



Evolution of high speed interfaces in disaggregated open networks

Stephan Neidlinger

Netnod, Stockholm, March 15, 2018



Outline

1

Disaggregated networks

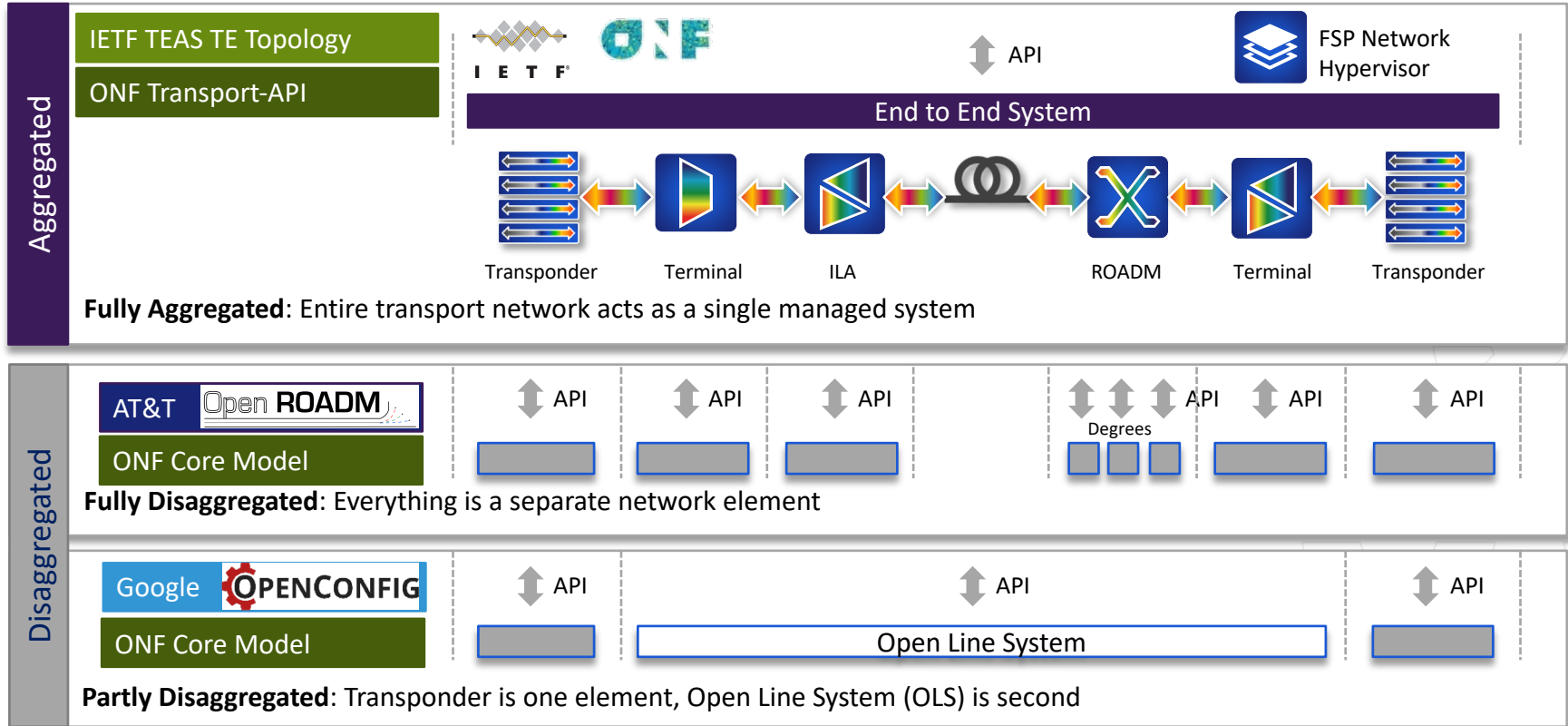
2

High speed interfaces and modulation formats

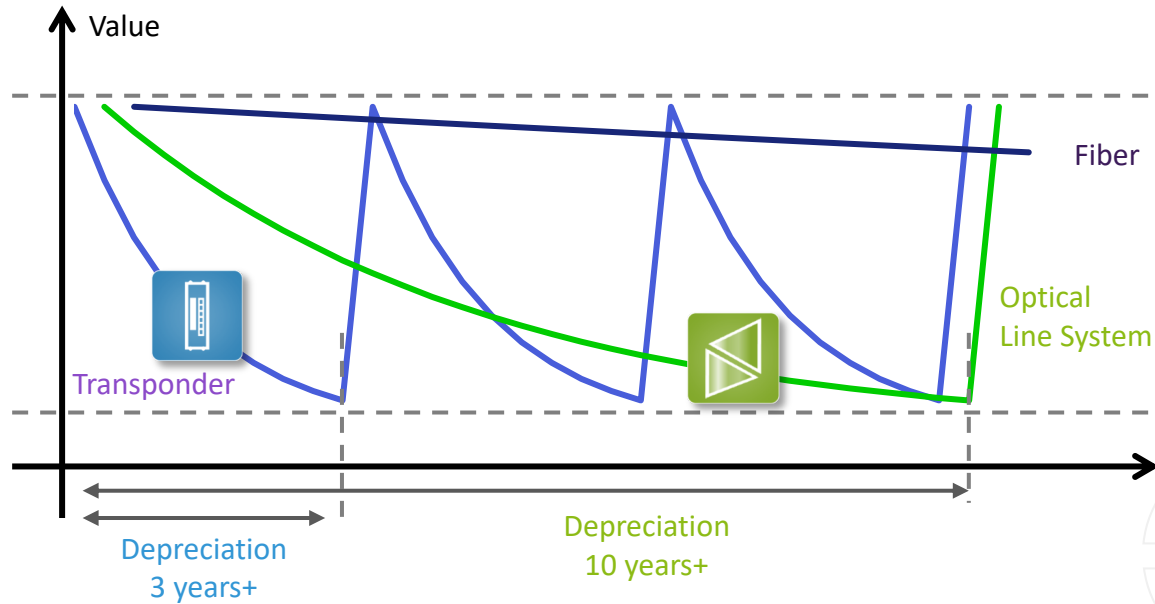
3

Multi-layer/-vendor orchestration/management

Aggregated and disaggregated networks

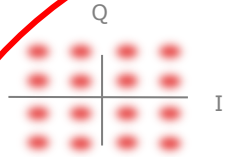


Investment and depreciation



Disaggregation flexibility: Different lifecycles for line systems and terminals

Modulation format comparison

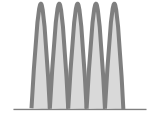


**Coherent
Detection**

*Local-oscillator (laser) at receiver, for optical phase detection.
Higher-Order-Modulation.*



