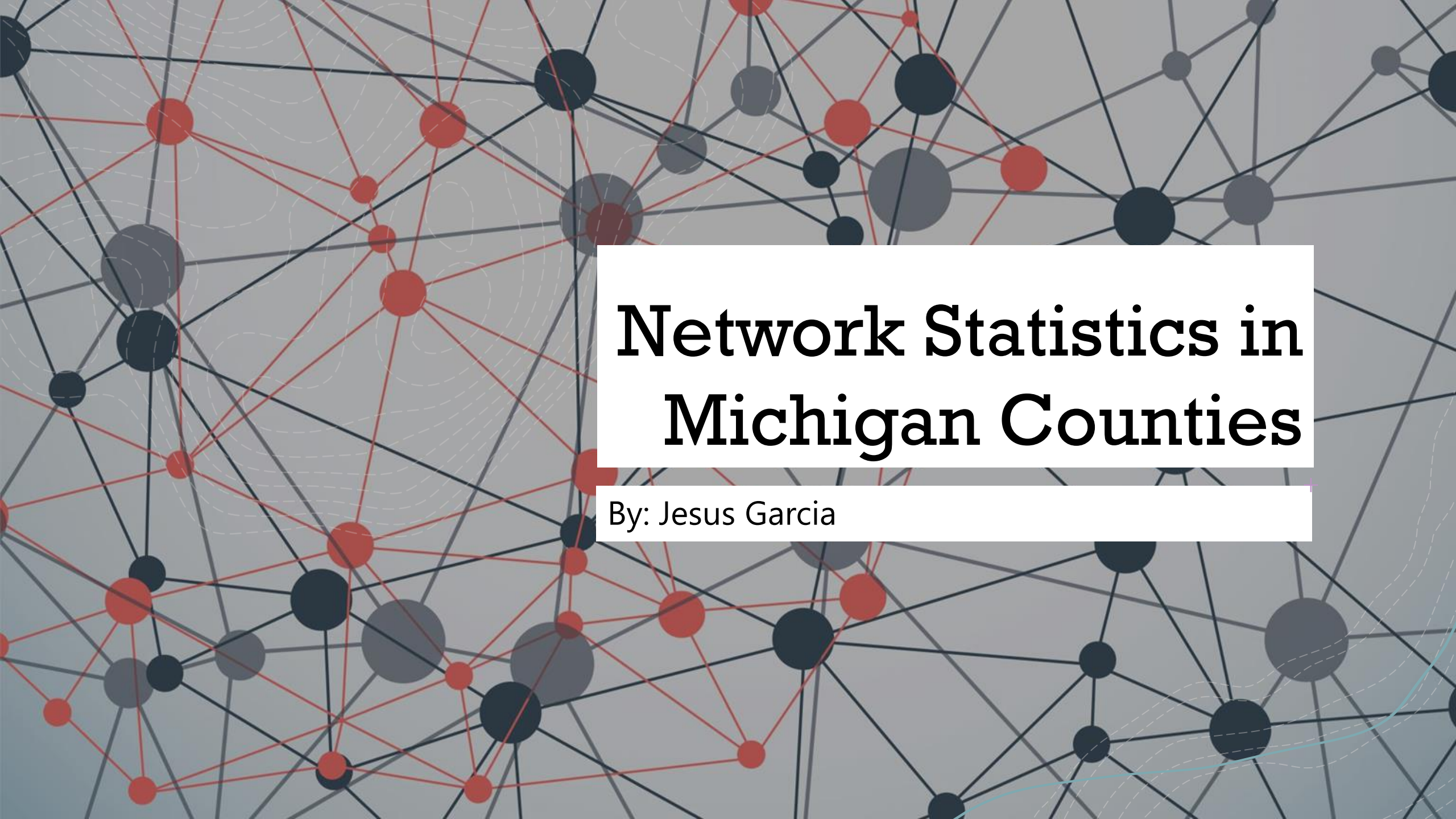
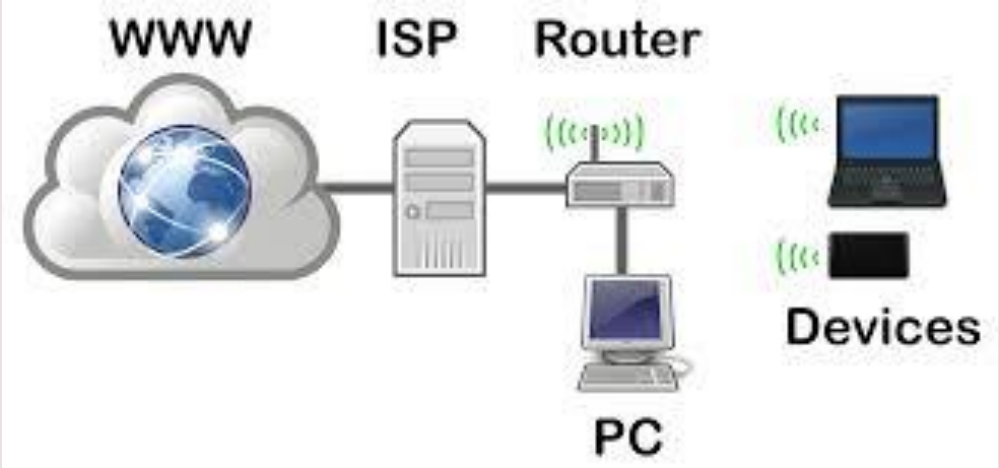


