Columbia University WiMAX Campus Deployment and Installation

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Contents

1 People

- Henning Schulzrinne (PI)
- SungHoon Seo (Postdoctoral researcher)
- Jan Janak (Visiting scholar)

2 TODOs

1. Contact Columbia Facilities to mount pole mask and ODU on outdoor site – The working started 06/16/2011
2. Activation of two Ethernet ports is required on the 16th floor at Mudd building; one for Internet connection and the other one for PDU (Power Distribution Unit) management. CUIT will provide it by June, 2011.
3. ~~Request permission from Dean's office, facilities, and real-estate committee~~
4. ~~Preliminary base station testing with Wi-Fi antenna by using signal power attenuator (it should be set with reduced (lowest) TX power 0 dBm).~~ See Section 8 Indoor testing for more details.
5. ~~Purchase additional necessary items: a pole mask, server rack cabinet, and PDU~~
6. ~~Ethernet activation (1402B) when all equipments are ready via Patrick (CUIT staff).~~ An Ethernet port for the outbound link of ASN-GW server will be activated through the other place according to a new location for indoor machines (ASN-GW, IDU, and power supplies) being placed (Antenna site will be also changed). Patrick (CUIT staff) may help us for this issue.
7. ~~Check rack space (smaller size) for IDU and ASN-GW~~

3 History

04/14/10 Obtained FCC licence

- Nature of service: Experimental
- Call sign: WF2XIU
- Class of station: XD FX
- File number: 0082-EX-PL-2010
- Station location: New York (NEW YORK), NY - NL 40-48-34; WL 73-57-36
- Frequency: 2590-2596 MHz
- Station Class: FX
- Emission Designator: 10M0W7D
- Authorized power: 32 W (ERP)
- Frequency tolerance (+/-): 0.00002 %

06/24/10 First site survey

At the Fairchild and Mudd buildings.

09/30/10 Second site survey

We chose the Fairchild building rooftop (12th floor) for mounting WiMAX antenna and ODU and HAM radio station (14 fl) to install IDU and server(s).

06/16/10 The first parts of WiMAX packages arrived

The list of shipment from WINLAB at Rutgers University is as in Table 1.

Table 1: 1st shipment of WiMAX kits from Rutgers University

Item	Quantity
Outdoor unit	1
GPS receiver antenna	1
Fiber cable	1 roll (10 m, approx. 30 feet)
Sector antenna	1
Mounting brackets for ODU and the antenna	1 set
Power connector for the ODU	1
Lightning surge protector for the WiMAX antenna	1

09/20/10 Requested to purchase necessary items (first order, via Elias Tesfaye, officer in CS department)

The list of purchased items is shown in Table 2.

Table 2: The list of 1st order

Item	Qty	Purchasing source
N Male Connector	3	http://www.mouser.com/ProductDetail/Amphenol-Connex/172100/?qs=sGAEpiMZZMtqi3rrGzC6kqBNVAfbUIcAs7pmvc7FO2w=
Lightning Arrestor N-Female N-Female	1	http://www.streakwave.com/Itemdesc.asp?ic=SP3-90-6-BFF&eq=&Tp=
bnc-j connector	1	http://www.mouser.com/ProductDetail/Amphenol-Connex/112348/?qs=sGAEpiMZZMtqi3rrGzC6kltfvaDq2xsFsjWEfeOv%2fog=
Weatherproof Box	1	http://www.streakwave.com/Itemdesc.asp?ic=DCE-H-7x6x2&eq=&Tp=
Barrier Terminal Block	2	http://www.mouser.com/ProductDetail/Tyco-Electronics-AMP/1546306-4/?qs=sGAEpiMZZMvXvCN7QvKasSL6eMCRZuY6zjs15Djvrtg=
Lightning Surge	4	http://www.mouser.com/ProductDetail/Littelfuse/SL1411A075A/?qs=ek3FaJ1hxEWg6rFszW4eAw==

10/06/10 Placed the second order (See Table 3)

Table 3: The list of 2nd order

Item	Qty	Purchasing source
Coaxial Cable 20AWG RG-58/U COAX 500' SPOOL BLACK	1	http://www.mouser.com/ProductDetail/Alpha-Wire/9058C-BK002/?qs=sGAEpiMZZMuwsoYAVCu3COxrc1%2ft2NbJpirN7iGs1GY=
Hinged DCE	1	http://www.streakwave.com/Itemdesc.asp?ic=DCE-H-7x6x2&eq=&Tp=
12/3 SJTOW Black 105 CEE	300 ft	http://www.americord.com/bulk-cable-62-prod-541.html

10/08/10 Visited WINLAB, Rutgers University

Obtained the rest of the equipment. See the list of the equipments in Table 4.

10/09/10 Project request to the Facilities

We filled out the form in http://facilities.columbia.edu/project-request and submitted it.

Table 4: 2nd shipment of WiMAX kits from Rutgers University

Item	Quantity
WiMAX indoor unit (IDU)	1
ASN-GW Server	1
IDU/ODU power supplies	2
AWB US210 USB clients	10
Intel Link 6250 mini PCI module	2

10/13/10 Space unit measurement

Figures 1 and 2 show diagrams including the space unit we measured at Fairchild building rooftop and for ODU.

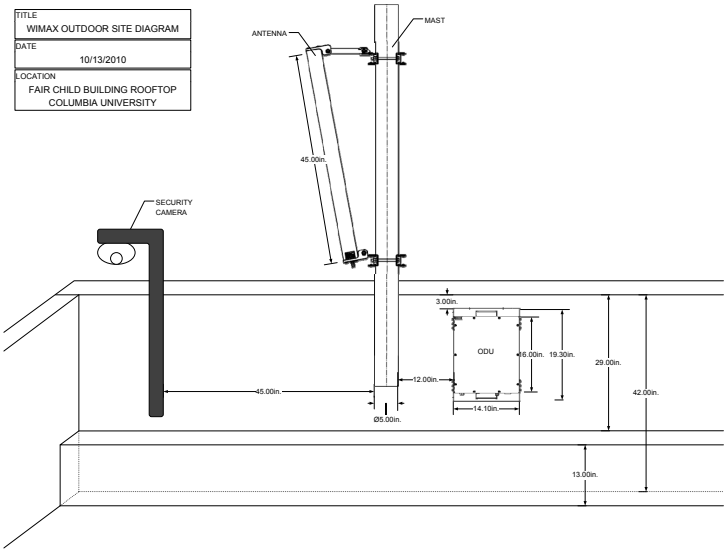


Figure 1: Diagram for WiMAX deployment (outdoor on Fairchild rooftop)

10/29/19 Completed to prepare settings for client testbed platform

See Section 7.2 for more details on NIC installation.

11/29/10 Meeting with Facilities with Michael Schultz (Facilities) and Elias Tesfaye (CS department) at CS office

Facilities said that an additional committee (real-estate) permission is required.

12/09/10 Site survey for a new outdoor location (indoor site as well)

With Facilities (Michael Schultz) and CUIT (Patrick Rausch) members, we took a look around Fairchild and Mudd buildings and it was determined that the current site should be moved to a new location. The Mudd building 16th floor is selected as a new site for the outdoor equipment.

