CENIC
Connecting California

Pacific Wave and Pacific Wave U.S. Extensions

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3rd GLOBAL RESEARCH PLATFORM WORKSHOP

October 10-11, 2022

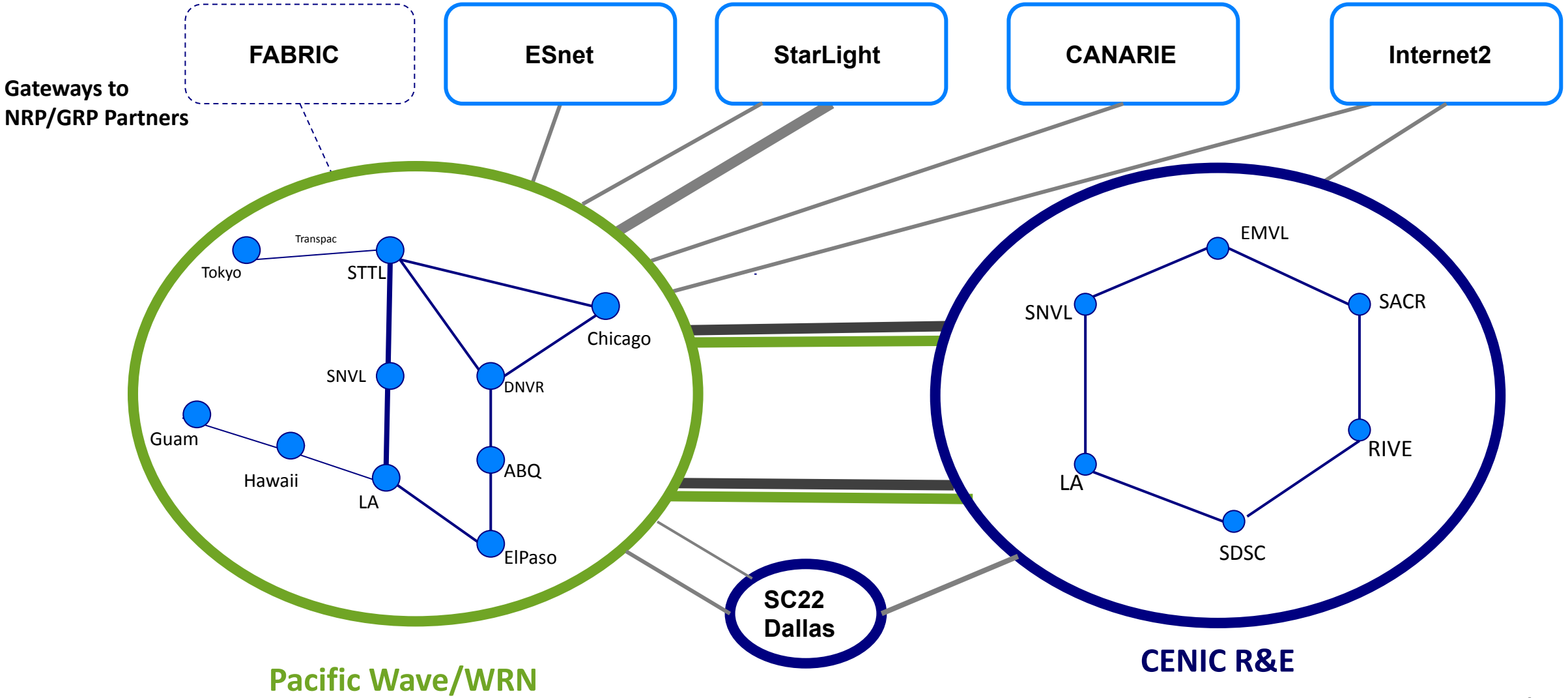
Agenda

- Overview of the Pacific Wave International Exchange.
- Infrastructure:
  - Pacific Wave at the core of the National Research Platform (NRP) and the Global Research Platform (GRP).
  - Pacific Wave and SuperComputing
- Overview of on-going Projects:
  - Capacity Upgrades
    - Pacific Wave
    - Western Regional Network
  - PerfSONAR
  - Route Server
  - IGROK flow export/analysis project in collaboration with SDSC
  - Multi-domain Orchestration
  - Telemetry
  - Optical Provisioning across domains
  - Coherent Optics (ZR/ZR Plus)

Overview

- Initially funded by the NSF in 2005, Pacific Wave is an open international R&E peering and exchange fabric operated by CENIC and the PNWGP.
- The exchange's primary large-scale backbone nodes are in Los Angeles, Sunnyvale and Seattle.
- The exchange's core infrastructure extends domestically to Hawaii (UH), Chicago (StarLight), El Paso, Albuquerque and Denver, and internationally to Tokyo via International collaborations.
- Exchange participants:
  - CENIC, PNWGP, Ultralight, Los Nettos, Internet2, ESnet, NOAA N-Wave, DREN, NASA, AARNET, CANARIE, CERNET, CSTNET, CUDI, GEMNET, JGN, KISTI, REANNZ, SINET, TransPAC, Transtelco, TWAREN and PREGINET.
- Multiple cloud providers of relevance to the R&E communities, including Microsoft, Amazon and Google.

