NGI Evolution Update
MAX Participants Meeting

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What is NGI?

- *The Next Generation Infrastructure Program is a full set of activities to review and update the services, value and supporting technology of the Internet2 infrastructure portfolio (and relationships in the larger ecosystem)*
  - *Includes new features, primarily driven by software, automation and systems virtualization to allow the infrastructure to be more readily integrated in to the broader campus, regional and cloud environment around us.*
  - *Includes the services and service models through which the community adopts Internet2 infrastructure services*
  - *Includes a number of infrastructure upgrade projects*

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Background: Community tells its stories

- ***Community discussion about shared future since 2016.***
  - 7+ F2F meetings with community leaders
  - RECINNS Paper Process
  - 14+ community leaders calls
  - 2022 Expectations Paper (requirements)
    - https://internet2.box.com/v/NGI2022
  - Pilots/Proofs of Concept - optical, router slicing, cloud completed
  - Decision to move to implementation, May, 2018

Guiding principles:

Ecosystem approach
- Focus on joint service delivery model campus, regional, Internet2

Experimentation
- Try stuff, short term commit
- No impact on current production service

Target research end users
- Push service delivery edge close to user

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5 Use Case Stories:

Support the Data-Centric Researcher

A researcher wants to move increasingly large file sets between collaborators in her field of study. She values fast transfers from her lab instruments to compute resources in the cloud and secure dissemination of results to students and other scientists.

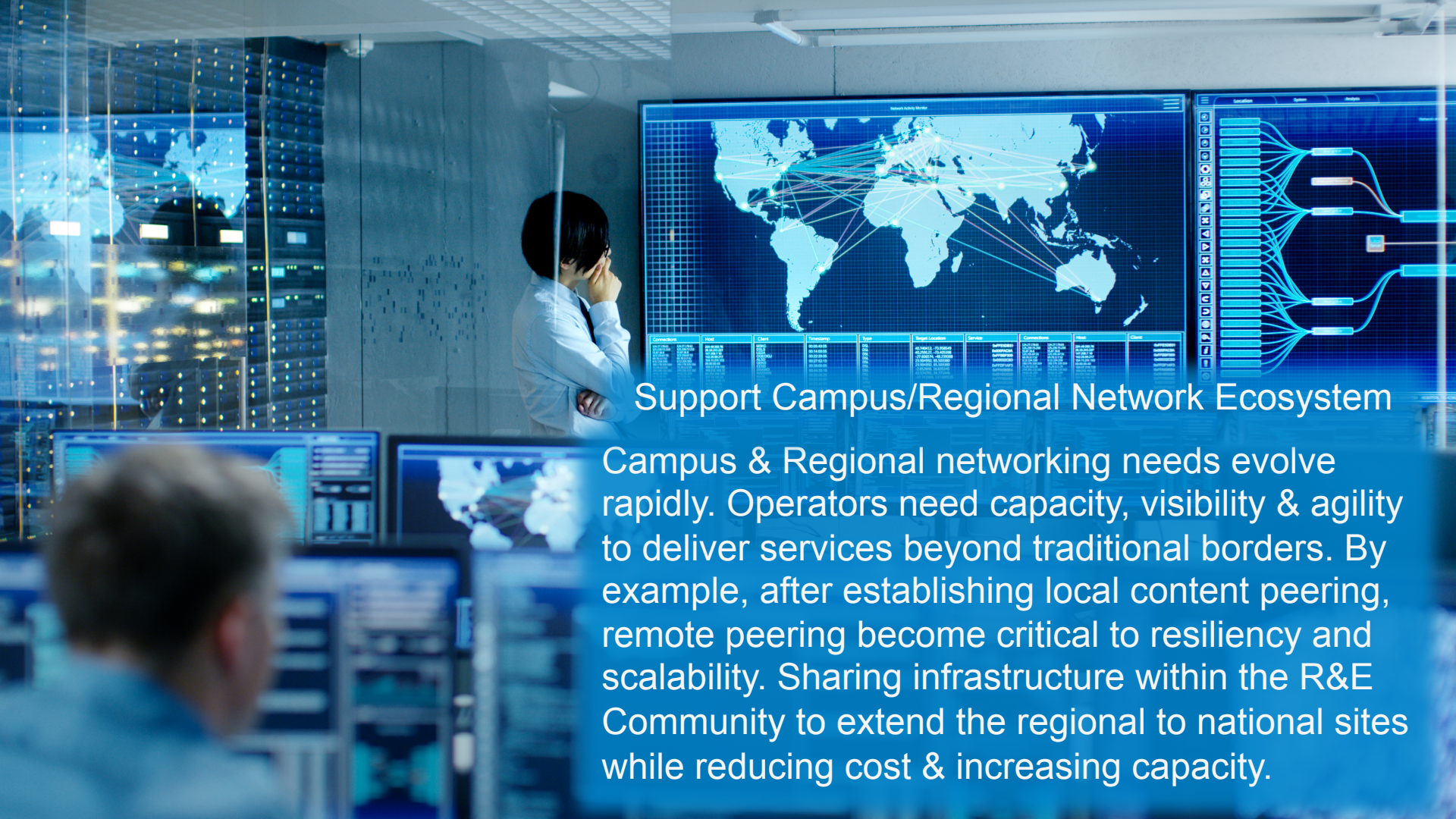
Valuing simplicity in her own workflow, she appreciates campus IT/Security is positioned to move data as fast as possible, that the data is secured to only her collaborators and that she can be alerted if there are any anomalies in the data movement, security, etc.

Support Software-Driven Infrastructure

As an end user of R&E infrastructure, operators and sophisticated research teams want to see software interfaces that can provision, change and support their own private network needs across the whole R&E ecosystem. Portal-driven configuration changes, customized telemetry for the private networks, and API–driven programmability allow them to build, monitor and change their own extended networks from their local compute cluster to their global collaborators and providers.