Quote for installation: 32,000.00 USD

12/16/10 Meeting with electricians for the antenna and its pole mount

At the 16th floor at the Mudd building and IRT

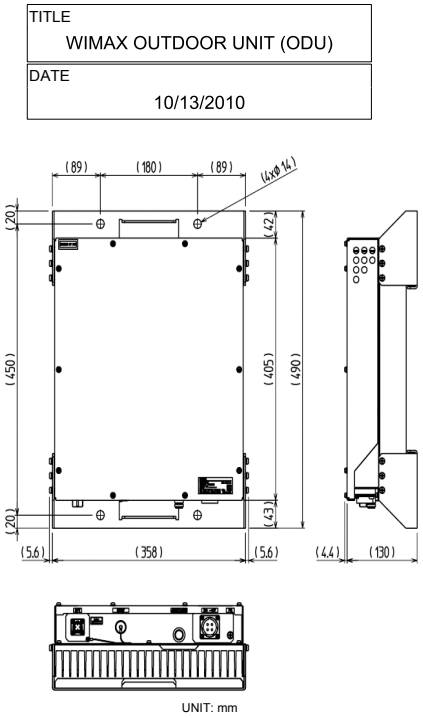


Figure 2: Diagram for WiMAX ODU

02/18/11 Phone meeting with Ivan Seskar, a researcher of WINLAB, Rutgers University

We tried to change several parameters on our BS based on the guidance of Ivan but the BS didn't work properly. The parameters we tried to change are as follows:

`odu_noise_floor`: 4 →40

`dlul_ratio`: 0x02 →0x00

`authgw_id`: 0000000041534E47 →0x41534E4757303030

`bs_tx_power`: 0 →20

We made a plan to visit WINLAB to figure out the problems on both BS and clients.

02/24/11 Visiting WINLAB at Rutgers University

- Contacted Ivan Seskar and Nilanjan Paul
- Solved every problems on both BTS and clients
- Upgraded OMF aggregation manager with the latest version and checked out that `wimaxrf` works

02/25/11 Indoor testing at IRT

We succeeded to scan and connect one of our WiMAX client (Linux OS) to BS for the first time. See Figure 14 for the testing result in detail.

03/03/11 HTC EVO Handset

We tried to purchase a HTC EVO handset which supports mobile WiMAX (IEEE 802.16e Wave 2 compliant) provided by Sprint carrier. Asked Daisy Nguyen (CRF manager, Columbia University) about the availability of university's contracts against the Sprint, but couldn't get any answer yet.

05/19/11 Purchasing server rack cabinet and PDU (Power distribution unit) via Daisy Nguyen (CRF) and Elias Tesfaye (CS Department)

(1) Triplite 12U rack: $444.73
(2) APC PUD for remote power (to hard boot machines in the rack): $425.45

06/09/11 Meeting with Donald A. Schlosser (Assistant Vice President of Campus Opers-Custodial Services, Columbia Facilities)

At IRT and the 16th floor, Mudd building. New quote for installation: 0.00 USD, for free.

06/14/11 Meeting with a technician from Facilities (Corey Sochinsky)

At IRT and the 16th floor, Mudd building. We measured the location where to mount the outdoor unit and the antenna. After the meeting, we moved every WiMAX equipment to the 16th floor, Mudd building.

06/16/11 Started to mount WiMAX equipment on site

Technicians from Facilities (Corey Sochinsky and John) and Nathan Schulzrinne (CRF intern) helped us for the deployment. The completed work includes as follows: Drilling holes on railing, fixed the mask and antenna, mounted ODU on the wall inside the building, and connected a coaxial cable between the antenna and the ODU.

06/17/11 Wiring optical fiber and power cables

06/23/11 Activation of Ethernet by CUIT

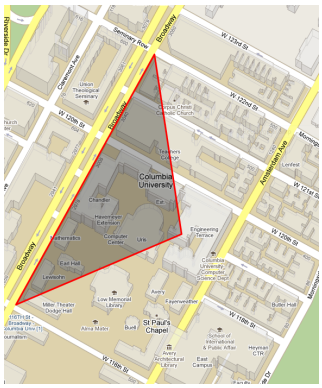
Two ports of Giga-bit Ethernet: one for Internet connection and the other one for PDU management.

4 Campus WiMAX radio coverage map

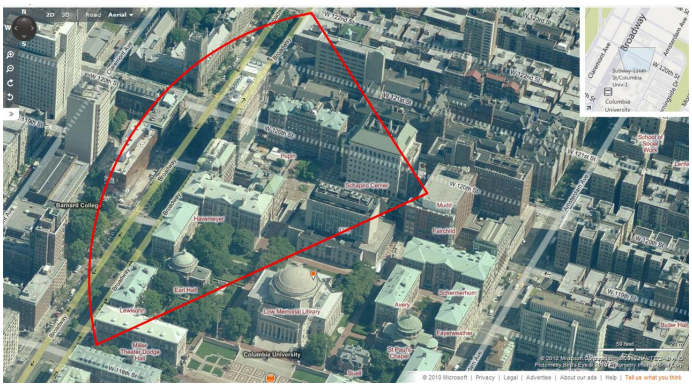
Figures 3(a) and 3(b) show an expected coverage of our campus WiMAX base station in Columbia University by using 120-degree sector antenna. Based on the transmission power configuration setting at the base station, i.e., `bs_tx_power`, the coverage may vary when the actual BS deployment completes.

5 Site survey

Because of Columbia University Facilities' exteriors and historic preservation regulation, previous candidates of WiMAX base station indoor and outdoor site A should be moved to the other location. On Dec. 16, 2010, based on the other site survey, we decided to change the outdoor and indoor sites to the southwest corner of the Mudd building, 16th floor, rooftop.



(a) 2D map view (by Google map)



(b) Aerial view (by Bing map)

Figure 3: Campus WiMAX coverage

5.1 Outdoor site

Figures 4(a)–4(e) show a new outdoor site which is located on the 16th floor at Mudd building. Figures 5(a) and 5(b) show the line-of-sight view point of the sector antenna. **To do** (1)

(a) Wide view

(b) Front view

(c) SW corner

(d) Side view

(e) Detail

Figure 4: A new outdoor site at the SW corner of the 16th floor rooftop on the Mudd building

(a) View 1

(b) View 2

Figure 5: Line-of-sight views

5.2 Indoor site

A new indoor site locates at Mudd 16th floor (near outdoor site, same level). Figure 6 shows the rack space where IDU and ASN-GW server will be located. We need to check the space availability in 5U as well as power supplies for IDU and ODU. **To do** (2)

Figure 6: Rack space where indoor parts be placed

As a reference, Appendix A describes another outdoor and indoor sites where we previously considered as candidates.

6 Base station deployment

6.1 Completed WiMAX installation and deployment

We completed the WiMAX installation and deployment on Jun 23, 2011. Figures 7 show the pictures of installation and deployment completed WiMAX kit on site.

(a) Antenna part (b) Antenna and wiring to indoor (c) ODU part

(d) ODU and its wiring (e) Indoor wiring (f) Testing

(g) Server rack cabinet (h) Working environment

Figure 7: WiMAX campus installation and deployment are completed

6.2 WiMAX kit

Table 5 briefly describes the function of each part of the WiMAX kit.

Table 5: Functional description of WiMAX parts

Part name	Description
Antenna	This part transmits and receives physical radio signaling over the air.
ODU	Outdoor unit: amplifies the power of radio signal relayed to the antenna.
IDU	Indoor unit: contains two components: CHC (Channel card) and NW INTFC (Network interface card). This part relays WiMAX frame from ASN-GW to the ODU, and vise versa.
ASN-GW	Access service network gateway, This part makes a transition between IP datagram and the WiMAX frame. Additionally, it allows to get or set the parameters on the BS through a console command line or a web browser with *wimaxrf* services (See Section 9.4).

6.3 Conceptual diagram for deployment

Figure 8 depicts the conceptual diagram for campus WiMAX deployment at Columbia University. The diagram includes antenna, ODU, IDU, and ASN-GW server parts and wiring between those parts.