Network Statistics in Michigan Counties

By: Jesus Garcia

Motivation

- How does income affect traditional home networks?
  - Do the network topologies differ?
  - Might it be more expensive to have 5Ghz devices?
  - How do the amount of devices in each network differ?



Locations for Data Collection

- The locations to collect data were based on income per capita
  - Ionia per capita income: $23,956 (Low)
  - Eaton per capita income: $31,982 (Equivalent)
  - Oakland per capita income: $42,760 (High)
- Average Michigan per capita income: $30,336

- The counties have approximately low, equivalent, and high incomes with respect to the average Michigan per capita income

Major Obstacles

- How can we collect network data while remaining mobile via motor vehicle?
- What kind of network data should be collected?
- How much data should be collected?
- What software can provide the needed GUI to observe the data?

Hardware Requirements

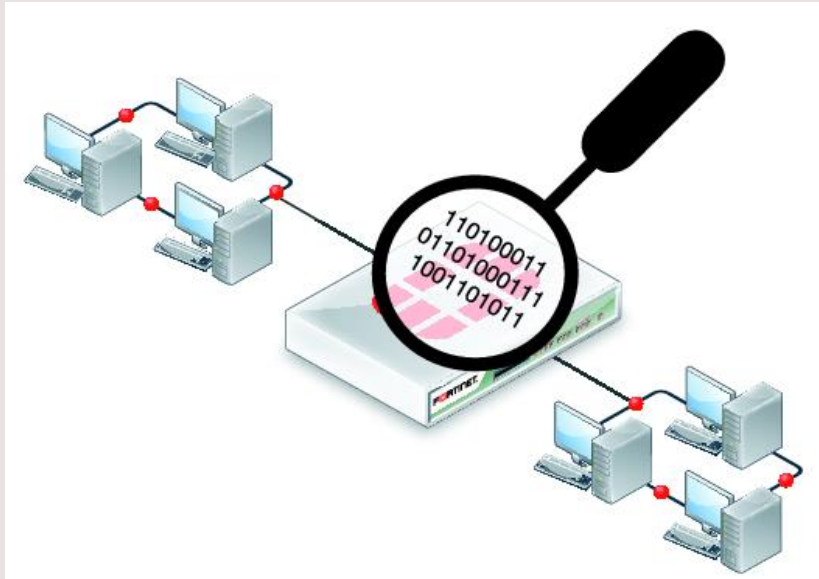
+ Raspberry Pi4 w/Display + Case

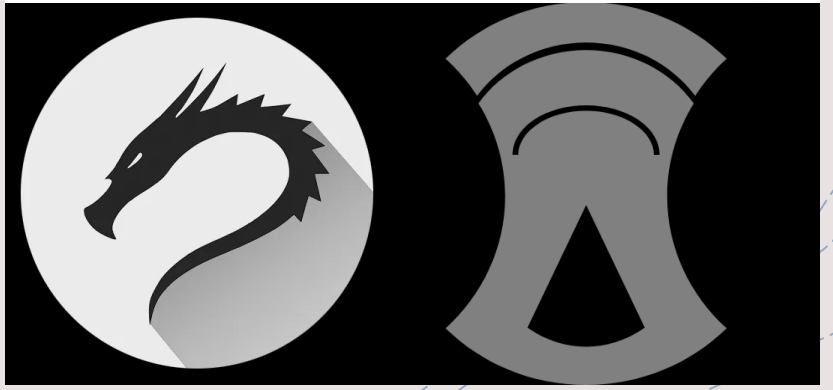
+ Long-Range Dual Band WiFi adapter x2 5dbi antennas (Capable of monitor mode)

