

# Detection of On-Road Vehicles Emanating GPS Interference



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# GPS in Critical Infrastructures



# GPS Jammers



# Newark Airport Incident

- In 2010, ground GPS receivers did not work for a few minutes repeatedly over couple of months.
- It took 3 months to locate the problem.



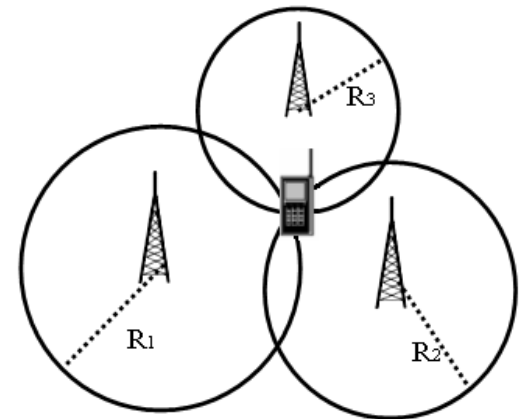
# Current Solutions

- Handheld devices
  - Works only in **static** scenarios
  - Used **manually** for a short time



- Standard wireless localization techniques
  - Not sufficient to pinpoint a vehicle in dense traffic

**What is needed?**



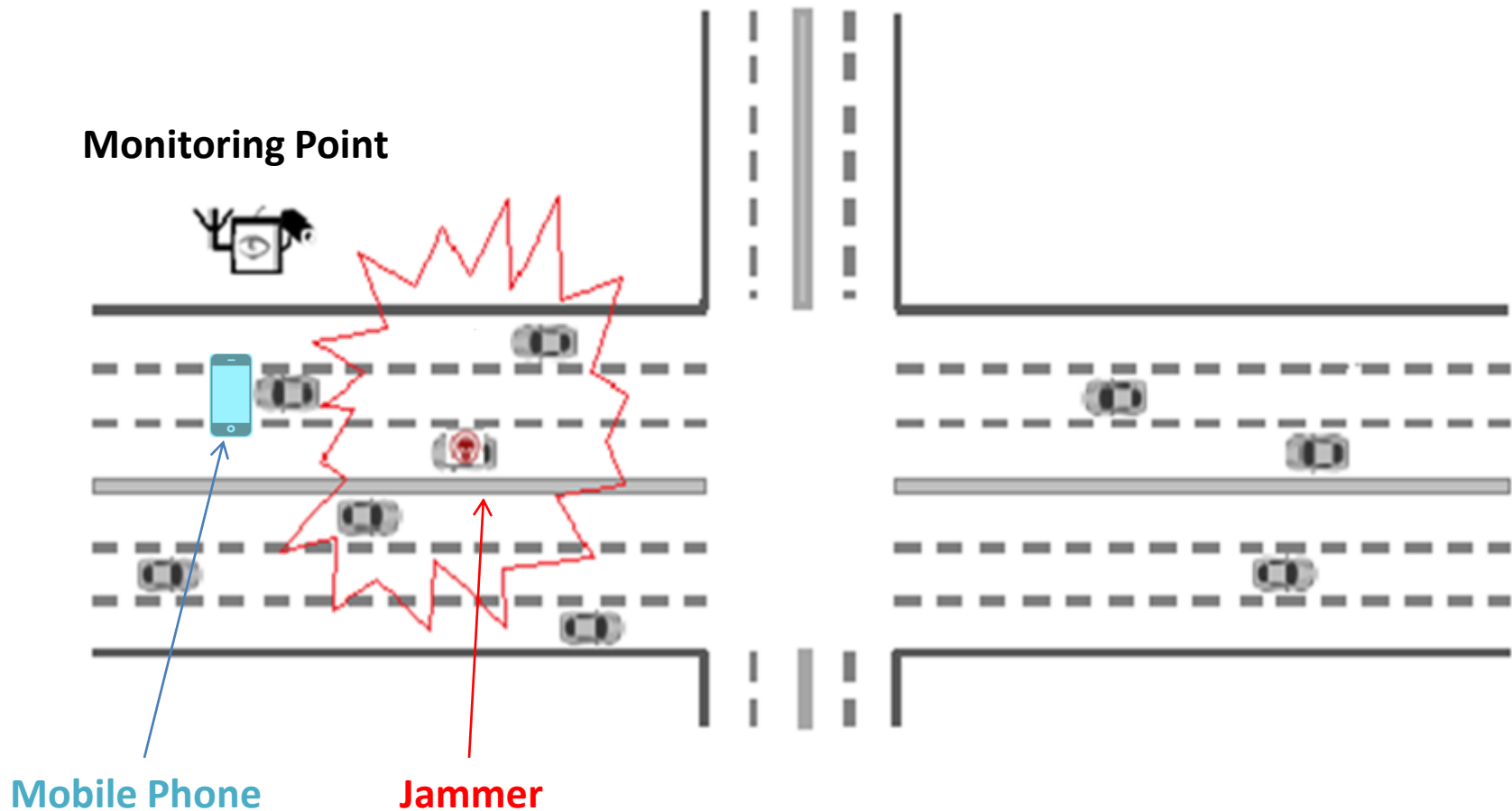
# What is Needed?

