



TOWARDEX[®]
Your network success story.

EdgeConneX Boston Expansion

February 2019

EdgeConneX Boston Build

- TWDX hadn't built to any new data centers in Metro Boston since 2016. This is our first data center expansion in 3 years.
- New Peering Site for TWDX IP (AS27552)
 - Increase diversity and reliability of our IP transit service.
- MASS IX installation at EdgeConneX:
 - Metro distributed IX fabric spanning multiple sites: MASS-IX is delivering a modern, distributed European-style IX fabric for the first time in Boston and southern New England.
 - IX port charges waived for ASNs connecting at EdgeConneX through 2020*
 - 10GE ports are free for first port. Additional ports will incur standard port charges; charges may be waived for content partners on business case basis.
 - 100GE ports are free only for content partners, and on justified basis (minimum traffic commitment).
- * Cross-connect charges (if applicable) not included.
- We're committed to developing new peering facilities in Boston to drive competition in the market.

Project Overview

- Diverse fiber routes back to TWDX hub facilities in 300 Bent Street (Cambridge, MA) and 70 Innerbelt Road (CoreSite Boston).
- State of the art network:
 - “10G-free” at the common photonic layer:
 - 400 Gbps modulation per lambda, no dispersion compensation required and eliminates regen
 - Lit capacity of 2.4 Tb/s back to downtown hub facilities at phase one. 32 Tb/s in the future.
 - <50ms 1+1 optical protection switching at phase one. CDC ROADM at phase two.
- Unique routing increases diversity and improves network reliability:
 - Avoids 1 Summer Street
 - Comcast New England (AS7015)’s preferred site of interconnection
 - Custom designed and TWDX owned entrance facilities, laterals and part network segments:
 - Splicing with leased fibers and IRU segments at TWDX owned outside plant facilities.
 - Increased level of network control and cable routing for assured diversity and network survivability.

Fully diverse fiber routes

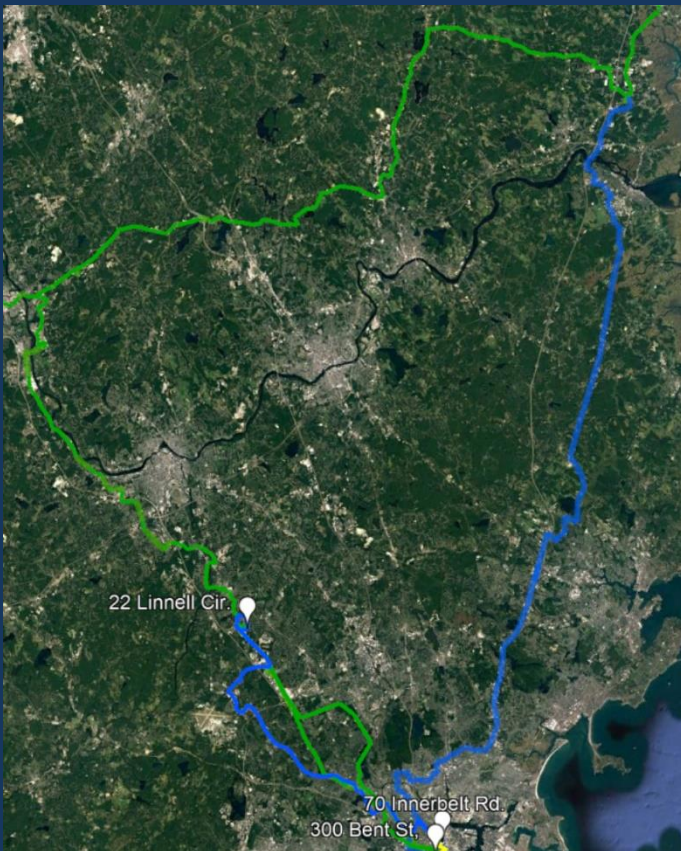
Coherent transmission: 400 Gbps per wavelength using PM-32QAM modulation.

- Up to 300km reach on SMF28.

WORKING PATH: Two routes (29km and 33km) spliced at pre-agreed points of interconnection onto TWDX laterals.
~40km total system distance: 100Ghz DWDM filters at terminal sites

PROTECT PATH: Two-strand long-haul fiber lease via Portsmouth, NH > Nashua, NH > Billerica, MA (~260km).

- No regens: Erbium Doped Fiber Amplifiers (EDFAs) combined with counter-propagating Raman pump at amp sites. Coherent 400Gb/s transmission eliminates dispersion compensation and need for signal regeneration.



