Building an Isolated Wireless Lab Space on a College Campus

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Problem Statement

- Create isolated wireless and cellular networks inside a Faraday cage
- Provide curriculum concepts that showcases the educational value of the isolated networks
- Ensure the security of student data

Resource/Cost Estimate

Name	Quantity	Price
Raspberry Pi 3	2	$35
USB Wireless Dongle	1	$34.99
Wireless Router	1	$142.63
Android Phone	2	$164.58(each)
Metal Fabric	3ft^2	~$15
Nickel Conductive Coating	1	$35
Copper Foil Adhesive	1	$15
SIM card reader/writer & cutter	1	$20.59
Plastic Tub	2	$3.99

~$670
total cost

What Makes Our Project Unique

- Only have wired environments
- Opportunity to do wireless labs
  - Real world application
  - Different protocols
- Completely new material

Non-Functional Requirements

- Deliverables: Lab curriculum concepts with network environment
- Flexible Network Architecture
- User Authorization
- Users can access network off-campus
- Cages will fit next to existing server on campus

Functional Requirements

- One cage
  - 802.11 WiFi network
  - Global Standard for Mobile communications (GSM) network
- Signal isolation
- Software Defined Radio (SDR) to act as cell tower
- Intended Android phones connect to SDR
- Network environment accessible via ISU VPN
- Network access point: VMs
- Automated clients
  - Send and receive text messages and make phone calls
  - Scripts to automate network traffic (emails, website logins, etc.)

SW/Technology Platforms

- GSM Traffic
  - Android Debug Bridge
    - Send SMS
    - Simulate phone calls
- 802.11 Traffic
  - Python scripts on Raspberry Pi
    - Send emails
    - Log in/out of arbitrary websites

SW/Technology Platforms

- ESXi 6.5
  - Hosts VM’s within virtual networks
- Virtual Machines
  - Kali Linux - Student - Learning
  - Kali Linux - Admin - Configuration
  - pfSense - Router
  - Ubuntu 64-Bit 16.04 - SDR Configuration

HW/Technology Platforms

- Faraday Cage
- Raspberry Pi 3's
- Android Phones
- Linux Server
  - Support ~50 users
  - Equipped with OpenBTS software
- National Instruments USRP-2920 SDR
  - Admin Linux VM - Ubuntu Server 16.04 LTS

Potential Risks and Mitigation

- Students would unintentionally sniff public wireless and cellular traffic.