Pacific Wave/WRN, the NRP, the GRP, and SC




PACIFIC WAVE
NATIONAL & INTERNATIONAL PEERING EXCHANGE
Pacific Wave is a project of CENIC & PNWGP
Fairbanks
PACIFIC WAVE
Vancouver
Seattle
PACIFIC WAVE
Tokyo
PACIFIC WAVE
Guam
PACIFIC WAVE
Oahu
Hawaii
Sunnyvale
PACIFIC WAVE
Los Angeles
PACIFIC WAVE
Los Nettos
Tijuana
El Paso
Albuquerque
Denver
Chicago
StarLight
New York
MAN/LAN
DC Area
WIX
Korea
Japan
China
Hong Kong
Taiwan
Philippines
Singapore
Australia
New Zealand
CSTNET
KISTI/KREONET
JGN (Seattle & Tokyo)
TransPAC/Pacific Wave
GEMNet2
WIDE
REANNZ
AARNET
UH
SINET
PIREN
JGA
IGN/SingAREN
SingAREN/Internet2
TWAREN/TANET
CERNET
PREGINET
CANARIE
PNWGP
ESnet
Internet2
DREN
NREN
(NASA Ames)
CENIC
FRGP
FABRIC
UltraLight
(Caltech)
ABQG
AP-REX
Transtelco
CUDI
SURFnet
JANET
GEANT
ESnet
Nordic Countries
United Kingdom
Netherlands
Europe
CERN
ANA
Partner Exchange Links
Participant Links
Prospective Links
AP-REX Links
Pacifc Wave Backbone
Pacific Wave POP
AP-REX POP
Pacific Research Platform (PRP)
PRP Science DMZ Fabric
AutoGOLE
Commercial Peering Points
(Amazon, Google, & Microsoft)
WESTERN REGIONAL NETWORK
States served by WRN members:
- ABQG: New Mexico GigaPoP
- CENIC: California
- FRGP: Colorado, & Wyoming
- PNWGP: Washington, Montana, Alaska, Oregon, & Idaho
- UH: Hawaii
With support from the National Science Foundation

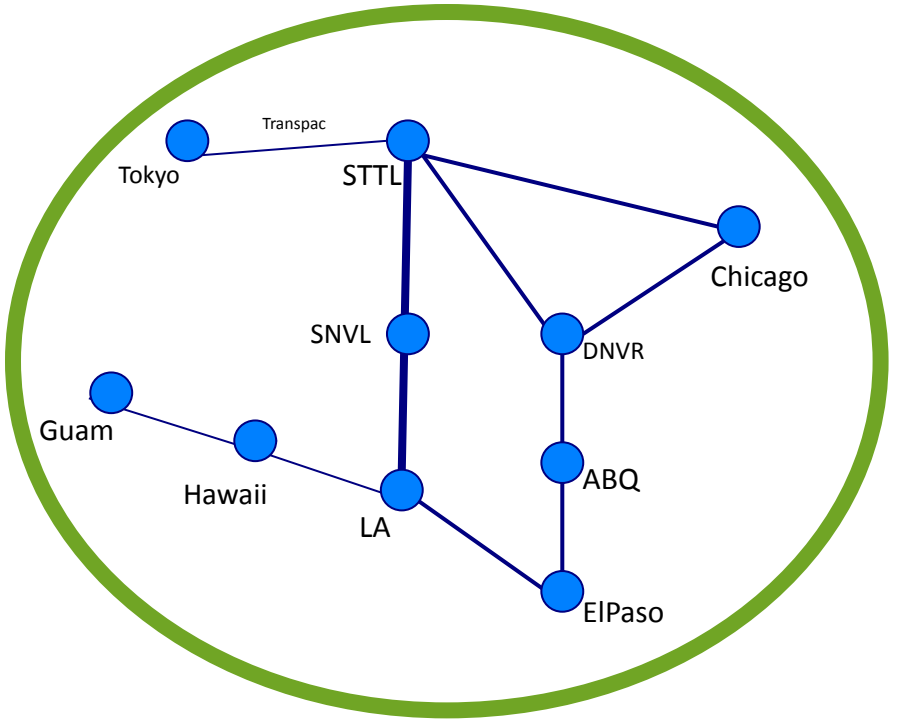
On-going Projects

Capacity Augmentations

Pacific Wave:
- LA - Sunnyvale: 500G, via CENIC
- Sunnyvale - Seattle: 400G, via Internet2

Western Regional Network:
- El Paso - Albuquerque: 400G, via Internet2
- Albuquerque - Denver: 400G, via Internet2
- Denver - Chicago: 400G, via Internet2
- Denver - Seattle: 400G, via Internet2
- LA - El Paso: Nx100G via Transtelco

