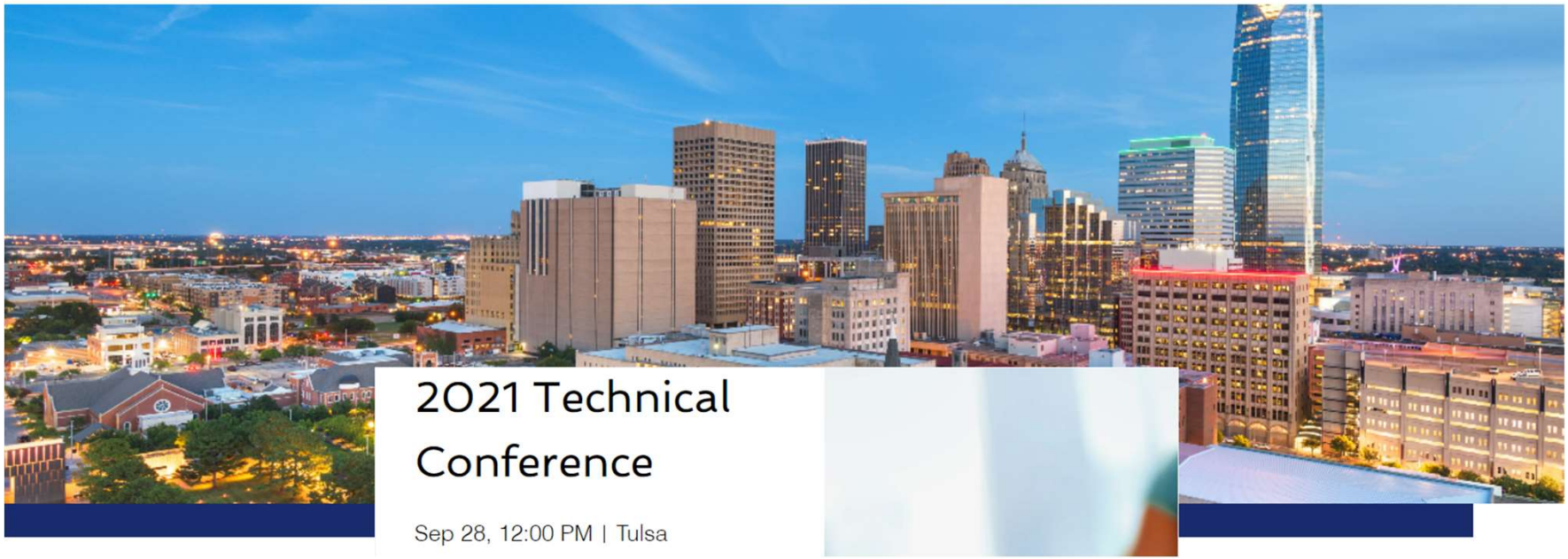
Fiber Transport



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Agenda

- Define The Term “Fiber Transport”
  - Optical Network Equipment
  - Physical Route
- Network Equipment Providers
- Optical Network Case Study
  - Review Technology Solutions
  - Review Equipment Components
- Large Scale Fiber Transport
- Leverage a transport fiber route

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Optical Network Equipment Vendors

- ADVA (Now Adtran)
- Ciena
- Cisco
- ECI (Now Ribbon)
- FiberHome
- Fujitsu
- Huawei
- Infinera
- Nokia
- ZTE

https://omdia.tech.informa.com/OM005920/Optical-Network-Hardware-Vendor-Scorecard---2020

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Fiber Transport Project Drivers

- Traditional Communications Provider
- Common network upgrades over time
- Looking For Growth Opportunities
- Tax Liability Dollars
- Project Vendor To Hit Short Timeline

CORE Telecom Systems

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Project Goals and Objectives

- Move multiple networks to one fiber ring
- Provide increased network capacity
- Provide scalability for future expansion
  - State Broadband Grants
  - USDA ReConnect Programs
  - RDOF Auction
  - Infrastructure Bill
- Meet project timeline

