



# I2 Services in 2022 and Beyond

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Network Services

## Agenda

- 1 | Highlights of the new Internet2 infrastructure  
Two productive years. Program accomplishments during a busy pandemic!
- 2 | Planning for software-enabled capabilities
- 3 | Q & A – Areas of Focus and Directions for 2022 and beyond

# Next Generation Infrastructure

**I2** COMPLETE  
**NGI**

# Internet2 Next Generation Infrastructure Program

**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 the services and service models through which the community adopts Internet2 infrastructure services
- Includes new features, primarily driven by software, automation and systems virtualization to allow the infrastructure to be more readily integrated into the broader enterprise, campus, regional and cloud environment around us
- Started in 2016 with gathering of user requirements

**Data-Intensive Research**

**Enhanced Cloud Access**

**Software-Driven Infrastructure**

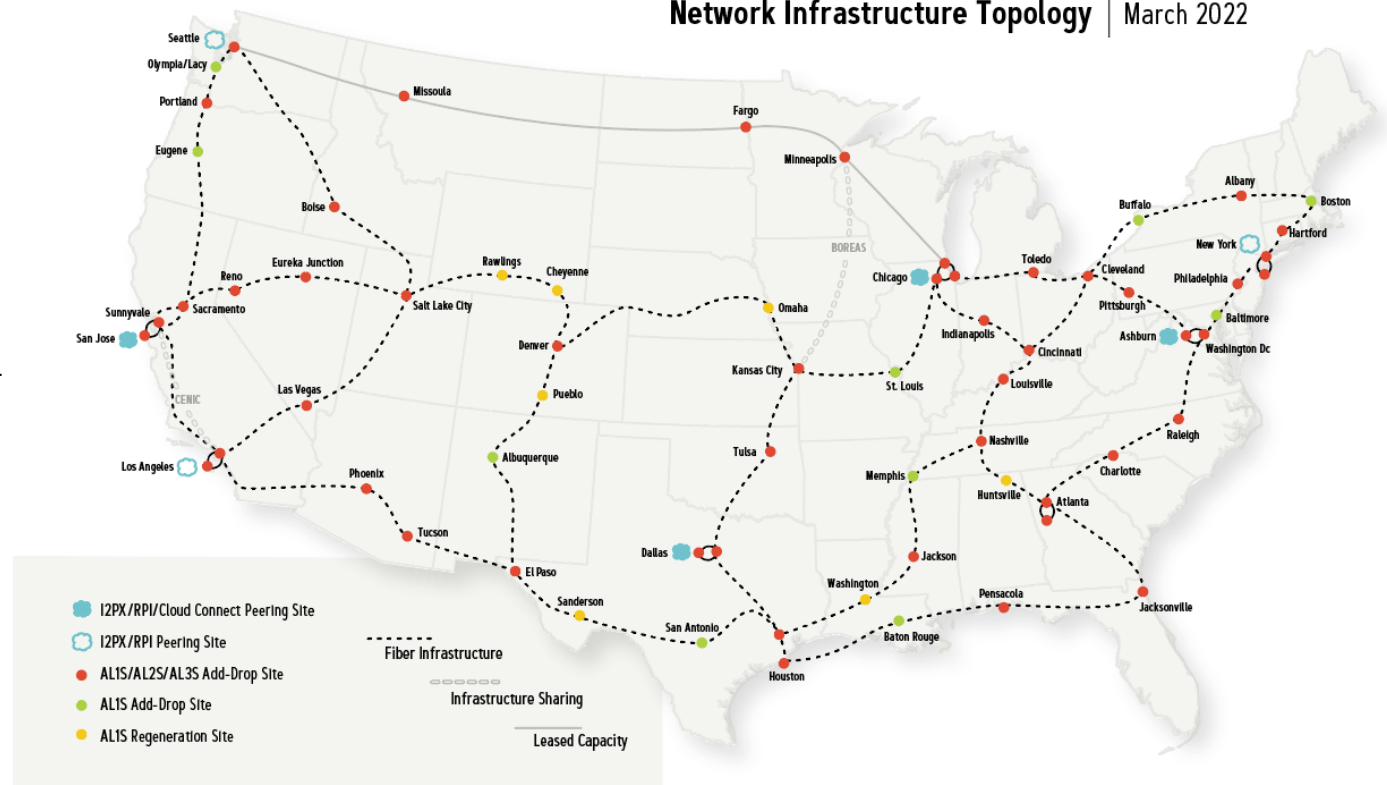
**Sustainable Economics**

**Infrastructure Sharing**

## NGI Capabilities Update

- Capacity
  - Automation
  - Measurement
  - Security
  - Operating Cost Reset
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- Expanded Engineering Team
  - New Software Team

