

Networking for the Next Generation

The international scientific community's attention was riveted on CERN (the European Organization for Nuclear Research) on September 10, 2008 when the first beams of protons were fired at the Large Hadron Collider (LHC). The event marked the beginning of a new era in scientific discovery, which commences in full force in the spring of 2009, when data begin flowing from the ATLAS and CMS experiments at the LHC. When hundreds of billions of protons, approaching the speed of light, collide within the main accelerator of the LHC—simulating the instant immediately following the Big Bang—the particle “wreckages” will be extraordinary. Scientists believe that the debris from these subatomic smashups will provide valuable insights into the origins of matter and dark energy in the Universe.

These experiments will produce data at an unprecedented level, posing entirely new challenges for moving, accessing, and analyzing these data. For researchers at national labs and universities in the United States, the Department of Energy's (DOE) cutting-edge Energy Sciences Network, better known as ESnet, will provide their critical link to the LHC data.

For the past several years, ESnet's engineers have been carefully planning and deploying a next-generation scientific network specifically designed to efficiently handle the massive amounts of data coming out of the LHC. The engineering team's solution to this data challenge is ESnet4, a new large-scale, dynamically provisionable science data transport network with enough on-demand bandwidth to transport multiple 10 gigabits of information per second—the equivalent of transmitting 500 hours of digital music per second for each 10 gigabit line—between any two endpoints.

The LHC is the first experiment to utilize this network, which connects DOE national laboratories to researchers across the country. But this is just the beginning of an exciting trend. The future of large-scale science is international. Some of the largest scientific challenges over the next decade will require the same level of international collaboration as the LHC, and consequently will demand similar if not much larger bandwidth from the networks. One example of these next-generation facilities is ITER, a nuclear fusion reactor project that will be built by an international partnership in France. The United States is a partner in this enterprise that promises to be the first facility to deliver energy from nuclear fusion. In order for U.S. researchers to share the results of this experiment and fully benefit from any breakthroughs in science and technology, a significant investment in inter-domain networking research is required to make experimental data seamlessly accessible via international networks. Another example is the climate simulations that will be carried out by multiple high-performance computing centers around the globe in support of the next assessment of the Intergovernmental Panel on Climate Change.

Large scientific experiments will increasingly rely on next-generation networks to become more productive and useful. But there is more to the story. The Internet today is still relying on networking technology developed in the late 1980s. Scientific

Biography in Brief

Dr. Horst Simon is Associate Laboratory Director at Lawrence Berkeley National Laboratory for Computing Sciences and the Division Director for the Computational Research Division and Adjunct Professor of Computer Science at the University of California–Berkeley. His research interests are in the development of sparse matrix algorithms, algorithms for large-scale eigenvalue problems, and domain decomposition algorithms.



Dr. Horst Simon

His recursive spectral bisection algorithm is a breakthrough in parallel algorithms, honored with the 1988 Gordon Bell Prize. He has served as a senior manager for Silicon Graphics, the Computer Sciences Corporation, Boeing Computer Services, and has been a member of the faculty at the State University of New York.

demands are forcing the accelerated development of services beyond what the commercial carriers can deliver. What we are now seeing is the deployment of switched, high-speed research networks solving new challenges such as advanced bandwidth reservation and end-to-end quality of service guarantees. As the scientific community develops these ingredients of next-generation networks, two huge opportunities will develop: the ability to carry out distributed science at an unprecedented scale and with world-wide participation, as well as the unforeseen commercial applications ahead. It was the high-energy physics community that gave us the fundamentals that made the World Wide Web possible. It is quite likely that the new networking technologies, used today for an esoteric physics experiment such as the LHC, will lead to a completely different networking infrastructure that is barely imaginable today. Think back to 1988—how could you explain Google or Facebook to your colleagues knowing what technologies existed then? Now try to imagine what the future could bring with an innovative and reliable infrastructure that allows people from all over the world, and across multiple disciplines, to exchange large datasets and analyses in an efficient way. It is certain that these collaborations, this sharing of information, will not only allow us to better understand the world around us, but also create unheard of scientific and commercial opportunities.

LHC is just the beginning—a completely different networked world lies ahead of us. ●

Contributor: Dr. Horst Simon, Lawrence Berkeley National Laboratory and the University of California–Berkeley