A Framework for Multidimensional Measurements on an Experimental WiMAX Testbed*

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Abstract. A major difficulty in the design, study, and implementation of wireless protocols and applications is the multitude of nondeterministic factors (e.g. interference, weather conditions, competing traffic) that can affect their performance. For this reason, testbeds that enable researchers to quantify these influences have become increasingly essential in the wireless research community. The growing sophistication of wireless testbeds and the wide array of services they can provide to researchers have advanced the field tremendously.

Toward this end, we present an early implementation of an instrumentation and measurement framework that we have deployed on an open-access 802.16e wireless research testbed at the Polytechnic Institute of NYU. We have created a set of tools to allow experimenters to routinely collect measurements of environmental conditions during experiment runtime. These tools integrate high volumes of multidimensional measurement data from a diverse array of sources, including measurements from software defined radio peripherals, sensors, and network device drivers. With this, we aim to give researchers the ability to conduct rigorous and repeatable over-the-air experiments. We also foresee potential applications for this framework beyond its use in experiments, such as in long-term testbed monitoring.

1 WiMAX Testbed at NYU-Poly

Current and proposed Internet protocols are mainly developed and tested over wired and WiFi networks, but Internet traffic is increasingly moving to new wireless broadband networks, including WiMAX and LTE. Because the properties of these networks are very different from traditional WiFi and wired networks, there exists a great need to evaluate Internet application and protocols over these networks. The WiMAX testbed at NYU-Poly supports this aim by providing an open-access, highly configurable wireless broadband network for use in research.

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T. Korakis, M. Zink, and M. Ott (Eds.): TridentCom 2012, LNICST 44, pp. 369–371, 2012.

2 Quantifying the Environment

It is difficult to conduct rigorous and repeatable over-the-air experiments because wireless signals are highly sensitive to the experimental environment. It is especially difficult for remote users of a wireless testbed to understand what is happening at the experiment site that may affect experimental results. Therefore, we provide a set of tools (built on top of OML [2], the OMF [1] measurement library) for experimenters to routinely collect measurements from a diverse array of sources, to help them quantify these environmental conditions.

3 Measurement Sources

Our measurement sources include:

- Software defined radio peripherals, which sense the RF environment and compute the FFT of raw WiMAX samples.
- Temperature and humidity sensors, which alert experimenters to extreme weather conditions that can affect the wireless signal, and light sensors, to indicate the level of human movement (which can contribute to multipath effects) in the area.
- WiMAX network cards, which are used for WiMAX connectivity and which also indicate signal strength and interference levels.

Each of these measurement sources can be configured to stream measurements to an OML server during experiment runtime.

4 Applications

The measurements are stored by OML together with experimental data and network configuration information, so that all relevant information about the experiment is archived in one place. They are also used for real-time feedback on network conditions during experiments, visualizations of multidimensional data, and long-term monitoring of testbed conditions.

References

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WiMAX Testbed

Current and proposed Internet protocols and applications have been developed and tested over wired and WiFi networks, but Internet traffic is moving to wireless broadband networks

- By 2016, global mobile data usage is predicted to reach 10.8 exabytes/month over 10 billion mobile devices
- The properties of wireless broadband networks (including WiMAX and LTE) are very different from WiFi or wired networks.

Controlled experimentation over wireless broadband is difficult:

- Over commercial networks, subject to changing carrier policies and competing traffic
- Simulations are only as good as their model
- Wireless broadband testbeds are costly to deploy

GENI WiMAX sites provide open-access, highly configurable, wireless broadband networks for use in research:

- 802.16e base station and computers with WiMAX network cards
- Open for use (by reservation) at http://witestlab.poly.edu

Quantifying the Environment

Supporting the goal of **rigorous, repeatable over-the-air experiments**

- Wireless experiments are very sensitive to the environment
- Especially difficult for remote experimenters to understand how their experimental results will be affected

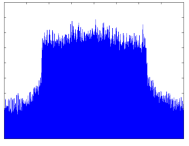
We provide a set of tools for experimenters to **routinely** collect measurements from a diverse array of sources.

- Built on top of OML framework
- Helps remote researchers quantify environmental conditions

Measurement Sources

Software Defined Radio

- USRP N210 with RFX 2400 daughter card at each node senses the RF environment
- GNU Radio script takes FFT of raw WiMAX samples and streams the results to OML server



Sensors

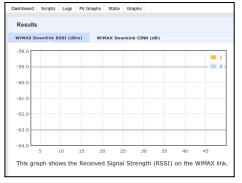
- Temperature and humidity sensors alert experimenters to extreme weather conditions that affect wireless signal
- Light sensors give indication of movement in the room, which introduces multipath effects
- OMF experiment periodically retrieves measurements from AVR cards and stores results in OML server

WiMAX Network Cards

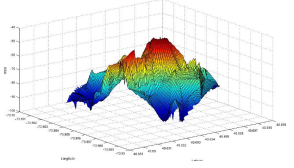
- Intel WiMAX 6250 cards used for WiMAX connectivity
- Driver API provides RSSI, CINR, Transmit Power

Applications

- Real-time feedback on network conditions during experiments



- Visualizations of multidimensional data



- Long-term monitoring of testbed conditions

- Archive experimental results together with environmental data and network configuration

http://wicat.poly.edu