# Wireless Research with GENI: Wireless 101 Lab Track

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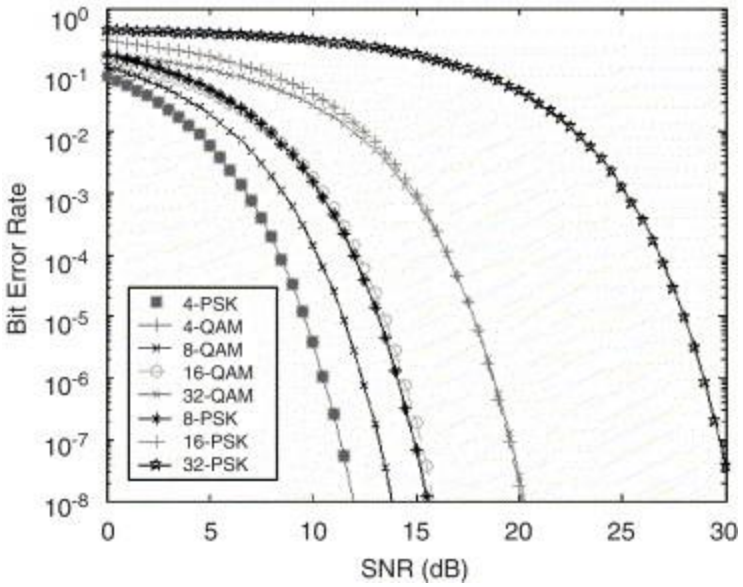
# Scenario

Communication Theory class learns these bit error rate (BER) versus signal to noise ratio (SNR) curves for different modulation and coding schemes (MCS).

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# Scenario

- Their professor wants to offer them an opportunity to learn the same concept in a hands-on lab-based setting.

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

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# Required Resources

- Devices with some kind of wireless broadband connection,
- with a high degree of configurability at the device and at the base station.

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# 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

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# Experiment Topology

- Use nodes on *sb4* which has its own WiMAX base station and variable RF attenuation between the BS and the nodes

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/

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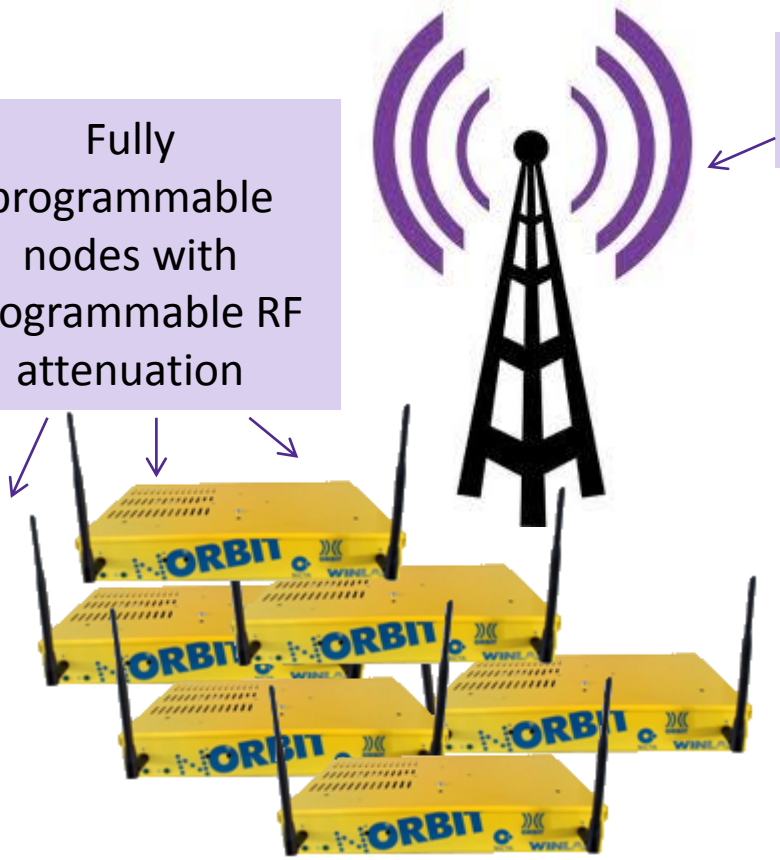
# Experiment Topology, Illustrated

