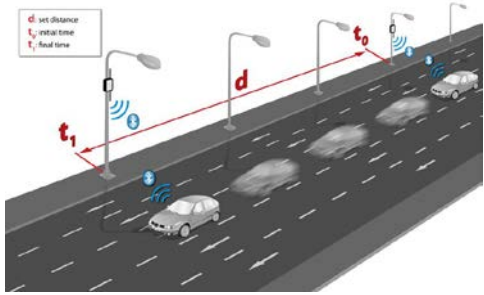

MDOT-MSU Traffic State Monitoring System

Antenna Configuration

The 1st Progress Report for MDOT

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MDOT

STATE

ACTION Laboratory

A research laboratory in CEE department

Advanced Computing In Transportation, Informatics, Operations and Networks

MISSISSIPPI STATE UNIVERSITY CIVIL & ENVIRONMENTAL ENGINEERING

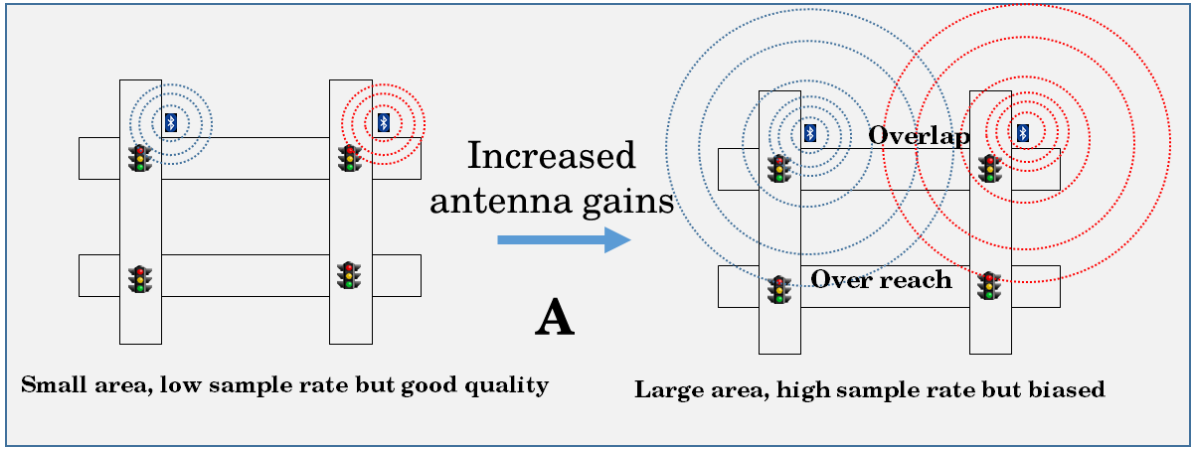
PC or tablet are recommended to view this website.

Outline

- Motivation
- Experiment design
- Prototype equipment
- Findings
- Discussion

Motivation

- To determine the best antenna type and configuration
- Most antennas in commercial products are high-gain omni-direction
  - Sample rate: Higher quantity but how about data quality?
  - Issues: (1) “cross-talk”; (2) large measuring errors
- Unlike the Bluetooth solution, we have two options to configure Wi-Fi antennas:
  - Option 1: high sample rate but low data quality
    - Suitable for large-scope planning survey, like regional O-D survey
  - Option 2: low sample rate but high data quality
    - Suitable for medium or small scope survey, like closely spaced arterials travel time study

