



# Wireless Sensor Networks for Internet of Things Applications



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## Background Information

### What is the Internet of Things?

- It's so new, it lacks an official definition!
- Adding sensors to items and connecting them to a network.

### What are we doing?

- Profiling network traffic for analysis.

### What aren't we doing?

- We are NOT monitoring what users are doing on networks!
- We are NOT invading personal privacy!

### What is this project trying to accomplish?

- Engineering design
- Data acquisition
- Wireless sensor networks
- Data analysis workflow

## Sensor System Setup

### Raspberry Pi:

- A credit card-sized computer that can be used for a multitude of tasks.
- Attaching a wi-fi dongle and loading wi-fi scanning software, we can create a sensor that can collect network traffic data.

### Database:

- We use a database to store and organize sensor data.
- A NoSQL database is used for its speed and flexibility.

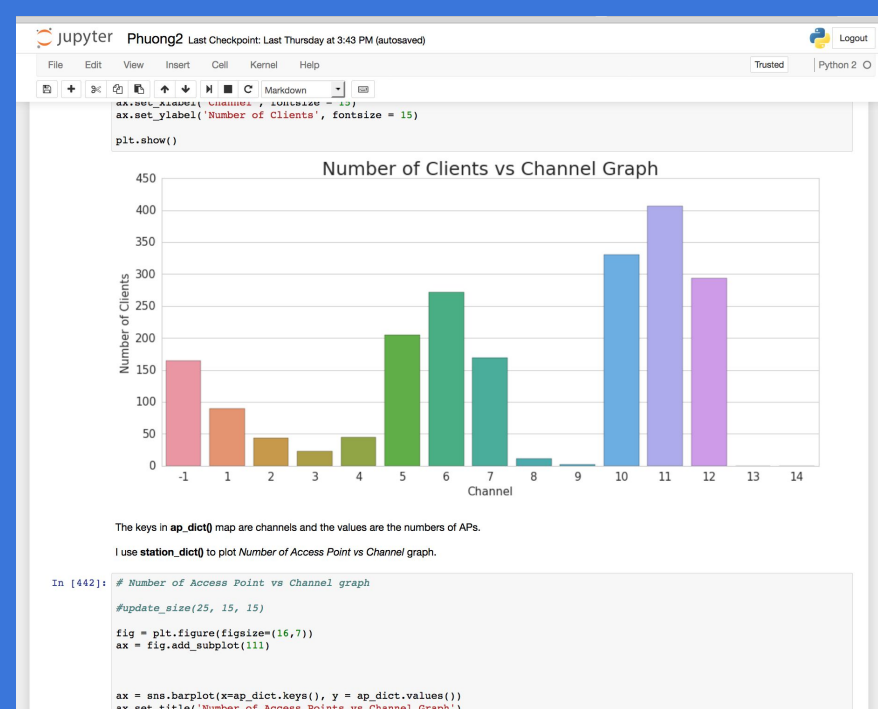
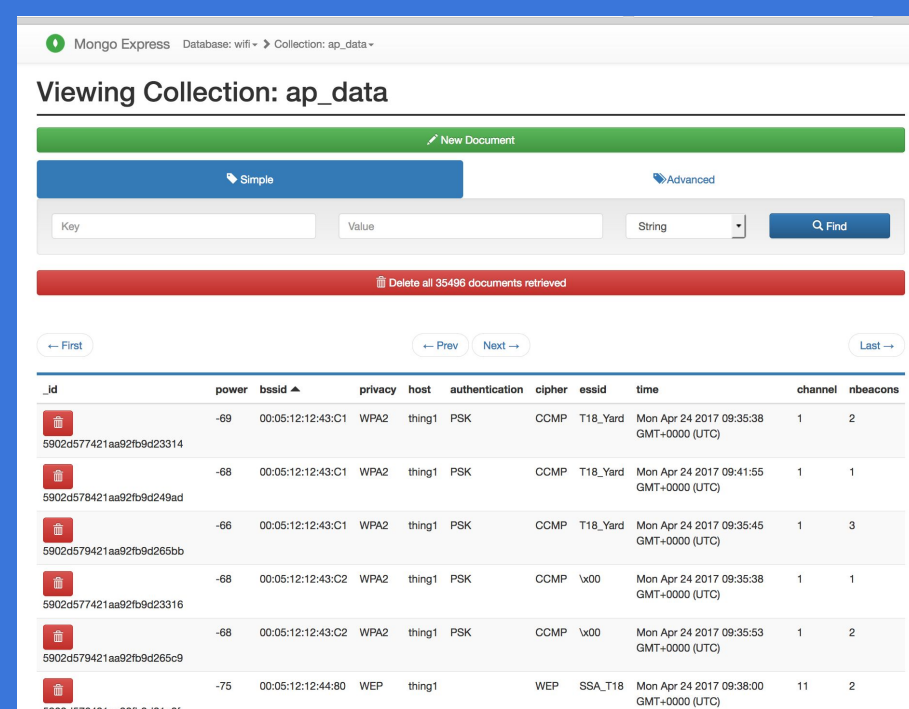
### Data Analysis:

- Python (scripting language)
- Quantitative data analysis
- Extract data from database and apply queries.

Sensor Data  
(Raspberry Pi)

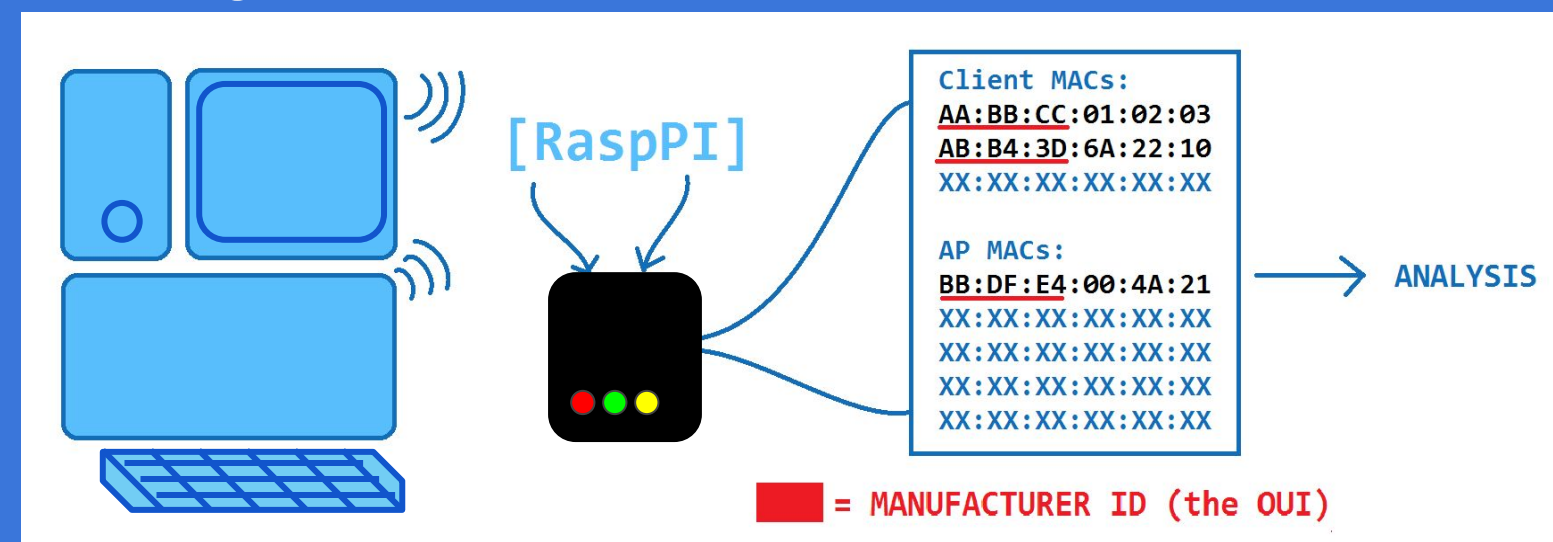
Database  
(MongoDB)

