Campus Research Network Overview

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Agenda

- Research Networking at UF
  - A brief history
  - CRNv2
- Florida LambdaRail
  - What is it?
  - How it provides for UFL’s Research Needs
- Internet2 Innovation Platform
  - Design
  - Requirements
  - Use cases
A Brief History @UF

Historically, all research was done over the production UF network.
- Late 90s: ATM, then 100Mbps Ethernet backbone in a ring topology.
- Early 2000’s: Gigabit Ethernet backbone in a star topology.
- Today: Moving toward ubiquitous dual 10G backbone links over the next 6 months.

Security was not as big of an issue.
- Public IP use was high.
- No central firewall.
- Some network access control in use.
- IDS was able to handle campus traffic.
A Brief History @UF (cont)

- External R&E focused connectivity was limited, but stayed ahead of demand.
  - OC-3 to Internet2 (vBNS backbone.)
  - OC-12 to Internet2 Abilene Backbone (some of this was carved off for Internet.)
  - Much was still likely going over somewhat congested Internet paths.
Need for a change

- Aggregation of research computing resources.
  - HPC Center
  - CMS Tier 2
- Increased focus on moving data around campus and externally
  - LHC (CMS)
  - Ultralight
- New regional and national network resources emerging
  - NLR
  - FLR
Need for a change (cont)

- Increase in expected data rates exceed what typical security devices could handle.
  - Do we slow the research or allow unchecked traffic deep into the campus production network?

- NSF MRI grant provided for the first “Campus Research Network” (CRN).
  - CASTOR: A High-Performance Communication and Storage Backbone for Data-Intensive Scientific and Engineering Computing

Campus Research Network v1

- CRNv1 provided for
  - 2*10Gbps research oriented network backbone to CISE, Physics, and Larsen Hall.
  - 1*10Gbps connectivity to another location in Larsen, as well as Benton.
  - 1*10Gbps dedicated research connection to FLR via a 10Gbps wave to Jacksonville, FL.
  - 1*10Gbps connectivity to the campus production network.

- CRN was connected “off to the side” of the production network, and outside of the security boundary.
  - This is now called a “Science DMZ”
Over time, new sites have been added, sites have moved around, and there have been very minor equipment upgrades.

Most of the equipment originally purchased in 2005 is still in use (7+ years!)

Some of the equipment is no longer under support contract due to EOL schedule.

Nearly all will become EOL this year.

Starting to see some contention on certain 10G links.
Time for an Upgrade (cont)

- 10G Research Wave to FLR becoming a limitation.
- We use “Etherchannel” to bond links together. We have no control over what traffic goes into what link, so congestion is possible with < 20Gbps of traffic.
- New UFDC/EC site and HPC cluster coming online.
- New network paradigms such as software defined networking emerging.
- Did I mention the current gear is old?
CRNv2 Goals

- 200Gbps backbone to the primary research compute and data storage locations on campus.
- Multiple 40Gbps or 10Gbps backbone to smaller research sites on campus.
- 100Gbps connection to FLR and other research networks.
- 10G and 40G edge ports.
- Flexibility to support advanced network paradigms such as SDN/Openflow.
- Preserve the “Science DMZ” style topology we enjoyed with CRNv1.
CRNv2 Design

- CRN Sites:
  - Tier 1 (200Gbps): Larsen 121, UFDC/EC.
  - Tier 2 (40/80Gbps): Physics 2250, AHC, Benton, GCRC.
  - Tier 3 (20/10Gbps) Weil, Physics 1114, Larsen 320.
  - Wan (100G) to FLR Jacksonville.
  - Main Campus (10 to 20Gbps).