- A detection and identification system that is;



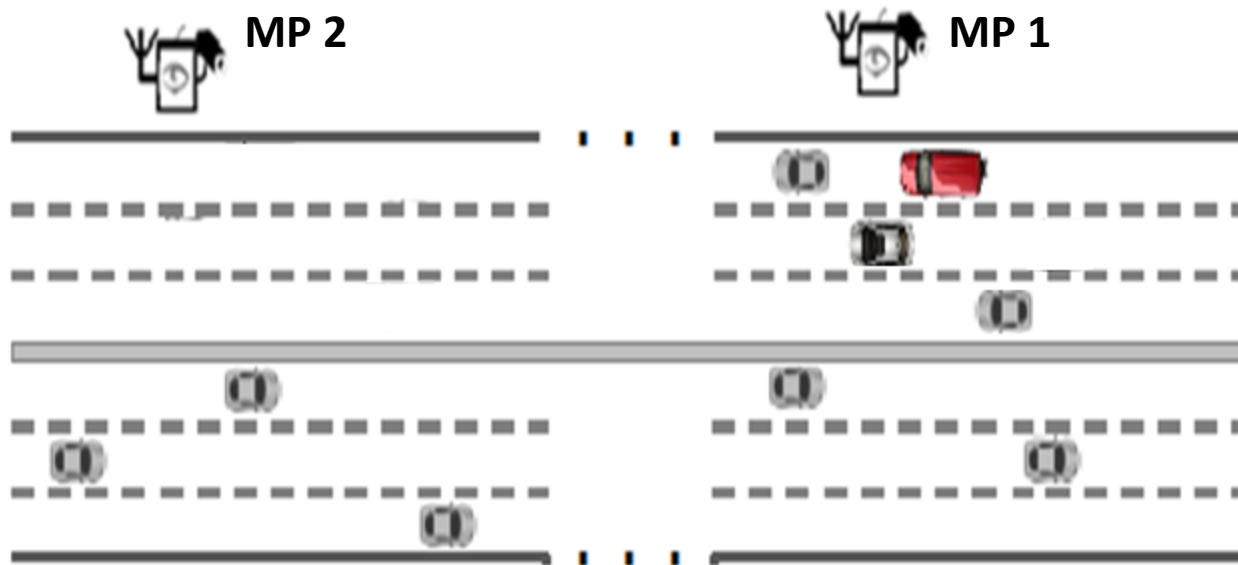
- automated, with high accuracy, and at a low cost,

