GENI: Slivers and Slices in a Diverse, Outdoor, Mobile Network Environment (DOME) Testbed

Quarterly Status Report, Q1

Project Number 1599
University of Massachusetts, Amherst, MA
Brian Levine, Mark Corner, Brian Lynn

Major Accomplishments

The major accomplishments are highlighted below.

- Upgraded the hardware on all buses. We upgraded the WiFi devices to 802.11abg mini PCI cards, and we upgraded our modems and cellular service to 3G. This also required the installation of new drivers and an update to our software image. (See milestones below and Appendix A.)
- We have begun the software development of software for running Xen virtual machines on our systems. We are currently able to initiate a DieselNet-specific VM, and we can execute existing DieselNet applications within the VM.
- We have started the development of software to perform logging for 3rd party (GENI) experiments.
- We have begun work on installation and scheduling of 3rd party experiments.
- We have had several meetings with the other Cluster-D participants. This has largely focused on issues related to ORCA framework integration.
- Attended GEC3. We made a presentation at the conference, participated in the poster session, and met with other projects.

See Description of Work below for more details.

Milestones Achieved, Deliverables Made

We had one milestone due two months after the start of the project:

> " Implement, integrate and document the required DieselNet hardware updates for your mobile nodes (bricks)"

The deliverable was completed on time and the documentation was submitted to the GPO. The details are provided in Appendix A.

Description of Work Performed During Last Quarter, Activities and Findings

Our effort for Q1 falls into two primary categories: upgrading the testbed hardware, and beginning the development of the software necessary to host experiments developed by the GENI community. Some of the work was initiated prior to the official October 1, 2008 start of project date.

The testbed hardware has been successfully upgraded. We have modified the existing DieselNet code-base, and we have re-imaged the hard drives of the computers on the buses in order to make use of the new hardware. By deploying the hardware with the existing (pre-GENI) software, we have gained valuable knowledge and experience that will make the GENI testbed more reliable. For example, we have studied the behavior of the 3G cellular network, and we have made adjustments to our algorithm for distinguishing between transient network problems and service outages. We have also studied the efficacy of forcing the modem to user slower GPRS and EDGE technologies during 3G disruptions. Moreover, we have collected data with the new WiFi and cellular hardware, and we have begun quantifying the benefits. The specifics of the DOME hardware are documented in Appendix A.

The second set of activities, the development of the software, is effort toward subsequent milestones. We summarize the work below.

The DOME testbed provides computers in a mobile environment. Each computer has multiple peripherals. Some peripherals must be exclusively controlled by the experiments, and other resources need to be shared with the DOME management and control software. The experiments need to be isolated so that they cannot impair the DOME software. Furthermore, multiple networking devices add complexity to the system. To isolate the DOME management and control software from the experiments, we are re-implementing DOME to run within Xen virtual machines. One of our first challenges was how to configure the networking subnets and routing tables for the computers and VMs. Figure 1 illustrates the structure that we have decided on.

Our initial development goal was to split the existing DOME functionality into two parts: the DieselNet software that constitutes our experiments, and the DOME control and management software. We successfully migrated the two functions into a Xen guest domain and domain 0, respectively. Though the software is not yet ready for deployment, it has demonstrated the technical feasibility of our approach. Our current effort is focused on all of the work that is involved in supporting both DieselNet experiments and 3rd party experiments submitted by the GENI community. Supporting 3rd party experiments involves distributing software throughout frequently disconnected mobile nodes, and addressing the scheduling and synchronization of experiments. (After these issues are resolved and the solutions are implemented, we will work on integration with the ORCA framework.)

Another technical problem that we have begun addressing is the logging of experimental results. There are several objectives: ensuring data does not get lost as a result of connectivity disruptions, supporting multiple data repository locations, and decoupling logging from VM instances to ensure collected data is logged even if an experiment is no longer scheduled to be run. We have previously developed UMass-specific logging solutions for DieselNet. We are now creating more general solutions for GENI. We have also begun to address the challenges associated with isolated data, as introduced by the support of virtual machines.