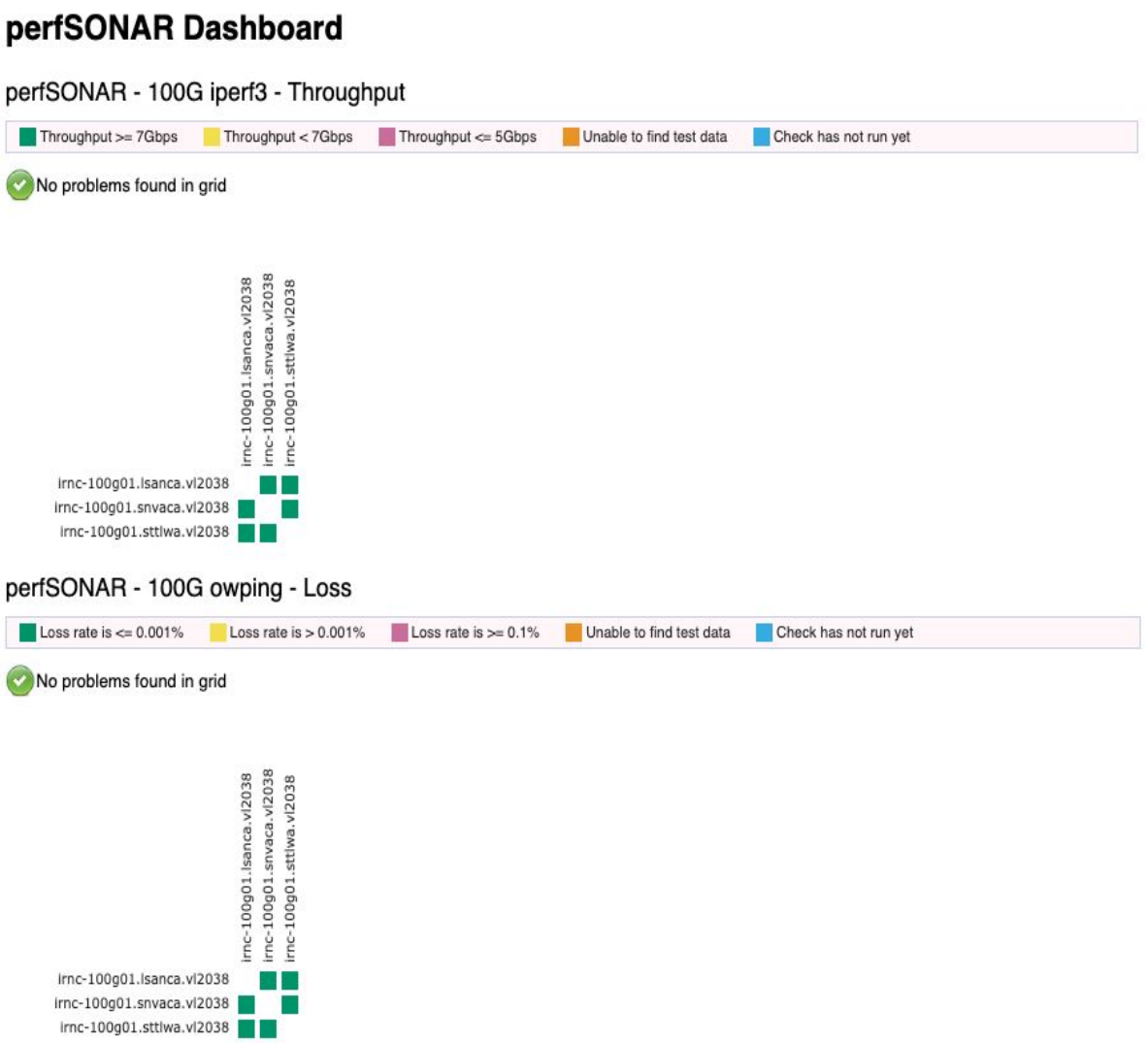
New target Completion: Q1/2023 (supply chain)



Researchers can focus on the actual research/experiment, instead of the infrastructure

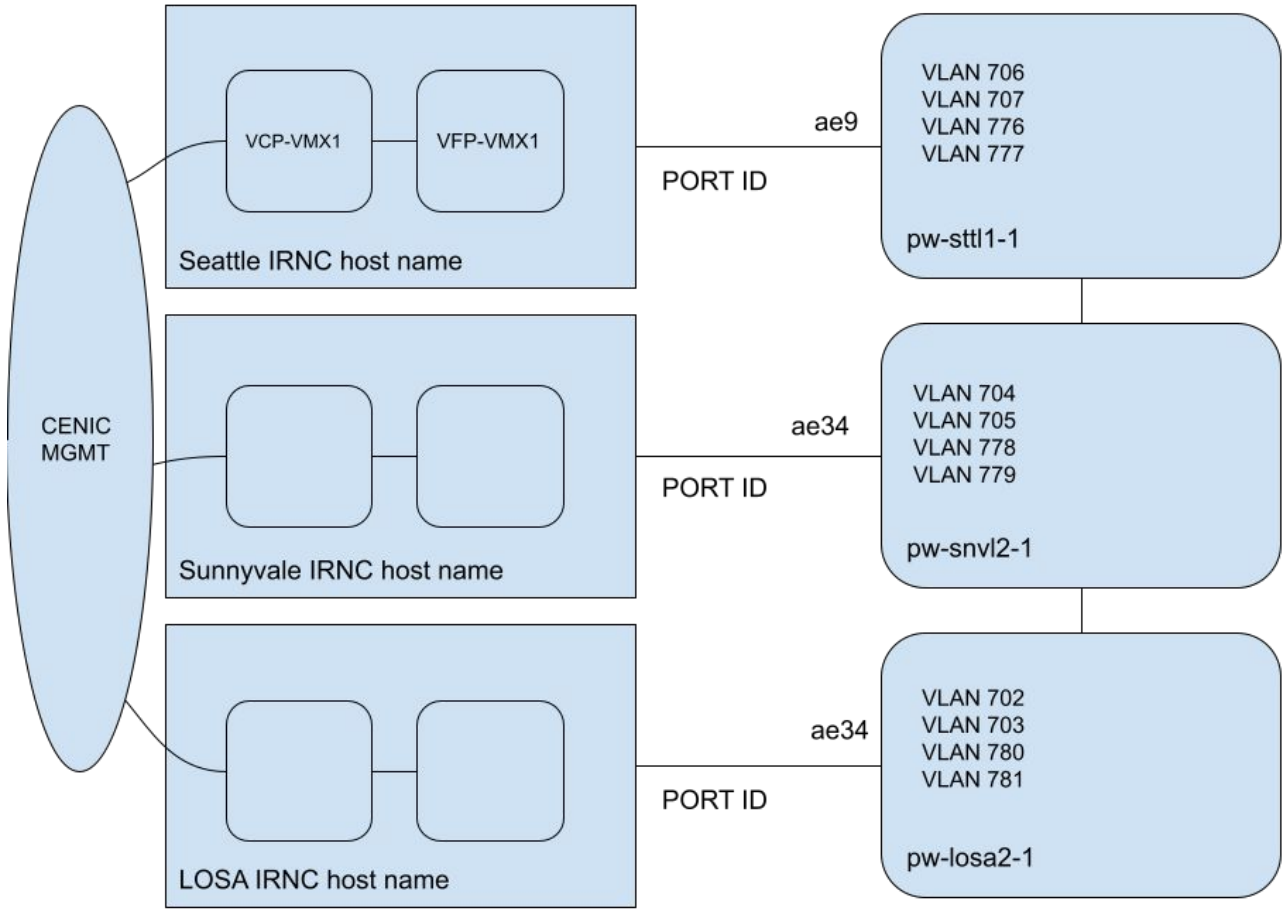
PerfSONAR

- Published on pacificwave.net
- Continue to tune performance
- Next step: Integration of the Pacific Wave perfSONAR test points with the APOnet perfSONAR mesh.