# Overview of Jamming Detection System



# Multiple Monitoring Points

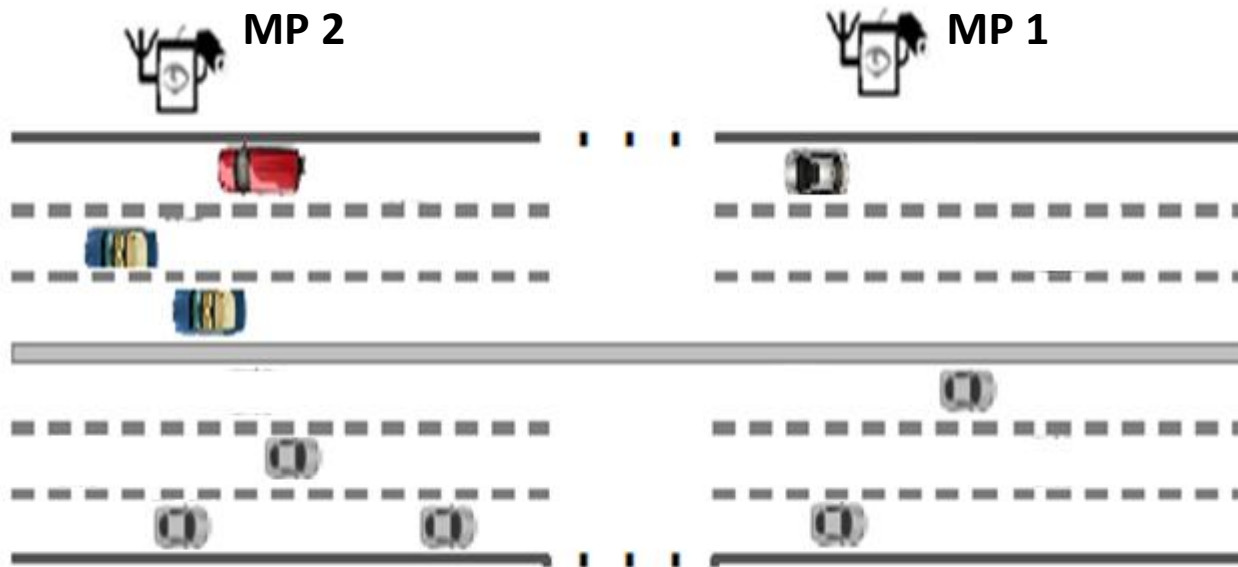
Jammer is detected with MP1 @ time  $t_1$