**Direct
Detection**



*No local oscillator (laser) at the receiver.
Higher-Order-Modulation.*

Maximum spectral efficiency



Reduced spectral efficiency

Fiber Capacity

Complex Tx/Rx, high speed ASICs and DSPs



Simpler, lower cost, lower power

Size, Power and Cost

Higher order QAM modulation



More carriers, low cost modulation formats

Evolution

Regional and long distance

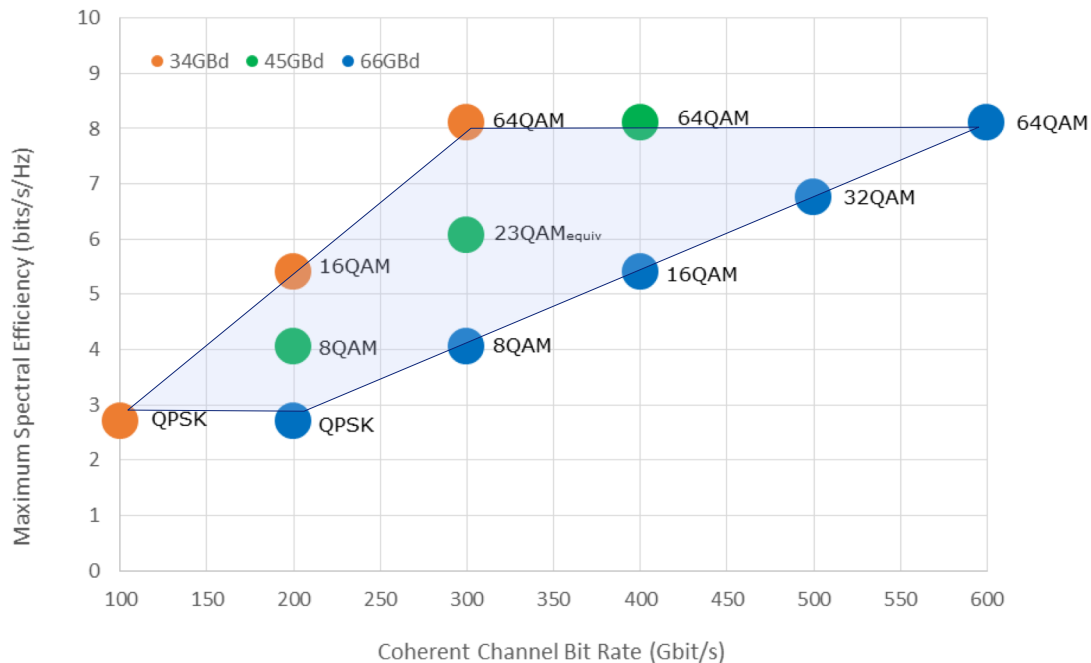


Shorter reach point to point metro

Applications

Coherent detection

Unprecedented Network Flexibility



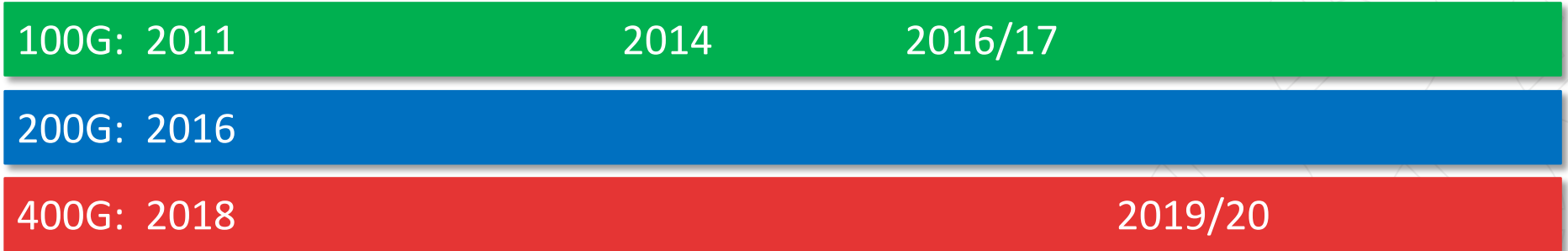
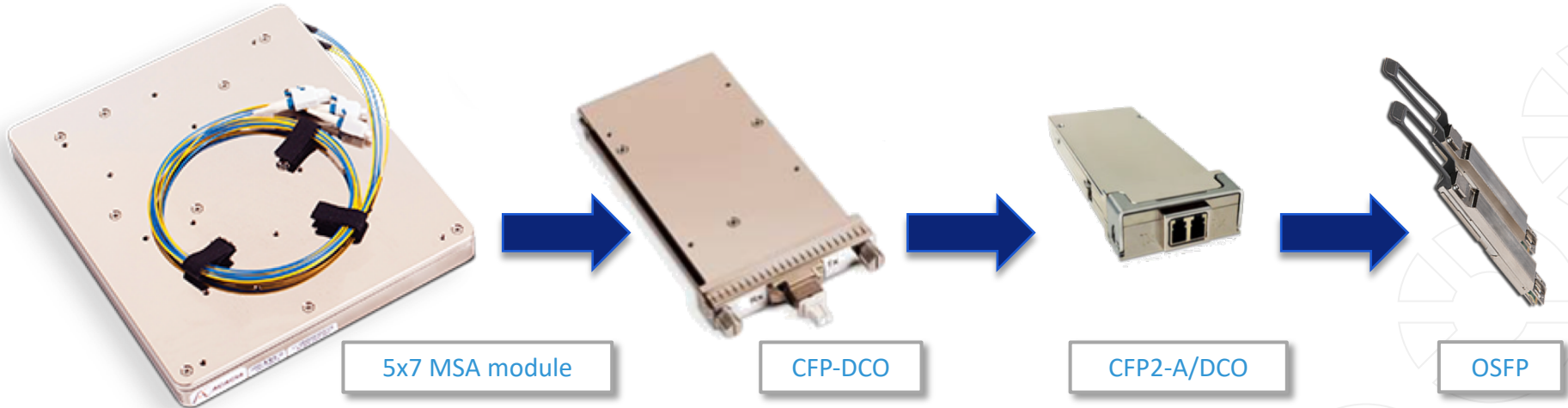
Configure constellation & baud rate for selected data rate