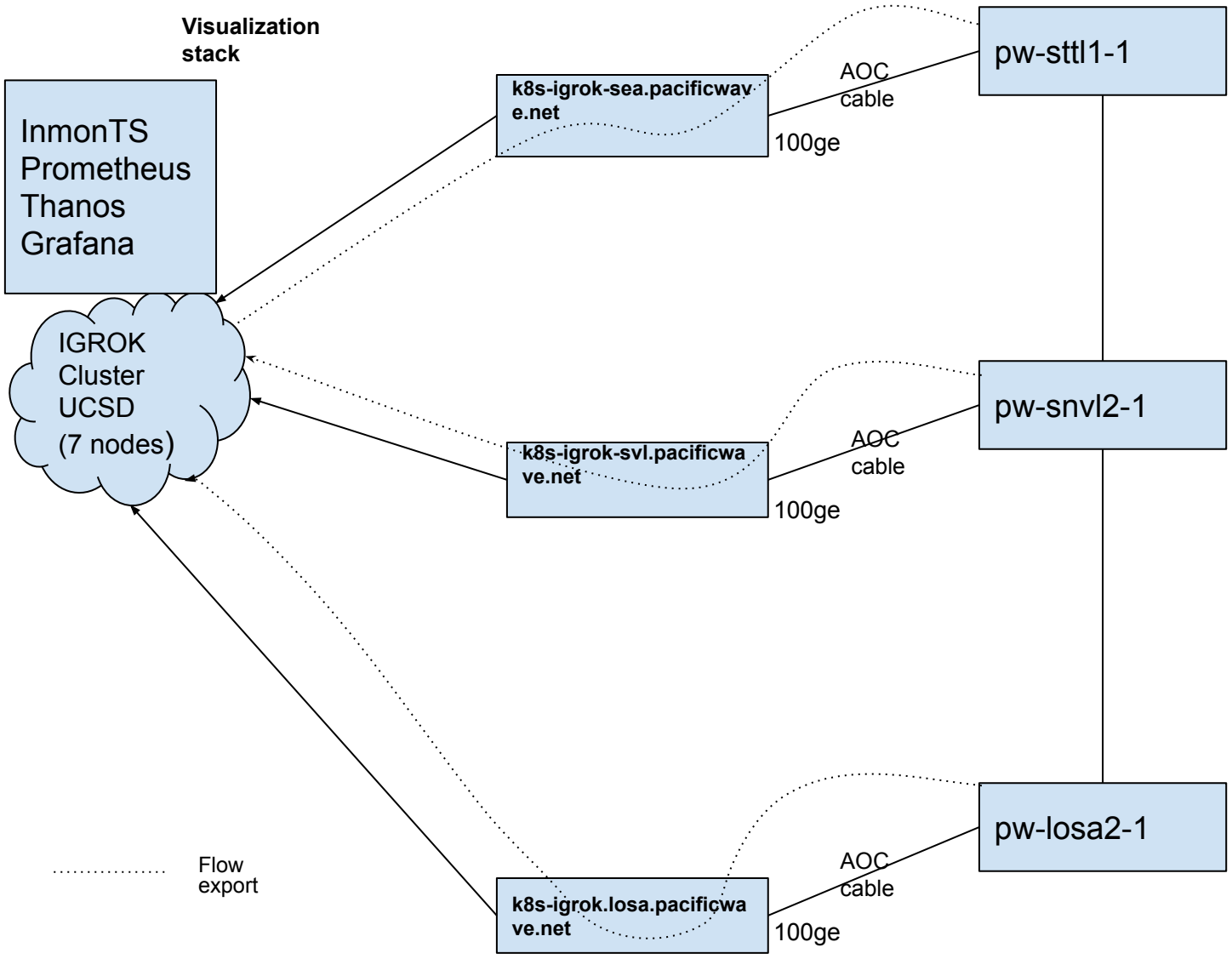


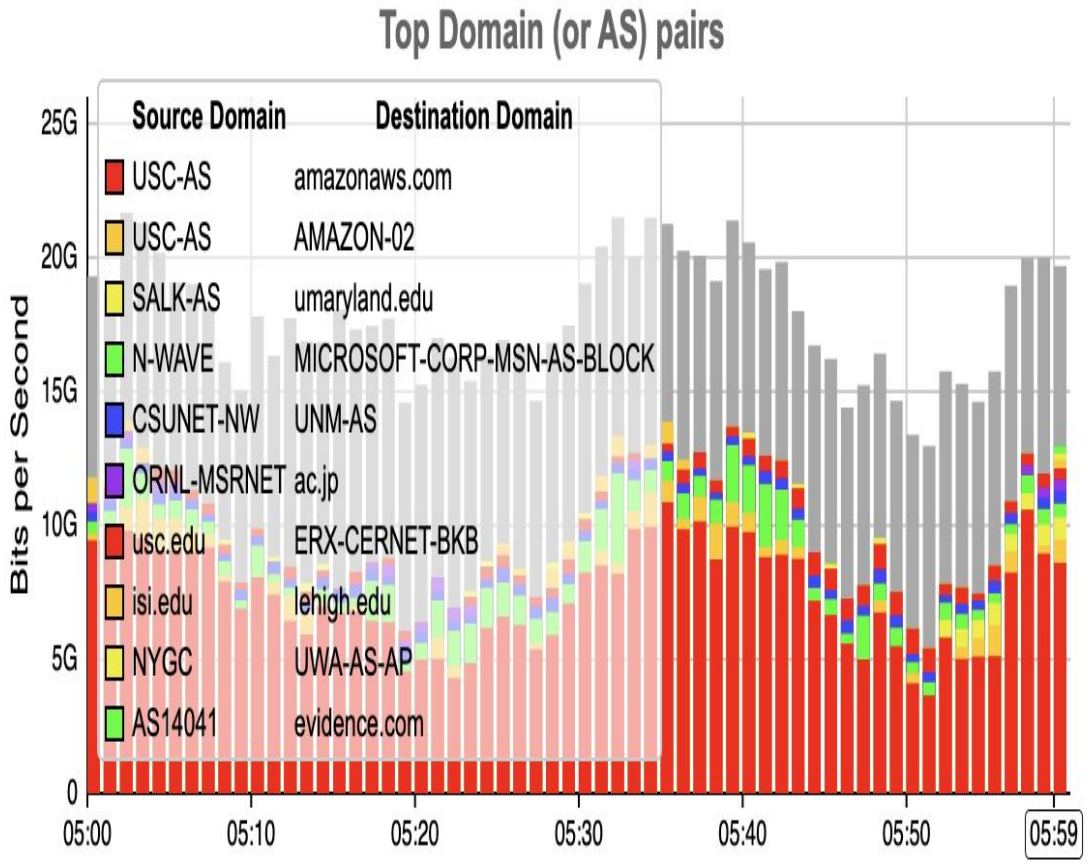
Route Server

- 3 Route Servers covering all exchange point vlans:
  - Los Angeles (CENIC)
  - Sunnyvale(CENIC)
  - Seattle(PNWGP)
- Juniper vMX
- RPKI enabled.
- CENIC (AS2153) and PNWGP (AS101) peering with the route servers turned up in summer 2022.
- TransPAC (AS22388) peering with the route server in Seattle turned up in September 2022.
- **Production Status.**
- We will be adding prefix filtering via IRR.



