

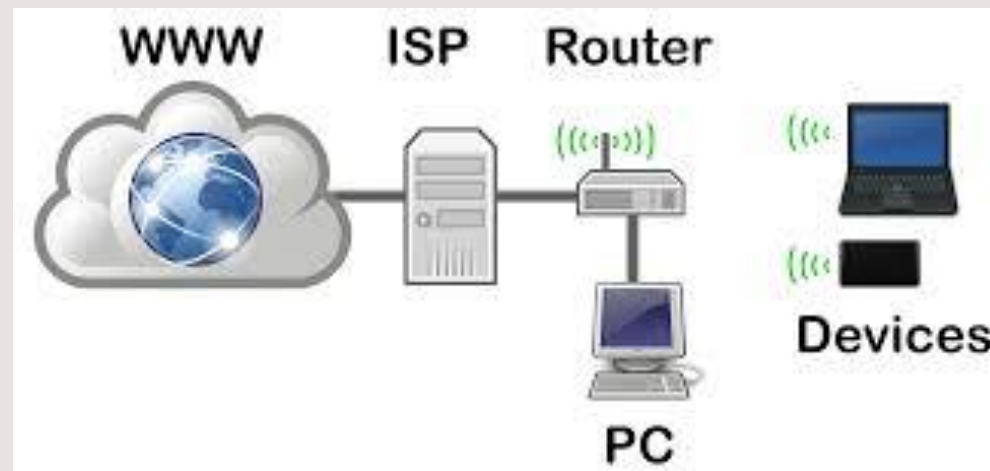
The background of the slide is a complex network graph. It features numerous circular nodes of varying sizes, colored in dark blue, red, and grey. These nodes are interconnected by a dense web of thin lines, with some lines being red and others dark grey. The overall pattern is abstract and represents a complex system or network.

# 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?



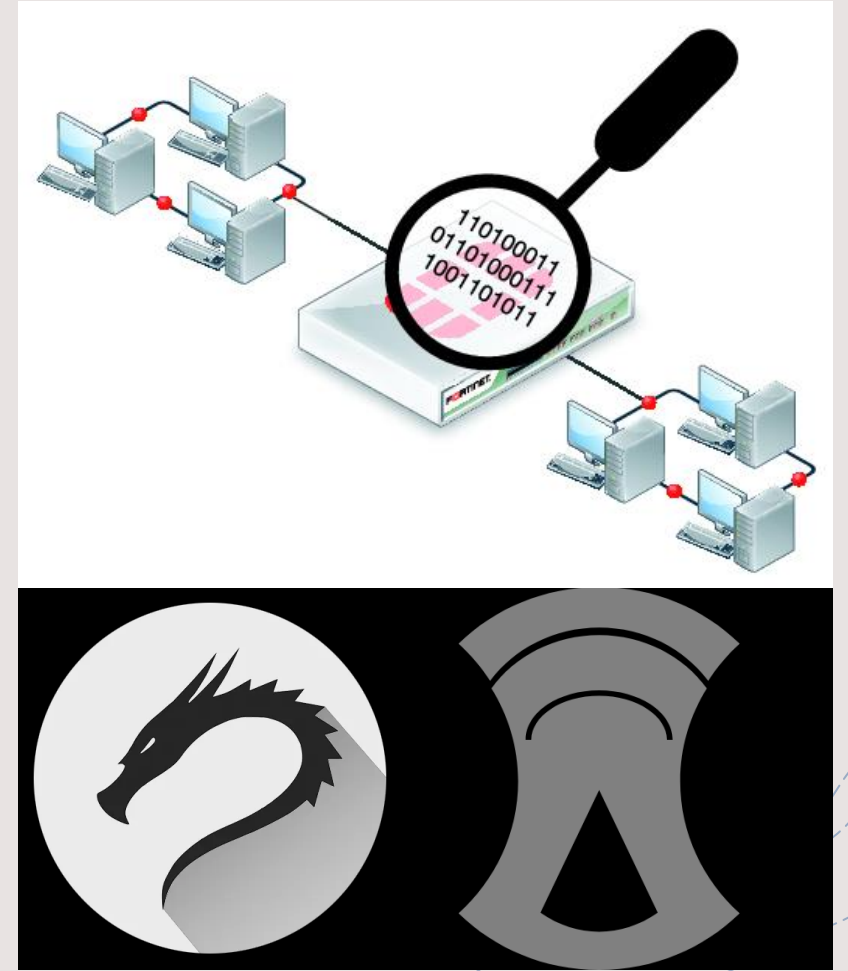
# Hardware Requirements

- + Raspberry Pi4 w/Display + Case
- + Long-Range Dual Band WiFi adapter x2 5dbi antennas (Capable of monitor mode)
- + Peripherals



