Stan Caldwell
Executive Director

Traffic21

A transportation research institute of Carnegie Mellon University

Mobility21

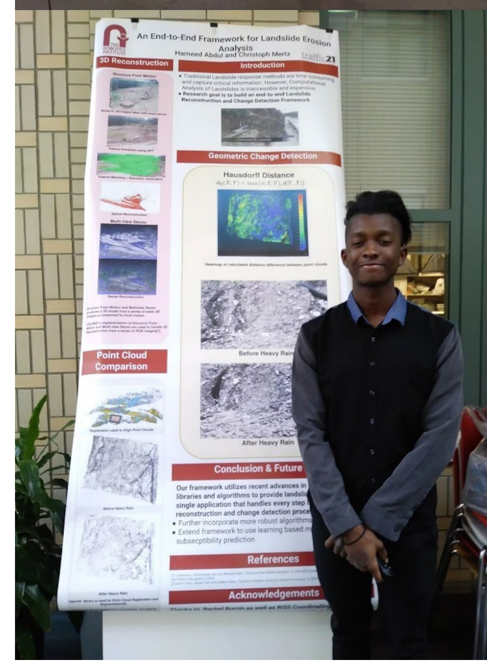
A USDOT NATIONAL
UNIVERSITY TRANSPORTATION CENTER

Carnegie Mellon University

Penn
University of Pennsylvania

The Ohio State University

CCAC



Trends in Information and Communications Technology

- Sensors
- Data Analytics (real time and predictive)
- Cyber Physical Systems
- Internet of Things
- Edge Computing
- 5G and Advanced Wireless

Technologies Disrupting Transportation

- Automation
- Connectivity
- Shared Use
- Electrification
- Novel Modes; Drones, Hyperloop, etc.

Traffic21's approach is…

- **R**esearch
- **D**evelopment
- **D**eployment through partnerships

Over 100 Deployment Partners

Traffic21

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How Did Pittsburgh and Pennsylvania Evolve as a Smart Transportation Test Beds and Build Industry Clusters?

Carnegie Mellon University
30 Years of Self-Driving Car Research

1984
- The Terregator's top speed was a few centimeters per second; it could avoid obstacles.
- NavLab launched. Its goal: apply computer vision, sensors and high-speed processors to create vehicles that drive themselves.

1986
Humans or computers controlled NavLab1, a Chevy van. Top speed: 20 mph.

1990
NavLab 2, a US Army HMMWV, wrangled rough terrain at 6 mph. Highway speed: 70 mph.

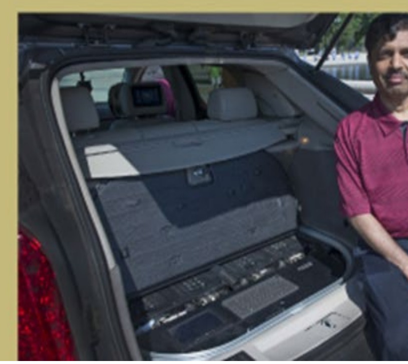
1995
NavLab 5, a Pontiac Trans Sport, traveled from Pittsburgh to San Diego in the "No Hands Across America Tour."

2000
NavLab 11, a Jeep, was equipped with Virtual Valet.

2005
Sandstorm and Highlander placed 2nd and 3rd in the DARPA Grand Challenge.

2007
Carnegie Mellon's "Boss" won the DARPA Grand Urban Challenge by outmaneuvering other vehicles along the 55-mile course.