Support Cloud Migration for Research and Administration

A Cloud Architect plans increasing reliance on public cloud resources to augment and supplant the campus data center. She needs assurance that her campus has the reliability, resiliency, security and economics that enable rapidly evolving architectures. She plans to use the R&E networks that her campus has invested in, but needs new agility and end-to-end visibility for success.

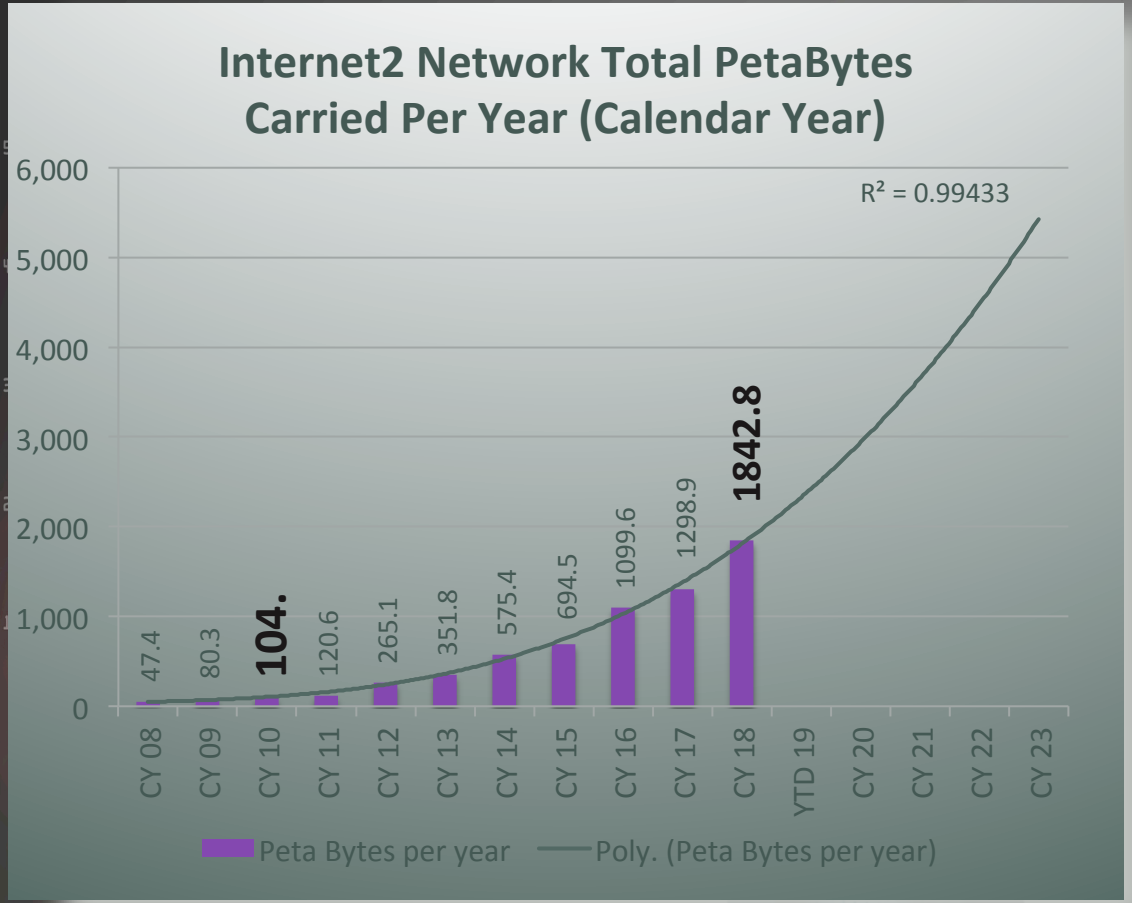


Support Campus/Regional Network Ecosystem

Campus & Regional networking needs evolve rapidly. Operators need capacity, visibility & agility to deliver services beyond traditional borders. By example, after establishing local content peering, remote peering become critical to resiliency and scalability. Sharing infrastructure within the R&E Community to extend the regional to national sites while reducing cost & increasing capacity.

Reset Internet2's Operating & Scale Economics

To support continued growth in utilization with flat annual contributions, Internet2 must have updated equipment that brings efficiencies in power draw, space used, automation and maintenance.



Story Solutions = R&E Value

- Support the Data Intensive Researcher
- Support Software Driven Infrastructure
- Support Cloud for Research and Administration
- Deliver Ecosystem-wide Solutions
- Reset Internet2 Economics for Scale

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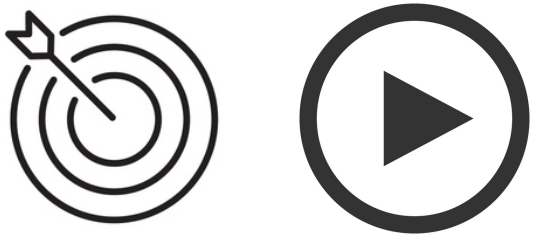


