April 20th 2011 – Internet2 Spring Member Meeting
Eric Boyd, Internet2 Deputy CTO

NSF MRI-R2: DYnamic NEtwork System (DYNES, NSF #0958998)
DYNES Motivation

• Data movement to support science:
  – Increasing in size (100s of TBs in the LHC World)
  – Becoming more frequent (multiple times per day)
  – Reaching more consumers (VO size stands to increase)
  – Time sensitivity (data may grow “stale” if not processed immediately)

• Traditional networking:
  – R&E or Commodity “IP” connectivity is subject to use by other users
  – Supporting large sporadic flows is challenging for the engineers, and frustrating for the scientists
DYNES Motivation

• Solution
  – Dedicated bandwidth (over the entire end to end path) to move scientific data
  – Invoke this “on demand” instead of relying on permanent capacity (cost, complexity)
  – Exists in harmony with traditional IP networking
  – Connect to facilities that scientists need to access
  – Integration with data movement applications
    • Invoke the connectivity when the need it, based on network conditions

• Proposed Deployment:
  – Software and hardware support spanning domain boundaries
    • Campus
    • Regional
    • Backbone
  – Integration with existing technologies and deployments
What is it?:
- A nationwide cyber-instrument spanning ~40 US universities and ~14 Internet2 connectors
  - Extends Internet2’s ION service into regional networks and campuses, based on OSCARS implementation of IDC protocol (developed in partnership with ESnet)
  - High-performance file store at sites

Who is it?
- A collaborative team including Internet2, Caltech, University of Michigan, and Vanderbilt University
- Community of regional networks and campuses
- LHC, astrophysics community, OSG, WLCG, other virtual organizations
DYNES Community Support

- **What are the goals?**
  - Support large, long-distance scientific data flows
    - LHC
    - LIGO,
    - Virtual Observatory
  - Build a distributed virtual instrument

- Internet2 received a total of 60 Letters of Collaboration representing potential DYNES sites and their collaborators
  - 44 Universities (some duplicates)
  - 14 Regional Networks
  - 1 Virtual Organization
  - 1 Federal Lab

- **Total Funding of $1.74 Million**
  - Original Request of $2 Million
DYNES Participants

• Application process required to establish participants
  – Submit applications to gauge institutional/network interest
  – Encourage discussion with PIs to advance understanding of the scientific use cases

• Deployment Announcements announced in Feb 2011:
  – 25 End Sites
  – 8 Regional Networks
  – Collaboration with like minded efforts (DoE ESCPS)

• Plans to consider provisional applications (send email to dynes-questions@internet2.edu if interested)
DYNES Proposed Topology (April 2011)

• Based on applications accepted
• Showing peerings to other Dynamic Circuit Networks (DCN)
DYNES Phase 1 Project Schedule

• Phase 1: Site Selection and Planning (Sep-Dec 2010)
  – Applications Due: December 15, 2010
  – Application Reviews: December 15 2010-January 31 2011
  – Participant Selection Announcement: February 1, 2011

• 33 Were Accepted in 2 categories
  – 8 Regional Networks
  – 25 Site Networks
DYNES Phase 2 Project Schedule

• Phase 2: Initial Development and Deployment (Jan 1- Jun 30, 2011)
  – Initial Site Deployment Complete - February 28, 2011
    • Caltech, Vanderbilt, University of Michigan, MAX, USLHCnet
  – Initial Site Systems Testing and Evaluation (almost) complete: April 29, 2011

• Phase 2 Status:
  – All equipment is in place at initial sites except for the IDC at Vanderbilt
    • Arriving any day now ...
  – Working on configurations and testing now
  – On track to support Phase 3 Group A deployments
DYNES Phase 3 Project Schedule

• Phase 3: Scale Up to Full-scale System Development (14 months) (July 1, 2011-August 31, 2012)
  – Phase 3-Group A Deployment (9 Sites): March 1-July 1, 2011
  – Phase 3-Group B Deployment (13 Sites): July 18-August 26, 2011
  – Phase 3-Group C Deployment (11 Sites): September 5-October 14, 2011