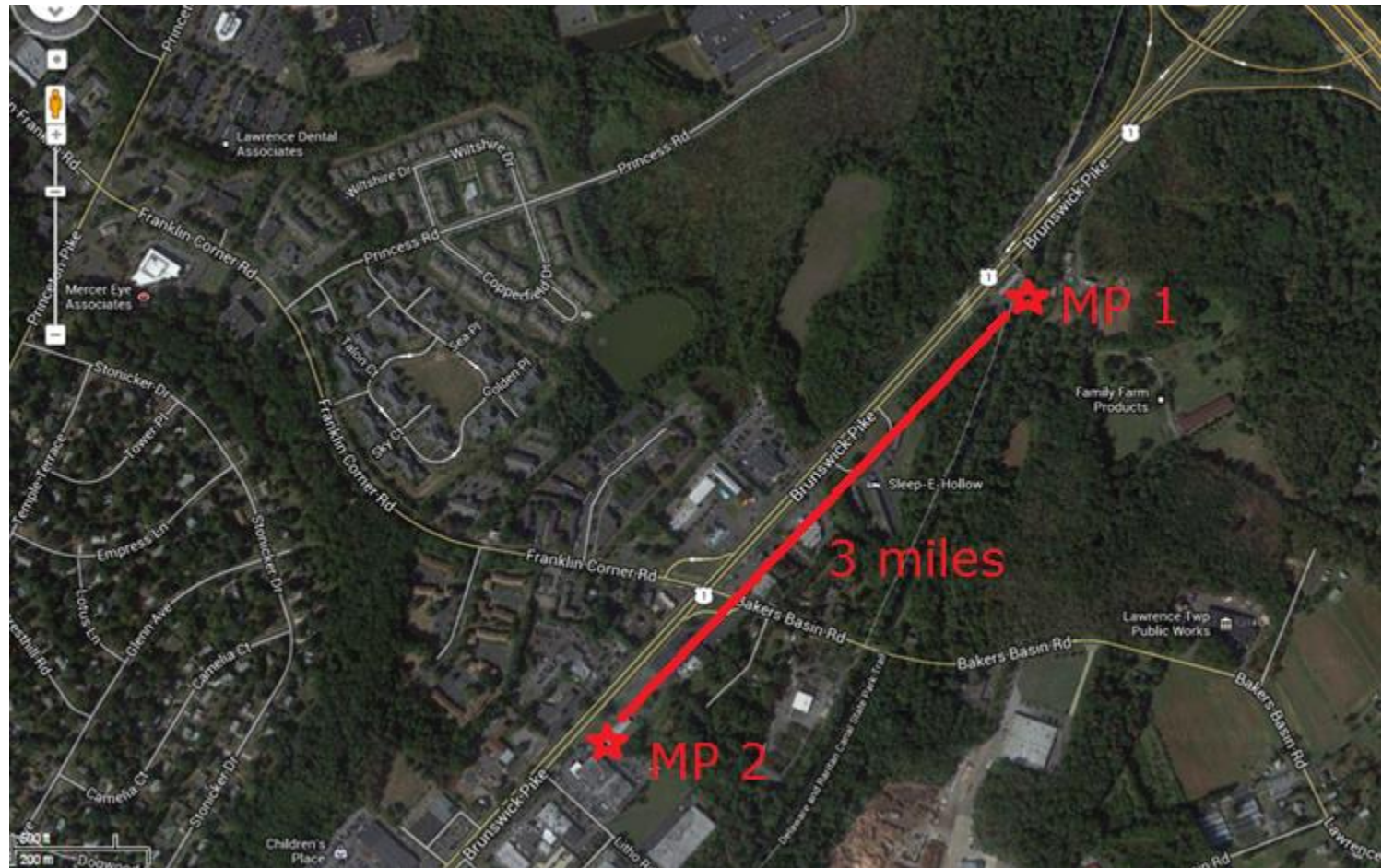


# Multiple Monitoring Points

Jammer is detected with MP2 @ time  $t_2$



# Monitoring Points



# Experimental Setup

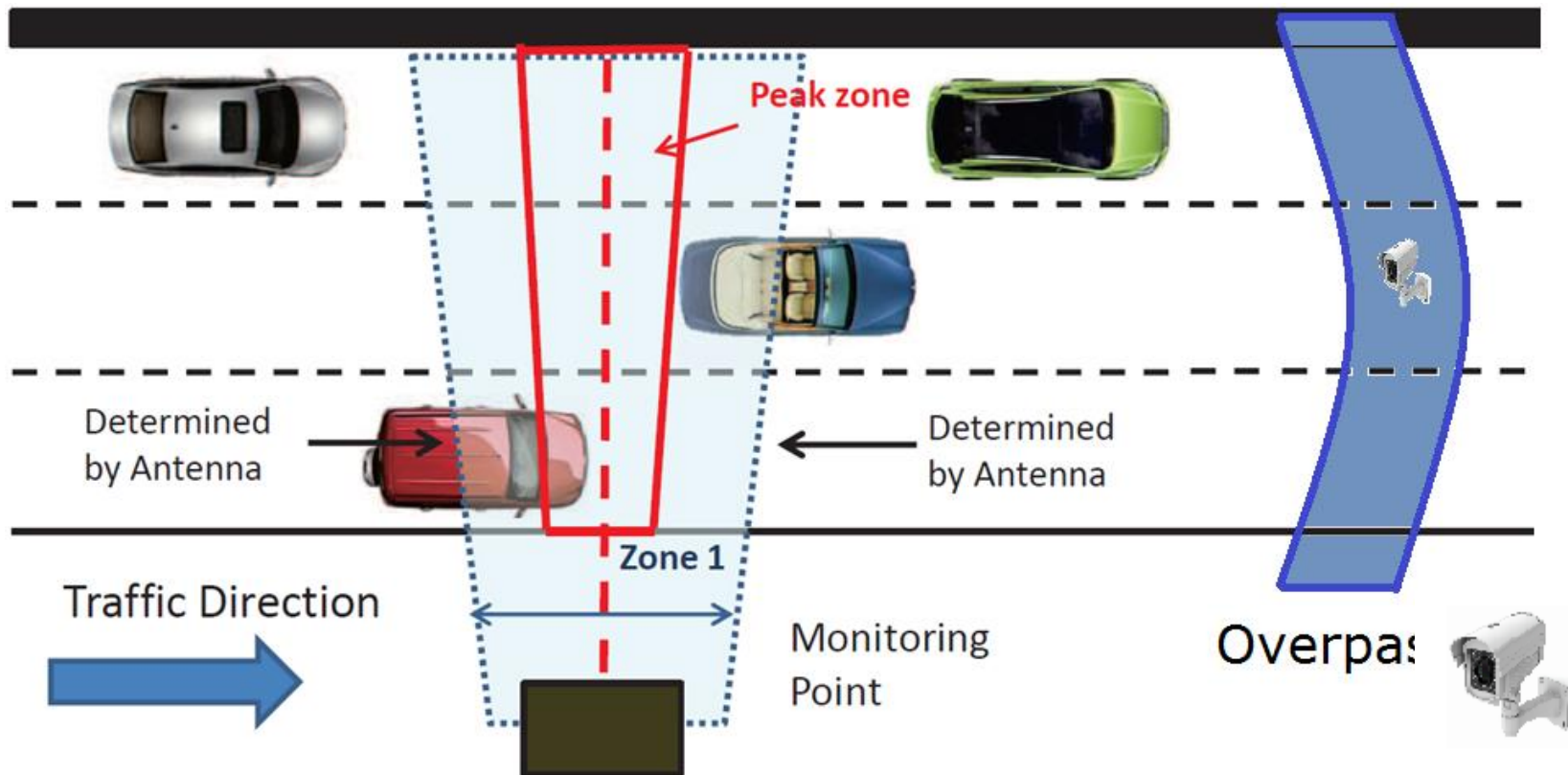




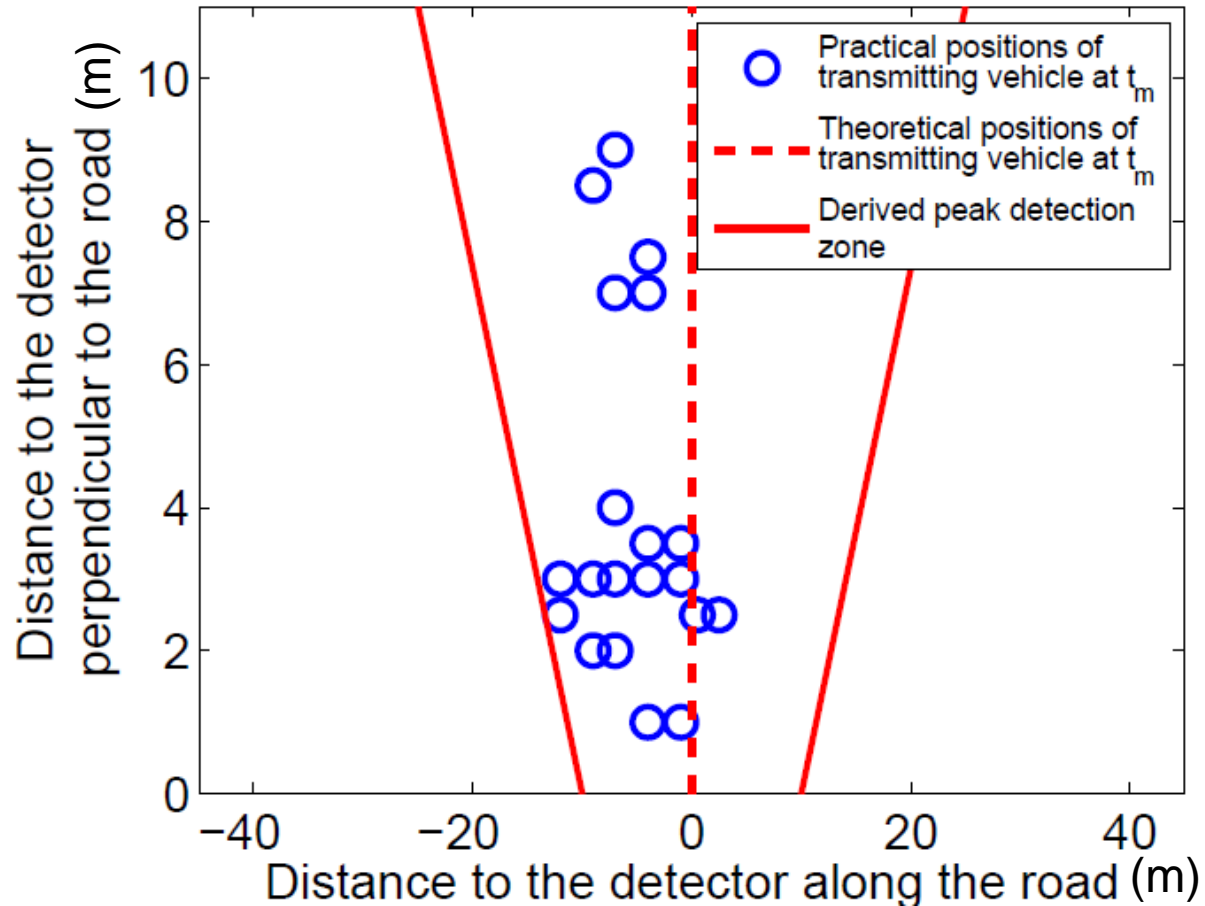
