Framework for Utilization of Mobile Data Collection

Parth Bhavsar (Rowan University)
Nidhal Bouaynaya (Rowan University)
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Agenda

Parth Bhavsar

- Problem statement & Background
- Overall concept
- System Architecture

Nidhal Bouaynaya

- Rowan initiative
- Image processing algorithm

Jeevanjot Singh

- Benefits
- Challenges
- Future

Question: Where are we?

- Connected Vehicles
- Semi-Autonomous Vehicles
- Autonomous Vehicles
- Connected-Automated Vehicles
- Flying cars?

http://www.aeromobil.com/

Movie: 5th Element

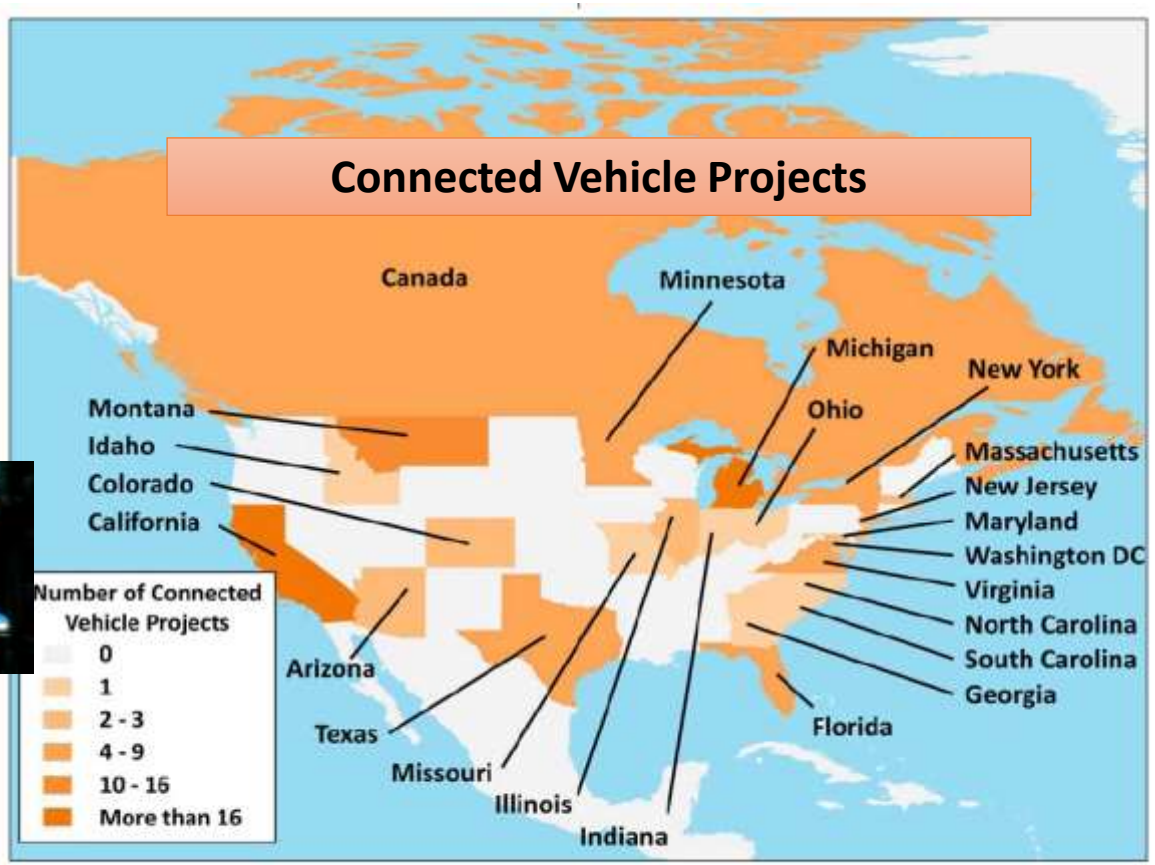
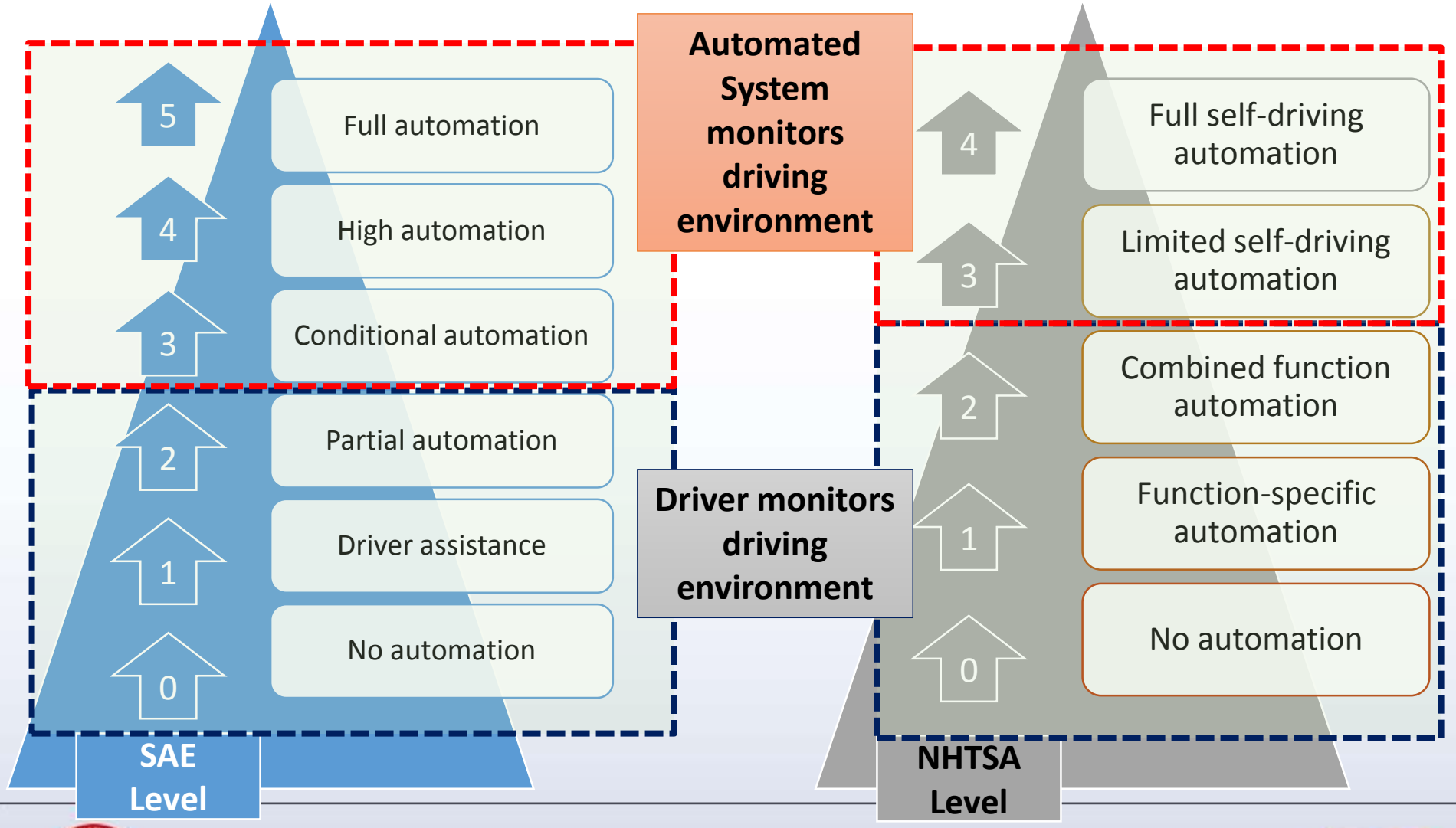