• Phase 4: Full-Scale Integration At-Scale; Transition to Routine O&M (12 months) (September 1, 2012-August 31, 2013)
  – DYNES will be operated, tested, integrated and optimized at scale, transitioning to routine operations and maintenance as soon as this phase is completed
Phase 3 – Group A Schedule Details

• Phase 3-Group A Deployment (10 Sites) (March 1-July 1, 2011)
  – Teleconferences and Planning with individual participants: March 28-May 2, 2011
    • Completed initial telecons with all Group A members
    • Subsequent interaction during installation
  – Finalize Phase 3-Group A Equipment Order List: May 2-9, 2011
  – Place Equipment Order: May 10, 2011
  – Receive DYNES Equipment: May 24, 2011
  – Configure and Test Individual Participant Configurations: May 24-June 7
  – Ship Phase 3-Group A Equipment to sites: June 14 2011
  – Deploy and Test at Phase 3-Group A Sites: June 21-June 28, 2011

• Begin Phase 3-Group A: July 1, 2011
Phase 3 Group A Members

- AMPATH
- Mid-Atlantic Crossroads (MAX)
  - The Johns Hopkins University (JHU)
- Mid-Atlantic Gigapop in Philadelphia for Internet2 (MAGPI)*
  - RUTGERS
  - University of Delaware
- Southern Crossroads (SOX)
  - Vanderbilt University
- CENIC*
  - California Institute of Technology (Caltech)
- MREN*
  - University of Michigan

Note: USLHCNet will also be connected to DYNES Instrument via a peering relationship with DYNES

* temp configuration of static VLANs until future group
Phase 3 Group B Members

- Mid-Atlantic Gigapop in Philadelphia for Internet2 (MAGPI)
  - University of Pennsylvania
- Metropolitan Research and Education Network (MREN)
  - Indiana University
  - University of Wisconsin Madison
  - University of Illinois at Urbana-Champaign
  - The University of Chicago
- Lonestar Education And Research Network (LEARN)
  - Southern Methodist University (SMU)
  - Texas Tech University
  - University of Houston and Rice University
  - The University of Texas at Dallas
  - The University of Texas at Arlington
Phase 3 Group C Members

- Front Range GigaPop (FRGP)
  - University of Colorado Boulder
- Northern Crossroads (NoX)
  - Boston University
  - Harvard University
  - Tufts University
- CENIC**
  - University of California, San Diego
  - University of California, Santa Cruz
- Great Plains Network (GPN)***
  - The University of Iowa
  - The University of Oklahoma
  - The University of Nebraska-Lincoln

** deploying own dynamic infrastructure
*** static configuration based
DYNES Software

- Dynamic Circuit Control
  - OSCARS
  - ION Service

- Monitoring
  - perfSONAR Circuit Monitoring

- Data Movement
  - FDT
  - ESCPS
DYNES Software – ION/OSCARS

• OSCARS v0.5.4
  – Released March 14
  – Features
    • VLAN translation to allow integration into existing network deployments
    • Robust handling of circuit creation and failures
    • Numerous Bugfixes
    • Additional Documentation/Installation Guidance
    • Security enhancements

• OSCARS v0.6
  – Anticipated May 2011
  – Features:
    • Major re-write of the underlying codebase by ESnet
    • Modular, web-services based design
    • Integration with perfSONAR monitoring framework

• DYNES will deploy OSCARS v0.6
DYNES Software – Monitoring Dynamic Circuits

• perfSONAR Monitoring
  – Framework designed to monitor end to end performance
  – Early focus – Layer 3 measurements
  – New projects
    • Describing/mapping network topology at all layers
    • Monitoring Layer 2 circuits (dynamic and static)
    • Joint effort in DICE (Dante Internet2 CANARIE/Caltech ESnet) collaboration
• If a failure occurs, what can a user do?
Monitoring Dynamic Circuits

