

ESnet4 Rolls Out New Cross-Country 10 Gbps Network

The first national ring of ESnet4 went live over the summer, marking a key accomplishment for a long-term plan to build the next-generation science network for researchers working in DOE's national labs, universities and industry.

The network ring, the first of several to be built, runs across the country with northern and southern routes before

meeting up at various locations along the east and west coast. ESnet4 will enable researchers to send and obtain raw data and research results at a significantly faster rate and with greater reliability. The infrastructure underlying ESnet4 is a joint project between ESnet and Internet2.

"The ESnet staff has once again

continued on page 3

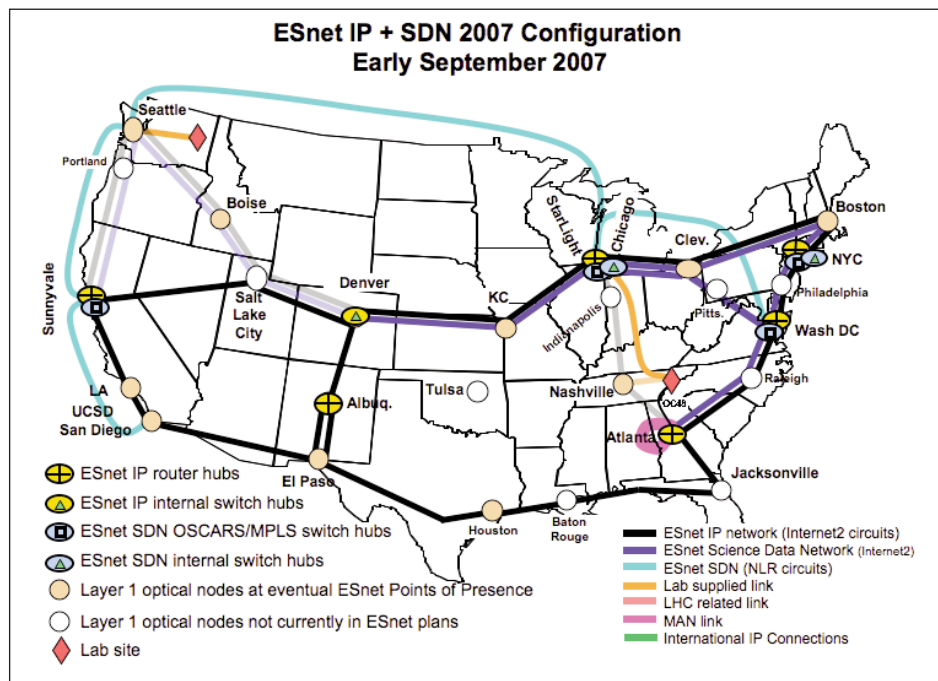
Framework for Data Traffic Exchange Set for Bandwidth Reservation System

ESnet engineers have finalized a plan for a virtual circuit service that maps out connecting nodes and network paths for a reservation system that will offer guaranteed bandwidth from various networks to thousands of scientists around the world.

The reservation system, called On-Demand Secure Circuits and Advance Reservation System (OSCARS), will enable researchers to better manage their projects and get faster results. Currently network traffic congestion, for example, does not allow scientists to build systems that must deliver a certain amount of data in a given time from one remote location to another. OSCARS will provide certainty by allocating bandwidths for specific projects, a practice that resembles the distribution of CPU hours at supercomputer centers.

Developing and deploying OSCARS requires the cooperation of many national science networks in North America and Europe, given that researchers often send data across several domains. ESnet achieved a milestone over this summer

continued on page 4



Workshops Held to Generate Network Improvement Strategies

ESnet recently hosted two workshops to determine network requirements for DOE scientists. The workshops were part of a new initiative to formalize the process of gathering and updating the networking requirements of ESnet's users.

Each workshop was organized in cooperation with one program office from within the DOE Office of Science. The first workshop included scientists and program representatives from the Basic Energy Sciences

(BES) Program Office, while the second was geared toward the Biological and Environmental Research (BER) Program.

The workshops provided a forum for the scientists and DOE program managers to give feedback about using ESnet and discuss their current and future networking needs. The workshops were the first of an ongoing process whereby ESnet will meet regularly with scientists and program managers from all six program offices within the

DOE Office of Science. Each year, ESnet will run workshops for two of the program offices.

