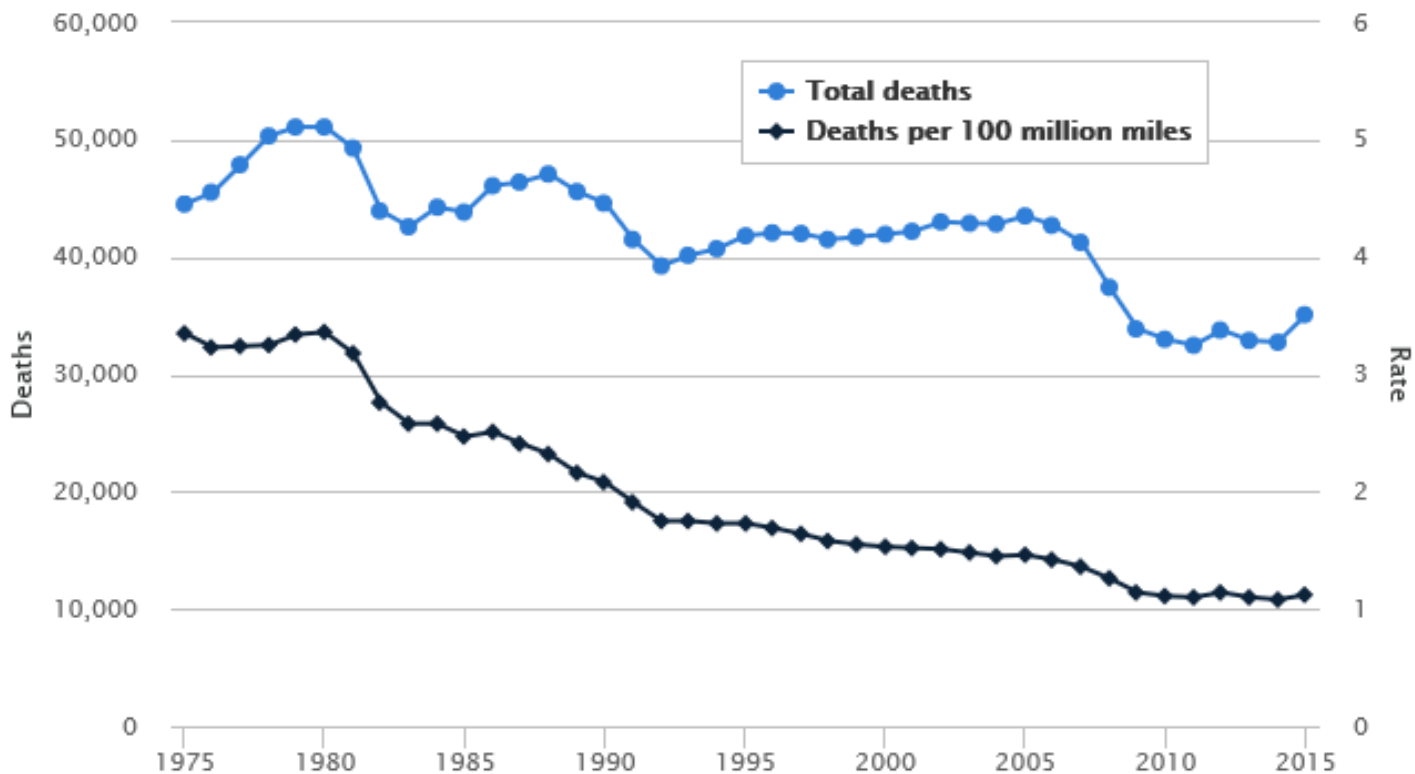




# Connected and Automated Vehicles: Deployments

Matthew Smith, P.E.  
Penn State TESC 2017

Motor vehicle crash deaths and deaths per 100 million miles traveled, 1975-2015



Source: Insurance Institute for Highway Safety

# The 5 levels of driving automation

For on-road vehicles



Human driver



Automated system

|  |                                 | Steering and acceleration/ deceleration | Monitoring of driving environment | Fallback when automation fails | Automated system is in control |
|--|---------------------------------|---|-----------------------------------|--------------------------------|--------------------------------|
| Human driver monitors the road             | <b>0</b> NO AUTOMATION          |   |                                   |                                | N/A                            |
|  | <b>1</b> DRIVER ASSISTANCE      |   |                                   |                                | SOME DRIVING MODES             |
|  | <b>2</b> PARTIAL AUTOMATION     |   |                                   |                                | SOME DRIVING MODES             |
| Automated driving system monitors the road | <b>3</b> CONDITIONAL AUTOMATION |   |                                   |                                | SOME DRIVING MODES             |
|  | <b>4</b> HIGH AUTOMATION        |   |                                   |                                | SOME DRIVING MODES             |
|  | <b>5</b> FULL AUTOMATION        |   |                                   |                                |                                |

