ESnet Status Update

Paul Wefel
Network engineer
Lawrence Berkeley National Laboratory

SAACC - Virtual meeting

April 2020

Outline

- What is ESnet
- ESnet6 Overview
  - Implementation Phases
  - Rough schedule
  - How the pieces go together
- Colo and Fiber
- Management network
- Optical Core
- Packet Core & Low Touch Edge Details
- High Touch services
- Questions

ESnet

ESnet: DOE's High Performance Network (HPN) Scientific User Facility derives its mission from Office of Science

Mission of DOE Office of Science:
...delivery of scientific discoveries and major scientific tools to transform our understanding of nature**...**

Mission of Energy Sciences Network:
Science network user facility designed to **accelerate** scientific research and discovery.
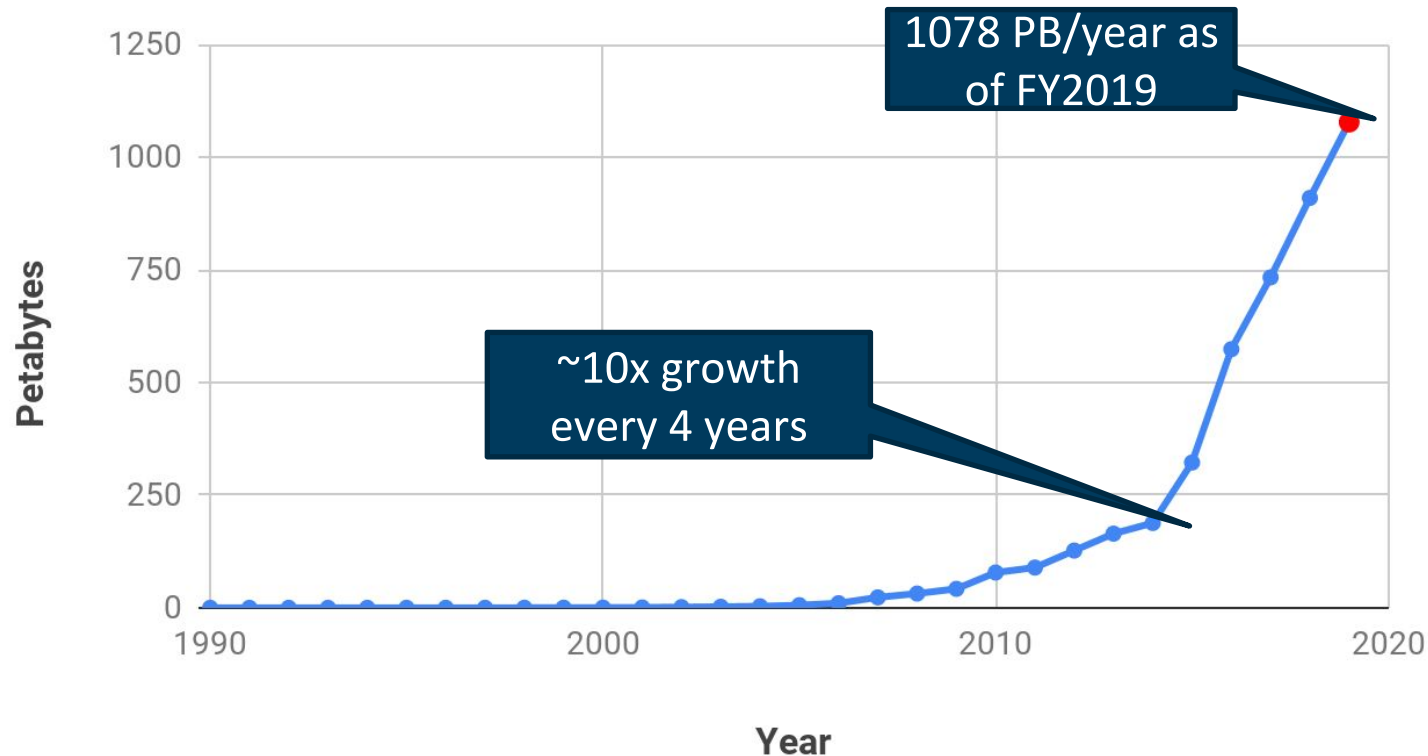
Our Vision Drives the ESnet Approach to the Mission

