

Princeton Gets a 6,400 Percent Increase in Bandwidth With ESnet Upgrades

ESnet finished improving its Internet connections to several institutions on Princeton University's Forrestal Campus, including the Princeton Plasma Physics Lab (PPPL), the High Energy Physics (HEP) Group within the Physics Department at Princeton University, and the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory (GFDL).

Now researchers around the globe can access data from these science facilities with increasing speeds and scalability, helping enable international collaborations on bandwidth-intensive applications and experiments.

"This is a great achievement," says Steve Cotter, head of ESnet. "With the availability of cutting-edge instruments and supercomputers, scientists around the world are collaborating to carry out large experiments that produce tremendous amounts of data. This upgrade links Princeton's physics researchers to that data through our robust and reliable net-



PPPL (shown here) and GFDL are both located on Princeton University's Forrestal Campus.

work, ESnet4, via point-to-point dedicated circuits and IP services at multiple gigabit per second speeds."

The Princeton network upgrade took approximately five months to complete, and involved running fiber optic cabling underground from the Forrestal Campus outside Princeton, New Jersey, along

Route 1 to South Brunswick, then to Philadelphia, where it is transported across the ESnet infrastructure to ESnet's main point of presence in McLean, Va.

On the Princeton campus, the PPPL's Internet connection is now operating at 10 gigabit speeds, 10 billion bits per second, significantly *continued on page 2*

ESnet4 Provides Critical Link for U.S. Researchers Accessing LHC Data

Approaching the speed of light, millions of protons will collide per second when the Large Hadron Collider (LHC) comes online next year. The experiment will generate more data than the international scientific community has ever tried to manage. Scientists suspect the outcome of these "subatomic smashups" will provide valuable insights into the origins of matter and dark energy in the Universe.

As thousands of researchers across the globe anxiously await the results of this experiment, getting the massive amounts of data to them is no insignificant task. Fortunately, network engineers at the U.S. Department of Energy's (DOE) Energy Sciences Network (ESnet) foresaw this data challenge years ago and developed ESnet4, a new large-scale science data transport network with enough bandwidth to transport multiple streams of 10 gigabits of

information per second — the equivalent of transmitting 500 hours of digital music per second for each 10 gigabit line.

The LHC, which straddles the Swiss and French borders on the outskirts of Geneva, will be the first experiment to fully utilize the advanced capabilities of this network, which connects DOE national laboratories to researchers across the country and collaborators worldwide.

"ESnet4 is one of the most robust scientific data networks in existence," says Steve Cotter, Department Head for ESnet. "The science environment of today is very different from that of a few years ago. ESnet4 provides the high-speed, extremely reliable connectivity between labs and U.S. and international research institutions required to support the inherently collaborative, global nature of modern large-scale science." *continued on page 3*

Steve Cotter Named New Head of ESnet

Steve Cotter began supporting science around the world as the new head of ESnet, the Department of Energy's high-speed network, on Friday, August 29, 2008. For more than a decade, Cotter has designed and deployed networks, for both research and commercial use, at home and abroad. Most recently, he served as Google's network deployment manager for Europe, the Middle East, and Africa. At ESnet, he succeeds Bill Johnston, who is retiring from Berkeley Lab after more than 35 years.

"Steve Cotter brings to this job exactly the right combination of experience in all aspects of network design, development, deployment and operation," said Lawrence Berkeley National Laboratory (LBNL) Associate Laboratory Director Horst Simon. "On top of that, Steve is already familiar with ESnet's staff and operations and has strong connections to the research network community. We are thrilled by his decision to lead ESnet."

Before joining Google in 2007, Cotter worked for Internet2, a high performance network serving more than 300 institutions in the research and education community in the U.S. Since 2006, ESnet and Internet2 have worked as partners in building ESnet's next-generation infrastructure.

"While at Internet2, I worked closely with ESnet on the design of their new infrastructure and became familiar with their research community and staff, a very impressive group," Cotter said. "Bill Johnston is leaving some big shoes to fill, but it's an exciting challenge and I welcome it. The services ESnet provides are not just good for the research community, but also the public by supporting important research in areas like global climate change and new and renewable energy sources."