WORKING PATH ~40 km:

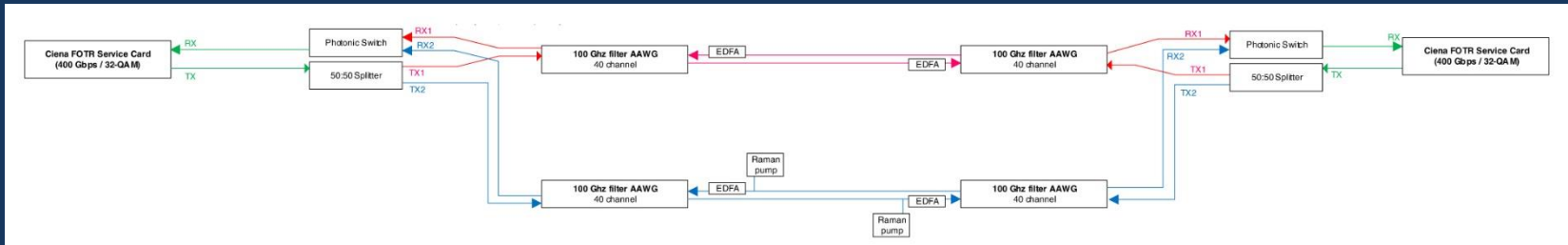
- Dark fiber lease available:
From 300 Bent Street & 70 Innerbelt to EdgeConneX
- 10G and 100G wavelength services available.

PROTECT PATH ~274km:

- Leased fibers from another carrier: Dark fiber lease is not available.
- Used by TWDX IP for line protection; 10G and 100G wave services are available in protected configuration.

Optical Transmission Pilot Testing - December 2018

- We've tapped Ciena for coherent transmission:
 - Utilizing WaveLogic AI 400 Gbps FOTRs on Ciena OME 6500 systems for 32-QAM modulation.
 - Plays nicely and compatible with existing passive plants used by 10G waves.
 - Test & demonstration topology in lab (December 2018) using spooled coils of fiber:



- Initial Phase for Launch (2019):
 - 6x 400 Gbps protected capacity lit on DWDM filters: 2.4 Tbps of initial lit capacity:
 - 1.2 Tbps to 300 Bent Street, 1.2 Tbps to 70 Innerbelt Road.
 - 1 + 1 optical line protection using photonic switches and 50:50 splitters for high speed failover (< 50ms) during fiber cut
 - CDC ROADM will replace optical line protection during Phase Two (estimated 2020)

TWDX IP Peering Enhancements

- Interconnections are being distributed throughout Boston metro.
 - Enhanced diversity: Data center events would have reduced impact on network operations.
 - TWDX IP peering routers are located at 300 Bent Street and 70 Innerbelt Road.
 - Comcast New England CRAN (AS7015) hub facilities are at Needham, MA and Woburn, MA.
 - Interconnection at EdgeConneX eliminates unnecessary backhaul to 1 Summer - more optimal routing and improved reliability by keeping traffic closer to Comcast's regional facilities.
 - Verizon (AS701) and CenturyLink fka Level 3 (AS3356) operate IP hubs in 300 Bent Street.
 - Eliminates unnecessary backhaul in the metro by connecting natively in the same hub.
 - GTT maintains optical node at 70 Innerbelt Road; Telia now on-net at EdgeConneX (recent deployment)
 - **IP interconnections are no longer concentrated at any single interconnection facility.**
- *Race to terabit*: 1 Tbps of blended IP bandwidth by end of 2019.
 - 400 Gbps of IP transit (CenturyLink/Level3, Telia, GTT)
 - 3x 100Gbps in Boston, 1x 100Gbps in NY/NJ
 - 210 Gbps of IX connectivity (MASS IX, DE-CIX both going 100G)
 - 370 Gbps of PNIs (upgrade major content PNIs to 100G, all PNIs moving to at least 2x10G)



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Project Status

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- EdgeConneX expansion project is being financed and completed in conjunction under the Joint Network Facilities (JNF) Program:
 - JNF delivers:
 - New joint-use facilities to house MASS IX, TWDX IP, Packetsurge and TOC operations under one roof.
 - New expanded head-end network hub facility at CoreSite Boston (70 Innerbelt Road):
 - 100KW critical load for network equipment use
 - 20 rack cage with expansion option for additional space.
 - Secure private suite for network hub facility at 300 Bent Street (completed on September 14, 2018)
 - 15 kilometers of new fiber optic cable being laid, with new construction for TWDX owned entrance facilities and conduits.
 - EdgeConneX fiber construction:
 - Construct new TWDX-owned lateral, entrance facilities and obtain easement & make-ready necessary aerial poles.
 - Interconnect/splice with leased fibers at outside plant on owned TWDX facilities.

