

# Modular Wireless Testbed

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## EE Capstone Project

### Your Client

Dr. Morgan Vigil-Hayes is researcher/professor in SICCS. She is interested in developing an easy-to-use, modular wireless testbed that allows me and my students to run high-fidelity wireless experiments with heterogeneous network technologies (e.g., various variants of 802.11, Bluetooth, Zigbee, LoRa) in a number of environments and scenarios.

There is a need for unifying and modular control that can make heterogeneous network set-up fairly plug-and-play. Right now, she needs to have students set up individual antennas and network interface cards for every single network interface that they are running experiments on. There is not an existing way to easily configure a heterogeneously networked node.

From this, she needs a mobile-friendly, software-configurable widget (such as a Raspberry Pi + easy for the non-EE breadboard + software + off-grid power) that enables or disables various network interfaces and also runs a light weight version of Linux that allows her and her students to run networked code across the interfaces.

One of the major challenges with wireless networking systems is that it can be difficult to accurately evaluate their performance in a simulated environment, since the data communication layer can be significantly impacted by line-of-sight obstacles, interference, and path fading. Her lab seeks to deliver applications and architectures over heterogeneous wireless networks and in order to accurately evaluate usability and performance, we need an on-the-fly configurable testbed that can mobilize into various configurations in the physical world to evaluate real-world deployment scenarios.

In addition, it is exceptionally difficult to demonstrate some of the challenges of wireless networking or to measure the impact of wireless on various Layer 3-5 protocols or to evaluate the difference between Layer 2 protocols in a computer networks course without extensive equipment setup. It would be really great to have something that could be configured easily from a command line (i.e., my widget nodes could be controlled in the cloud)!

### Prototype Milestones

This project will closely adhere to the deadlines set in class.

### Project Features

1. The product must enable software configuration of network interfaces.
2. ... must support at least 4 networked technologies simultaneously: FM RBDS receiver, WiFi mesh, WiFi access point, LoRa.
3. ... must support modularity such that I could easily add a new networked technology to the node.
4. ... must be small enough to be mobile (i.e., can fit in a backpack).
5. ... must enable topographic configuration such that units can network together to form a single local network (i.e., one giant offline mesh), or have some meshed units operate as gateway nodes, or have specific nodes coordinated to talk to each other and not other nodes.
6. ... should some of the specific aspects associated with the antennas (i.e., specific WiFi channel) would be configurable with software.

7. ... ideally there would be an API that enables the support of adding new configurable antennas.

### **Project Success**

The end product will be able to transmit and receive wireless data transmissions from multiple network technologies simultaneously as part of a mobile lab testbed environment. All nodes should be simultaneously configurable using a simple software user interface (command line is fine) with a configuration file format that can run from an office bound desktop computer.

### **Satisfaction Standards**

*Exemplary* - The user interface is easy to use and provides clear configuration options. The final product is so stellar that Dr. Vigil-Hayes is able to being using the product for her class next year.

*Good* - The final product is functional and complete, with a user interface that is pretty easy to use. The product is ready for “prime time,” but still needs some work to make it ideal.

*Fair* - The basics are there, with a user interface that is usable, but this isn’t the kind of product anyone actually wants to use.

*Poor* - The final product is a box of parts, some of which might work individually, but nothing works in unison.

### **Special Team Skills**

Students on this project should have taken some Computer Science or Computer Engineering courses beyond that which is required for Electrical Engineering. A background knowledge in embedded programming will be a real plus here.

### **Specialty Equipment**

This project will require special antennas (LoRa, FM RBDS receiver, WiFi mesh, WiFi AP), which be provided by Dr. Vigil-Hayes.