Source: SAE International

# What is a Highly Automated Vehicle?



# Highly Automated Math

## Input Variables

- Level 5 Capabilities = 2018
- Level 5 Passenger Vehicles =
- Level 5 Every new passenger vehicle = 2030
- Median Fleet Age = 11.5 years
- Fleet Turnover = 23 years



## Equation

$$2030 + 23 = \dots\dots\dots 2053$$

## Connected Automation for Greatest Benefits

### Autonomous Vehicle

Operates in isolation from other vehicles using internal sensors



### Connected Automated Vehicle

Leverages autonomous and connected vehicle capabilities

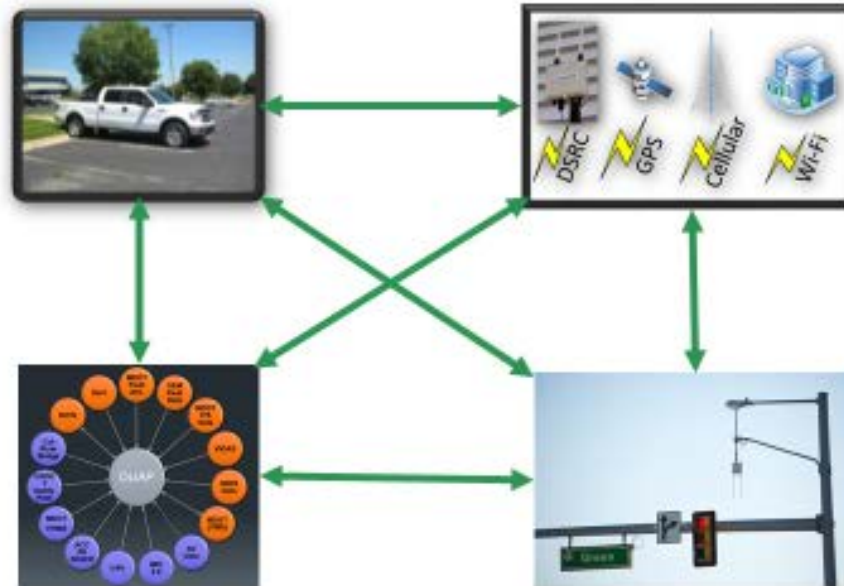
### Connected Vehicle

Communicates with nearby vehicles and infrastructure

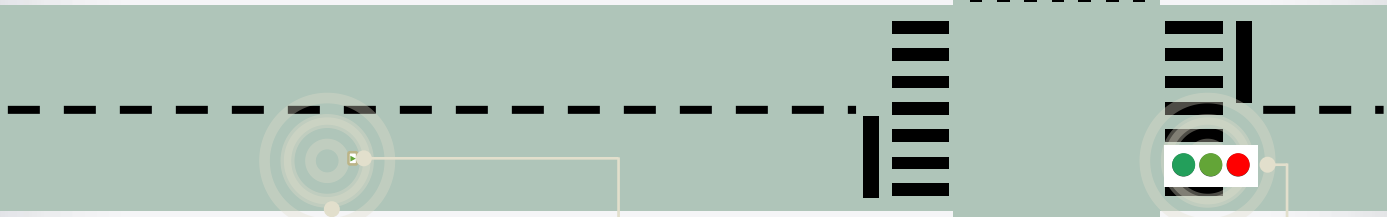


U.S. Department of Transportation  
ITS Joint Program Office

# Components of a V2I System



# Red Light Violation Warning



Vehicle approaching intersection too fast, signal is turning red

Approaching vehicle receives SPaT message, identifies threat

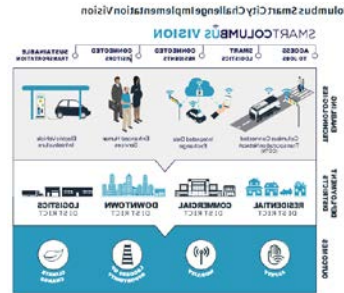
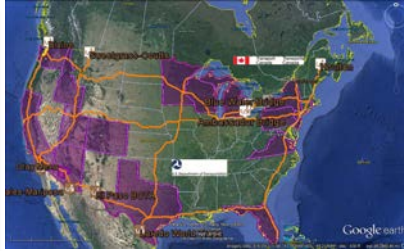
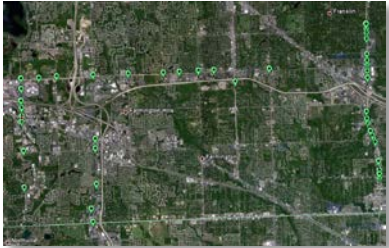