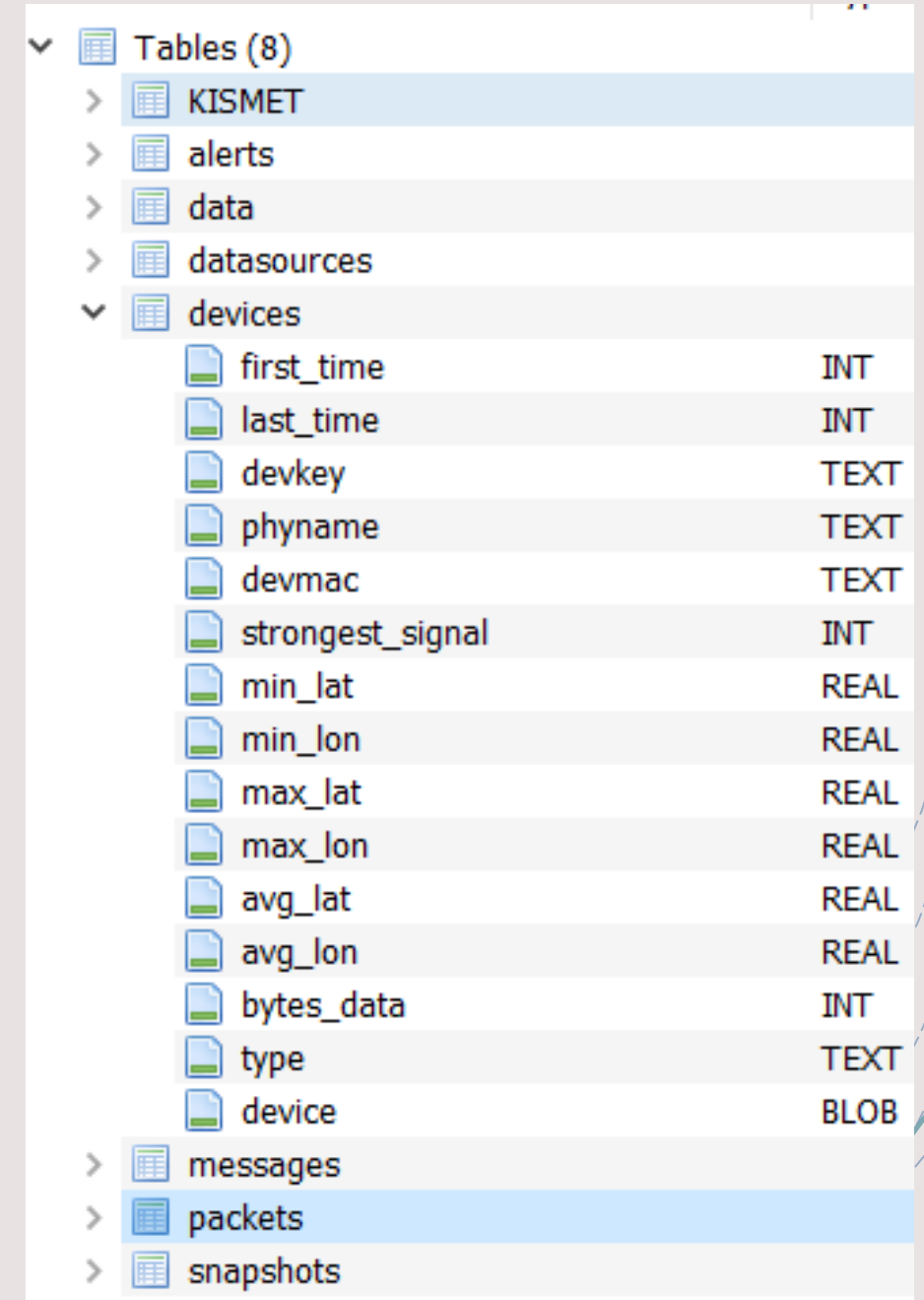
# Software Requirements

- + 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



Tables (8)	
> KISMET	
> alerts	
> data	
> datasources	
▼ devices	
first_time	INT
last_time	INT
devkey	TEXT
phyname	TEXT
devmac	TEXT
strongest_signal	INT
min_lat	REAL
min_lon	REAL
max_lat	REAL
max_lon	REAL
avg_lat	REAL
avg_lon	REAL