6.4 Topology setting

Figure 9 shows the IP address allocation for each network components including, ASN-GW, CHC (Channel card)/NW INTFC (Network interface card) at IDU, and WiMAX client. `eth0` at ASN-GW is connected to a port on a router (labeled "Linksys Router" in the figure) which has DHCP capability. `eth1` at ASN-GW is connected to the `eth0` on NW INTFC at IDU. `eth2` at ASN-GW is not currently connected but will be used for the purpose of maintenance.

When a WiMAX client performs an association procedure to the BS, its MAC address should be registered at the software module in the BS (see Section 9.2 for more information). As soon as the client successfully connects to the BS, the DHCP function at the Linksys Router leases an IP address to the client within the range of `10.41.0.xxx` in our configuration. Finally, a data tunneling is established between the ASN-GW and the WiMAX client.

6.5 PDU setting

This section should be filled as soon as we get a static IP address for the PDU. The administration account of the PDU is `root` and its password is `wimax101`.

6.6 Router setting

In order to assign IP addresses to WiMAX clients, DHCP functionality is required so that we deployed one Linksys router (wired only) inside the rack cabinet and connected it to both outside network (Internet) and the ASN-GW. Through any type of web browser, we can maintain the configuration of the router and this procedure is as follows:

1. Connect an Ethernet cable between one of ports on the router and a laptop.
2. In the laptop, open a web browser and type the IP address of the router (currently, `10.41.0.1`) and go.

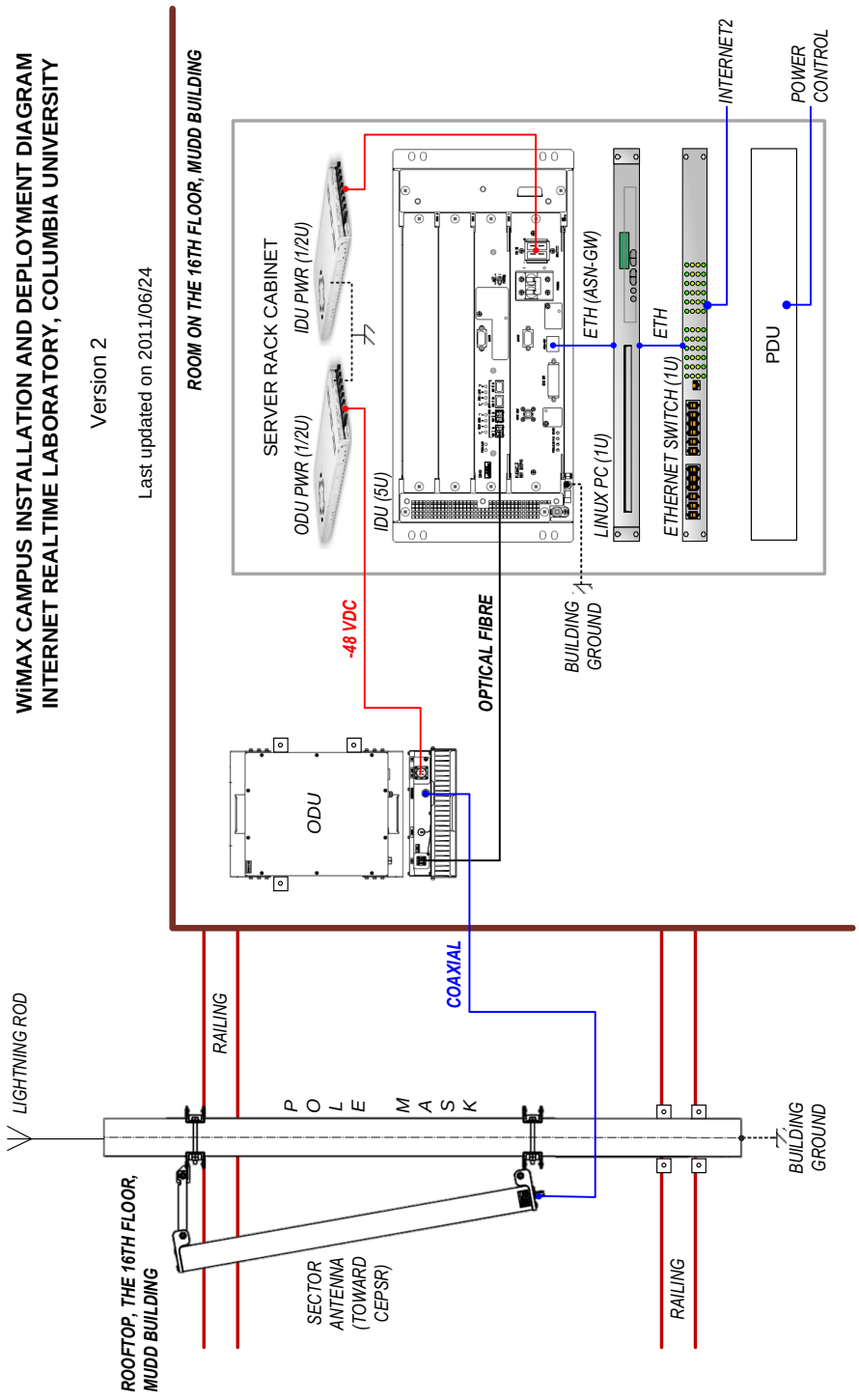


Figure 8: Conceptual diagram for campus WiMAX deployment

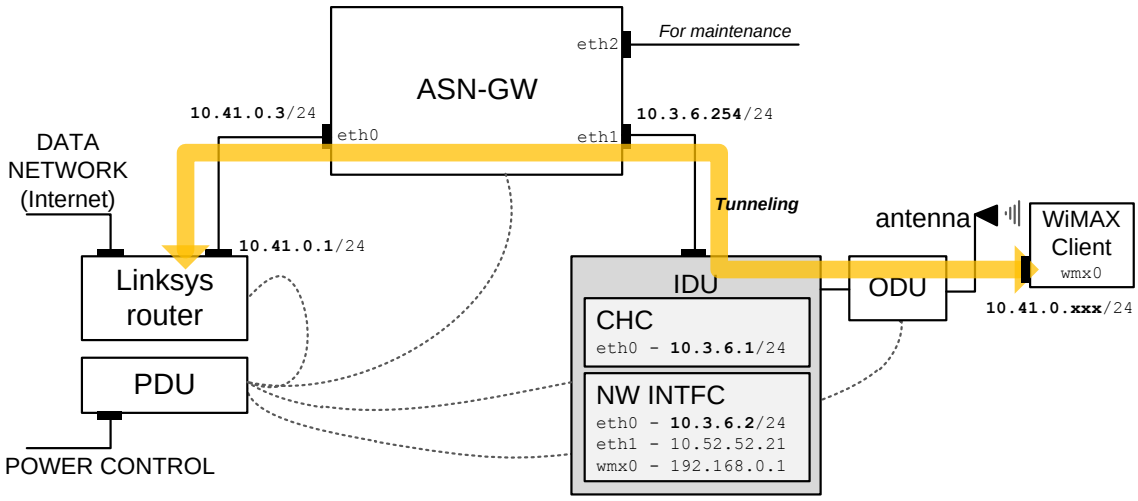


Figure 9: IP allocation for deployment: A WiMAX client obtains an IP address provided by DHCP on Linksys Router and makes a tunnel over the ASN-GW and WiMAX base station

3. The router's administration account is `root` and its password is `wimax101`.

4. Configure the settings whatever required.

7 Client settings

7.1 Platform information

Table 7.1 provides the platform information we used for setting WiMAX clients.