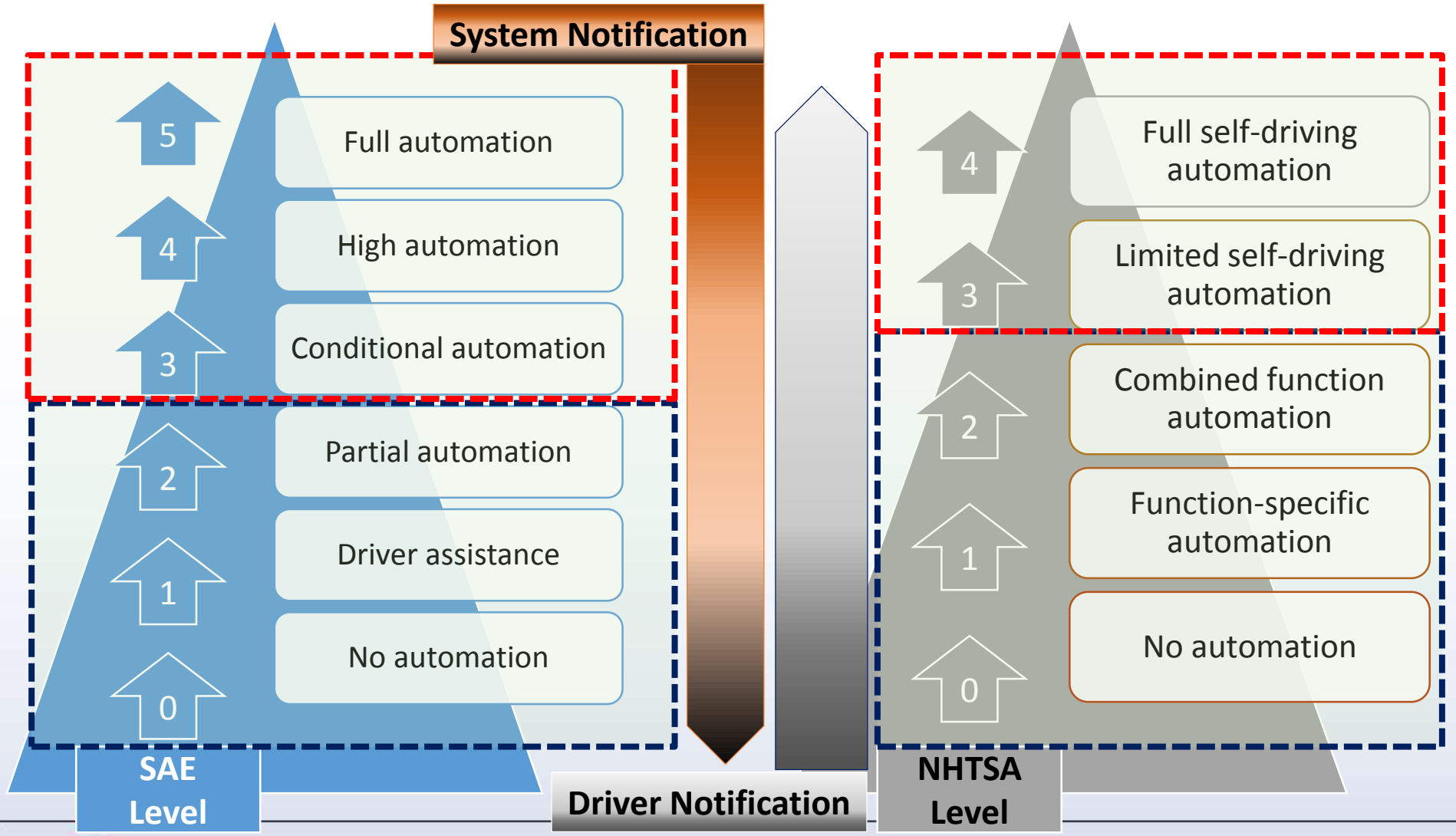
Figure 2: Connected Vehicle Projects in North America
Source: CAR 2012

Automated Vehicle- Automation Levels



SAE J3016: http://www.sae.org/misc/pdfs/automated_driving.pdf
NHTSA: www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf

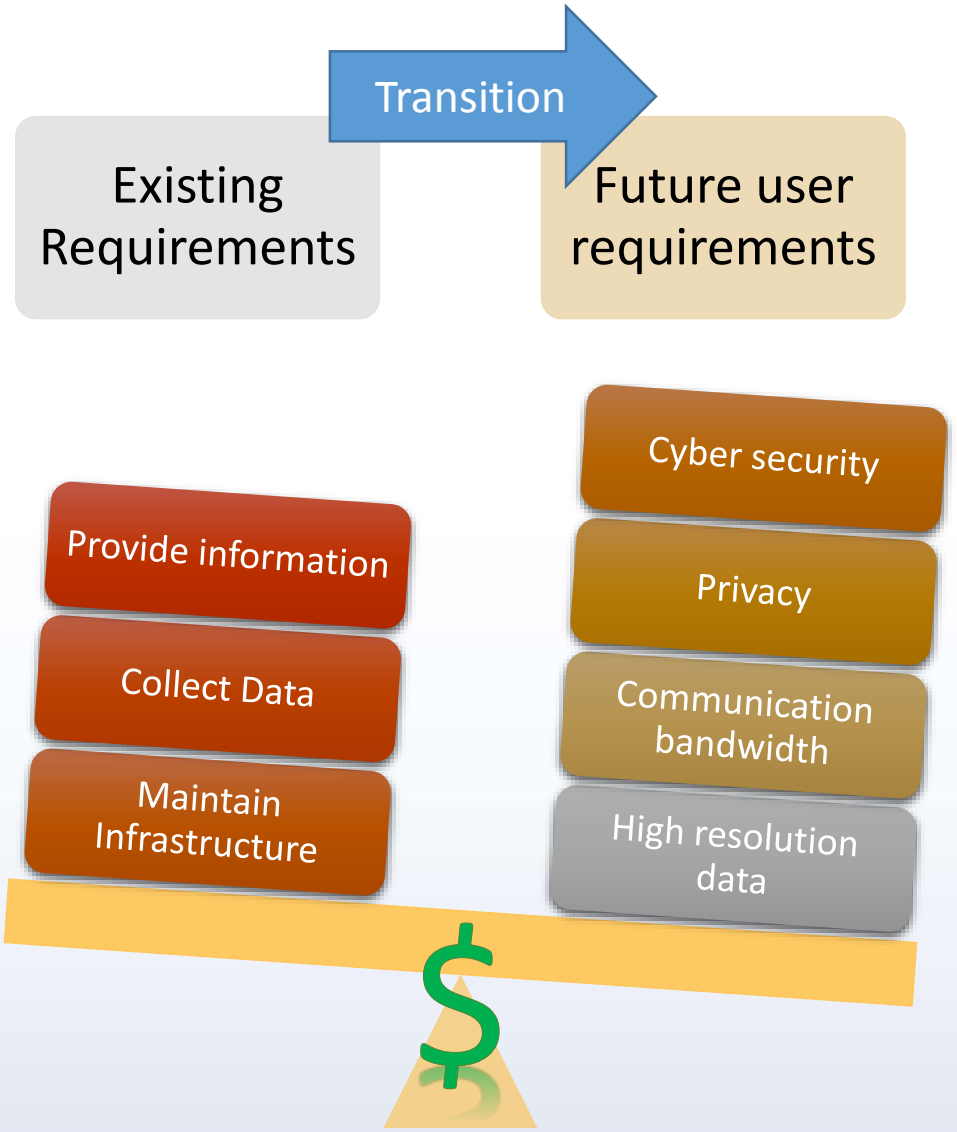
Data Dissemination: Conventional - Autonomous



SAE J3016: http://www.sae.org/misc/pdfs/automated_driving.pdf
NHTSA: www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf

Challenges for DOTs

- **Efficient transition from current transportation system to future connected-automated system**
  - Optimize existing resources
  - Satisfy user requirements over time
  - Continue maintaining infrastructure components
  - Balance budget



State of the art

Source: WYDOT

Figure 2-2. App Reporting Screen on the Tablet

Wyoming Department of Transportation (WYDOT) Road Condition Reporting Application for Weather Responsive Traffic Management

- Improve the efficiency of road condition reporting by maintenance staff.
- Improve the efficiency of the transportation Management Center (TMC) operations in responding to the reported road conditions.
- Improve the timeliness of updated traveler information.
- Improve the situational awareness of maintenance staff in the field regarding road weather conditions

State of the art

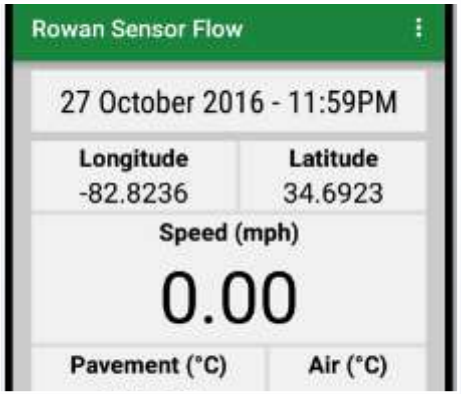
- Minnesota
  - 80 snowplows with onboard sensors
    - Type of material dispatched
    - Location
    - Route
- Nevada
  - 40 vehicles in Reno-Carson city area with advanced sensors and equipment to enhance the maintenance management
- Michigan
  - 60 fleet vehicles (20 snow plow trucks and 40 light- and medium-duty vehicles)
    - Camera Image of road conditions
    - location, time and direction
    - Temperature, humidity dew point
    - ABS, traction control, wheel speed

Problem Statement

- **Develop a platform for user and location specific data collection**
- **Optimize existing resources**
- **Develop an affordable yet portable system**