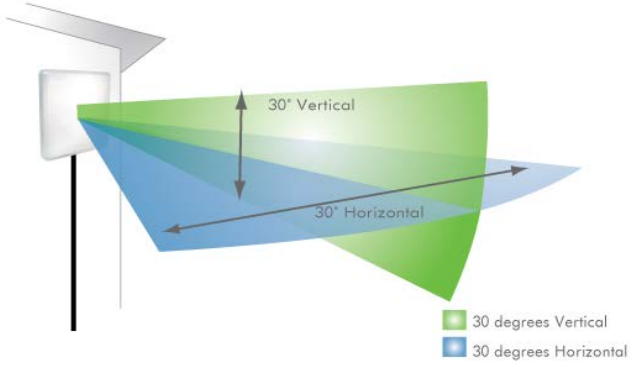


Motivation

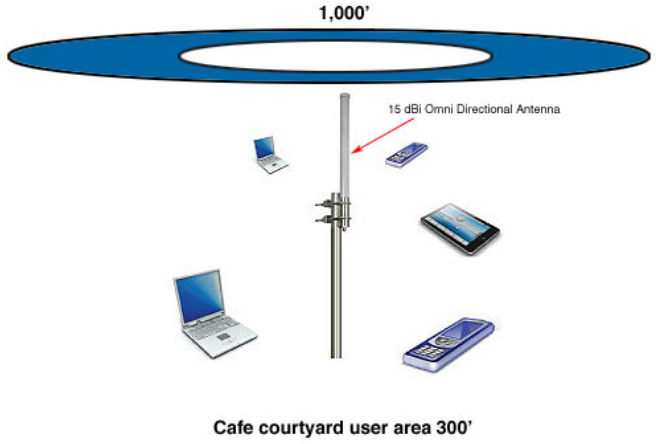
- Most information about the Wi-Fi travel time estimation from Internet is inconclusive nor supported with experiments
  - We found some contradict the experiment findings by us.
- It is decided to conduct experiments to examine the effectiveness of a special configuration of directional Wi-Fi antennas
  - Reduce the sensing scope first
  - Examine the Wi-Fi MAC capturing rate and estimate measuring errors
- This is critical to determine the proper type of Wi-Fi antennas to install for the following research tasks

A proof of concept for a special configuration of Wi-Fi antennas (prototype)

- Some facts:
  - The directional (patch) Wi-Fi antenna aims to transmit signal over a long distance (horizontal)
  - The directional Wi-Fi antenna minimize the spread of Wi-Fi signal along its direction



Directional Wi-Fi Antenna



Omni directional

A proof of concept for a special configuration of Wi-Fi antennas (prototype)

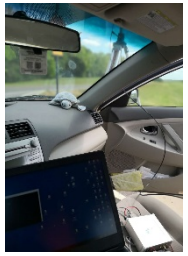
- The concept:
  - Our prototype is to make the directional Wi-Fi antenna facing up and minimize the horizontal signal spread.
  - The horizontal sensing range will be small. Whenever a MAC address is captured, it would be close the Wi-Fi sensors
    - Reduce the measuring errors.

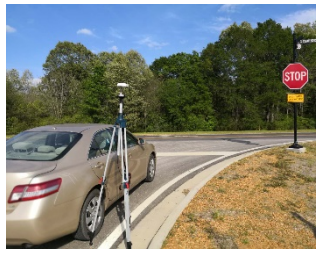
Equipment List

- A special programmed Wi-Fi sensor
  - Only captured a specified Wi-Fi MAC address
  - Report the MAC address immediately on the screen
  - Battery-powered (up to 20 hours per charge)
- Three phones:
  - Test phone: An old Iphone (with no Wi-Fi MAC randomization)
    - Wi-Fi searching mode v.s. Home-screen mode
  - Navigation phone: windshield-mounted with real-time GPS info recording
  - In-car communication: to receive vocal indication of Wi-Fi MAC capturing from the road side.
- The prototype Wi-Fi antenna mounted on a tripod

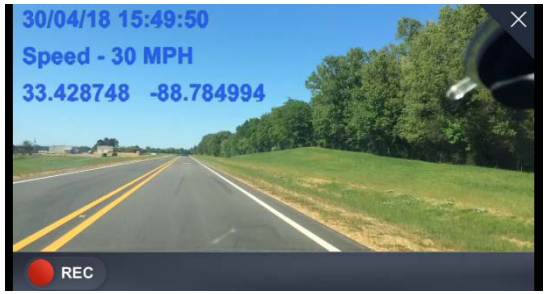
Experiment design

- Two groups of staff:
  - Roadside group: monitor the Wi-Fi sensor to report whenever the Wi-Fi MAC address is captured when the probe vehicle passes