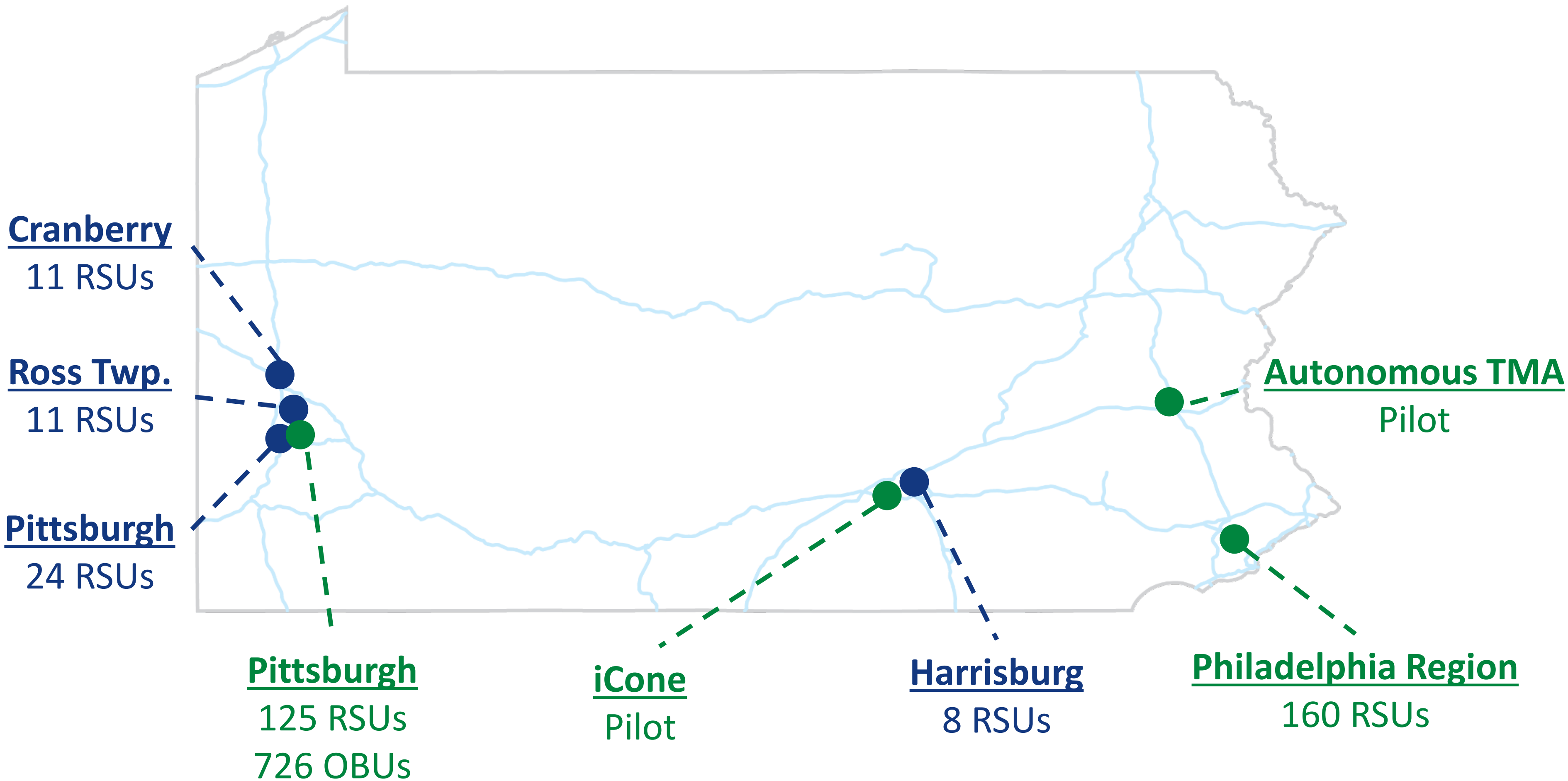
2014
Carnegie Mellon's **14th self-driving vehicle** is a Cadillac SRX that:
- avoids pedestrians and cyclists
- takes ramps and merges
- recognizes and obeys traffic lights
- looks like other Cadillac SRXs