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# Experiment

*Does this experiment topology meet the requirements?*

- ✓ Devices with some kind of wireless broadband connection,
- ✓ with a high degree of configurability at the device and at the base station.

and also

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

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# 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 (old BS)
  - `wget -qO- http://wimaxrf:5052/wimaxrf/defaults`
  - `wget -qO- http://wimaxrf:5052/wimaxrf/restart`
- Configure datapath (connectivity endpoints) for WiMAX clients

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

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# 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)
  - I installed an application for monitoring WiMAX signal, 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
  - `omf-5.3 load -i mcs-lab.ndz -t node1-2.sb4.orbit-lab.org,node1-1.sb4.orbit-lab.org`

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

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# Experiment: Sequence of Events

- Steps to run experiment (receiver):
  - `ssh root@node1-1.sb4.orbit-lab.org`
  - `wimaxcu connect network 51`
  - `ifconfig wmx0 10.41.14.1 netmask 255.255.0.0`
  - `iperf –s –u –i 1`
- Similar procedure at sender
- Meanwhile, simultaneously vary attenuation at regular intervals:
  - `wget –qO- "http://internal2dmz.orbit-lab.org:5052/instr/setportA=1\&portB=9\&att=0”`
  - …every 3 seconds

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# Experiment: Sequence of Events

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

```
  defGroup('sender', "#{property.prefix}#{property.res1}#{property.suffix}") do |node|
  node.net.x0.profile = '51'
  node.net.x0.ip = "10.41.14.#{property.res1}"
  node.net.x0.netmask = "255.255.255.0"
  node.addApplication("test:app:wimaxcu_app") do |app|
    app.measure('status_link')
  end
  node.addApplication("test:app:iperf") do |app|
    app.setProperty('udp', true)
    app.setProperty('client', "10.41.14.#{property.res2}")
    app.setProperty('interval', 1)
    app.setProperty('len', 1400)
    app.setProperty('bandwidth', 1000000)
    app.setProperty('time', 45)
    app.measure('UDP_Periodic_Info', :samples =>1)
  end
end
```

Set up WiMAX connectivity

Configure provided application for measuring WiMAX signal strength

Configure *iperf* application

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# Experiment: Sequence of Events

- …and the experiment's sequence of events

```
onEvent(:ALL_UP_AND_INSTALLED) do |event|
  system("/usr/bin/wget -qO- #{property.noMCS}")
  wait 10
  allGroups.startApplications
  system("/usr/bin/wget -qO- #{property.mcsUrl}#{property.dlMCS}")
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res1}\&portB=9\&att=0")
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=0")
  wait 5
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=3")
  wait 5
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=6")
  wait 5
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=9")
  wait 5
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=12")
  wait 5
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=15")
  wait 5
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=18")
  wait 5
  system("/usr/bin/wget -qO- #{property.attUrl}portA=#{property.res2}\&portB=9\&att=21")
  wait 5
  wait 5
  allGroups.stopApplications
  #system("/usr/bin/wget -qO- #{property.mcsUrl}13,15,16,17,18,19,20,21")
  wait 5
  Experiment.done
end
```

# Experiment: Sequence of Events

- After writing the script, students can run it with a simple command:

```
omf-5.3 exec mcs-lab.rb
```

Vary the MCS used by passing it to the experiment as a variable

```
omf-5.3 exec mcs-lab.rb -- --dlMCS 21
```