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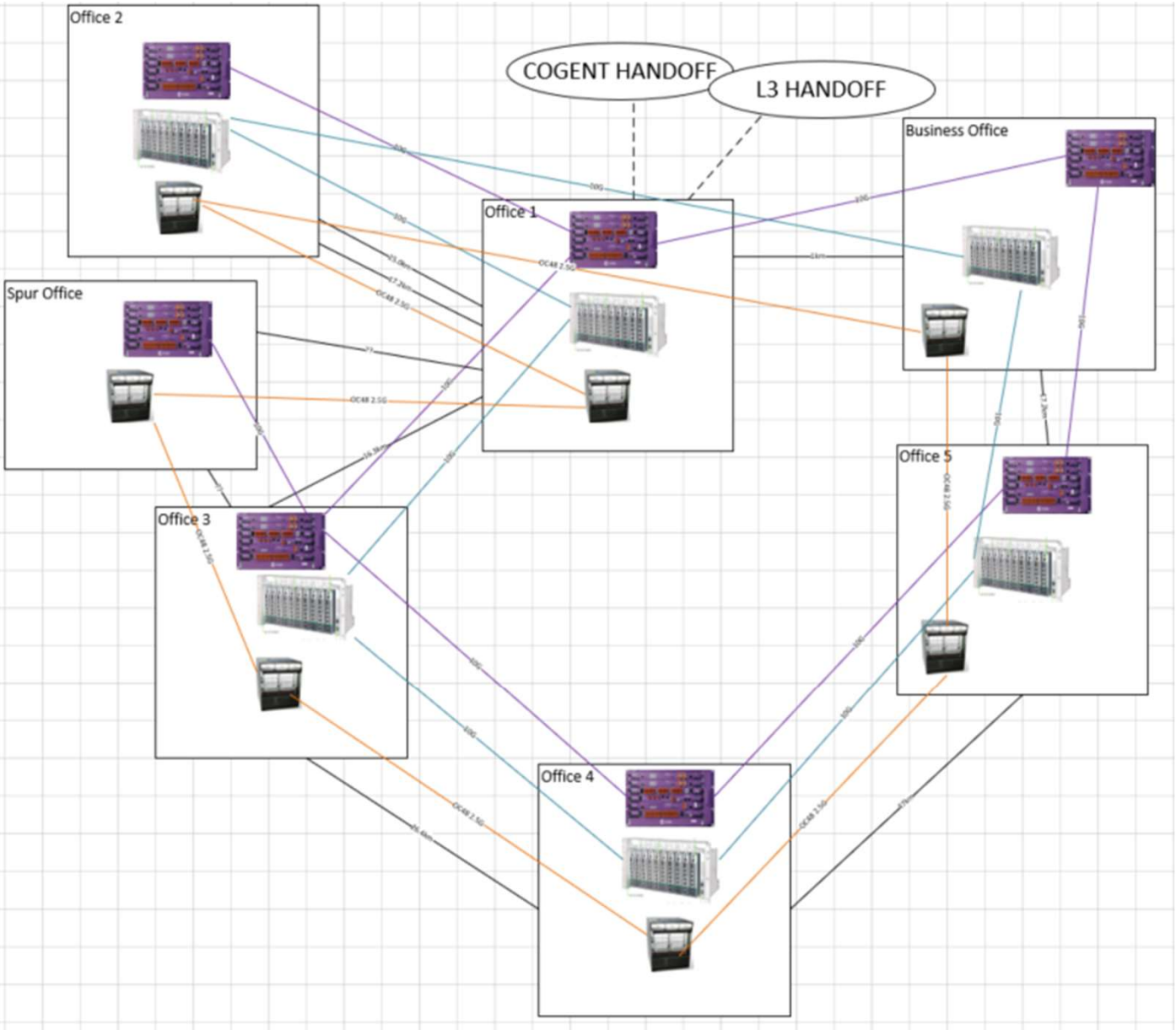
Existing Network