Scientific progress will be **completely unconstrained** by the physical location of instruments, people, computational resources, or data.
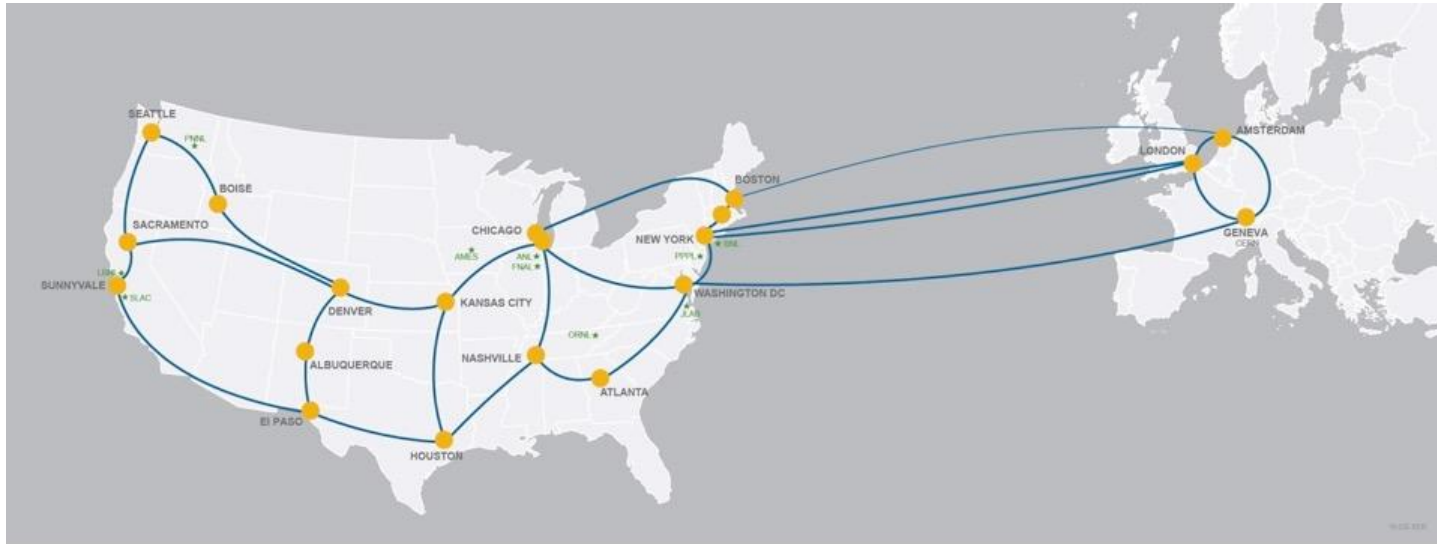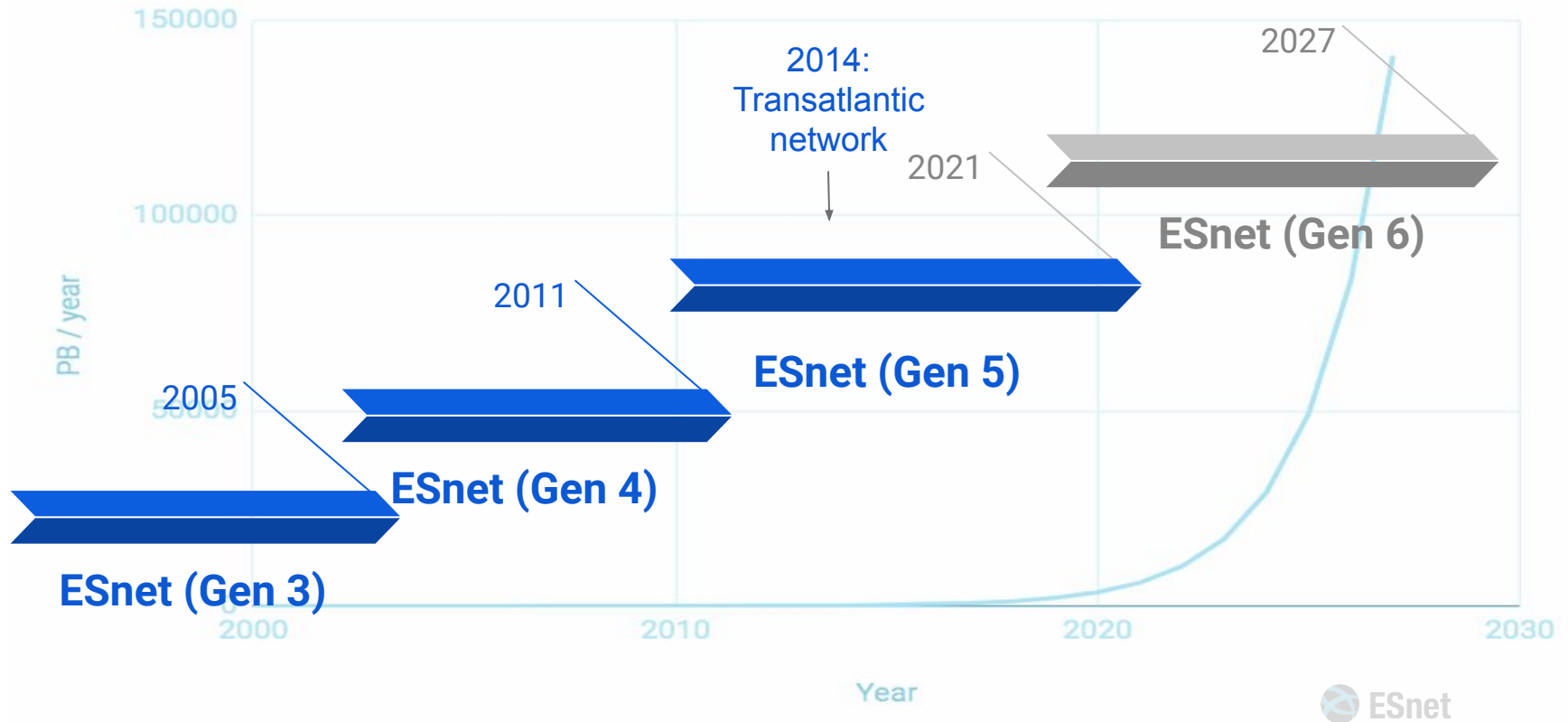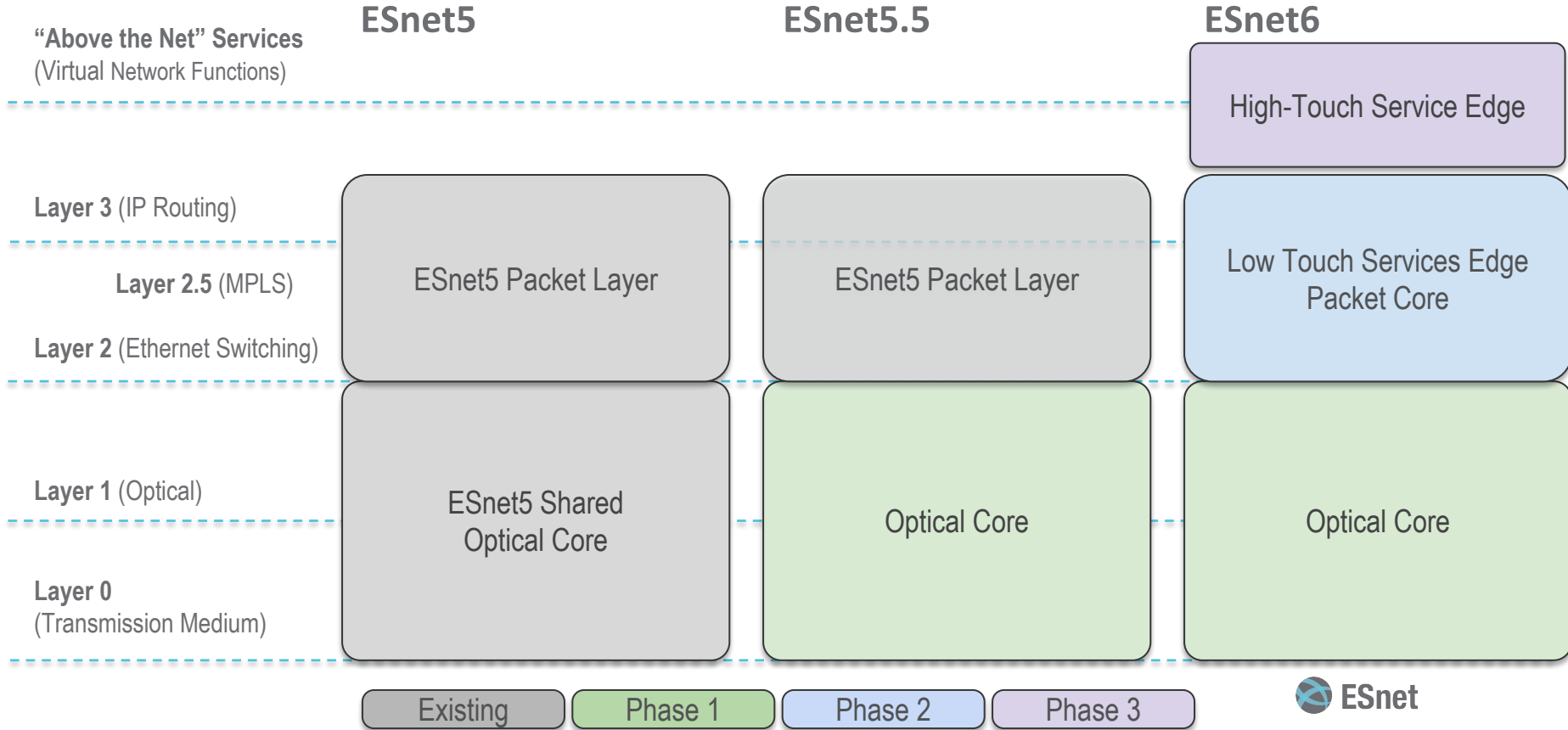