ESnet, or the Energy Sciences Network, is managed by LBNL for the Department of Energy. ESnet provides direct connections to more than 40 DOE sites, as well as fast interconnections to more than 100 other networks. Funded principally by DOE's Office of Science, ESnet services



Built for speed: When Steve Cotter is not heading ESnet, he's zipping through the French Alps on bike.

allow scientists to make effective use of unique DOE research facilities and computing resources, independent of time

and geographic location.

Based on his experience in the commercial sector, Cotter said he sees that ESnet is not alone in pushing the envelope of advanced networking. He believes the entire community can benefit from continuing ESnet's strong record of building alliances with other organizations to advance the state of networking. Key areas include transferring massive sets of scientific data and supporting "cloud" computing.

"Google is an incredible place to work and I learned a lot, but ESnet is doing some amazing things as well," Cotter said. "This is an opportunity to be part of a great team and to make an impact."

Cotter brings a broad range of experience with other *continued on page 4*

Princeton *continued from page 1*

faster than its previous speed of 155 megabits, or 155 million bits per second. This is a 6,400 percent improvement in performance, and ESnet's international connectivity will facilitate collaborations on world-class facilities, including the future ITER fusion reactor in France and existing fusion energy facilities such as the superconducting tokamaks in Korea (KSTAR) and in China (EAST).

Meanwhile, the upgrade brought a new 1 gigabit circuit to GFDL, providing high speed access to other ESnet sites such as the Oak Ridge National Laboratory's Leadership Computing Facility, where advanced climate simulations will be carried out. The HEP Group in the Physics Department also received its own 1 gigabit circuit, allowing it to access data from Europe's Large Hadron Collider (LHC). Based at the European Center for Nuclear Research (CERN) in Switzerland, LHC is the world's largest particle accelerator. Over 15 million gigabytes of data per year will be distributed to researchers across the globe, when the LHC begins smashing together beams of protons to

search for new particles and forces, and beams of heavy nuclei to study new states of matter. The ESnet4 network plays a significant role in providing access to this data for U.S. researchers.

"This world-class network capability places the Princeton institutions on par with the upper echelon of research institutions and allows researchers to collaborate with institutions around the world at speeds necessary to conduct large scale science," says Joe Burescia, General Manager for ESnet.

This upgrade is a collaborative effort involving the U.S. Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), the University of Pennsylvania, and Princeton University. Internet2's regional connector, MAGPI, based at the University of Pennsylvania, will coordinate and manage the multi-agency consortium that connects Princeton to the ESnet4 network. The DOE and NOAA equally shared the cost of the fiber installation to Princeton institutes, while the University contributes to the on-campus cost of the optical equipment. ■

ESnet4 *continued from page 1*

Flowing Information to America

The European Center for Nuclear Research (CERN), which manages the LHC, will initially collect the experiment's data. The information will then migrate across the Atlantic Ocean via fiber optics on a network called USLHCnet, which is managed by researchers at the California Institute of Technology in Pasadena, Calif.

Like a virtual Ellis Island, an ESnet hub on 8th Street in Manhattan will be the US entry point for LHC data. From there, ESnet will deliver data from the LHC's ATLAS detector to Brookhaven National Laboratory in Upton, N.Y., where it will be processed and stored. Meanwhile, data from the LHC's CMS detector will go to the Fermi National Accelerator Laboratory in Batavia, Ill., for processing and storage.

Researchers at universities and DOE laboratories across the country will then be able to connect to these databases through ESnet4, the DOE's next-generation scientific network. Internet2, the country's leading education and research

network, and ESnet officially launched a partnership in 2006 to develop and deploy ESnet4 just in time for the LHC experiment.