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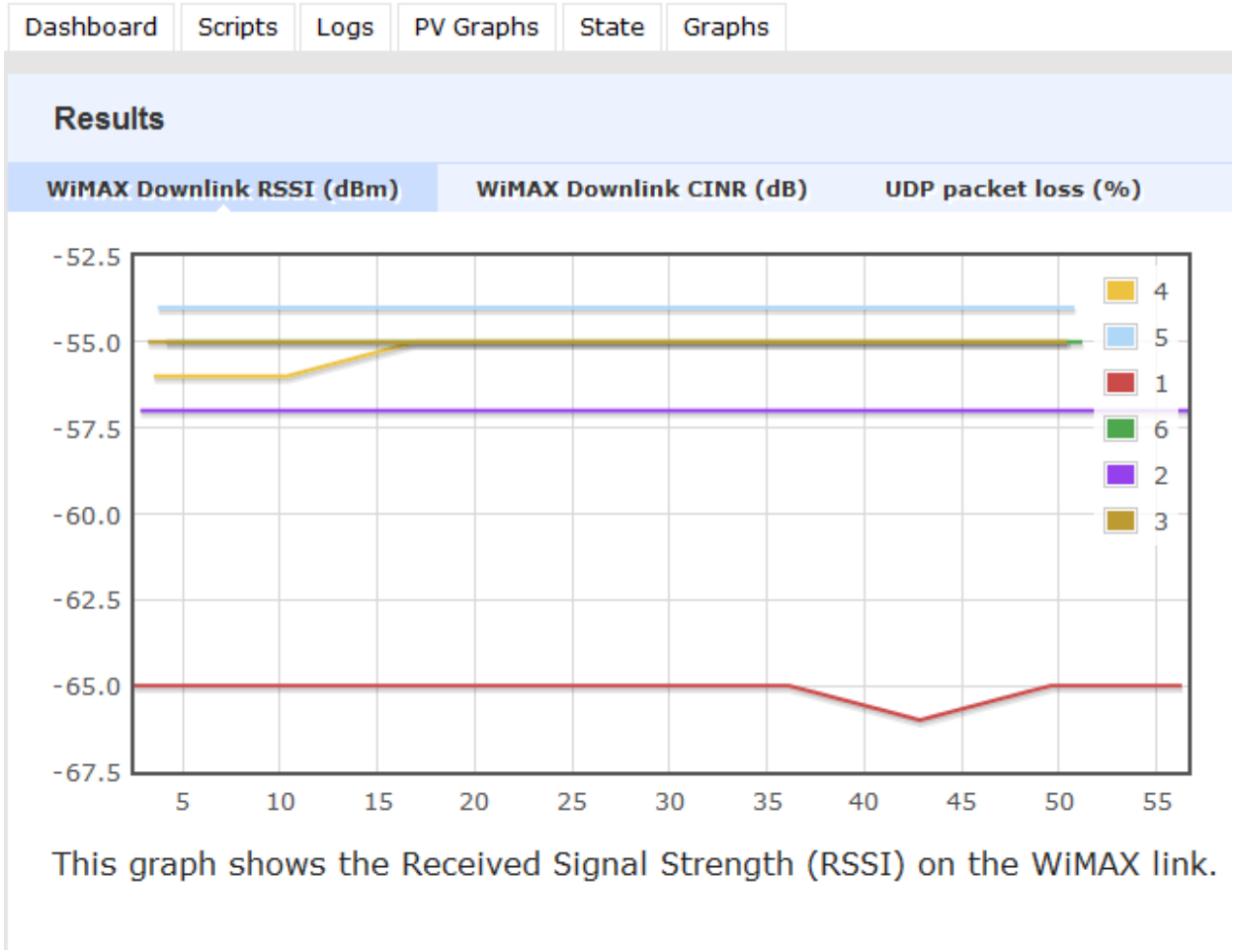
# Experiment: I&M

- 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*.