www.engineering.cmu.edu

V2I Deployments

CURRENT **PLANNED**



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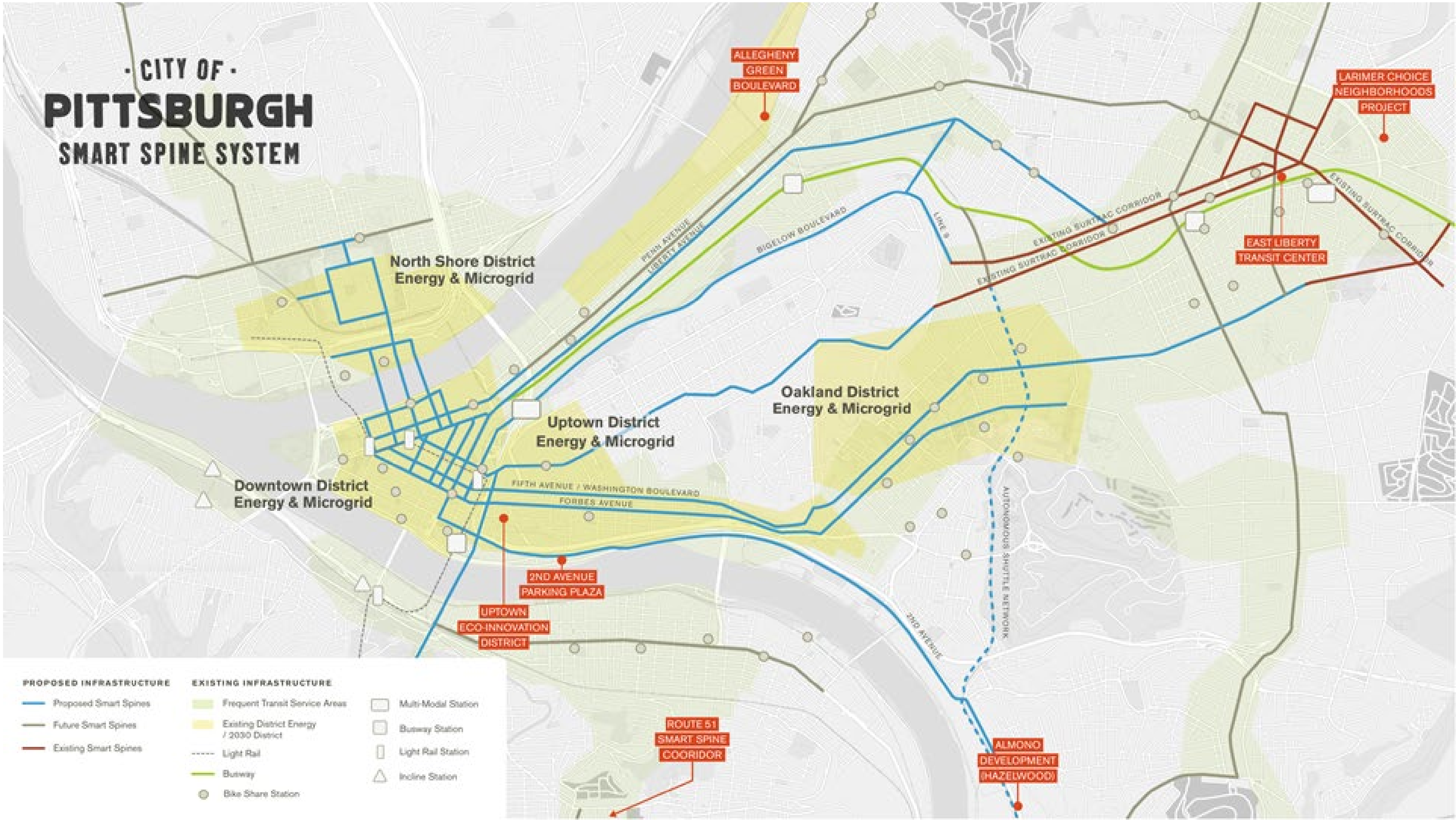


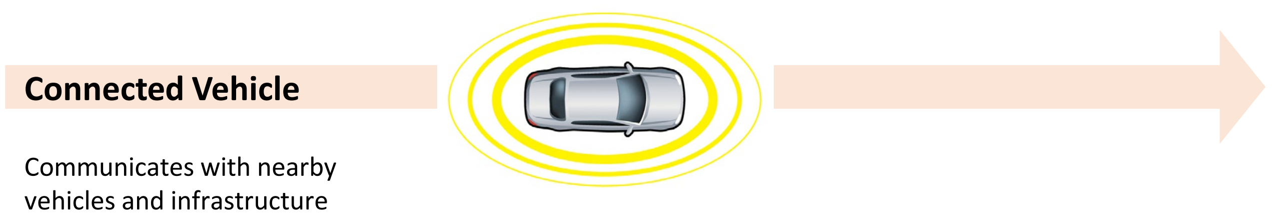
50 intersections today

150 more in the next 3 years

Connected and Autonomous Vehicles

Connectivity

- Includes all types of communication with vehicles and infrastructure (Wi-Fi, DSRC, Cellular, etc.)