2018	2019		2020
Design and development			
	Optical design validation and testing with Ciena		
	New JNF colocation facility fit-out at 70 Innerbelt		400 Gbps router interface deployment
	Cable duct, lateral, vault and manhole construction at 70 Innerbelt Road		Optical transport full migration to CDC ROADM architecture
	Ciena optical transport installation: Phase in new equipment onto existing fibers already operating for 10Gs		CDC ROADM architecture design and validation testing
	TWDX IP peering router installation at 300 Bent (ibr02.bos01)	Completion of 1 Tbps interconnection capacity for IP network	New TWDX IP hub aggregationx router (dcr03.bsn04) at 70 Innerbelt to replace dcr01.bsn05
	Aerial pole licensing, fiber approach design and lateral construction at Billerica, MA	TWDX IP peering router installation at 70 Innerbelt (ibr03.bsn04)	
	Fiber construction and installation at EdgeConneX.		
		Initial Service Commencement at EdgeConneX	Full Service Commencement at EdgeConneX

Estimated Project Cost

- Total estimated cost at ~\$2.29M
 - \$742,991 of \$2.29M budget already allocated as of December 31, 2018.
 - Estimated project completion - H1CY2020
- Required funding for FY2019 construction package is \$771,364 to meet program deadline.
 - \$481K paid by cash, with priority given to capital expenses eligible for full deduction under 26 U.S.C. § 179
 - Remaining \$290K being financed through revolving credit facility

	Budgeted Cost	Notes
Outside Plant Construction		
OSP Splicing, Lateral Construction, Pole Licensing and 10 year Infeasible Right of Use (IRU)	\$382,300.00	
EdgeConnex 275km protect route (via New Hampshire) fiber lease for 5 years	\$411,131.52	
Manhole & Vault Construction, Mobilization Costs	\$167,700.00	
New Entrance Facilities - 70 Innerbelt Road	\$50,747.00	
Insurance, Engineering Services and Administrative Costs	\$98,897.00	
Inside Plant Construction		
Colocation License - 22 Linnell Circle	\$0.00	TOC share of cost is zero. TWDX IP and EdgeConneX, Inc. contribute 60% of colocation and cross-connect costs through operating expenses and concessions; MASS IX budget contributes remainder through operating expenses.
BSN 04 Joint Facility Construction - 70 Innerbelt Road Cage fitout including racks, risers, electrical distribution, structured cabling, etc	\$189,000.00	
Colocation License - 70 Innerbelt Road (BSN 04) New DC4 Expansion Space	\$0.00	TWDX IP contributes 100% of colocation costs through operating expenses; 10 year lease already pre-negotiated and executed with CoreSite in 2018. TOC share of colocation costs is zero.
Optical Transmission and Lineside Equipment		
Ciena 6500 (S7, S14 and S-32) and WaveLogic AI Terrestrial Line Kits upto 1,000KM	\$528,821.00	
ROADM equipment, EDFA (amplifiers), Raman pumps, photonic switches, splitters and lineside filters	\$101,068.00	
IP Networking and Peering Equipment		
TWDX IP Peering Router ibr02.bos01 - 300 Bent Street Cisco ASR 9906, Lightspeed Commons + Tomahawk LC	\$132,850.00	TOC/JNF project covers 100% of CapEx for new TWDX IP peering hardware, in exchange for TWDX IP paying for CoreSite and CenturyLink colocation licenses.
TWDX IP Peering Router ibr03.bsn04 - 70 Innerbelt Road Cisco ASR 9906, Lightspeed Commons + Lightspeed LC	\$147,982.00	
Interim TWDX IP Peering Router ibr01.bsn05 - 70 Innerbelt Road DC5 Cisco ASR 9901 (temporary equipment until DC4 expansion is operational)	\$34,252.00	TWDX IP contributes 50% share of CapEx costs for interim peering router, plus support contract, licenses, etc. TOC share of item cost is remaining half.
Packetsurge / MASS-IX Switches - 22 Linnell Circle 2x Cisco ASR 9901	\$45,669.00	Packetsurge and MASS-IX budgets each contribute 33% pro-rata share of CapEx costs. TOC covers the remaining 33%.
TWDX IP Aggregation Router dcr03.bsn04 Cisco ASR 9922 (Megatron), Lightspeed LC	\$0.00	Although being done in conjunction with JNF, TWDX IP is solely responsible for dcr03.bsn04 capital costs. TOC share of costs is zero.
Total Program Cost	\$2,290,417.52	

Questions?

Contact us at ip-admin@twdx.net