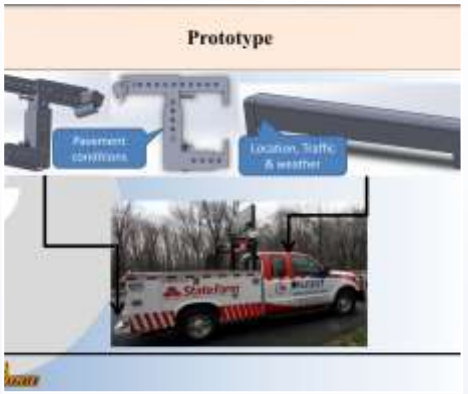
SSP Vehicle

Existing Vehicle



Android UI

Mobile & connected platform



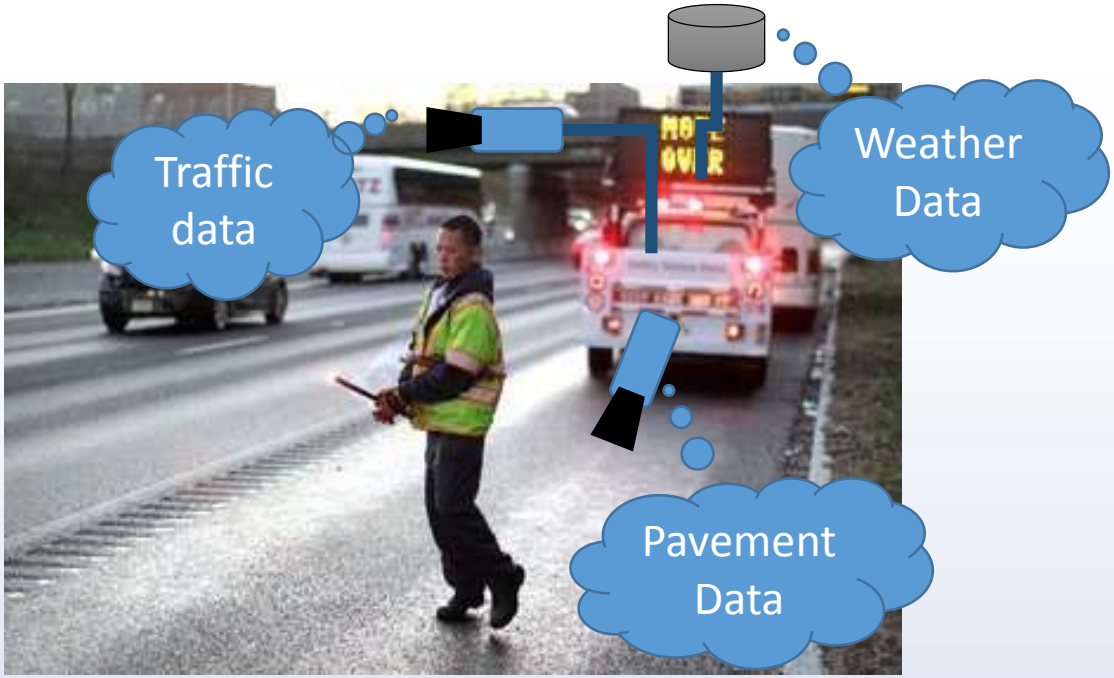
Prototype casing

Portable Platform

Communication Platform

- Goal: Optimize the usage of existing vehicle fleet

- Collect data while performing routine tasks
- Develop a common communication platform to receive data from various sensors and send/disseminate data based on priority
- Develop portable data collection units

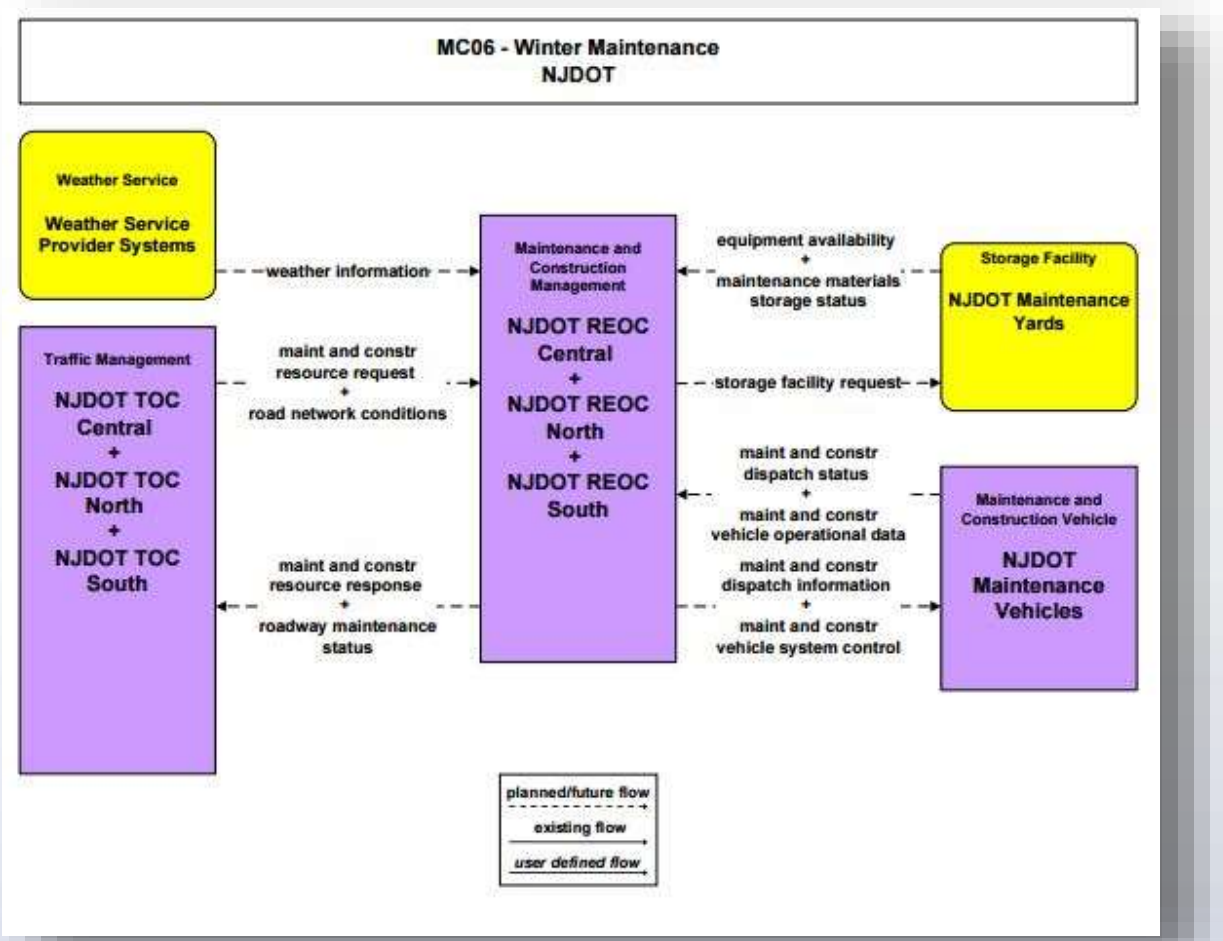


Communication Platform: Potential

- High resolution location specific data is the necessity for several connected vehicle applications.

