NERVE:

Network Event Realtime Visualization Engine for Security Monitoring

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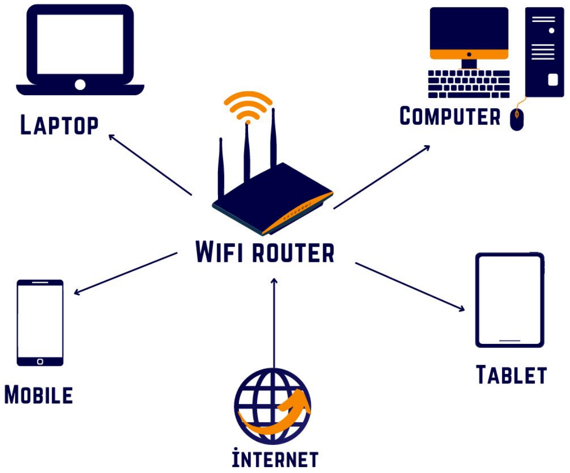
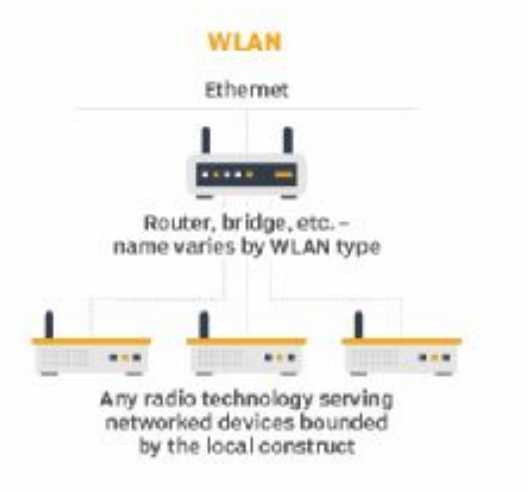
Introduction to WLAN

- A wireless local-area network (WLAN) is a group of colocated computers or other devices that form a network based on radio transmissions rather than wired connections.
- A Wi-Fi network is a type of WLAN



How does WLAN work?

- Information transmitted over radio waves.
- Data is sent in packets.
- The packets contain layers with info to enable routing to intended locations

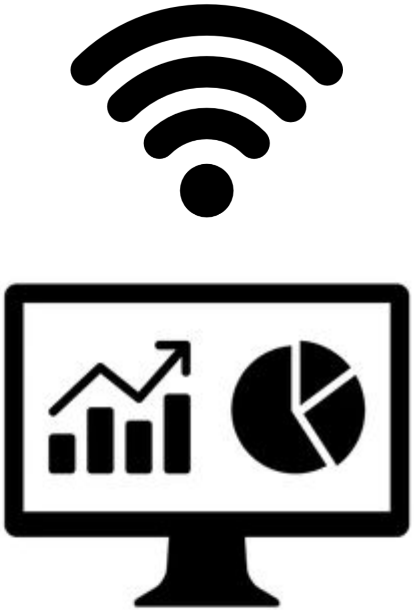

WLAN
Ethernet
Router, bridge, etc. – name varies by WLAN type
Any radio technology serving networked devices bounded by the local construct

Is a WLAN secure?

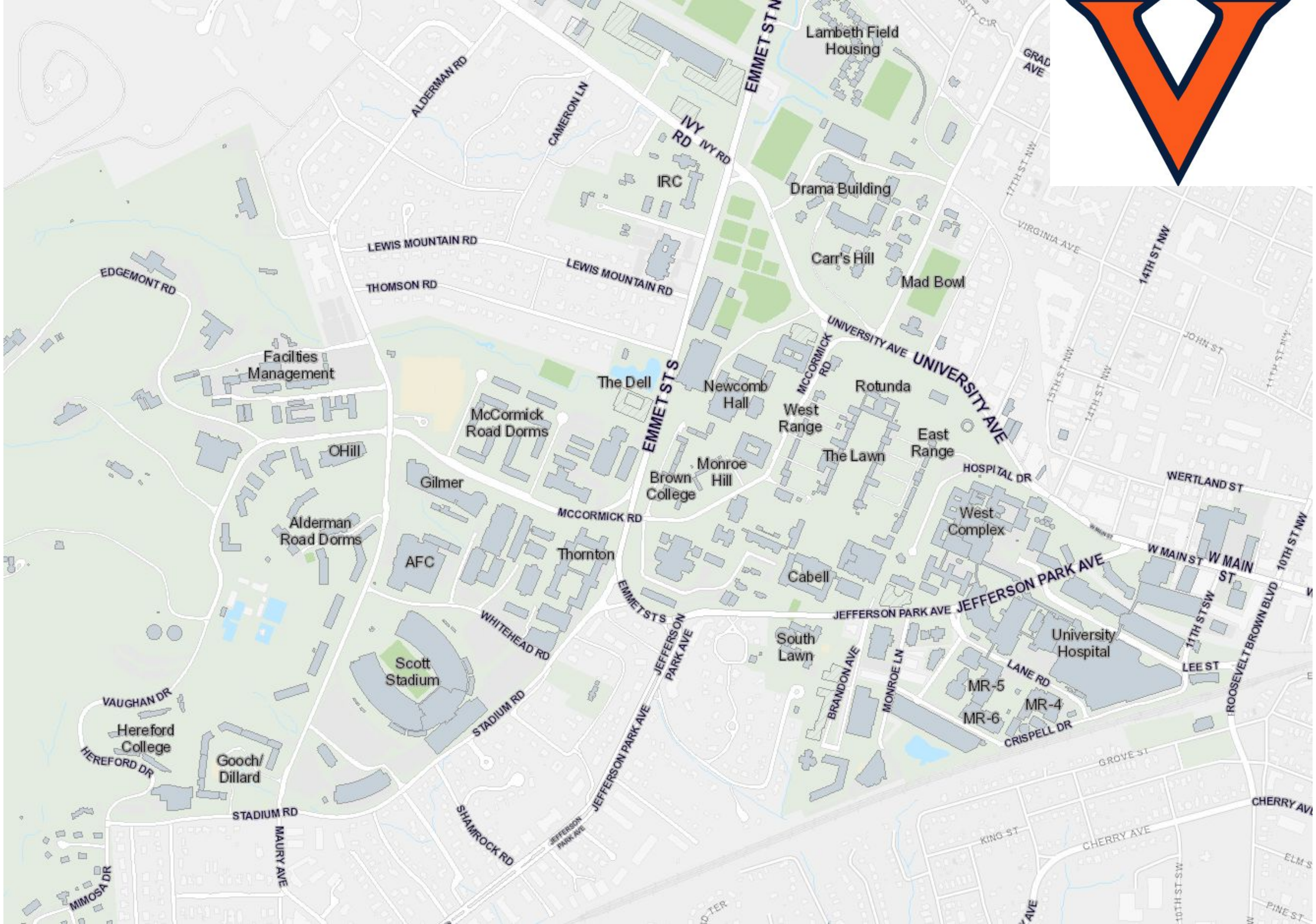
- A WLAN is more vulnerable to being breached than a physical network.
- To access a WLAN, a bad actor must simply be within range of the network.

Our project

- We worked on designing a real-time dashboard tool to capture packet data on wireless networks and analyze it.
- Our tool is a type of wireless sniffer solution, which we built to capture wireless network traffic and analyze it to generate insights into what's going on in a network at any given time.