Table 6: Platform information

Platform	Dell Latitude D830 (IRT0045)
NIC	Intel Centrino Advanced-N WiMAX 6250 - Mini-PCI express with half size slot[1]
OS	Ubuntu 10.10 Maverick with patched linux kernel 2.7.36-rc3

7.2 Network interface card installation

This section describes how we installed the network interface card (Intel Centrino Advanced-N WiMAX 6250) into our testbed client platform (Dell's Latitude D830).

7.2.1 Temporary installation

The type of network interface card is mini-PCI express. The client platform (Latitude D830) has two internal mini-PCI express slots, one for WLAN (Wireless Local Area Network) and the other for WWAN (Wireless

Wide Area Network). We selected the WWAN slot to install the NIC as an additional interface. The slot only allows full-size interface which does not fit to the half-size of NICs we have. In order to make the NIC fit on the slot, we temporary fixed the NIC on the slot with wood sticks as shown in Figures 10(a) and 10(b)

(a) Need to be fastened (b) Fixed with wood sticks

Figure 10: Temporary installed NICs

7.2.2 NIC size extension

In above mentioned reason, we needed to purchase brackets to extend the size of "half-size" NIC card to be fit into the "full-size" mini-PCI express slot. We placed the order two brackets through Ebay[2] which only cost few dollars ($4.66 USD each). We attached the bracket to the NIC as shown in Figure 11.

Figure 11: NIC with bracket

7.2.3 Final installation

Finally, we removed the wood sticks and installed the NIC extended full-size into the slot. The snapshot of the installed NIC is as follows:

[2]Bracket to extend half-size mini-PCI into full-size one which is available through `http://cgi.ebay.com/ws/eBayISAPI.dll?ViewItem&item=170544115545&ssPageName=STRK:MEWNX:IT`

Figure 12: Installed NIC with bracket

7.3 Software installation

7.3.1 Required software packages

All necessary packages referred to this report can be found and downloaded from `http://www.linuxwimax.org`.

1. NIC firmware: `i2400m-fw-1.5.0`
2. Driver: Compiled and built by patched Linux kernel
3. WiMAX tool: `wimax-tools-1.4.4`
4. Open source supplicant: `wpa_supplicant-0.7.2` with patch to build `libeap.so` library
5. WiMAX network service: `wimax-1.5.1`, Intel's WiMAX daemon

7.3.2 History

1. Initial compilation and installation (10/28/10)
    - We followed the guideline from `http://wimax.orbit-lab.org/wiki` to compile and install WiMAX software packages at a client machine. The client is able to trigger scanning and discover commercial NSPs. However, we couldn't check the scanning results of our base station because the BS was not operational at this time.
2. NSP definition does not detect the geni NSP id 51 (01/07/11)
    - This issue has been discussed on `linuxwimax.org` mailing list.
3. Patch for GENI NSP ID '51' (02/02/11)
    - Update WPA supplicant (wpa_supplicant-0.7.3 + wpa_supplicant-0.7.3-generate-libeap-peer.patch
    - Replace XML file on wimax-1.5.1

- Appended GENI NSP information into ~/InfraStack/OSAgnostic/WiMax/Agents/NDnS/XML_Files/NDnSAgentConfig_forDriver.xml
- Note: Don't miss running `ldconfig` after the compilation completes.

- Replace GENI definition and database files (`WiMAX_Def.bin` and `WiMAX_DB.bin` obtained from orbit-lab) on ~/InfraStack/OSAgnostic/Product/AppSrvInfra
  - Installation completed and checked working properly
  - Note: The file of `/var/lib/wimax/WiMAX_DB.bin` is changed whenever `wimaxcu scan` is performed.

4. Build from scratch (02/24/11)

   - To make the WiMAX client software modules work properly with our base station, WiMAX network service should be clean built. The binary files of `WiMAX_Def.bin` and `WiMAX_DB` including NSP information should be replaced with xml files provided by GENI's guide wiki page.

8 Indoor testing

This section describes a note for the purpose of preliminary base station test at indoor environment.

8.1 Important notes

It is strongly recommended that connecting to the IDU (CHC's serial port) is allowed through 'serial cable' by using any modem control application (*e.g.*, minicom) for the monitoring and maintenance purpose. However, connections to the CHC and NW INTFC on IDU can be also established with `telnet` or `ssh` protocols.

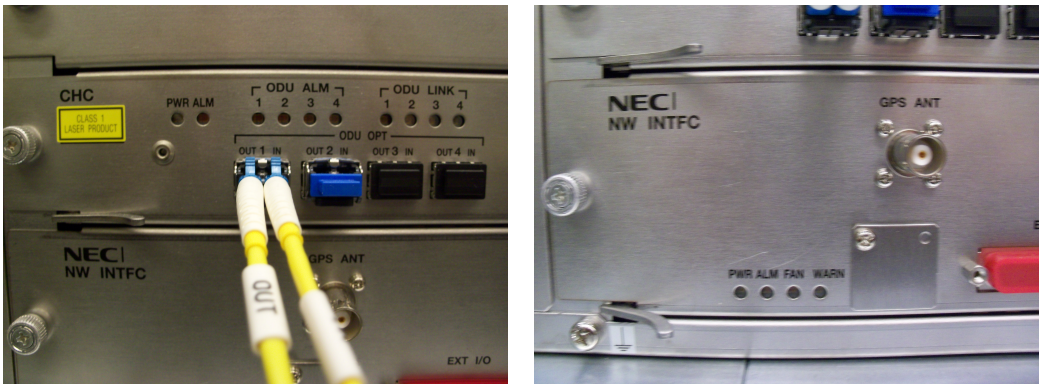
We prepared a preliminary base station indoor testing environment with the attenuated sector-antenna. It is worth noting that a signal power attenuator should be located between ODU and the antenna. Otherwise, if it is unavoidable to turn on the ODU without an attenuator in the indoor environment, `bs_tx_power` parameter on the base station should be set in 0 dBm. In case that an attenuator exists, the `bs_tx_power` can be set in 20 dBm which is a guided value by Ivan Seskar from WINLAB, Rutgers University.

8.2 Testing topology

1. **ASN-GW**

   - `eth0`: `10.41.0.3/24` → connected to the monitoring console machine. In the actual deployment other than the testing as mentioned in Section 6.4, this port should be directly connected to a router (or DHCP capable subnet) which is capable to provide DHCP functionalities because WiMAX clients obtain their IP address from the DHCP server other than any BS components whenever they associate with the base station.
   - `eth1`: `10.3.6.254/24` → connected to the IDU
   - `eth2`: This port is needed for maintenance.

2. **IDU**



(a) Indicators in CHC (b) Indicators in NW INTFC

Figure 13: Indicators on IDU

- CHC: `10.3.6.1/24`
- NW INTFC: `10.3.6.2/24`

3. **Monitoring console machine**

   - `eth0`: `10.41.0.111/24` → directly connected to the `eth0` at ASN-GW

8.3 Boot up sequence

First time, whenever we tried to boot up the ASN-GW server, IDU, and ODU, NW INTFC and CHC at IDU indicated that several warning and alarm lights were turning on. Figures 13(a) and 13(b) show the location of the indicators of CHC and NW INTFC at the front panel of the IDU. The meaning of each alarm light indicator describes as follows:

- ALM light (red) at NW INTFC: It is turned on when the BS does not have the connectivity to the GPS receiver. Even though we did not connect the GPS receiver, for indoor testing purpose, there is no problem for BS to work properly. If we deploy the BS on site with GPS connectivity, this alarm light should be off.
- WARN light (orange) at NW INTFC: It indicates that "Real time clock seems stuck!" which is caused from time sync issues because GPS receiver is not connected at this time of testing.
- ODU ALM light (red) at CHC: Setting up the ODU failed.
- ODU LINK light (green) at CHC: When it's on, it means the connection between IDU and ODU has been established successfully.

