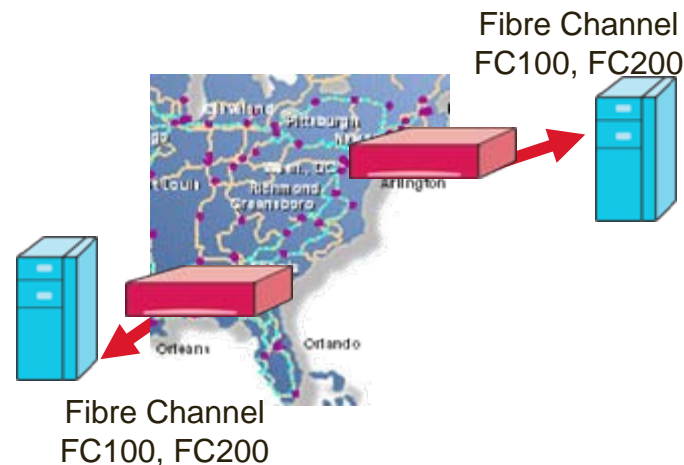
Case Study

Recommended option (NYC-ATL)



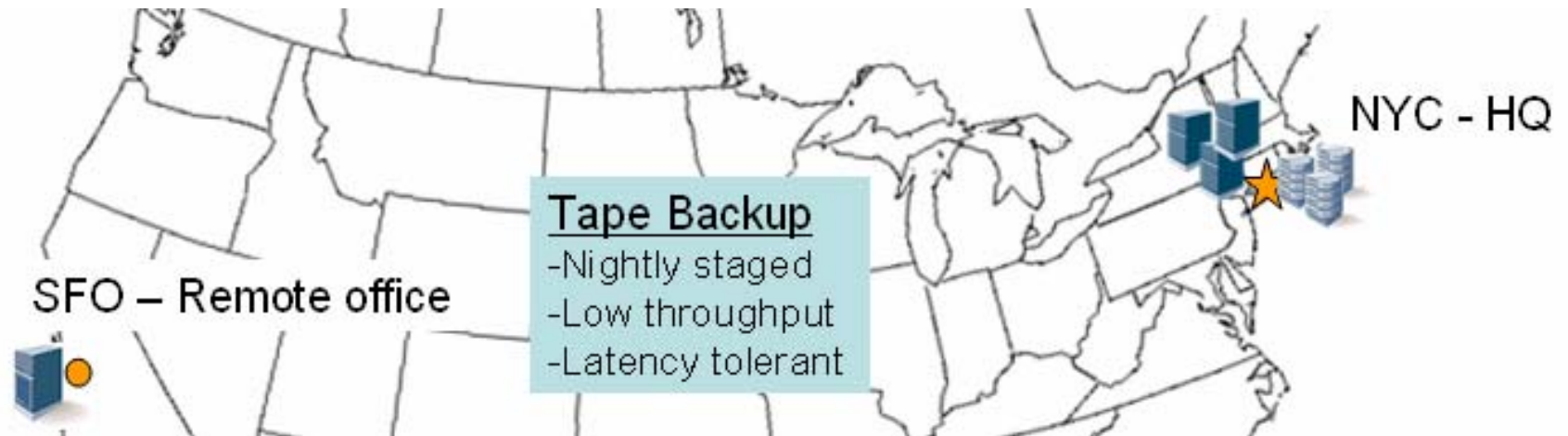
SONET

- OC-3 or Storage/WAN bundled service
- SONET protection
- Asynchronous Disk Mirroring due to distance
- Flow control / Write Acceleration minimizes latency effects
- Data compression optimizes throughput



Case Study

Recommended option (NYC-SFO)



TCP/IP over Ethernet or DS-3

- Off hours, non-peak use
- Lower bandwidth required
- Flow control / Tape pipelining minimizes latency effects
- Data compression optimizes throughput
- Option to include backup of other locations on the WAN

Summary

- Drivers, Applications & Protocols
- Extension Optimizing Techniques
- Transport Technologies
 - WDM
 - SONET/SDH
 - Ethernet & TCP/IP
- Putting it all together
 - Case study
- Q&A

References

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- The Resilient Enterprise - The Readiness Guide for the Enterprise
Veritas Press ISBN: 0974457809
- SNIA IP Storage Forum – www.snia.org/ipstorage/home
- SNIA Dictionary – www.snia.org/dictionary
- SNIA Web Site – www.snia.org/education

Check out

SNIA Tutorials:

- Networking Technologies: Concepts in Internal and External Networked Storage
- IP Storage Technologies & Solutions
- IP Storage Protocols



Q&A / Feedback

- Please send any questions or comments on this presentation to SNIA: track-networking@snia.org

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