Threat Model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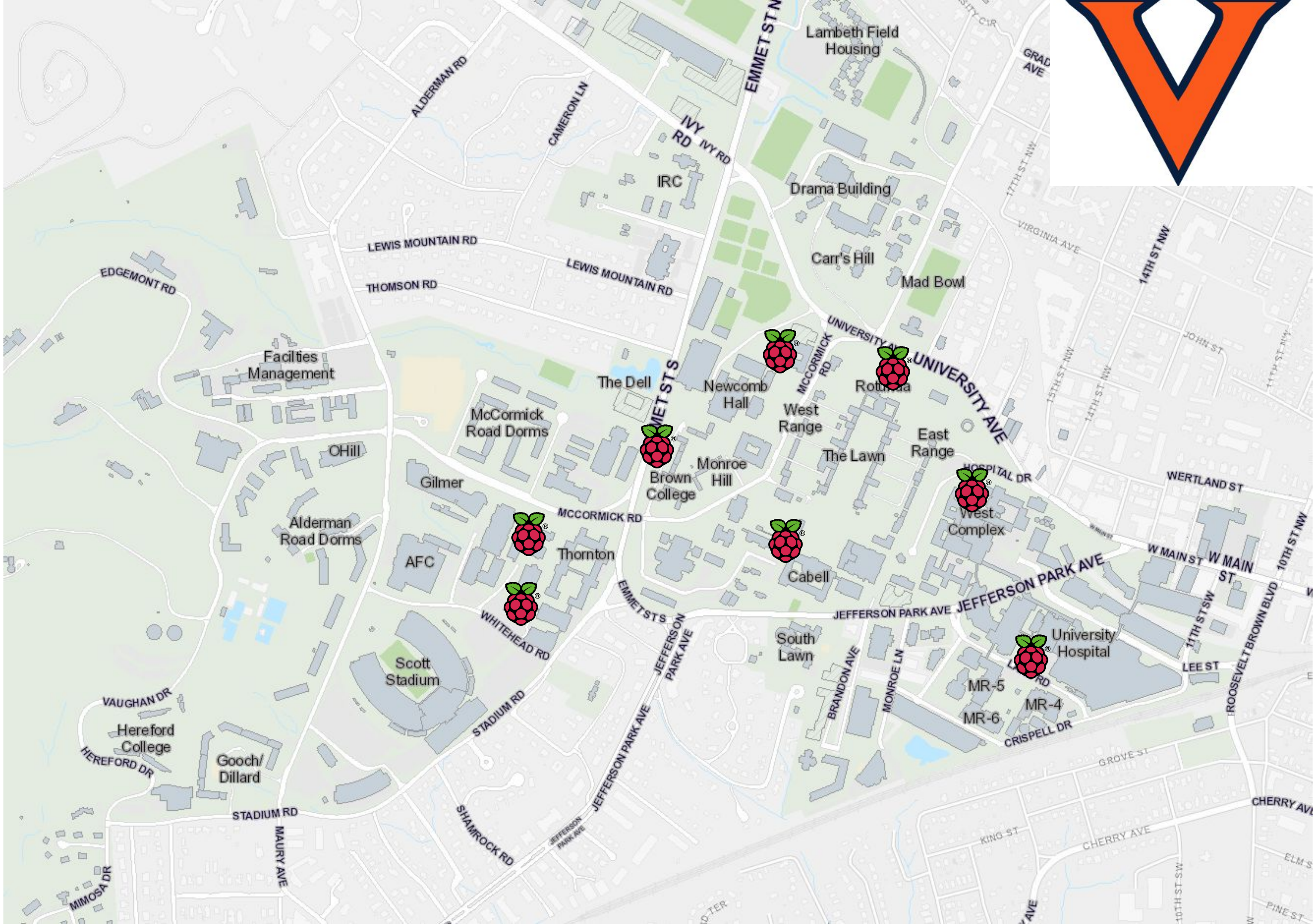
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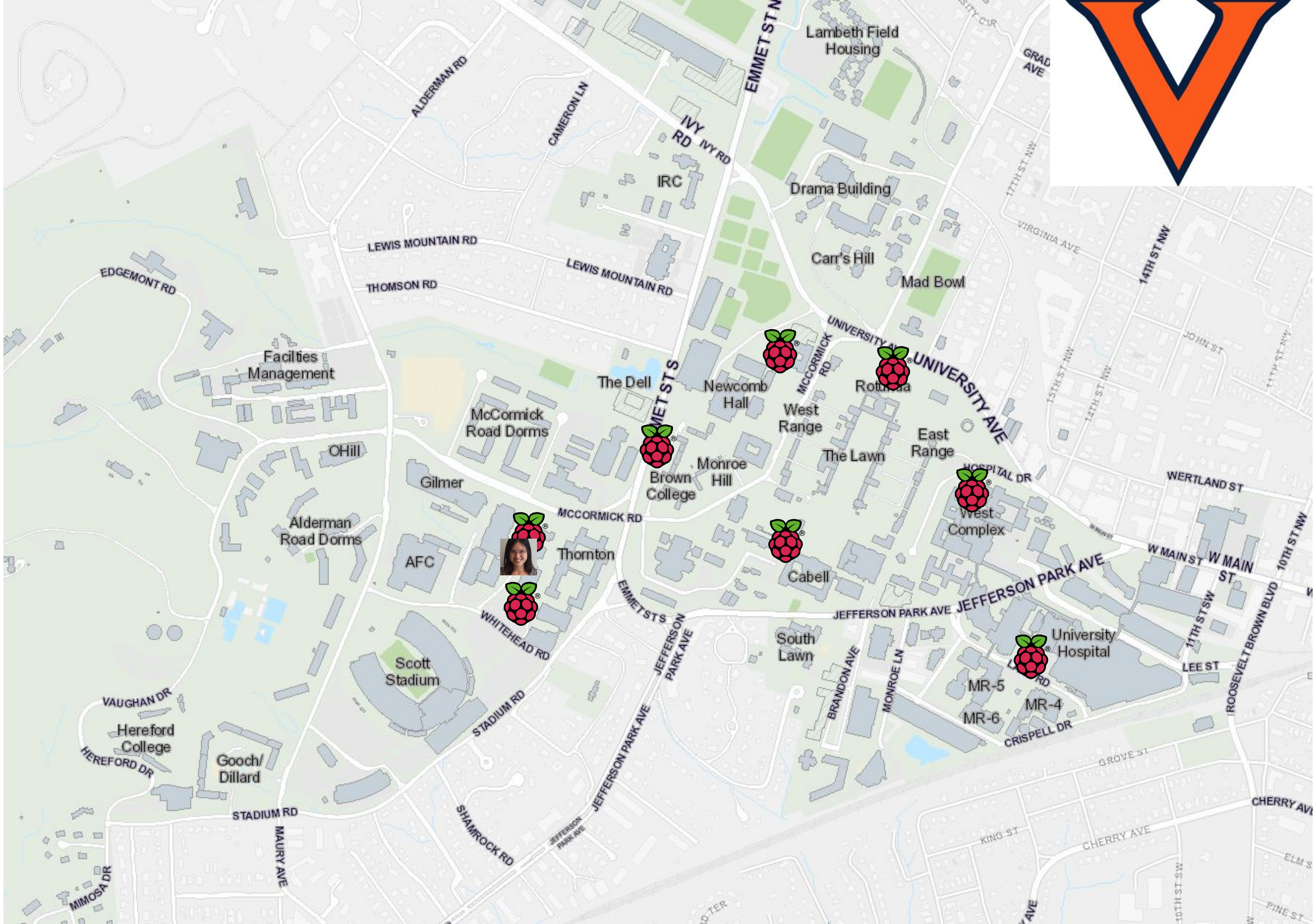
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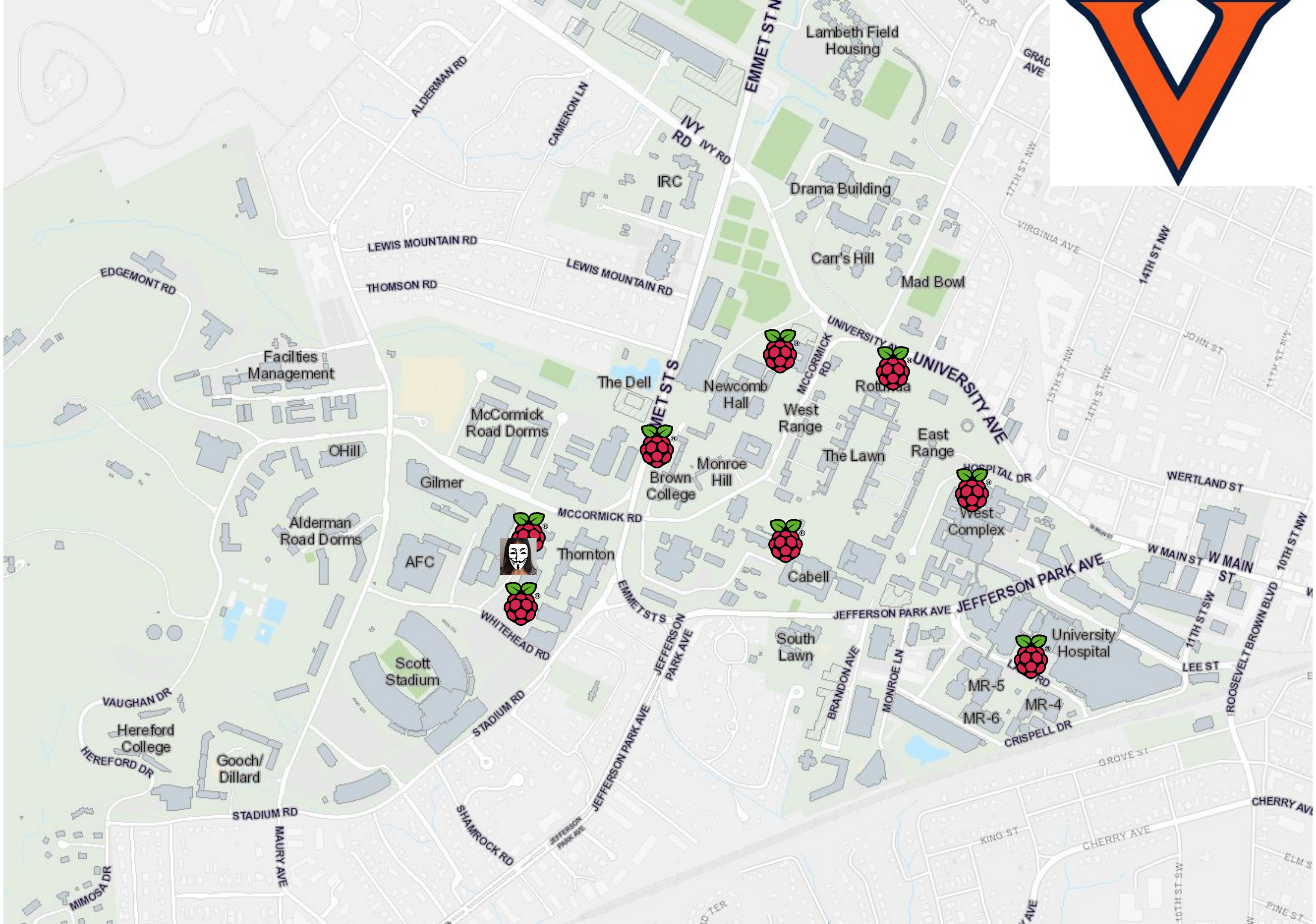