OC-48

10 Gig

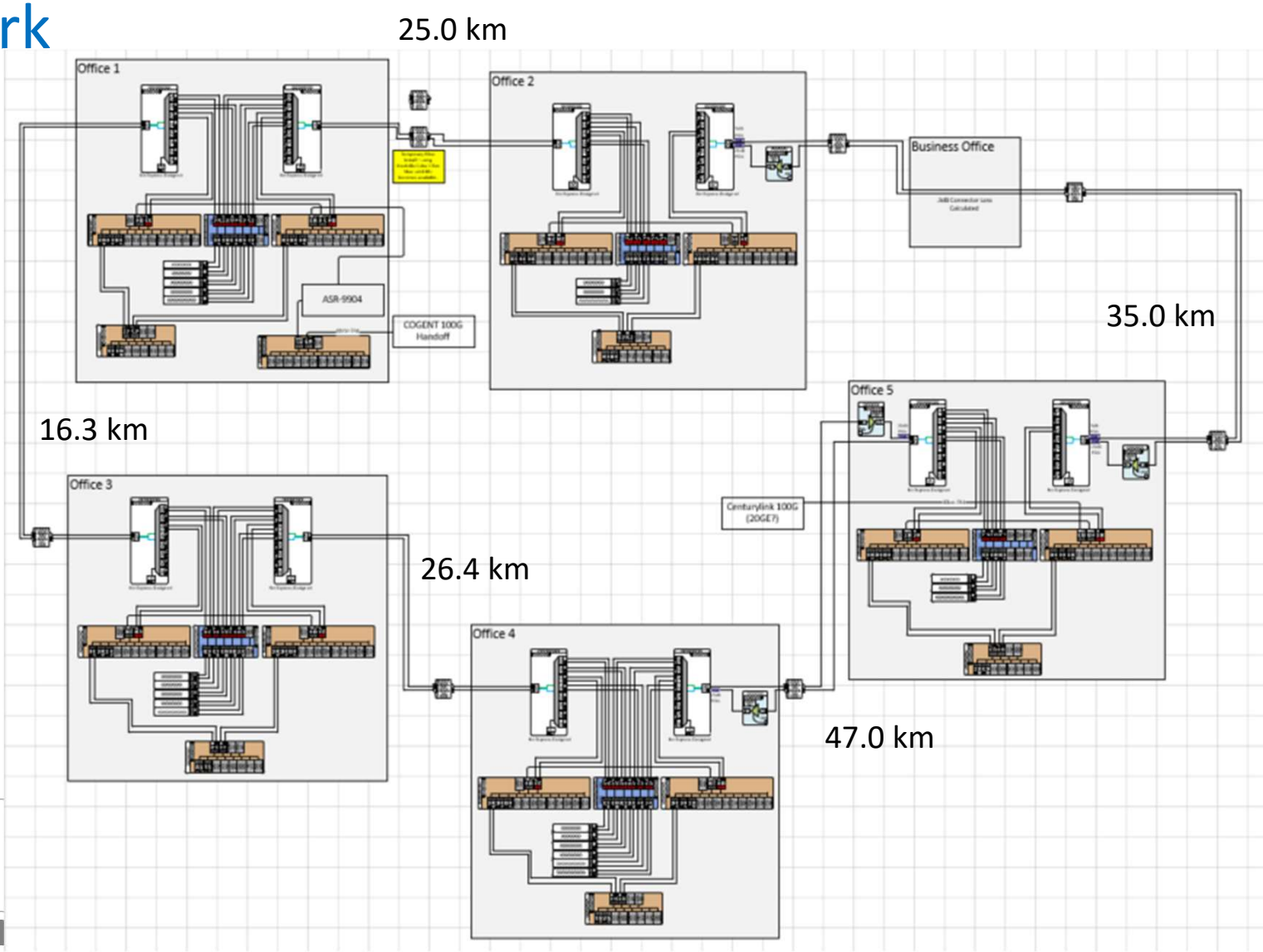
10 Gig

Proposed Network

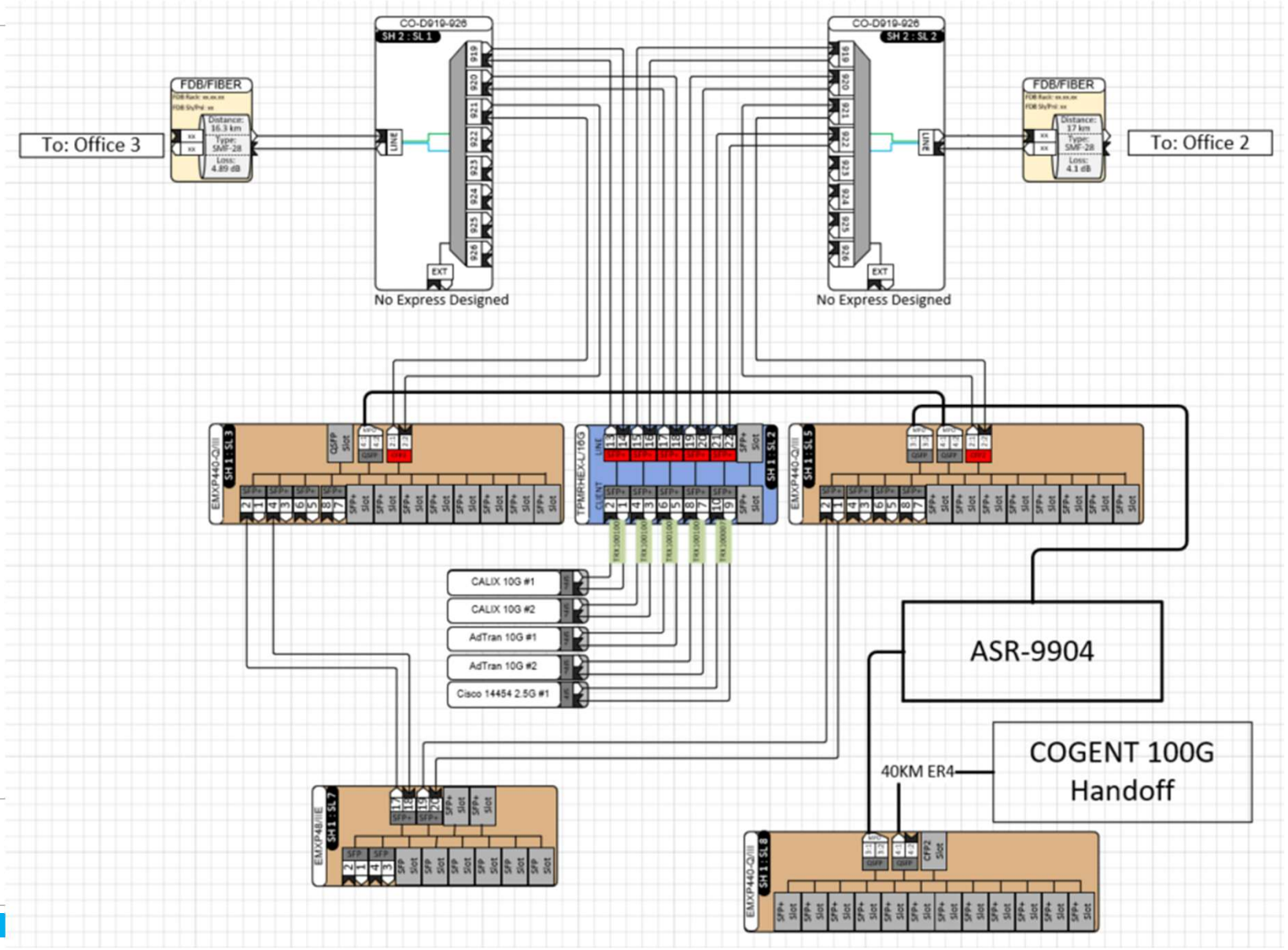
2 Fiber Ring
Each Direction