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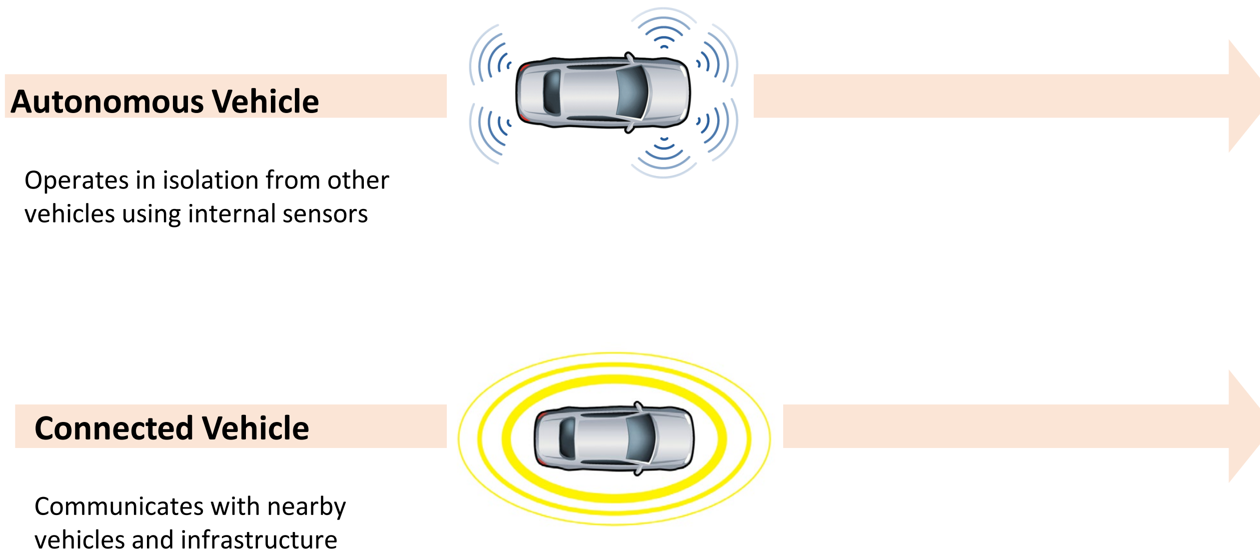

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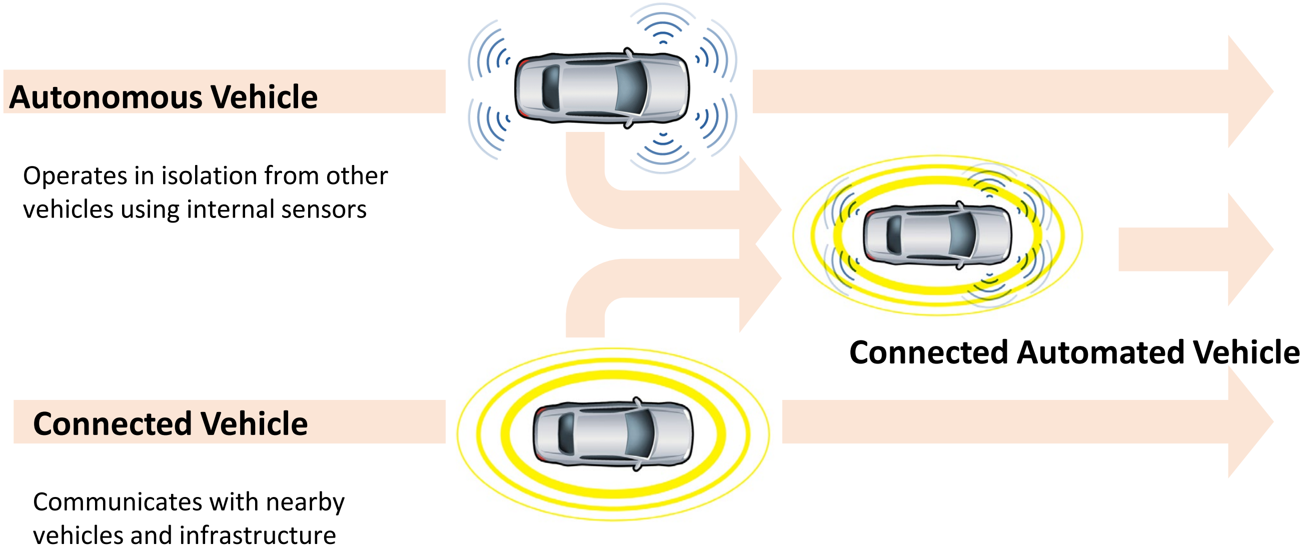
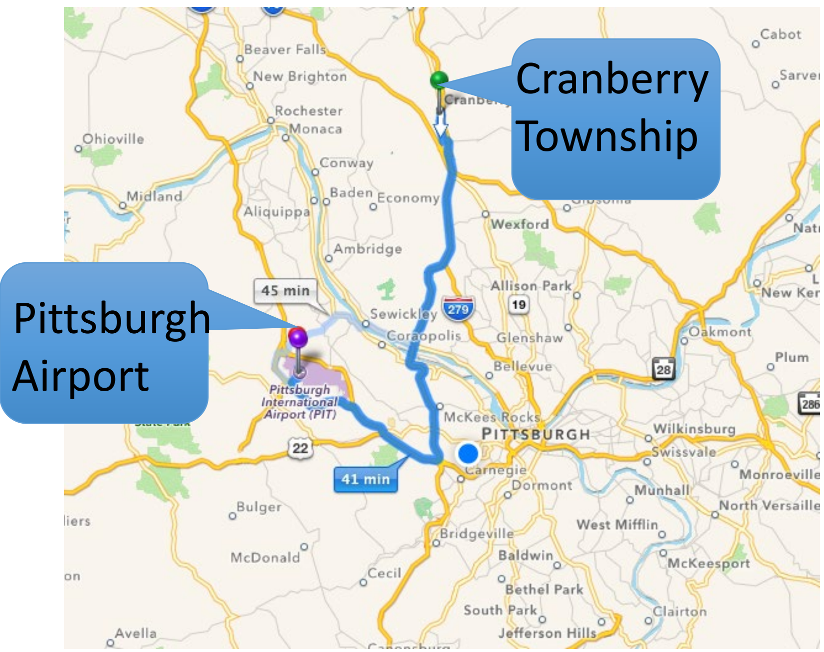