To maximize efficiency, ESnet4 utilizes three main elements:

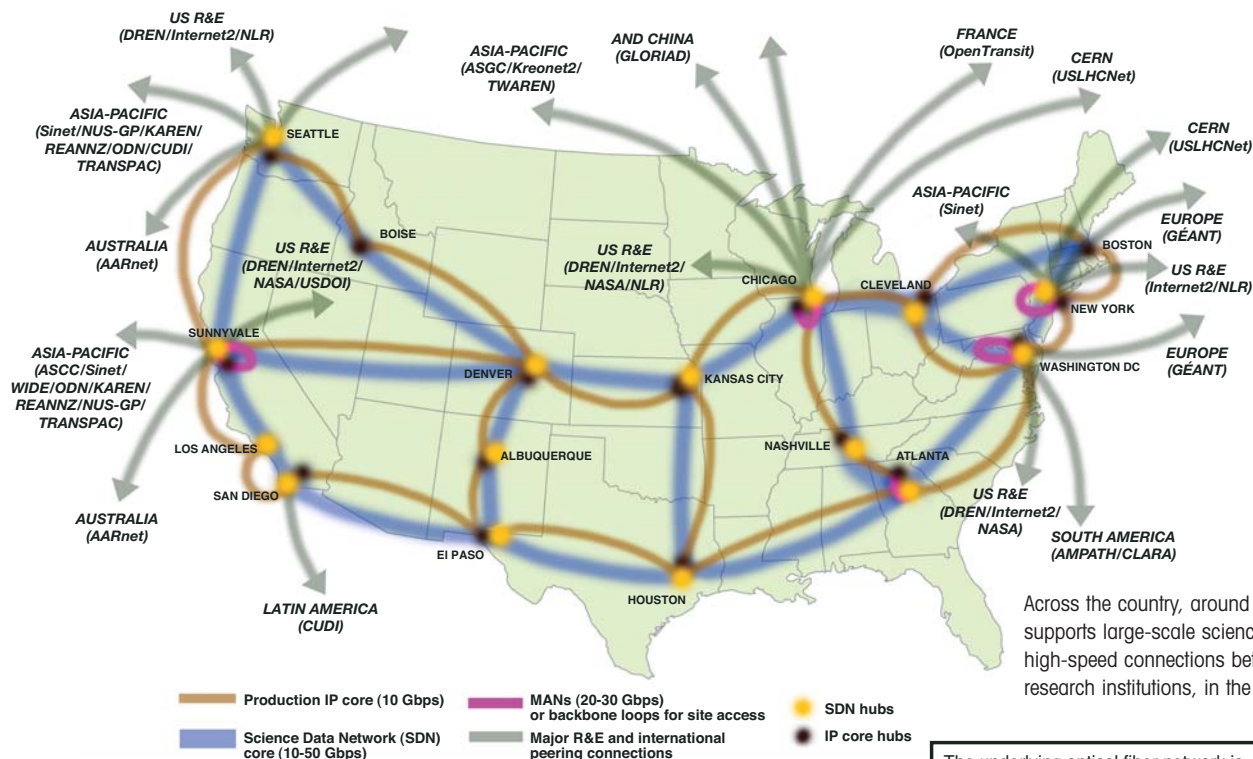
A circuit-oriented Science Data Network for moving terabytes of data. Like a direct line connecting two endpoints, this dedicated network allows information to flow directly at high data rates from one remote host to another.

An Internet Protocol (IP) network for typical data transfers. Unlike the Science Data Network, the IP network is connected to many computers, and can have multiple endpoints. To reach a destination, information traveling on an IP network will constantly encounter "gateways" that quickly direct and redirect it. Like air-traffic controllers, the gateways virtually determine which routes are preferred and find the most efficient routes for travel. Because information will move through numerous gateways before reaching its destination, IP networks are

not the most efficient tool for moving massive datasets. Like hundreds of cars trying to pass on a toll road, large datasets can cause virtual "traffic jams" if too much information is trying to pass through the gateways. Thus, the Science Data Network is ideal for moving large datasets.

Metropolitan Area Networks (MANs) are the last component of ESnet4. This system carries both Science Data and IP networks to effectively connect research centers in the same geographic region. Currently, 11 ESnet sites are served by MANs. The Long Island MAN and the Chicago Area MAN were specifically built to facilitate the movement of data from the LHC experiments.