Data Analysis  
And Visualization

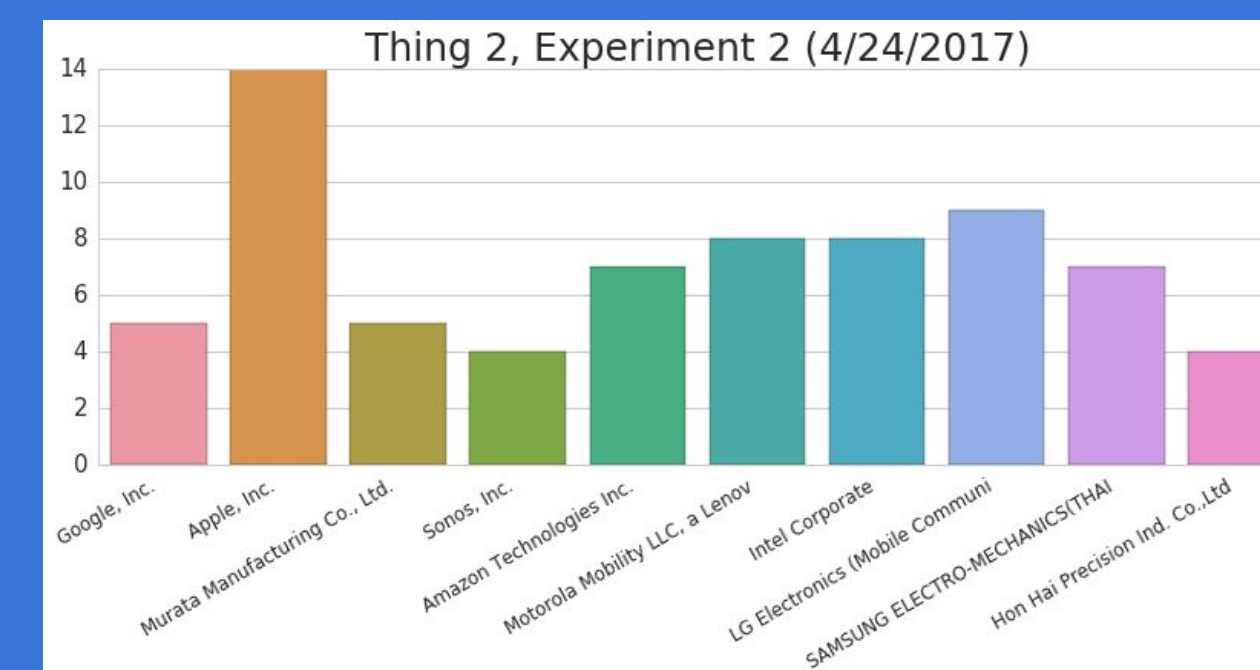