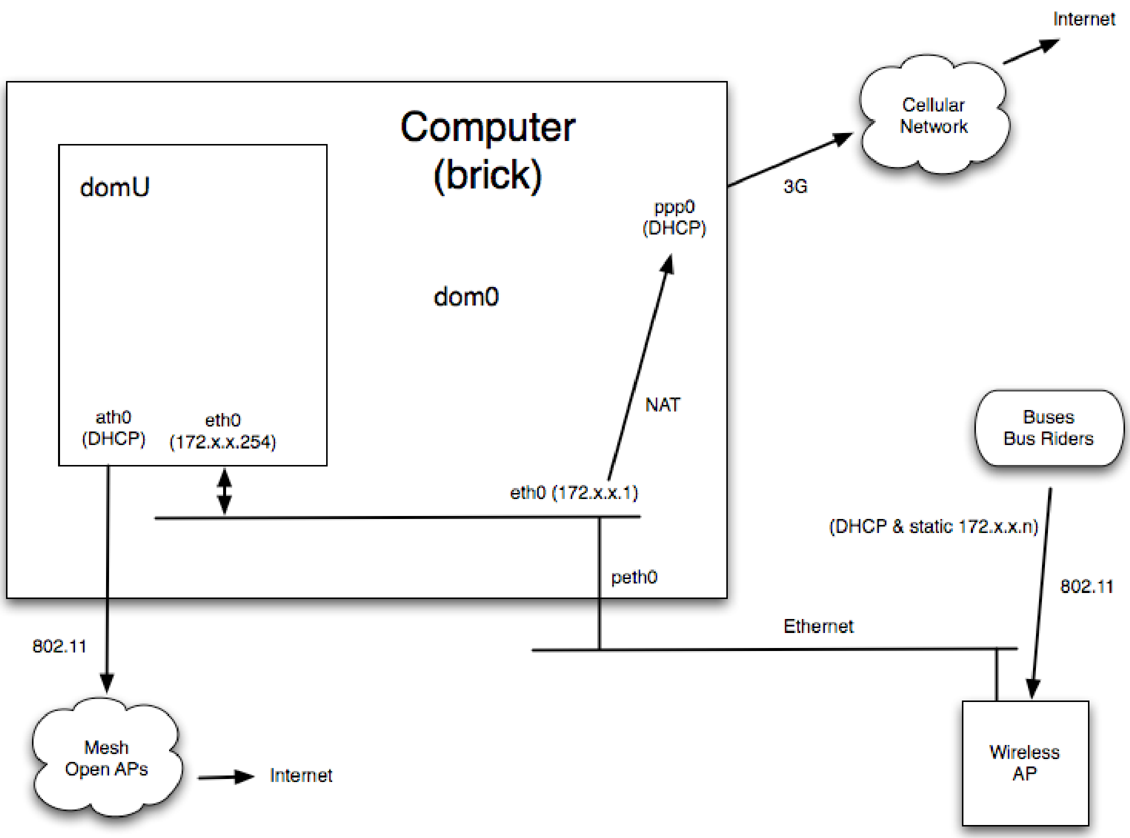

Figure 1: DOME Structure

Project Participants

The project participants have been Brian Levine (PI), Mark Corner (PI), Brian Lynn (engineer).

Publications

- Poster for GEC3: http://prisms.cs.umass.edu/dome/GEC3-poster.pdf
- Presentation for GEC3 http://prisms.cs.umass.edu/dome/GEC3-umass-levine.ppt
- DOME Substrate Catalog: http://groups.geni.net/geni/attachment/wiki/DOME/DOME_SubstrateCatalog.pdf
- Milestone 1a deliverable (see Appendix A).
- Submitted paper to Mobisys 2009.

Outreach Activities

We hired two undergraduate students to work on the maintenance of DOME. We have also made progress in bringing full internet access to bus passengers and we expect to announce that service in the next two months.

Collaborations

Our effort to upgrade the hardware on the buses was done in collaboration with the UMass Pioneer Valley Transit Authority (UMass PVTA). We are in the process of working with the PVTA to introduce Internet connectivity to bus riders, as enabled by the introduction of 3G modems. This hope is that this could lead to GENI user opt-in experiments.

Our new 802.11 Mini PCI cards have access to the UMass wireless network and the Town of Amherst wireless mesh. This was achieved in cooperation with UMass and Amherst IT.

We have also been involved in exploring potential synergies with other GENI projects. In collaboration with the CASA project, we have added software to our buses to record the GPS coordinates and signal strength of locations where the buses are able to see CASA WiFi beacons. This could potentially lead to CASA and DOME interconnectivity.