bytes_data	INT
type	TEXT
device	BLOB
> messages	
> packets	
> snapshots	

# Data Collection

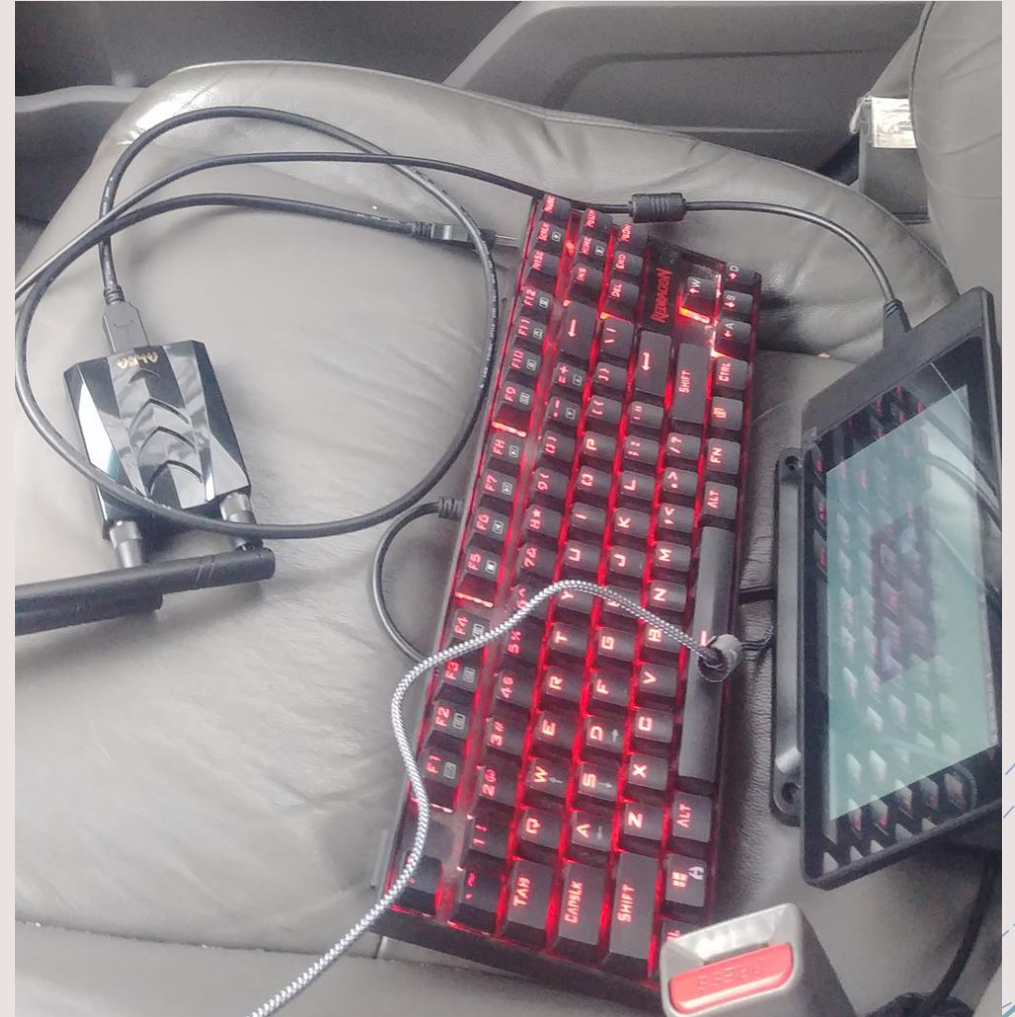
- + To collect data, I drove through 3 random residential neighborhoods in each county
- + For each neighborhood, 3 miles worth of data was collected
- + Data is logged every 300ms into a SQLite database to account