Next Generation Infrastructure
2019 and Beyond

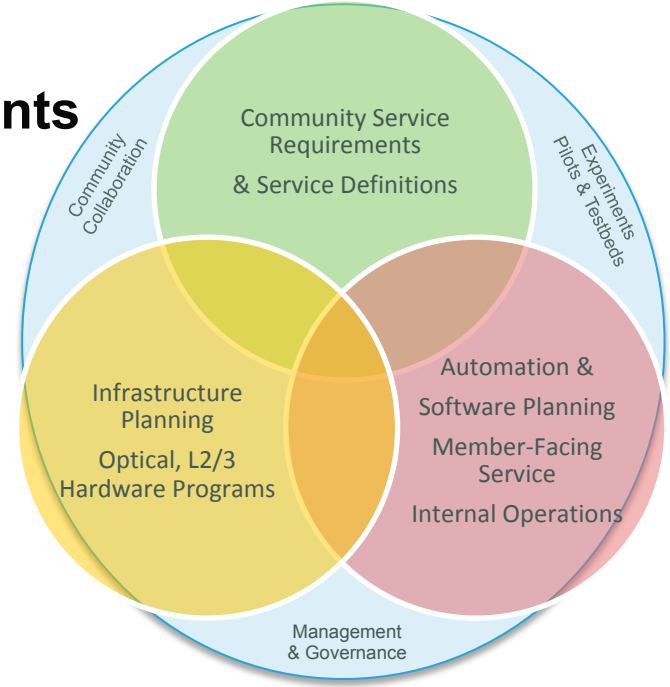
NGI Background: *Where are we?*

- Service Requirements & Value Improvements
- Service Model (fees) Discussion

- Optical RFP -> Implementation
- Packet RFI->Workshop->RFP

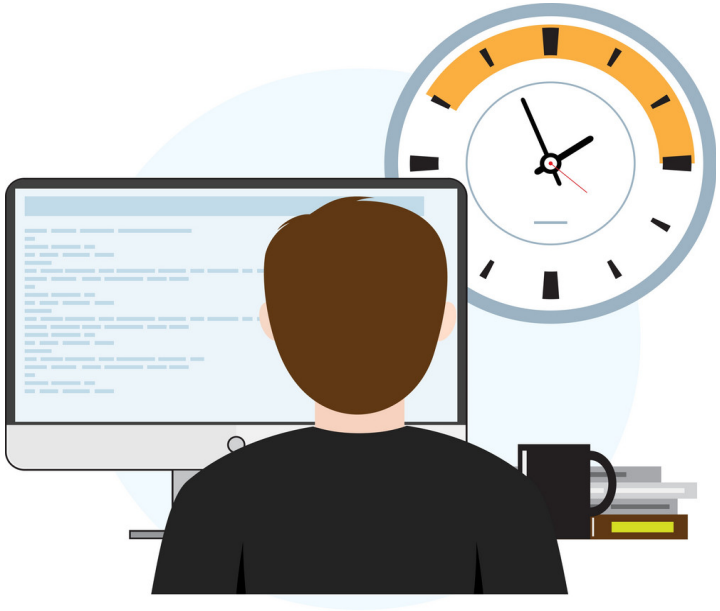
- Network Automation
- Service Orchestration

- Testbed



NGI: *Wins since Global Summit 2018*

- Cloud Connect Portal
  - On Demand Layer 3 connectivity to Big-3 providers
  - Major value proposition according to campus CIO's
  - Over 50 campuses already piloting service
- TR-CPS "Cap" raised to 50G / Peering Exchange Upgrades to 100G in progress
- 2x100G to 3x100G upgrade offered as reduced-cost pilot
- Optical RFP released, received and under evaluation
- Router Slicing, Routed Service Futures, Alien Wave Pilots, Open Science Grid/Stashcache, NRP Pilot



Focus: Peering Portfolio Building Blocks

Enhanced Cloud Delivery & Cloud Performance Services
- Continue training, outreach, topology expansion and service enhances to Cloud Connect Service
- perfSONAR or other performance tool on demand at cloud-edge

Rapid Deployment 10G & 100G PNI Ports
- low cost 10G and 100G dedicated ports at the peering points for connectors to do direct-connects at remote sites

Cloud Router / Shared Router / Dedicated Router
- Several options for connectors to deploy a virtual or physical router at a remote peering point at lower TCO

Virtual Network Function Hosting
- Virtual machines available at peering sites for connectors to run software of their choice on their private network

Clean Pipe Services
- Internet2 services delivered “scrubbed” with appropriate reports on attacks, threats, etc.

Enhanced self-service & telemetry
- Great self-configuration & telemetry associated with services and API’s to drive the network from applications.