λ Infinera 200Gig

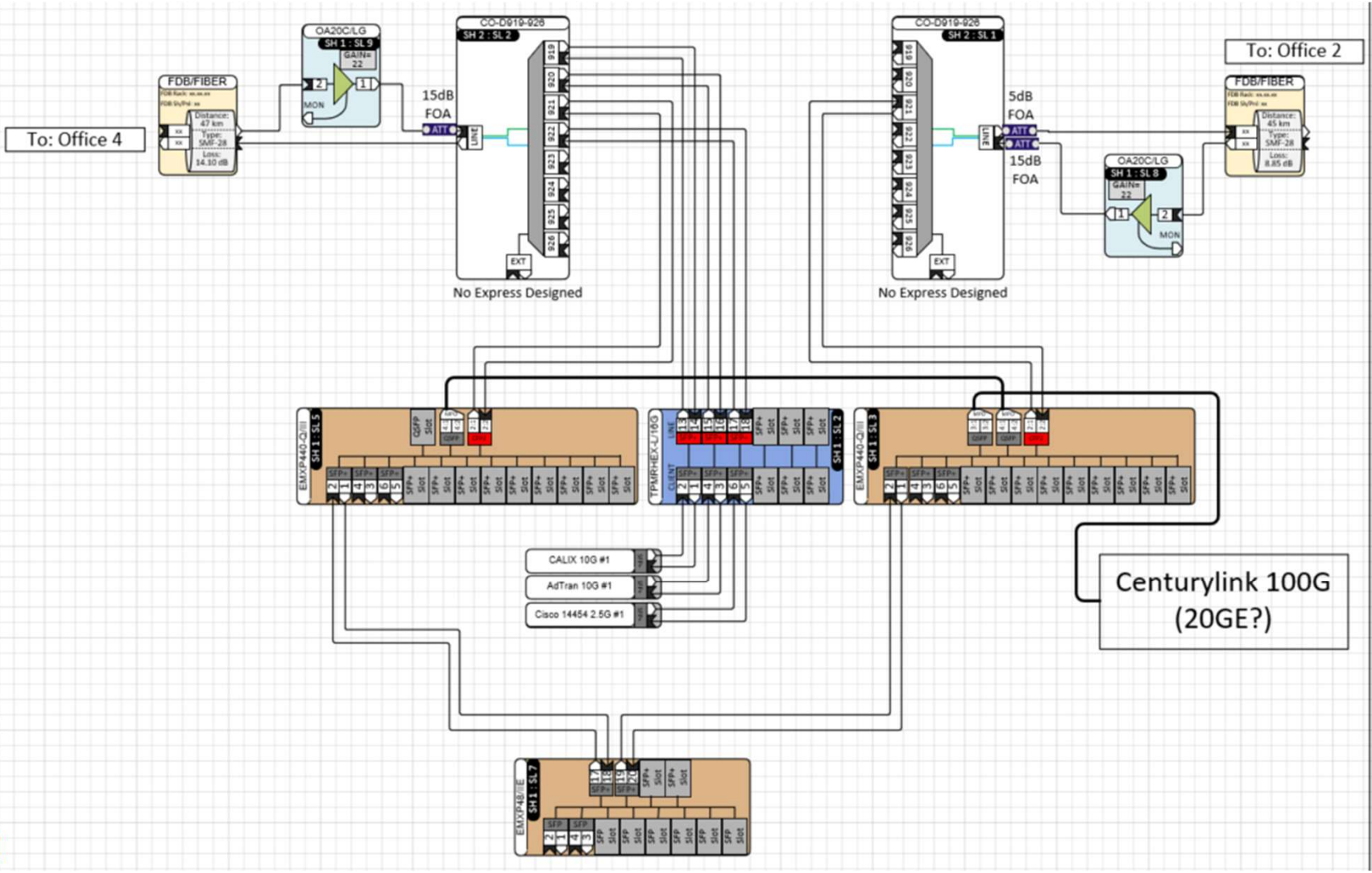
- λ SONET OC48 T-1's DS-3's
- λ Calix FTTH 10 Gig
- λ Direct Ethernet 10 Gig