# MP Location



# Detection Zone

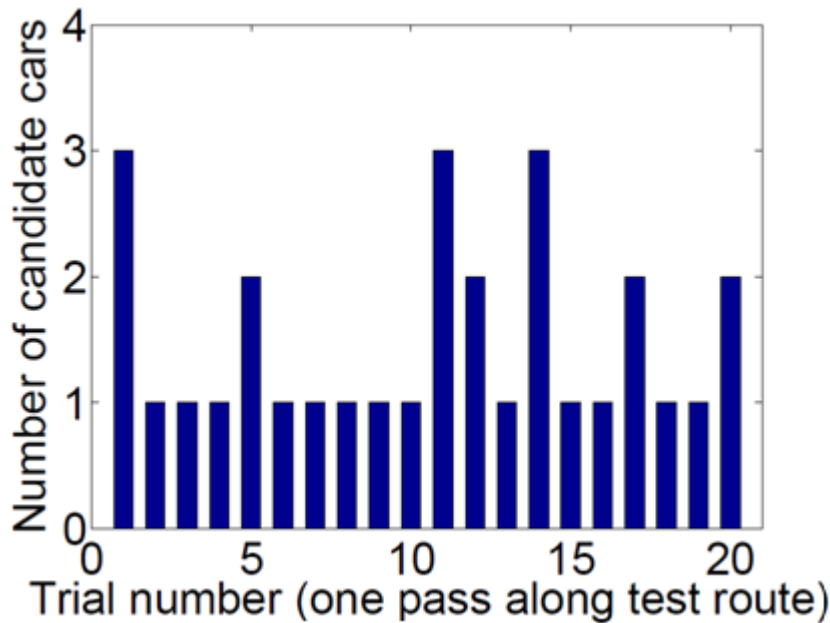


# Identified Vehicle Positions at $t_m$

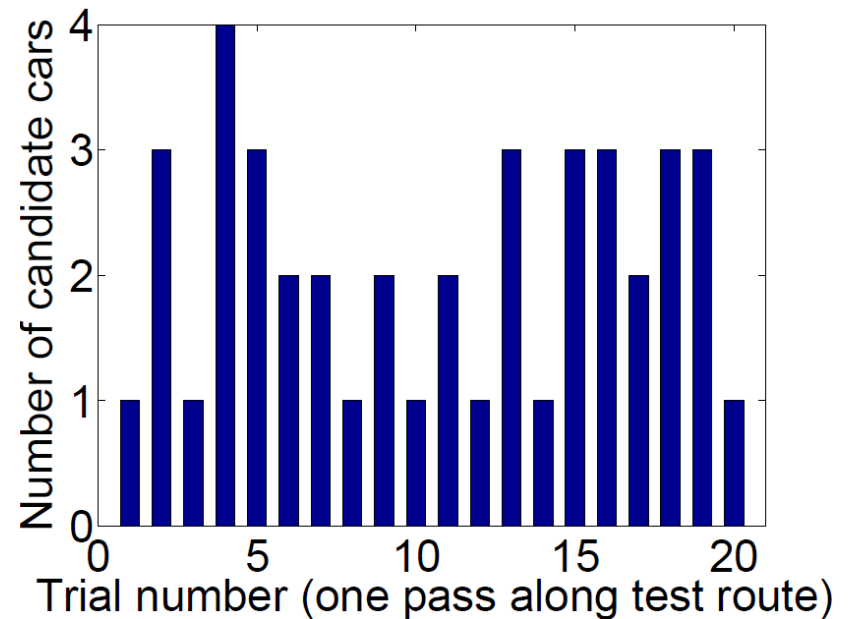


# Single Monitoring Point Case

@ MP 1



@ MP 2