Pittsburgh Demonstration
9-4-14



33 miles along Route 19 in multi-lane, dense traffic with lights and two interstate highways

Connected and Autonomous Vehicles 2040 Vision

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Proposed PennDOT Actions

2014 - 2020

2014-2016

- Thorough evaluation of all existing and planned capacity/LOS enhancement and ITS related investments.
- Collaboration with private sector to convert data into information for sending to cloud.
- Prioritization of safety and mobility applications.
- Identification and prioritization of key locations for DSRC and roadside equipment deployment.
- Funding allocation for DSRC and roadside units.

2015: FHWA Guidance to V2I Deployment

2016-2020

- Upgrading signal controllers, equipment and firmware where necessary.
- Early small-scale deployment of V2I applications at key locations.

2021 - 2030

- Collaboration with local and state educational institutions to enhance workforce training.
- Update of testing criteria for level 3 automation.
- Design of driver licensing training for emergency situations, system malfunctions, regulations and human interaction levels.
- Work with the trucking industry and State Police to design features tailored to these stakeholders.
- Deployment expansions – large scale deployment of equipment and applications.

2031 - 2040

- Provisions for a new license class for those wishing to drive their manual cars.
- Dedicating some highway lanes to autonomous vehicle use.
- Reconfiguration and repurposing of the lanes.
- Phasing out the freight infrastructure (e.g. over-height warnings, weigh stations) as new technologies are introduced.

Report to the Citizens of Pennsylvania

Vehicle Automation in Pennsylvania

February 1, 2018

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AV Policy Task Force

- Government -

- PennDOT
- PTC
- DCED
- PSP
- Insurance
- FHWA
- City of Pittsburgh

- Advocacy -

- AAA
- ATA
- PMTA

- Academia -

- CMU
- U Penn
- Penn State

- Industry -

- Uber
- SAE
- GM
- Global Automakers

PREPARING for the FUTURE

Stay Informed

Understand the Implications

Start Small & Work With Partners

Develop a Plan

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Infrastructure Requirements

- Line Paint
- Retroreflectivity
- Asset Databases
- Pavement Condition

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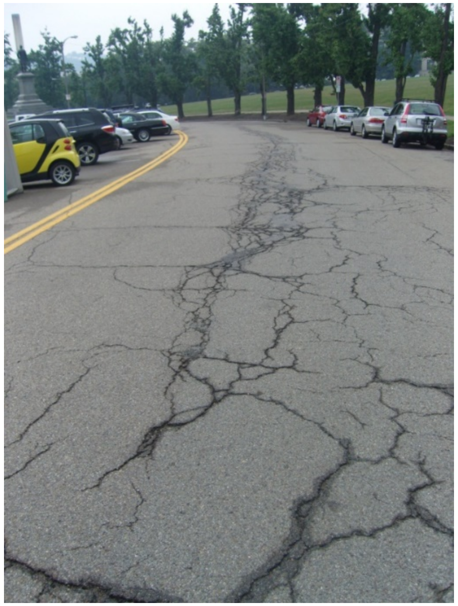
Sample Infrastructure Research Projects