Office 1


To: Office 3
FDB/FIBER
CO-D919-926
SH 2 : SL 1
No Express Designed
CO-D919-926
SH 2 : SL 2
No Express Designed
FDB/FIBER
To: Office 2
CALIX 10G #1
CALIX 10G #2
AdTran 10G #1
AdTran 10G #2
Cisco 14454 2.5G #1
ASR-9904
40KM ER4
COGENT 100G
Handoff

Office 5


To: Office 4
FDB/FIBER
OA20C/LG
SH 1 : SL 9
GAIN= 22
MON
15dB FOA
CO-D919-926
SH 2 : SL 2
No Express Designed
CO-D919-926
SH 2 : SL 1
No Express Designed
5dB FOA
15dB FOA
OA20C/LG
SH 1 : SL 8
FDB/FIBER
To: Office 2
EMXP440-Q
SH 1 : SL 5
TPUHHEX-LI16G
SH 1 : SL 2
EMXP440-Q
SH 1 : SL 3
CALIX 10G #1
AdTran 10G #1
Cisco 14454 2.5G #1
Centurylink 100G (20GE?)
EMXP48/E
SH 1 : SL 7

CO-D919-926 DWDM

Figure 65. Front panel of CO-D919-926.

5.1.31 CO-Dxxx-xxx

The CO-Dxxx-xxx plug-in units are 8ch DWDM dual fiber working Mux/Demuxes with upgrade port. By cascade connecting the different CO-Dxxx-xxx units it can provide 40-channel DWDM support with 100 GHz spacing on the ITU-T grid.

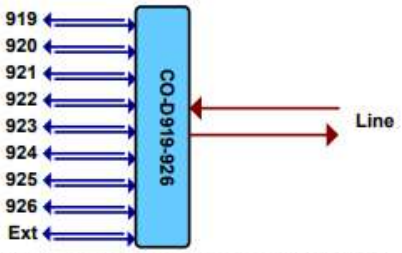


Figure 64. Basic function of CO-D919-926.

5.1.31.1 Optical Port and Connector Definition

CO-D919-926	CO-D927-934	CO-D935-942	CO-D943-950	CO-D951-958
Line Rx				
Line Tx				
Ext Rx				
Ext Tx				
919 Rx	927 Rx	935 Rx	943 Rx	951 Rx
919 Tx	927 Tx	935 Tx	943 Tx	951 Tx
920 Tx	928 Tx	936 Tx	944 Tx	952 Tx
920 Rx	928 Rx	936 Rx	944 Rx	952 Rx
921 Rx	929 Rx	937 Rx	945 Rx	953 Rx
921 Tx	929 Tx	937 Tx	945 Tx	953 Tx
922 Tx	930 Tx	938 Tx	946 Tx	954 Tx
922 Rx	930 Rx	938 Rx	946 Rx	954 Rx
923 Rx	931 Rx	939 Rx	947 Rx	955 Rx
923 Tx	931 Tx	939 Tx	947 Tx	955 Tx
924 Tx	932 Tx	940 Tx	948 Tx	956 Tx
924 Rx	932 Rx	940 Rx	948 Rx	956 Rx
925 Rx	933 Rx	941 Rx	949 Rx	957 Rx
925 Tx	933 Tx	941 Tx	949 Tx	957 Tx
926 Tx	934 Tx	942 Tx	950 Tx	958 Tx
926 Rx	934 Rx	942 Rx	950 Rx	958 Rx

