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

Milestones 1c and 1d Status and Documentation

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Project Number 1599
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Status

Milestone 1c: Implement, integrate and document virtualized access to the WiFi radio, for your mobile nodes.

Status: Completed. The virtual environment is functional with access to WiFi, 3G, Ethernet and the GPS.

Milestone 1d: Import and setup a GENI-compliant control framework based on ORCA, from the "…Prototype GENI Control Plane (ORCA)…" project (project 1582).

Status: Completed. We have set up ORCA. We have also implemented controllers and handlers for DOME, and we have integrated the DOME portal with ORCA.

Milestone 1c Implementation and Documentation

The DOME control plane and devices under the control of DOME execute in Xen domain 0 on a DOME mobile computer "brick" (Figure 1). GENI experiments will execute within a Xen domU guest domain. The experiments require access to the brick's resources: WiFi, 3G, Ethernet and GPS. Below we document how each resource is provided to the guest domain.
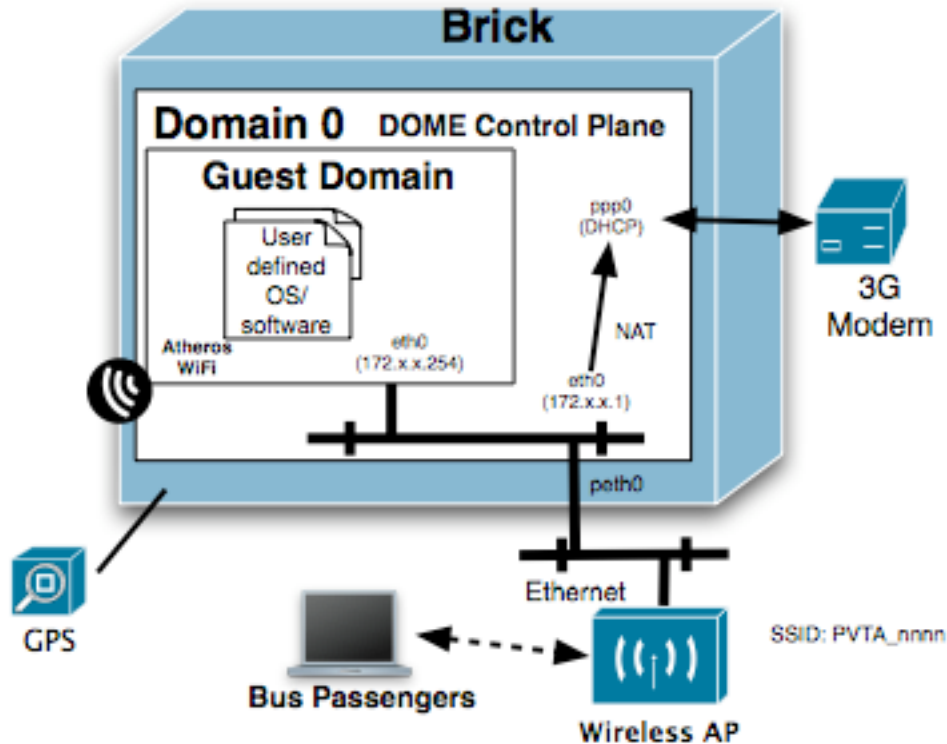
Figure 1: A DOME Brick

WiFi

There are two WiFi devices connected to a brick: an Atheros WiFi card and a WiFi access point. In this section we discuss the Atheros WiFi card. The Atheros card is a Compex WLM54AGP23 Mini PCI card (see the Milestone 1a documentation for more details on the DOME hardware). The Atheros card is not implemented as a shared device; instead, the domU guest domain has exclusive access to the device. This allows GENI experiments to have complete control over the WiFi link: choosing which SSIDs to permit or blacklist, determining when to associate with APs and when to disconnect, deciding on the protocol and transmission speed (802.11 a/b/g), and deciding priorities for connecting to buses versus organic APs or the town and UMass meshes.

To provide virtualized access to the WiFi card we have taken advantage of Xen's PCI pass-through capability, which yields control of a PCI device to a guest domain. The WiFi card and PCI slot are hidden from domain 0; the GENI experiment guest domain runs the native driver and has full access to the device.

The default guest virtual machine boots with the MadWifi driver (see http://madwifi-project.org). This is an open source driver with a closed source hardware abstraction layer (HAL). Alternatives exist, such as the "new" MadWifi driver with OpenHAL (ath5k). A GENI researcher can install an alternative driver, or even implement his or her own driver. The Atheros chipsets are very feature rich, and the supplied MadWifi driver

supports a broad range of advanced features and configuration options. Additionally, the Atheros card can be used as an access point as well as behave as a WiFi client. Documentation for using WiFi with the MadWifi driver is available at http://madwifi-project.org/wiki/UserDocs/UsersGuide. Because we use PCI pass-through, the WiFi interface available in the guest domain is the same as it would be in a non-virtualized environment.

