Keynote

GENI – Global Environment for Network Innovations

Chip Elliott
GENI Project Director
Chief Engineer, BBN Technologies
Cambridge, MA 02138, USA
celliott@bbn.com

I. Global Environment for Network Innovations

The Global Environment for Network Innovations (GENI) is a novel suite of infrastructure now being designed to support experimental research in network science and engineering [1].

This new research challenges us to understand networks broadly and at multiple layers of abstraction, from the physical substrates, through the architecture and protocols, to networks of people, organizations, and societies.

The intellectual space surrounding this challenge is highly interdisciplinary, ranging from new research in network and distributed system design to the theoretical underpinnings of network science, network policy and economics, societal values, and the dynamic interactions of the physical and social spheres with communications networks.

Such research holds great promise for new knowledge about the structure, behavior, and dynamics of our most complex systems – networks of networks – with potentially high social and economic impact.

II. Technical Approach

The GENI Project Office is working with the academic and industrial research community to develop a detailed vision of GENI infrastructure and an engineering approach to achieve that vision. At a high level, it calls for a suite of experimental infrastructure in which all components (computers, servers, switches, storage, sensor networks, etc.) will be:

Highly programmable at a number of conceptual levels, from programming how bits are physically represented in a Radio Frequency (RF) environment, to programming how servers are to be distributed through the network. Researchers will be able to build upon each other's work.

Virtualizable so that a researcher can reserve an end-to-end virtual space (slice) across multiple heterogeneous components. This virtual network with all its programmable components should appear isolated and free-standing even though hosted on a shared infrastructure.

Federated so that any organization with infrastructure that is programmable and virtualizable should be able to attach that infrastructure (federate) to GENI. Federation is important both to allow GENI to incorporate new technologies as they become available (future-proofing GENI), and as the means for GENI to connect to emerging, experimental infrastructure operated by industry, other parts of the US government, and other nations.

All these elements (programmability, virtualization, federation) are wrapped together to enable an at-scale, experimental infrastructure for network science and engineering research, aiming to transform the field via an emphasis on instrumentation, measurement, and repeatable experiments. Its federated infrastructures will grow and replicate, and be shared among a large number of individual, simultaneous experiments with extensive instrumentation that makes it easy to collect, analyze, and share real measurements.

III. Current Status

GENI entered its prototyping phase in 2007 when the US National Science Foundation awarded the GENI Project Office (GPO) role to BBN Technologies.

GENI is currently being designed and prototyped by spiral development, an engineering process in which system requirements are translated into a system design, and the result is prototyped, tried, and evaluated. Based on experience derived from this prototype, the design is revised (and requirements may be revised as well) and a new prototype is built, tested and evaluated. Each cycle of design, prototype, integrate, test and evaluation, is known as a *spiral*.

The GPO has initiated a community-based design and planning process, and issued a set of 29 academic / industrial subcontracts to build, integrate, and attempt to operate the earliest GENI prototype, which is called GENI Spiral 1.

GENI Spiral 1 is progressing quickly. It kicked off in October 2008 as multiple academic / industrial teams started creating and integrating early prototypes of the GENI suite. Spiral 1's two central goals are to demonstrate: (a) one or more early prototypes of the overarching GENI control framework, and (b) end-to-end slices operating across multiple technologies. It has already shown concrete results, with earliest demonstrations conducted in March 2009 at the GENI Engineering Conference. Progress will be repeatedly demonstrated in subsequent conferences at four month intervals, with a goal of demonstrating success at both goals by the end of Spiral 1 in October 2009.

[1] GENI project website: www.geni.net

BIOGRAPHY

Chip Elliott is the Principal Investigator and Project Director for the GENI Project Office (GPO). GENI is a national-scale experimental facility being created by the National Science Foundation for "clean slate" research in global networking. He has been actively involved in GENI's planning since early 2006 as a system engineer for the wireless group.

As Chief Engineer at BBN Technologies, he has nearly thirty years of experience in leading large, technically-challenging projects, both in industry and in academia, with particular expertise in routers, wireless Internet technology, mobile "ad hoc" networks, quality of service issues, advanced optical techniques, and novel routing architectures. He has led the design and successful implementation of secure, mission-critical networks based on novel technology for the United States and its allies, with aggregate value above $3 billion.

From 2001 to 2006, Chip served as Principal Investigator for the DARPA Quantum Network, in which he led the design and build-out of the world's first quantum cryptography network - 10 optical nodes across metro Boston providing highly secure key distribution non-stop through both telecom fibers and the atmosphere - as well as the design and implementation of large-scale, mission-critical "ad hoc" radio networks now used in nearly a dozen nations including the United States, UK, and Canada. Chip holds more than 85 issued patents covering a variety of inventions in network technology. He is an AAAS Fellow and IEEE Fellow, currently serves on the Standing Committee on Research, Development, and Acquisition Options for U.S. Special Operations Command, and, and has participated in a variety of other national advisory panels including the Defense Science Board, Naval Studies Board (National Academy of Sciences), Army Science Board, and DTO Technology Experts Panel for Quantum Cryptography. He received Frost & Sullivan's Award for

Excellence in Technology (2005), is a Fellow of the World Technology Network, and a Finalist for the 2004 World Technology Award for his leadership in quantum cryptography. Over the years he has held visiting faculty positions at Dartmouth College, Tunghai University in Taiwan, and the Indian Institute of Technology, Kanpur.

Chip graduated from Dartmouth College in 1976 with an honors degree in mathematics. He has published 14 conference papers and 23 refereed articles and book chapters, been an invited speaker at numerous conferences, and served on peer reviews for the National Science Foundation and the Natural Sciences and Engineering Research Council (Canada).

For additional information, please see http://www.geni.net