Table 37. Optical ports

EMXP440 III Transponder

Key benefits:

- Compact and cost-efficient switching, demarcation and aggregation of Ethernet services
- Full wire-speed 440 Gb/s capacity for all frame sizes and up to 640 Gb/s capacity for average frames of 200 Bytes and above
- Dual pluggable 100 Gb/s/200 Gb/s interfaces for tunable metro WDM transport with 100 Gb/s (QPSK) or 200 Gb/s (16QAM) wavelengths
- Up to 24x 10 Gb/s interfaces through 12 onboard small form-factor pluggables (SFP+), and the option to extend to an additional 12x 10 Gb/s interfaces via a PTIO-10G unit
- Provides Carrier Ethernet 2.0 (CE 2.0)-compliant E-Line, E-LAN, E-Access and E-Tree services
- Ultra low latency and almost zero jitter
- Flexible network resiliency options through ERPS, LAG and MPLS-TP
- Synchronous Ethernet and IEEE 1588 for the efficient frequency and time synchronization essential for mobile backhaul and enabling time-division multiplexing (TDM)-over-packet services
- Low power design ensures low total cost of ownership

EMXP IIE Port Connections

The EMXP IIe Range Includes from the Upper Left: EMXP48 IIe, EMXP62 IIe, EMXP120 IIe, EMXP220 IIe and EMXP240 IIe – All with the Same Feature Set and Capabilities, but with Different Interface Configurations.

Key benefits:

- Compact and cost-efficient switching, demarcation and aggregation of Ethernet services
- 10 Gb/s interfaces with selectable mode: OTU2e with FEC for enhanced reach, or 10 Gb/s LAN
- Pluggable 100 Gb/s interface with support for CFP modules for SR10, LR4 and coherent 100 Gb/s with up to 1200 km reach
- Provides Carrier Ethernet 2.0 (CE2.0)-compliant E-Line, E-LAN, E-Access or E-Tree services
- Ultra low latency and almost zero jitter
- Connection-oriented transport of services through MPLS-TP
- Flexible network resiliency options through Ethernet ring protection, link aggregation and MPLS-TP
- Efficient video distribution enabled by source-specific IP multicast in combination with Internet group management protocol (IGMP) snooping
- Synchronous Ethernet and IEEE 1588 for efficient frequency and time synchronization essential for mobile backhaul and enabling TDM-over-packet services
- Low power design ensures low total cost of ownership

TPMRHEX-L/16G Transponder

Key benefits:

- Optimized for data center/SAN interconnects and mobile fronthaul thanks to broad support for services such as Fibre Channel (FC), 10 GbE and Common Public Radio Interface (CPRI)/Open Base Station Architecture Initiative (OBSAI)
- Unprecedented high density capabilities with six transponder functions on a one-slot unit, saving valuable rack space
- Wide range of supported traffic formats using SFP and SFP+ transceivers (614 Mb/s – 14 Gb/s)
- Technology-agnostic. Pluggable transceivers enable usage in CWDM as well as DWDM networks
- Low latency, making this unit ideal in data center and mobile fronthaul applications
- Low power consumption, reducing the total cost of ownership

Case Study Project Costs *

Location	Hardware Costs
Office 1	$77,000
Office 2	$79,000
Office 3	$77,000
Office 4	$80,000
Office 5	$81,000
Install; Training; Spares; TAC; License; EMS; Etc.	$106,000
Grand Total	$500,000

SFP's	Costs
TOM 100G QSFP28 SR4	$830
TOM 100G QSFP28 ER4 40kM 100 grey optic R34 Req	$11,950
CFP2-DCO Universal 100/200G	$14,927
Tune SFP+ DWDM 9.9-11.1 Gb/s 80km	$1,050
SFP+ 1310nm SM 10Gbps 10Km E-Temp	$98
SFP+ 1310nm SM 100 – 2700 Mbps 2Km	$61
SFP Ch22 DWDM 622-2700 Mb/s 120km	$505

* 1. Volume discounts apply
  2. Project Year 2019

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Case Study Expansion Success

Figure 1-1 TM-EMXP-XH800/DC Unit

1. Neighboring Town FTTH Expansion

2. Large Business (10 Sites) WAN Expansion – Office 4- Initial 1 Gig expand to 10 Gig

EDU5-TE

EDU5-GT

TM-EDU10G-LT

Key benefits:

- Low delay and jitter with Ethernet wire-speed performance for unprecedented QoS and SLA fulfillment
- Provides CE2.0-compliant E-Line, E-LAN, E-Tree and E-Access services
- Highly accurate and precise operations, administration and management OAM and performance monitoring through microsecond resolution
- Per-service visibility for all key operation administration and management (OAM) and SLA parameters, enabling individual SLA monitoring and service differentiation
- Synchronous Ethernet capabilities
- Provides seamless integration of Ethernet services into flexible CWDM and DWDM networks
- Hardened product options available

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Large Scale Transport

- Educational / Training Facility Focus
- Estimate 90 Entities
- Estimate 840 - 850 fiber end points
- Estimate a 12 or so Regional Hubs
- 800 Mile Ring

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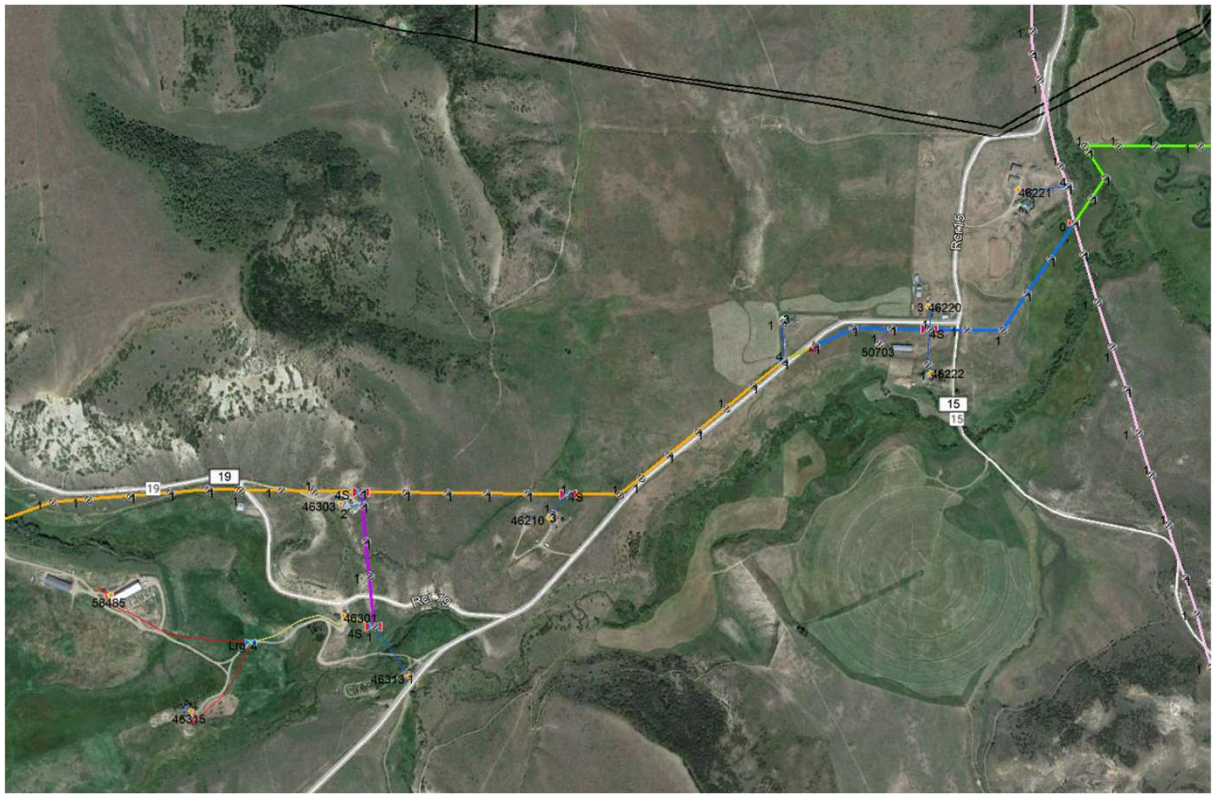
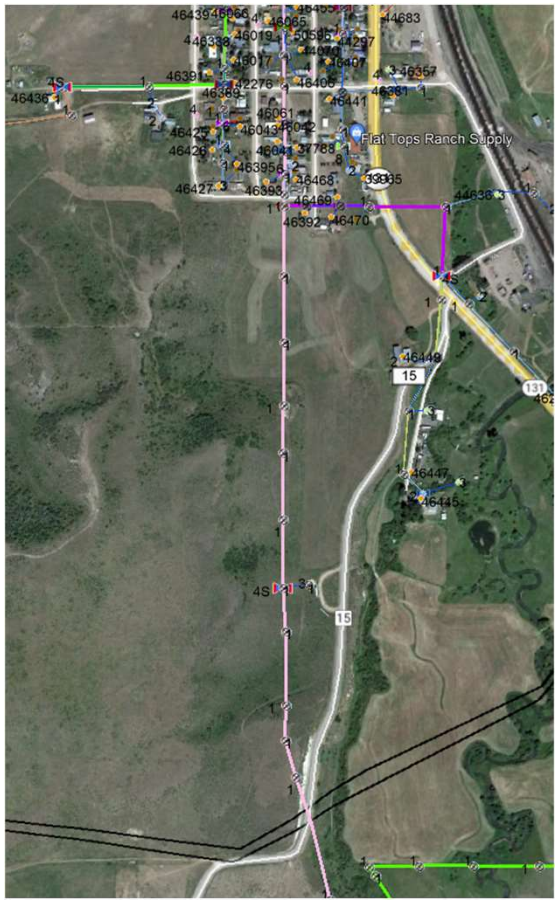
Leverage The Transport Route





