Wireless Research with GENI:
Cooperative Packet Recovery in Heterogeneous Networks Track

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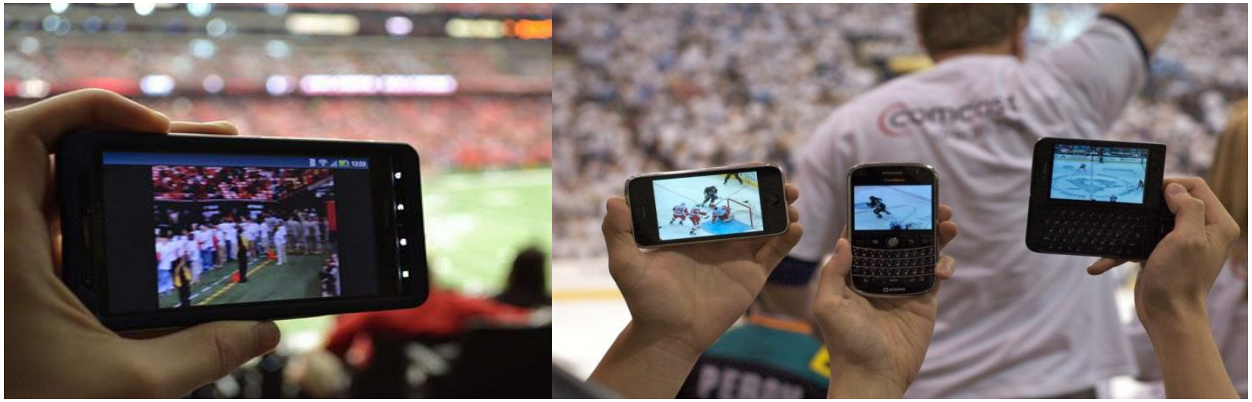
Scenario

- Stadiums, etc. may offer participants at sporting events the opportunity to view a live feed on their phones
- The broadcast must be at a low rate, since some users have poor channel conditions



Scenario

- We have implemented a cooperative recovery protocol in which the live feed is streamed at a high rate over the primary (WiMAX) network, and clients form a secondary (WiFi) network to recover lost packets from each other.

What physical and computing resources are required to evaluate this implementation?

Required Resources

- Physically distributed devices with two radios (WiFi and cellular data),
- and some packet loss over the cellular data network.

Optional Resources

- A way to set up and orchestrate complicated experiments with many parts
- Full control over all parts of the experiment, including nodes and all communication links
- Instrumentation and measurement tools for systematically collecting and comparing results

Experiment Topology

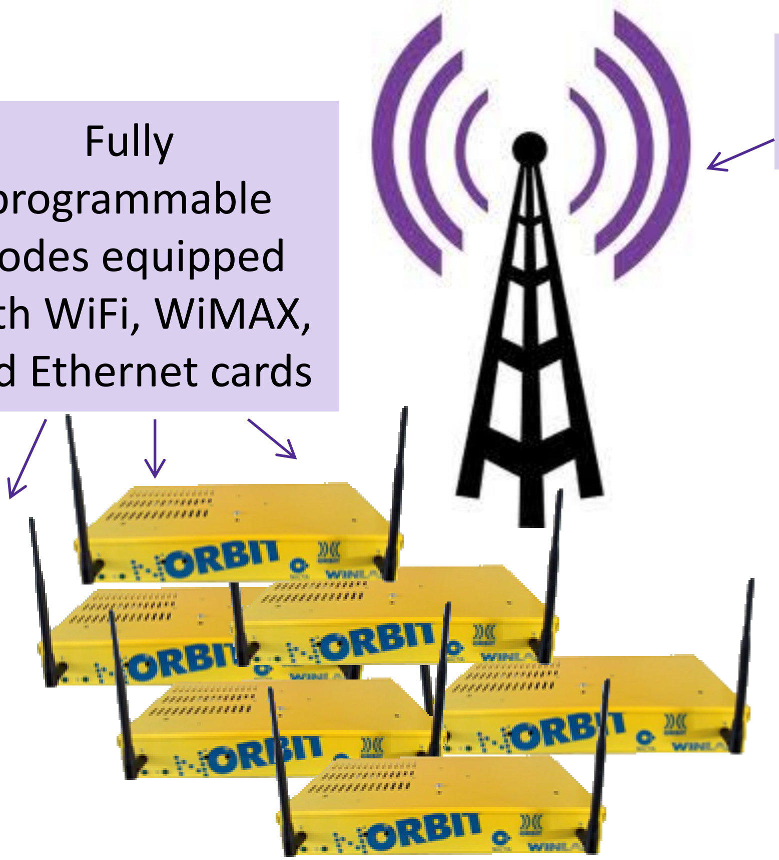
- Use nodes on *outdoor* which have WiFi, WiMAX, and Ethernet interfaces

