NEXT GENERATION INFRASTRUCTURE

2018 TechEX, Orlando, FL

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Next Generation Infrastructure Requirements Process
NGI Background: Community Discussion Evolution

- **Community discussion about shared future since 2016.**
  - 5+ face-to-face meetings with community leaders
  - 12+ community leaders calls
  - Pilots/Proof of Concepts - optical, router slicing, cloud, etc.

- **Detailed, phased, planning has begun…**
  - “Open Line System” photonic-layer sharing beginning in 2019
  - Advanced investments in interconnect, management network in 2019
  - In 2019, complete more detailed planning for services, including service models, layer 2/3 and automation/software for future delivery

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
NGI Background: Five Community drivers for services:

- **Research Community: Support emerging science infrastructure requirements**
  - Consider instrumented, integrated allocation of 100G+ capacity for research applications – in partnership with regionals

- **Research Community: Deliver software-driven infrastructure**
  - More easily integrate with E-2-E science workflows and support API's/orchestration/automation for big science applications

- **Campus & Regionals: Additional end-to-end and infrastructure sharing**
  - Reduce duplicative investment in new capital as well as operating expenses

- **Campuses & Regionals: Cloud Access Services**
  - Continue to enable cloud-access including enhanced self-service portal support

- **Regionals: Respond to requests to increase capacity offered per dollar**
  - Raise capacity offered for core services: peering, research, cloud and general R&E
NGI Service Requirements:

• Shareable Optical Wavelength & Spectrum Services

• Programmable Packet Platform
  – Research Networks
  – Academic Enterprise

• Custom Platform Support & Build Your Own

Cross-Cutting Success Criteria:

• Support of Research
• Automated & Programmable
• Cloud & Peer Connected
• Embedded Security
• Regional/National Integration
• Infrastructure Sharing
• Enterprise Support
• Global Reachability
• Measurement Services
• Research Data Services
• Resiliency
• Economics & Scalability
• Operations
• Secure Management
NGI Capacity Driver: updating scale economies

\[ y = 9.3273e^{0.0312x} \]

\[ R^2 = 0.9189 \]
NGI Capacity Driver: updating scale economies

Likely less accurate the farther in to the future we look, but still significant growth to anticipate.
Internet2 Network Total PetaBytes Carried Per Year (Calendar Year)

Peta Bytes per year
Expon. (Peta Bytes per year)

CY 08  CY 09  CY 10  CY 11  CY 12  CY 13  CY 14  CY 15  CY 16  CY 17  YD 18  CY 19  CY 20  CY 21  CY 22  CY 23

R² = 0.9787
NGI Background: *Where are we?*

- Following Global Summit Discussions
  - Kicked off formal project with 3 areas
  - Refocused to enable Agile approach
  - Significant progress in many areas
    - Optical Infrastructure
    - Interconnect Infrastructure
    - Automation & Software
    - Requirements & Business Model

- Board Approved Budget (and future forecast)
  - Enables Optical project, secure management network, IXP upgrades to start in 2019
NGI Background: Requirements & Service Models

Continuing input and feedback on service and investment strategy

• Collaborate with the community to consider what the service delivery model for expanded bandwidth should be and how to deliver that capacity for science, cloud and traditional R&E applications

• Model scalability and sustainability of the technology choices and the service delivery models
NGI Background: *Photonics Investment*

*Underlying photonic transport system for community wavelength sharing*

- Support >100G wavelengths (for capacity)
- Support >35gbd modulation rates (for distance)
- Enable multifaceted “sharing” opportunities with regional partners and community projects
- Drive out scaling costs / find efficiencies
NGI Background: *Programmable Packet Platform*

*Underlying system for community packet services*

- Introduce more deeply programmable and virtualizable network elements to our platform
- Allow us to offer an Nx100G bandwidth increase to connectors and address demand for capacity
- Adjust approach and topology to increase value delivered, reduce cost, & enable scale-up
  - Includes downsizing many locations to smaller platforms as well as scaling up core peering locations
  - Also includes potential sharing with partners
NGI Background: *Software, Systems, Automation*

*New opportunity to automate operations & service delivery; reduce time to service; enable sharing*

- Automate internal processes & automate configurations for consistency, rapid delivery
- Add self-service & API features that reduce time to results and enable infrastructure sharing
- Update measurement, analytics and operational transparency tools
- Provide leading network security capabilities that enable and also protect science workflows
Our approach has changed away from a single plan, developed at the start and implemented over several years.

- Data driven; timely and iterative decision making along a multi-year path
- Still looking for economies of scale on major platform decisions, but less tied to schedules
- Tends to enable more complex decisions and better efficiencies

Early wins:
- Cloud Connect Portal/OESS 2.0
- Interconnection 100G platform and capacity increases
- Increase in cloud exchange/peering capacity
Next Generation Infrastructure
Progress Update
## NGI Requirements Gathering & Business Model

**What we’ve completed:**
- Conducted calls with 26 of 48 connectors and network members
- TR-CPS usage analysis / modeling A recommendation to increase the cap to 50G was reviewed.
- Began modelling options and assumptions for a detailed expense model/calculator
- Developing service offering models for discussions with the community in Tempe
- Spinning up an NAOP pag NGI Service Model Subcommittee