Also installed in the default GENI guest domain are the Wireless Tools for Linux. These support the Atheros card with the MadWifi driver. Documentation is available at http://www.hpl.hp.com/personal/Jean_Tourrilhes/Linux/Tools.html.

Since the guest domain has direct and exclusive access to the driver, a GENI experiment could implement layer 2 access to the Atheros card.

Customization of the GENI guest domain's operating system is supported by DOME. Figure 2 shows a screen shot from the DOME portal. Researchers can submit disk partitions that are mounted by the guest domain. A "user partition" is required; it contains the experiments that will be run within the domain. The other type of partition -- which is optional -- is a root partition, containing the kernel and OS modules. A researcher could, for example, replace the MadWifi modules with a custom version.
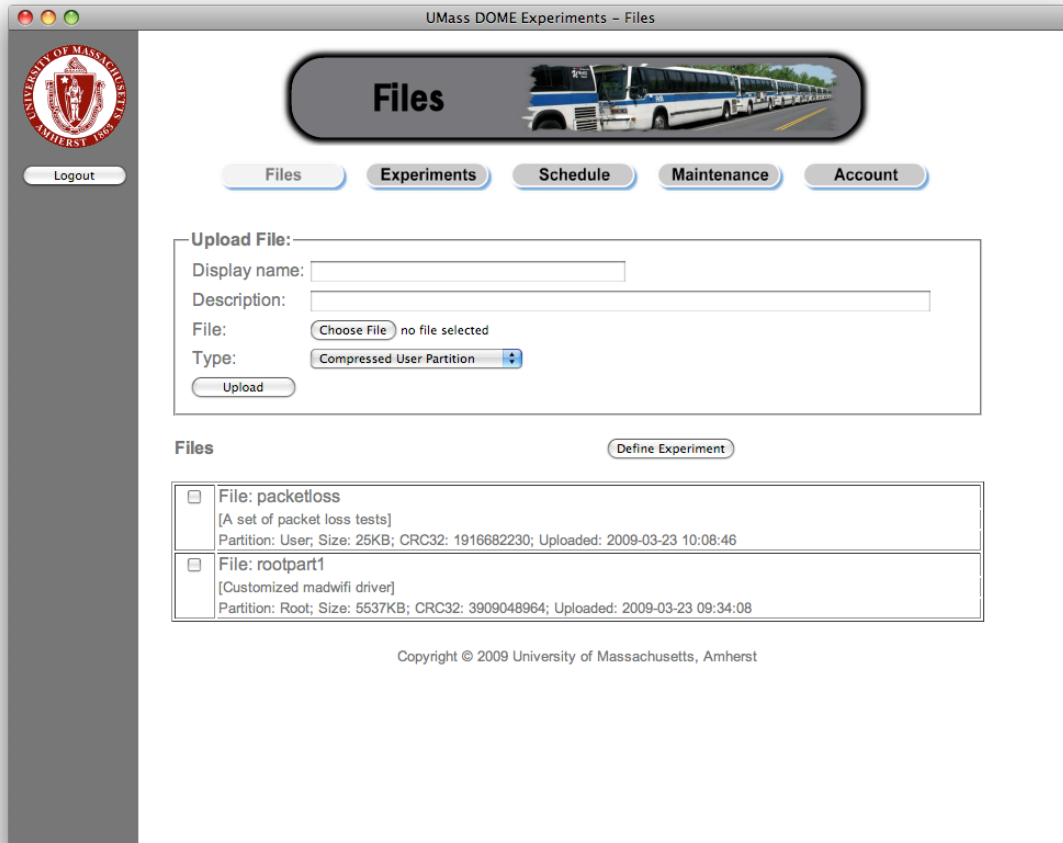
Figure 2: DOME Portal

WiFi Access Point

The bricks have WiFi access points attached to their LAN ports. A user or another bus (i.e. an Atheros WiFi card on another brick) can associate with the access point and establish communication with the GENI guest domain. A file named /domeinfo/ssidmap is available to each executing experiment, identifying the SSIDs of all DOME buses and providing their IP addresses.

The access points are closed, off the shelf devices. Therefore, only layer 3 access is provided. However, as noted above, the Atheros cards can also be used as access points.

Ethernet

Xen virtualizes the Ethernet port on the bricks. Xen bridges the domains' logical Ethernet devices to the physical LAN port, routing packets by the 802.11 MAC address. To prevent IP address collisions, DOME implements a scheme to ensure all bricks use a different IP subnet. DOME makes Ethernet information available to the guest domain in

file /domeinfo/eth0_subnet. More information on address allocation is provided in the Milestone 1b documentation.