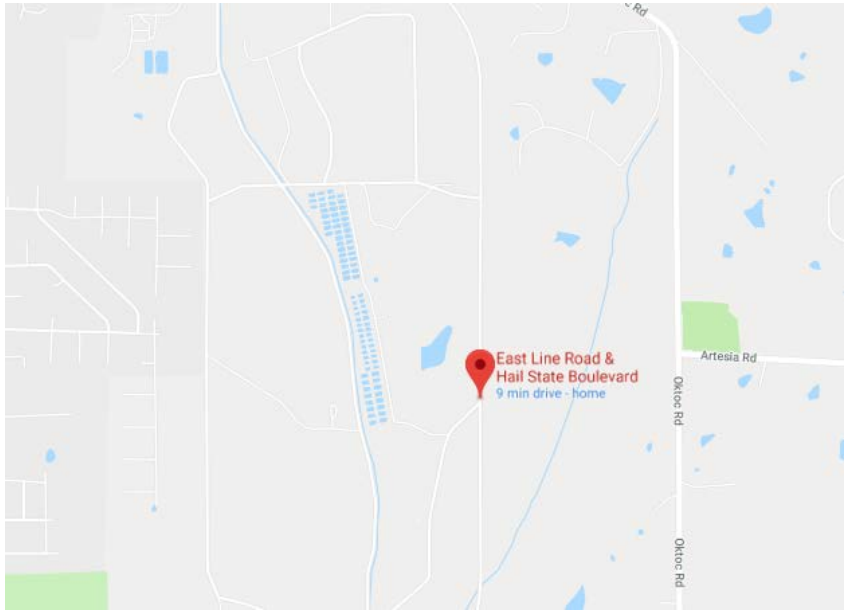
  - In-vehicle group: monitor the GPS and record the coordinates when a vocal indicator is received from the roadside