**What’s Next?**
- Create service descriptions and potential business models based upon community input from regional calls, Routed Services Futures WG input, researchers, CIO’s etc.
- Working with the NGI subcommittee, prepare for service model discussion with regionals in Tempe
- Maintain an open dialogue with the community, and continuously share feedback with the project team
NGI Software and Automation

What we’ve completed:
• Documented initial scope and service requirements
• Delivered Cloud Connect Portal Pilot / OESS 2.0
• Internal Testbed: Research and test streaming telemetry & integrating automation tools
• Arista Testbed: Research Flow detection, dynamic path alteration, and streaming telemetry
• Collaborated with Pacific Research Platform (PRP) and Open Science Grid (OSG) teams on kubernetes, federation, cache and automation to support new OSG nodes in the PRP pilot
• Developed PShooter, a web service (in-development) that works with perfSONAR’s pScheduler to automate performance problem troubleshooting along a path between two points
• Began to conceptualize & design a policy compliance tool

What’s Next?
• Continue collaboration with PRP and OSG teams
• Automation & telemetry -- configuration management
• Vendor engagement & market survey
• Software & Automation Testbed
NGI Infrastructure: Interconnection Project

**What we’ve completed:**
- Completed peering & TR-CPS baseline data collection & analysis in support of the cap increase proposal
- Evaluated multiple models and completed ROI / cost-benefit analysis of new hardware vs legacy platform investment across the 7 peering sites. A recommendation to deploy MX10003s in Ashburn & Chicago, and redeploy MX960s from Ashburn & Chicago to Seattle, Los Angeles, Dallas, San Jose and NYC was reviewed and approved
  - Result: 63% reduction in CAPEX and 31% decrease in OPEX per 100G port
- Continued to invest in the TR-CPS service and coordinated with peers to continue necessary augments
- Collaborated with the Routed Services Futures WG and presented an initial draft of operating principles and approaches for peering

**What’s Next?**
- MX10003 deployment (Chicago, Ashburn) and MX960 Parts Reclamation and Redeployment
- Coordinate next steps on Router Services Futures Workgroup Report
Next Generation Infrastructure
Optical Line System Deep Dive
Next Generation Infrastructure
Service Improvement Announcements
TR-CPS Cap Increase to 50G

- Increase “cap” from 20G to 50G for TR-CPS on all 100G AL2/3S ports
- Initial analysis indicates this may lead to the need to increase capacity on several segments that are adjacent to peering points
- Will also alter current practice for when to implement capacity augments on large 100G LAG groups
- Coincides with project to install new equipment at key peering points to support 100G capacity upgrades
Cloud Connect Portal / OESS 2.0 Pilot

- Introducing Cloud Connect features & Layer 3 VRF’s in the OESS Portal
  - Includes Amazon provisioning integration with Google and Microsoft to follow
  - Like Equinix, Megaport and others, campuses and regionals can provision multicloud VRF services leveraging their R&E networks
- Introducing “Phonebook” for non-network engineer users and resources
- Begins to introduce a new “look and feel”
- Pilot open after TechX; feedback welcome
- Some data and provisioning coordination with regionals likely needed
Next Generation Infrastructure
Community Activities at Tech EX
Community Activities

- **Progress on Experiments & Pilots reporting progress at Tech X**
  - Router Slicing Working Group Report
  - Future Routed Services Working Group Report
  - "Voyager" Optical Pilot Readout
  - Cloud Orchestration Experiments
  - National & Eastern Research Platform Pilots

- **Demonstrations**
  - Cloud Connect Portal / OESS 2.0
  - Streaming Telemetry
  - Flow Identification and pathing
  - Performance Troubleshooting (pShooter)
Key Tech EX NGI Activities

Track Sessions

NGI Project: Plans for Next Evolution of Internet2 Infrastructure (Vietzke, Wilkinson, Milford) - Now

NGI Ecosystem: Report on Workshops at University of Michigan (Boyd, Vimawala) – Today – 11:20

NGI Ecosystem: Community Experiments Toward the Next-Gen Infrastructure (Moore, Von Oehsen, Lehman, Longo) Today – 1:40

NGI Ecosystem: National Research Platform (NRP) (Moore, Deaton) – Today – 2:40


NGI Ecosystem: Desired Future State of Quality of Service (Wallace) – Weds - 9:20

NGI Ecosystem: Routed Services Future Working Group Report (Deaton, Gallo, Schopis) – Weds - 10:20

NGI Project: OESS 2.0 / Cloud Connect Portal (Ragusa) – Weds 10:40

NGI Project: Interactive Session on Plans for Next Evolution of Internet2 Infrastructure (Roos/Vietzke) – Weds 2:00

NGI Project: Interactive Breakout Sessions (Roos/Vietzke) – Weds 2:30

NGI Project: Breakout Reports -(Teams) – Thurs AM

Tutorials & Hackathons

Network Automation Workshop
Network Automation Hackathon
Introduction to Kubernetes
Automated perfSonar with Ansible
Routing Security

Standing Meetings:
Network Connector Member BoF
NTAC Meeting (NGI Voyager Pilot - Owens)

Chalk Talk with Cloud Providers
Amazon, Google, Microsoft 1-1’s

Demonstration Area:
pShooter
Cloud Connect Portal / OESS 2.0
Flow Detection, Prioritization & Telemetry Analytics
Next Generation Infrastructure
Discussion / Next Steps