These alarms do not mean any functional error in the base station. However, we found that, in order to make BS work properly, there is a special order of sequence to turn on these devices including ASN-GW, IDU, and ODU; the turn-on sequence can be summarized as follows:

1. Turn on the power of ASN-GW server;

- Send ping to `10.41.0.3` (IP address of ASN-GW) from monitoring console to check that the server is alive.
- ssh to `10.41.0.3`

2. Turn on the power of NW INTFC;
   - Send ping to `10.3.6.2` (IP address of NW INTFC) from a console at ASN-GW to check that the NW INTFC is alive.
   - telnet to 10.3.6.2
3. Turn on the power of CHC;
   - Send ping to `10.3.6.1` (IP address of CHC) from a console at ASN-GW to check that the CHC is alive.
   - telnet to `10.3.6.1`
4. Restart the asn-gw module at a console of ASN-GW;
   - `sudo /usr/bin/asn-gw stop`
   - `sudo /usr/bin/asn-gw start`: This command will reboot the CHC (internally bs_restart is called)
   - Wait until CHC is ready by sending ping to `10.3.6.1` (IP address of CHC)
   - Check the ODU LINK light on at the CHC panel
5. For logging information, manually synchronize the time between machines;
   - We activates `ntpd` daemon at ASN-GW for the testing purpose.
   - `ntpdate 10.3.6.254` (IP address of the ASN-GW)
   - `export TZ=EST`
   - NOTE: At CHC, `TZ` variable is automatically recovered to the `JST`, Japan standard time (GMT+0900).
6. Assigning a dynamic IP address to `eth0` at ASN-GW;
   - `sudo dhclient eth0` at the console of ASN-GW.
   - If a static IP address is allocated to `eth0` at ASN-GW, this procedure can be skipped.
7. Restart OMF aggregate manager at ASN-GW;
   - `/etc/init.d/omf-aggmgr-5.2 stop`
   - `/etc/init.d/omf-aggmgr-5.2 start`
8. Perform scanning and establish connection on a WiMAX client;
   - `wimaxcu connect network 51`

- Before try to connect to the BS, the MAC address of the WiMAX client should be registered to the allowed list of clients at the ASN-GW.

9. Check log messages at ASN-GW to verify that the client obtains IP address;

   - `tail -f /var/log/omf-aggmgr-5.2.log`

8.4 Testing result

8.4.1 Using Linux OS and Intel 6250

Testing on 02/10/11: As soon as we checked the BTS seems to work properly, we did a wide range of test for scanning procedures from linux based WiMAX client, but failed to see the GENI id'ed base station (NSP=51). Tried to change the `bs_tx_power` to the 10, but nothing changed.

Testing on 02/25/11: By visiting WINLAB at Rutgers University, we solved every outstanding problem. We did a try for WiMAX client with Intel's 6250 NIC to perform scanning and to connect to our base station and it succeeded (See the messages on Figure 14. The two binary files on the client should be replaced to the managed xml files which only embed the GENI's NSP ID numbered 51 (it is same to that of Sprint carrier).

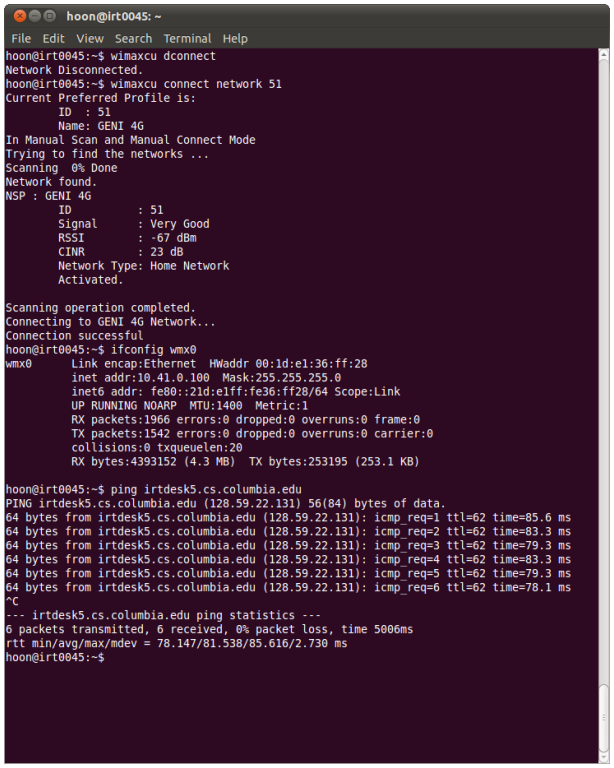
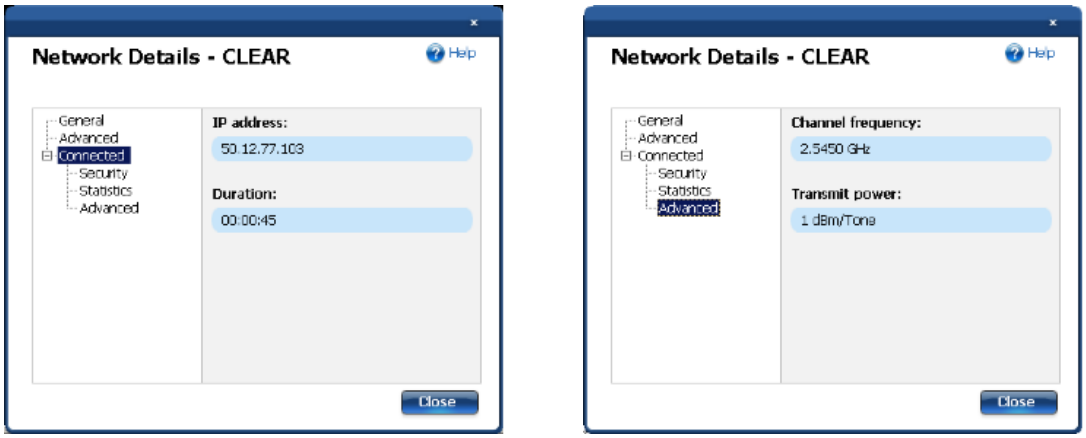


Figure 14: The console messages show that the client successfully connects and sends ping to the outside of network through our BS

In addition to replacing the binary, it is needed to clean the source code build environment of the WiMAX service tool module (with a command, `make clean`, at the root directory of the module) and turn off the laptop completely. The reason to shutdown the client is to flush the firmware on WiMAX network interface card. After rebooting the client, the WiMAX service tool should be compiled from scratch then you can see the successful scanning and connection to the GENI based base stations.

8.4.2 Using Windows OS and Intel 6250

On the Windows OS[3], there is no way to use the Intel's 6250 NIC for the purpose of using at GENI's base station because there is no way to modify XML binaries provided by Intel's device driver. But it works properly to the commercial NSPs. Figure 15 shows an example of connection to Clear WiMAX carrier with Intel 6250 NIC on Windows OS.