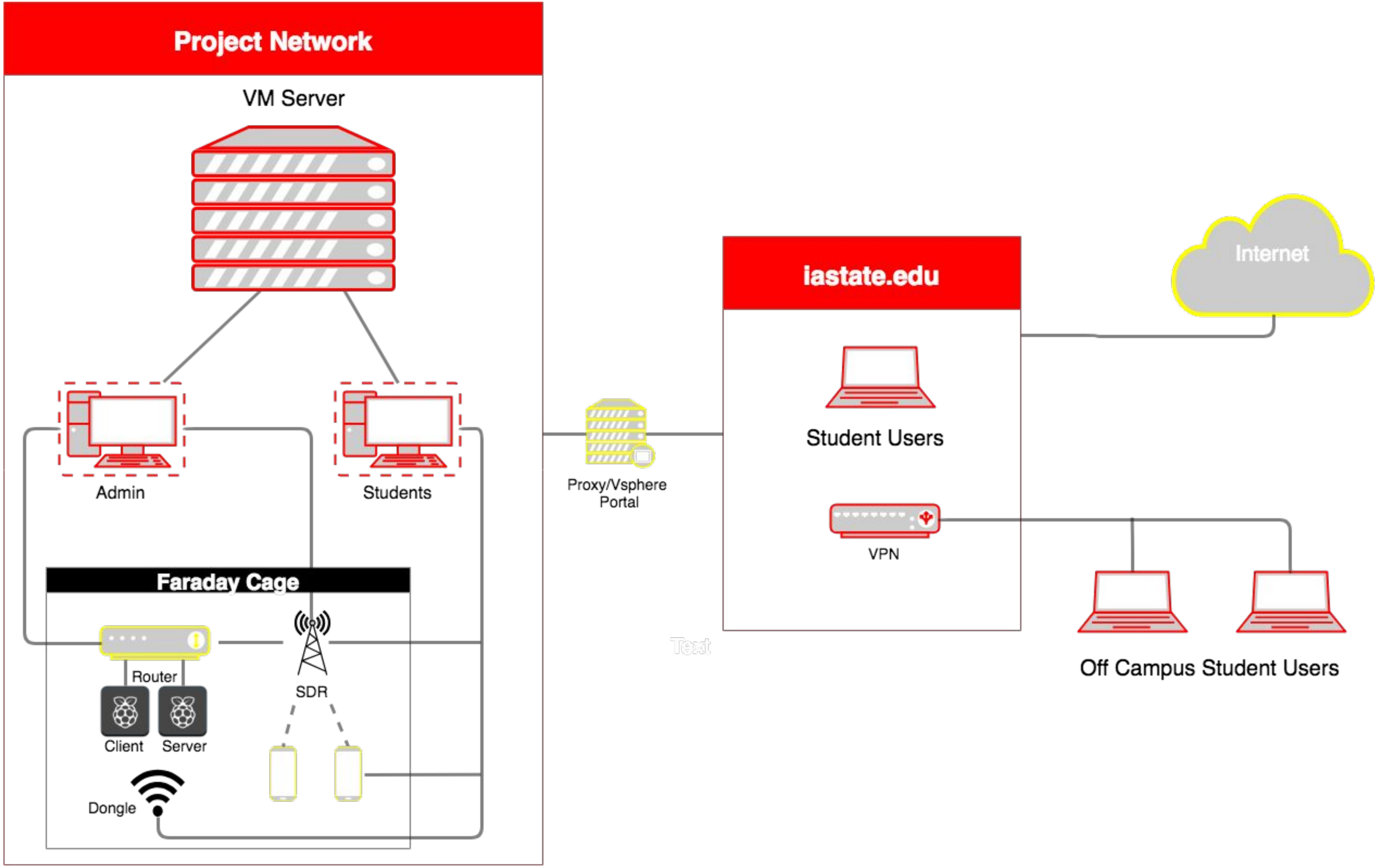
- If we were working with malware or viruses they could escape to the wild.

- Personal Cell Phones could connect to our SDR

- As mitigation, extensive testing will be done to ensure no signals cross the cage walls.
- Restricted access to the environment.