IGROK: flow data analysis in collaboration with SDSC

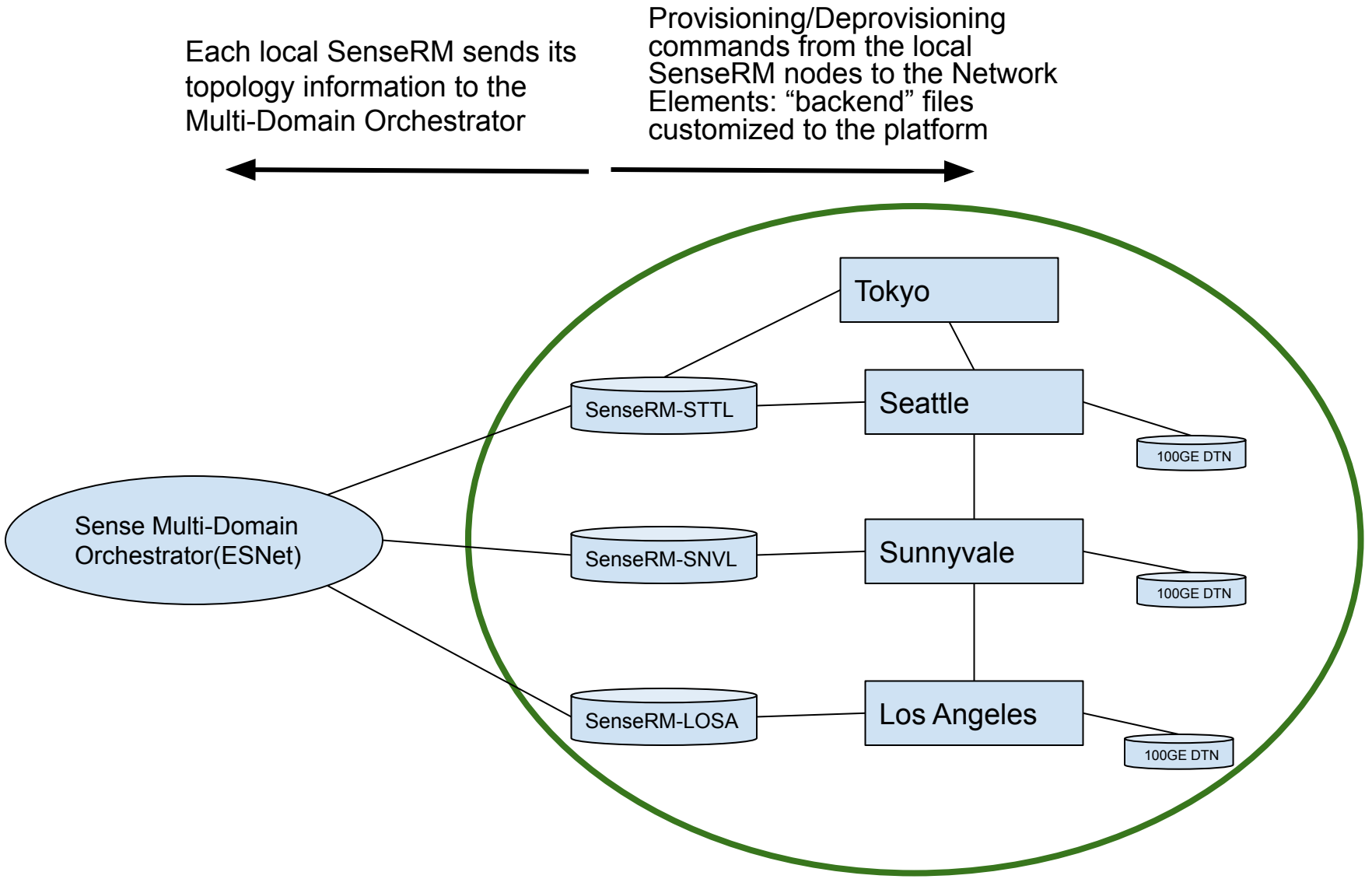




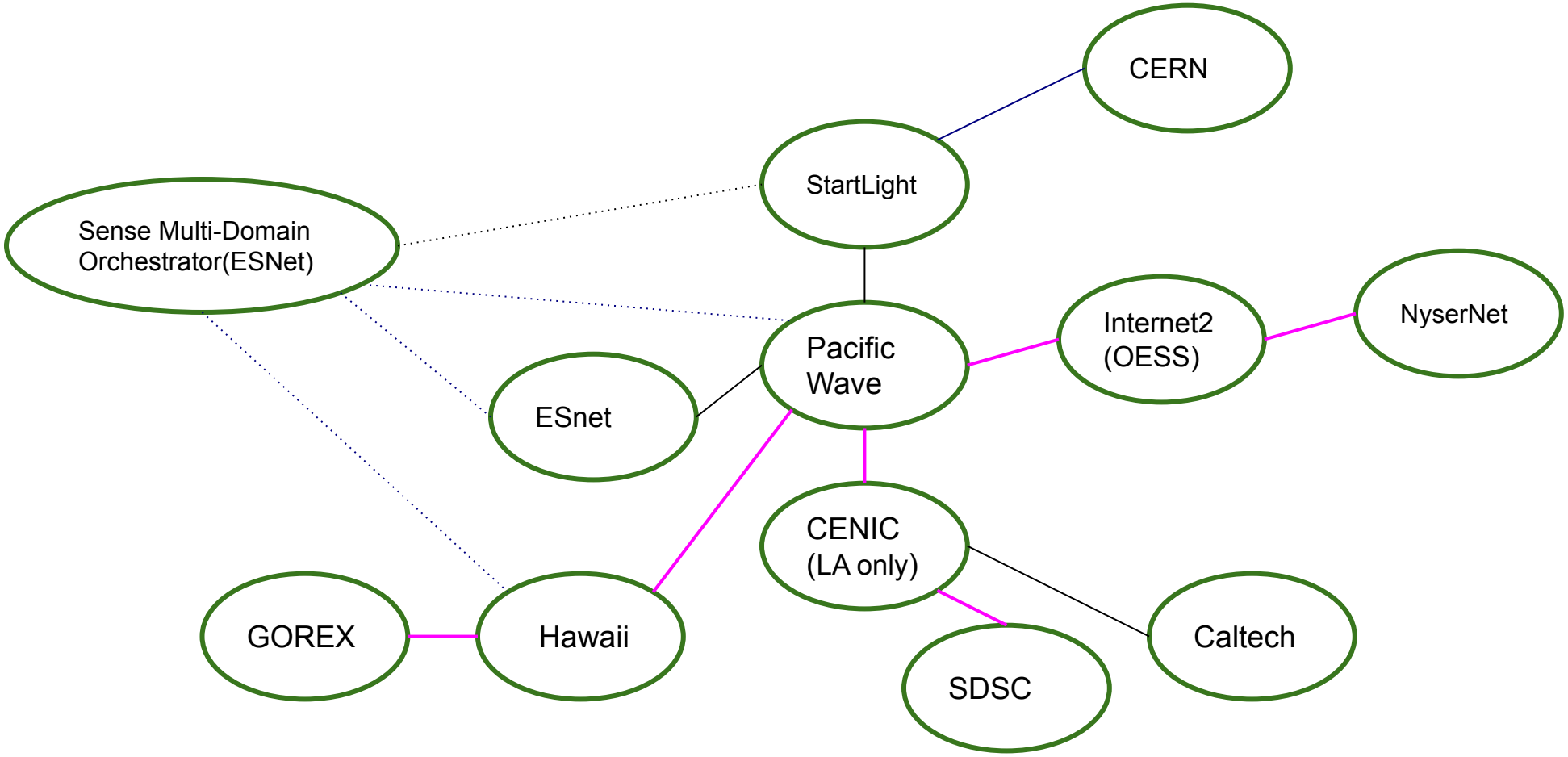
Multi-Domain Orchestration

- Big Science is multi-domain.
- It is challenging to provision paths across multiple domains.
- Building layer 2 paths across multiple domains, **dynamically, on-demand greatly benefits the flow of research data.**
- Pacific Wave has been working with the GNA-G AutoGOLE/SENSE Working Group to deliver network services end-to-end in a fully automated way – saving considerable provisioning time.
- SDSC and Caltech have been pilot users.
- Recent enhancements:
  - Paths over AL2S: NYSERNet to SDSC
  - Longer international paths: Chile to California
- Ongoing migration of the Pacific Wave Autogole/SENSE infrastructure to Kubernetes.
- We will be extending the functionality to CENIC NorCal.