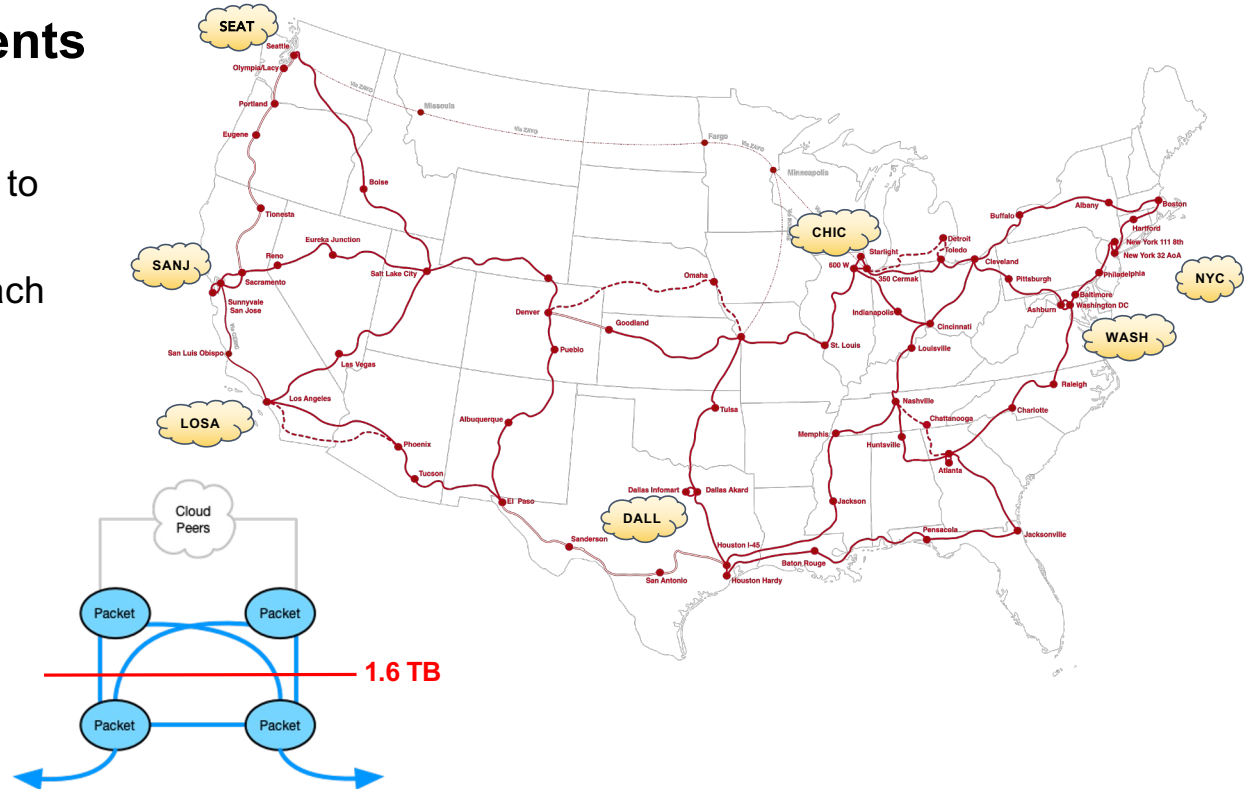
Network Infrastructure Topology | March 2022



# Cloud Capacity Enhancements

Internet2 Network now extends directly to these peering points

- Allows regionals and members to reach cities their own infrastructure doesn't reach
- Highly Resilient
- Rapid / low friction implementation
- Massive scale of the service
- Increasingly self-service