ESnet

An Exabyte Network Today

Yearly aggregate traffic in PB carried by ESnet

1078 PB/year as of FY2019

~10x growth every 4 years

ESnet

The evolution of the ESnet network

Implementation Context

"Above the Net" Services
(Virtual Network Functions)

ESnet5   ESnet5.5   ESnet6

High-Touch Service Edge

Layer 3 (IP Routing)

ESnet5 Packet Layer   ESnet5 Packet Layer   Low Touch Services Edge Packet Core

Layer 2.5 (MPLS)

Layer 2 (Ethernet Switching)

Layer 1 (Optical)

ESnet5 Shared Optical Core   Optical Core   Optical Core

Layer 0
(Transmission Medium)

Existing   Phase 1   Phase 2   Phase 3
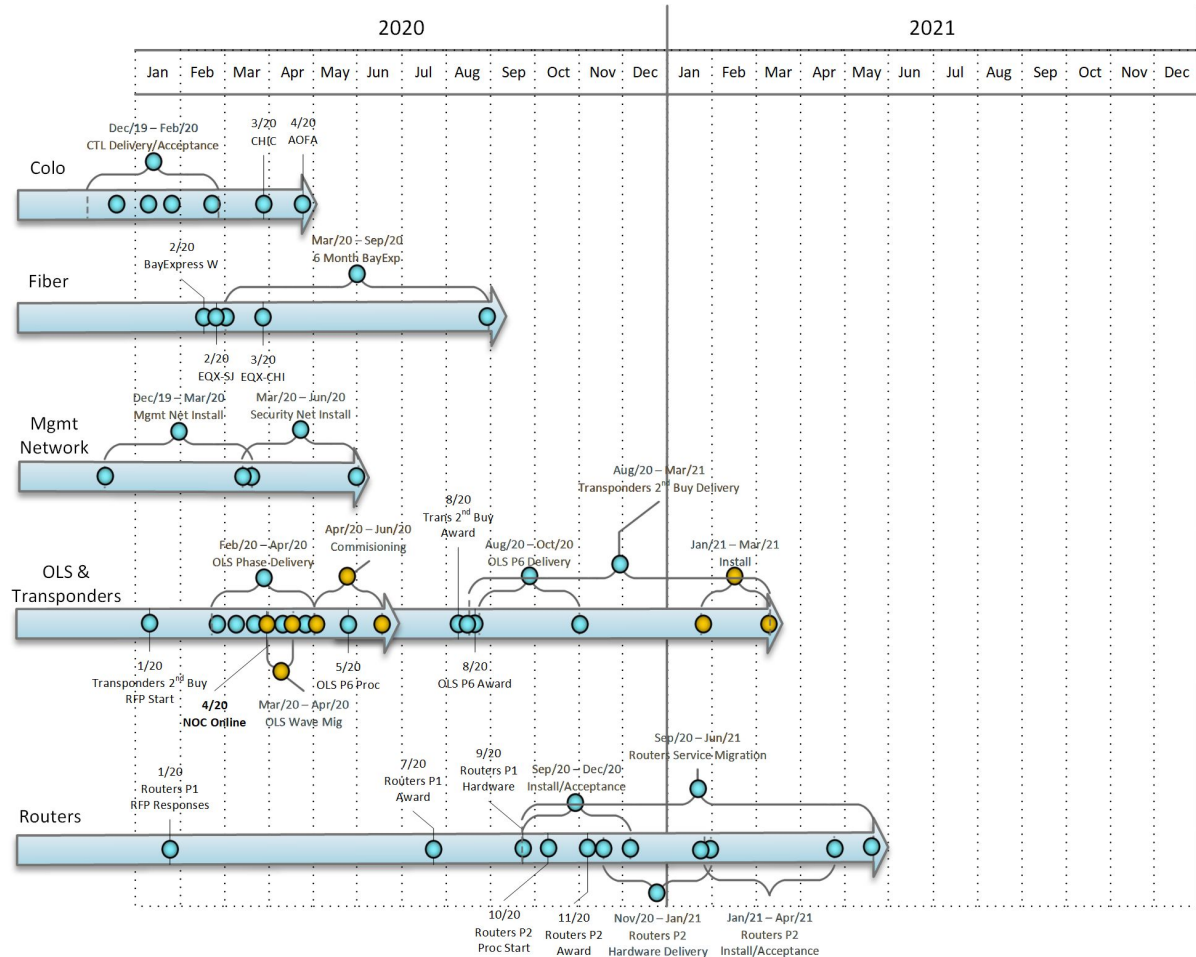
ESnet