Connected Vehicle Reference Implementation Architecture (CVRIA) Type of Applications
Environmental (22 applications)
Mobility (36 applications)
Safety (30 applications)
Support (9 applications)

Communication Platform: Potential



Team

- NJDOT
- NJIT
- Rowan Smart Vehicle Research Group
  - Rowan Graduate and Undergraduate students from CEE & ECE
  - Clemson Graduate Student

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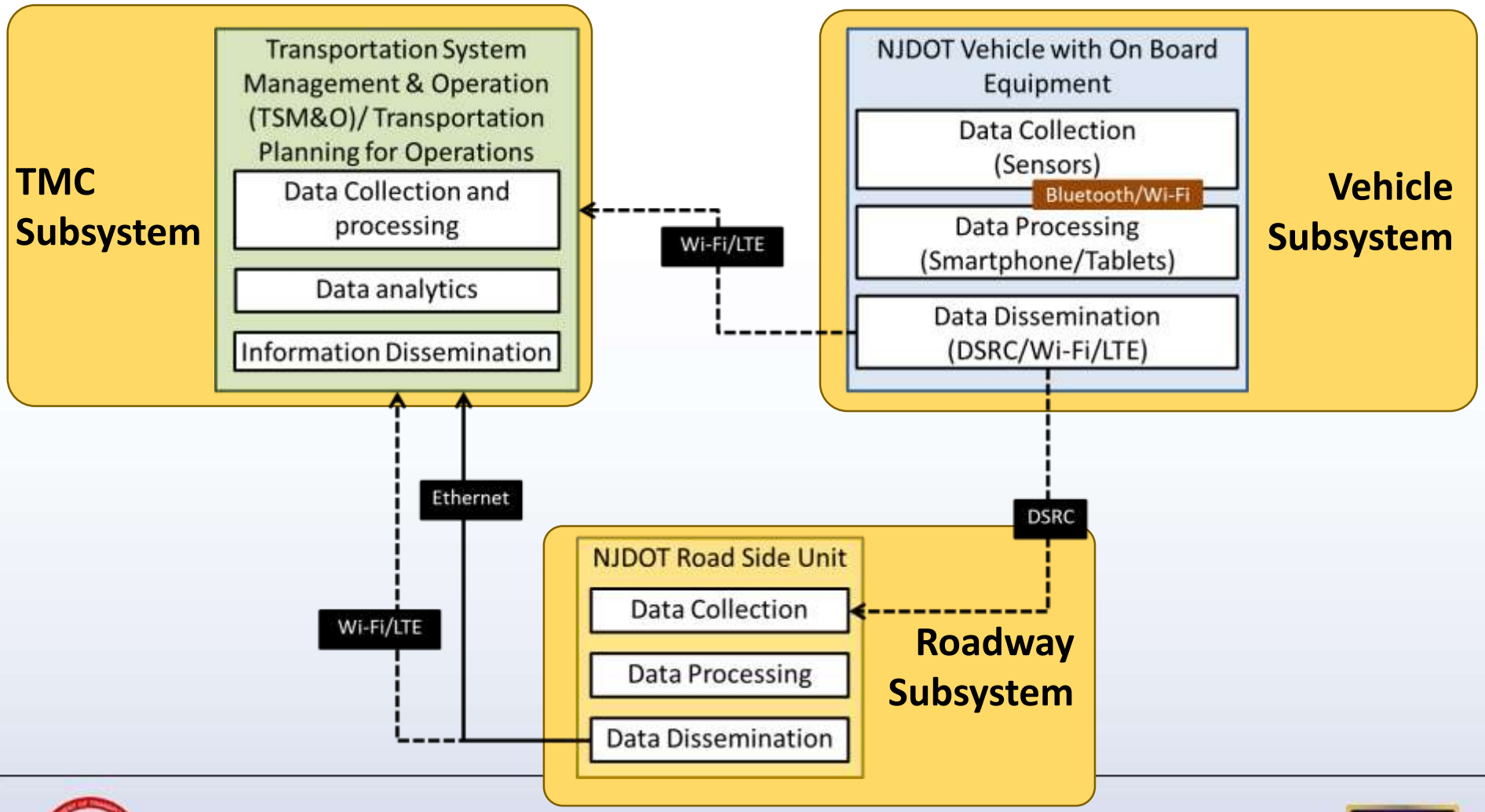
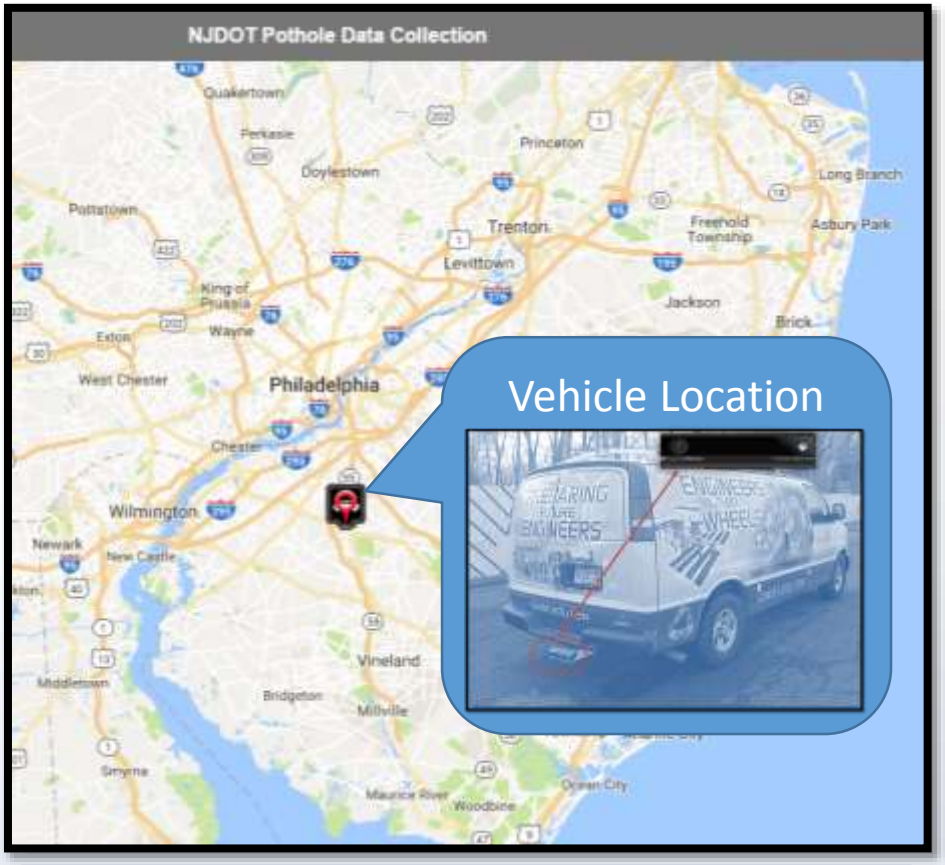
System Architecture