+ Peripherals

Software Requirements

- Flash Raspberry Pi with Kali Linux OS
- Reconfigure Dual band adapter to operate in monitor mode via Kali config files
- Download Kismet
- Configure logging functions and data sources

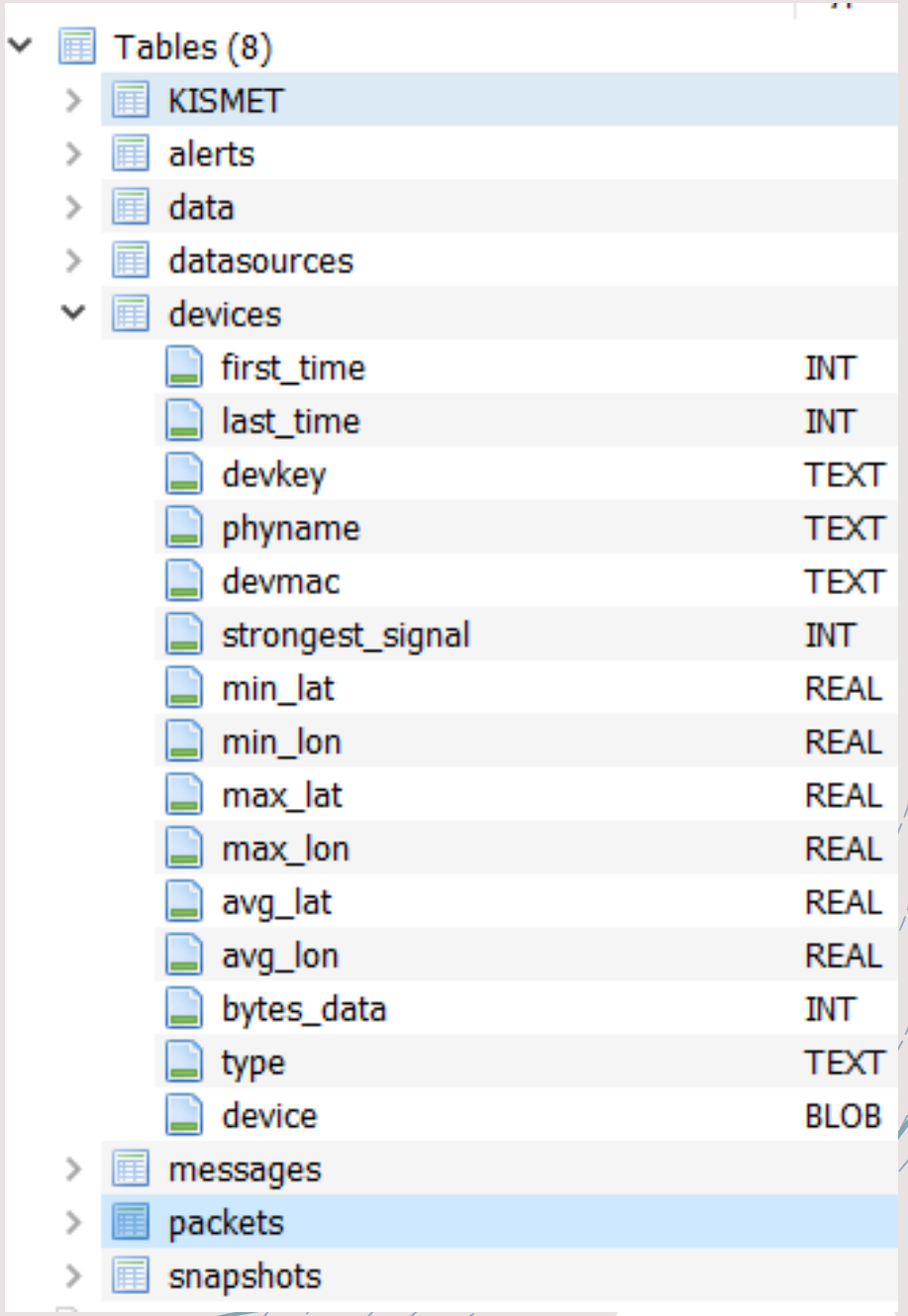




Data Collection

- With Kismet we can collect data on:
  - Source/Destination MAC's for packets
  - Frequency & Signal Strength
  - Packet Length
  - Device Type (Wi-Fi Client/Device/Bridged/AP/Ad-Hoc)
  - SSID's (Including Cloaked SSID's)