Targeted Telemetry

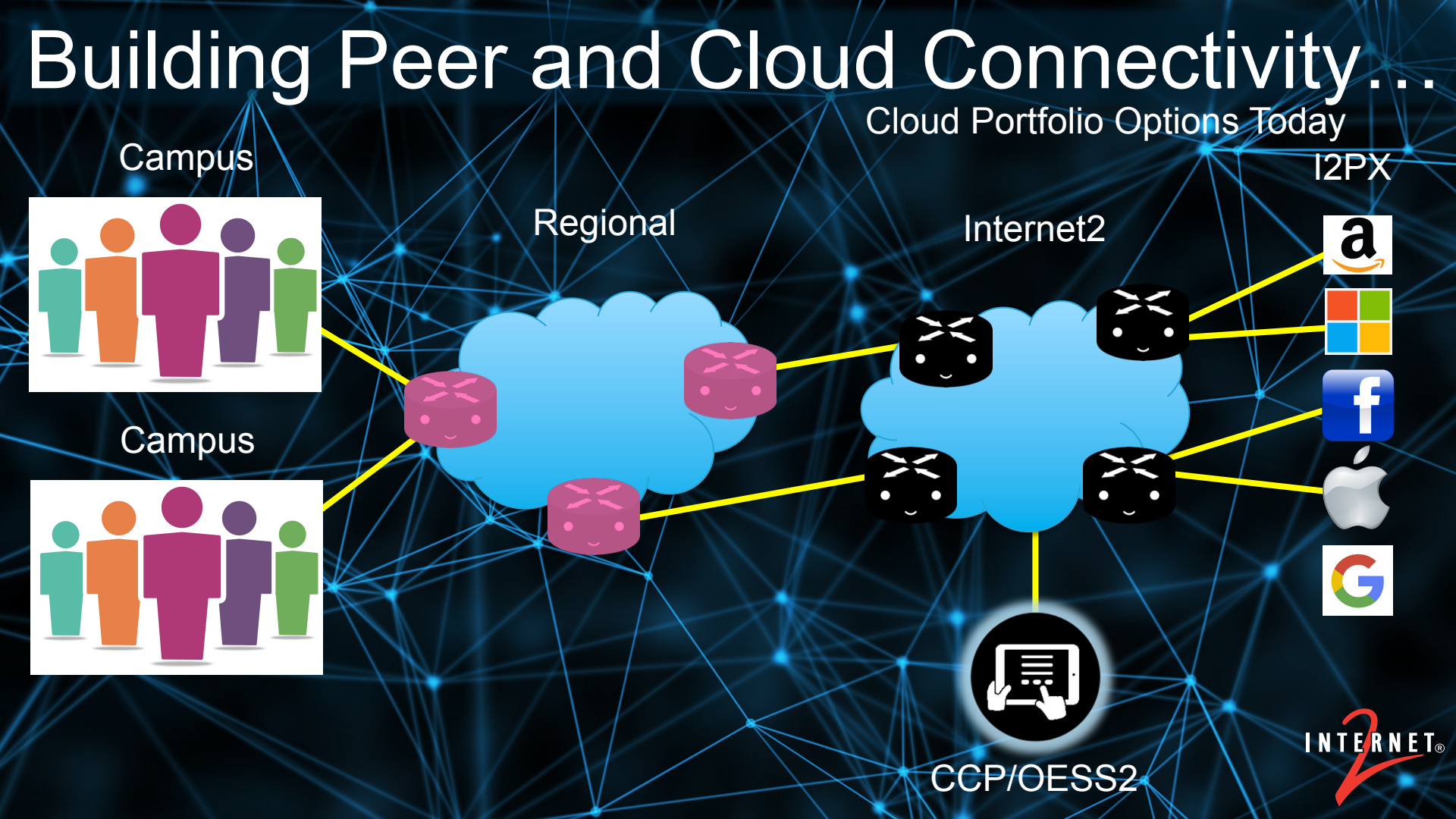
Targeted Portals

Rapid

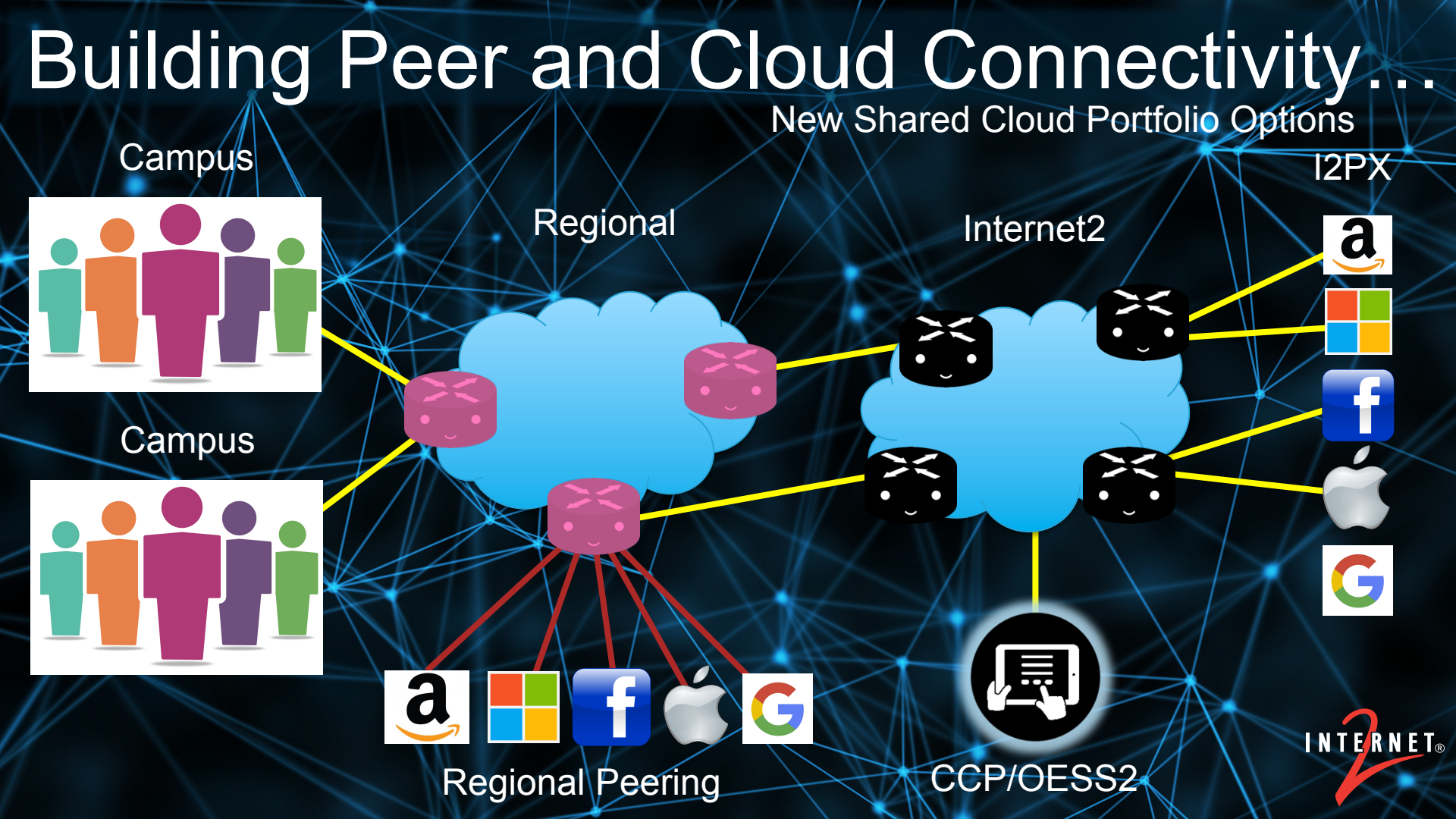
Agile

Automated

Building Peer and Cloud Connectivity…

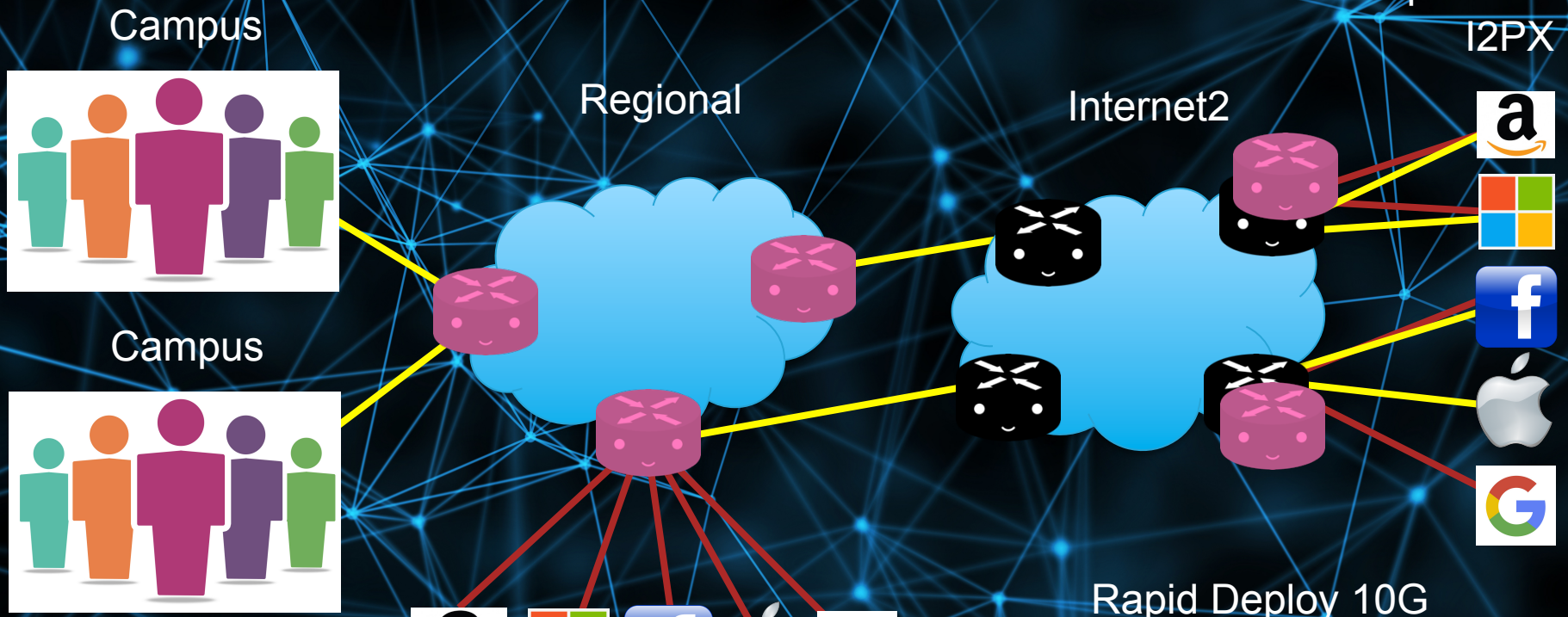


Building Peer and Cloud Connectivity…



Building Peer and Cloud Connectivity…

New Dedicated Cloud Portfolio Options



Building Peer and Cloud Connectivity…

Example 1: A regional wants to establish 20G connectivity in Chicago and 20G in Sunnyvale for peering and dedicated cloud connect

- Use 4 10G Layer 2 Rapid Deploy ports and leverage L3VRF Portal
- Internet2 backbone backhauls traffic to the regional ports
- No remote colo, power, hardware or transport
