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

Quarterly Status Report, Q2 March 2009

Project Number 1599
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Major Accomplishments

The major accomplishments are highlighted below.

- Completed Milestone 1b on schedule (see below).
- Virtual Machines (VMs) are functional on the DOME hardware (bricks).
- The guest VM has full access to the WiFi.
- The guest VM is able to access to the 3G control plane link.
- The GPS device is accessible by the guest VM.
- A guest logging mechanism was proposed and implemented.
- We have the ability to install, schedule and launch 3rd party experiments on our development bricks (as configured by the web interface).
- A web interface for managing guest experiments was implemented.
- The previous two bullets are backed by a data store, which will be used for future integration with the GENI control framework (in our case, ORCA).
- We will be doing a demo of the above work at GEC4.

See Description of Work below for more details.

Milestones Achieved, Deliverables Made

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

> "Implement, integrate and document the Xen operating system and its virtualization features for your mobile nodes (bricks)."

The deliverable was completed on schedule and the documentation was submitted to the GPO. Source code was made available on our UMass web site. The details are available in the document that we submitted (http://groups.geni.net/geni/wiki/DOME).

Description of Work Performed During Last Quarter, Activities and Findings

The emphasis of our work has been to create the environment for executing 3rd party experiments, and to define an interface for GENI researchers to upload and define experiments. We have made significant progress and will be demonstrating our work at GEC4.

The first phase of our effort was to implement the OS on our bricks as a Xen host domain (dom0), and to support the execution of guest domains (domU). Once completed, we needed to ensure the guest domain had access to the system networking and peripherals. The solutions that we implemented are listed below.

- Ethernet link. This was solved with the support of Xen guest domains, since Xen automatically provides support for virtualization (shared access between dom0 and domU) of Ethernet links. Rather than use DHCP to allocate IP addresses, we have implemented a mechanism to assign static IP addresses so that guest domains have well-known addresses accessible through the WiFI access points (APs) attached to each brick's Ethernet port.
- 3G link. The 3G link is used as the DOME control plane. We have chosen to make the link sharable between dom0 and domU by implementing NAT routing of domU Ethernet traffic. By making the control plane link available to domU, the guest domain has access to a relatively reliable link (about 90% connectivity). Furthermore, this link can enable guest domains to offer opt-in experiment involving transit passengers.
- Atheros WiFi PCI device. We have chosen to hide the PCI address from dom0, making it visible only to the guest domain. This means the guest domain has full, native access to the WiFi device. All features of the Atheros WiFi card and madwifi driver are available to the guest domain. The guest domain may even install customized a device driver.
- GPS device. We run a gpsd daemon in dom0 that can be accessed from the guest domain (directly, or via the libgps library).

The second phase of our work was to implement the ability for guest VMs to be installed, scheduled and launched on bricks. To achieve this, we implemented the following.

- A database schema was created that defined the following objects and the relations between those objects: users (GENI researches, UMass members of the DOME community), files (VM partitions), experiments (one or more partitions and the associated resources, such as the WiFi device), and instances of experiments (the scheduling of experiments).
- A set of server-side scripts was developed to enable bricks to access the DB and retrieve files from the servers.
- Programs were developed to mange the critical tasks on the bricks.
    - dome_pullexperiments: This is a daemon that downloads experiments (i.e., all required files) from a server to a brick. The daemon is designed to deal with the DOME disruptive environment of network disconnections and the powering-down of equipment. Files are downloaded in chunks and progress is checkpointed so that events can be resumed from a known

state. The daemon prioritizes downloads based on schedules, and performs garbage collection when disk space becomes a concern.
- dome_getexpschedules: This is the daemon that is responsible for making the experiment schedules available to the bricks.
- dome_cleanexperiments: This is the daemon responsible for safely removing deprecated experiments from the bricks.
- dome_runexp: This is the program that is responsible for launching a guest VM on the brick. It uses input from dome_pullexperiments and dome_getexpschedules to determine the VM to launch. Dome_runexp will create the partitions required by the VM, configure the networking, and make critical information available to the VM. See the Milestone 1b documentation for more information.
- Additionally, various utilities (dome_getexpired, dome_killdomu, dome_vmrunning, dome_getrunning) were implemented to monitor the status of guest VMs, and to shutdown VMs.

The above is progress toward our next two milestones.

Additionally, we have implemented a mechanism for 3rd party experiments (guest VMs) to generate log files, and for the content of the log files to be asynchronously uploaded to arbitrary servers (i.e., sent to user-defined destinations by dom0 when the guest domain is not executing). See the Milestone 1b documentation for more information.

Finally, we have implemented the web interface for: uploading files to a server so that they can be staged for installation on buses; defining experiments; and scheduling experiments. This will be shown at GEC4. This effort and the work defined above are intended to be the foundation for integration with ORCA.

See Appendix A for a diagram of the bricks, devices and software.

Project Participants

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

Outreach Activities

We have two part-time undergraduate students working on the systems deployed on the DOME buses. We have also officially deployed Internet access to bus passengers using DOME hardware.

Collaborations

Our effort to provide Internet access to bus riders was done in collaboration with the UMass Pioneer Valley Transit Authority (UMass PVTA). This hope is that this could lead to GENI user opt-in experiments

We continue to work with UMass OIT and the Town of Amherst in order to have access to the campus and town WiFi networks. Equipment for the town's WiFi mesh was provided by the DOME project.

Appendix A