Pro tip: See more information about the different kinds of nodes available

- at NYU-Poly http://witestlab.poly.edu/index.php/instructions.html
- at WINLAB http://www.orbit-lab.org/status/orbit/

- One node will broadcast over Ethernet, six others will receive over WiMAX
- Run cooperative recovery layer on WiFi on receiver nodes
- Run *iperf* on top of this layer to test recovery

Experiment Topology, Illustrated



Fully programmable nodes equipped with WiFi, WiMAX, and Ethernet cards

Configurable WiMAX Base Station

Experiment

Does this experiment topology meet the requirements?

✓ Physically distributed devices with two radios (WiFi and cellular data) and some packet loss over the cellular data network.

and also

✓ Full control over all parts of the experiment, including nodes and all communication links

Accessing a GENI WiMAX Testbed

- Register for an account and make a reservation to use a testbed ahead of time

Pro tip: Two WiMAX testbeds are currently open to experimenters.

- To register at NYU-Poly, visit http://witestlab.poly.edu and click “Register” in the top left corner – you’ll get an email later than day with further instructions.
- To register at WINLAB, visit http://www.orbit-lab.org/userManagement/register

- At the designated time, use an SSH client to log in to the console of a WiMAX testbed, e.g.
    - `ssh ffund@omfserver-witest.poly.edu`

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Setting up Experiment

- Reset base station to default settings

```
wget -qO- http://wimaxrf:5052/wimaxrf/bs/default
```

- Configure datapath (connectivity endpoints) for WiMAX clients

```
wget -qO- “http://wimaxrf:5052/wimaxrf/datapath/config/load?name=ffund”
```

Pro tip: See more information about the pre-configured datapath options available at NYU-Poly at http://witestlab.poly.edu/index.php/instructions.html

- Make necessary changes to BS configuration

```
wget -qO- “http://wimaxrf:5052/wimaxrf/bs/set?bs_tx_power=35”
wget -qO- http://wimaxrf:5052/wimaxrf/bs/restart
```

Setting up Experiment (cont.)

- Install disk images
  - `omf-5.3 load -i <image name> -t <list of nodes>`
  - We started with a baseline image that already has WiMAX drivers
  - (Images are provided by testbed operators at each testbed)
  - Then, I installed the cooperative recovery layer and its dependencies, and saved a disk image using `omf-5.3 save -n <node name>`
  - From now on, I can just load this saved image onto my nodes at the beginning of every session – no need to set it all up every time

Pro tip: See more information about the prepared baseline images for NYU-Poly at http://witestlab.poly.edu/index.php/instructions.html

Setting up Experiment (cont.)