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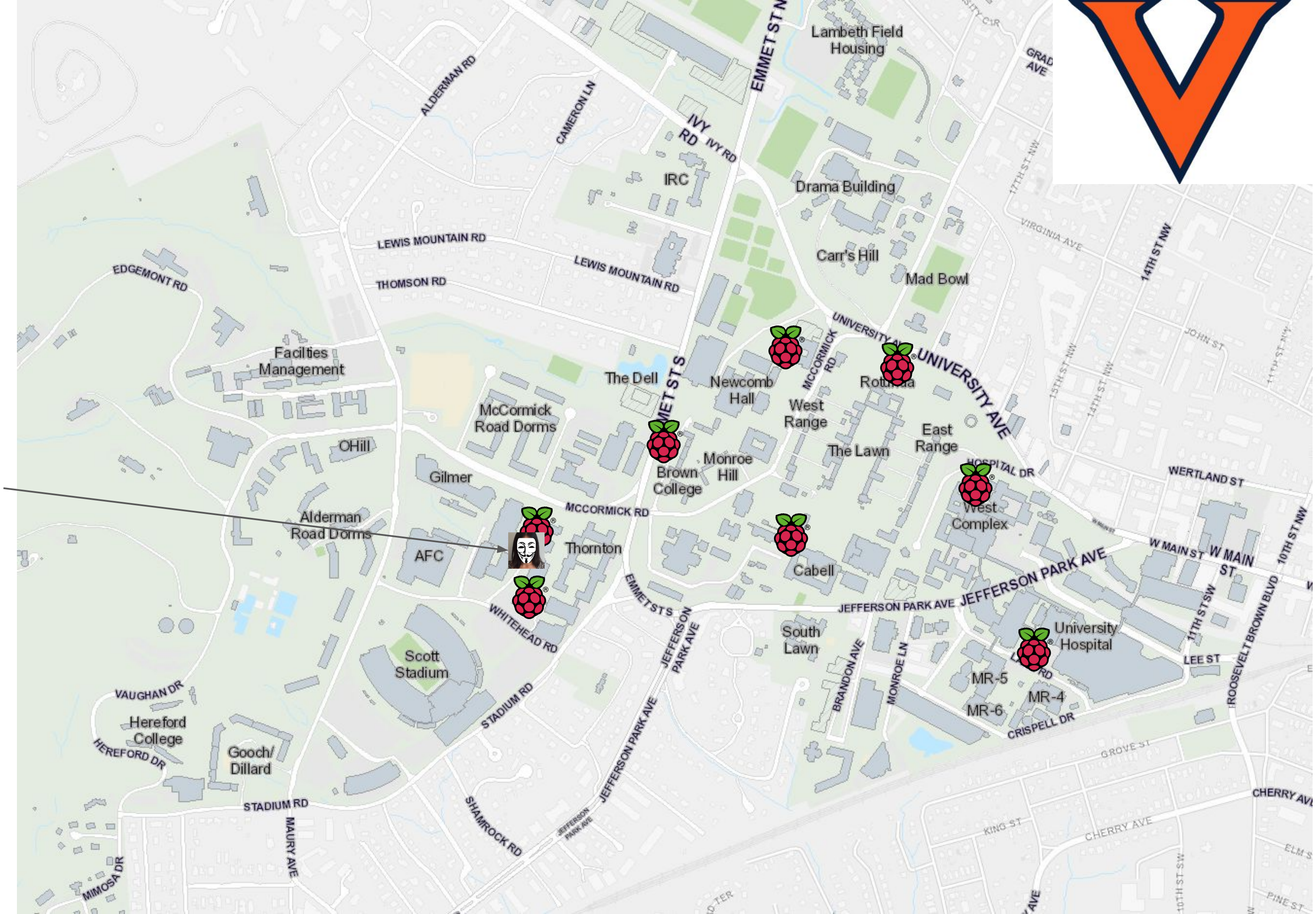
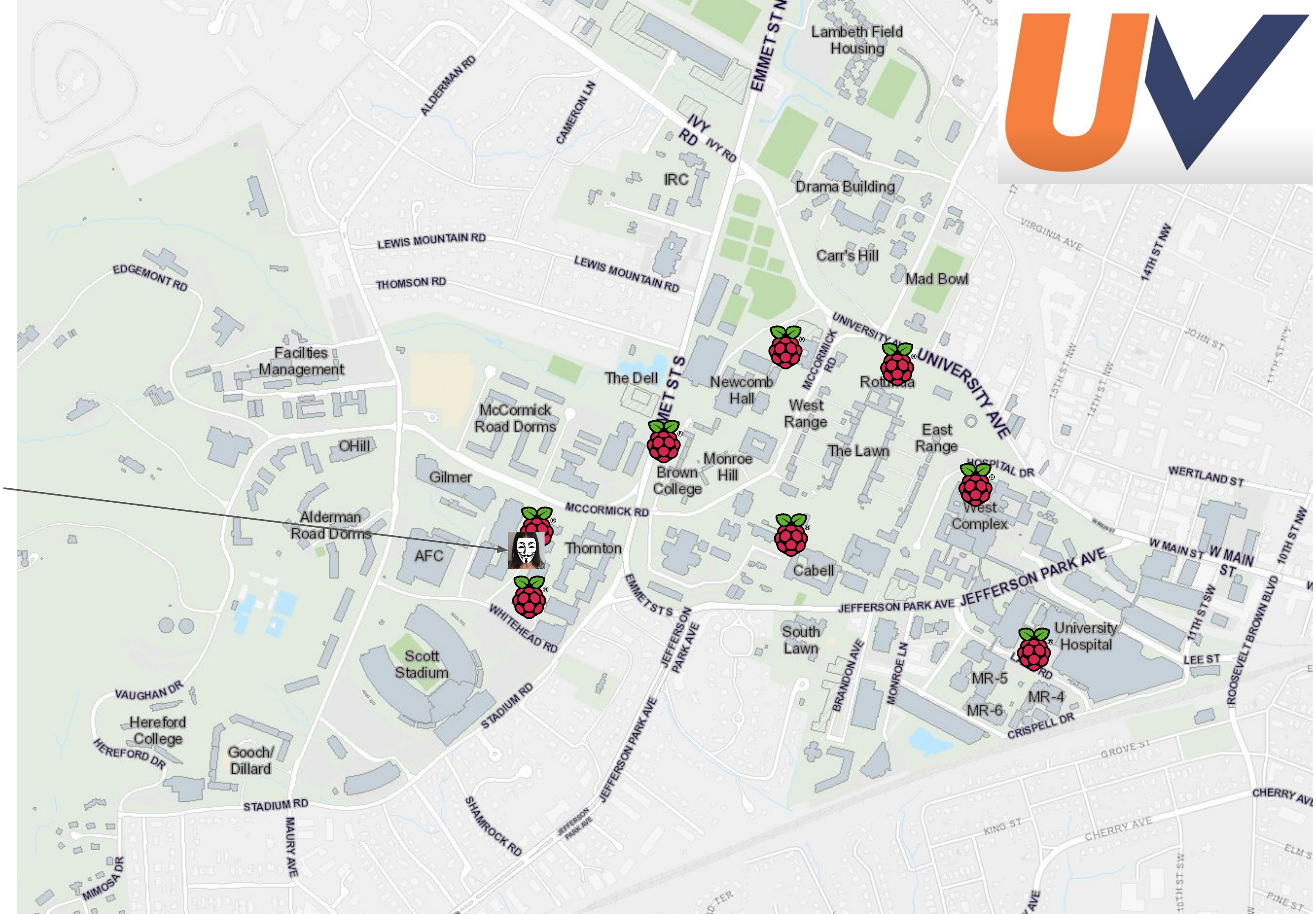