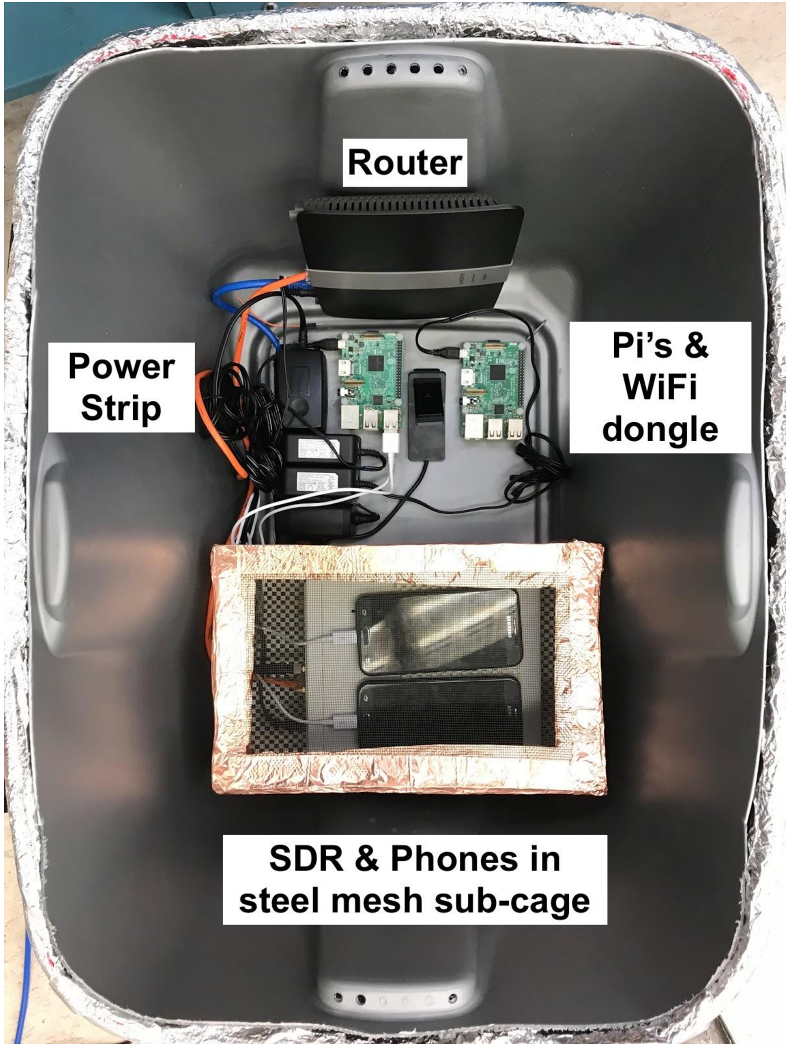
Technical Challenges

- Route GSM signals to simulate cellular traffic -> OpenBTS
- Configure VM Network -> ESXi & VSphere
  - External network interaction
  - NAT
- Cage Design
  - Durability
  - Wiring
  - Blocking Signals


Project Network
VM Server
Admin
Students
Faraday Cage
Router
Client
Server
SDR
Dongle
Proxy/Vsphere Portal
iastate.edu
Student Users
VPN
Internet
Text
Off Campus Student Users

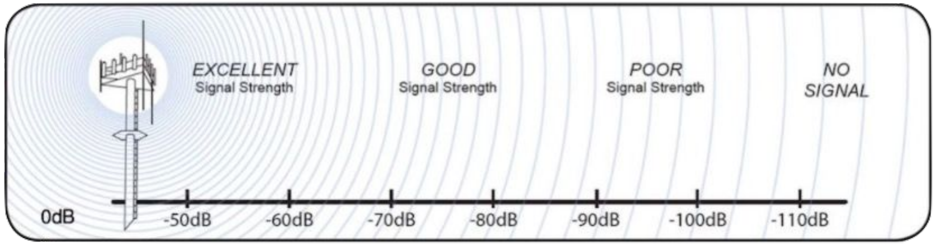
Final Faraday Cage

- Low cost
- Steel Mesh for 900MHZ
- Removed router antenne
- Only 3 cables out:
  - Power strip
  - Ethernet cable
  - USB WiFi dongle

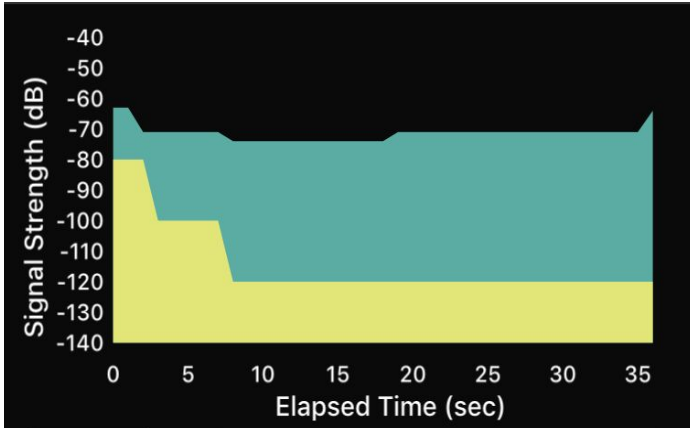


Test Plan and Results

- Individual material testing
- Individual and combined signal isolation
- Component specific testing
- Signal strengths measured with FaradayTest iOS app

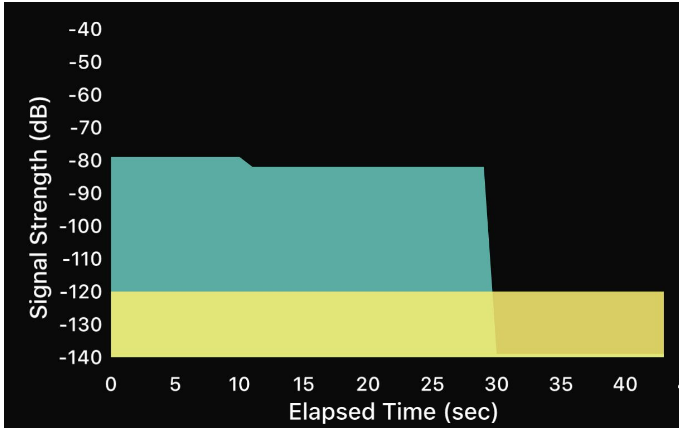


Cellular Sub-Cage Only



- ● WiFi
- ● Cellular

Entire Cage



Questions

Appendix