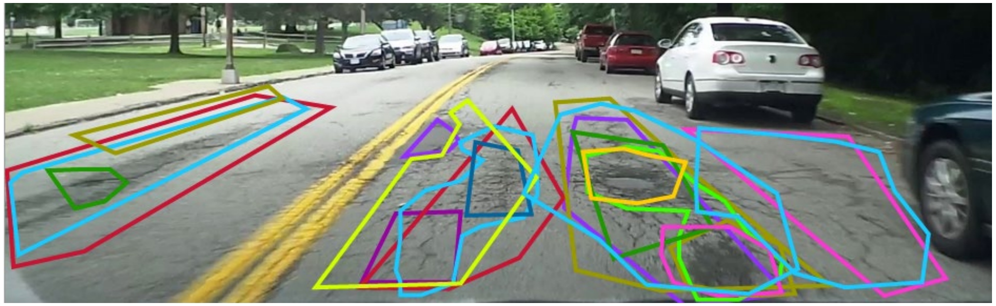
Monitor Road Surface Damage



- Inexpensively
- Accurately
- Continuously

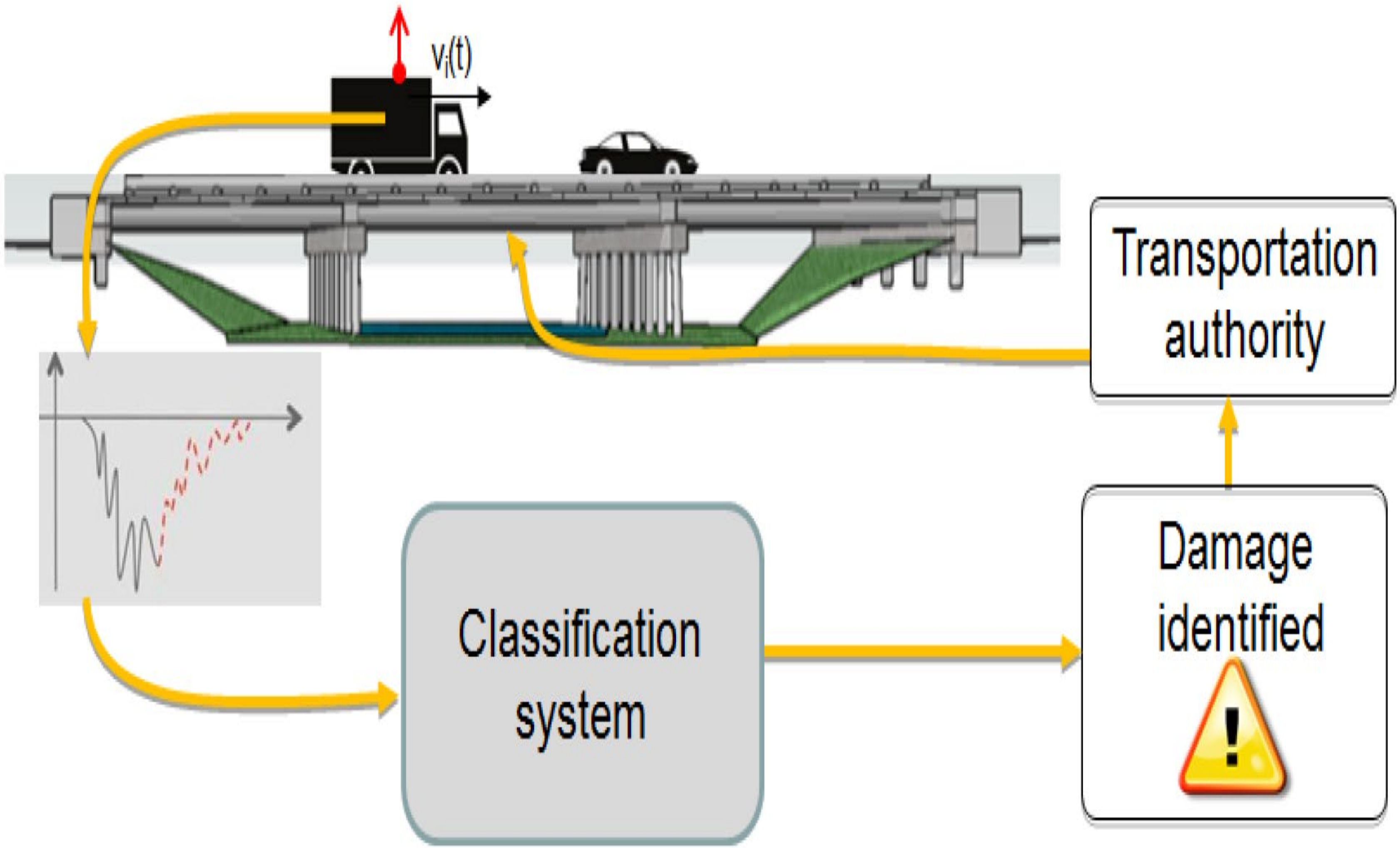
Smartphone Mounted in Car

Convert Images to Data



RoadBotics

Indirect Structural Health Monitoring



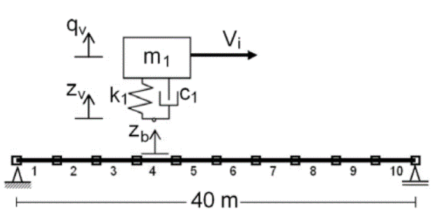
Research process

Numerical model

Laboratory model

Field experiment

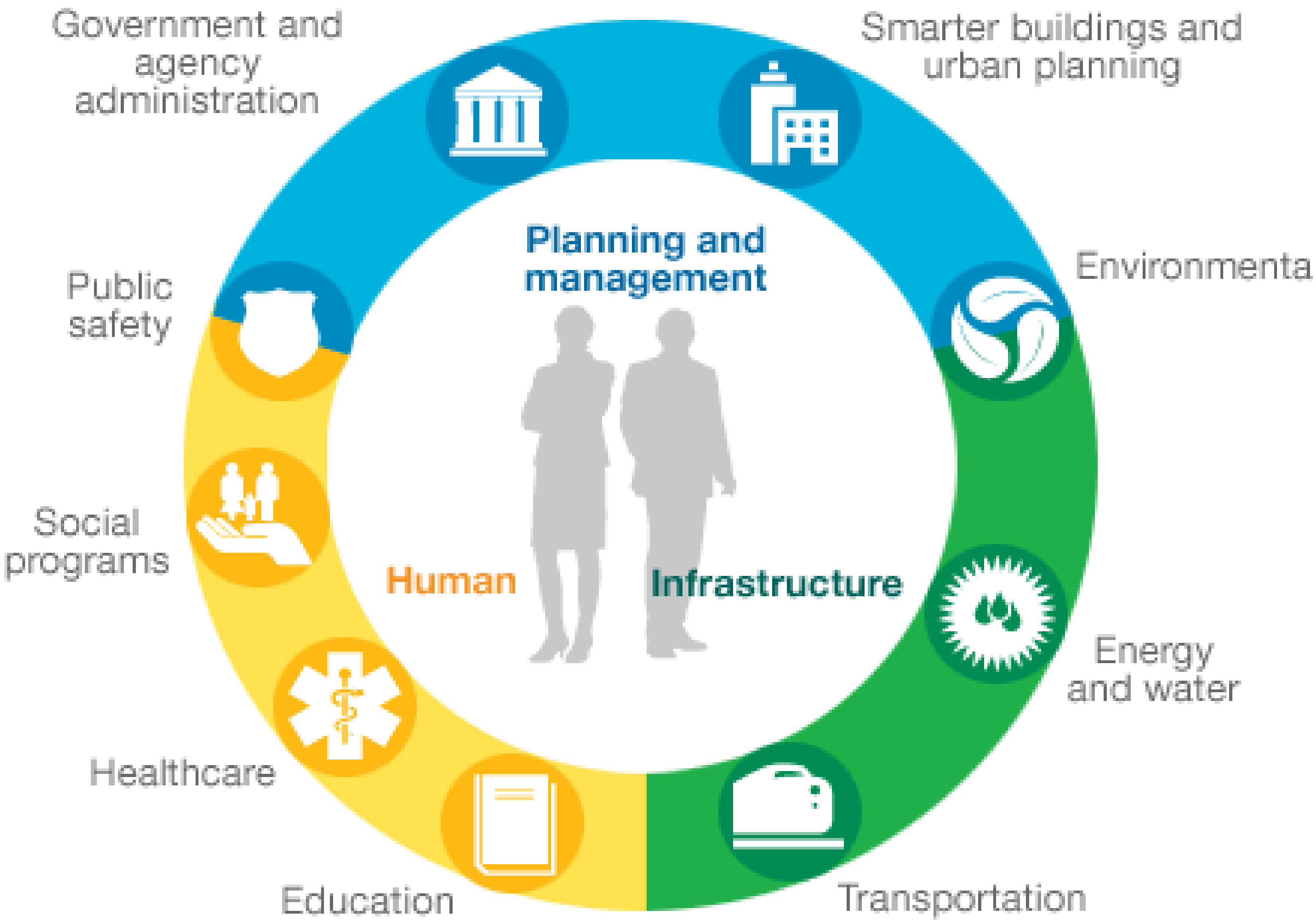
Field implementation



Autonomous Aerial Mapping and Inspection for Infrastructure

Carnegie Mellon
THE ROBOTICS INSTITUTE

Northeastern University
Civil & Environmental Engineering



Government and agency administration
Smarter buildings and urban planning
Environmental
Planning and management
Public safety
Social programs
Human
Infrastructure
Energy and water
Healthcare
Education
Transportation