# Experiment: I&M

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

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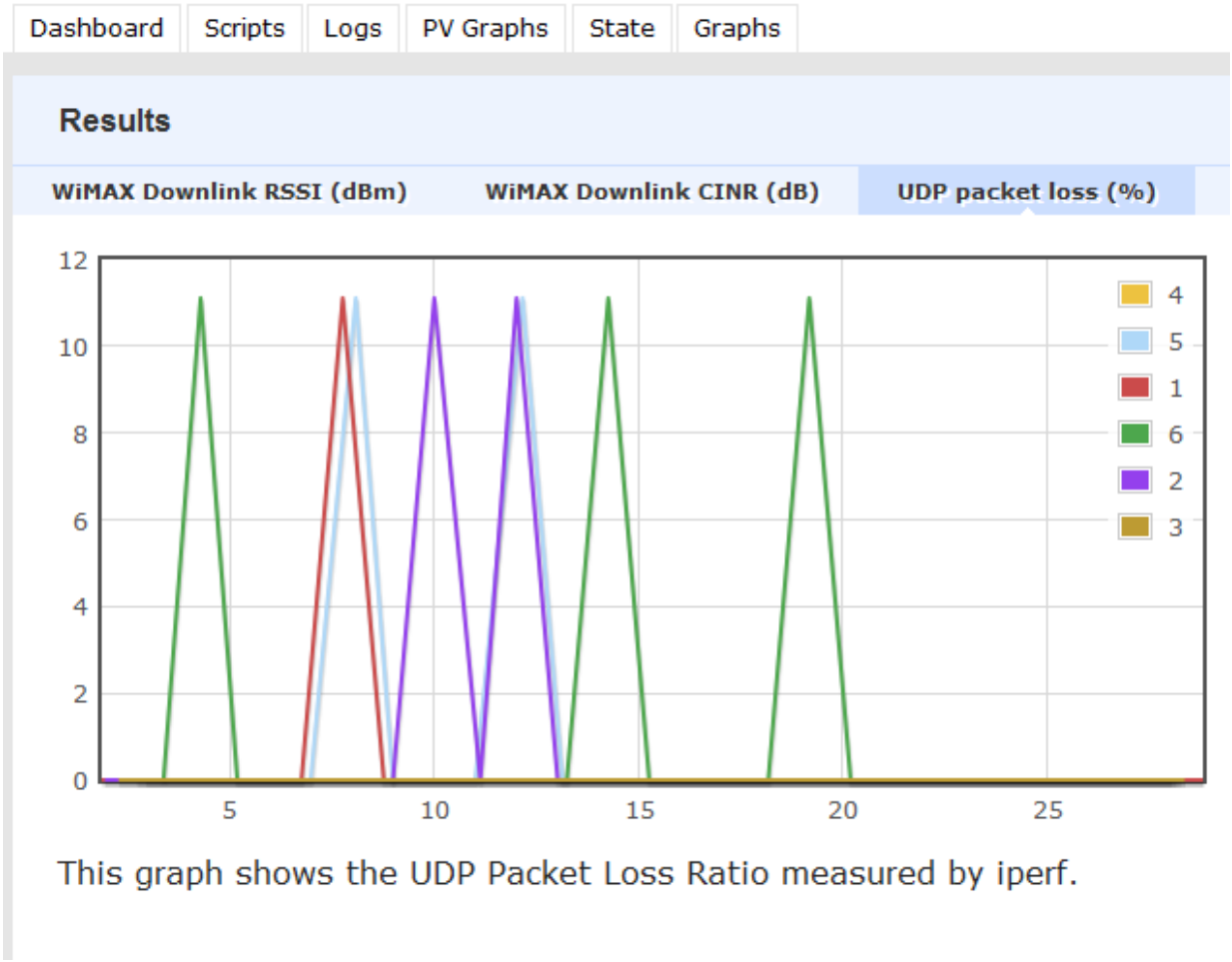
# Experiment: I&M

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

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# 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

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# Discussion

*Questions?*

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

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