Mobile data collection platform

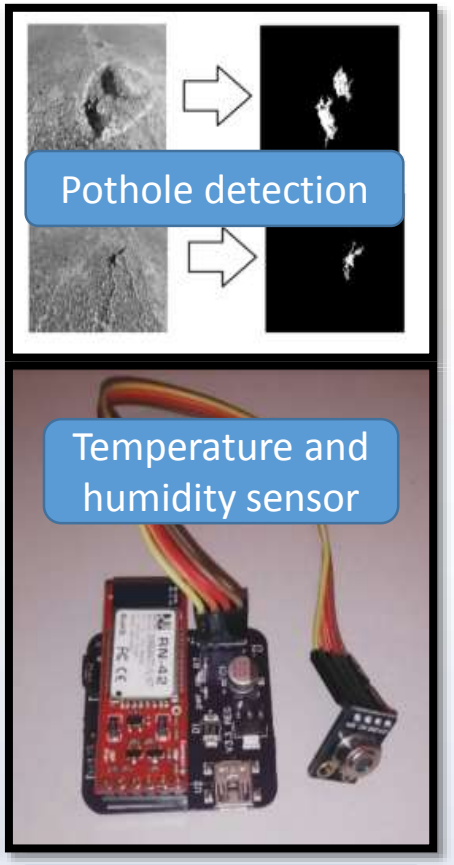
- Communication Platform
  - Mobile application based on the INFLO (Intelligent Network Flow Optimization) application (open source application available from USDOT/ITS JPO)
- Data Collection Units
  - Pothole detection sensor
    - Microsoft-Kinect to collect images
    - Image processing algorithm to detect pothole
  - Temperature and humidity sensor
    - Infra Red Thermometer Sensor
    - Arduino
    - Bluetooth Transceiver

Current Status



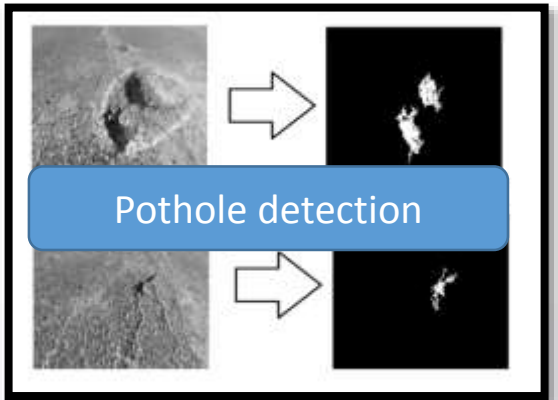
Server side user interface

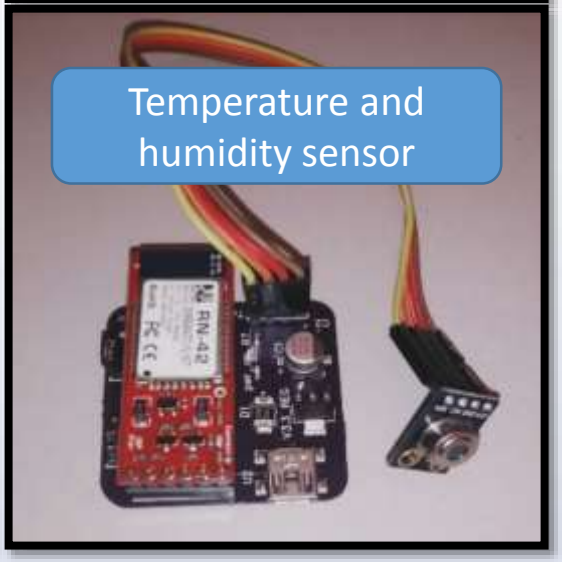
Android application



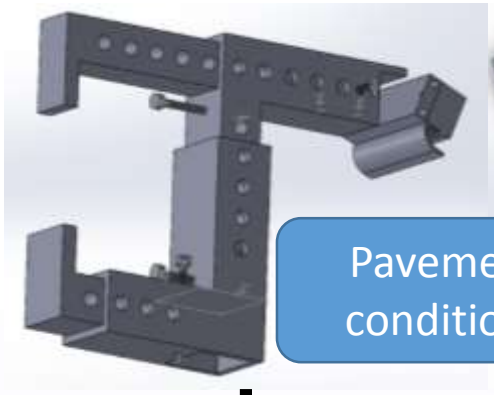
Data collection

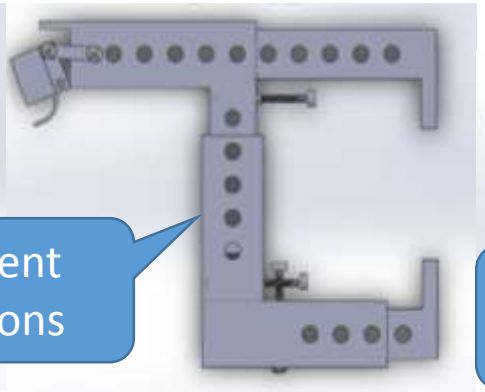
Prototype Evaluation





Prototype





Pavement conditions

Location, Traffic & weather

Mobile data collection platform: Future recommendations

- Develop a comprehensive mobile data collection platform that can help NJDOT transition from current transportation system to a next generation connected & automated transportation system.
  - Integrate other sensors as required
  - Integrate DSRC protocols to disseminate data
  - Develop plug and play functionality for future integration
  - Support existing and future decision support system by providing high resolution location specific data

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System wide Benefits

Location Specific HighRes Data Demand

System wide Benefits

Location Specific HighRes Data Demand

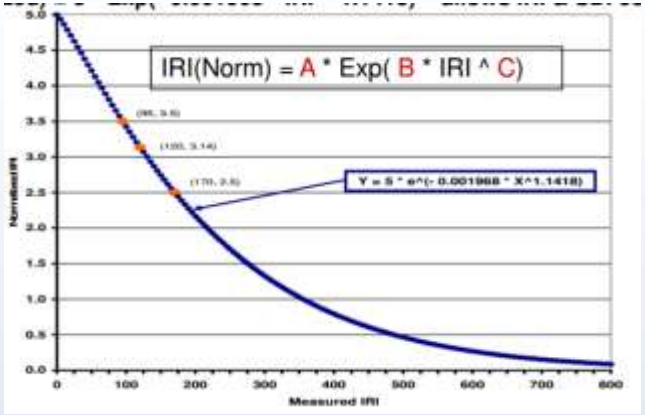
Pavement condition assessment and management

Current Practice

- Annual data collection (4600+ miles)
- High Speed Profiler
- Predict International Roughness Index (IRI) or Remaining service life.