- Regional pays peering/cross connects as if they were there
- Cost estimate for service is <$50K/yr for 40G

Example 2: A regional wants 100G peering in Chicago w/their own remote router

- Add a pair of resilient 100G Internet2 Rapid Deploy port in Chicago
- Internet2 provides partial rack space, management Ethernet port
- Internet2 provides 20 hours/year remote hands
- Internet2 backbone to backhaul traffic to the regional
- Regional provides router
- Regional pays peering/cross connects as if they were there
- Cost estimate for service is <$60K/yr for 2x100G

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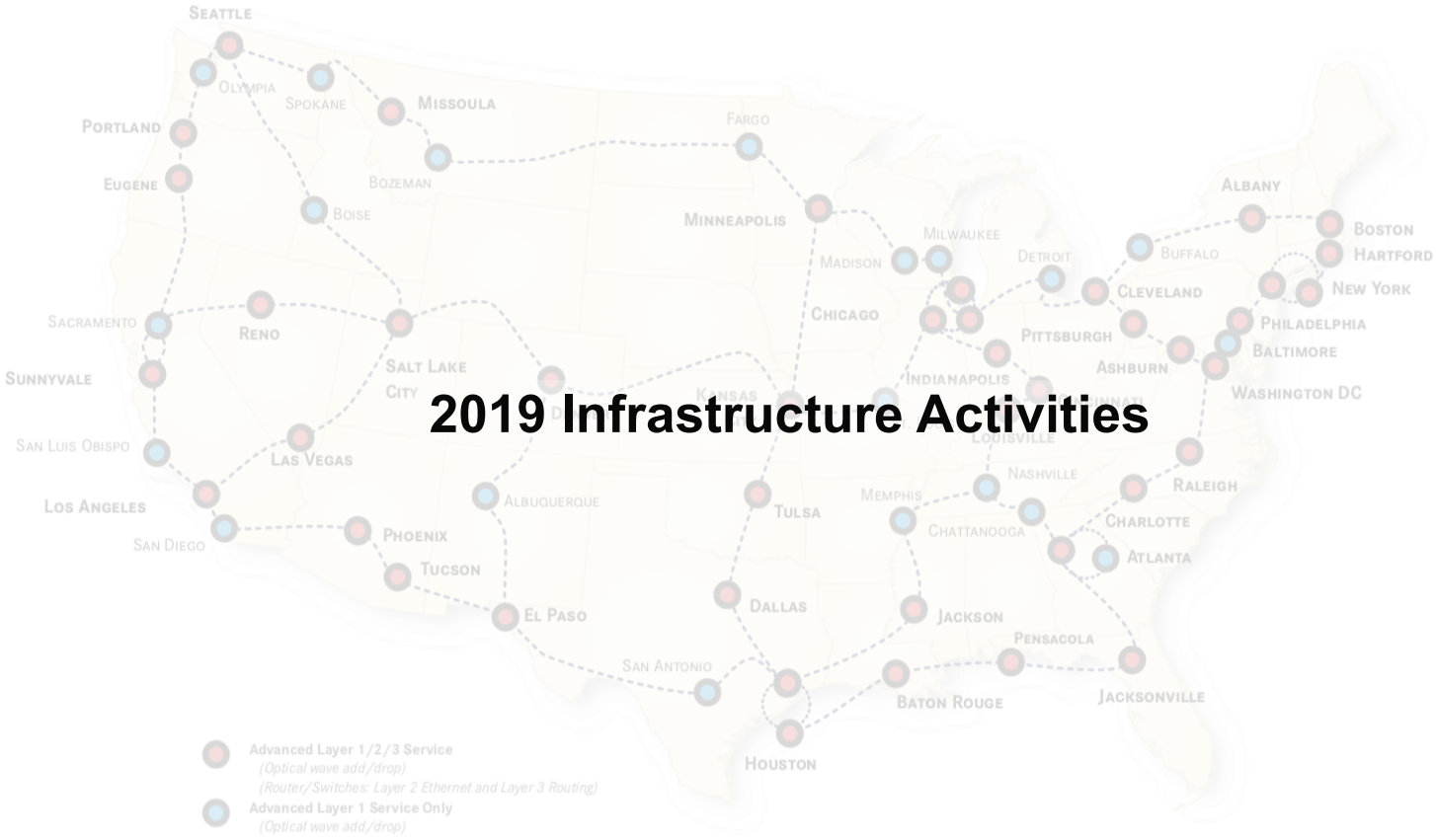