Additionally, we have provided the hardware configuration and an in-development version of our image to the ORBIT project. The objective is to determine the feasibility of running some of ORBIT software in a VM on our systems.

Appendix A

The following is a copy of the Milestone 1a documentation submitted to the GPO on December 4, 2008.

Overview

This purpose of this document is to summarize the hardware that will be used in the DOME GENI testbed. It also provides the status of DOME Milestone 1a: deploying the required hardware on the buses. This document is intended to fulfill the DOME GENI Milestone 1a documentation requirement.

Status

To support DOME for GENI, two major hardware upgrades to the testbed were required. The first upgrade was to replace the 802.11b USB WiFi dongles, based on a Prisms2 chipset, with an 802.11abg Mini PCI card based on the Atheros AR5413 chipset. This has been completed using Compex WLM54AGP23 WiFi cards. We have also worked with the UMass IT department and the Town of Amherst to ensure continued use of the UMass WiFi network and the Amherst Town WiFi mesh via the new cards. The benefits of this hardware upgrade are: the device can be isolated and accessed in a Xen VM through PCI virtualization; higher throughput using 802.11g versus 802.11b; the addition of 802.11a support; the PCI cards are more reliable than the USB dongles; and the support of a current, widely-used chipset with a large development community and feature-rich (madwifi) driver.

The second upgrade was to migrate the RS232/serial port MultiTech GPRS modems to a 3G solution. We have worked with our cellular service provider to switch to a 3G data plan, and we have acquired Sierra 881U USB modems. The benefit of 3G over GPRS is greater throughput, which is important since the 3G link is the backbone of the experimental control plane. We are currently quantifying the bandwidth improvements of 3G versus GPRS.

All hardware has been installed and deployed on the UMass transit buses. This also required an upgrade of the Linux operating system, and we have re-imaged all hard drives on the buses. Our GENI development system, which will provide the next-generation image for our computers, also supports the new hardware.

Additionally, the new hardware introduced a slightly different antenna configuration on the Gillig buses (there are two bus vendors, requiring separate hardware placement configurations). We have repositioned antennas on all of the Gillig buses.

Hardware

This section summarizes the hardware installed on each of the buses. This also defines the hardware that would be required to reproduce a DOME node for sandbox testing of GENI experiments.

Computer

We use systems with a CI852A motherboard. We have deployed the Hacom OpenBrick-E Intel Celeron-M 1GHz CI852A-4RN10 systems on the buses. Hacom has started to end-of-life these systems, and instead offers the Lex Neo Intel Celeron-M system. These systems use the same motherboard, but have a different case permitting faster (hotter) CPUs. We have verified the Lex Neo with the DOME software. Each computer has:

- CI852A motherboard
    - 400 MHz FSB
    - Intel 82852GM chipset
    - 5 USB (2+2+1) on the OpenBrick, 4 USB (2+2) on the Neo
    - 4 100Mb LAN ports
    - Mini PCI slot
    - Serial port
    - IDE (1 x 40 and 1 x 44 pins)

    - Compact Flash slot
- 1 GHz Intel Celeron M processor
- 1 GB memory (DDR 400)
- 60 GB IDE hard drive

WiFi

Every computer has a Compex WLM54AGP23 Mini PCI WiFi card. This uses the Atheros AR5413 chipset. GENI experiments will have full access to the WiFi card, and by default it will be configured to use the madwifi driver. The driver is very flexible and supports both client and AP configurations. We attach external antennas to these devices. This requires a U.FL to reverse SMA antenna cable. The antenna is a standard WiFi reverse SMA antenna.

There is also a WiFi access point connected to each computer via a LAN port. The AP allows for WiFi connections into the computer. We use off-the-rack APs by various vendors. Examples include the Netgear WGR614, Linksys WRT54GC and Airlink 101 AR335W.

3G Modem

Each bus has a Sierra 881U 3G USB modem. The cellular link is used as the control plane, and it is shared between the VM executing GENI experiments and domain 0. Guest domains will have their eth0 traffic routed though the 3G modem.

Our cellular provider is AT&T. They have a soft cap of 5 GB/month on their 3G service.