The BES and BER seminars, which took place in June and July, offered timely discussions for scientists who were gaining access to new DOE research facilities and funding. The Molecular Foundry at Berkeley Lab, for example, only opened last year and is responsible for fostering collaboration in the international nanoscience community

continued on page 2

Network Monitoring Tools To Deploy Across Continents

A new set of network monitoring software called perfSONAR is scheduled for fall deployment among science networks that support the international high-energy physics community.

Over the summer, the Large Hadron Collider Optical Private Network (LHCOPN) agreed with perfSONAR developers, including ESnet, on deploying the monitoring tools. The LHCOPN is designed to move the massive data that will be generated by the Large Hadron Collider (LHC) at CERN near Geneva to research centers in the United States and other countries.

PerfSONAR (Performance Service Oriented Network Monitoring Architecture) has been developed by an international consortium of science network operators

that seek to create better tools for collecting and distributing network performance data. Aside from ESnet, major partners include Internet2 in the United States and GEANT2 in Europe.

Some PerfSONAR services have been deployed sporadically on various networks over the past few years. With LHC scheduled to go online next year, the consortium has been working together to improve the software, deploy it on the networks supporting the LHCOPN, and making sure that all the LHC research centers are familiar with its use.

Data from the LHC will first go to designated Tier1 centers for processing. Those centers include the DOE's Fermi National Accelerator Laboratory near Chicago and Brookhaven National

Laboratory on Long Island in New York, both of which are served by ESnet.

"Transferring all of this data is a critical part of the LHC experiments, so the centers need better network management tools," said Joe Metzger, a network engineer at ESnet.

The consortium was formed in January 2005, at a time when individual network providers used their independently developed monitoring systems. Each of these systems had different capabilities, and most were focused on providing data to network operators, not to the scientists who were using the networks. Scientists were sending data across multiple networks as a result of collaborating with researchers in different parts of the

continued on page 5

Workshops

continued from page 1

by providing instruments, techniques and other resources. In June this year, DOE announced plans to spend \$375 million for building three Bioenergy Research Centers.

These new resources promise to boost the scientists' ability to carry out larger experiments and generate more and better data. These opportunities also would require some researchers to rely more heavily on ESnet.

"Some scientists have been heavy network users for years, while others have only recently moved to a network-intensive scientific model," said Eli Dart, an ESnet engineer who led the two workshops.

"Regardless of their experience with the network or the specific requirements they may have, we want to figure out what they need from the network to get their science done."

The workshops set out to chart short-term, medium-term and long-range network requirements, which would ensure that ESnet provides the necessary services to scientists in the next 12 months as well as for years to come.

The template for the workshops came from a successful 2002 High Performance Network Planning Workshop, organized by the DOE Office of Science. As a result, Dart asked participants of the BES and BER workshops to write a "case study" outlining the



ESnet hosted a workshop for addressing the network needs of scientists who now have access to new facilities such as the Molecular Foundry (pictured), which opened in Berkeley Lab only last year.

scope of their research, the type of data they generate, the computing and other resources they use and network problems they have encountered. These write-ups, submitted before the workshops began, formed the basis of discussions and context for the final report that ESnet will submit to DOE program managers.

"You don't ask the scientists what their network requirements are but what their science process is — how do they use the network and move the data," Dart said. "Some scientists are not network experts

and just want the data to get there."

Although the final report for each workshop won't be completed until this fall, ESnet is already taking steps to help scientists who have expressed frustration with using the network. As an example, ESnet is building a website to put in one place all the resources that the researchers would find helpful for using the network for bulk data transfer, Dart said.

Learn more about ESnet's network requirements gathering effort at <http://www.es.net/hypertext/requirements.html>

ESnet4

continued from page 1

demonstrated that they have the knowledge, experience and dedication to accomplish major paradigm shifts in the service that ESnet provides to DOE's Office of Science community," said William Johnston, head of ESnet at the Lawrence Berkeley National Laboratory.