3G Modem

The 3G modem provides the control plane to DOME and the GENI experiments. The device is used to provide Internet access when coverage is available. The 3G modem is visible to and controlled by domain 0. The GENI guest domain has access to the 3G modem's Internet connection via its Ethernet interface. DOME configures domain 0 networking so that it NATs the guest domain's traffic through the 3G modem.

GPS

Domain 0 executes a GPS daemon (gpsd) that continually reads sentences from the GPS device. The GENI guest domain can connect to the daemon and get access to GPS coordinates, or even the raw sentences. Documentation is available at http://linux.die.net/man/8/gpsd and http://linux.die.net/man/3/libgps.

Milestone 1d Implementation and Documentation

We have built and installed the version of ORCA released by RENCI on April 8, 2009. We have also implemented software to allow DOME to integrate with ORCA.

DieselNet Controller

The DieselNet controller receives requests for leases and submits the requests to ORCA for processing. The controller is loaded into ORCA as a package. Upon initialization, it listens for XML-RPC messages requesting leases. The DOME portal invokes those XML-RPC methods. A discussion of the controller, along with a more detailed description, can be found at http://groups.geni.net/geni/wiki/DOMEControllerModule.

DieselNet Handler

The DieselNet handler is a pair of Ant tasks that are invoked by ORCA when a lease begins or terminates. The Ant tasks call DOME XML-RPC routines, which implement the DOME-specific functions for managing leases. The DieselNet handler is built into the ORCA tomcat war. A description of the handler can be found at http://groups.geni.net/geni/wiki/DOMEControllerModule.

DOME Portal

We have added support for ORCA to DOME, including integration with the DOME portal. When a researcher uses the portal to schedule an experiment (Figure 3), DOME makes a request to the DieselNet controller for a lease. When the lease begins, DOME is notified by ORCA. Bricks will periodically query the portal, and upon learning of the

lease they will launch the appropriate GENI guest domain. When the lease expires, ORCA will again notify the portal and the bricks will terminate the experiment.
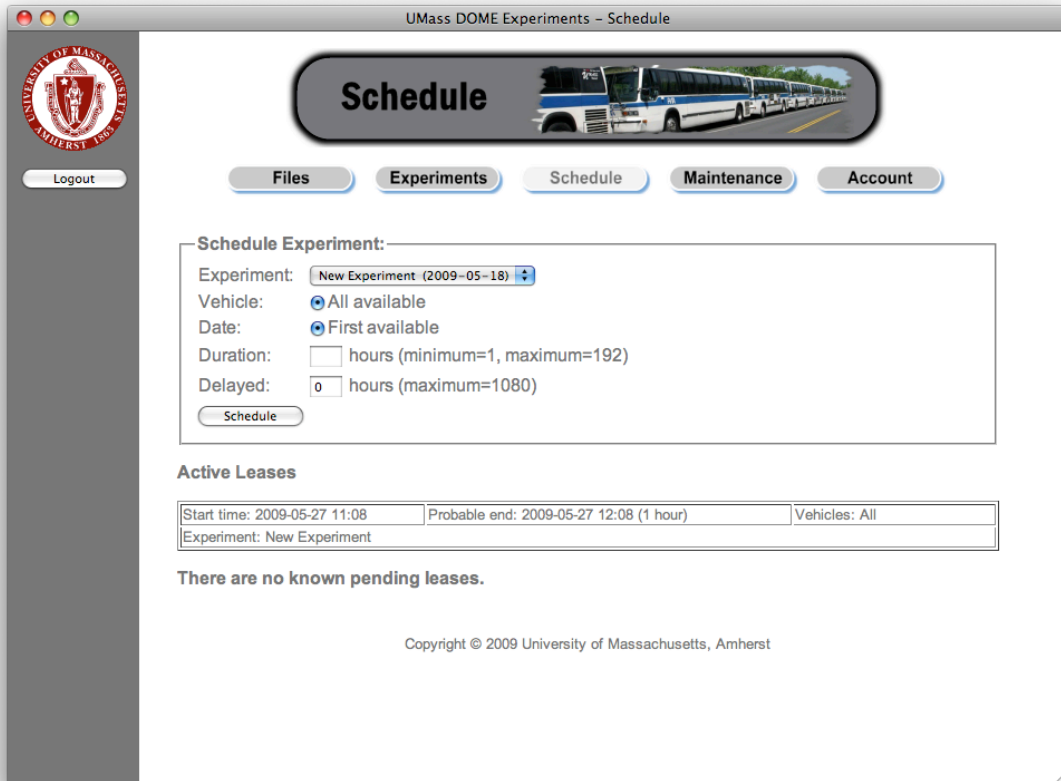

Figure 3: DOME Portal and ORCA