Metro21 Smart City Institute at CMU

Metro21

SMART CITIES INSTITUTE

30 cities, 30 universities, 100 projects

METROLAB
NETWORK

Connecting Smart Cities, States and Regions

Michael Baker INTERNATIONAL

We Make a Difference

Smart Belt Coalition

MDOT Michigan Department of Transportation

Ohio Department of Transportation

Ohio Turnpike

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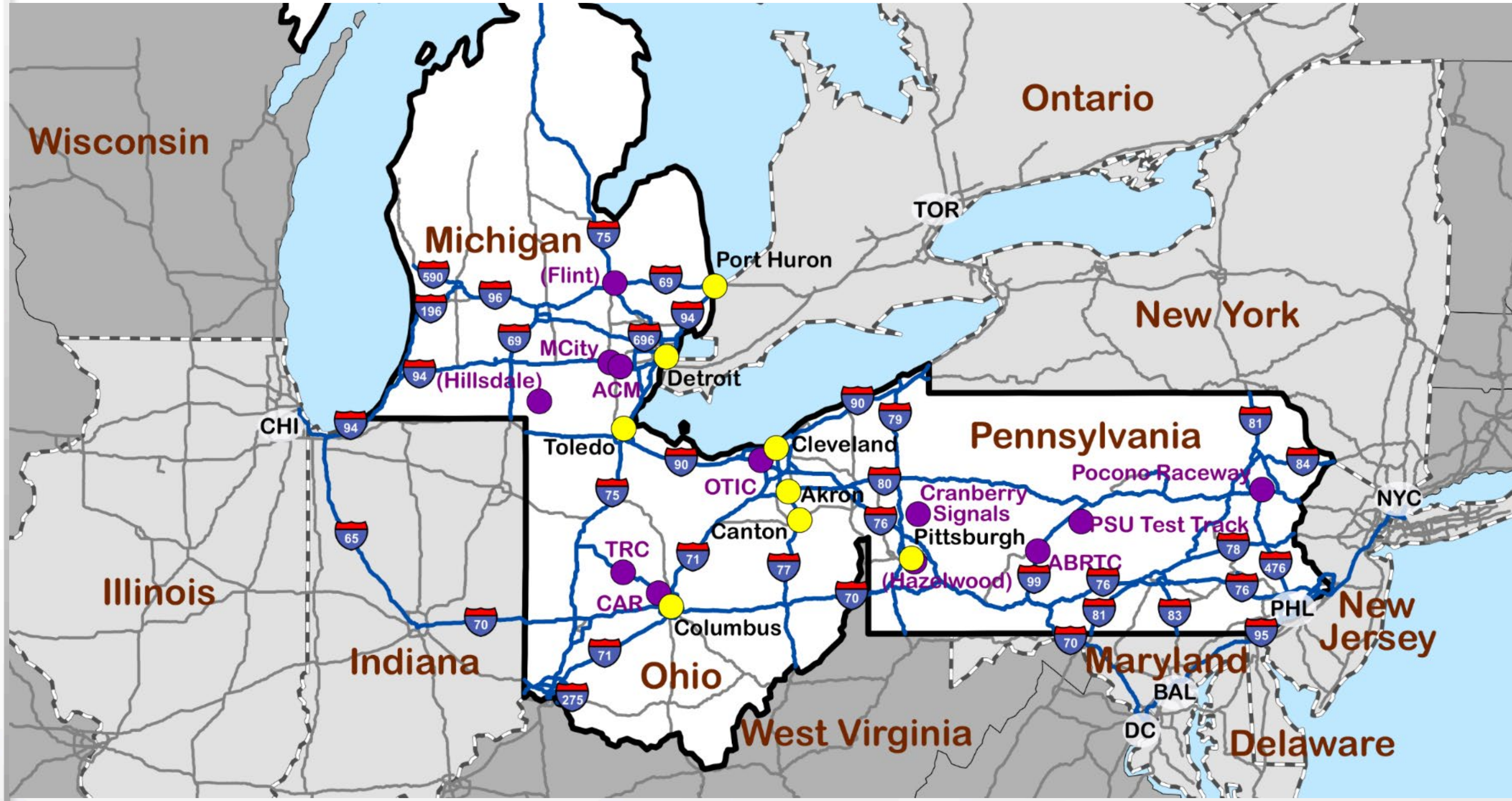
PENNA TURN PIKE



Smart Belt Coalition (SBC)

A Regional Connected and Automated Vehicle Collaborative

What is it?

- High-profile, high-impact, and long-distance connected and automated vehicle network
- Multi-jurisdictions
- Four distinct seasons
- Urban and rural roadways
- Support the testing and deployment of connected and automated vehicles
- Cooperative deployments
- University research
- Leverage opportunities for Federal grants

Questions and Discussion

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