RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Security and Privacy on the Road

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WINLAB Research Review

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Very Hard (and Fun!) Problem

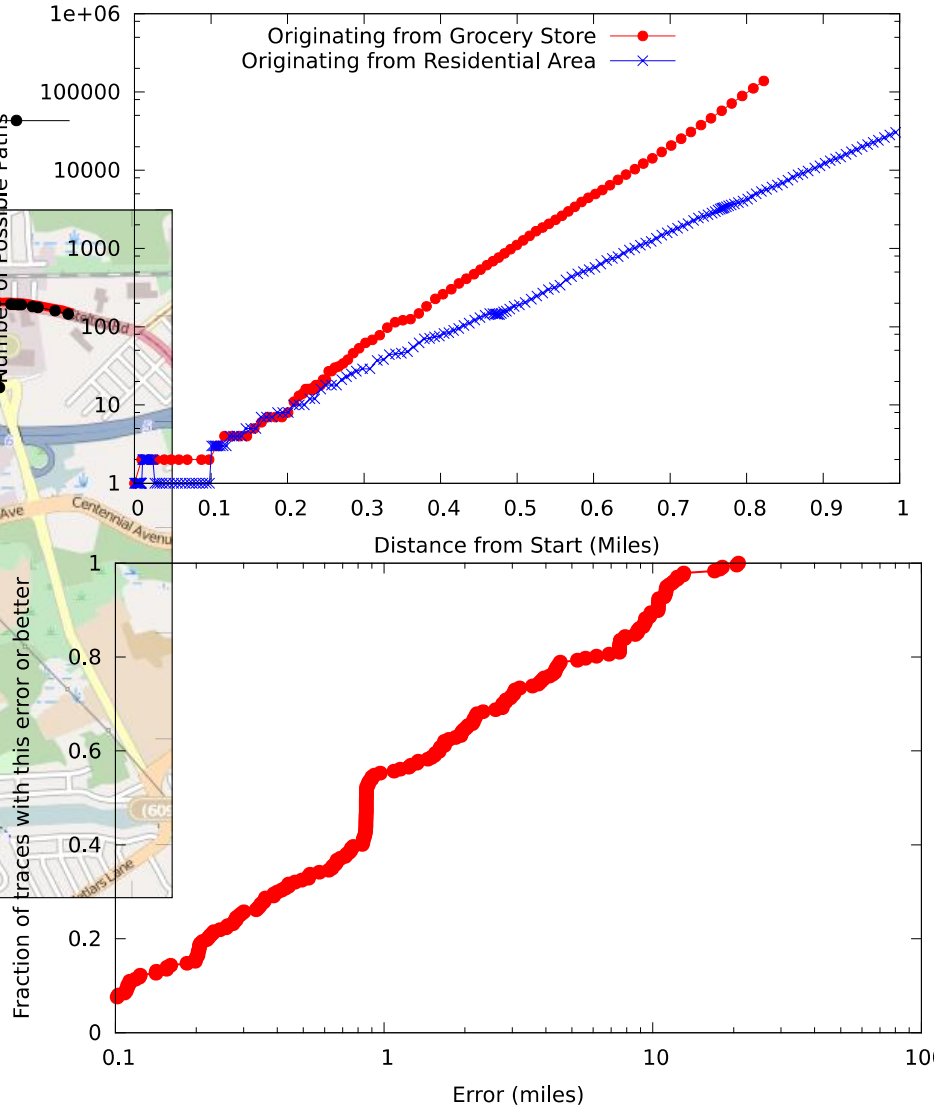
- Is it possible to track you when we just know your:

- Starting location

and

- Your driving speed with timestamps?