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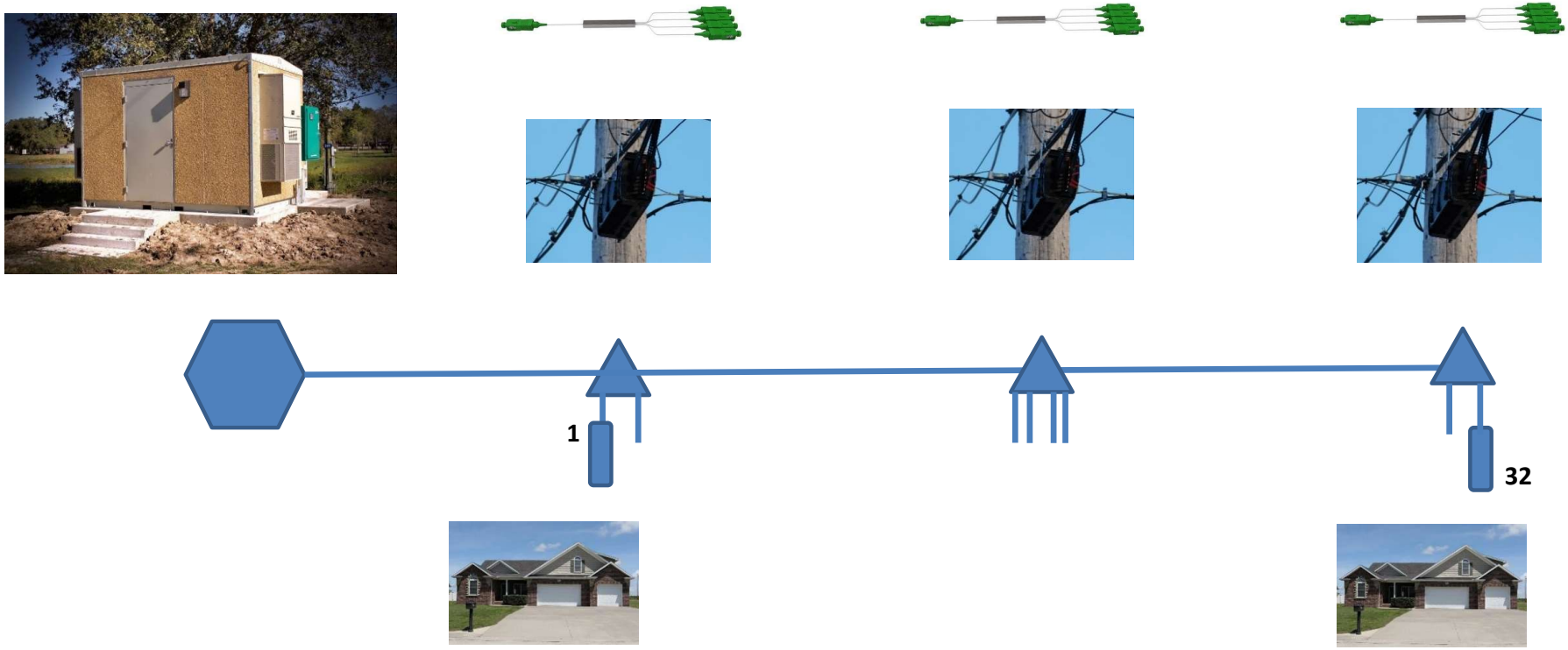
Leverage The Transport Route - Passive Tap



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References

Core Telecom Systems

https://www.coretelecom.net/

OMDIA – Global Research Leader

https://omdia.tech.informa.com/

JR1

Thank you!

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Slide 20

JR1 Julie Rieder, 9/22/2021