Sierra has recently announced plans to end-of-life the 881U. The replacement modem, the Sierra Compass, uses the same driver as the 881U.

GPS Device

Each system has a Deluo USB GPS device attached to it. We use the open source gpsd GPS daemon to share the device with the Xen virtual machine. A benefit of gpsd is that it hides the particulars of the GPS hardware from users.

900 MHz Radios

The buses are equipped with Digi (previously known as MaxSteam) XTend USB RF modems that operate at the proprietary 900MHz frequency. Support for these modems are a Year 2 deliverable.

Bus-Specific Hardware

We have a couple components that are specific to our environment; they are not required to build a DOME system for sandbox development. They are:

- Power transformer for converting the bus's 24V DC battery output to 120V AC to power the computer and peripherals.
- Proprietary UMass microcontroller that we have developed to simulate pressing the power-on button when the buses provide power. We have found the computer's BIOS power-on state to be unreliable.

We also make use of external antennas on the Gillig buses. The mini PCI WiFi cards, APs and XTend radios all use reverse polarity SMP connections. The Sierra 881U USB modems use an SSMB connector.

Hardware Installation

The following diagram illustrates the hardware as installed on the UMass buses.

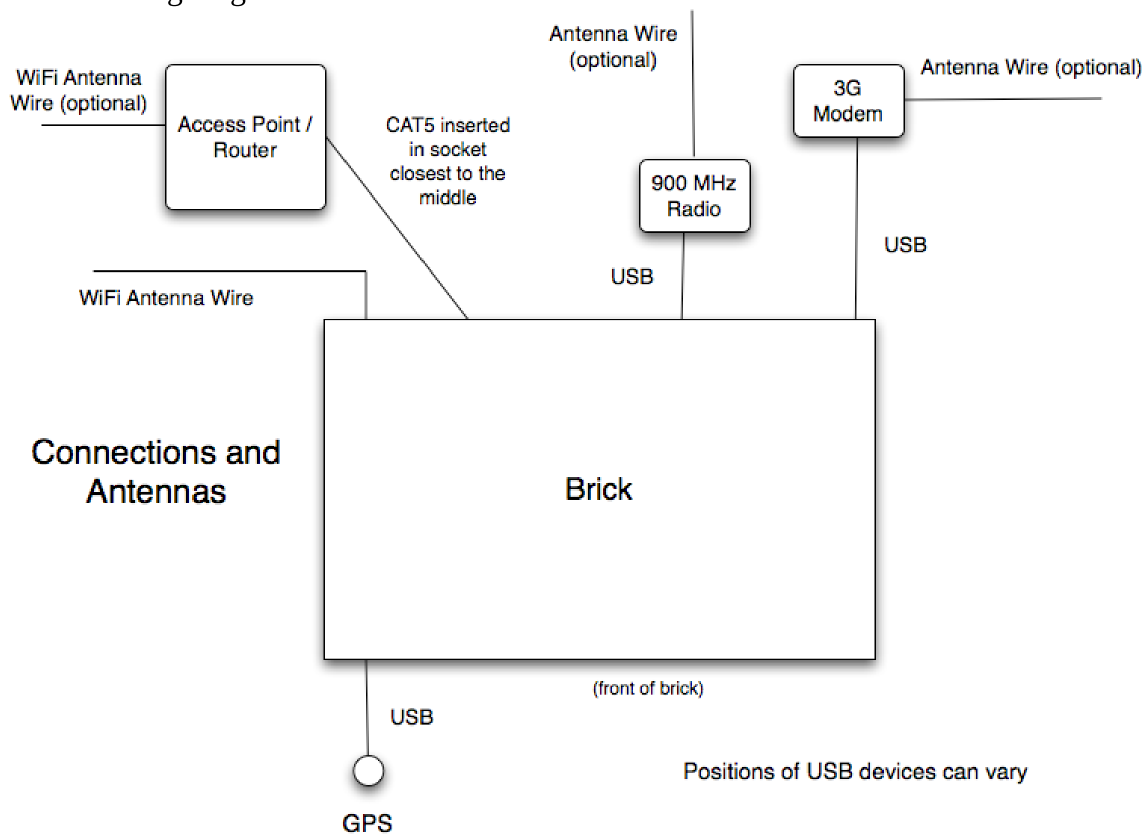

Figure 2: Hardware Installed on Buses