• Goal: to enable users to get measurements in their circuits while allowing domains to provide as much or as little information to the user as the domain wants

• Develop a solution in collaboration with other groups and organizations including DANTE, ESnet, the Network Markup Language Working Group and the Network Measurement Control Working Group
  – Broad agreement ensures that users can monitor their circuits, no matter what domains they traverse

• Multi-faceted approach
  – Enable domains to export monitoring data about circuits
  – Enable users to discover the domains that make up their circuit, and the monitoring data those domains contain about the circuit

• Leverage the standard perfSONAR infrastructure when available
Circuit Monitoring Architecture
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perfSONAR Measurement Archive
perfSONAR Topology Service
perfSONAR Measurement Archive
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Circuit Monitoring Agent

• This agent is the “glue” that connects together a Domain’s provisioning software (OSCARS) and monitoring infrastructure with the perfSONAR services so that users can find information about circuit statistics.

• When new circuits are brought up, the agent looks at the intra-domain path for the circuit, and builds a description of that path.
  – This description is then registered into a perfSONAR Topology Service.

• Needs to know how the domain monitors its devices to ensure an appropriate description of the circuit.
  – If configured, the agent can use a user-defined script to start circuit monitoring.
Router/Switch Monitoring Component

- Everyone has their own method of monitoring their hardware
- Define the needed functionality instead of requiring a specific solution
  - Offer a specific solution to users who want to use it
- Requirements:
  - Software that can measure the operational status and utilization of the elements making up the circuit
  - These measurements are made available using standard perfSONAR protocols
- As long as the monitoring meets the above requirements, it can be made to work in the Circuit Monitoring infrastructure
Specific Solution: ESxSNMP
- Developed by Jon Dugan at ESnet
- Uses SNMP to monitor operational status and utilization statistics for all equipment elements, including physical interfaces, VLAN interfaces and LSPs
- These interface statistics are then made available using the perfSONAR-PS SNMP MA
- This software will be packaged for easy installation
Each DYNES Sites will be assigned DYNES Project private address space (10.20/16)

Each DYNES FDT Server will be assigned a DYNES EndPoint Name (siteZ.fdt1)

The DYNES FDT Server will include a data storage and reference structure to allow user to identify and indicate the data to be moved via DYNES. This data storage and reference structure will be project dependent. This will allow users to specify the desired data in the form of a DYNES Data Id.

The combination of the DYNES EndPoint Name and DYNES Data ID will form a "DYNES Transfer URL" (siteZ.fdt.1/datalocationref30)

Users will need to present a "DYNES Transfer URL" to their local DYNES Agent to initiate the data transfer.
The DYNES Agent (DA) will provide the functionality to request the circuit instantiation, initiate and manage the data transfer, and terminate the dynamically provisioned resources. Specifically the DA will do the following:

- Accept user request in the form of a DYNES Transfer URLs indicating the data location and ID
- Locates the remote side DYNES EndPoint Name embedded in the Transfer URL
- Submits a dynamic circuit request to its home InterDomain Controller (IDC) utilizing its local DYNES EndPoint Name as source and DYNES EndPoint Name from Transfer URL as the destination
- Wait for confirmation that dynamic circuit has been established
- Starts and manages Data Transfer using the appropriate DYNES Project IP addresses
- Initiate release of dynamic circuit upon completion
The dynamic circuit network infrastructures and control plane will provide for the multi-domain circuit instantiation. The high level workflow is as described below:

- Upon receipt of a circuit request from a DYNES Agent, the IDC utilized the DYNES LookUp Service to translate the DYNES EndPoint Names into dynamic circuit source and destination URNs.
- The initiating IDC then uses these URNs to set up the multi-domain dynamic circuit and notify the DYNES Agent when circuit is ready for use.
- The IDC will also accept requests from the local DYNES Agent to tear down the dynamic circuit after data transfer is complete.