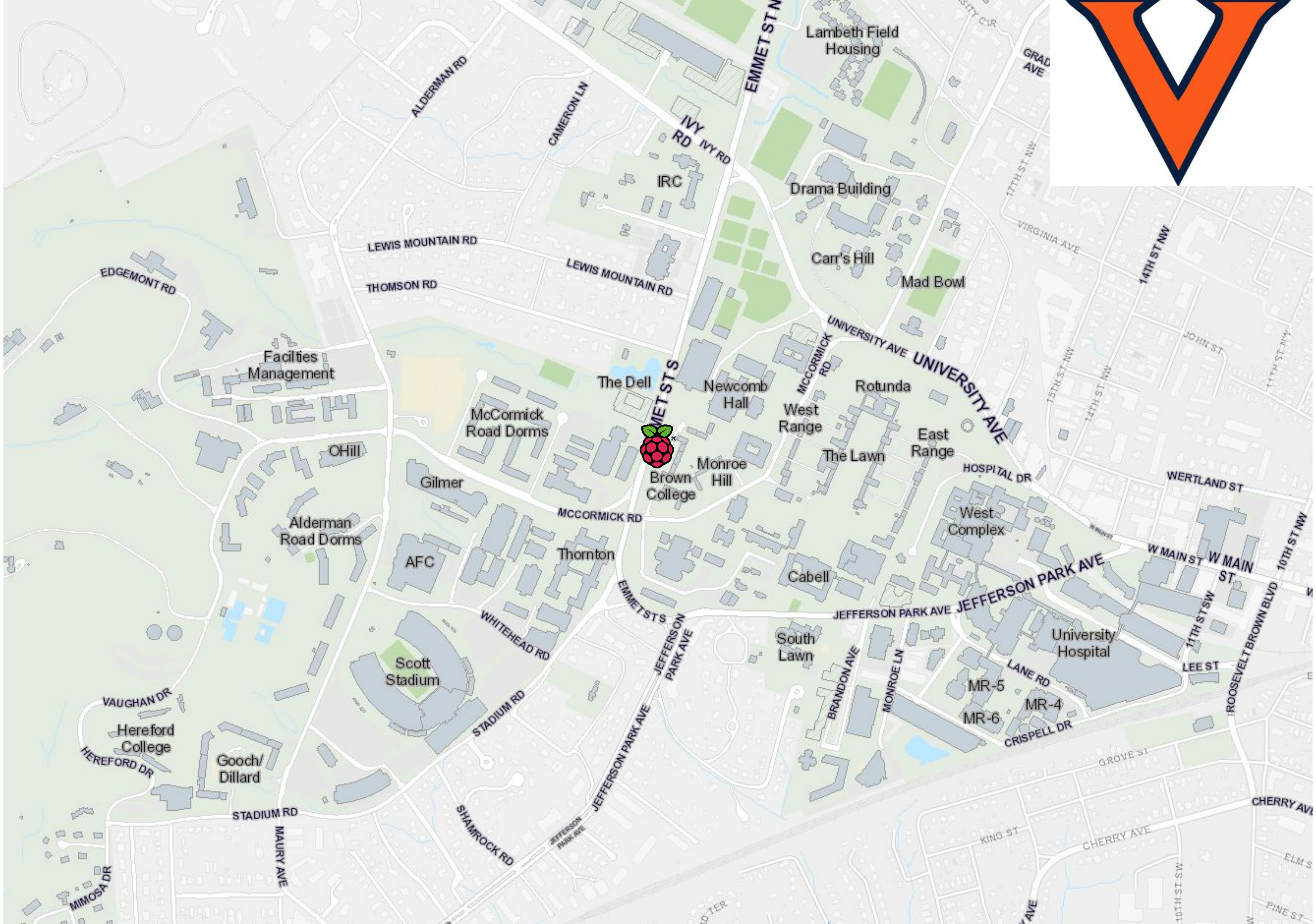
Identify hacker

Identify hacker



Validating Our Approach

A Small Scale Experiment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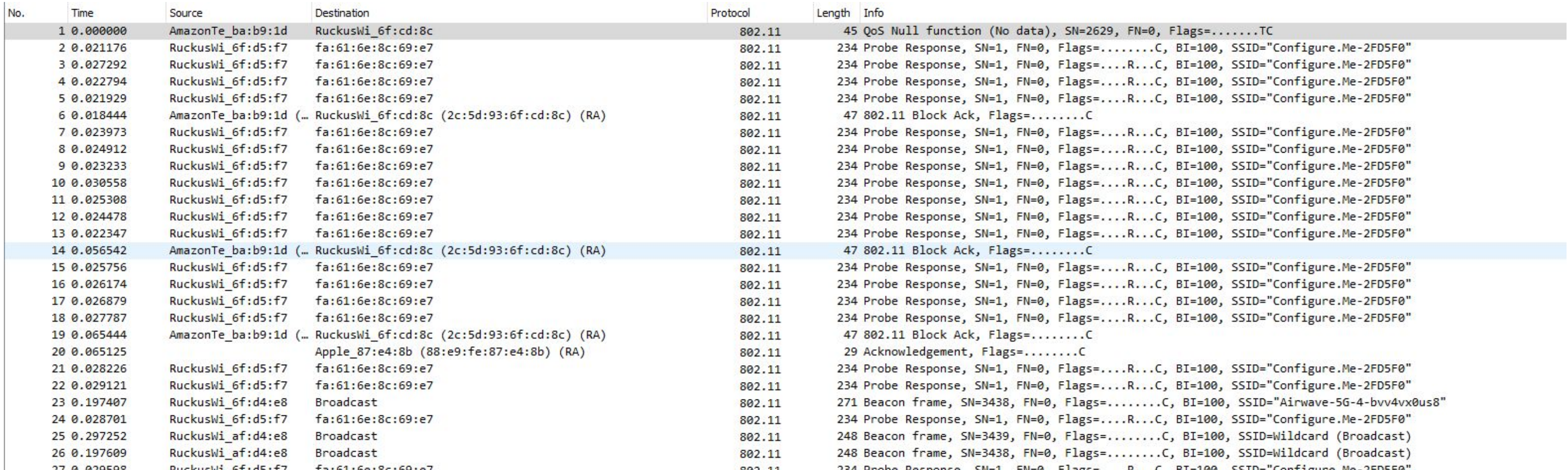
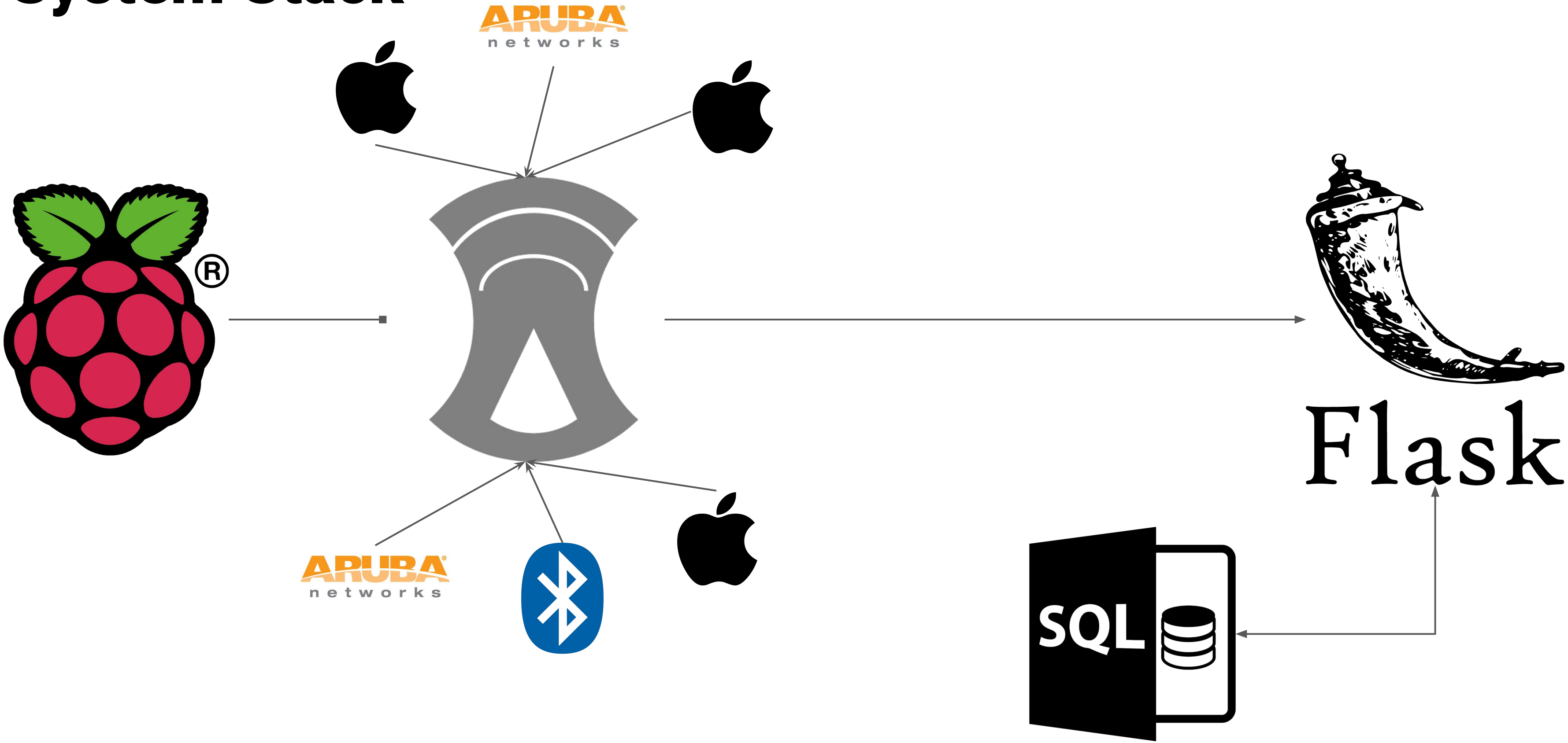
What is Wifi Sniffing?

- WiFi sniffing = intercepting and decoding wireless network traffic
- Capturing data packets (802.11 protocol) → analyze data being transmitted
  - Glean information about devices in topography of the network



No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	AmazonTe_ba:b9:1d	RuckusWi_6f:cd:8c	802.11	45	QoS Null function (No data), SN=2629, FN=0, Flags=.......TC
2	0.021176	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=........C, BI=100, SSID="Configure.Me-2FD5F0"
3	0.027292	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
4	0.022794	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
5	0.021929	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
6	0.018444	AmazonTe_ba:b9:1d (…	RuckusWi_6f:cd:8c (2c:5d:93:6f:cd:8c) (RA)	802.11	47	802.11 Block Ack, Flags=........C
7	0.023973	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
8	0.024912	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
9	0.023233	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
10	0.030558	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
11	0.025308	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