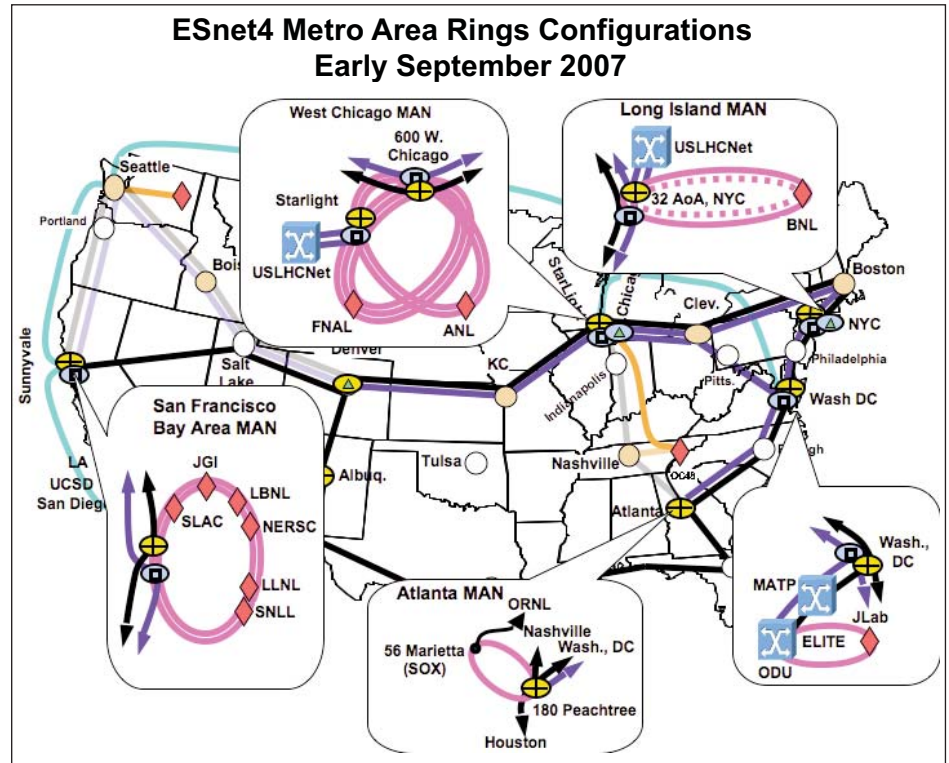
The partnership between ESnet and Internet2 brings together the expertise of two organizations that provide network services to the majority of scientists in the country. More than 50,000 DOE scientists and 18,000 researchers from universities, other government agencies and private businesses rely on ESnet. Internet2 serves 5 million users at 270 research and educational institutions.

ESnet and Internet2 first announced their partnership to build and deploy the ESnet4 optical circuit-based infrastructure in August last year. After signing an initial agreement to work on the project, the two organizations inked a multi-year extension of that agreement in July this year.

"This continued investment in ESnet by the Department of Energy's Office of Science represents a significant contribution to the nation's research and education infrastructure. In fact, as the single largest supporter of basic research in the physical sciences in the United States, the Office of Science provides research funding for thousands of scientists at universities," Johnston said.

The agreement between ESnet and Internet2 stems from the conclusion that by sharing a common optical circuit infrastructure that is larger than either community could obtain individually, both DOE's and the U.S. research and education community's research would have access to a network infrastructure bigger than either community could build on their own. Another factor supporting the partnership is the fact that nearly 90 percent of the network traffic on ESnet flows to and from the research and education community.

ESnet4 consists of three main elements: the IP network for transferring data at gigabytes or less; the circuit-oriented Science Data Network for moving terabytes of data; and the metropolitan area networks for connecting research centers in



the same region to each other and to the IP network and Science Data Network. The Science Data Network will provide on-demand, virtual circuits that will ensure the timely delivery of massive research materials. The project to develop the virtual circuit services is an international collaboration involving ESnet, Internet2, HOPI, NSF's Dragon research network, DOE's Ultra Science Net, CANARIE in Canada, DANTE/GEANT and several of the NRENs in Europe, as well as others.

The deployment of the first national network ring is timely for scientists in disciplines such as high-energy physics. The Fermi Accelerator National Laboratory near Chicago and Brookhaven National Laboratory on Long Island in New York will be the data archive centers in the United States to store, process and distribute data from the Large Hadron Collider (LHC) at CERN near Geneva. LHC, which is scheduled to begin operation next May, will generate roughly 15 petabytes of data annually.

The 10 Gbps national ring represents the first phase of the overall ESnet4 project. Anticipating a significant growth in network traffic in years to come, ESnet and Internet2 set out to build the new network that will meet the researchers' needs. Plans are in place to boost the network's

capacity over the next five years, when it will reach more than 200 Gbps.

Through the use of increasingly sophisticated scientific instruments, more powerful supercomputers running more sophisticated models, and parallel file mover systems, scientists are generating a steadily increasing amount of data that must be shared by widely distributed collaborations. In fact, the traffic on the pre-ESnet4 network has had a steady increase of 10 times every 47 months, on average, since 1990. With a new generation of instruments and computers coming on-line in the next several years (starting with the LHC), this rate of growth is expected to increase dramatically.