- 100-600G
- 50G steps

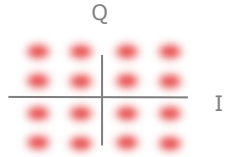
Optimize for given channel

- based on receive OSNR & spectral shaping due to ROADMs cascades

Coherent evolution



Modulation format comparison

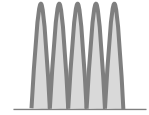


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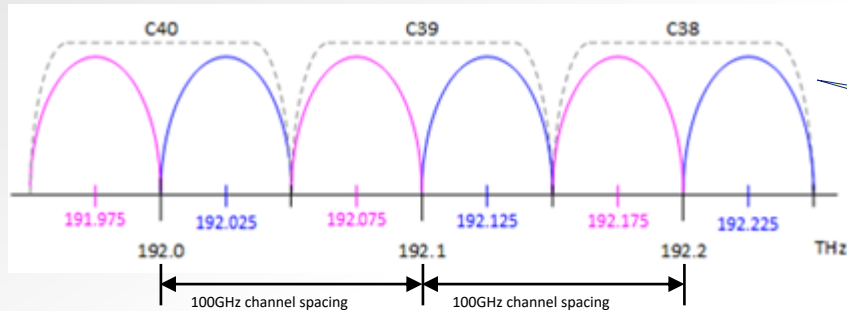
Shorter reach point to point metro

Applications

Direct detection

Direct Detect Pluggable

- QSFP28 DWDM (non-tunable) pluggable optics (directly into switch/router)
- Dual-wavelength 2x 56Gbit/s PAM4 (non-tunable)



Each channel, made up of two wavelengths, is centered on the ITU-T 100GHz channel grid

- One wavelength is offset from the grid center frequency by -25GHz
- The other wavelength is offset by +25GHz

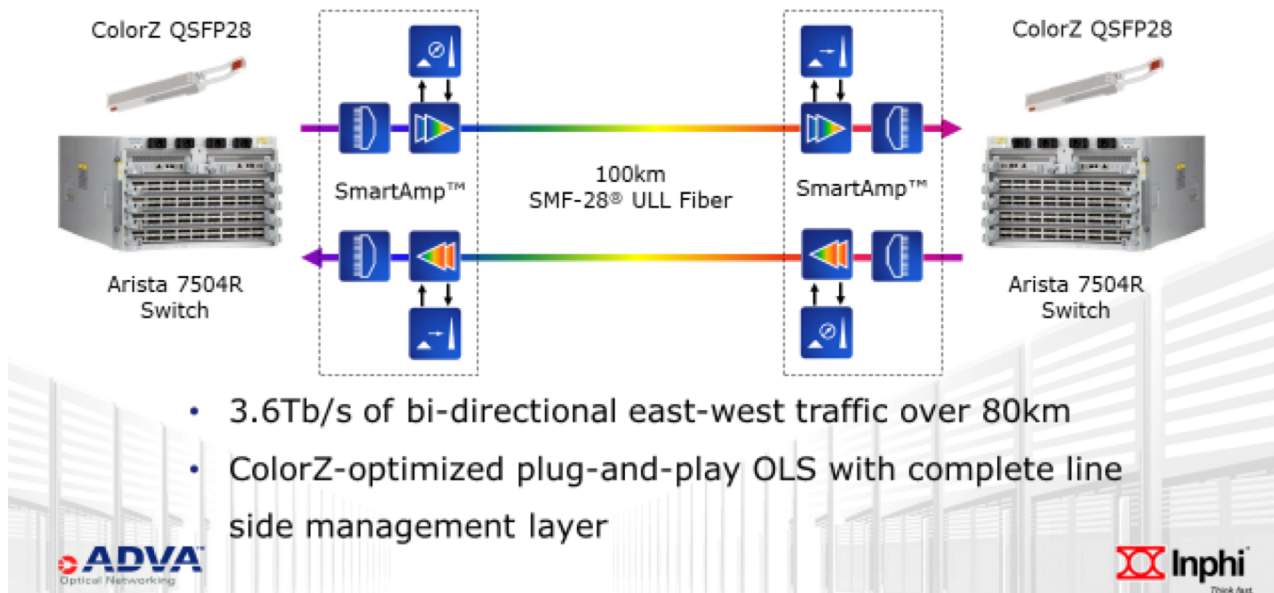
→ 100G of capacity in 100GHz of bandwidth

