Pathways to Worldwide Network and Computing Facilities

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The Chicago Metropolitan Area Network (MAN)

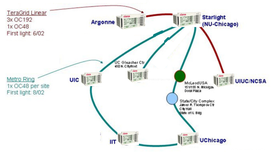
Genesis of a Metropolitan Area Network

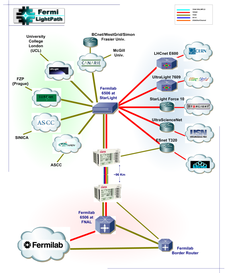
I-Wire Optical Network Deployed:

⇒ Argonne National Laboratory leases optical fiber pair to StarLight

⇒ DWDM equipment is from Ciena

2002





Fermi LightPath Optical Network Deployed:

⇒ Fermilab leases optical fiber to StarLight

⇒ Fermi LightPath used for end-to-end circuit connections

⇒ DWDM equipment is also from Ciena

2004

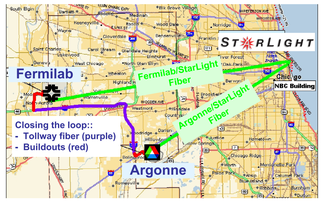
Fiber Ring Is Closed:

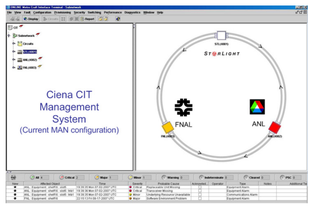
⇒ DOE proposes MAN for Chicago area National Labs

⇒ Argonne and Fermilab agree to provide MAN services

⇒ Missing fiber link between Argonne and Fermilab put in place

2006





Three Node MAN is implemented:

⇒ Argonne and Fermilab fiber and Ciena DWDM equipment integrated

⇒ Joint management of MAN infrastructure initiated

⇒ DOE ESnet uses MAN channels to provide internet access for the Labs

2007

MAN Technical Specifications

⇒ Linear (pt-to-pt) architecture with pass-through
- Not SONET-based rings (too expensive)
- Redundancy provided through multiple paths
- Failover left to higher layer (IP) rerouting

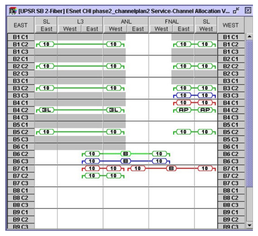
⇒ G709 Forward Error Correcting
- Correction of burst errors up to 128 consecutive bytes

⇒ Tunable wavelength transponder modules

⇒ Longest segment 96km (Fermilab-StarLight)

⇒ Bandwidth capacity:
- 33 channels available on each fiber
- Channels currently capable of supporting 10GE
- 40Gb/s (4x10GE) modules are on the horizon

⇒ Optical Band:
- B-channel (1529.55nm – 1563.05nm)
- 100Ghz (0.8nm) channel spacing



MAN Advantages & Disadvantages

⇒ Benefits:
- Economic means of providing high offsite bandwidth capacity
- Flexibility in configuring and changing offsite connectivity
- Deterministic (cost & lead time) expansion capability

⇒ Drawbacks:
- High initial deployment cost
- Significant additional management effort
- Different technology requiring difficult-to-find skill sets
- Offsite equipment to maintain

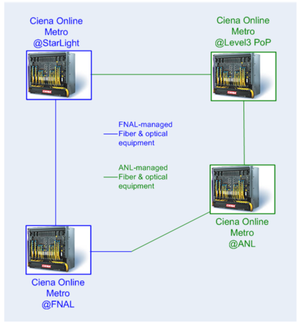
Anatomy of the Esnet Chicago MAN

Bottom (Physical) Layer:

⇒ Leased fiber between hubs

⇒ DWDM central chassis

⇒ Assigned management responsibilities for each Lab



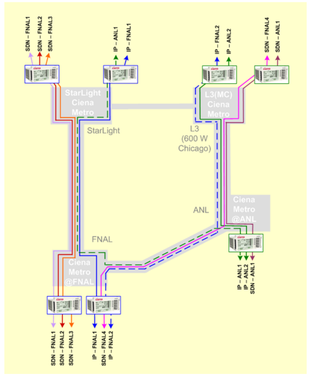
Middle (Channel) Layer:

⇒ FlexSelect with 10GE modules provide data channels

⇒ Each channel is a 10GE data pipe between a Lab & a PoP

⇒ Each Lab has 10GE data pipes to both PoPs for redundancy

⇒ Assigned management responsibilities for each Lab



Upper (Service) Layer:

⇒ ESnet has MAN switches at each Lab and each PoP

⇒ 10GE data pipes provided to ESnet as a layer-2 links between their switches

⇒ ESnet provides layer-3 (routed) and circuit (SDN) services for to the Labs

⇒ Responsibility for services shared between Labs & ESnet

⇒ Total number of 10GE data channels provided:

	StarLight	Level3 PoP	Total
Argonne	1	2	3
Fermilab	4	2	6
		MAN total:	9