Internet2 Cloud Connect  
**I2CC**

Internet2 Peer Exchange  
**I2PX**

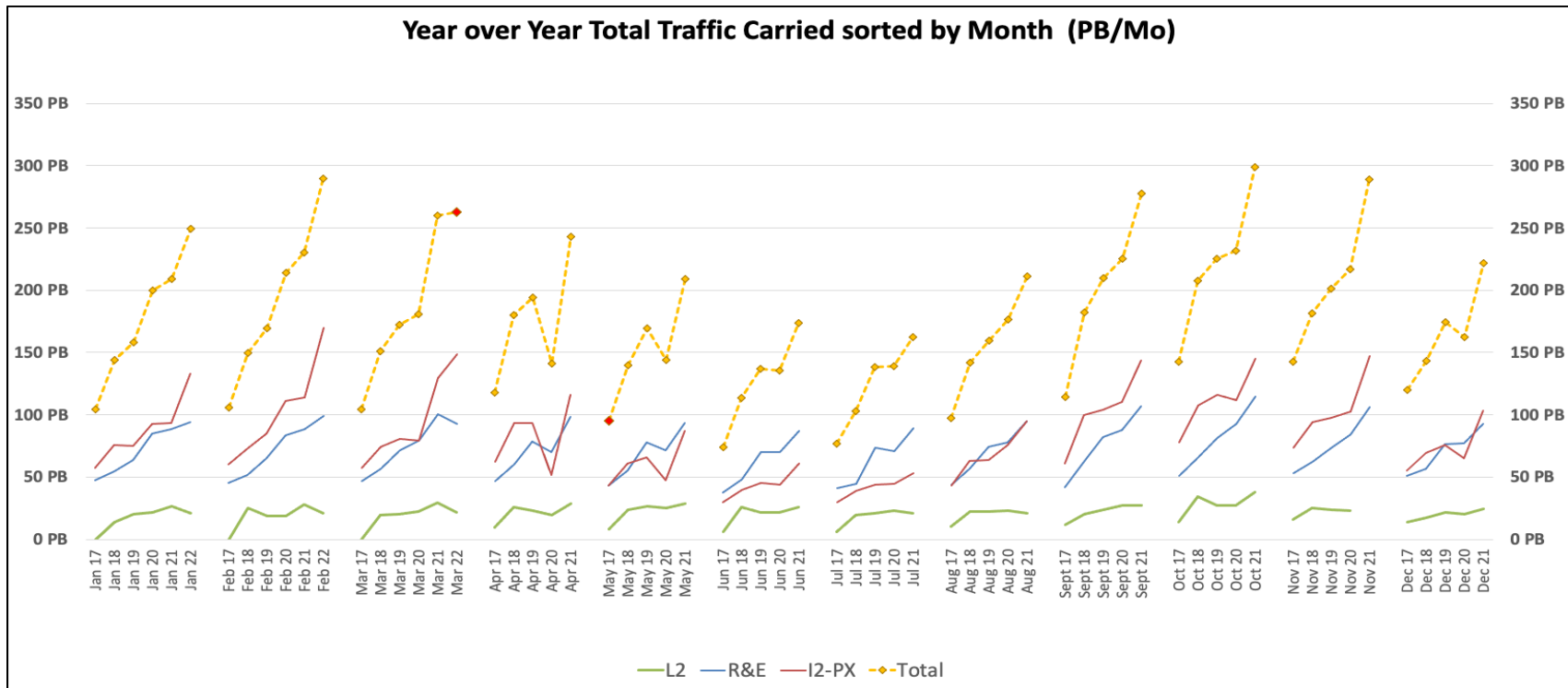
Internet2 Rapid Private Interconnect  
**I2RPI**