- No GPS data was collected

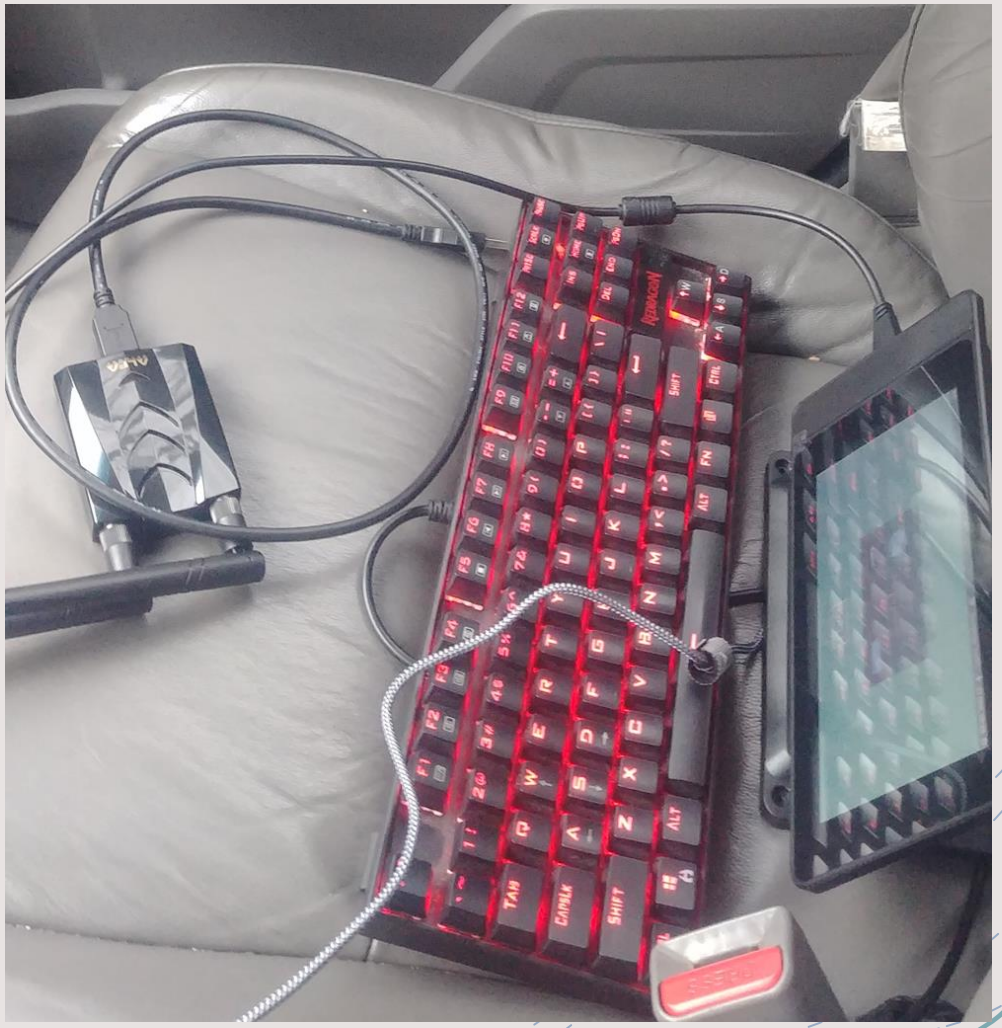


Data Collection

- To collect data, I drove through 3 random residential neighborhoods in each county
- For each neighborhood, 3 miles worth of data was collected
- Data is logged every 300ms into a SQLite database to account

Hypothesis

- As income increases, I believe we will also see an increase in:
  - Packet Interception
  - Devices
  - 5GHz Access Points