"LHC is just the beginning," says Joe Burescia, General Manager for ESnet. "ESnet4's innovative and reliable infrastructure allows scientists from all over the world, and across disciplines, to exchange large datasets and analyses in an efficient way. It is these collaborations, this sharing of information, that allows us to better understand the world around us." ◻



Across the country, around the world: ESnet4 supports large-scale science by providing reliable high-speed connections between labs and research institutions, in the U.S. and abroad.

Core networks: scalable to 50-60 Gbps by 2009-2010, 200-600 Gbps by 2011-2012
ESnet Network as of December 2008

The underlying optical fiber network is ~14,000 miles/24,000 km, and is built on a shared infrastructure with Internet2.

Connect with ESnet at SC08

What's New at ESnet?

Booth Meet and Greet

Come learn about the Department of Energy's next-generation science data network, ESnet4, and how it will revolutionize large-scale science research. Steve Cotter, ESnet head, and Joe Burescia, ESnet general manager, will be available to answer questions about ESnet4 and other networking topics at the Berkeley Lab Computing Sciences booth.

When: Tuesday, November 18
10:30 am – 12 noon
Where: Berkeley Lab
Computing Sciences,
Booth 540

Network Measurement

Birds-of-a-Feather Session

ESnet network engineer, Jon Dugan leads a discussion about measuring networks in the local area and wide area. The organizers have many years of experience in measuring, operating and debugging networks. Anyone involved or interested in network measurement is encouraged to attend. Be sure to bring your questions or even a short presentation.

When: Tuesday, November 18
12:15 pm – 1:15 pm
Where: Room 10B

ESnet Contributes to SC08's SCinet

For seven days, the Austin Convention Center is home to one of the most powerful networks in the world — SCinet. Built each year specifically for the SC Conference, SCinet brings to life a highly sophisticated and extreme networking infrastructure that can support the revolutionary applications and network experiments that have become the trademark of the event. SCinet serves as the technological platform for conference competitions like the HPC Bandwidth Challenge, the Analytics Challenge and the Cluster Challenge.

The networks are designed and delivered by volunteers from educational institutions, high performance computing centers, network equipment vendors, U.S. national laboratories, research institutions, and research networks and telecommunication carriers. Members of ESnet who contributed expertise to this effort are Eli Dart, Jon Dugan, and Brian Tierney.

Cotter *continued from page 2*

leading firms to his new role. While serving as Internet2's Deputy Operations Officer, their close collaboration with ESnet's OSCARS project and others in the research community resulted in the rollout of Internet2's Dynamic Circuit Network — delivering on NSF's Cyberinfrastructure vision that the network should be available as a schedulable, on-demand resource like supercomputers are today. Cotter said, "I was also the CEO of Internet2's subsidiary FiberCo — brokering dark fiber acquisitions and providing consulting/project management services to the higher education and research community."

Before that, Cotter was assigned


from Internet2 to National LambdaRail, where he led the build-out and design of their DWDM (dense wave division multiplexing) and IP network. He got his start in optical network technologies while an engineer at Cisco Systems and also served as a Director in SBC Global Communications' (now AT&T) engineering and construction departments. He is well known in the networking community, having been a speaker at networking meetings and conferences in the U.S. and Europe.

Although he has extensive experience in industry, Cotter said his approach to management was shaped during his

eight years as a combat helicopter pilot in the U.S. Marine Corps. Cotter led missions in both the former Yugoslavia and Somalia and Liberia in Africa, facing everything from hostile fire to the most difficult weather conditions.

"You learn to focus on the mission at hand, to push forward no matter what obstacles you come across, and to take care of those you are responsible for," Cotter said. "You rely on your people to do their job, to do it well and to work as a team. I've carried over that philosophy of having faith in those who work for you by letting them do their job and getting out of their way."

Raised in New Jersey, Cotter attended the U.S. Naval Academy, where he earned his bachelor's degree in aeronautical engineering. He earned an MBA from Boston University and has completed about 75 percent of his coursework toward a master's degree in Information Economics, Management and Policy at the University of Michigan.

Cotter and his wife, Pallas, have two young sons and live in Davis, Calif. 

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>.

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