Internet2 Last Resort Full Internet Access  
**rIPcord**

# Traffic Trends, Peering and Cloud Capacity Augments

**COMMERCIAL  
PEERING CAPACITY**

2019 980 Gbps	2021 5,640 Gbps
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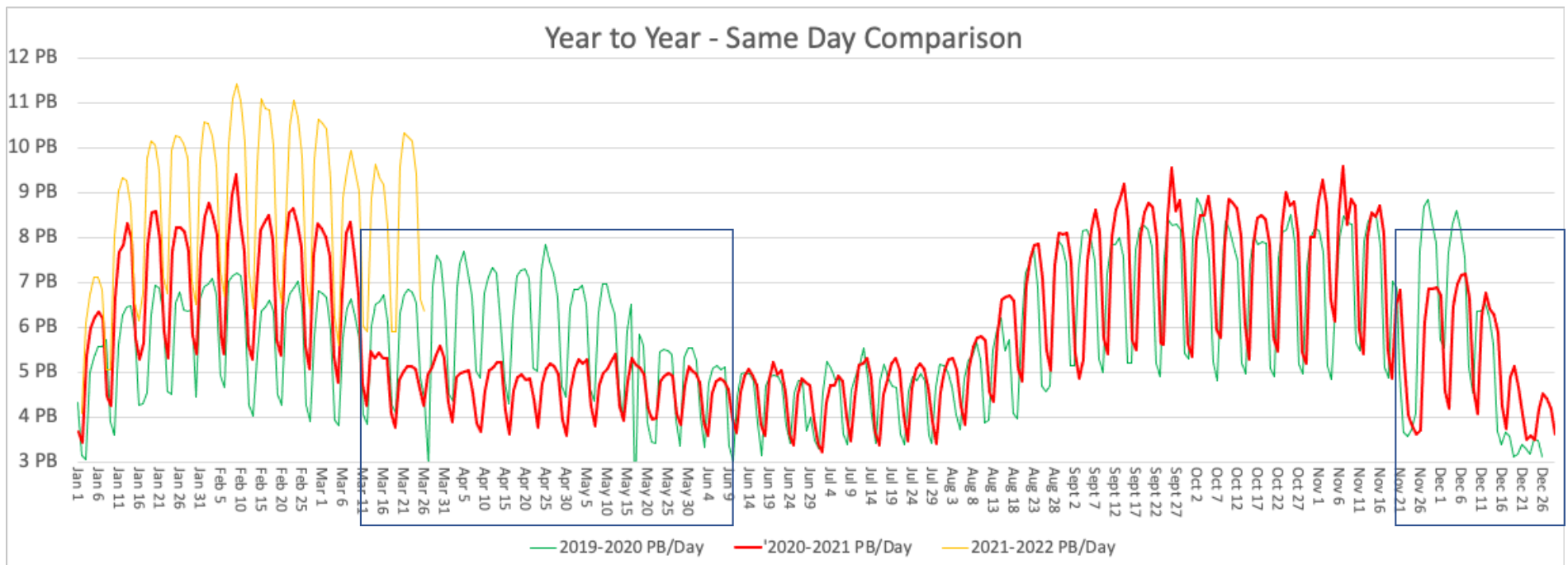