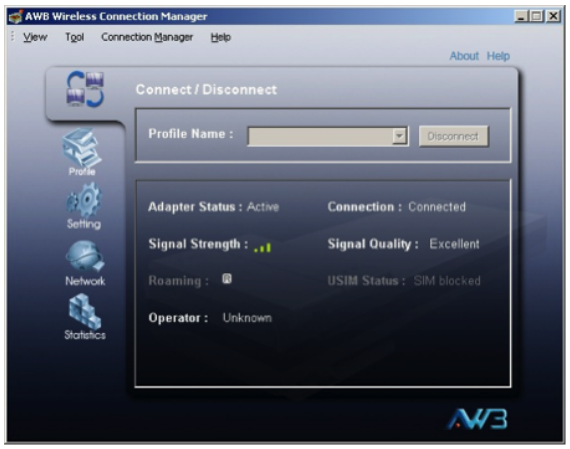
(a) IP allocation (b) Frequency setting

Figure 15: Intel 6250 at Windows OS

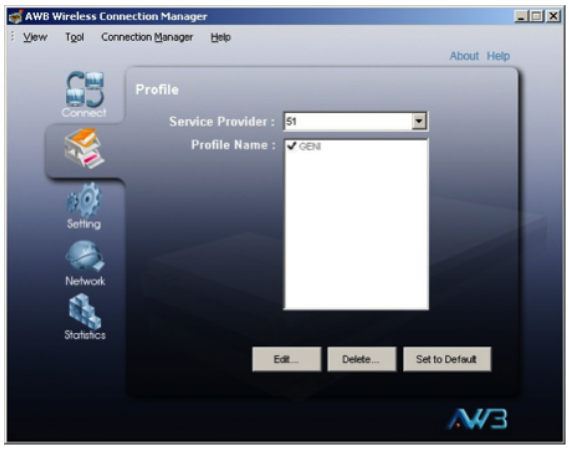
8.4.3 Using Windows OS and AWB US210

We have ten AWB US210, an external USB type of adapter for WiMAX, for the research purpose, but the manufacturer only provide Windows version of device driver. Unfortunately, this type of network interface does not work for commercial WiMAX carrier such as Time Warner Cable 4G, Sprint, Clear, or Comcast. The network interface card seems to successfully scan commercial NSPs while connection fails because of authentication problems. The log messages from this network interface show that timeout occurs when the authentication procedure against the commercial base station is unsuccessful (no response). However, it can be used for our GENI base station working on 2.9 GHz frequency band successfully, because current version of our base station does not require any authentication procedure when clients try to connect. Figure 16 shows that the general information how to set AWB US210 for connecting GENI base stations and log message for successful connection.

[3]We tested on Windows XP professional with service pack 3. Intel's manual said that it also works on Windows Vista and Windows 7 regardless of the type of platform architecture, x86 and x64.

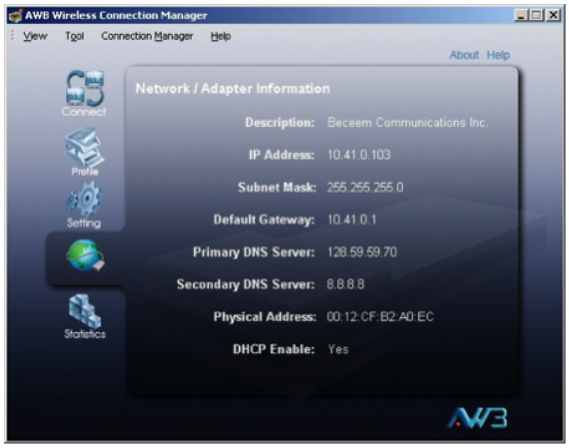


(a) Connected



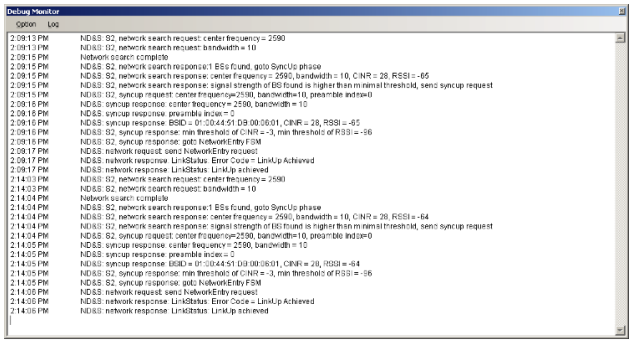
(b) Profile setting

(c) Settings



(d) Network and adapter information

(e) Statistics



(f) Log message

Figure 16: AWB US210 usage and connection result

9 Other information

9.1 ASN-GW software package update

ASN-GW server can be easily updated and upgraded with `apt-get update; apt-get upgrade` commands. Before upgrading, you should backup all configuration and setting files (currently, backup with postfix `.org`) which are generally located in `/etc` directory.

9.2 WiMAX clients' IP address assignment

There are two ways to assign IP addresses to the WiMAX clients over WiMAX base station system. The first one is provided by `SAMrb` which stands for simple authentication manager. In this case, the MAC address of WiMAX clients should be defined in this configuration file that is implemented with the syntax of Ruby programming language.

The other way is based on the OMF aggregate manager which is designed to provide the functionalities of orbit-lab. Configuration files of the OMF aggregate manager are located at `/etc/omf-aggmgr-5.2`. As similar as the `SMArb` way, a configuration file located at `/etc/omf-aggmgr-5.2/enabled/wimaxrf` maintains the list of WiMAX clients so MAC addresses of allowed WiMAX clients should be explicitly registered at this file. This file also follows Ruby syntax[4] and has a category, named `slice`, which is to schedule individual group of clients when the BS works under the orbit-lab maintenance. Currently, the default setting of IP assignment on our base station is with the OMF aggregate manager.

9.3 Configuring WiMAX base station

This subsection introduces how to check and change the configuration setting of the WiMAX base station by using the command line executives in console. There is another way to configure the base station which is allowed by using *wimarxrf* functionalities via web browser and this method will be described in Section 9.4.

As the first step, you should be connected to the ASN-GW by `ssh`. The IP address of the ASN-GW is current set in `10.41.0.3` within the internal network provided by the WiMAX router (Linksys router). Secondly, from the prompt of the ASN-GW, you should make a `telnet` connection to the CHC of the WiMAX kit whose current IP address is `10.3.6.1`. The administrative account of the CHC is `root` and its password is blank (Just press the Enter key). There are two main command `wiget` and `wiset` where are to get the information of the configuration setting of the base station and to set (or to modify) the configuration of the base station, respectively. It is worth noting that, after using the `wiset` to change the value of any parameters, the base station should be restarted in order to make the changed parameter value be effective.

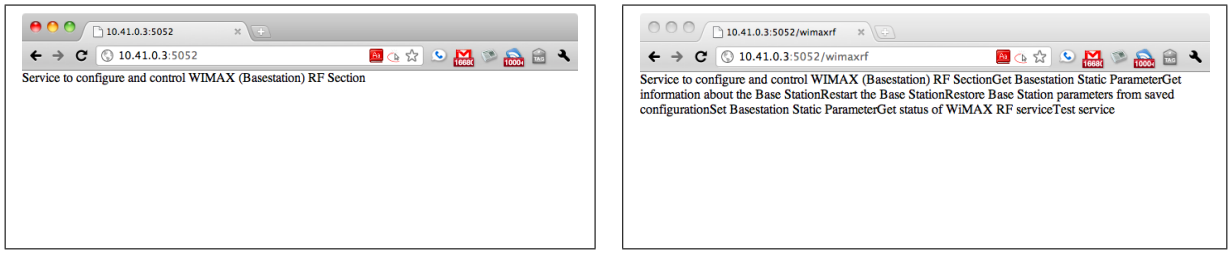
9.4 Using *wimaxrf*

wimaxrf is a web-based module which allows users to query and set parameters of NEC base station. It is implemented based on an XML thus you can use it through a certain kind of web browser supporting xml viewer.

[4]Note that Ruby interpreter does not allow any tab based indentation so that every indentation should be separated by space.