- To estimate the errors in terms of seconds

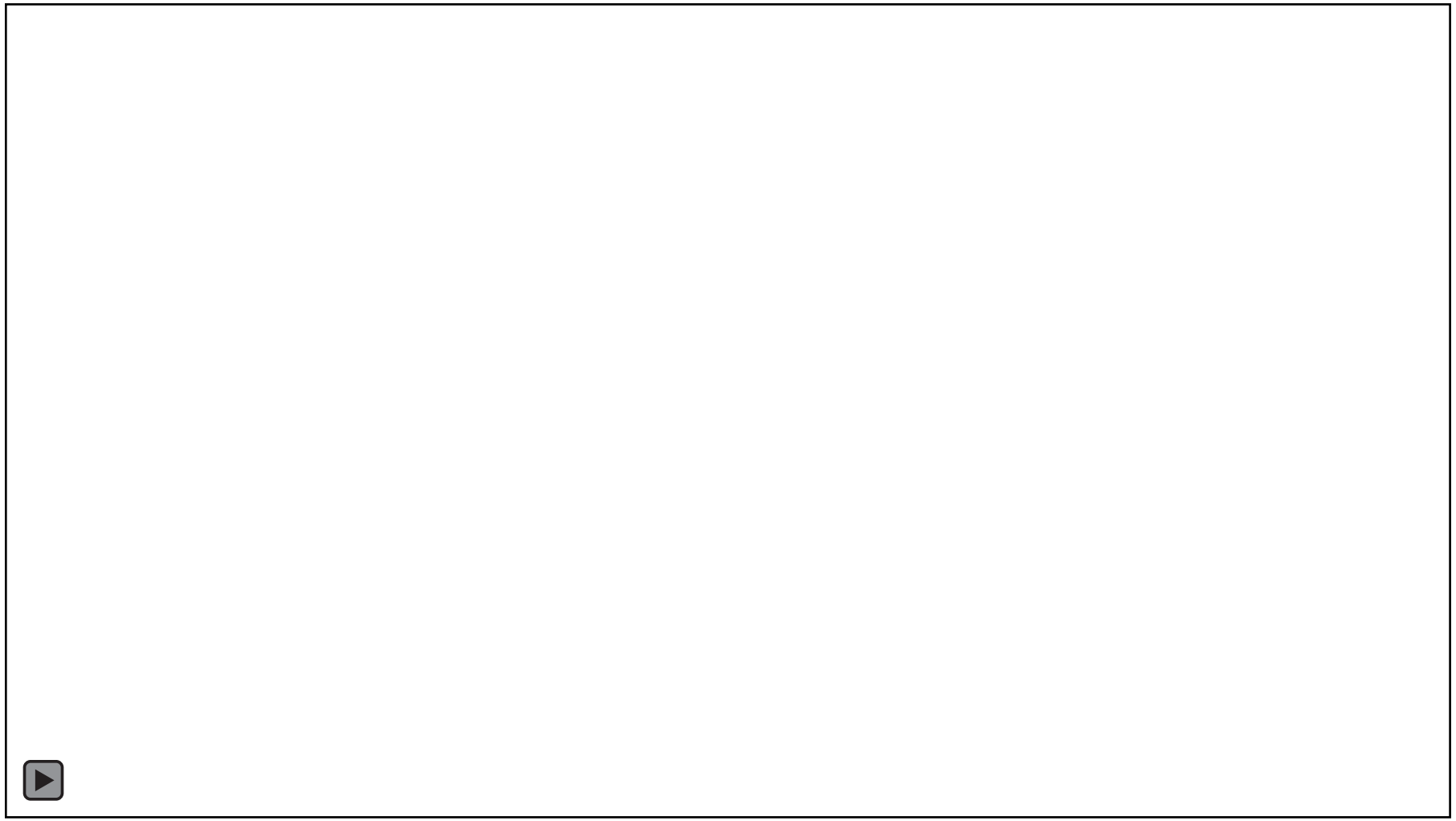
Road segment for the test

- The Hail-state Blvd in Starkville: opened in Oct-2017.
  - very low traffic now
  - Safe to drive at various speeds
  - A good candidate for MDOT to conduct tests in the future



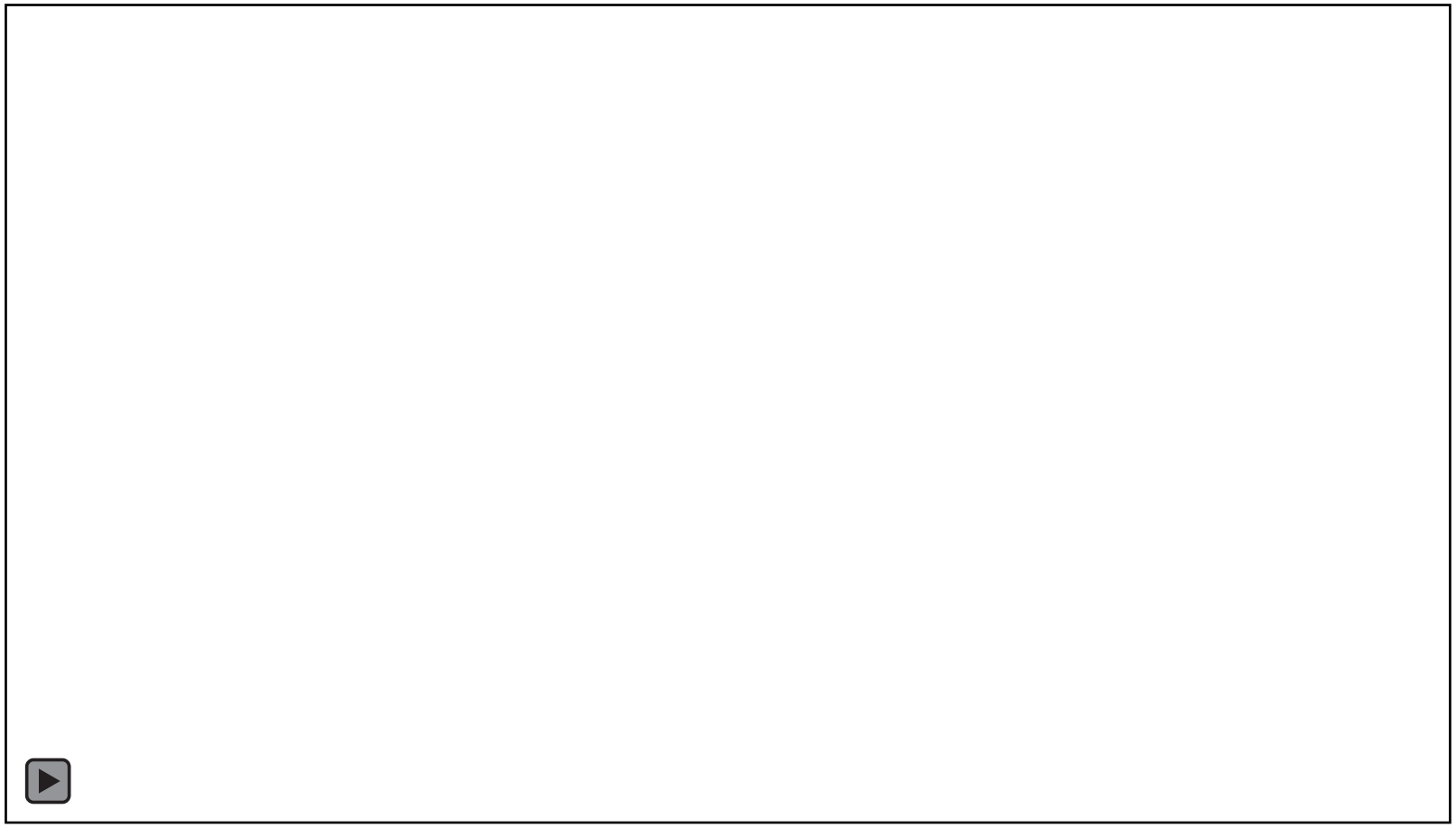
How were the data collected?