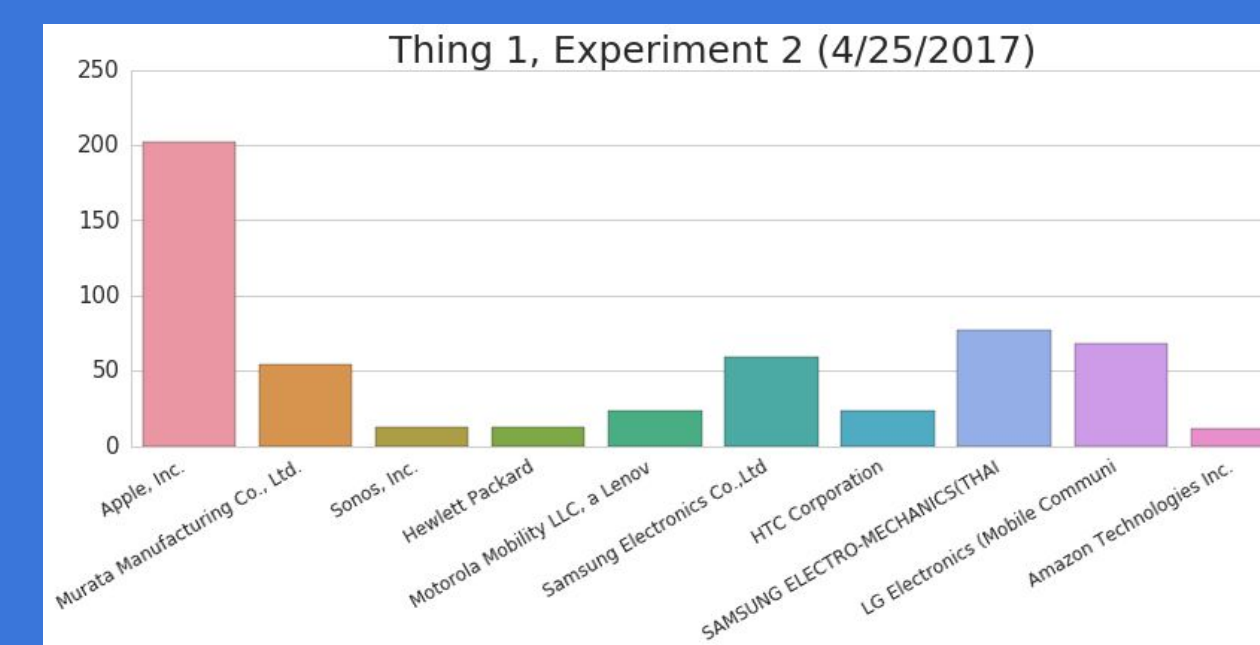
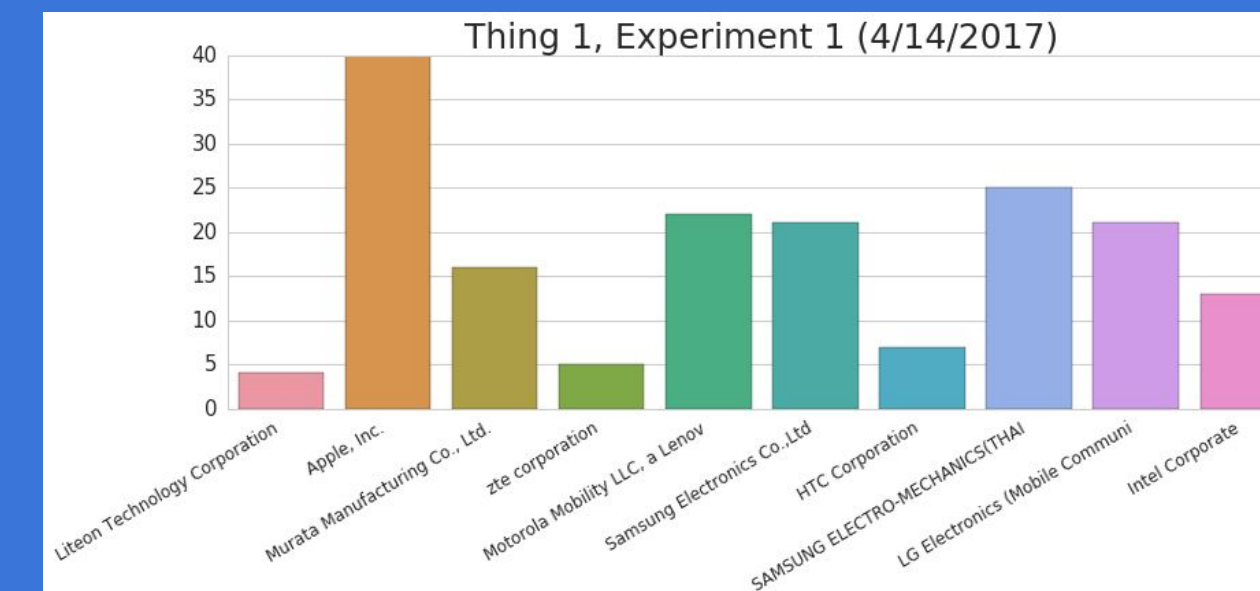


