Internet2 Accelerates New Scientific Possibilities

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Bandwidth demand increased 20x in 10 years for Internet2. A programmable and scalable infrastructure to deliver increased capacity for research and education networking provided a solution. Cisco® 8200 routers deliver massive scale and density for 48 400G access sites nationwide while lowering power consumption almost 70 percent.

Executive Summary	
Customer Name: Internet2 **Industry:** Research and Education **Location:** Ann Arbor, Denver, Washington DC, West Hartford **Number of Employees:** 199	
Challenges	• Bandwidth demand increased 20x in 10 years • Supplying bandwidth for increasingly large data sets and cloud connectivity • Adding capacity with existing routing infrastructure requires costly investments • Existing infrastructure expansion increases power and cooling expenses • Flexibly providing connectivity to network resources demanded by researchers
Solutions	• Cisco 8000 Series routers • Cisco Network Services Orchestrator
Results	• Upgraded network to 400G links, enabling up to 32 Tbps of backbone capacity • Delivered massive scale and density for 48 400G access sites • Reduced footprint and lowered power consumption by almost 70 percent

Accelerating time to science

Internet2 is a community of research and education partners working together to solve technology challenges and develop solutions to advance research. Internet2 operates a national research and education network, cloud services, trust and identity solutions, and broadband-enabled collaboration to a

community of researchers, scholars, and learners. Founded in 1996 by the nation's leading higher education institutions, the Internet2 network supports over 320 university, scientific, regional and state education networks, and government research facilities that connect to over 100 countries across more than 70 partner networks.

The Internet2 backbone network delivers as much as 10 petabytes on a busy academic day with a foundational design built on 100 Gbps connectivity. To power the growing and future requirements of big data research, Internet2 needed to expand capacity to support speeds between 400 Gbps and 1.2 Tbps on its backend, its cloud connectivity, and its research instrument connectivity. "We need a network that can enable individual scientists to do their work in an increasingly multi-disciplined, distributed environment of collaborators and instruments around the world," says Rob Vietzke, vice president of network services, Internet2.

Internet2 also needed to deliver more programmable interfaces and automation to meet the increasingly dynamic and real-time demands of its community of users. "The network needs to be as flexible as the demand from researchers. The dynamic nature of scientific research requires on-demand compute and storage infrastructure," he says.

At the same time, Internet2 was looking to achieve economies of scale in delivering this expanded capacity with an architecture designed to optimize density, space, and power. Internet2 also wanted an operational framework to improve cost-effectiveness with a simpler, more reliable, and secure network. The key is flexibility. "The next-generation networking infrastructure must be agile enough to allow scientists to spin up the resources they need, when and where they need. We needed to make it economically and environmentally feasible to offer abundant bandwidth in every location while lowering operating costs," Vietzke explains.

" Our infrastructure enables the brightest minds to come together to solve a problem, wherever they are in the world. That's exciting."

-Rob Vietzke, Vice president of network services, Internet2

Infrastructure on demand

Cisco's selection was the result of a rigorous proposal process. It was reviewed by networking experts from the Internet2 community and was part of the Internet2 Next-Generation Infrastructure (NGI) program, which focuses on supporting the data-intensive researcher, enabling campuses to connect to the cloud, delivering edge-to-edge performance, and creating a software-enabled environment.

Cisco solutions are supporting Internet2 Network Services objectives to deliver their NGI program, which consists of upgrading their research and education (R&E) network infrastructure with increased capacity that is programmable and scalable. The Internet2 NGI is evolving the national backbone network from groups of 100 gigabit links to groups of 400 gigabit links. This will enable individual researchers on the network to move files at tremendous speeds between the cities in the US and their global collaborators.

This Internet2 NGI is built on the Cisco 8200 Series Routing platform powered by Cisco Silicon One Application Specific Integrated Circuits (ASICs), running Cisco IOS® XR7, and Network Services Orchestration (NSO) software. The Cisco 8201 and 8202 routers are deployed at 48 locations across the country utilizing between one and four devices per node, depending on the capabilities needed. A typical node, which connects national backbone resources with state and regional networks, has between 24 and 96 400G network access ports. With some intercity routes topping 1.2 terabits per second, the Internet2

network infrastructure between the East and West coasts will feature multiple contiguous routes equipped with 800 gigabits per second of bandwidth.

Routing will be segmented with multiprotocol label switching (SR-MPLS) and Ethernet virtual private network (EVPN). This will enable researcher applications to claim an entire 400G link for a particular application while other network uses are moved to other paths. This routing segmentation will provide abundant headroom to support big data research across disciplines, including high-energy physics, astronomy and astrophysics, genomics, health and life sciences, engineering, medicine, and earth sciences.

Internet2 is also deploying Cisco Network Services Orchestrator (NSO) as the foundation for an extensible network-wide automation platform and to support regional, national, and cloud services orchestration. The software and automation layer is very important to the Internet2 NGI. NSO intermediates the very high-speed backbone that moves the data with the applications and the educational tools. It enables users with very specific research demands to program the network on demand to respond to their application needs. It also means that researchers can turn up and tear down resources very quickly.

"This approach simplifies the user experience of scientific collaboration across the network. With network automation and a software-enabled infrastructure, it becomes easier to access and provision services across the network," says Vietzke.

"We need the flexibility to transport data between where it is generated and where it is stored, and to use the burst-ability of cloud resources to process that data."

-Rob Vietzke, Vice president of network services, Internet2

Cadence of research

The Internet2 NGI reimagines scientific collaboration. "It changes what is possible," says Vietzke. "It allows the scientific community to think differently about how to approach a problem. The speed and cadence of time to science increases with faster infrastructure."

By partnering with Cisco, Internet2 is increasing capacity to its national research and education network and enhancing access to on-demand cloud-connectivity, while reducing overall costs and carbon footprint. Internet2 selected Cisco Mass Scale Infrastructure solutions to deliver key services that help accelerate research by connecting researchers, instruments, and data across distances and networks, easily and securely sharing massive amounts of data, and enabling real-time collaboration.

With Cisco solutions, Internet2 will deliver nearly 12 times more capacity across the national footprint while reducing power consumption by almost 70 percent. This will reduce the collective carbon footprint of Internet2 members by 668 metric tons due to the increased efficiency of the network, including reduced power usage and cooling requirements. These savings enable Internet2 to transfer investment into the software layer to continue making the network more dynamic and supporting the advancement of scientific research and education activities.

Learn More

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