Elastic Pathing: Speed is Enough to Track You



technology review
Published by MIT

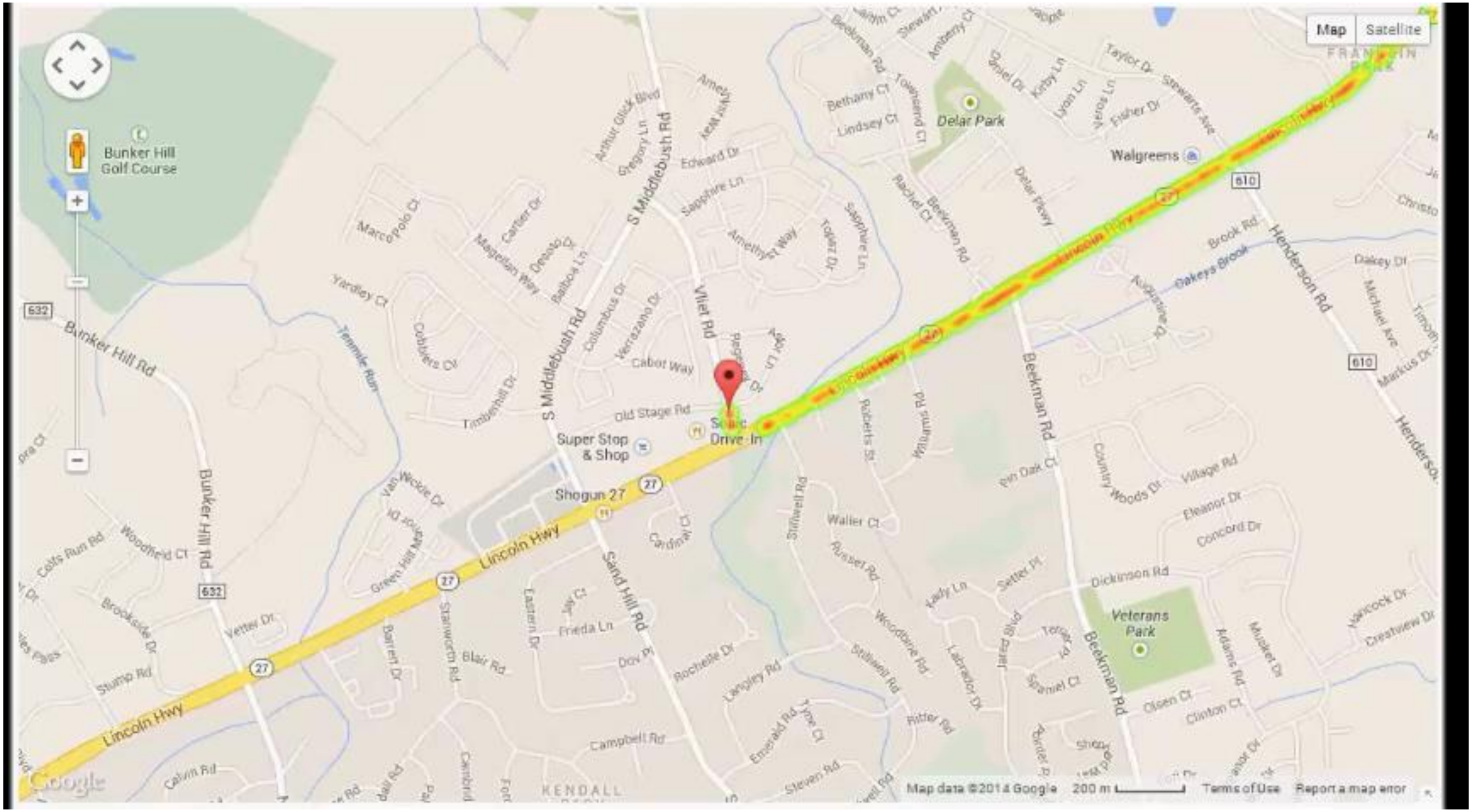
Additional Motivation: Usage-Based Automotive Insurance

- Some companies claim to only collect speed data to preserve privacy
- Examples
  - PROGRESSIVE: Snapshot device
  - Allstate: DriveWise device
- **Starting location: home address known by insurance companies**

Key Idea: Elastic Pathing Algorithm

- Accumulate distance from speed
- Include all the possible paths while matching
- Priority First Search:
  - First explore the candidate path having smallest overall error
  - Drop the path if current speed is way beyond the speed limit
  - Sort the possible path according to the overall error
  - Repeat until complete

Demo


Map
Satellite
Bunker Hill Golf Course
Bunker Hill Rd
Delar Park
Walgreens
Lincoln Hwy
S Middlebush Rd
Vliet Rd
Old Stage Rd
Super Stop & Shop
Shogun 27
Beekman Rd
Henderson Rd
Sand Hill Rd
Veterans Park
Dickinson Rd
Oakeys Brook
Map data ©2014 Google
200 m
Terms of Use
Report a map error