2019 Infrastructure Activities


Where are we?
Self-Service Portal & Telemetry
Automation
Packet
Optical

Advanced Layer 1 Service

Today:

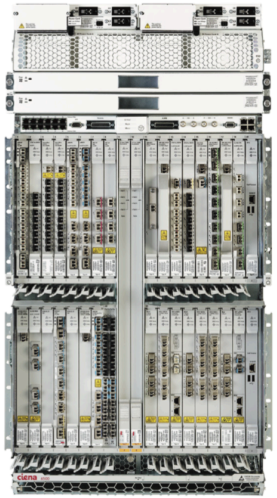
10, 40 & 100G waves

“Dark Channel” with Ciena Equipment

Fiber/System Sharing in bulk agreements

Fixed 50 Ghz spectrum

Distance & hardware based pricing



Likely Tomorrow: **Available 2020**

100, 200, 400, 800 G waves

Support 3rd party transponders

Fiber/System sharing in bulk agreements

Flex 50+ Ghz spectrum

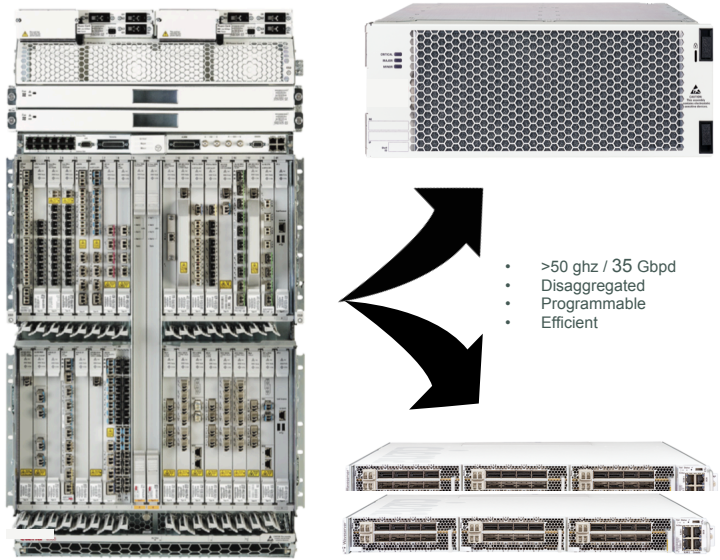
Custom Telemetry

Updated segment fees

NGI: *Optical Photonics Investment (2019 Activity)*

Underlying photonic transport system for nationwide community wavelength sharing

- Implement new nationwide optronic kit to support:
  - >50Ghz media channels
  - 200-800G transponders
  - inter-network optical connections and foreign waves
  - Twelve Request for Proposal Responses Received February 5, 2019
    - Next Step is Best and Final Offers for equipment with top 3-4 potential partners
    - Also reviewing operational impact and professional services to smooth transition



Address sub-optimal OSNR on some paths

Advanced Layer 1 Service

- Open Line System Upgrade First
  - Twelve Request for Proposal Responses Received February 5, 2019
    - Next Step is Best and Final Offers for equipment with top 3-4 potential partners
    - Also reviewing operational impact and professional services to smooth transition
- Optical Transponder & Pluggable Capacity will come next
  - New 200G-800G Transponder Platforms part of RFP responses
  - Also expect pluggable 400G DWDM modules to begin shipping in late 2019
- Expect to have first segments upgraded late in 2019

Advanced Layer 2/3 Service

Today:

10 & 100G access

Uniform delivery typically by local router

R&E, Peering, Special Services blended in to uniform connection-based pricing

Cloud Connect Portal to AWS, Google at L2 and L3

Likely Tomorrow:

10, 100, Nx100G, 400 G connection offerings

Differentiation of connector platform and peering portfolio fee models

Backhaul and “local router” options

On demand, portal and API driven layer 2 and layer 3 services, including cloud connect

Enhanced self-service & telemetry

Advanced Layer 2/3 Service

- High Level Request for Information to be released
- Asks leading providers to envision a 2022 R&E Network
  - Asks providers to describe an integrated, automated, efficient platform for the ecosystem (packet platform, optronics, controllers, portals, telemetry, etc)
- Community Workshop, mid-summer, to finalize design options prior to release of Request for Proposals late summer
- Ideally evaluating proposals in the 3rd quarter for award in 4th quarter