Future

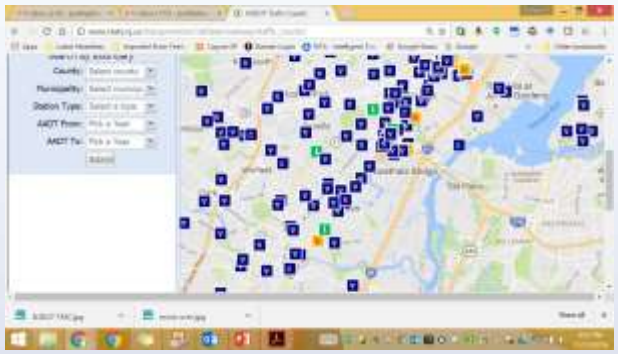
- **Significant increase in data collection frequency**
- **Utilize Safety Service Petrol (SSP) and other vehicles to collect pavement data**
- **Improve/Optimize pavement design, prioritize projects, & save $$$**



Weather Responsive Traffic Management

Current Practice

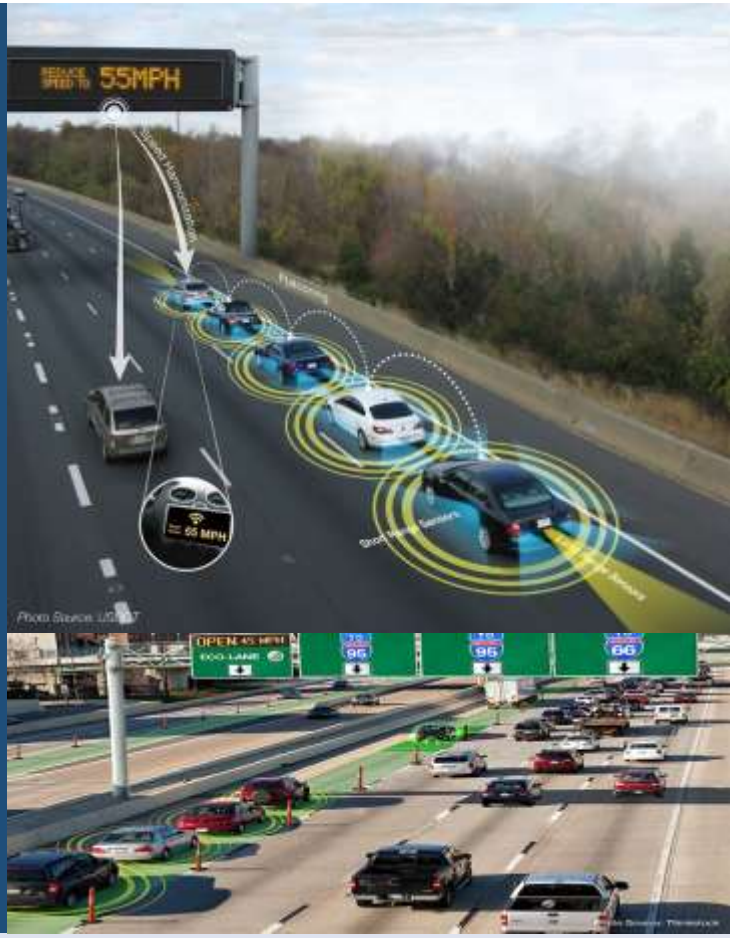
- Rich data collection units (camera, loop detectors, radar etc..)
- Majority of the data collection units are stationary units (i.e. road side units)
- Backbone for various traffic, incident and emergency management services
- Real-time traffic information dissemination



Weather Responsive Traffic Management

Future

- Mobile data collection units
- Location specific data
- Connected yet affordable solution
- Improve overall location specific accuracy
- TSM&O for connected and automated vehicle fleet



System wide Benefits

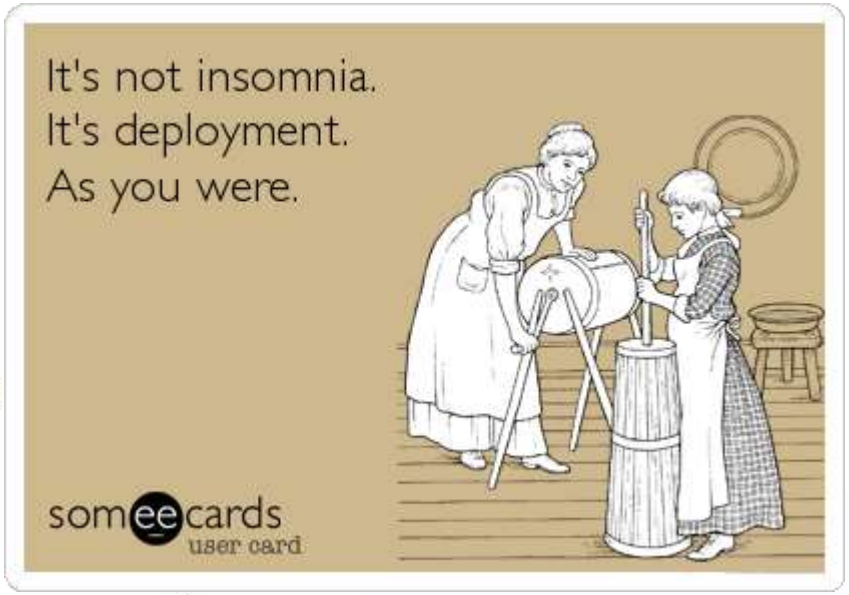
Location Specific HighRes Data Demand

System wide Benefits

Location Specific HighRes Data Demand

Challenges


Operations
Service Management
Production
Quality Management
Product
Planning
Material Planning
Productivity Analysis
Cost control
Supply Chain Management
Industrial labor relations
Development
Manufacturing


It's not insomnia.
It's deployment.
As you were.
someecards
user card


C-could I buy some security p-p-please?
Of course, sir. That will cost you 5 privacies.