9.4.1 Accessing *wimaxrf* using web browser

In order to access the *wimaxrf*, open a web browser from a machine which is connected through the Linksys Router and connect to the web service with `http://address:port` where `address` is the address of ASN-GW and the `port` is the port number of ASN-GW's *wimaxrf* service. Under our BS configuration, we can connect *wimaxrf* using the url of `http://10.41.0.3:5052` where the `address=10.41.0.3` is the IP address of our ASN-GW and `port=5052` is a pre-defined port number which is determined by the current version of OMF. In this case, a connection is established through the `eth0` on the ASN-GW. As an alternate way, we can also use an `eth2` port on the ASN-GW to directly connect web-based *wimaxrf*. To trigger *wimaxrf* commands, we can use with `http://address:port/wimaxrf`. Figures 17 show snapshots of accessing *wimaxrf* by using a web browser.



(a) Front page of *wimaxrf* (b) Accessing *wimaxrf*

Figure 17: *wimaxrf* through web browser

9.4.2 Listing information

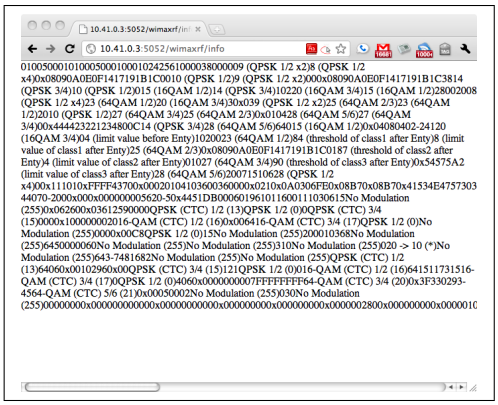
To see the information of *wimaxrf*, you can try a command using `http://address:port/wimaxrf/info`. Figure 18(a) is the list of information provided by *wimaxrf*. In some reason, these commands sometimes fail to show xml files on the web browser as shown in Figure 18(b). But you can refresh the web browser to properly show the xml result.

9.4.3 Get and set parameters

To query the parameter of the base station, through the web browser, you can use the command with an url like `http://address:port/wimaxrf/get?parameter` where `parameter` is the name of the parameter want to get in the base station. On the other hand, to set the parameter of the bastation, you can use the command with `http://address:port/wimaxrf/set?parameter=value` where `parameter` is the name of the parameter to set and `value` is the parameter value to be set. As an example, getting and setting BS identifier, 'bsid', can be performed via `http://address:port/wimaxrf/get?bsid` and `http://address:port/wimaxrf/set?bsid=0x4451db000001`, respectively. Figure 19(a) shows an example to get a BS parameter, `bs_tx_power`. Figure 19(b) shows an example to set a BS parameter, `bs_tx_power` with 10 dBm.

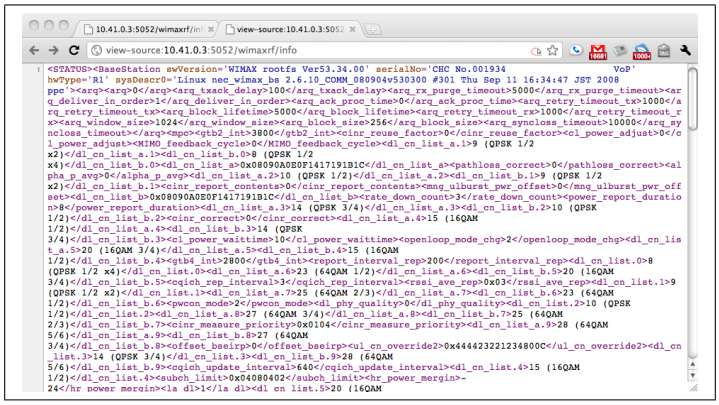
9.5 Log messages

Here is the list of useful log files:



(a) List of information

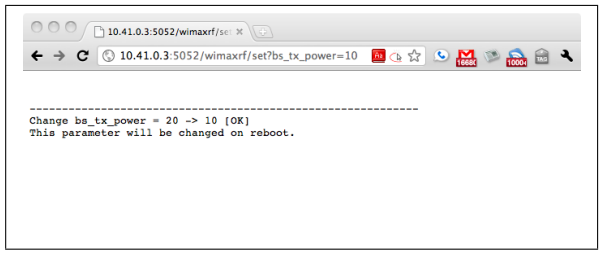
(b) XML parsing error; just do reload



(c) View XML source of information list

Figure 18: Listing *wimaxrf* information

(a) Getting a BS parameter



(b) Setting a BS parameter

Figure 19: Getting and setting a BS parameter using *wimaxrf*

- `/var/log/omf-aggmgr-5.2.log`: to see whether the OMF aggregation manager allocated clients' IP addresses properly
- `/var/log/asnctrl.log`: to see BS up

10 Measurements

10.1 Signal quality

After deploying the BS on site, we will need to measure the signal quality such as received signal strength, CINR, etc. The measured signal quality information may help to configure the transmission power of the radio signal from antenna at the BS to control the coverage area and the propagation range of the WiMAX system.

10.1.1 Measurement tools

We use a signal measurement tool for WiMAX which can be found in the following site: `http://wimax.orbit-lab.org/wiki/WiMAX/30/02#WimaxMeasurementApplication:wimax_gps_oml2` This tool utilizes signal quality measurement according to the location which is gathered by GPS receiver (connected via USB).

10.1.2 Measurement procedure

We selected 30 position locations and measure WiMAX signal from the WiMAX base station by using the WiAMX testbed. Figure 20 shows the position locations for the first signal measurement survey on 06/27/2011. For this measurement, we set the transmission power of the antenna (`bs_tx_power`) with 30 dB.

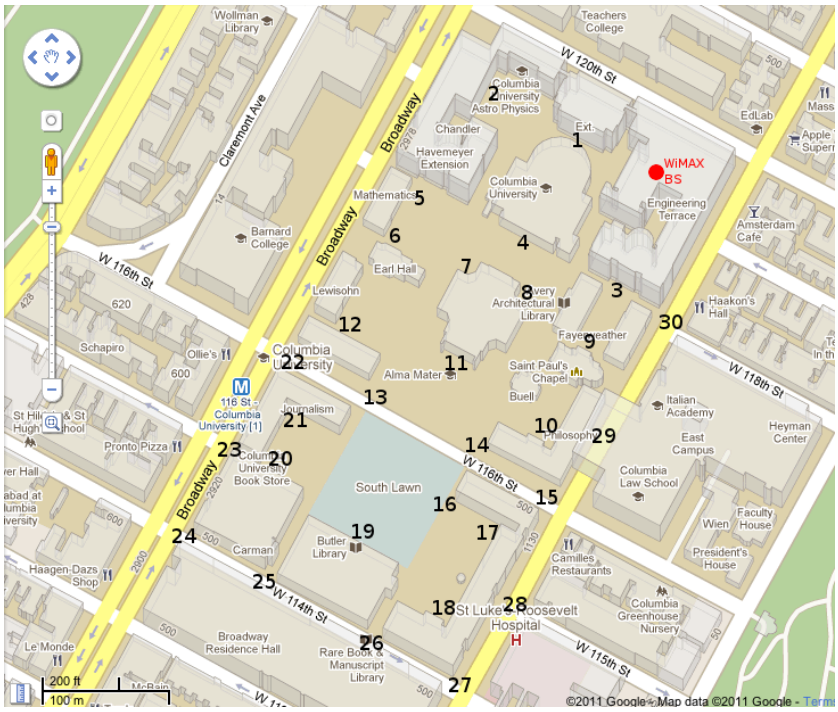


Figure 20: Signal survey: WiMAX signal measurement points

10.1.3 Results

Table 7 shows results of the first signal measurement survey. The results show that the most outdoor area of the campus is exposed to the WiMAX signal so that WiMAX clients are capable to get Internet connectivity via WiMAX base station. To provide the better understanding of the results, Figure 21 depicts the visualized WiMAX signal (RSSI: Received Signal Strength Index) map within the campus which is drawn through the `http://www.gpsvisualizer.com/map_input?form=google`.