- Vocal indication and post processing



How were the data collected?

- The roadside view



Experiment Results

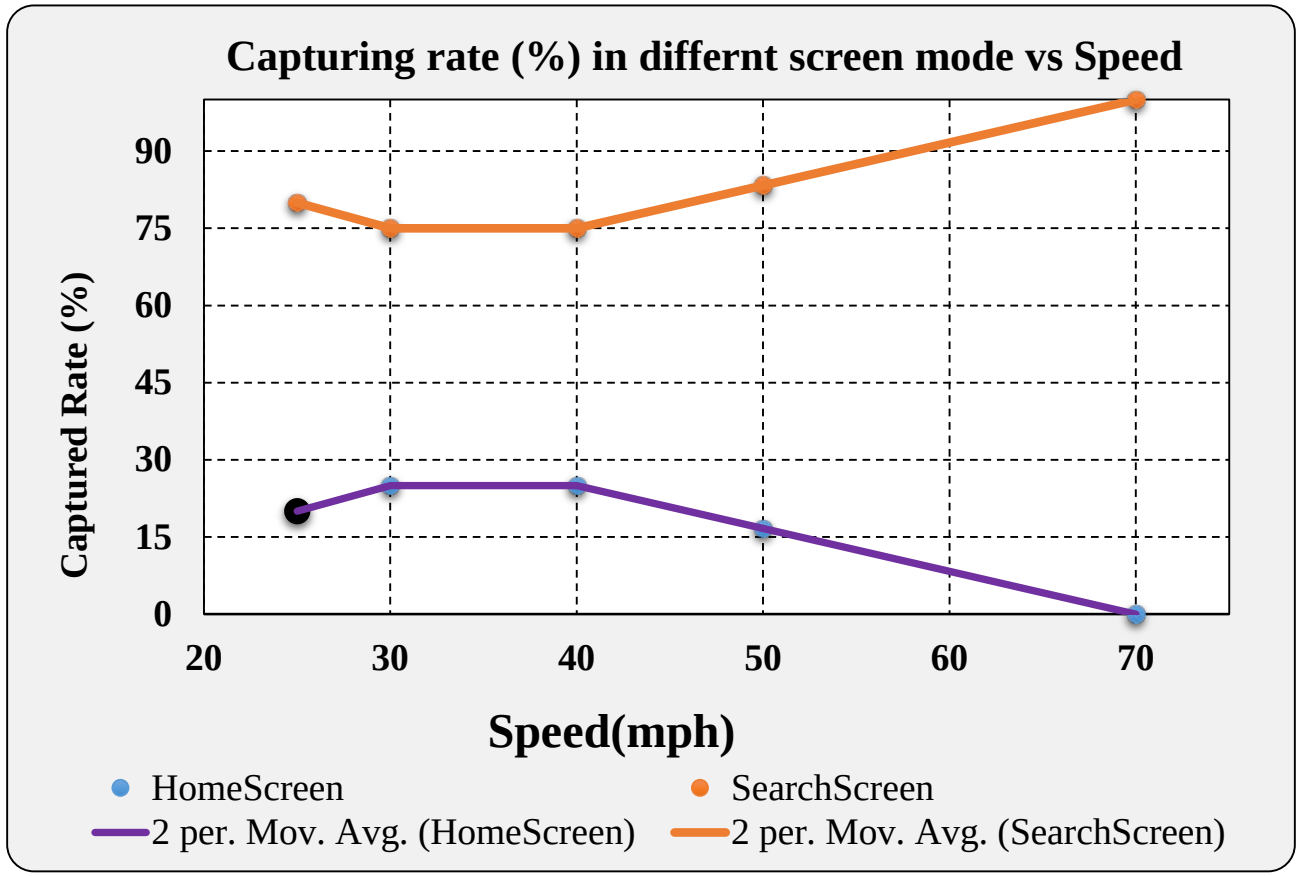
- Total duration: 4+ hours

- Samples with our own probe vehicle (known Wi-Fi MAC address)
  - Total samples: 48;