## By the Numbers – Network Traffic Carried

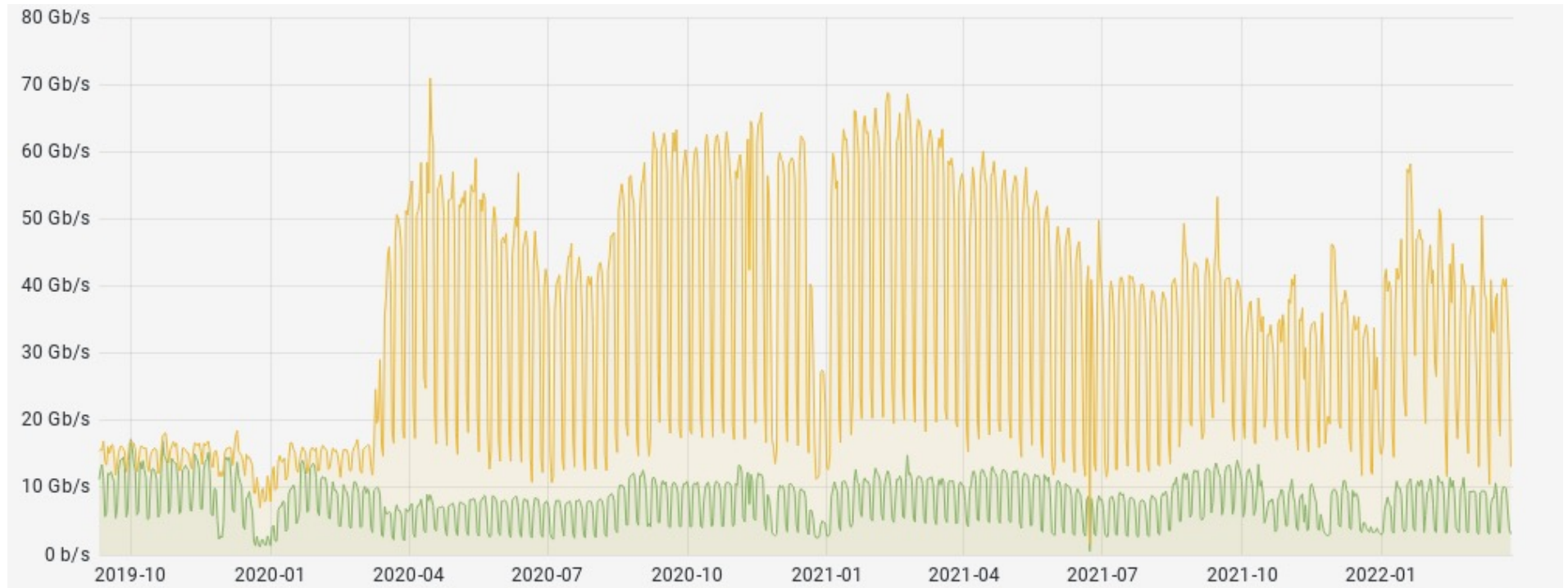
70% less space / 70% less power

	2010	NGI Online (Dec 21)
• Total Annual Traffic	104 PB	2,785 PB
• Total I2PX Traffic	56 PB	1,288 PB
• Total R&E Traffic	48 PB	1,161 PB
• Total "Other" Traffic (Cloud Connect, LHCOne, L2, etc.)	0PB	334 PB
• Total Contracted Bandwidth	203 Gbps	10,290 Gbps
• Backbone Link Capacity	250 Gbps	127,700 Gbps
• Total Device Capacity (installed 100g/400g ports)	453 Gbps	810,000 Gbps

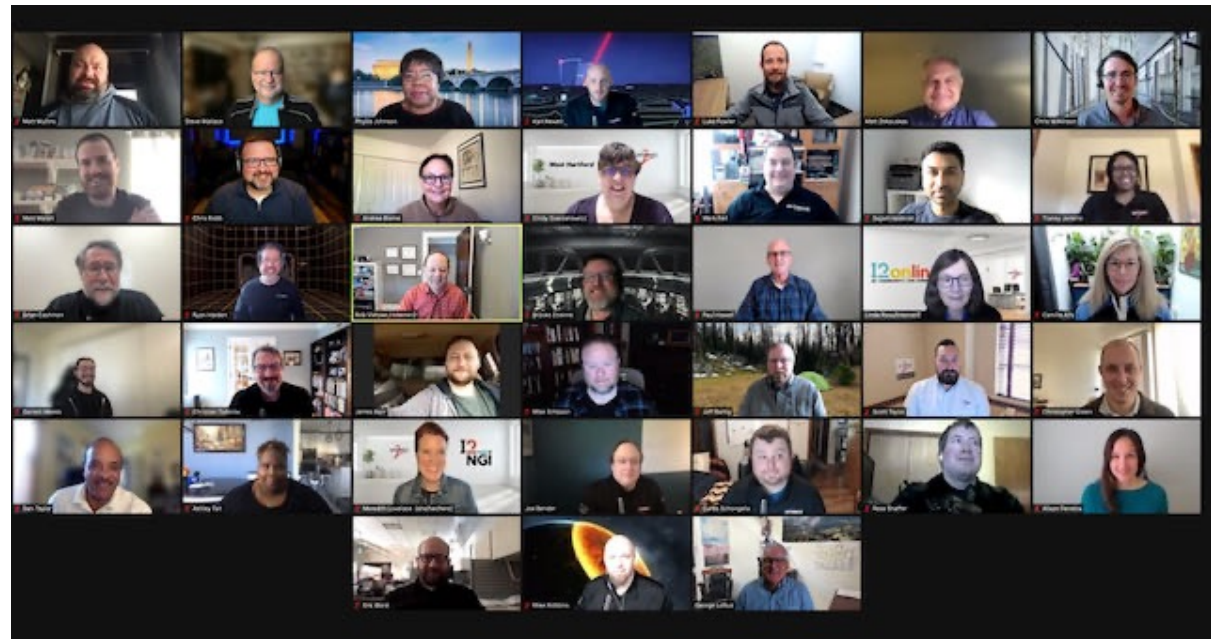
## Internet2 Overall Pandemic Traffic History



## One Large Home Broadband Provider During the Pandemic



# An Enormous Community Effort. Thank you!



There are many additional Internet2 and GlobalNOC contributors who didn't make the photo. THANK YOU TOO!