Table 7: The first WiMAX signal measurement survey results

Pt #	RSSI (dBm)	CINR (dB)	Tx Pwr (dBm)	Notes
1	-61	27	-61	
2	-61	28	-59	
3	-88	1	-36	
4	-58	29	-34	
5	-77	13	-34	
6	-81	8	-34	
7	-71	18	-34	
8	-74	15	-34	
9	-82	7	-34	
10	-73	17	-42	
11	-68	21	-45	
12	-85	4	-33	
13	-85	5	-33	
14	-72	17	-33	
15	-92	0	-22	
16	-69	20	-53	
17	-85	5	-45	
18	-83	6	-44	
19	-66	23	-43	
20	-81	9	-39	
21	-87	3	-38	
22	-94	-5	-33	
23				No connection
24				No connection
25	-90	0		Scan successful, but failed to connect
26	-68	20	-48	LOS is available in this location
27	-94	-5	-35	
28				No connection
29				No connection
30				No connection

10.2 Throughput

In order to measure the throughput from a WiMAX client, I tried to use popular network monitoring and measurement tool, Wireshark and iPerf. To the best of our knowledge, unfortunately, link level throughput cannot be measured because WiMAX MAC level frames are emulated into Ethernet (IEEE 802.3) frames internally in the network interface card, i.e., Intel's 6250 NIC. Thus, the only header information we can see

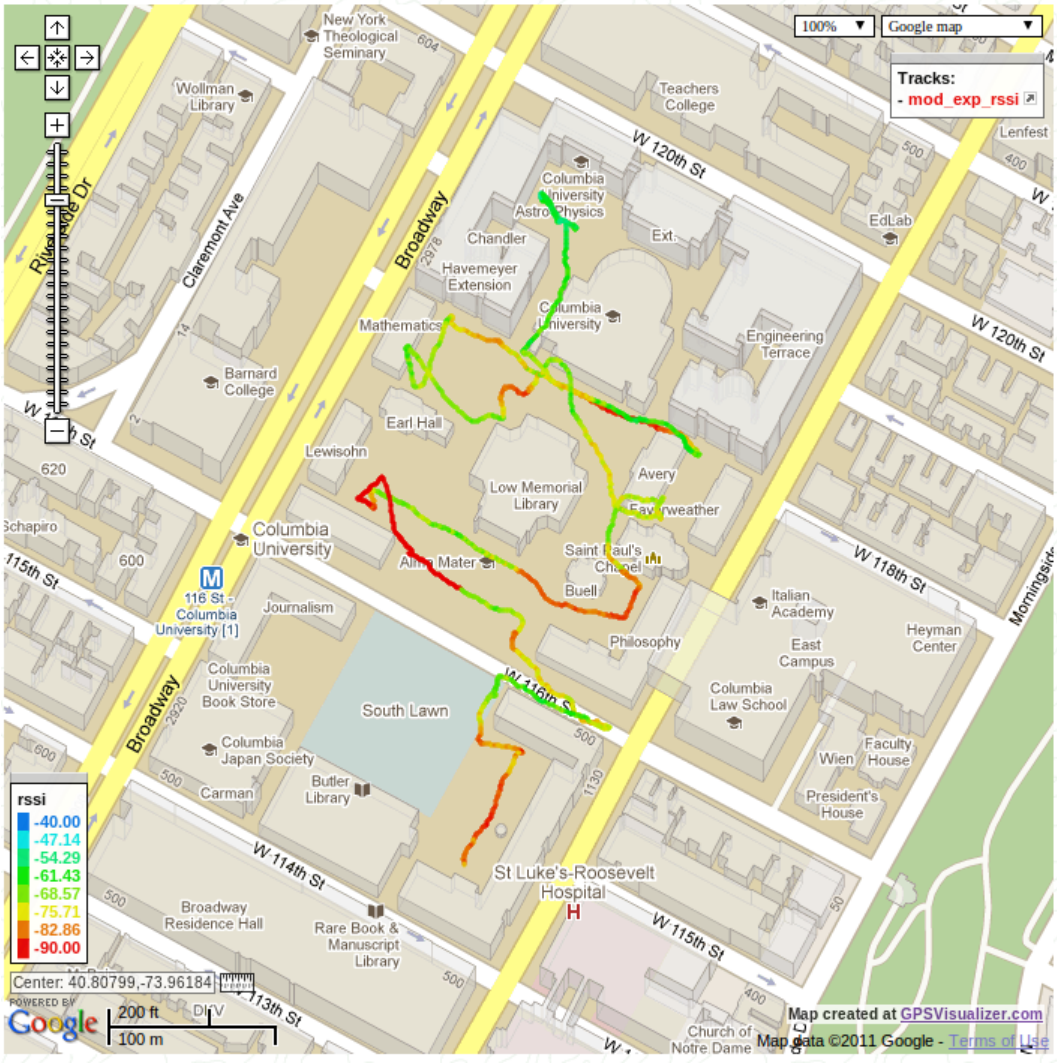


Figure 21: Measured WiMAX RSSI and location mapping with GPSVisualizer

through the monitoring tool is Ethernet level and its upper layer information.

We will try to solve this matter to see the frame, layer 2, information other than Ethernet emulated one.

11 Useful links

1. WiMAX Meso-Scale Deployment Integration
   Web site: `http://groups.geni.net/geni/wiki/WiMAXInteg`
   Mailing list: `http://email1.winlab.rutgers.edu/cgi-bin/mailman/listinfo/wimax-developer`

2. GENI WiMAX Base Station Kit – Columbia University Deployment, a.k.a., WIMXCOLUM
   `http://groups.geni.net/geni/wiki/WIMXCOLUM`

3. GENI WiMAX Platform

`http://wimax.orbit-lab.org/wiki`

4. OMF (cOntrol, Management and Measurement Framework) – A Control and Management Framework for Networking Testbed
   `http://www.mytestbed.net`

5. WiMAX Drivers for Linux
   Web site: `http://www.linuxwimax.org`
   Mailing list: `http://lists.linuxwimax.org/mailman/listinfo/wimax`

A Appendix: Previous candidate sites

This section describes previous candidates for both outdoor and indoor sites in our campus. It should be regarded as a reference. These sites were changed to the other proper locations as described in Section 5.

A.1 Previous outdoor site

Previous outdoor site was located at the Fairchild building rooftop, 12th floor, as shown in Figure 22.

(a) Location (b) LOS (c) Rooftop

Figure 22: Previous outdoor site

A.2 Previous indoor site

Previous indoor site was located at the HAM radio station at the Mudd building, 14th floor, as shown in Figure 23.

References

[1] "Problem with unauthrized MiniPCI network card," http://www.thinkwiki.org/wiki/Problem_with_unauthorized_MiniPCI_network_card.

(a) HAM radio station

(b) Inside of the station

(c) Wall line hole (inside)

(d) Wall line hole (outside)

(e) Ethernet activation

(f) Rack space 1

(g) Rack space 2

Figure 23: Previous indoor site

To do...

- ☐ 1 (p. 8): Update figures with new ones
- ☐ 2 (p. 9): Update information and insert a rack cabinet figure