  - Samples with captured MAC address: 34;
  - Speed range: 25 MPH->70 MPH with 5 MPH increments

- Samples from passing (anonymous) vehicles
  - Total samples: 41;
  - Captured Wi-Fi MAC addresses: 15
  - Not captured: 26

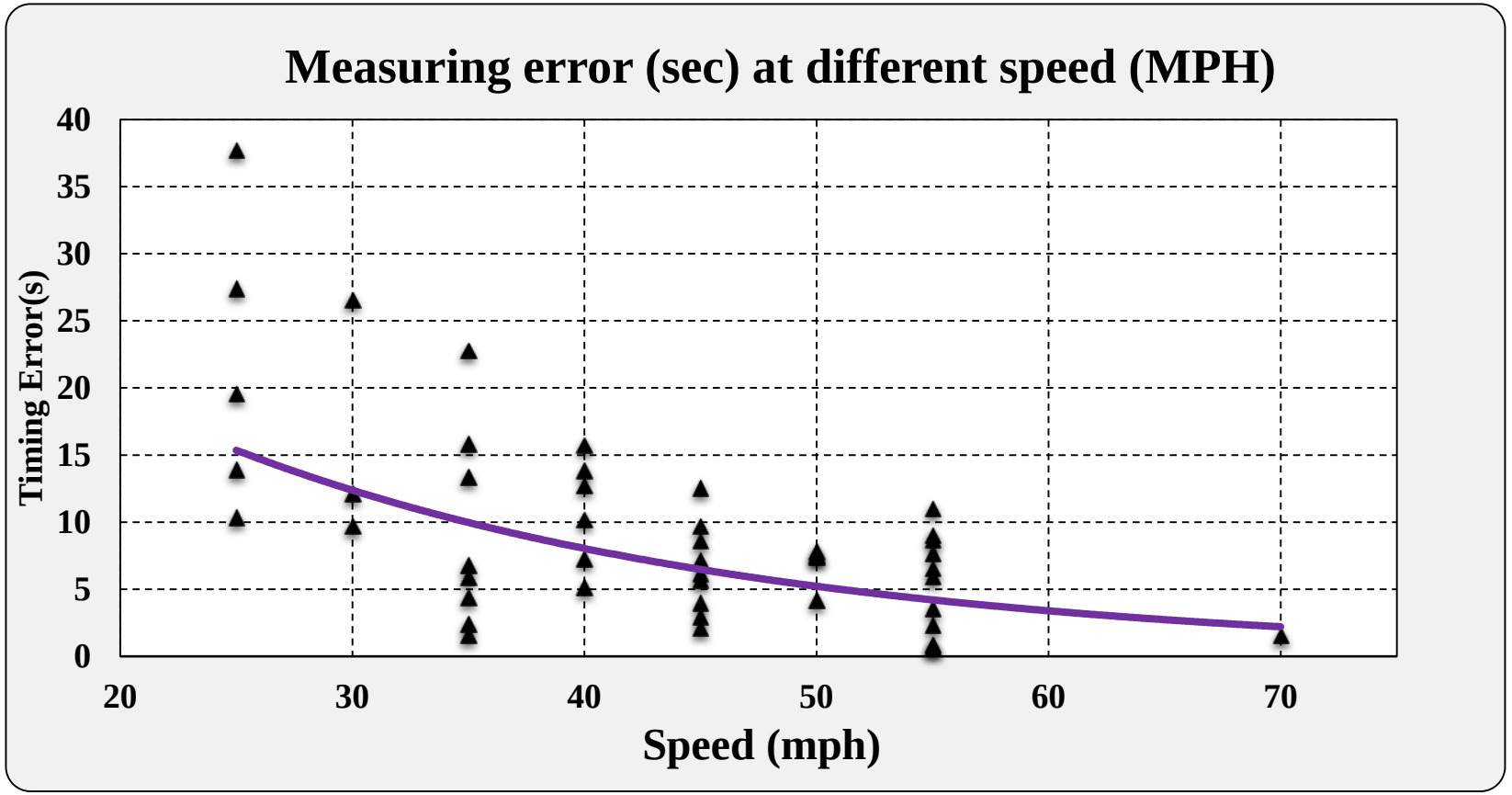
Finding 1:

- Wi-Fi MAC capturing rate v.s. vehicle speed



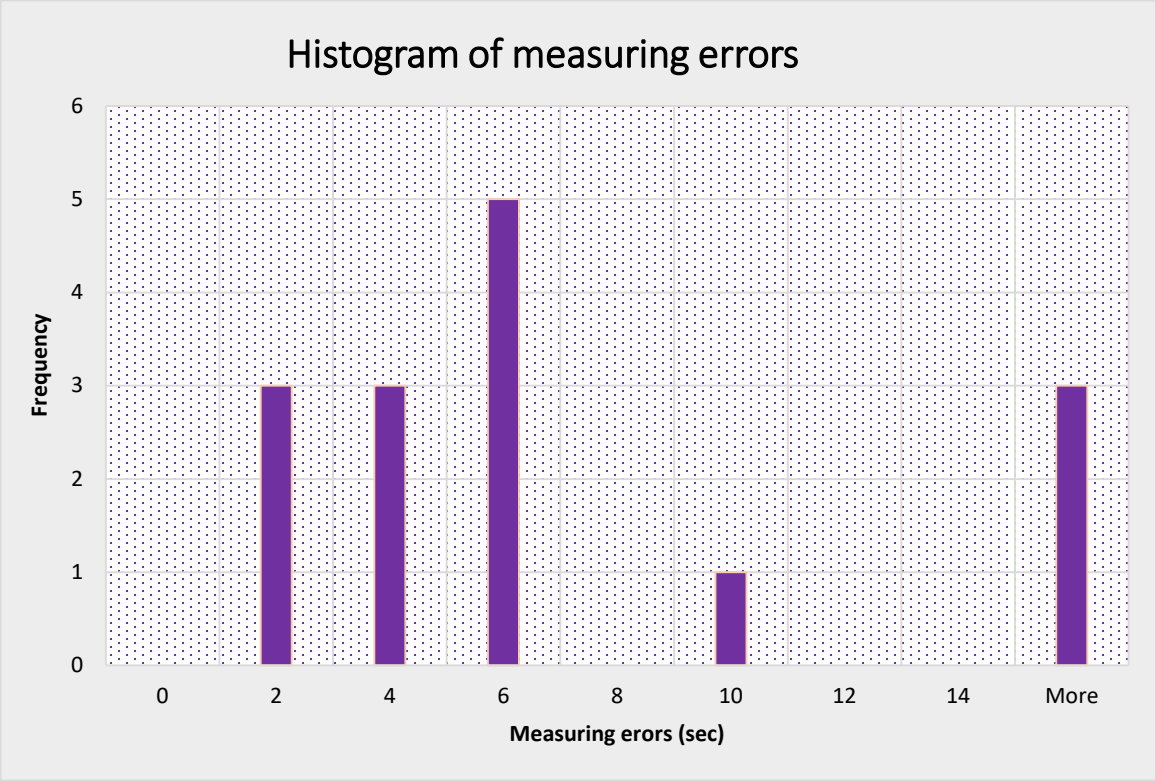
Finding 2:

- Measuring errors v.s. vehicle speed



Finding 3

- Capturing rate and timing errors of general (anonymous) vehicles



Capturing rate=40%

Conclusions

- Specially configured directional Wi-Fi antenna could possible work for this project
- It could possibly collect samples at a lower rate but with a higher quality
- The best location for Wi-Fi antennas is the mid blocks where vehicles are faster than at intersections.
  - But additional installation efforts may be needed.

Questions and comments?

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