**Towards the Future!**

**FIRST  
TO 400€**

I<sup>2</sup> COMPLETE  
NGI

FIRST  
TO 400G



OARnet

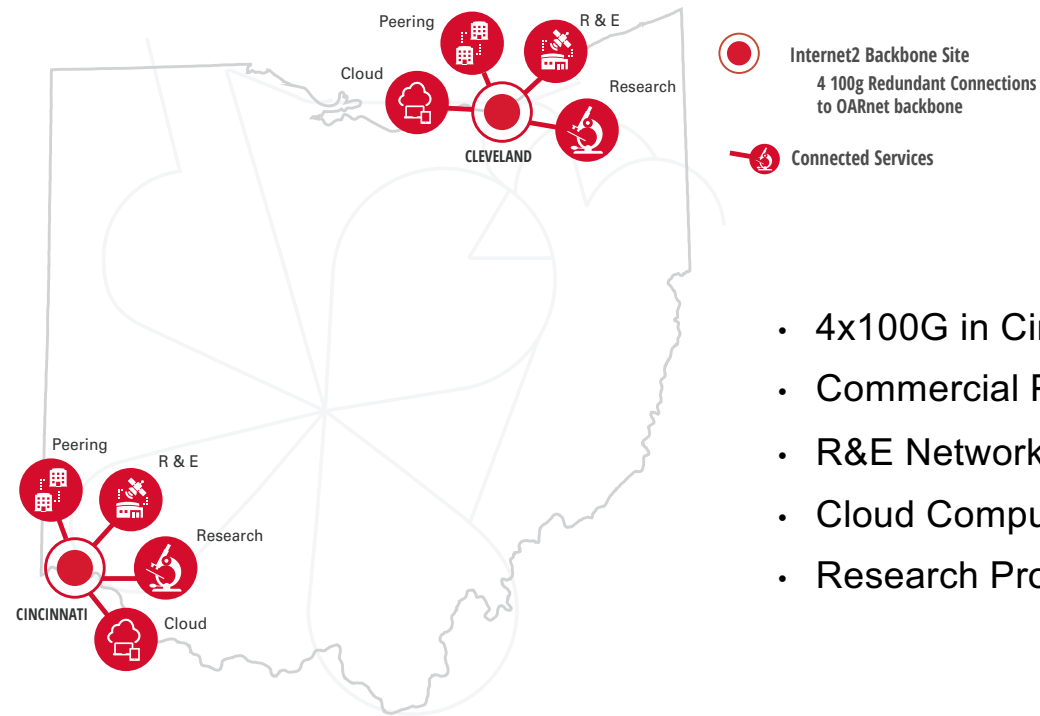




# OARnet

An **OH·TECH** Consortium Member

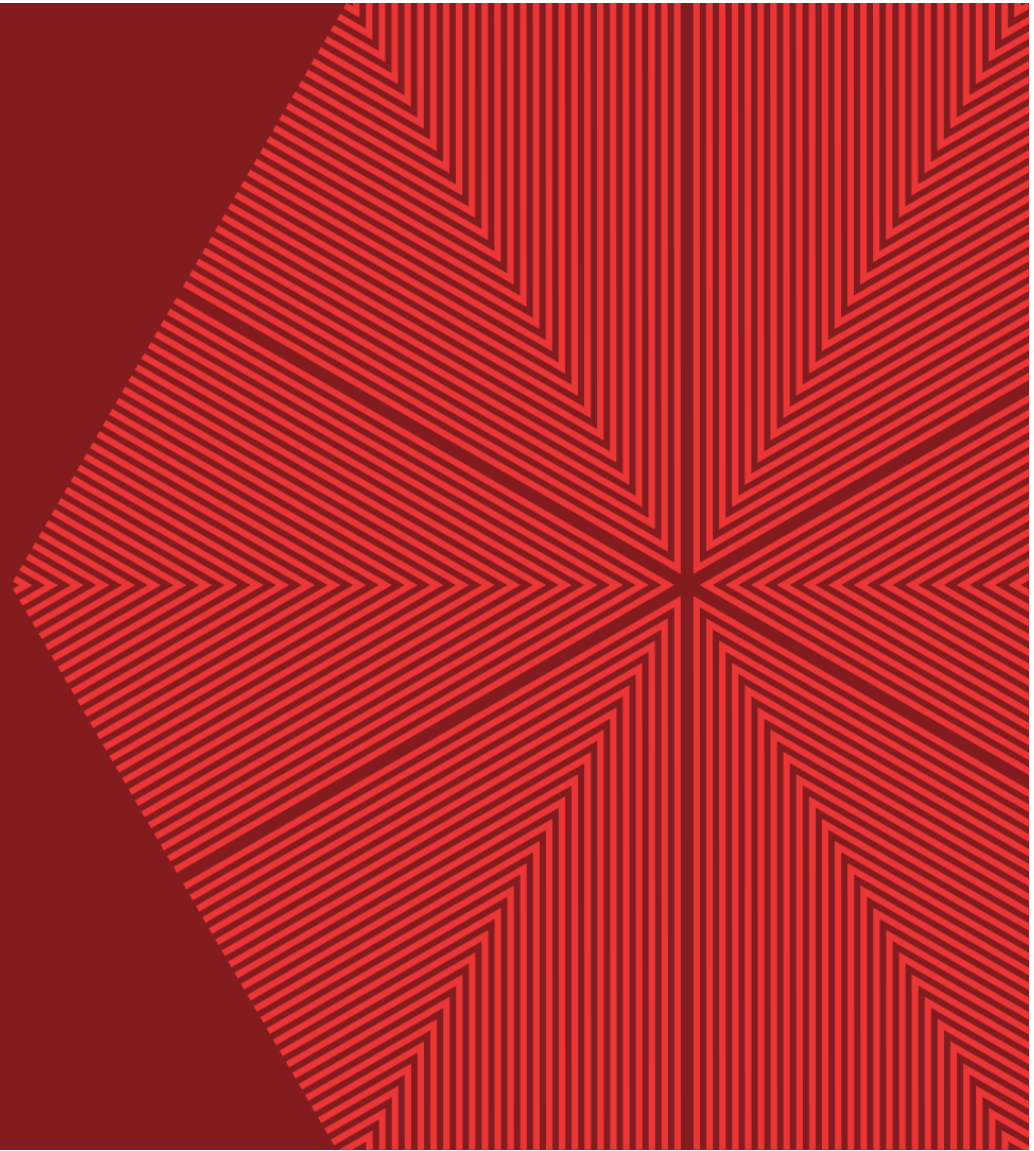
OARnet is one of the first five networks to implement a 400G connection to the Internet2 Network



