GENI D&P WiMAX Infrastructure Buildout

Supported by NSF award #0944089, and managed by the GENI Project Office at BBN Technologies; see below and www.geni.net.

GENI Overview

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

GENI entered its prototyping phase in 2007, when NSF awarded the GENI Project Office (GPO) role to BBN Technologies. The GPO subsequently initiated a community-based design and planning process, and issued a set of academic / industrial subcontracts to build, integrate, and operate the earliest GENI prototype, called GENI Spiral 1.

Completion of Spiral 1 Prototype

GENI Spiral 1 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 were to demonstrate: (a) one or more early prototypes of the overarching GENI control framework, and (b) end-to-end slices operating across multiple technologies. Completion of these goals was demonstrated in October 2009 at the GENI Engineering Conference.

Beginning of Meso-Scale Prototype GENI Infrastructure

Next, a "meso-scale" prototype GENI infrastructure will be built from GENI-enabled commercial hardware across 13 university campuses, linked by compatible build-outs through two US competing national research backbones (Internet2 and NLR). This work is funded by the NSF award #0944089, for "GENI D&P Infrastructure."

This will include two types of campus build-outs – OpenFlow and WiMAX – with significant commonality in the technologies employed, and significant overlap between the two sets of campuses. This will GENI-enable more than a dozen campuses of major research universities throughout some or all of their footprint.

WiMAX Infrastructure Buildout

The WiMAX build-out will create an open, programmable, GENI-enabled "cellular-like" infrastructure through 8 major research university campuses. This will open up a path for direct "opt in" of student users in these campuses into GENI research experiments, via WiMAX modems and, as they become available, WiMAX handsets.

Open WiMAX base stations will provide network researchers with wide-area coverage and the ability to support both mobile and fixed end-users. Campus-wide WiMAX coverage will make it possible to quickly extend GENI services for "opt-in" by large user populations with a relatively low capital investment.

The GPO assesses this build-out as involving low risk with high payoff. It is low risk because: the software required is less ambitious and has already been demonstrated; only one equipment provider is involved; the deployment does not, as yet, directly affect campus

production networks; and each campus team already has considerable experience in installing and operating wireless testbeds.

This build-out is high payoff because it opens a path towards research experimentation with open, programmable cellular telephony systems. Many researchers believe that user interaction with "future internets" will take place primarily through cell phones; this is one of the few feasible paths towards making such experimentation widely available to the research community.

Figure 1 depicts the campuses that will participate in the initial WiMAX buildout. Each will perform its own local experimentation with the equipment and also make it available as part of the end-to-end GENI infrastructure to researchers across the United States.

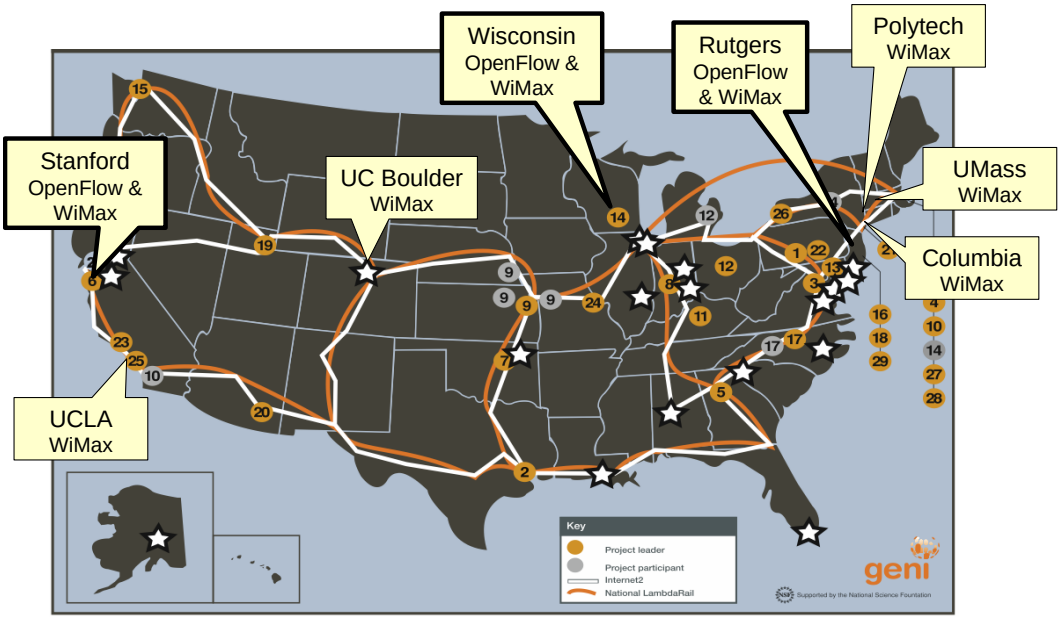

Figure 1. WiMAX campus buildout.

Table 1 provides a summary list of campuses, Principal Investigators (PIs), and campus IT leadership who will be responsible for these build-outs. As can be seen, the majority of projects already have campus infrastructure officials committed to the build-out; the GPO will ensure that *all* campuses have such active partnerships. At present, 4 of the 8 campuses are already engaged in GENI prototyping activities; all have directly relevant research projects that can benefit from involvement with the GENI project (and vice versa).

Campus	PI & IT Leadership	Build-out
Columbia Univ New York, NY	Henning Schulzrinne	WiMax
NYU Polytechnic Brooklyn, NY	Thanasis Korakis	WiMax
WINLAB Rutgers Univ North Brunswick, NJ	Ray Raychaudhuri Charles Hedrick (CTO)	WiMax (and OpenFlow)
Stanford University Stanford, CA	Nick McKeown	WiMax (and OpenFlow)
UCLA Los Angeles, CA	Mario Gerla James Davis (CIO)	WiMax
Univ of Colorado (Boulder) Boulder, CO	Dirk Grunwald	WiMax
UMass. Amherst Amherst, MA	Mark Corner Daniel Blanchard (ACIO)	WiMax
Univ of Wisconsin (Madison) Madison, WI	Suman Banerjee Perry Brunelli (Dir.)	WiMax ((and OpenFlow)

Table 1. Campus researchers and IT leadership committed to GENI infrastructure build-outs.

WiMAX Hardware

NEC's WiMax base-station hardware is a 5U rack-based system which can be populated with up to three channel cards, each supporting one antenna sector for a maximum of three sectors. It operates in the 2.5 Ghz or the 3.5 Ghz bands and can be tuned to use either 5, 7 or 10 Mhz channels. The base station has been tested for radio coverage and performance in realistic urban environments and is being used in early WiMAX deployments – typical coverage radius is ~3-5Km, and peak service bit-rates achievable range from 15-30 Mbps depending on operating mode and terrain.

The WiMAX base station has an external PC controller that runs the ORBIT control framework software to interface the base station to other parts of the GENI suite of infrastructure. This controller provides support for multiple GENI slices. Each slice runs within its own virtual machine and can emulate its own router and perform IP routing, or alternatively implement novel non-Internet protocols.

Rutgers will buy additional WiMAX equipment from NEC, and will help each of the campuses install the equipment and make it operational. Campuses will buy auxiliary equipment such as WiMAX modems. Rutgers will continue to enhance the ORBIT control framework to control these base stations. The GPO will assist as needed with integration and shake down, and will maintain stable software repositories.

GENI D&P Infrastructure Award

As noted above, the GENI D&P Infrastructure Buildouts are supported by NSF award #0944089, summarized here:

Award Abstract #0944089
GENI D&P Infrastructure
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0944089

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