# 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

74	
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
91	HOME 802.11

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

```
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

File Size Per County

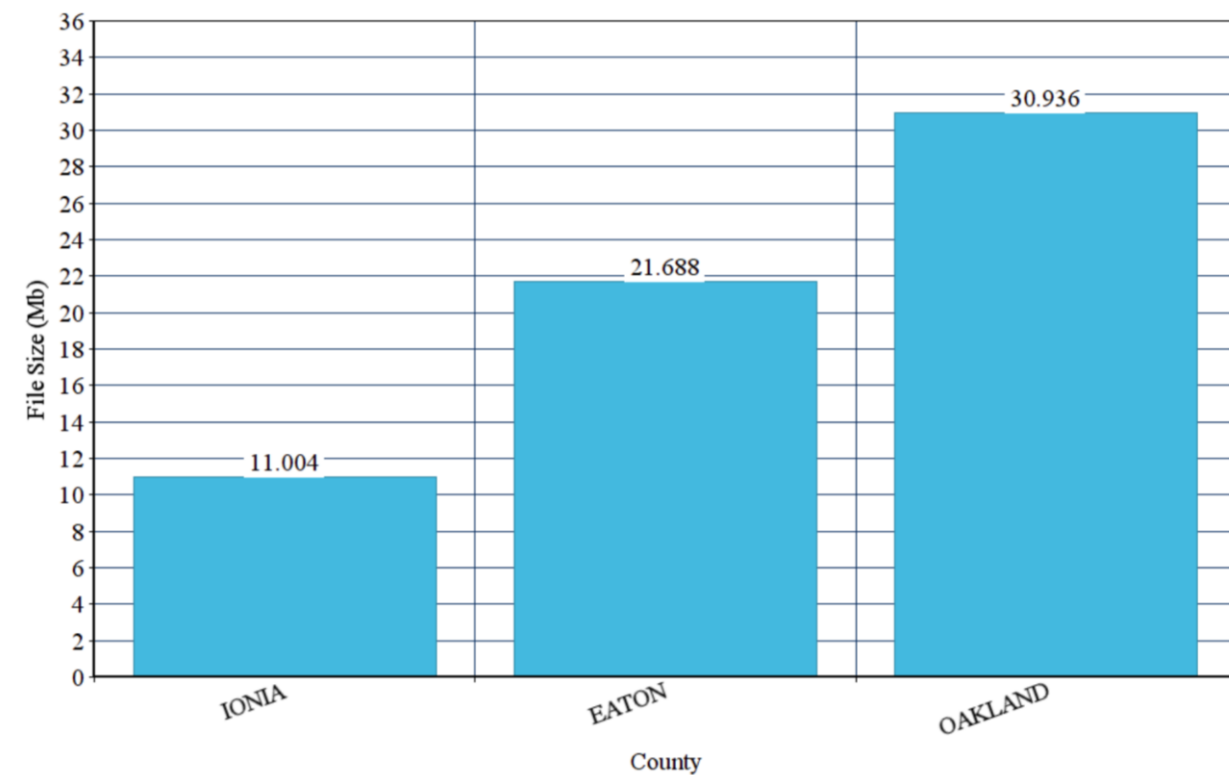


Figure 1

WiFi Client Devices per County