## MAC Addresses & Vendors

- A MAC address is a unique identifier given to devices with network capabilities [1]. See diagram below.

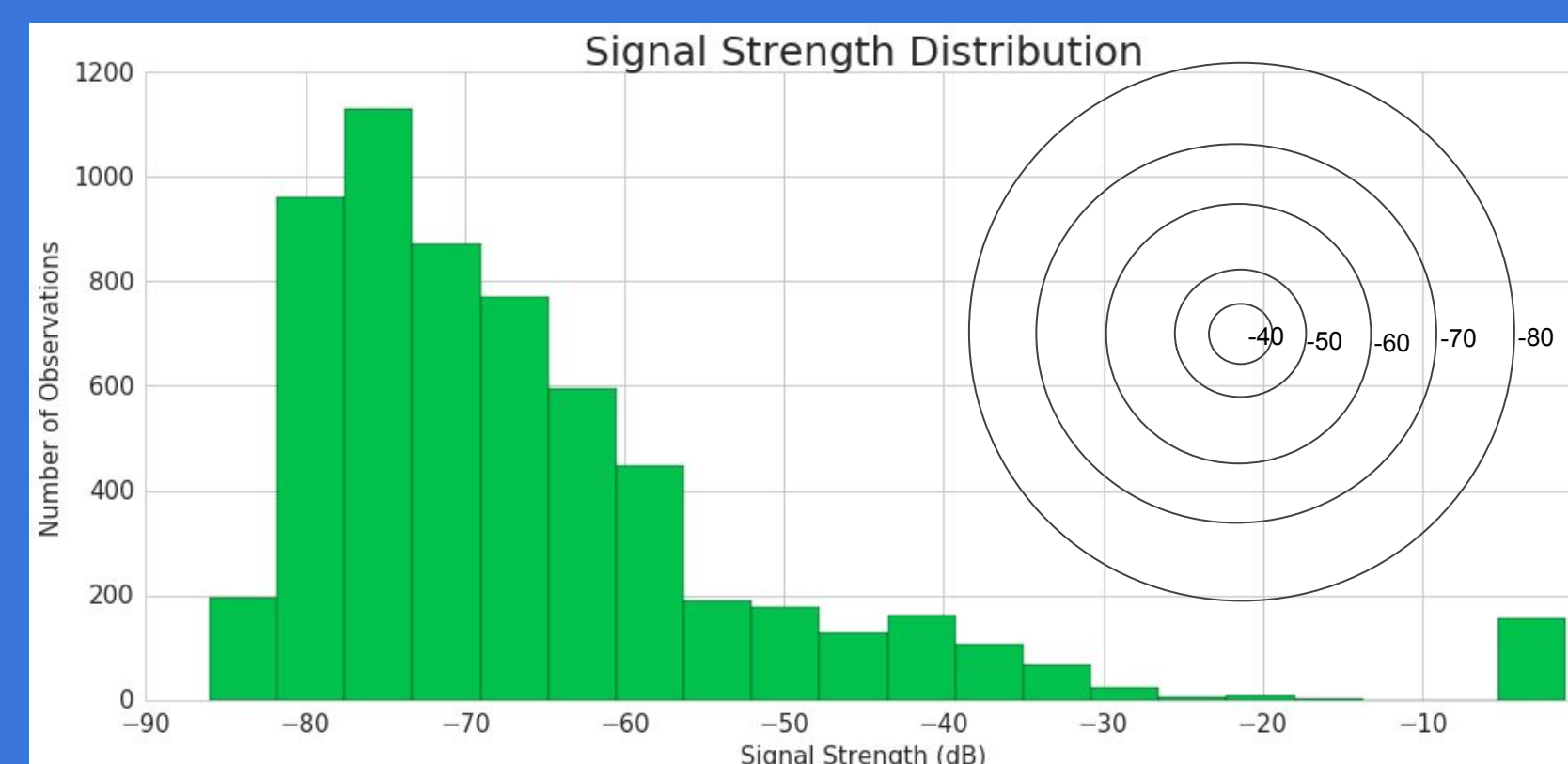
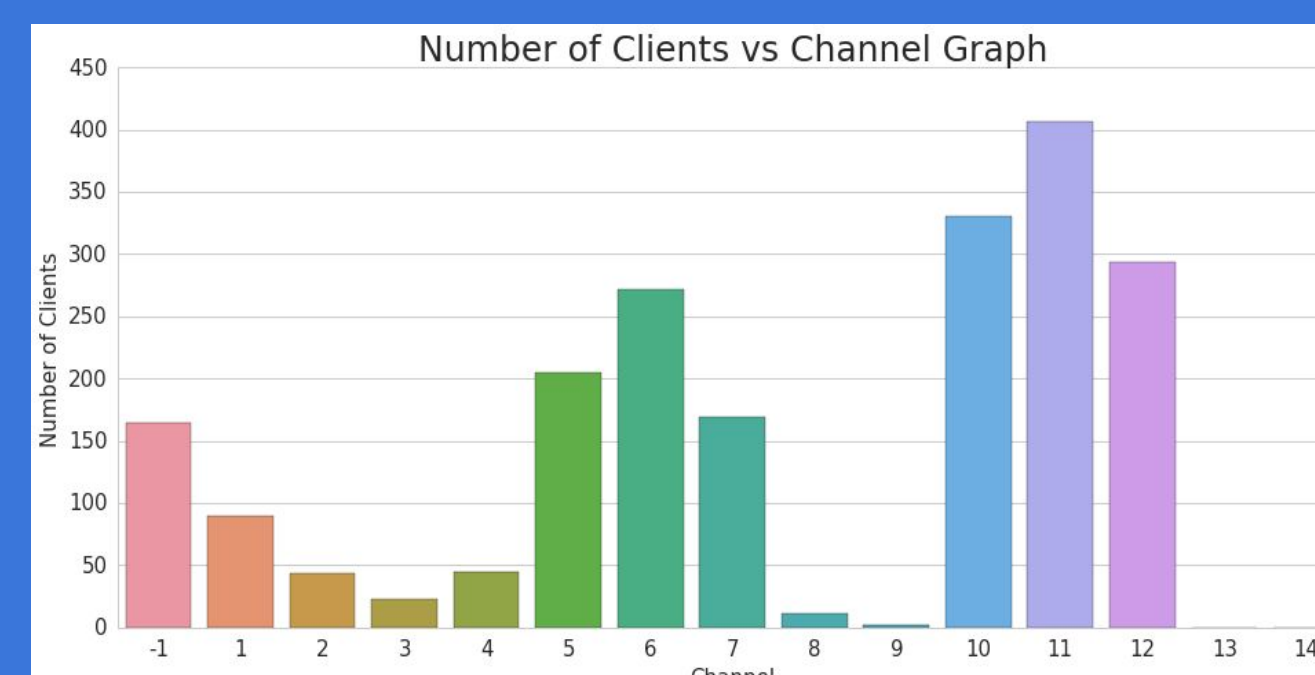
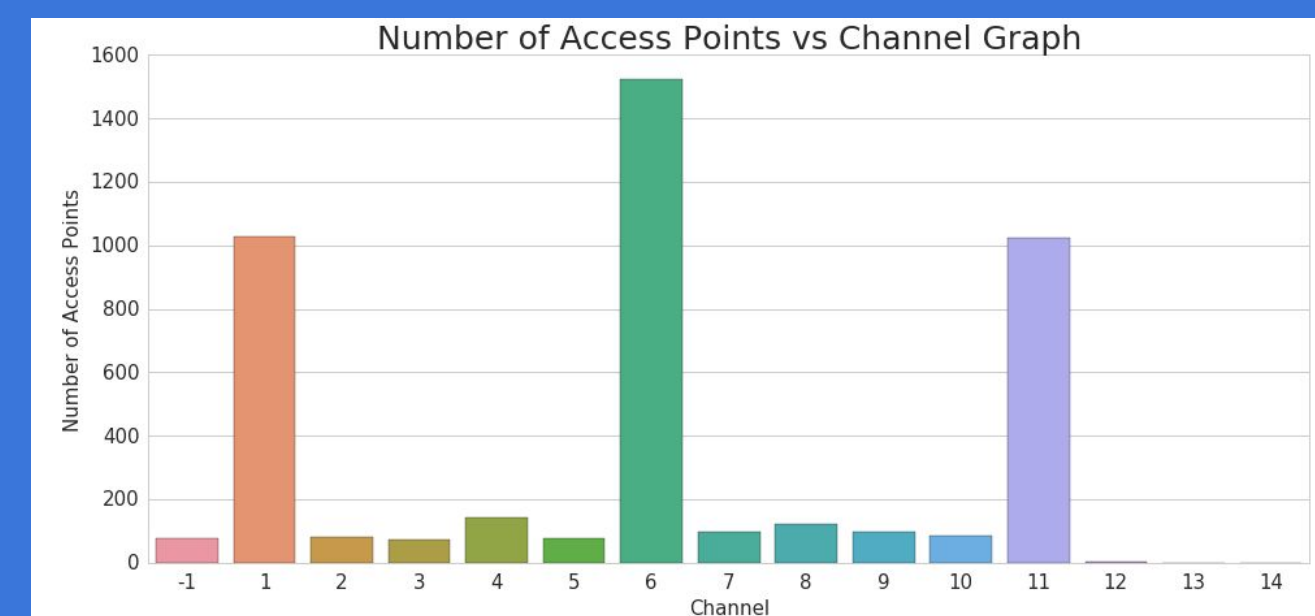