"By working with Internet2 to increase the reliability and capacity of ESnet, our goal is to advance scientific discovery through access to large-scale scientific resources and improved collaborations. Further, the strategy of building ESnet4 as a partnership with the R&E community was specifically intended by DOE's Office of Science to contribute to the robustness of the U.S. R&E network environment," Johnston said.

ESnet4, which builds on Internet2's backbone infrastructure, will be managed by ESnet. Learn more about ESnet4 at <http://www.es.net/ESnet4/index.html>.

OSCARS

continued from page 1

when it met with representatives from these networks to finalize the topology exchange schema, a framework for letting autonomous networks communicate to each other how data traffic would be permitted to flow within each network.

"It is similar to when you make a phone call to New York, the phone company has to decide where the signal should pass through, whether the call goes to Utah or Colorado first," said Chin P. Guok, part of the Networking Engineering Services Group at ESnet. "We need to understand which part of our network we should create the circuits over as well as the topology of other networks, so that we can determine which path to take."

ESnet's partners in the OSCARS project include Internet2, Delivery of Advanced Network Technology to Europe (DANTE), Canadian Network for the Advancement of Research, Industry and Education (CANARIE) and Dynamic Resource Allocation via GMPLS Optical Networks (DRAGON). The group also is working with the Network Measurements Working Group (NMWG) at the Open Grid Forum on developing the topology schema.

After determining the topology, ESnet and its partners will work on the protocols for cross-domain scheduling of the bandwidth and time, as well as sending and managing data traffic. Guok, in collaboration with other ESnet partners, is also working on an authentication system with the University of Amsterdam's Advanced Internet Research group in order to boost security as provisioning requests and data flow across domains.

ESnet began working on OSCARS in 2005, after a DOE's Office of Science workshop identified a critical need for a more efficient service that can ensure the timely delivery of large and sensitive data. ESnet started carrying out the first test runs within its own network and with other networks last year. A couple dozen scientists from research institutions and industry have been participating in the test deployment and providing feedback to Guok.

The full deploying of OSCARS will take places in phases over the coming year, as

Network Services Expert Joins ESnet

Vangelis Chaniotakis, a senior software engineer from the University of Crete in Greece, has accepted a one-year appointment with ESnet to work on a virtual circuits provisioning project.

Chaniotakis started his post at ESnet in August, bringing with him expertise in developing network services for the Greek Research and Technology Network (GRNET), a national network supporting research and academic institutions, and for GÉANT – the pan-European research and education networking organization (similar to Internet2 in the United States).

"I am very happy to be here and to have a chance to work on this exciting project. I hope to learn a lot from ESnet's extensive experience providing network services, and to help the scientific research community make the most of the network's resources," Chaniotakis said.

At ESnet, Chaniotakis will work on the On-Demand Secure Circuits and Advance Reservation System (OSCARS), which allocates network bandwidth to large-scale scientific projects in the form of virtual circuits across multiple networks, ensuring high-performance data transport. ESnet has been working with science network operators from the U.S. and Europe to deploy OSCARS and ensure its interoperability with similar bandwidth provisioning software.

Part of Chaniotakis's assignment will be to promote a common data exchange schema of topological information between international research and education networks. This is an impor-



Vangelis Chaniotakis

tant step in allowing the set up of these circuits to become fully automatic.

Before ESnet, Chaniotakis spent three years at the Networks and Communications

Center at the university, where he managed a development team and led the design and implementation of web-based services and systems. He was a key developer for GRNET's ANStool project, which automated the provisioning of network services such as L2/L3 virtual private networks (VPNs) and QoS.

His work included modifying ANStool to interoperate with the Automated Bandwidth Allocation across Heterogeneous Networks (AutoBAHN), a GÉANT project that is similar to OSCARS and serves scientists across Europe.

Graduated with a bachelor's degree in mathematics from the University of Crete, Chaniotakis has worked mostly at his alma mater. From 1997 to 2002, he was a system and network administrator and software engineer at the university's Networks and Communications Center.

He then left the university to carry out a mandatory term of service in the Greek military, as a second lieutenant specializing in communications. After the two-year service, he returned to the university as a senior software engineer in 2004.

Fluent in English, Chaniotakis enjoys fencing and kickboxing.

ESnet and its partners roll out different levels of services, Guok said. A major goal for the deployment is to serve the scientific community when the Large Hadron Collider (LHC) at CERN near Geneva is in operation, which is scheduled to begin in May next year.