Current Infrastructure in Support of Multi-Domain Orchestration

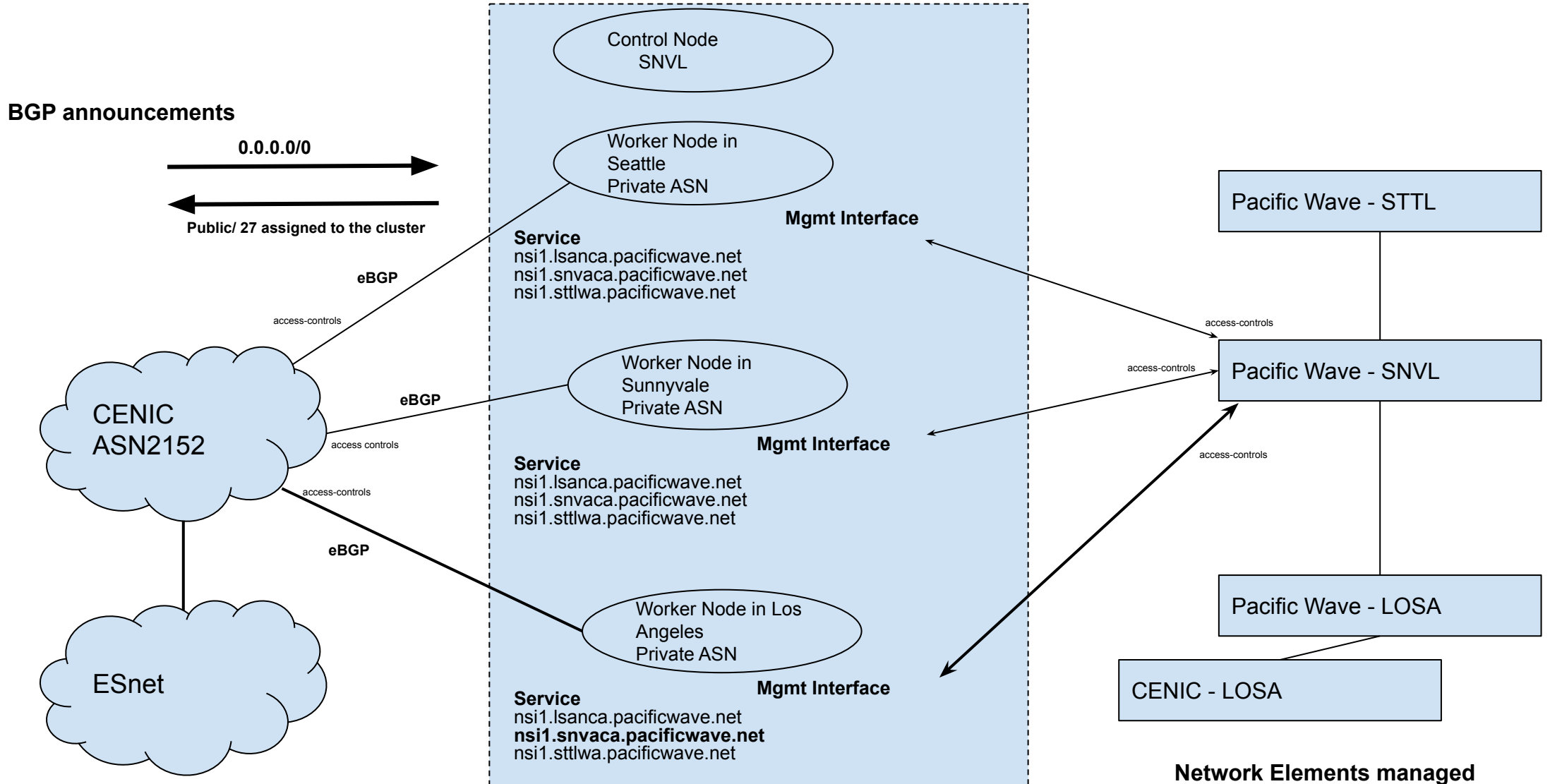


New Paths Successfully facilitated by Pacific Wave



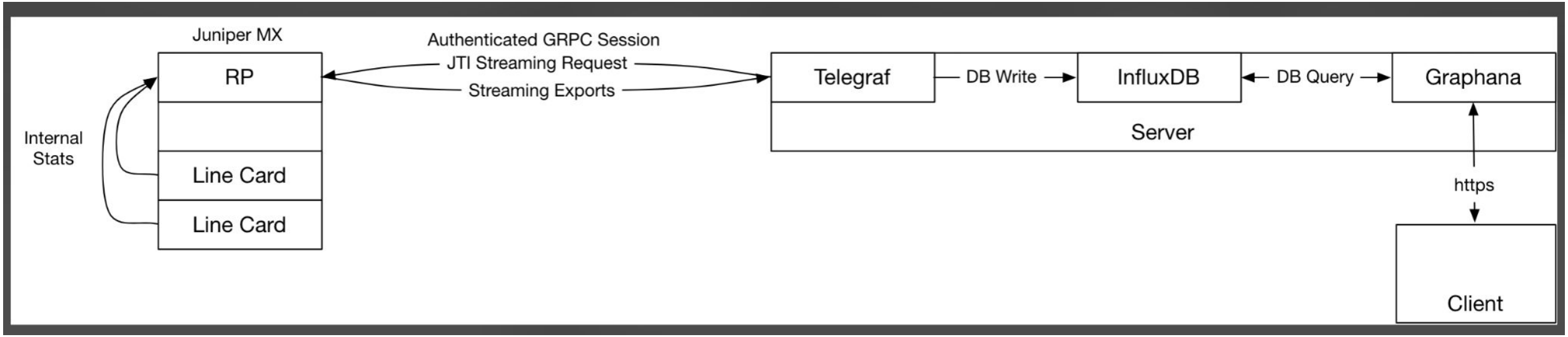
- Paths are provisioned on a regular basis via Autogole/SENSE
- **NYSERNet - Internet2(OESS) - Pacific Wave - CENIC- SDSC**
- **GOREX – Hawaii - Pacific Wave - CENIC - SDSC**