- The graphs to the right show the distribution of client device manufacturers (brands) across all entries in our client device database.
- Environments of the respective experiments: a neighborhood, shopping center, and a bus ride
- Using data analysis tools, we can turn raw data into more useful information and insights.



## Channel Crowding & Signal Strength

- The "Number of Access Points (APs) vs Channel" graph shows that most of the APs are on Channel 1, 6, and 11 (you can think of an AP as a router that devices can connect to via wifi). Since these channels are non-overlapping, they are commonly used by routers as default operable channels [2].
- Clients (bottom right graph) are more distributed throughout all 14 channels. [3, 4]
- A comparison of the two graphs on the right reveal *there are more available APs than clients*, as opposed to more clients than APs. (*Bigger picture: channel crowding by routers*)
- Multiple Environments: data was taken in a neighborhood, near a shopping center, and on a bus ride.
- Each experiment (three in total, for three environments) collected data for a 2-hour block



## Tools Used

- Raspberry Pi:
  - Debian Linux
  - Aircrack-ng
  - SSH
  - Python
- Database:
  - MongoDB
  - MongoExpress
- Data Analysis:
  - Python
  - Jupyter
  - Numpy
  - PyMongo
  - Matplotlib

## References

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## BSSID Hall of Fame

- "Bill Wi the Science Fi"
- "ERMAHGERD! WIERFIER"
- "WhateversClever"
- "FreeViruses"
- "LAN Before Time"
- "NachoWifi"
- "A wifi has no name"