- Install disk images

  -
    ```
    omf-5.3 load -i coop-recv.ndz -t node1-1.outdoor.orbit-lab.org,node1-2.outdoor.orbit-lab.org,node1-3.outdoor.orbit-lab.org,node1-4.outdoor.orbit-lab.org,node1-5.outdoor.orbit-lab.org,node1-8.outdoor.orbit-lab.org
    ```

  -
    ```
    omf-5.3 load -i coop-send.ndz -t node1-7.outdoor.orbit-lab.org
    ```

Experiment: Sequence of Events

- Steps (at each node) to run experiment:

  ```
  ssh root@node1-1.outdoor.orbit-lab.org
  wimaxcu connect network 51
  ifconfig wmx0 10.43.100.1 netmask 255.255.0.0
  modprobe ath9k
  iwconfig wlan0 mode ad-hoc channel 3 essid coopshim
  ifconfig wlan0 192.168.0.1 netmask 255.255.255.0
  ifconfig wlan0 up
  iwconfig wlan0
  /root/coopshim/coopexp.py
  iperf -s -u -i 1 -p 12345
  ```

- Repeat for each of receiver nodes… and a similar, but separate, procedure for the broadcaster

Experiment: Sequence of Events

- To save time, we can use OMF to configure the receivers…

```
  info "Group Sender #{i}: '#{senders}'"
  groupList << "Sender#{i}"
  defGroup("Sender#{i}", senders) do |node|
    node.net.x0.profile = '51'
    node.net.x0.ip = '10.43.100.%y%'
    node.net.x0.netmask = "255.255.0.0"
    node.net.w0.mode = "adhoc"
    node.net.w0.type = 'g'
    node.net.w0.channel = "6"
    node.net.w0.essid = "coop"
    node.net.w0.ip = "192.168.0.%y%"
    node.net.w0.netmask = "255.255.255.0"
    node.addApplication("wimaxcu_app") do |app|
      app.measure('status_link')
    end
    node.addApplication("test:app:iperf-old") do |app|
      app.setProperty('udp', true)
      app.setProperty('server', true)
      app.setProperty('port', 12345)
      app.setProperty('interval', 1)
      app.measure('UDP_Rich_Info', :samples =>1)
    end
  end
end
```

Set up WiMAX connectivity

Set up WiFi connectivity

Configure provided application for measuring WiMAX signal strength

Configure *iperf* application

Experiment: Sequence of Events

- …the broadcaster…

```
defGroup("Broadcaster", "node1-7.outdoor.orbit-lab.org") do |node|
  node.net.e0.ip = '10.43.160.%y%'
  node.net.e0.netmask = "255.255.0.0"
  node.addApplication("test:app:iperf-old") do |app|
    app.setProperty('udp', true)
    app.setProperty('client', '10.43.160.%y%')
    app.setProperty('len', 1400)
    app.setProperty('bandwidth', '100k')
    app.setProperty('port', 34567)
    app.setProperty('time', property.duration)
    app.setProperty('interval', 1)
    app.measure('UDP_Periodic_Info', :samples =>1)
  end
end
```

Set up Ethernet connectivity

Configure *iperf* application

- … and the experiment’s sequence of events

```
onEvent(:ALL_UP_AND_INSTALLED) do |event|
  wait 25
  allGroups.exec("/root/coopshim/coopexp.py")
  wait 10
  allGroups.startApplications
  wait property.duration
  wait 10
  allGroups.stopApplications
  Experiment.done
end
```

Experiment: Sequence of Events

- After writing two scripts (one for the cooperative recovery case and one without, for comparison,) I can run this experiment as many times as I want with a simple command:

```
omf-5.3 exec coop.rb
omf-5.3 exec nocoop.rb
```

Experiment: I&M

- The OML-enabled *iperf* and *wmstat* applications save measurements in a database, so I don’t need to worry about capturing the results.

- I can retrieve these measurements as an *sq3* or *csv* anytime after the experiment runs, and plot them using standard data analysis tools like *gnuplot* or *R*.