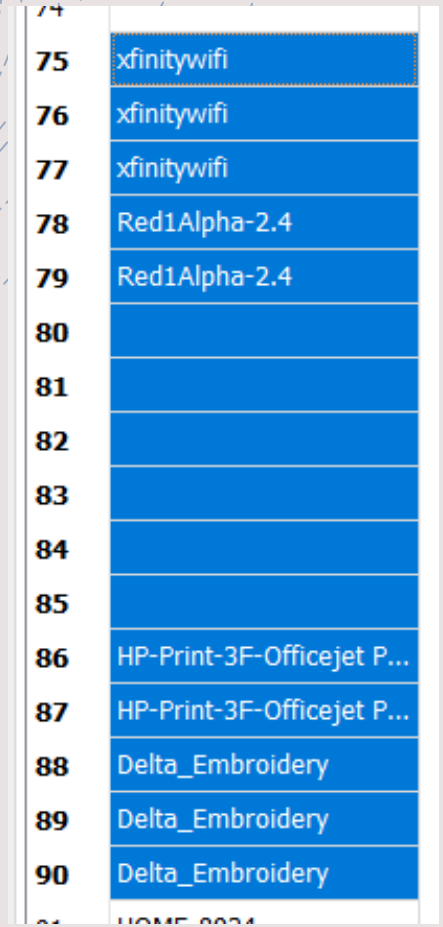


My State-of-the-Art Laboratory

Visual Observations

- I collected the data in the order of Ionia, Eaton and Oakland
- Some devices might not be logged due to signal attenuation
  - As income increased so did home size
  - As income increased more houses seemed to be built of brick
- Neighborhood size decreased as income increased (Does this have any bias towards higher speed internet availability?)

Cleaning the Data



75	xfinitywifi
76	xfinitywifi
77	xfinitywifi
78	Red1Alpha-2.4
79	Red1Alpha-2.4
80	
81	
82	
83	
84	
85	
86	HP-Print-3F-Officejet P...
87	HP-Print-3F-Officejet P...
88	Delta_Embroidery
89	Delta_Embroidery
90	Delta_Embroidery

devmac	strongest_signal	bytes_data	type	device
Filter	Filter	Filter	Filter	Filter
[redacted]	0	385	Wi-Fi Bridged	{"kismet.device.base.type": "Wi-Fi Bridged","dot11.device": {"dot11.device.last_bssid": "3C:B7:4B:...
[redacted]	0	391	Wi-Fi Bridged	{"kismet.device.base.type": "Wi-Fi Bridged","dot11.device": {"dot11.device.last_bssid": ...
[redacted]	-80	52	Wi-Fi Client	{"kismet.device.base.type": "Wi-Fi Client","dot11.device": {"dot11.device.last_bssid": [redacted]
[redacted]	0	52	Wi-Fi Device	{"kismet.device.base.type": "Wi-Fi Device","dot11.device": {"dot11.device.last_bssid": [redacted]

```
SELECT j.value
FROM VALID_APS AS d
JOIN json_tree(d.device) AS j
WHERE j.key = 'dot11.advertisedssid.ssid';

CREATE VIEW VALID_APS AS
SELECT *
FROM devices
WHERE type ='Wi-Fi Bridged' OR type='Wi-Fi AP' OR type='Wi-Fi Ad-Hoc';
```