- Native Capabilities
  - Line rate IPv4 and IPv6 routing.
  - Multi-Protocol Label Switching and VLAN support to provide transparent Layer 2 transport for off campus circuits and the Openflow testbed.
  - VRF support to enable multiple virtual networks.
  - Redundant route modules, power supplies, fan trays, etc.
  - Many many other features you would expect of high end Enterprise class equipment.
CRNv2 Design (cont)

- Openflow Testbed:
  - Native: SSRB, NEB, CISE, NS Lab
  - Tunneled: Lar121, UFDC/EC
  - Eventually all Tier 1 and Tier 2 sites will natively support Openflow via code updates. Full support for both SDN and “classical” network operations on the same hardware.
  - Flowvisor and test controller housed within CNS.
  - We are also deploying an Openflow testbed on the FLR backbone.
    - One Openflow switch in each FLR core pop, 10Gbps connected.
    - 10G Statewide SDN ring.
  - The combination of Openflow testbeds along with the connection to the Innovation Platform permits UF to participate in both regional and national SDN efforts.
New Hardware:
- Brocade MLXe16s at Tier 1 sites
- Brocade ICX6650s at Tier 1 and Tier 2 sites
- Existing Hardware at Tier 3 sites (Cisco/Force10/Arista)
- Pica8/Pronto Switches at Openflow testbed sites (3295/3920)
- Dell R620 servers for perfsonar.
University of Florida
CRNv2 rev4.2 Research Network
3/14/2012 - 1

CRNv2
Topology
CRN Upgrade

- Three distinct projects/grants made the CRNv2 upgrade possible
  - NSF CC-NIE Network Infrastructure: Dr. Erik Deumens PI
  - NSF MRI “Acquisition of Gatorcloud”: Dr. Andy Li PI
CRNv2 Upgrade Status

- 100G circuit over FLR to Jacksonville, Innovation Platform 100G connection in Jacksonville and installation of central CRNv2 node at SSRB was completed and operational on January 30th.
- UFDC/EC and Lar121 Tier 1 sites have been installed and are in production.
- Tier 2 site installation will be commencing in the next few weeks pending some fiber installation.
- Openflow switches will start deployment in the next few weeks.
Florida LambdaRail

- Member owned, facilities based network.
- 12 equity owners including UF.
- Connects all Florida SUS institutions, most major private schools, as well as many Florida College System institutions.
- UFL is also the site of the FLR Network Operations Center.
  - Engineering.
  - 24x7 support.
Florida LambdaRail (cont)

- Optical Network
  - “FLRwave”
  - Dense Wave Division Multiplexing (DWDM) optical network.
  - Up to 32 channels (100Ghz spacing.)
  - 1540 miles of dark fiber around the state.
  - Provides 1G, 2.5G, 10G, 40G, 100G waves between optical add/drop sites.
  - Based on Cisco 15454 optical nodes.
  - 28 locations around the state.
  - 38 active optical shelves.
FLR Optical Topology

Florida LambdaRail
“FLRwave”
Optical Topology Map
7/1/2006

- Level 3 15451 Optical Transport POP Site
- Level 3 15451 Optical POP Site
- Level 3 15451 I.A. Site
- Qwest 15454 Optical POP Site
- Qwest 15454 I.A. Site

Level 3 Fiber
Qwest Fiber
Florida LambdaRail (cont)

- Transport Network
  - “FLRnet”
  - 5 Core nodes (Jax, Orl, Mia, Tpa, Tlh). Several 2nd tier nodes as well.
  - MPLS based transport network. Provides Layer 2 and Layer 3 services.
  - Point to Point Ethernet Circuits (Pseudowires)
  - Commodity Internet Services.
  - Commodity Peering.
    - Google
    - Microsoft
    - Netflix
    - etc
Florida LambdaRail (cont)

- R&E Networking
  - Internet2
    - I2 Innovation Platform
  - National LambdaRail
  - R&E Peering @ Starlight
- Layer 3 VPN service ("Virtual Backbone")
  - UF Statewide Backbone VRF
  - Research Backbones (XSEDE, etc)
- Based on Cisco ASR 9010 routers
  - 10G, 40G, 100G capability.
  - 4M IPv4 routes.
About FLRnet