12	0.024478	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
13	0.022347	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
14	0.056542	AmazonTe_ba:b9:1d (…	RuckusWi_6f:cd:8c (2c:5d:93:6f:cd:8c) (RA)	802.11	47	802.11 Block Ack, Flags=........C
15	0.025756	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
16	0.026174	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
17	0.026879	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
18	0.027787	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
19	0.065444	AmazonTe_ba:b9:1d (…	RuckusWi_6f:cd:8c (2c:5d:93:6f:cd:8c) (RA)	802.11	47	802.11 Block Ack, Flags=........C
20	0.065125		Apple_87:e4:8b (88:e9:fe:87:e4:8b) (RA)	802.11	29	Acknowledgement, Flags=........C
21	0.028226	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
22	0.029121	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
23	0.197407	RuckusWi_6f:d4:e8	Broadcast	802.11	271	Beacon frame, SN=3438, FN=0, Flags=........C, BI=100, SSID="Airwave-5G-4-bvv4vx0us8"
24	0.028701	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"
25	0.297252	RuckusWi_af:d4:e8	Broadcast	802.11	248	Beacon frame, SN=3439, FN=0, Flags=........C, BI=100, SSID=Wildcard (Broadcast)
26	0.197609	RuckusWi_af:d4:e8	Broadcast	802.11	248	Beacon frame, SN=3438, FN=0, Flags=........C, BI=100, SSID=Wildcard (Broadcast)
27	0.029598	RuckusWi_6f:d5:f7	fa:61:6e:8c:69:e7	802.11	234	Probe Response, SN=1, FN=0, Flags=....R...C, BI=100, SSID="Configure.Me-2FD5F0"