The FDT Servers can also have public IP addresses which can also be utilized for data transfers when dedicated circuits are not instantiated.

In this basic scenario, only the provided FDT server will be integrated into the DYNES instrument. However, other site servers can also be integrated into the DYNES infrastructure.
DYNES Data Flow Overview
DOE Funded project to developer intelligent software to utilize dynamic circuit networks

• Combines several efforts from earlier projects
  – Terapaths
  – Lambdastation
  – Phoebus
  – Monitoring via perfSONAR compliant tools

• DYNES and ESCPS Interplay:
  – DYNES is an infrastructure project looking for additional software
  – ESCPS is a software project looking for infrastructure

• Next steps include validating current generation of ESCPS software on test sides (those of the PIs and the University of Delaware)
• Inter-domain Controller (IDC) Server and Software
  
  – IDC creates virtual LANs (VLANs) dynamically between the FDT server, local campus, and wide area network
  
  – IDC software is based on the OSCARS and DRAGON software which is packaged together as the DCN Software Suite (DCNSS)
  
  – DCNSS version correlates to stable tested versions of OSCARS. The current version of DCNSS is v0.5.3.
  
  – It expected that DCNSSv0.6 will be utilized for Phase 3-Group A deployments and beyond. DCNSSv0.6 will be fully backward compatible with v0.5.3. This will allow us to have a mixed environment as may result depending on actual deployment schedules.
  
  – The IDC server will be a Dell R410 1U machine.
DYNES Standard Equipment

• Fast Data Transfer (FDT) server
  – Fast Data Transfer (FDT) server connects to the disk array via the SAS controller and runs the FDT software
  – FDT server also hosts the DYNES Agent (DA) Software
  – The standard FDT server will be a DELL 510 server with dual-port Intel X520 DA NIC. This server will a PCIe Gen2.0 card x8 card along with 12 disks for storage.

• DYNES Ethernet switch options:
  – Dell PC6248 (48 1GE ports, 4 10GE capable ports (SFP+, CX4 or optical)
  – Dell PC8024F (24 10GE SFP+ ports, 4 “combo” ports supporting CX4 or optical)
DYNES Equipment and Existing Infrastructure

- DYNES Switch is capable of accepting connections from existing resources at the end site
  - Storage
  - Compute Resources
- Integration of existing resources:
  - Assign ports a “DYNES Friendly” name
  - Use the ION interface to request a circuit between endpoints
  - Use existing software (e.g. GridFTP) to transfer between endpoint locations connected via common DYNES enabled connection
DYNES Additional Activities

• We anticipate that will be able to add a some more sites. Additional applications are being collected from those interested:
  – RENCI
  – FIU (as an End Site in addition to AMPATH as Regional)
  – Discussed this week:
    • University of Florida
    • Texas A&M

• Send email to dynes-questions@internet2.edu if interested
DYNES Documents

- [http://www.internet2.edu/dynes](http://www.internet2.edu/dynes)
- DYNES: A Nationwide Dynamic Network System – Overview of the DYNES objectives and architecture
- DYNES: Regional Network and End-Site Participation Requirements
- DYNES: Criteria for Site Selection
- DYNES: Application Package
- DYNES: End-to-End Data Flow Architecture
- DYNES: Frequently Asked Questions (FAQ)
- DYNES Regional Network Application
- DYNES End-site Application
- DYNES Deployment Plan
DYNES References

- DYNES
  - http://www.internet2.edu/dynes
- OSCARS
  - http://www.es.net/oscars
- DRAGON
  - http://dragon.east.isi.edu
- DCN Software Suite (DCNSS)
  - http://wiki.internet2.edu/confluence/display/DCNSS/
- FDT
  - http://monalisa.cern.ch/FDT/
NSF MRI-R2: DYnamic NEtwork System (DYNES, NSF #0958998)

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For more information, visit http://www.internet2.edu/dynes