Cloud Services

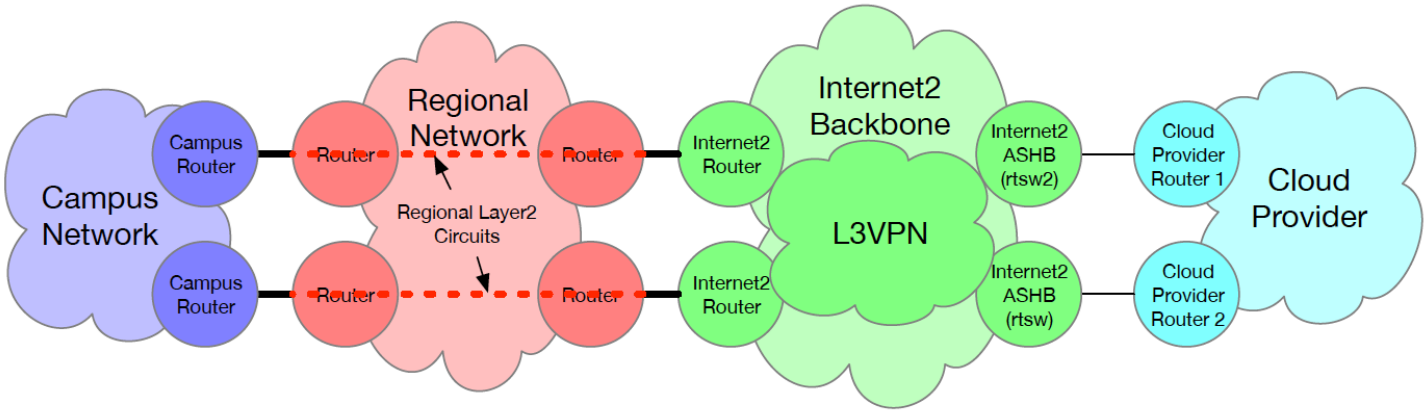
Internet2 Peer Exchange I2PX

Use of the community's existing 800 Gbps+ of layer 3 peering capabilities to the major cloud providers for advanced, community enabled access to cloud services.

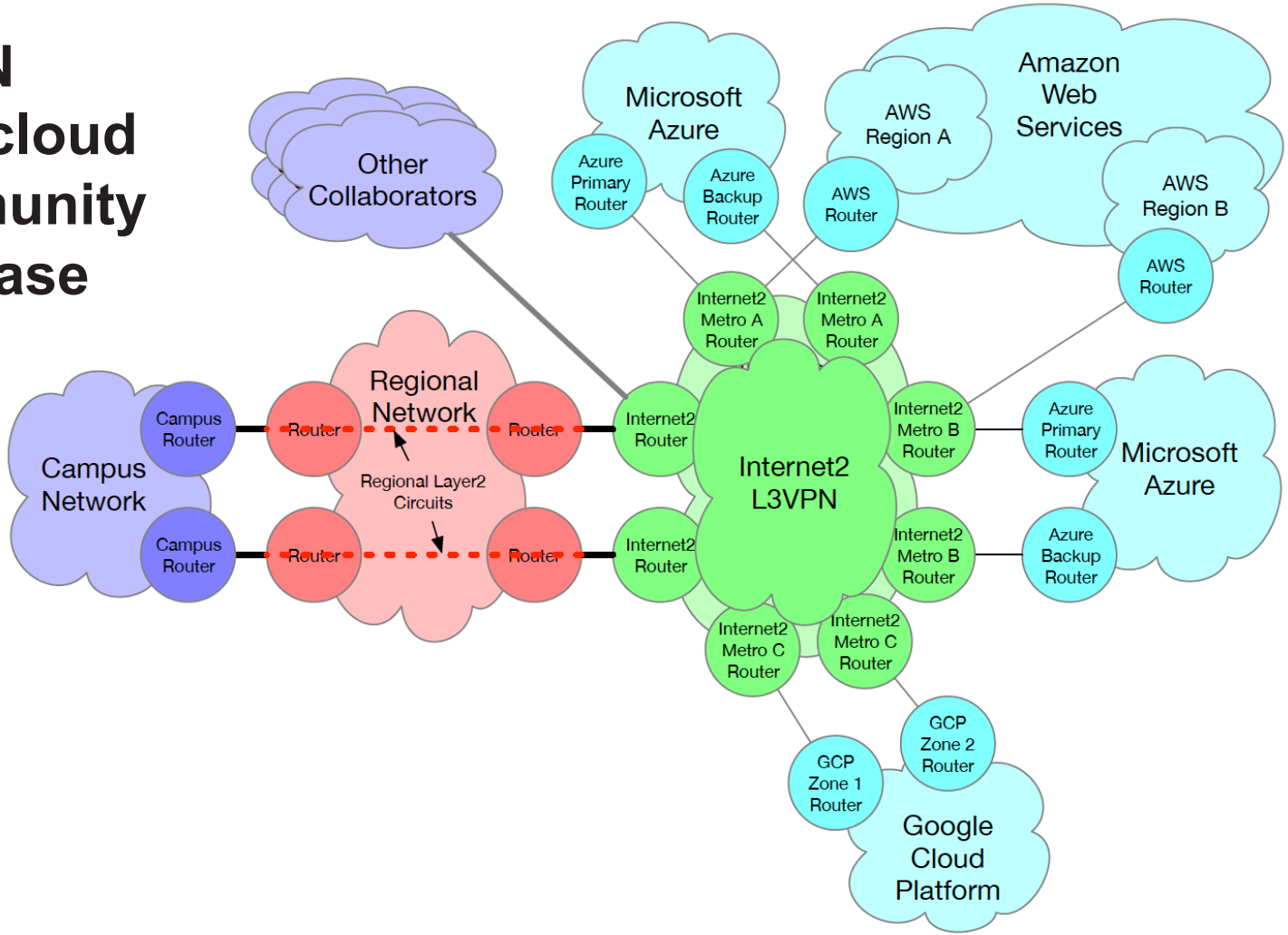
Cloud Connect

Enabling Internet2 & Regional infrastructures to offer "direct-connect" ***private Layer 2 and Layer 3*** access to Microsoft, Amazon and Google cloud platforms.