ESnet5.5 ~ 11 Tbps of Circuits

- Circuits are defined here as client gray optics, across transponder & FlexILS to client gray optics on the far end.
- Phase 1 of the transponders (Groove CHM2T) will provide enough capacity to:
  - Replace 77 ESnet5 circuits on our shared Ciena infrastructure
  - Add 8 circuits for pending capacity upgrades
  - Plus 57 circuits for ESnet6 router turnup next fall/winter.
- We will re-optimizing Circuits after the ESnet6 routers are deployed.
  - Decom all the 10G muxes
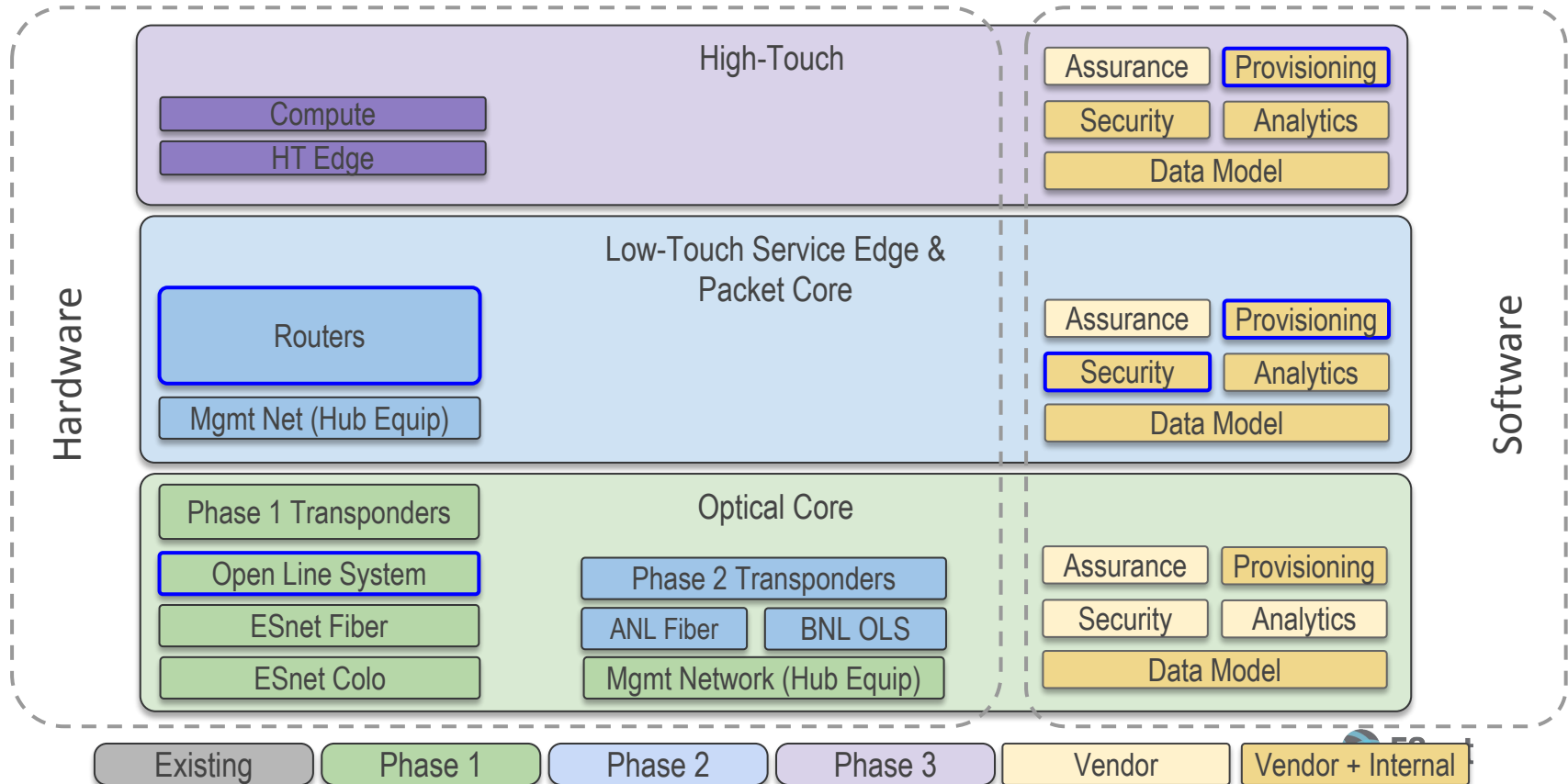 - Migrate parallel links to 400G client side interfaces if/where possible