- Up to 4Tbit/s capacity in C-band
- Low power solution: ~4.5W

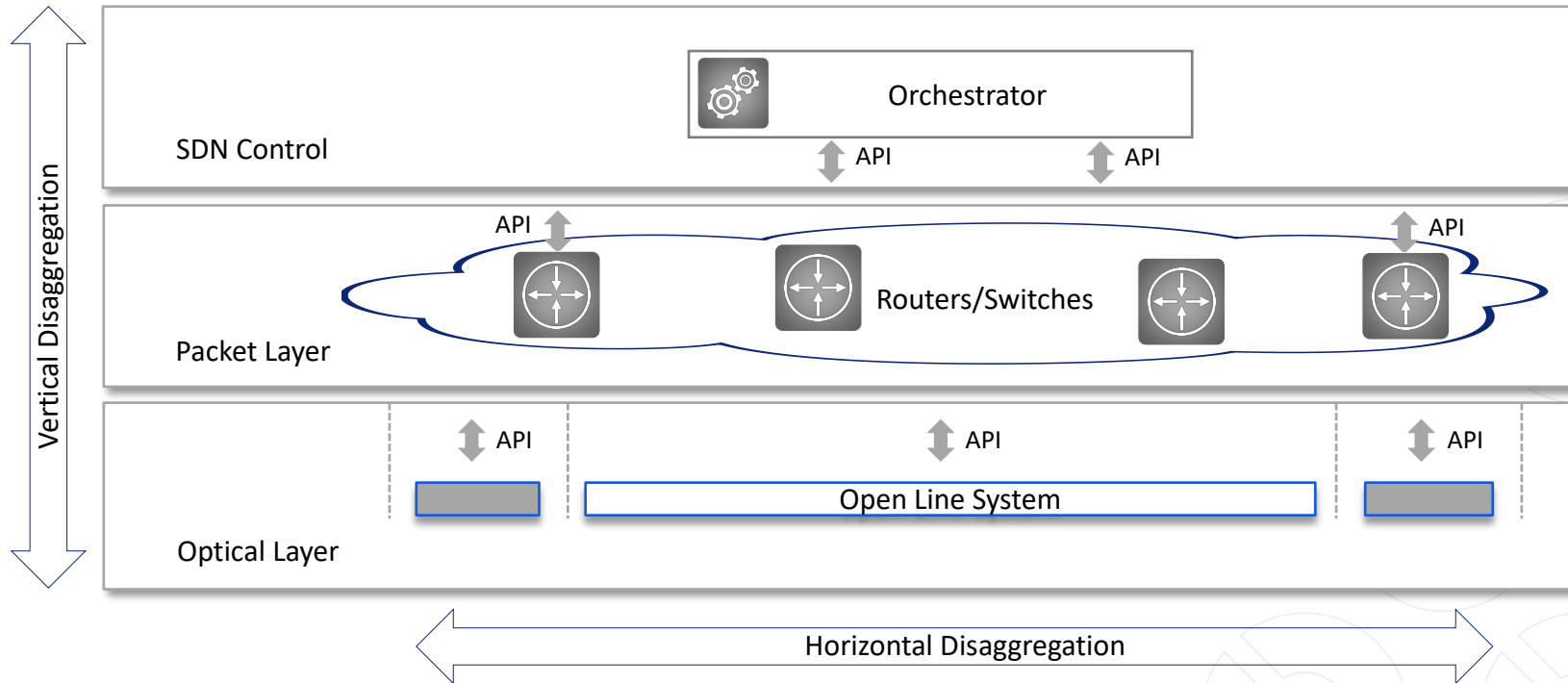
OFC 2017 direct detect demo



SmartAmp™ Open Line System



Multi-layer/-vendor orchestration/management



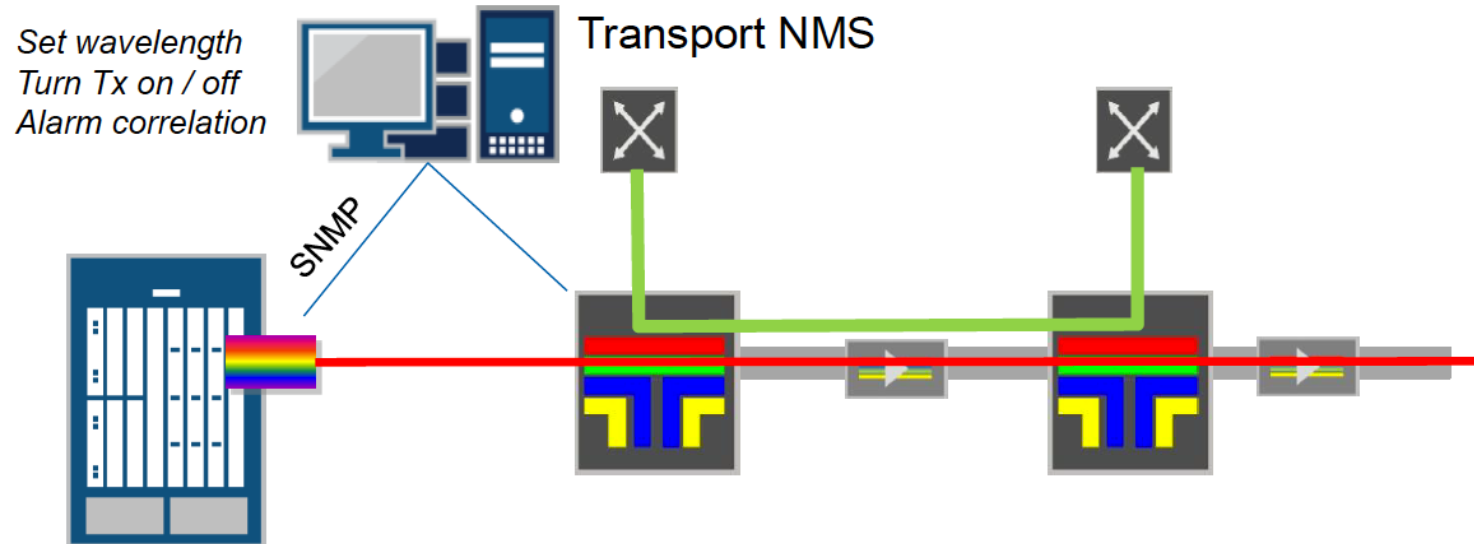


New Nationwide network 2016

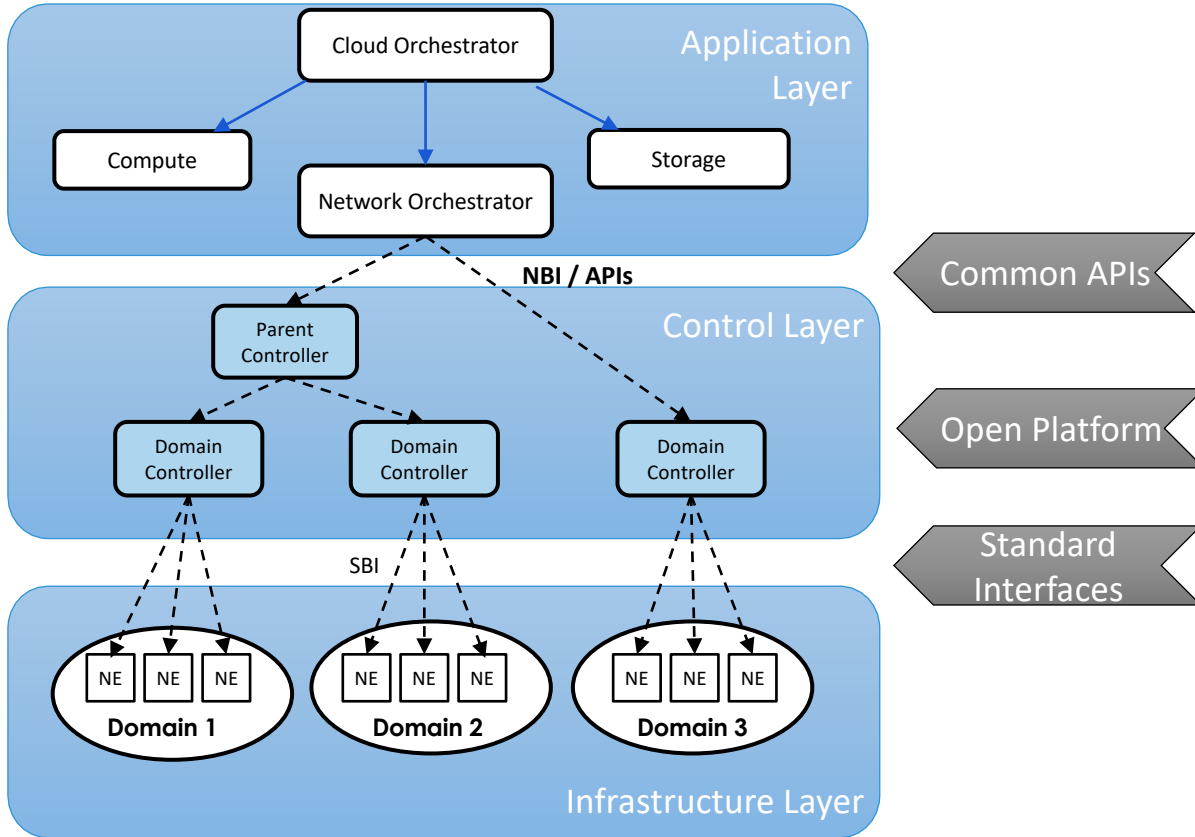
- 3 fiberpaths to all regions
 - Improved redundancy
 - 15 year IRU
- Possibility to connect customers at ~50 sites (with smaller modifications ~80 more)
- Cross border fibers at:
 - Kiruna-Narvik
 - Luleå-Kemi
 - Malmö-Copenhagen
- Leased capacity to Gotland (Visby)

Managing the network

- The Transport NMS from ADVA controls the Juniper DWDM interface