Data Results

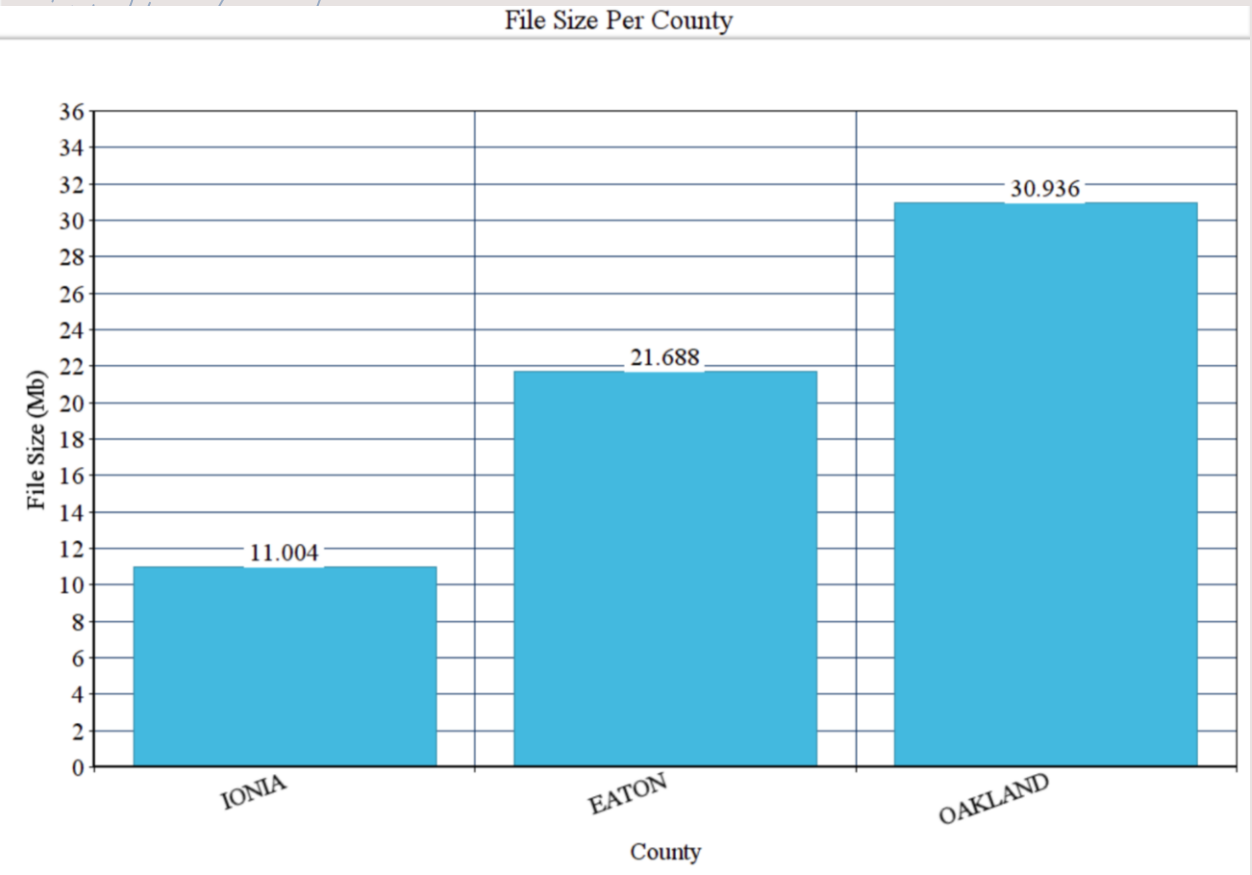


Figure 1

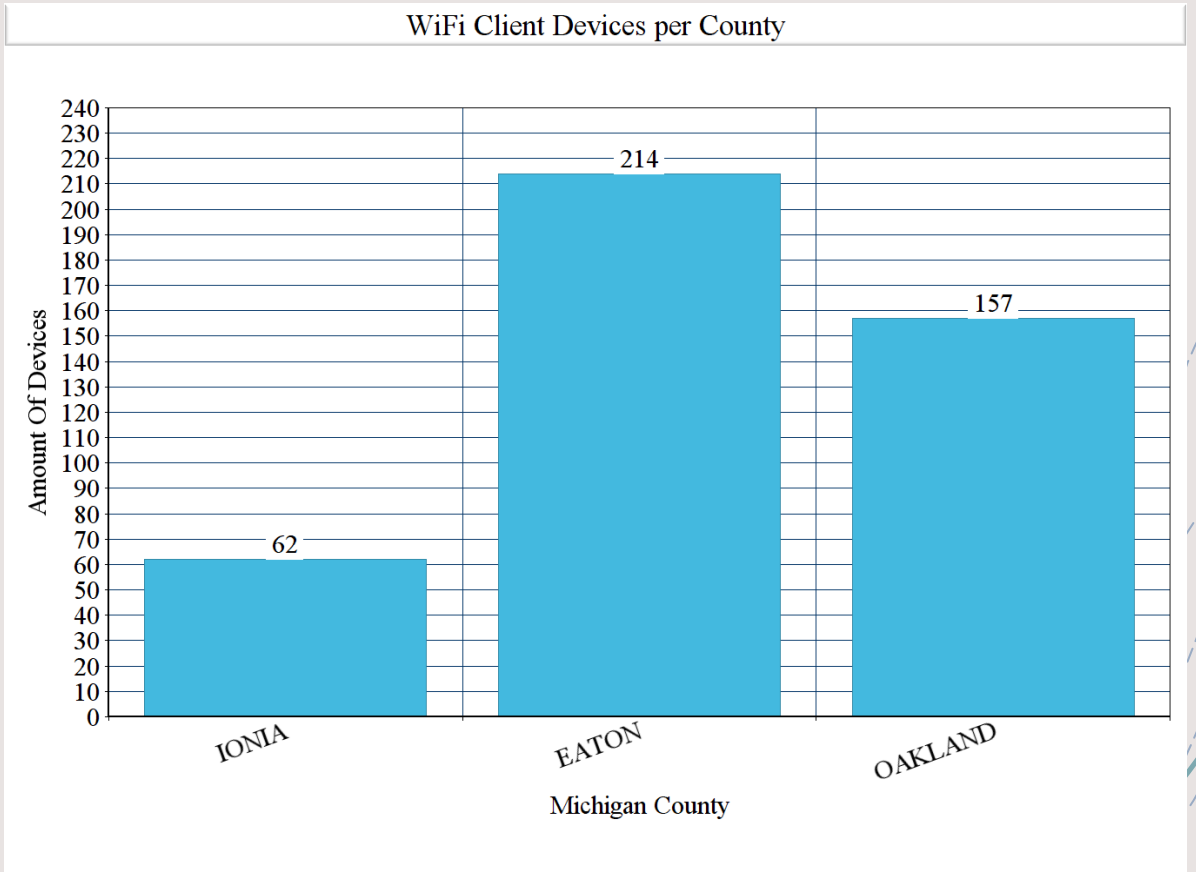


Figure 2

Data Results

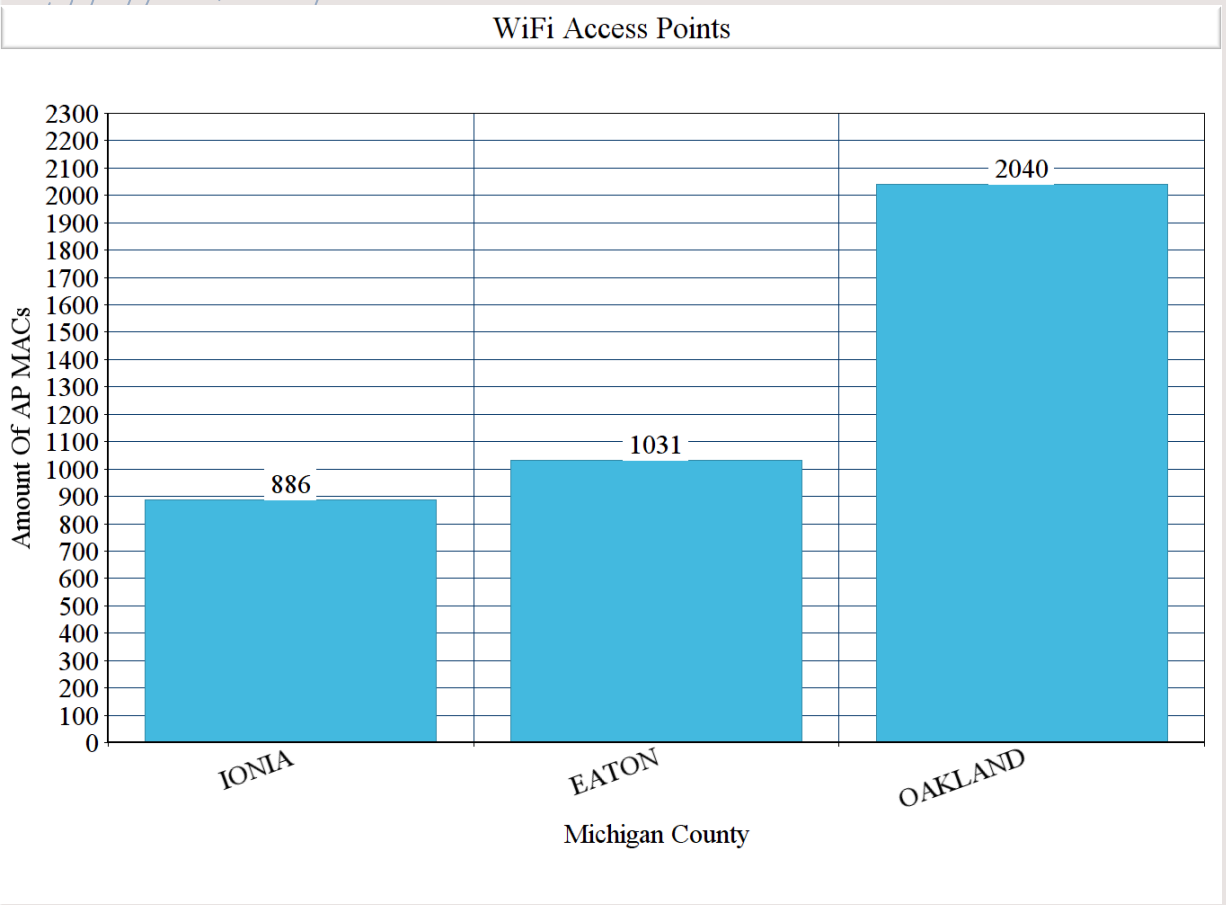


Figure 3

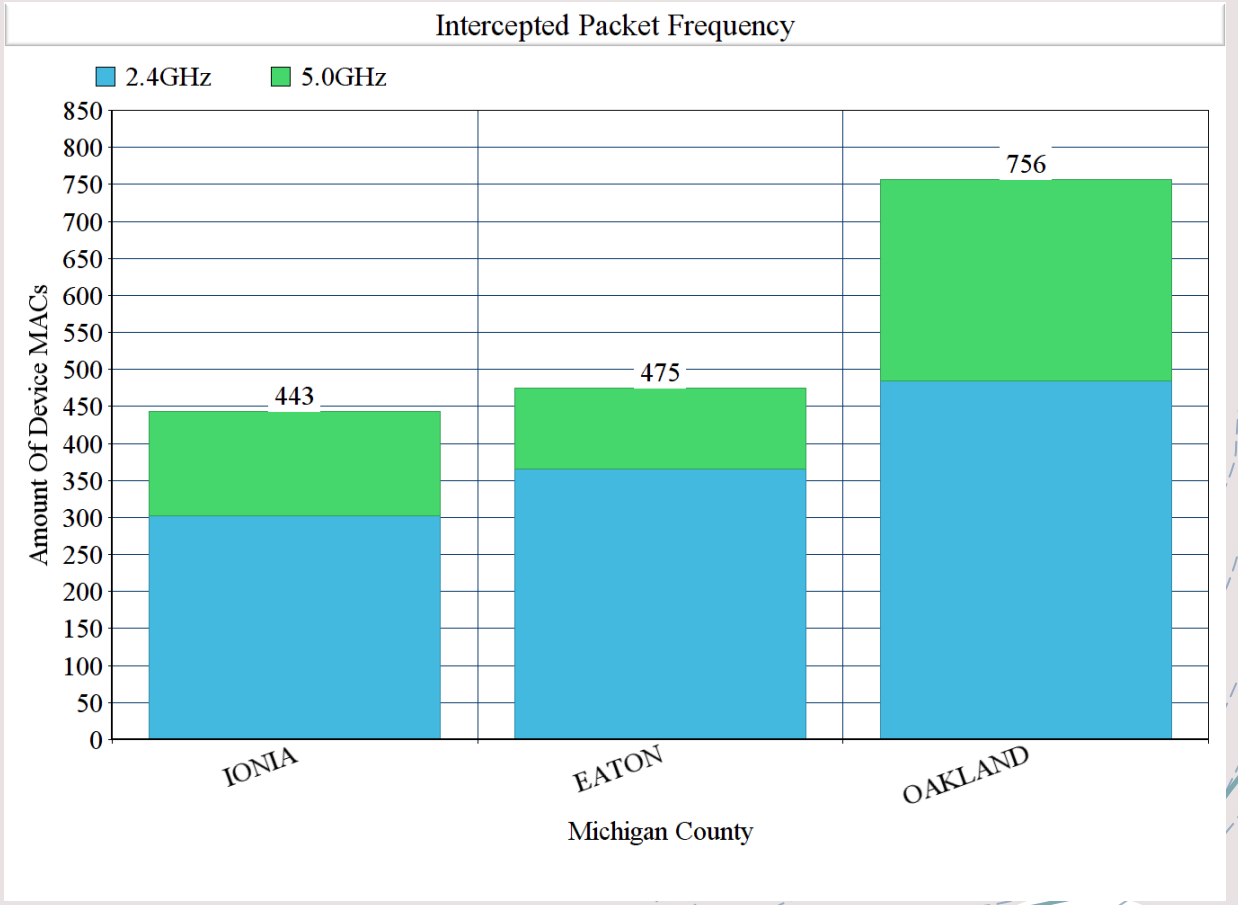


Figure 4

Discussion

- Data suggests that there is double the amount of AP's in Oakland(High Income)
- A higher proportion of logged devices through packet interception operate in 5GHz frequencies
- Is it possible that the Wi-Fi client count was not accurate because of signal attenuation in Oakland County?

Future Work

- All possible foot paths within a certain radius should be traversed to attempt to discover more devices
- To make a more in-depth analysis with future experiments:
  - Discover device type by MAC
  - GPS data should be collected
  - Home count should be collected
  - Upgraded dual band antennas (higher dbi)
  - More data per county should be collected

THANK YOU!
QUESTIONS?

References

[1]

"U.S. Census Bureau QuickFacts: Michigan." https://www.census.gov/quickfacts/fact/map/lakecountymichigan,MI/INC910218 (accessed Oct. 10, 2020).