System Stack



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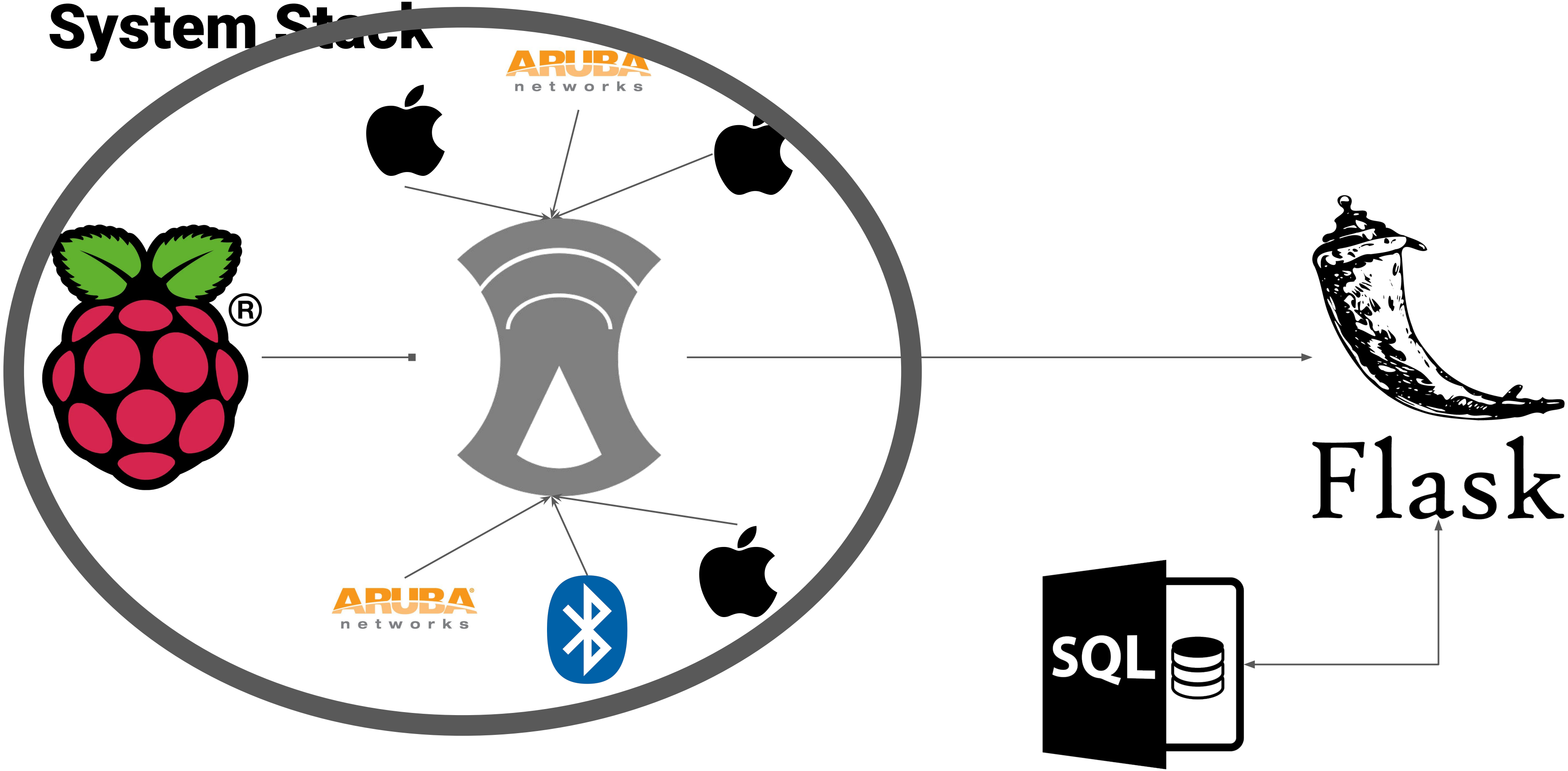


Setting Up Wifi Sniffing

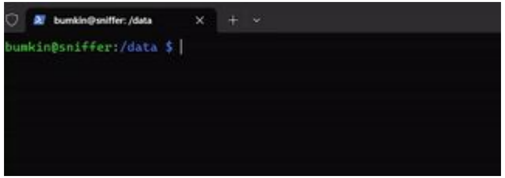
1. Acquiring a WLAN card that supports Monitor Mode

Setting Up Wifi Sniffing

1. Acquiring a WLAN card that supports Monitor Mode

2. Headless Raspberry Pi Setup with Linux

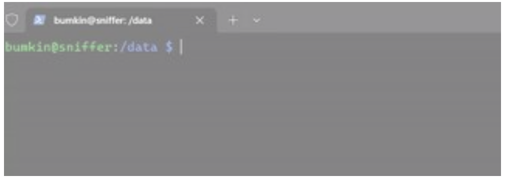
    a. Debugging (Firewall, DNS)



```
bumkin@sniffer:/data $ 
```

Setting Up Wifi Sniffing

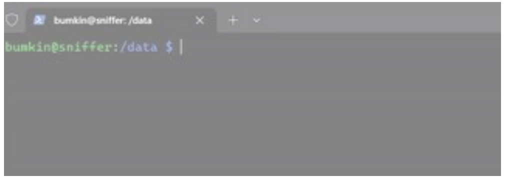
1. Acquiring a WLAN card that supports Monitor Mode
2. Headless Raspberry Pi Setup with Linux
   a. Debugging (Firewall, DNS)
3. Install Kismet



```
bumkin@sniffer:/data $ |
```

Setting Up Wifi Sniffing

1. Acquiring a WLAN card that supports Monitor Mode
2. Headless Raspberry Pi Setup with Linux
   a. Debugging (Firewall, DNS)
3. Install Kismet
4. Port Forwarding

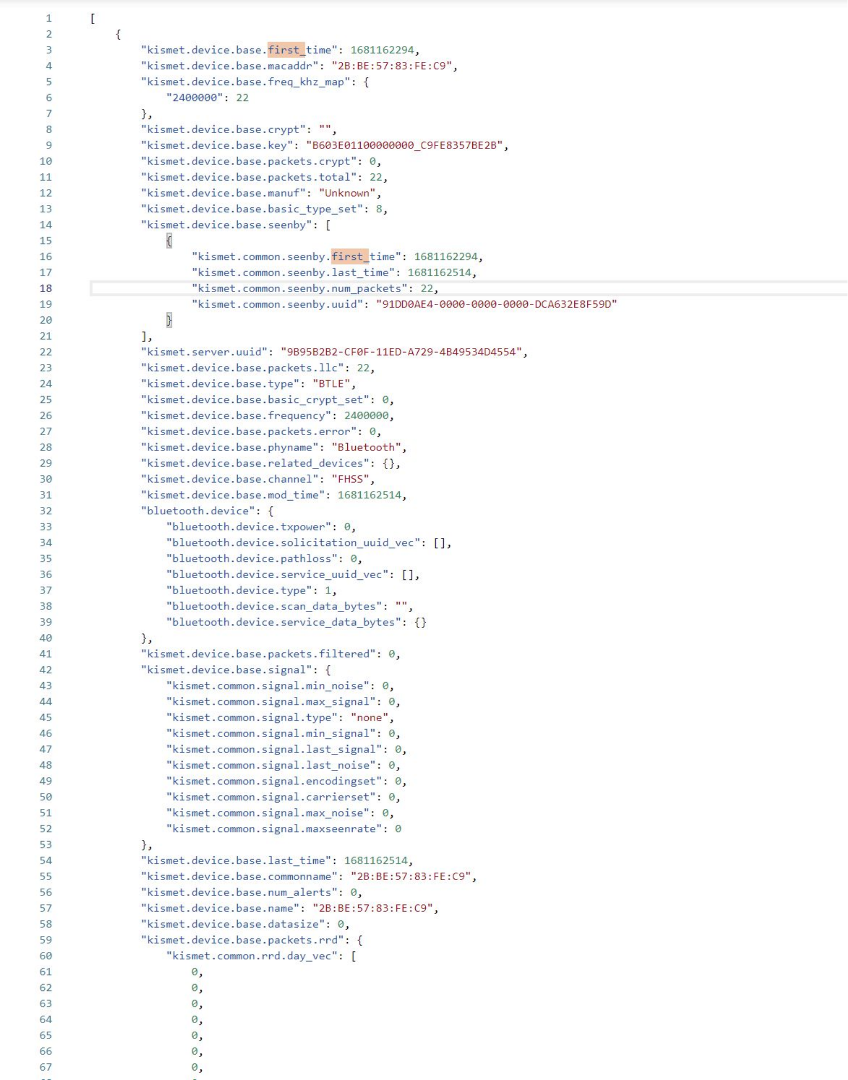


```
bumkin@sniffer:/data $ |
```

Data Analysis

Data Retrieval

- Endpoints:
    - /devices.json
    - /channels.json
    - /ssids.json
    - /tracked_fields.html