- 20G Backbone (dual 10G waves)
- 150G of Research Peering Capacity
  - 100G Internet2 Innovation Platform/Advanced L2 Service
  - 10G Primary, 10G Secondary to NLR L3
  - 10G to Internet2 direct to Atlanta.
  - 10G to Starlight (used for Esnet peering and other research).
  - Peering with Cwave at 10G.
- >52G+ of Commodity Peering Capacity.
  - 10G at the NOTA.
  - 10G at TIE.
  - 20G to Google.
  - 1G with Transitrail, 1G+ with CPS.
  - 10G to Akamai AANP.
- 55G of Internet Capacity.
FLR Optical Node
Typical FLRnet Node
Internet2 Innovation Platform

- What is it?
  - Next generation Internet2 Network
    - 100G connected.
    - Lower cost nodes (thus more of them, less backhaul)
    - SDN (Openflow) capable
    - Based on Brocade MLXe and Juniper MX Platforms. Most nodes are currently Brocade.
    - Will provide the Advanced Layer 2 Service (AL2S) on day 1.
Internet2 Innovation Platform (Cont)

- Operates over Internet2’s upgrade optical network provided by the BTOP award.
- Current production I2 network will continue to operate on the existing I2 backbone. Will eventually migrate to IP based on publicized plans of I2.

- Architecture
  - Internet2 is encouraging a standard R&E networking environment on campuses, at least through the initial phase of the project, through a set of requirements in order to connect.
Science DMZ
- Don’t run your research network traffic “at scale” through your production network, and thus through your production firewall, ids, etc.
- Create a purpose built network and connect it outside of the typical campus security parameter.
- Within the Science DMZ, you must run PerfSonar.
- Sounds a lot like the UF CRN!

Layer 2 connectivity at 100G.
- The intent is for “unlimited bandwidth” or as close as you can come to it. Prevent congestion from being a limiting factor.
Layer 2 paths provide for more deterministic behavior by the network. Typical “hop by hop” routing is replaced by pre-configured paths through the network.

CRNv2 will provide for this by Jan 2013.

FLR will be connected to the IP at 100G, thus giving UF a 100G path from the CRN to the IP node in Jax at layer 2.

SDN Network Capabilities

- The IP itself will be SDN based. Goal is to provide for ubiquitous end to end SDN capabilities.
- CRNv2 will have an Openflow testbed on day 1.
- All Tier 1 and Tier 2 CRNv2 sites will have hardware which is capable of Openflow once we decide to turn it on.
- CRN is also currently running Dynes, which is another form of SDN.
Internet2 Innovation Platform (Cont)

- Philosophy
  - Unlimited Bandwidth.
  - Ubiquitous Deployment/Environment.
  - End to End.
    - Capabilities
    - Monitoring
  - Disruptive.
    - Researchers free to do new and interesting things.
  - “Friction Free.”
    - Clear of as many network impediments as possible.
  - At Scale.
Internet2 Innovation Platform (Cont)

- Innovation Platform is being introduced as a limited pilot.
- University of Florida is 1 of around 14 sites which are part of the pilot program.
- Connected January 2013.
- University of Florida is the first site nationwide to complete all three requirements for the Innovation Platform Pilot.
  - 100G connection
  - Science DMZ
  - SDN capability (Dynes project)
Innovation Platform Pilot

(As of July 10, 2012)
What will UF do with the IP

- Initial use cases center around AL2S.
  - Static high speed L2 circuits between UF and other IP connectors.
    - Research
    - Production Traffic (future)
    - Perfsonar used to monitor health of the network, end to end.
  - General dynamic capability integrated into the CRN.
  - Openflow test/research.
  - Currently planning a project with FNAL to test end to end network/systems/storage performance at scale.

- What's next?
  - Really up to the research community.
  - IP + SDN capable CRNv2 are foundational infrastructures for disruptive and innovative applications. Please commence disrupting!
Thanks!