LHC is expected to generate roughly 15 petabytes of data annually. CERN will distribute these data to DOE's Fermi

National Accelerator National Laboratory and Brookhaven National Laboratory, and the labs will then make the data available to the data analysis centers at universities in the U.S. as well as institutions in the U.S., Europe, and elsewhere.

"We've been developing the network with LHC in mind, and we understand what its users' requirements are," Guok said,

continued on page 5

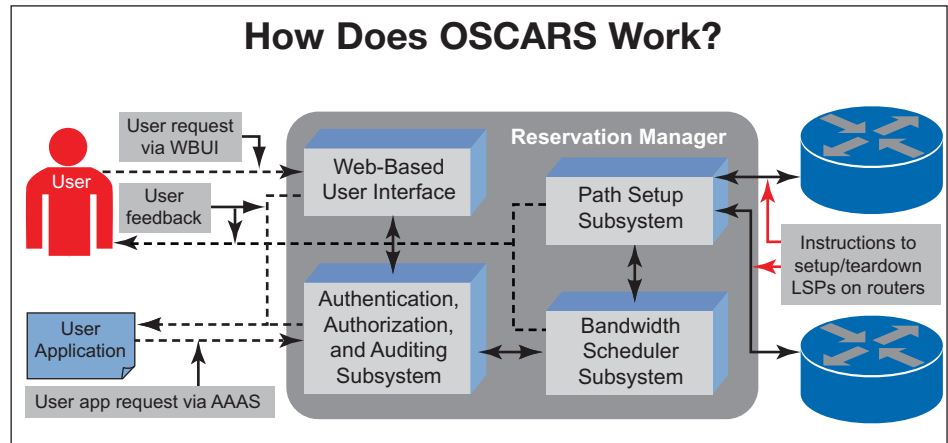
OSCARS

continued from page 4

however the requirement for such a service has been expressed by essentially every major Office of Science experiment facility.

To prepare for the full deployment, Guok recently hired Vangelis Chaniotakis (see sidebar) to work on the OSCARS project for one year. Chaniotakis, a software engineer from the University of Crete, was working for the national Greece Research and Technology Network before starting at ESnet in August.

More information about OSCARS can be found at <http://www.es.net/OSCARS/index.html>.



perfSONAR

continued from page 2

world, but they didn't have a way to monitor data transfer as it crosses each network.

As more scientists at national labs, universities and private enterprises were carrying out larger experiments and simulations, they wanted a better way to ensure a smooth transfer of those large data sets. The researchers began to ask for a standardized monitoring system that will enable them to obtain network status promptly and identify bottlenecks.

"Most of the ESnet network traffic is users transferring data from DOE labs to university sites and vice versa," Metzger said. "Scientists are concerned about the performance of their data transfers which are crossing multiple domains. They want to use the same tools for measuring performance issues across the entire path."

Work by the perfSONAR consortium is leading towards technical standards for creating software and services that

pull and exchange performance data from different networks. This way, the consortium members have the freedom to develop and roll out software based on their own needs and timelines while ensuring that the software would interoperate and work with data sources from across multiple domains.

The perfSONAR software acts a layer between applications that measure network performance and those that visualize network performance, analyze the network measurements and diagnose problems. In addition to culling the latest performance data, the software can provide the ability to retrieve historical measurement data from an archive.

With the Large Hadron Collider (LHC) coming online, perfSONAR members are accelerating efforts to finalize software deployment plans to support the high-energy physics community. The software is now running on the majority of the

European networks. ESnet, which deployed perfSONAR, has provided a training ground for GEANT2 to demonstrate how to use the software.

Aside from working on LHC-related projects, ESnet also is collaborating with Internet2 on perfSONAR tools for monitoring network performance between the two networks, Metzger said. Internet2 provides a national network to U.S. university researchers, who work extensively with DOE scientists served by ESnet.

Learn more about perfSONAR at <http://www.perfsonar.net>.

About ESnet News

ESnet News is a quarterly that highlights the services and accomplishments by the staff of the Energy Sciences Network (ESnet), a high-speed communications network that serves more than 50,000 scientists and their collaborators at dozens of national labs and research centers funded by the U.S. Department of Energy. ESnet is headquartered at the Lawrence Berkeley National Laboratory. Learn about ESnet's services at <http://www.es.net>.

ESnet News is edited by Uclia Wang, who can be reached at Uwang@lbl.gov or 510 495-2402.

DISCLAIMER This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor The Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or The Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or The Regents of the University of California. Ernest Orlando Lawrence Berkeley National Laboratory is an equal opportunity employer.