**We could uniquely identify the transmitting car with 65% @ MP 1 and 35% @ MP 2 with NO false positive rate.**

# Multiple Monitoring Case

- **The detection rate can be improved by combining the information collected from both zones.**
  - Intersect the candidate vehicle sets @ MP1 and MP2.



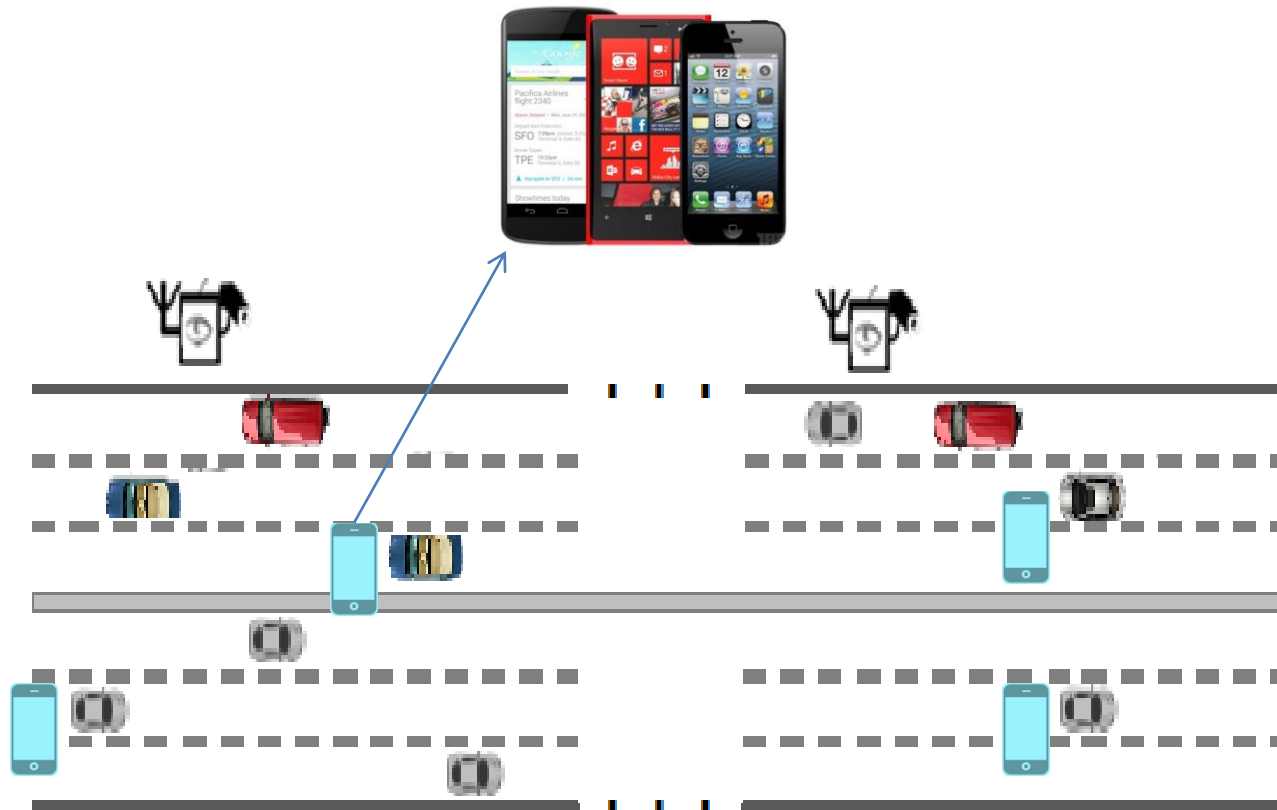
This resulted in only a **single detected vehicle** and a correct identification of our transmitter vehicle in **all cases**.