ESnet

ESnet6 Summary Schedule

BTW, High-Touch prototypes in FY20 & FY21, and equipment & service deployment in FY22 not shown.

ESnet6 Network System

Key Implementation Strategies

Hardware: COTS

- All the hardware we are purchasing is commercial-off-the-shelf.

Software: Buy vs. Build

- Integrate supported components whenever we can and develop from ground up **only when it is required**.
- *Most software effort is focused on **Integration.***

Installation: Leverage Subcontractors

- Use installation subcontractor and the colo operator's staff to manage logistics and physical installs, coordinated by ESnet staff.
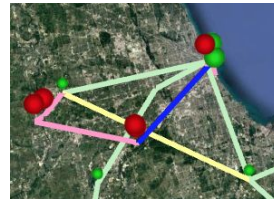
ESnet

Colo and Fiber Status Feb 28 2020

Colo
- Green = Space Ready
- Red = Not Ready

Fiber
- Light Green = Engineer Approved Test Results
- Yellow = Engineer Did Not Approve Test Results
- Pink = Test Results Not Available
- Blue = Glass Through: State lookup too complex
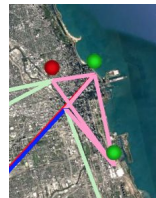- Red = Fiber Not in Acceptance Sheet

As Of: 2/28/2020 15:59:02

Bay Area

Chicago Metro

Chicago Downtown

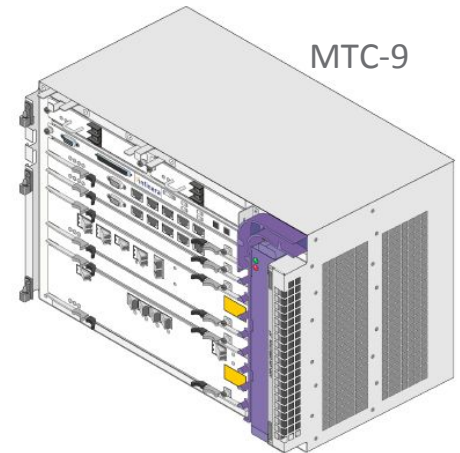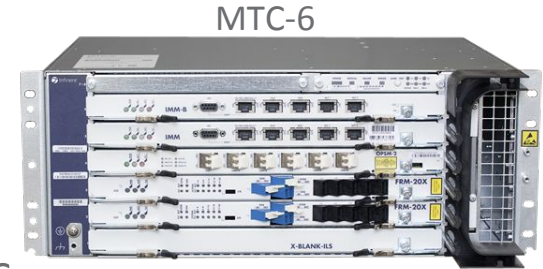ESnet

ESnet6 Management Network

- Provides in band and out of band (oob) connectivity to the management ethernet and serial consoles of all the equipment (except ILA).
- IPv6 only network (It's 2020, this should be easy right?)
- Cellular LTE instead of POTS modems for oob
- Consists of
  - Opengear IM7200
  - Juniper QFX 5110

ESnet

What is the Optical Core?