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[
    {
        "kismet.device.base.first_time": 1681162294,
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            }
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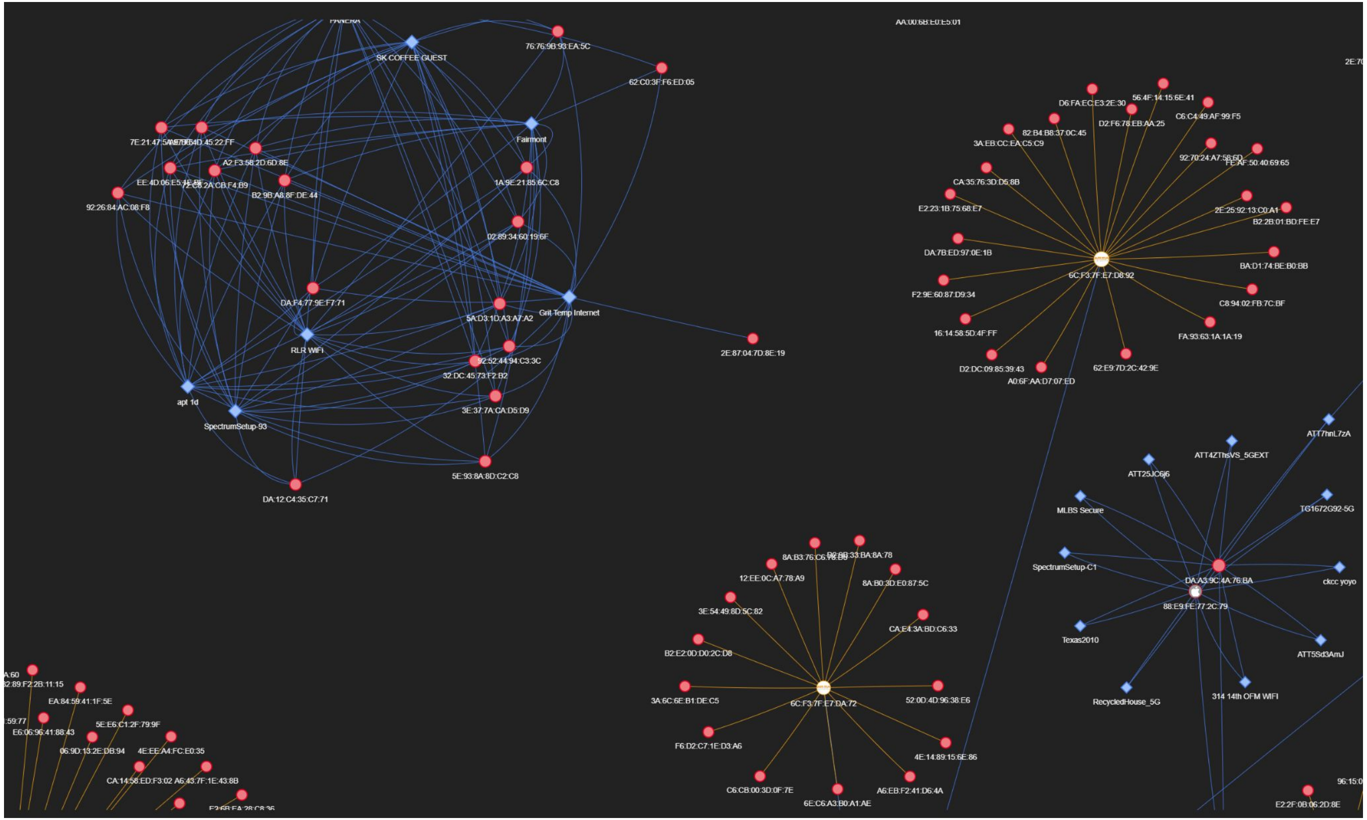
        "kismet.device.base.packets.rrd": {
            "kismet.common.rrd.day_vec": [
                0,
                0,
                0,
                0,
                0,
                0,
                0,
```

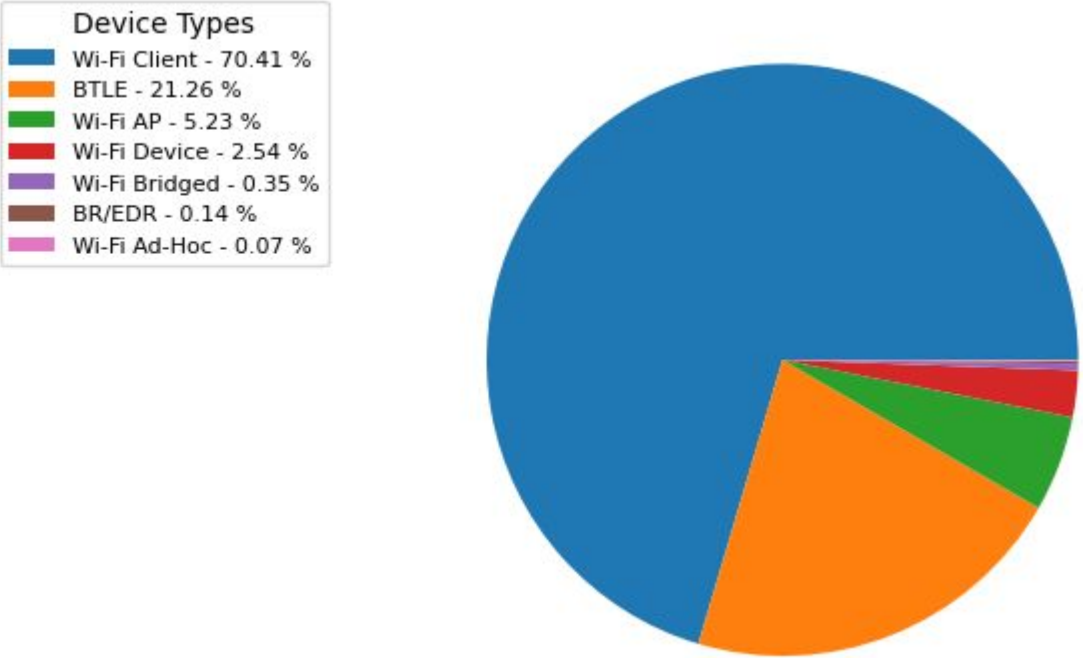
Data Processing

- Jupyter Notebooks
- Pandas dataframes
- Matplotlib
- Pyviz

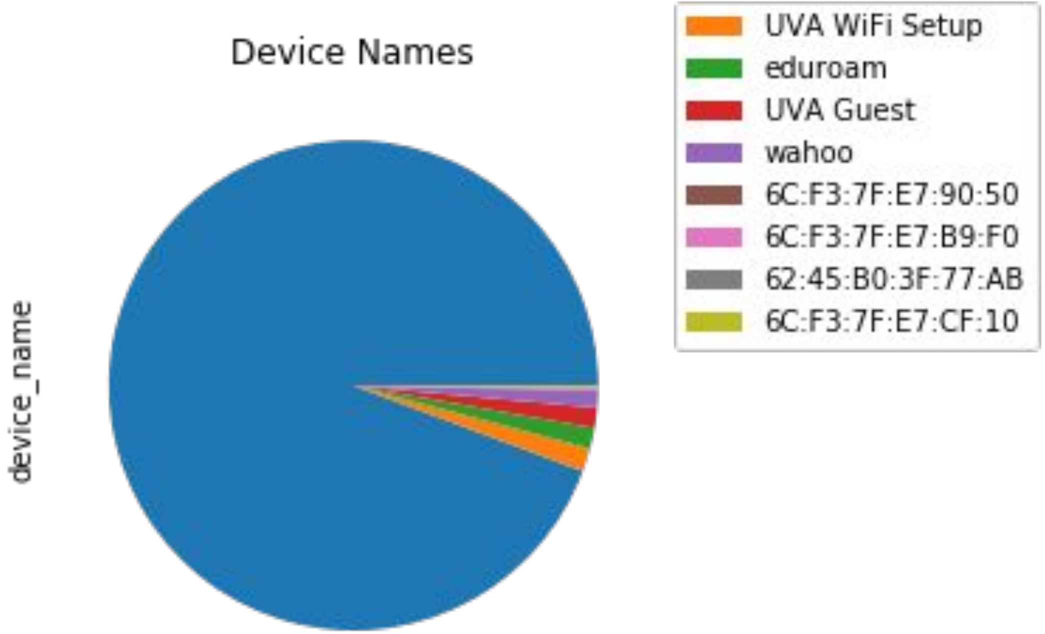
Data Analysis - SSIDs



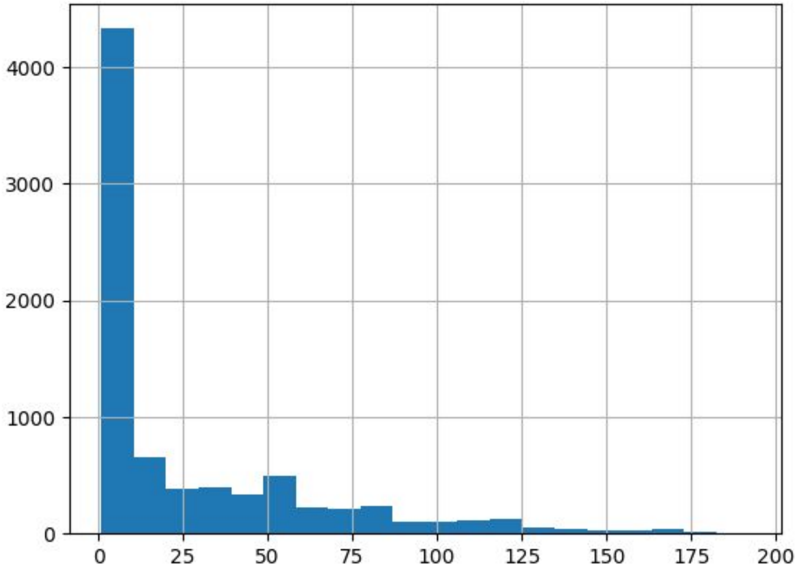
Data Analysis - Summary Statistics

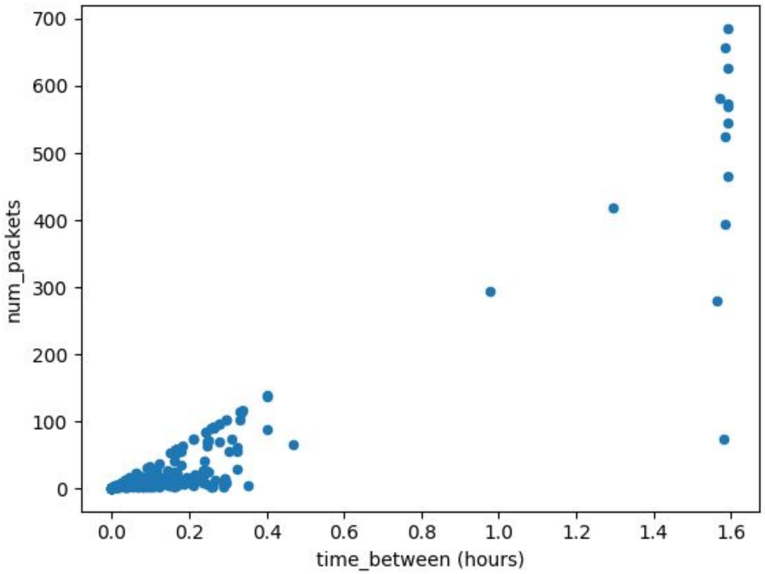


Data Analysis - WLAN



Data Analysis - Bluetooth





Limitations and Challenges

Monitor Mode

- Unsupported by most Windows laptops and some Macs
- Solution: Raspberry Pi and capture card

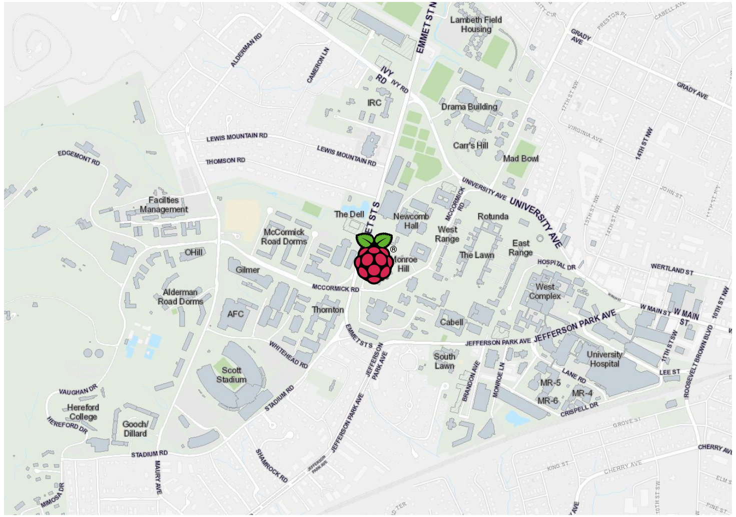
Img source: https://en.wikipedia.org/wiki/Computer_monitor