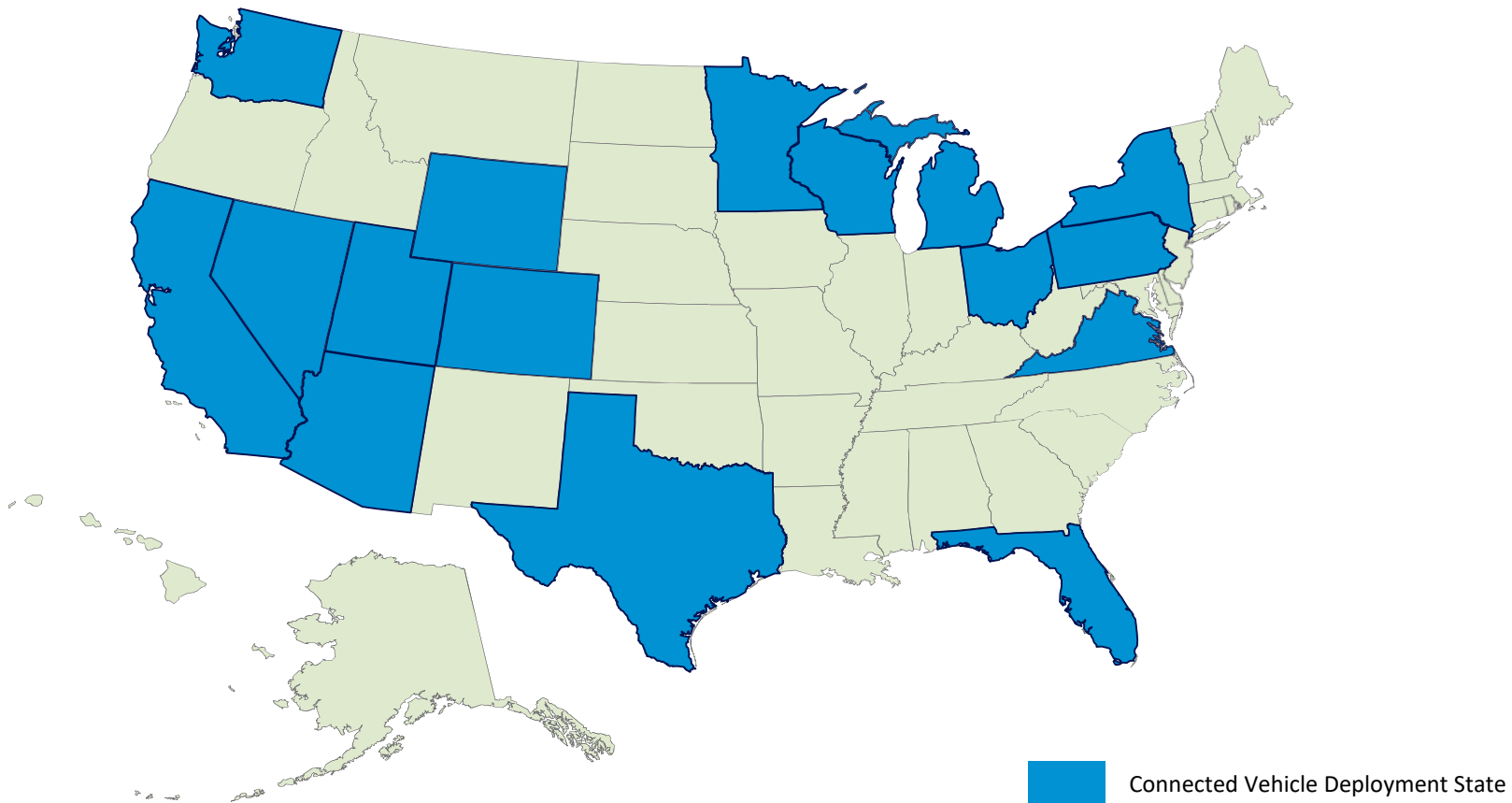
Driver Vehicle Interface (DVI) alerts driver to brake

Smart signal broadcasting Signal Phase and Timing (SPaT)



# “Connected” Vehicle Evolution





# Cooperative Work



## Connected Vehicle Pooled Fund Study

*Program to Support the Development and Deployment of Connected Vehicle Applications*

CV PFS Charter, September 2014

## VEHICLE TO INFRASTRUCTURE DEPLOYMENT COALITION



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# What does the future look like?

- More Congestion?
- Less Congestion?
- More Urban Living ?
- More Sprawl ?
- Increased Mobility and Access ✓
- Car Ownership ✓
- Changing Travel Patterns ✓
- Mixed Fleets ✓
- Technology! ✓
- Partnerships! ✓



# Challenges (Opportunities) for Public Agencies

- Vehicles
- Communications Networks
- Data Management
- Workforce Development
- Business Processes
- Cybersecurity
- Partnering
- Technology Advancement
- Regulatory Developments
- Financing/Business Models

**Michael Baker**

**INTERNATIONAL**

*We Make a Difference*

# Questions?

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