- An "OPEN" line system. De-coupled line equipment from transponders. No restrictions on using non-line system vendor components.

- The Optical Core provides point-to-point Ethernet circuits between backbone routers and service edge devices and within the backbone.

- It operates at Layer-1.

- The Optical Core uses DWDM (Dense Wave Division Multiplexing) to provide static, un-protected, high-capacity links to the Packet Core.

ESnet

ESnet6 Optical Core
Open Line System Technical Summary

MTC-6

- Infinera Flex-ILS: Colorless, Directionless, Contentionless (CDC), Redundant
  - 2 CDC drop mux's per ROADM node
  - Redundant shelf processors, including amp sites
  - RAMAN on 75 spans (>20dB of loss)
- Integrated OTDR @ 130 locations (RAMAN & Metro)
- **Completely open line system**
  - No per-wave license restrictions
- 6 & 9 slot chassis are being deployed
  - MTC6 only at AC and 19" rack locations

MTC-9

ESnet6 Optical Core
Phase 1 Transponder Details

G30

- Phase 1 transponders are ~50% of total ESnet6 capacity
- Coriant Groove (recently bought by
  - G30 Chassis - 2 at most ROADM nodes
  - CHM2T 1.2Tb Tunable Transponders
    - 2 100G-600G transponders per card
    - Flexible 100G/200G/400G client port muxing
    - Acacia DSPs under the covers
    - Full license to use all features & ports except for MACSEC
  - XTM2 10G muxes (during transition to ESnet6)
    - No waves < 100G!
- ESnet 5.5 Optical Core will only use:
  - 100G client optics: QSFP28-LR4 & AOC
  - 10G client optics: SFP+ LR 10G

CHM2T

XTM2

ESnet

Open Line System Architecture
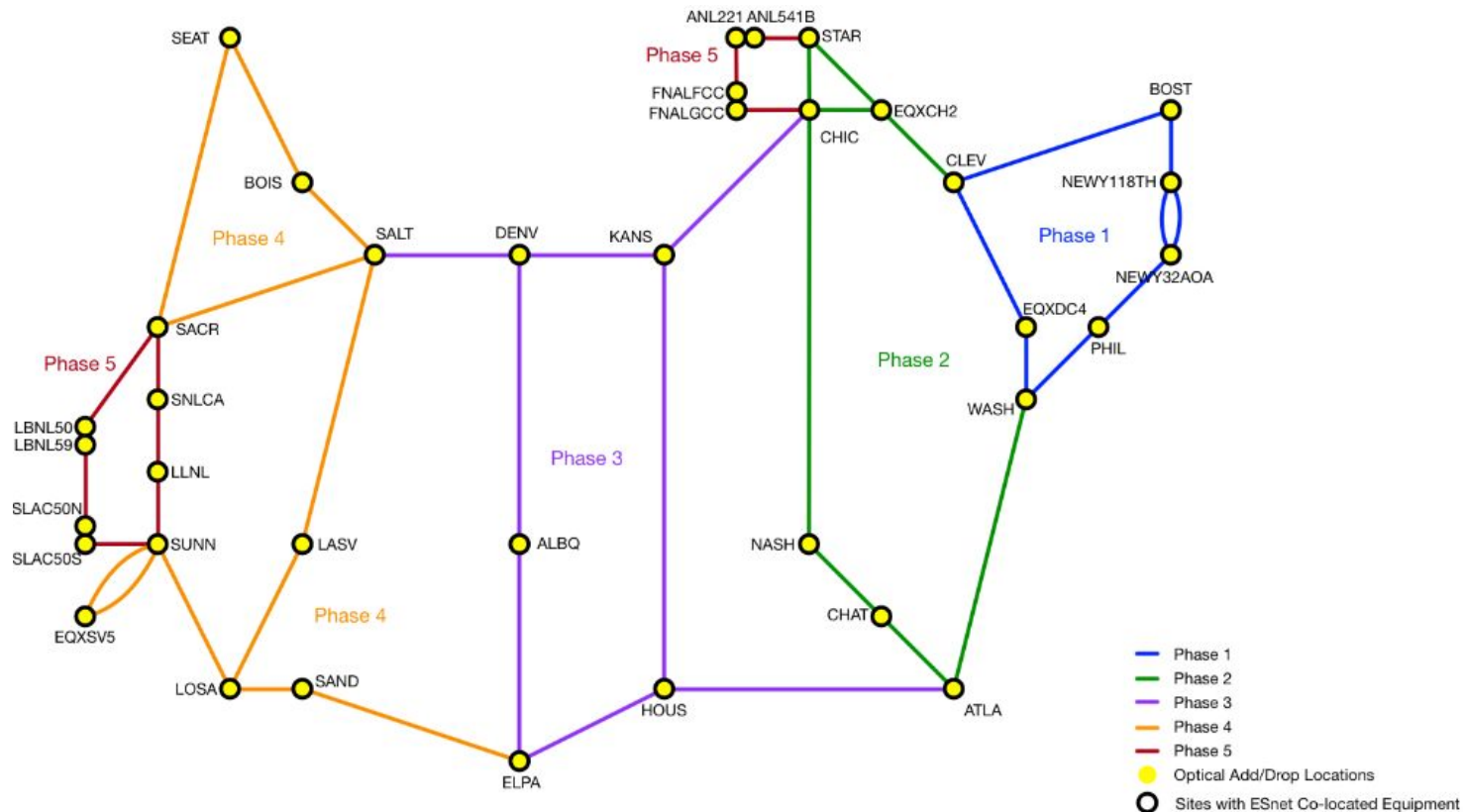# 3 Degree ROADM Example