# Passive Roadside Monitoring

- 5 locations are chosen in NJ and SC; 200 hours of monitoring passively,
  - a major highway,
  - one of the busiest toll road,
  - and an urban road
- Two suspicious interference incidents are detected.
- May not come from real jammer, but still proves the interference exist @ L1 frequency band (which is GPS band, 1.5 GHz).

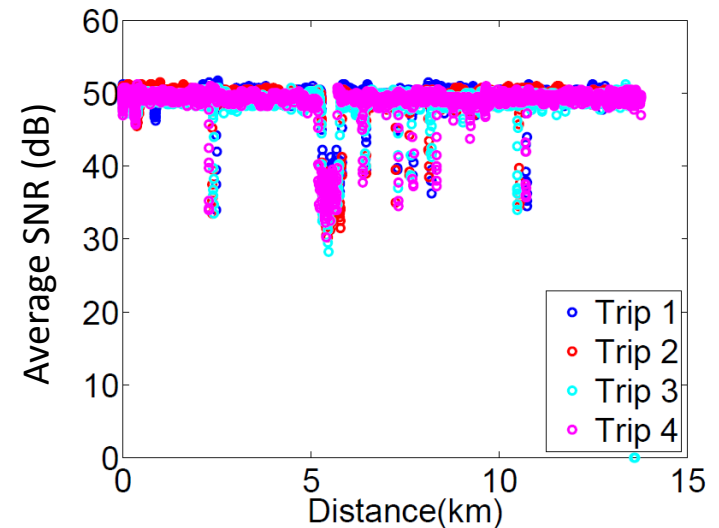
# Mobile Detectors



# How to Detect the Interference via Mobile Phones?

## Profiling

- Use Android API to get the current SNR(Signal-to-Noise Ratio) value of the location
- Create a SNR profile of a sample route by matching SNR with GPS position (expected SNR)



## Anomaly Detection

- Compare current reading(SNR) of the mobile detector with the expected SNR from profiling stage
- If current reading of SNR is lower than the expected SNR, there should be an interference at L1 freq., central office should be notified.

# Conclusion

- Presented a low-cost jammer identification system that can be mass deployed in roadways to automatically detect and identify the vehicles with GPS jammers.
- The key components of the system are monitoring stations and mobile detectors.
- Our mobile detector can detect interfering signals based on measurements that are readily available in most GPS receivers
  - Thus, it is possible to detect jammers via crowdsourcing.

# THANKS!

- Any questions?