Finding: Accuracy Differs with Drivers

Summary

- New Jersey dataset
  - 14% traces: error less than 250 meters (0.16 miles)
  - 24% traces: error less than 500 meters (0.31 miles)
- Seattle dataset
  - 13% traces: error less than 250 meters
  - 26% traces: error less than 500 meters

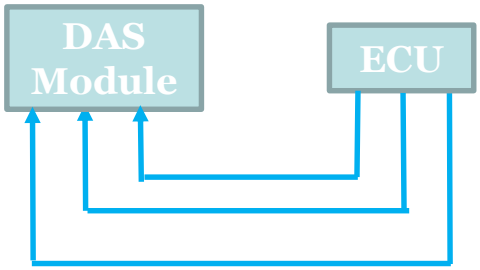
- **More information and full demo video at:**
- **http://elasticpathing.org/**

Accuracy Differs with Drivers?

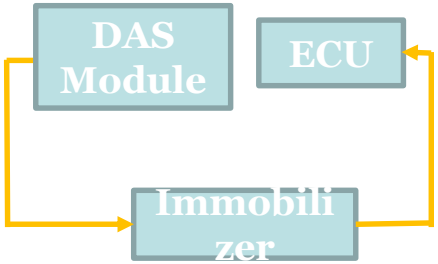
- **Car theft: a major problem**
  - FBI's estimate for 2013: "just under 700,000 units" stolen vehicles just in the United States
  - Only 42.6% of stolen vehicles were recovered in 2008
- **Solution : Authenticate drivers by driving behavior**
  - Use driving data
  - Distinguish between drivers based on their driving habits

DAS: Driving Authentication System

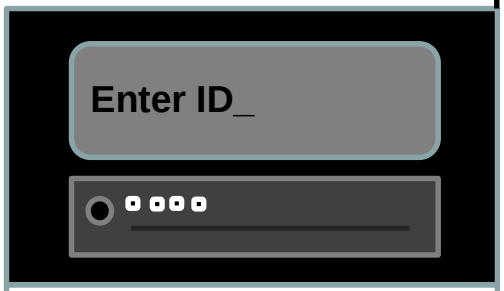
Ignition



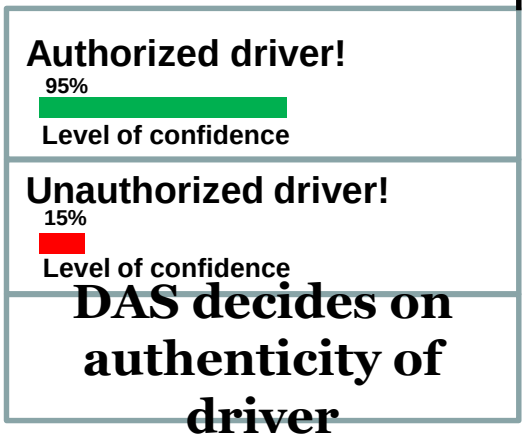
DAS collects driving data from ECU



DAS sends the appropriate signal to ECU via immobilizer.