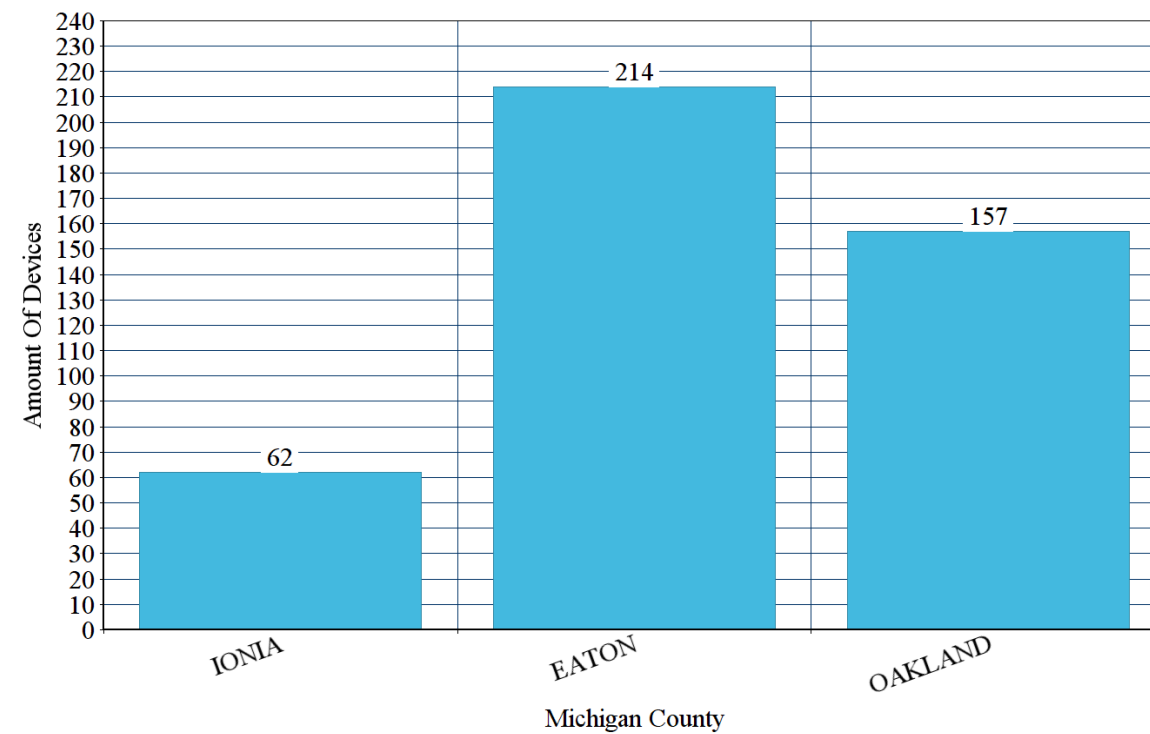


Figure 2



# Data Results

WiFi Access Points

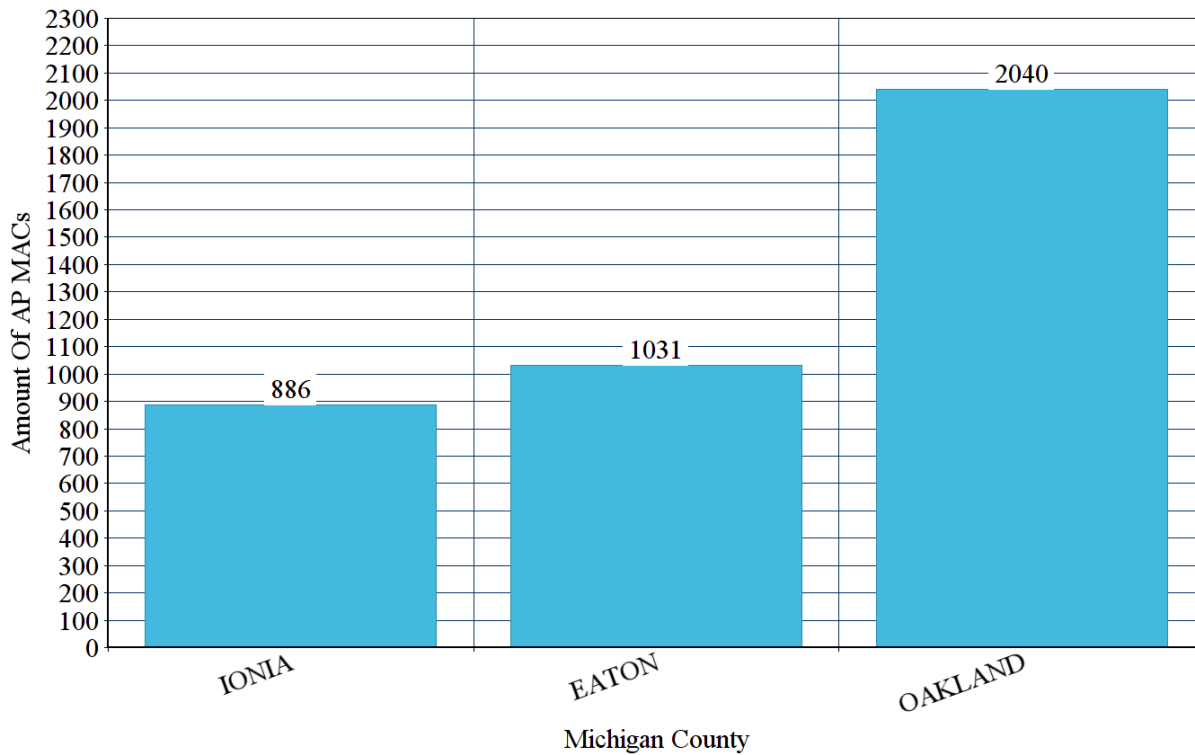


Figure 3

Intercepted Packet Frequency

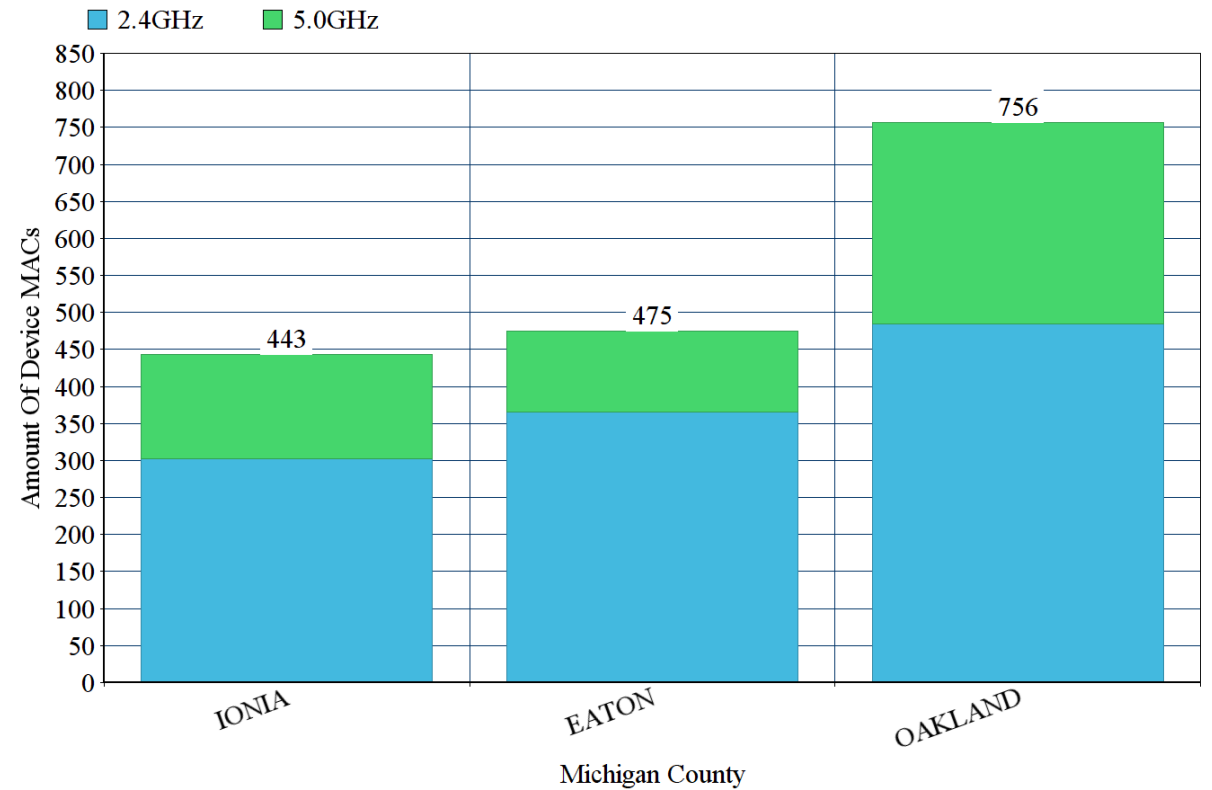


Figure 4

# 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

The background is a light gray color. In the top-left corner, there is a white circle partially cut off by the edge, with several dashed blue lines flowing downwards and to the right from it. In the bottom-right corner, there is another white circle partially cut off by the edge, with several dashed blue lines flowing upwards and to the left from it. The text is centered in the middle of the slide.

**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).