GENI and ORBIT
Experimental Infrastructure Projects

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Cluster E: ORBIT

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WiMAX Virtualization
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Meso-scale Deployments

WiMAX: Rutgers, Stanford, Brooklyn Poly, UMass, Columbia, UCLA, UWisconsin-Madison, Ucolorado

OpenFlow: Stanford, Rutgers, Clemson, Georgia Tech, Indiana, UWisconsin-Madison, UWashington, Princeton
Spiral I Project: Orbit Management Framework

- Mature testbed control framework (more than 6 years old)
- Currently @ version 5.2:
  - Full pub/sub implementation (xmpp) for control management
  - Multiple simultaneous experiment support
  - Disconnected operation support
  - New aggregate managers (WiMAX, Cognitive radio, ION)
  - Extended to support multiple heterogeneous testbeds
OMF 5.2 Disconnected Operation

- Supports disruption-free experiments when control network coverage is not available
- Allows for disconnected experiment control and data collection
- Measurement results are stored on disconnected nodes and retrieved back to the central measurement database upon reconnection
OMF 5.2: Controlling Mobile Experiments with Spatial and Temporal Triggers

- Provides spatial and temporal control on the experiments e.g., executes commands when:
  - Vehicle passes a certain region of the highway
  - 15s after vehicle enters into parking lot
  - Five nodes are within ½ mile radius

- Implemented through feedback loop using GPS on mobile nodes

- Current implementation allows specifying trip-lines on Google Maps and creates trip-line coordinates for experiment script
  - Experiment script binds trip-lines to commands
  - GPS updates are matched with these trigger commands
Orbit Measurement Library (OML) 2

- Push based architecture
- All experiment data in one place – including metadata
- Separation of concerns
  - Instrumentation
  - Collection
- Minimize collection overhead
  - Application CPU time
  - Experimental traffic interference
- Proxy server for disconnected operation
OML2 Client + Server

Application or Service

Measurement points

Filters

Measurement streams

OML Server

Database (SQL)

Database tables

File

OML client library
Where is OMF currently used?

- Rutgers University, New Jersey
- INRIA, France
- University of Thessaly
- Thomson Lab
- Alcatel-Lucent
- GENI
- PlanetLab (early integration)
- NICTA, Sydney
New in OMF 5.3

- Federation of OMF Control tools with PlanetLab
  - New OMF packages for Fedora distribution
- General naming scheme
  - Replaces previous coordinate-based scheme to identify resources on any testbed
- New user-definable event-driven mechanisms (defEvent) enables measurement driven (steered) experiments
- New support for Netem-based traffic shaping on resources
- Architectural support for virtualisation (separation of RM and RC)
- New post-install configuration script to simplify OMF deployment
- Misc:
  - Improved Documentation
  - Refactoring/cleanup of code
  - Aggregate Manager services now support Publish/Subscribe communication
  - Many bug fixes
- Target Release date: End of July 2010
  - Track: http://tiny.cc/omf-5-3
- Experimenters include the cellular-like system as a part of their experiments
- Backbone is time shared ..so.. How do we share the BTS?
Coverage map of the WiMAX BaseStation
WiMAX Virtualization: Prototype Architecture

Outdoor Network

Internal Network

vBTS Substrate

ASN Substrate

Base Station (BTS)

Outside Bus (Trunk)

VM Bus (Trunk)

Instrumentation Network

Outside World
Spiral II project: CR kit

Open Source Platform

- Range of COTS baseband FPGA platforms
  - Medium size (LX50)
  - Large size (SX95)

- Standard interfaces:
  - 1000 BaseT, (SFP)
  - USB
  - (8x PCIExpress)

- 4 (2) configurable radio modules for phased or smart antenna applications:
  - SDR – 25 MHz, ISM
  - WDR – 25 MHz, 0-7 GHz
  - XDR – 500 MHz, 0-7 GHz

- Application framework with support for both RTL and Matlab (Simulink)
Each module allows two 25 MHz bands from 30 to 8000 MHz
- 50/80 MSps 12bit A/D converter.
- 200MSps 12bit D/A converter.
- 1 usec RF frequency switching time

99 x 99 mm, double sided 12 layer PCB, Rogers 4350B high-frequency material

Supports full duplex operation.
Switched antenna diversity for both TX and RX channels
CR Kit Software Architecture
MESO-SCALE DEPLOYMENTS
WiMAX Meso-scale Deployments

Figure 1. WiMAX campus buildout.
OF Meso-scale Deployments: Rutgers

LEGEND:
- OpenFlow Enabled Switch
- OpenFlow Enabled Router
- Access Router (not OF)

Rutgers Core Network

NetFPGA Busch Campus

NetFPGA Cook Campus

1.) SB9
   - GENI Open Base Station (WiMax)
   - Outdoor ORBIT
   - Outdoor RU Wireless

2.) ORBIT Grid
   - GENI Open Base Station (WiMax)
   - Outdoor ORBIT
   - Outdoor Wireless

3.) Rutgers Outdoor Network

4.) Rutgers Outdoor Network

L3 → L2

L2

To MEGP1 PoP (Philadelphia)

IP8800

sw-out06.orbit-lab.org

sw-out-top.orbit-lab.org

sw-sb09.orbit-lab.org

sw-co-top.orbit-lab.org
ION: ORBIT I2 Connectivity
ION Performance

60 sec. transfer size [MB] vs. Dialed bandwidth [Mbps]

- TCP
- UDP

Data points:
- 333 MB at 665 Mbps
- 325 MB at 638 Mbps
- 1331.2 MB at 1228.8 Mbps
- 2918.4 MB at 2918.4 Mbps
- 5519.36 MB at 5519.36 Mbps
- 5775.36 MB at 1000 Mbps