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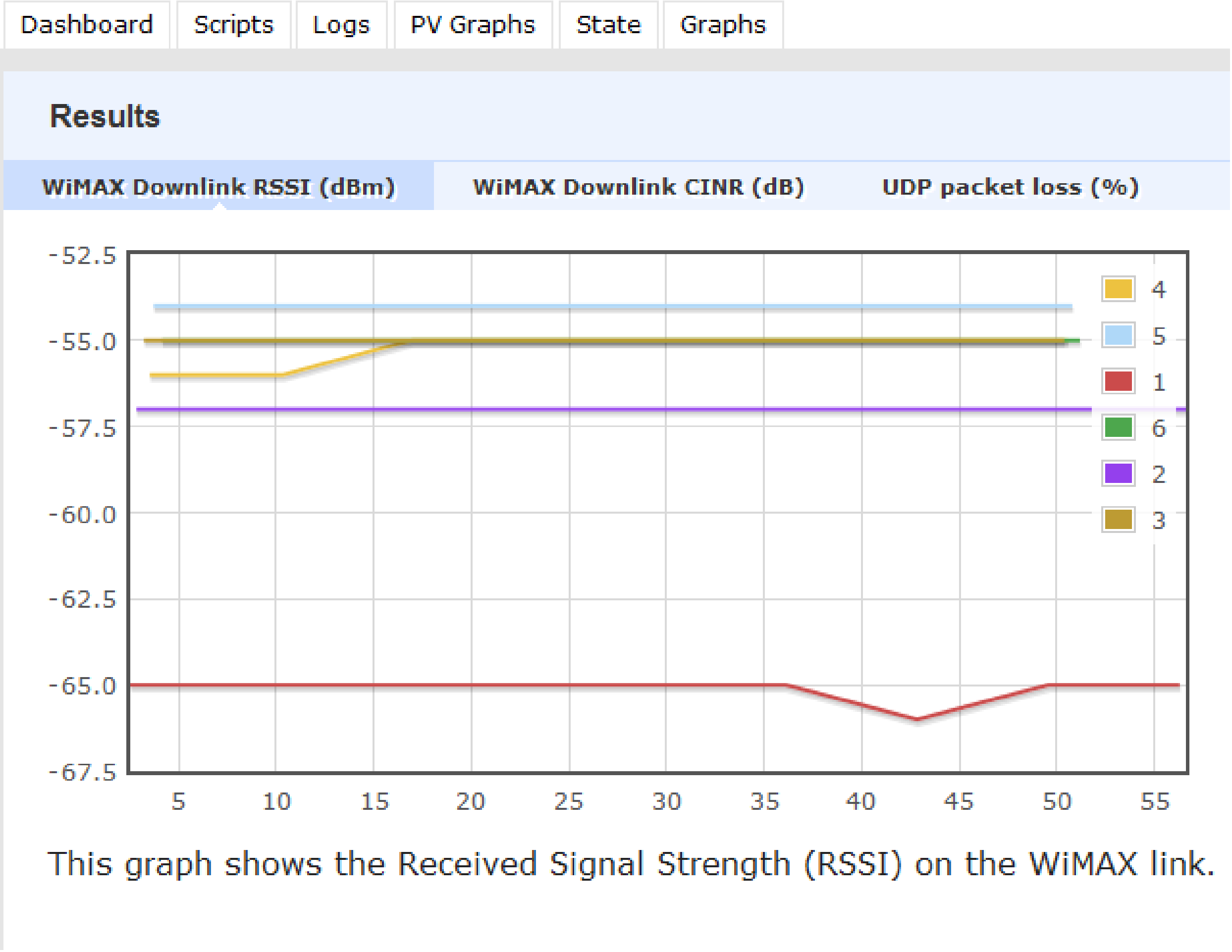
Experiment: I&M