Layer 3 – MPLS L3VPN Option



L3VPN Multi-cloud Community Use Case

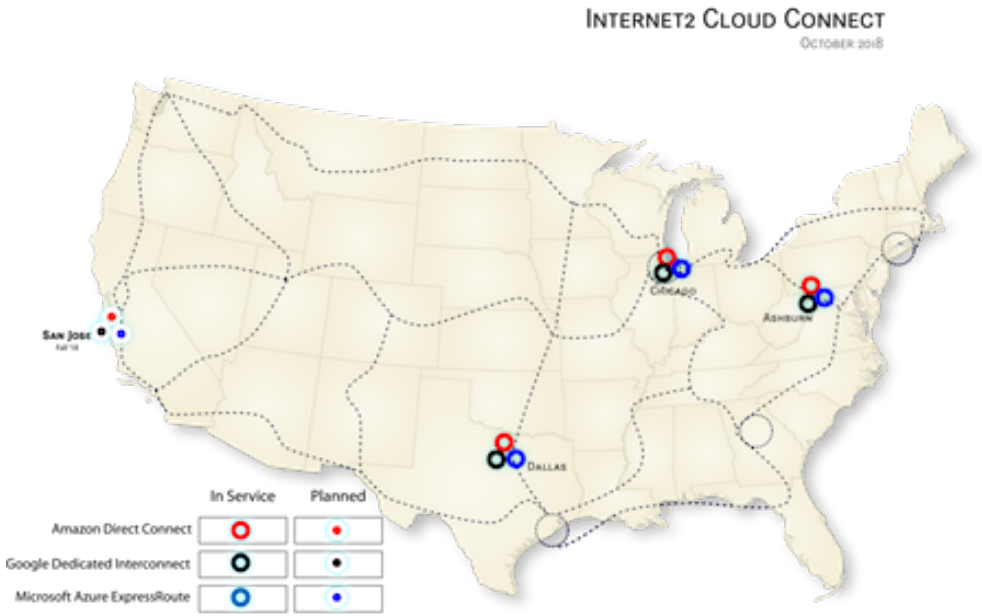


Cloud Connect – Current Status

- **Microsoft:**
  - Access:
    - Available: Ashburn, Chicago, Dallas
    - Future: Bay Area
  - Members connected:
    - OSHEAN – Layer 2 & Layer 3
    - Georgia Tech – Layer 3
    - Vanderbilt – Layer 2
    - University of Chicago – Layer 3

- **Amazon:**
  - Access:
    - Available: Ashburn, Chicago, Dallas
    - Future: Bay Area
  - Members connected:
    - Florida State – Layer 2
    - Georgia Tech – Layer 3

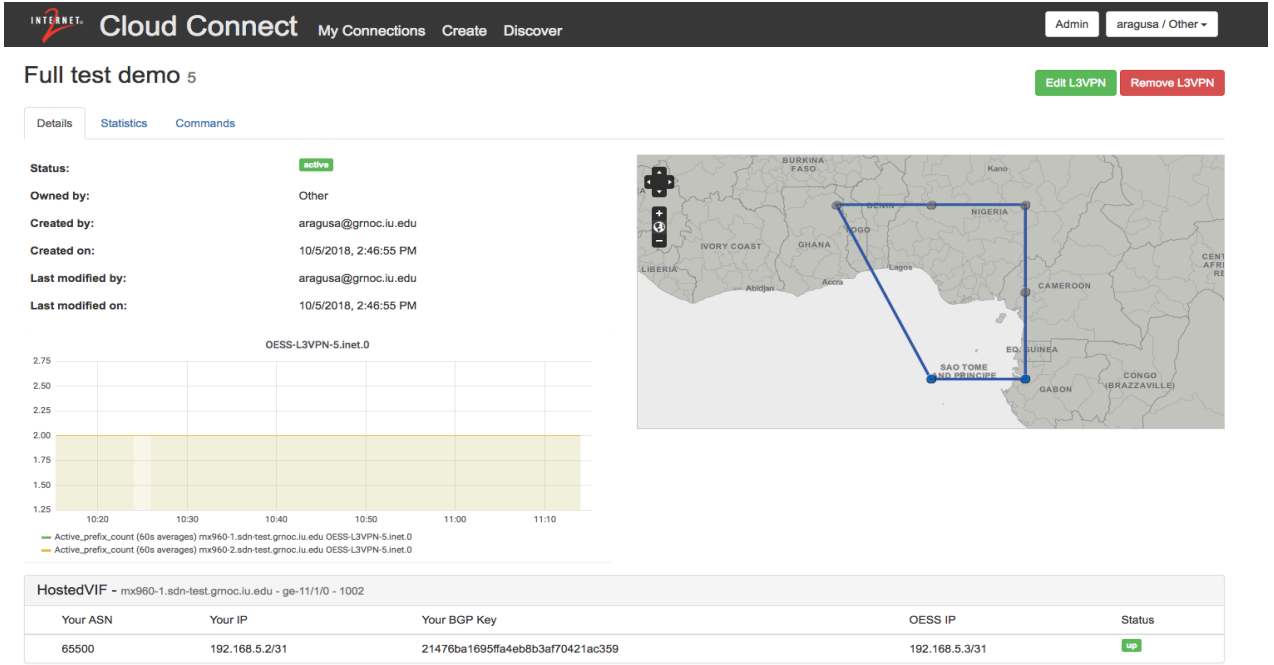
- **Google:**
  - Access:
    - Available: Ashburn, Chicago, Dallas
    - Future: Bay Area



Internet2 Cloud Connect Portal

- L3VPN (VRF) provisioning
- New Web-UI
  - L3VPN provisioning today, (Layer 2 on roadmap)
- Phonebook
- Cloud provider integration
  - AWS Direct Connect
  - Microsoft ExpressRoute
  - Google Dedicated Interconnect
- Q-in-Q support
- Traffic Shaping

New WebUI



Demo @ https://www.youtube.com/watch?v=Va3sK6Sy1Rs&t=8s
Info @. CloudConnect_Request@Internet2.edu