GOVERNANCE

Challenges: Deployment

Standards

- USDOT is working with public and private sector to define:
  - Communications standards for DSRC
  - Other media, e.g., 4G LTE and/or HD radio may be used for appropriate applications
  - Information exchange standards:
    - Message sets for V2X [SAE J2735]
    - Minimum performance requirements for V2X messaging [SAE J2945.x]
    - Certification to ensure off-the-shelf interoperability of devices

Challenges: Funding

- At present USDOT is promoting pilot deployment program through research funding
- However, in future the responsible city, county and state governments will pay for implementation and maintenance. They have to
  - Identify resources to fund new CVT based projects
  - Maintain existing infrastructure
  - Bear additional burden of maintaining and upgrading the new CVT implementation
  - Identify innovative ways to generate additional revenues

Challenges: Operations

- The federal, state and local governments will have to
  - Develop standard procedures to implement, maintain and operate CVTs.
  - Employ skilled personnel
  - Provide training to existing employees

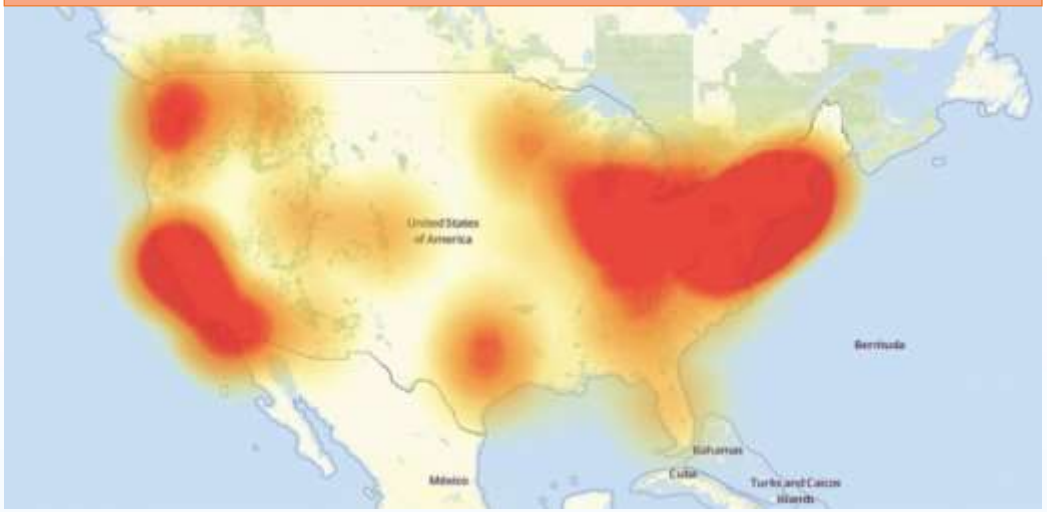
Challenges: Privacy & Security

This hacked traffic sign on Jersey Shore route may make you stop

2015: Hackers Remotely Kill a Jeep on the Highway

2016: Keen Security demonstrated that Tesla cars can be hacked into and controlled remotely.

2016 October: DDoS attack crippled east coast web



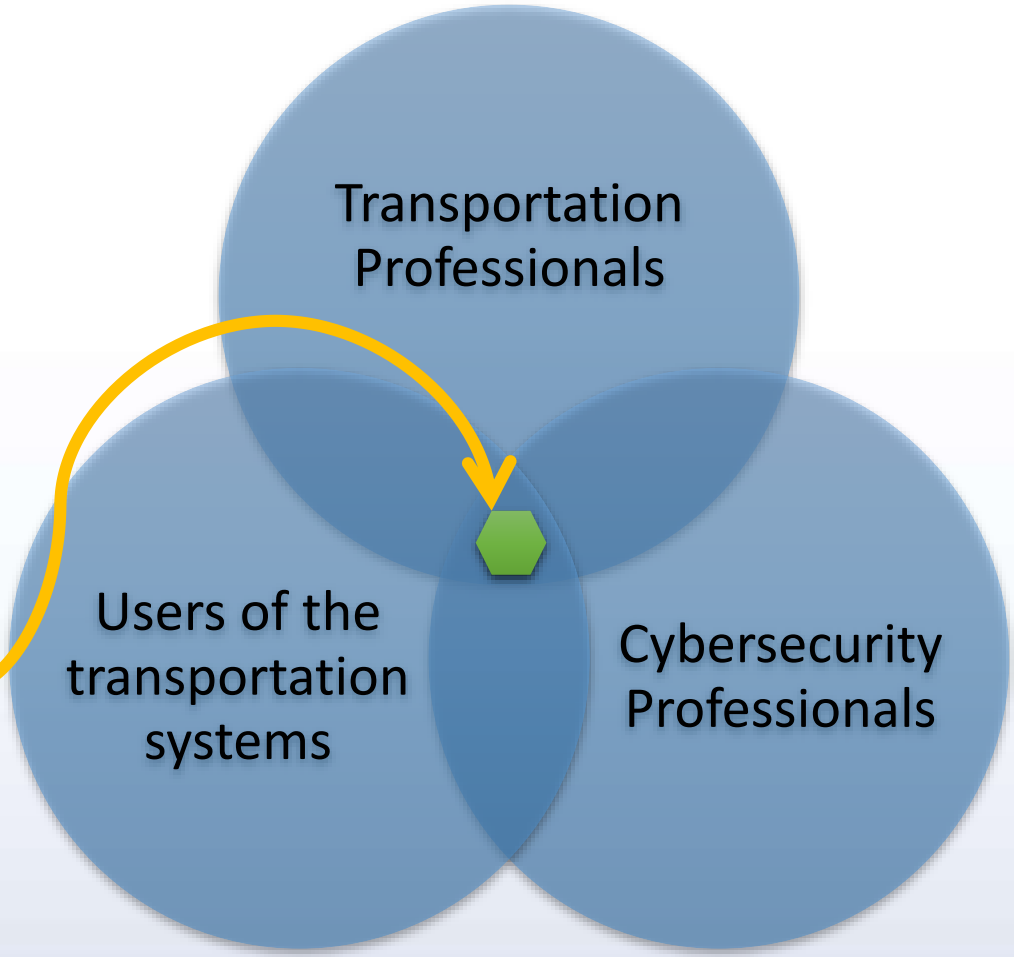
Source: https://www.truevault.com/blog/massive-iot-ddos-attack.html
Video Source:
2015 Jeep Hack
https://www.wired.com/video/2015/07/hackers-wireless-jeep-attack-stranded-me-on-a-highway/

2016 Tesla Hack
https://www.youtube.com/watch?v=c1XyhReNcHY

Challenges: Privacy and Security

- Developing a general consensus of secure but connected & automated environment

Safe, Secure, & Sustainable Transportation System of the future



Questions?