- 4x100G in Cleveland
- Commercial Peering
- R&E Network
- Cloud Computing
- Research Projects

- 4x100G in Cincinnati
- Commercial Peering
- R&E Network
- Cloud Computing
- Research Projects

# **Enabling Science & Enterprise Services**



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## 2022 Network Services Activities

Delivery of member-facing self-service software-driven network products

- Updated Router Proxy

- New Routing and Routing Security Portal

- Updated Cloud-Connect Portal

- More enhanced role-based access / authorization for services via InCommon

Platform Services Agreement – Complete new agreement transition

Rallying Routing Security Across the Community

Community Telemetry Sharing Project – Research Data Tagging – Automation

Operations RFP Award & Transition – RFP Implementation & Onboarding Senior Staff

Supporting community interests in federal infrastructure programs

... and a few others ..

## 2022 International Global Connectivity Highlights

400G Transatlantic Capacity Additions/Upgrades on Amitié cable

- 1 x 400G for Internet2/CANARIE (Boston – Bordeaux)

- 2 x 400G for ESnet (Boston – London, Boston – Bordeaux)

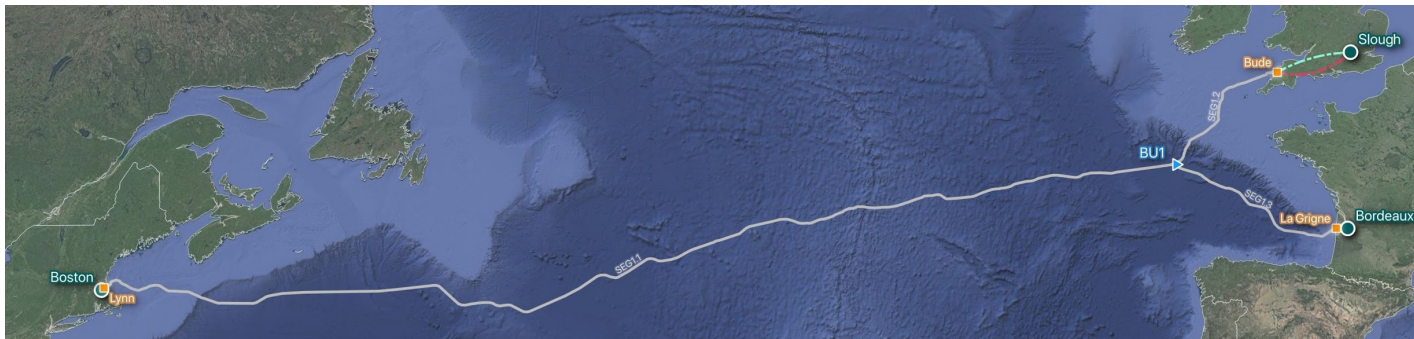
late 2022 / early 2023 (due to construction of both wet-plant and terrestrial)

Potential upgrade of exchange-points (MAN/LAN and WIX)

- Hardware (Juniper QFX likely replaced with Cisco NCS or ASR)

- Automation (support for FABRIC)

- Protocols (move to EVPN)



## 2022 Open Science Grid Long Term Vision

Create an Open National Cyberinfrastructure that allows the federation of CI at all 3,900 accredited degree granting higher education institutions.