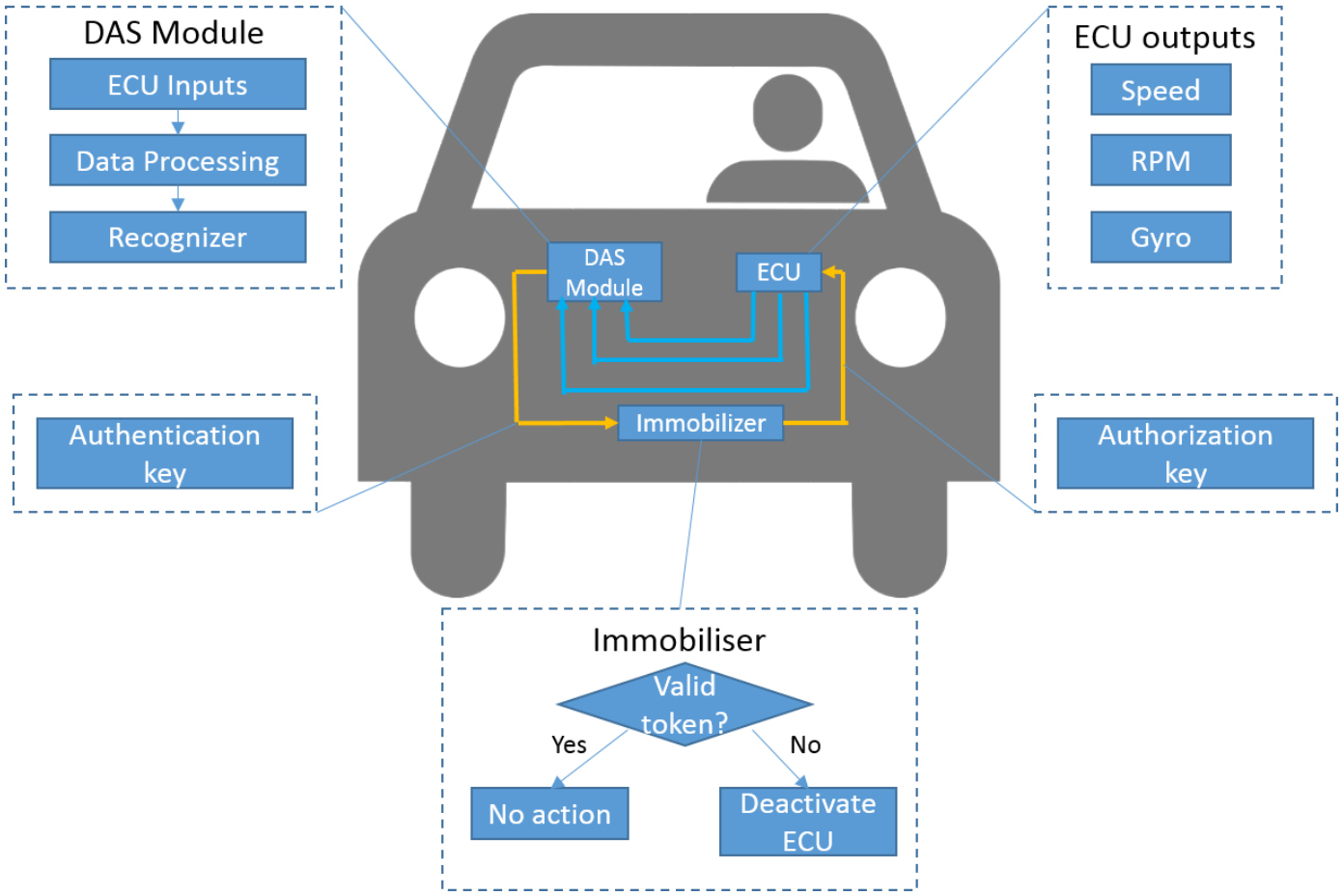


User claims their identity



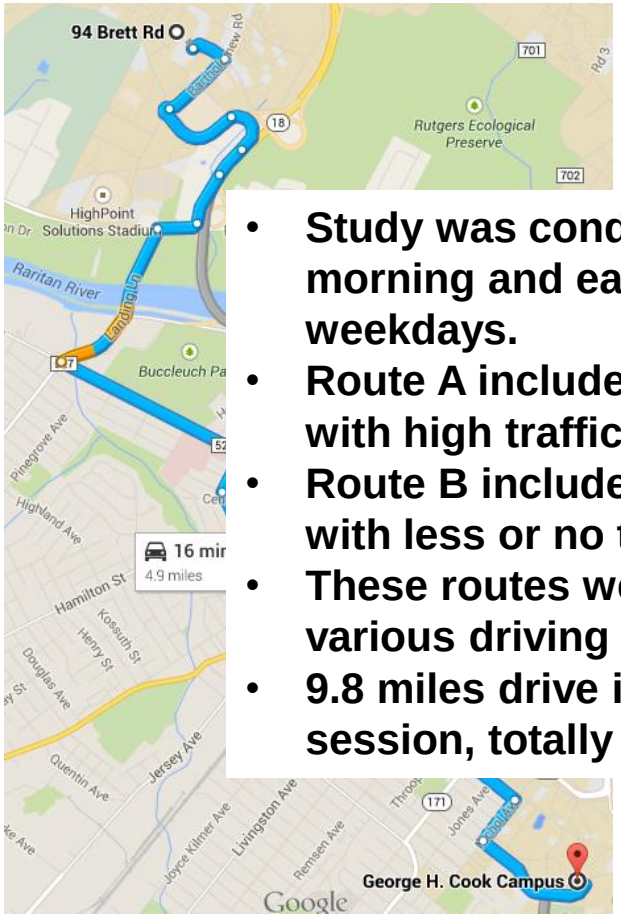
DAS decides on authenticity of driver

- System Architecture

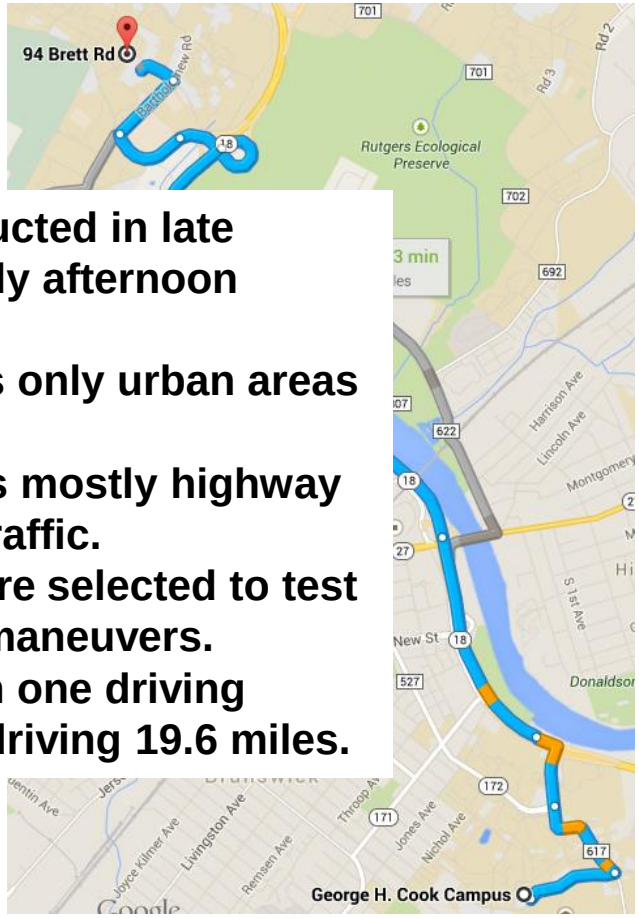


- **Design Considerations**
  - Number of people
    - How many people drive the car?
  - Lending your car
    - Friend, rental cars etc
  - Variable driving patterns
    - Changes in driving behavior at different times
  - Environmental effect
    - Changes in weather conditions, road obstruction, etc.
  - Regional effect
    - Changes in driving behavior in different cities

- **Formal study with 30 participants**



Route A



Route B

- Study was conducted in late morning and early afternoon weekdays.
- Route A includes only urban areas with high traffic.
- Route B includes mostly highway with less or no traffic.
- These routes were selected to test various driving maneuvers.
- 9.8 miles drive in one driving session, totally driving 19.6 miles.

- **Individual Analysis of Drivers Equal Error Rate**

	Driver# 1	Driver# 2	Driver# 3	Driver# 4	Driver# 5	Driver# 6	Driver# 7	Driver# 8	Driver# 9	Driver# 10
EER (%)	0	0	0	6.67	6.67	10	6.67	6.67	0	3.33
	Driver# 11	**Driver# 12**	**Driver# 13**	**Driver# 14**	**Driver# 15**	**Driver# 16**	**Driver# 17**	**Driver# 18**	**Driver# 19**	**Driver# 20**
EER (%)	6.67	0	3.33	0	10	13.33	6.67	6.67	13.33	0
	Driver# 21	**Driver# 22**	**Driver# 23**	**Driver# 24**	**Driver# 25**	**Driver# 26**	**Driver# 27**	**Driver# 28**	**Driver# 29**	**Driver# 30**
EER (%)	16.67	0	10	0	0	3.33	0	3.33	0	0

- **Unfamiliarity with route: inconsistent driving**
- **Road obstruction**

Summary

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Thank you!