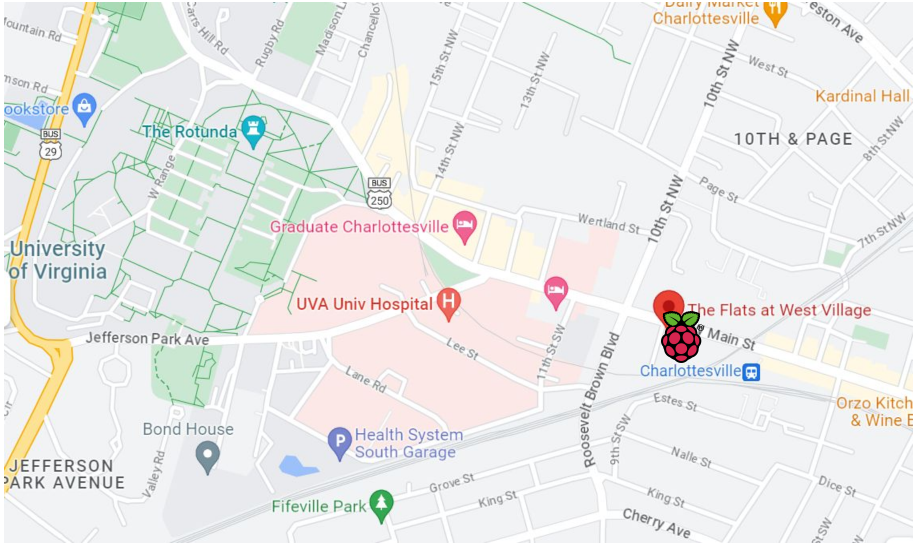
Kismet

- Works for Linux and macOS

Data Collection Locations

- Ability to leave data collection devices unattended was necessary





Unavailable Information

- Eduroam Security
- Unknown Device Manufacturers

https://www.flaticon.com/free-icon/cyber-security_1797500

Dashboard Tool

Backend

- Flask framework
- Application instance
    - “run” method - launches Flask’s integrated development web server.
    - Waits for incoming requests from client - requests are sent to application instance
    - To process incoming data - use request object
        - can use GET and POST methods to receive or send data.
    - Flask invokes a view function and returns a response value to the client.
- Used pandas and matplotlib libraries to create visuals of our analysis for display on the dashboard

Frontend

- Frontend of web apps handles how the application is displayed to the user
- For this project was built using HTML, CSS, and Javascript.
  - HTML is used to display the content
  - CSS describes styles of content
  - Javascript is for “client-side” services.

Demo

Thank you!

Questions?