- Open Science
- Open Data
- Open Source
- Open Infrastructure

Internet2 will be hosting 5 additional open science grid caches in the network this year.

- Existing Internet2-hosted nodes are the highest utilization in the world.
- Our piece of the national research platform proposal award.



# New Network Services Web Portal and API Set

The screenshot shows the I2Network web portal interface. The left sidebar contains navigation links: Dashboard, I2RE, I2PX, I2CC, I2Global, Research, I2DDoS, rIPcord, I2RPI, I2Wave, and I2Spectrum. The main content area is titled 'localhost:3000/#/organization/interfaces'. It features a table of network interfaces with columns for Owner, Interface, Device, and PoP. The 'University of Georgia' interface is highlighted. To the right of the table, a detailed view for 'Hu0/0/0/6.959' is shown, including its owner, device, PoP, and a list of subinterfaces with their respective status (Ok, Alert, Warning) and metrics (up/down arrows and values).

Owner	Interface	Device	PoP
Harvey Mudd College	Hu0/0/0/6.248	core2.dojo.net.internet2.edu	Houston
Missouri University of Science and Technology	Hu0/0/0/3.212	core2.ymzs.net.internet2.edu	Reno, NV
Northern Arizona University	Hu0/0/0/4.139	core6.dxws.net.internet2.edu	Houston
Northern Arizona University	Hu0/0/0/6.300	core5.cdcq.net.internet2.edu	Chicago
Radford University	Hu0/0/0/2.310	core5.xznn.net.internet2.edu	Jacksonville
Salisbury University	Hu0/0/0/9.725	core4.kcst.net.internet2.edu	Cleveland
Scripps College	Hu0/0/0/8.306	core3.dhgh.net.internet2.edu	Portland
Thomas Jefferson University	Hu0/0/0/5.378	core0.zxcx.net.internet2.edu	Chicago
University of Georgia	Hu0/0/0/6.959	core4.wvfe.net.internet2.edu	El Paso
University of Iowa	Hu0/0/0/8.797	core3.tdmo.net.internet2.edu	Chicago
University of Iowa	Hu0/0/0/6.301	core4.lhgq.net.internet2.edu	Reno, NV
University of Montana	Hu0/0/0/8.803	core1.euws.net.internet2.edu	Chicago
Vassar College	Hu0/0/0/1.966	core9.puvv.net.internet2.edu	Ashburn
Wingate University	Hu0/0/0/4.304	core3.ywuv.net.internet2.edu	Indianapolis
Worcester Polytechnic Institute	Hu0/0/0/4.826	core9.sggp.net.internet2.edu	Portland

Subinterfaces for Hu0/0/0/6.959:

Status	Interface	Up	Down
Ok	Hu0/0/0/7.574	37	37
Alert	Hu0/0/0/4.368	94	94
Ok	Hu0/0/0/5.270	22	22
Warning	Hu0/0/0/8.547	52	52
Alert	Hu0/0/0/7.855	52	52
Warning	Hu0/0/0/8.933	18	18
Alert	Hu0/0/0/3.341	65	65
Alert	Hu0/0/0/1.988	44	44
Ok	Hu0/0/0/5.477	62	62
Warning	Hu0/0/0/3.171	47	47
Warning	Hu0/0/0/8.331	82	82
Ok	Hu0/0/0/4.327	29	29
Alert	Hu0/0/0/8.896	17	17
Warning	Hu0/0/0/1.649	75	75
Alert	Hu0/0/0/3.260	18	18
Warning	Hu0/0/0/4.171	10	10
Ok	Hu0/0/0/3.943	81	81
Alert	Hu0/0/0/4.324	54	54
Warning	Hu0/0/0/2.790	92	92
Alert	Hu0/0/0/9.239	38	38

“Internet2 Insight”

Access to many of our software-controlled services

“Interface status” example

A night-time photograph of the Denver skyline, featuring several illuminated skyscrapers. Overlaid on the cityscape is a complex network of glowing blue and purple dots connected by thin lines, resembling a digital or data network. The sky is a deep purple and blue.

**2022**  
**TECHNOLOGY**  
**exchange**

**DENVER**



**DECEMBER 5-9**

**Questions?**