 - Wavelength
 - Output power
 - Alarm Correlation and Monitoring
- Using GMPLS for setting up waves



Transport SDN architecture



- Diverse applications
 - Planning, optimization, services, etc.
- Common framework
- Multi-vendor NW SW
 - Routing, Resiliency
- Standard, programmatic interfaces across layers
- Open/common device data models

YANG data models – 'Pick and Choose'

SDO



IA



Carrier

ISPs, IP over Optical

Web 2.0

Disaggregation

Services

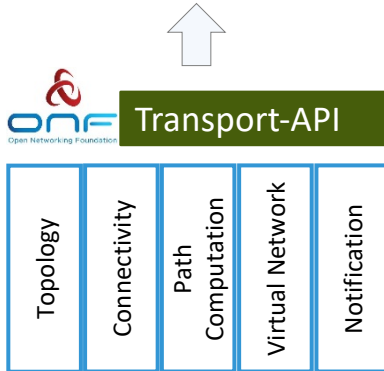


IETF TE Tunnels



TELECOM INFRA PROJECT

Network



IETF Network

Telemetry

Services

IETF Network-Topology

IETF TE Topology

IETF Flexi-Grid TED

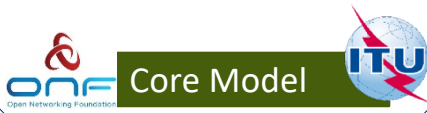
IETF Flexi-Grid media channel

Common

Network

Infrastructure

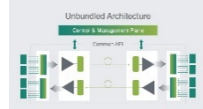
Device



IETF WSON Technology

Optical Transport

Device



Key take-aways

- Disaggregation will increase network flexibility and reduce vendor dependency
- Partial disaggregation will reduce network operator integration efforts
- High speed interfaces and higher order modulation need to be supported by open optical line systems (wavelength grid, optical impairments compensation, ...)
- Multi-layer *and* -vendor orchestration/management is key for real network deployments





Thank you

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