Amp Chain &
Other ROADMs

FRM 20X
Flexible ROADM Module
1x20 Wavelength Selectable Switch

FSM CDC-8D-12 EC
FlexROADM Switching Module
12 Port
Add Drop
8x12 Multicast
Switch & Amps

Transponder Ports

FSM
FlexROADM Switching Module
12 Port
Add Drop
8x12 Multicast
Switch & Amps

Transponder Ports

MPO Fiber Shuffle Panel
Full Meshs all FRMs and FSMs

FRM 20X
Flexible ROADM Module
1x20 Wavelength Selectable Switch

IRM
RAMAN Amp
(Optional)

Amp Chain & Other ROADMs

OTDR

FRM 20X
Flexible ROADM Module
1x20 Wavelength Selectable Switch

Amp Chain &
Other ROADMs

Example node is about ½ of a rack with components distributed across 4 MTC-6 chassis.

Multiple Ribbon Cables with MPO connectors

Transponder Input/Output

Line-Side Fibers to other locations

ESnet

OLS Installation Phases

OLS install snapshot 4/13/2020

What is the Packet Core?

- The Packet Core provides network reachability between backbone and service edge sites. It operates at Layer-2 and above.

- Packet Core uses SR-MPLS (Segment Routing, an extension of MPLS) to provide a programmable, flexible, resilient forwarding plane.

- Commercial PCE (path computation engine) used for managing overlays.

ESnet

Router Procurement

- Currently in the RFP process for ESnet6 routers

- 2 hardware configurations and a PCE Software component requested

- Proposals are currently being reviewed

- Award an MSA late March/early April

- First phase purchase: Summer 2020

- Installation 4QCY2020

- Installation services proposals also requested

ESnet

What is High Touch?

- A programmable data plan for development and deployment of innovative science data services.
    - Provides unprecedented flexibility to customize packet processing at scale.
    - Developing new services to support emerging science application workflows not currently supported by mainstream packet edge routers without the huge expense of contracting router vendors to develop (and support) the capability.
    - Platform for research into features and functions that will educate the design and architecture of ESnet7.
- First High Touch Service: **Precision Network Telemetry**
    - We can get detailed insights into how the network is behaving.
    - We can profile how flows are performing in our network and take proactive action.
    - We can use the detailed flow information for traffic engineering, capacity planning, or anomaly detection (e.g., AI/ML applications)

ESnet

Questions...

ESnet