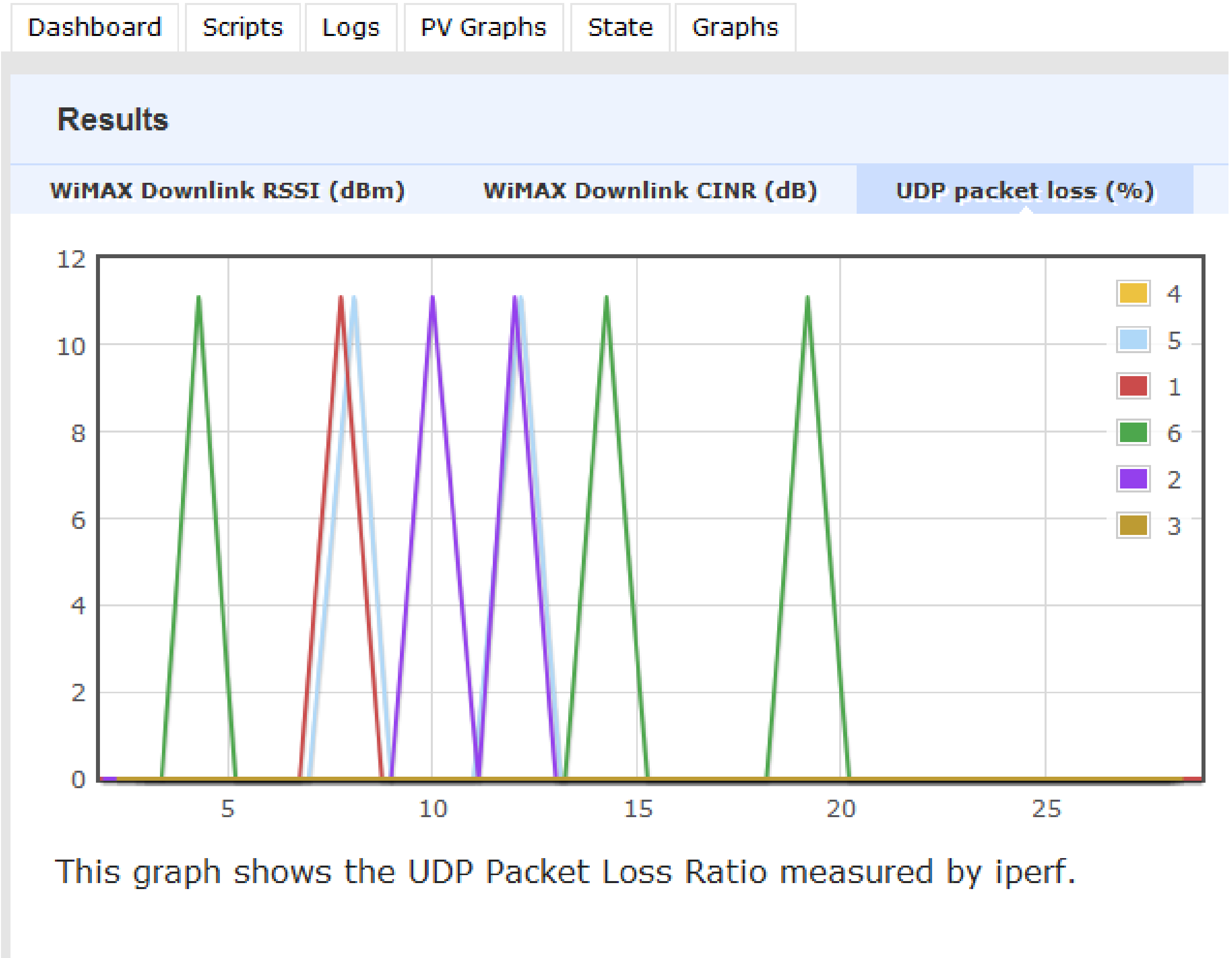
- If we configure graphs in the experiment script, we can view the visualization live and check on progress during the experiment



This graph shows the Received Signal Strength (RSSI) on the WiMAX link.

Experiment: I&M

Pro tip: Click on “Logs” to see the console output and “Scripts” to see the experiment script.



Results

This graph shows the UDP Packet Loss Ratio measured by iperf.

Experiment – with OMF

What useful functionality do we gain from using OMF? At what cost?

- ✓ A way to set up and orchestrate complicated experiments with many parts
- ✓ Instrumentation and measurement tools for systematically collecting and comparing results

Discussion

Questions?

(Someone will explain this experiment to the other groups –approximately 2 minutes)

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