New Infrastructure in Support of Multi-Domain Orchestration



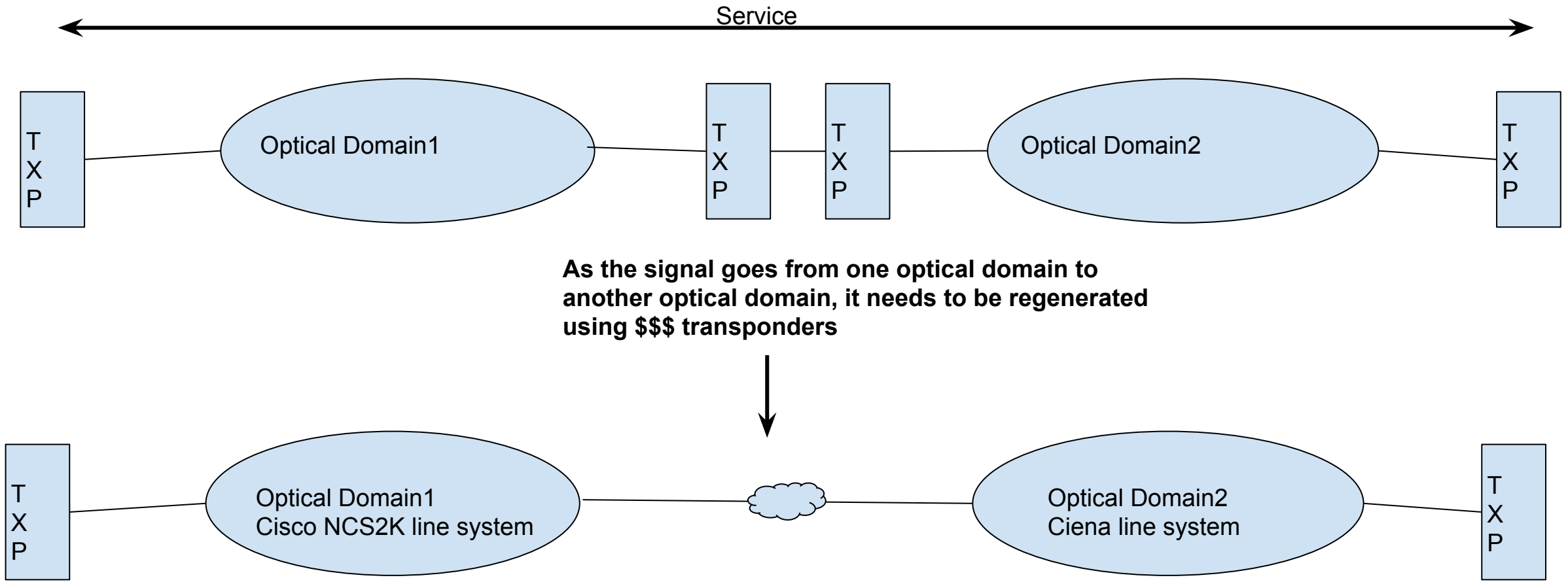
New Infrastructure - Metal-LB Enabled

Telemetry


Juniper MX
RP
Line Card
Line Card
Internal Stats
Authenticated GRPC Session
JTI Streaming Request
Streaming Exports
Telegraf
DB Write
InfluxDB
DB Query
Graphana
Server
https
Client

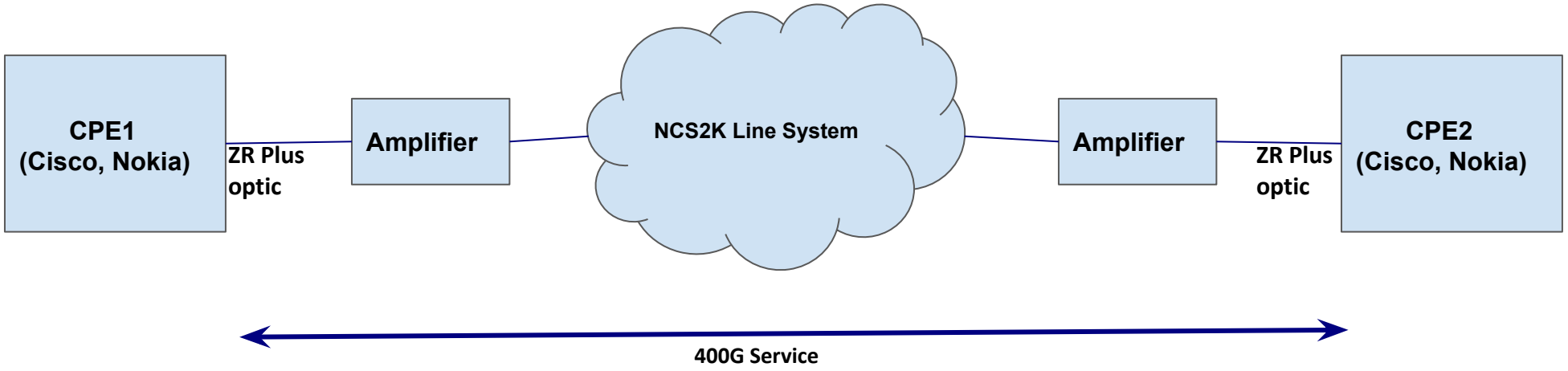

General / pw-snvl2-1
Seattle
Los Angeles
CENIC

Multi-domain Optical Provisioning



Engineer a solution that eliminates Regen - Lab Testing is ongoing

Coherent Pluggables a.k.a ZR, ZP Plus



Testing over the production network is next

Acknowledgements

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For more information see: www.pacificwave.net

Thank you