

Lean Disaggregated Regional Optical Transport

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- Stanford, Caltech, USC
- University of California System
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20,000,000 Californians use CENIC

NREN



- **8,000+** miles of optical fiber
- Members in all 58 counties connect via fiber-optic cable or leased circuits from telecom carriers
- Over 12,000 sites connect to CENIC

- A non-profit chartered & governed by its members
- Collaborates with over 750 private sector partners and contributes > \$100,000,000 to the CA Economy
- **20 years** of connecting California

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Lean Disaggregated Regional Optical Transport

Introduction

- Looking for a "crafty" use of optical communication infrastructure
 - Not necessarily looking for a purpose built solution that's packaged for sale I.E. a vendor based Optical Line System
- Natural application:
 - Soon to face constraints in short metro segments
 - Specifically with regard to cost efficiency and aggregate capacity available
- Bonus: Get to share results of initial deployment adding to the body of NANOG presentations in this domain

Situation Overview Diagram



Situation Overview

- Want to interconnect metro sites with reasonable capacity/density
- Requirements:
 - Low overall power footprint
 - 100GHz spacing compatible
 - To work with existing equipment & systems
 - Reasonable cost delta compared to other alternatives
- Not necessarily looking for 100% transparent DWDM/OTU transponders
 - IP/Ethernet transport is suitable between locations

Tech Dive

Deployed: 100Gb/s QSFP28 DWDM Pluggables

100G DWDM pluggables recently came to market

- Projected to be available through many suppliers
- Generally sourced back to one manufacturer (Inphi)
 - Manufacture collaborated heavily with Microsoft to refine these lean DWDM pluggables specifically for regional reach







QSFP28 DWDM Pluggables

- Easy to deploy incremental channels
 - No expert training required to operate
 - Centralized available expertise remains invaluable
- **Higher Density**
 - 32/36 ports per 1RU
- Low Power (4.5W)
- 80KM Reach w/DCF
- 2 PAM4 waves, in single 100GHz channel
- "Transponder"-like
- FEC on pluggable
- Lower overall cost and complexity



Pow





QSFP28 DWDM Pluggables

Considerations

- Lower launch power (Tx) than common pluggables (LR4, SR4)
- Need higher input power (Rx) than common pluggables
- Dispersion matters
 - We ran at approx.
 8KM without DCF
- Hardcoded wavelength



Diagram of deployment in the CENIC Network



Diagram of deployment in the CENIC Network

- Initial deployment ran 200Gb/s LAGs between two metro sites over a single fiber pair using QSFP28 PAM4 DWDM pluggables
- Put live traffic on top of it ran great, passed the scream test!
- Host Devices:
 - Router with QSFP28 ports on one side
 - Switch with QSFP28 ports on the other
- Ran a passive mux in front of line fiber, to run more than 1 circuit
- Amplifier is required but can be deployed on one side to save complexity
- No complex pre-packaged OLS (optical line system) was used can disaggregate components and deploy as needed

Live traffic – Operating Error Free



Live traffic – some FEC Data

- Site 1:
- pre-FEC BER of no more than:
 - •9.22e-04
- SNR Lane 1 around 19.6 dB
- SNR Lane 2 around 19.0 dB
- Uncorrected BER of 0

• Site 2:

- pre-FEC BER of no more than:
 - •8.77e-05
- SNR Lane 1 around 19.5 dB
- SNR Lane 2 around 19.9 dB
- Uncorrected BER of 0

Conclusions of deployment

• Wanted a leaner option to scale capacity/density between metro locations than we had previously considered or validated

• 100G DWDM QSFP28 pluggables have matured enough to be suitable and cost effective for our deployment needs in many metro areas

- Can continue to scale channels fairly easily with this approach.
- Retained flexibility for future use on a given optical segment.

Future Work

- Further validate MACsec with host devices (comes for free with the pluggable)
- We expect to share more details on our longer duration findings in the future
 - We're doing a fair amount of work with optical communication at varying distances with varying technology this is just one example.
- We welcome feedback or input from others doing similar work in this domain
 - We know you're out there, please come talk to us!
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Thank You