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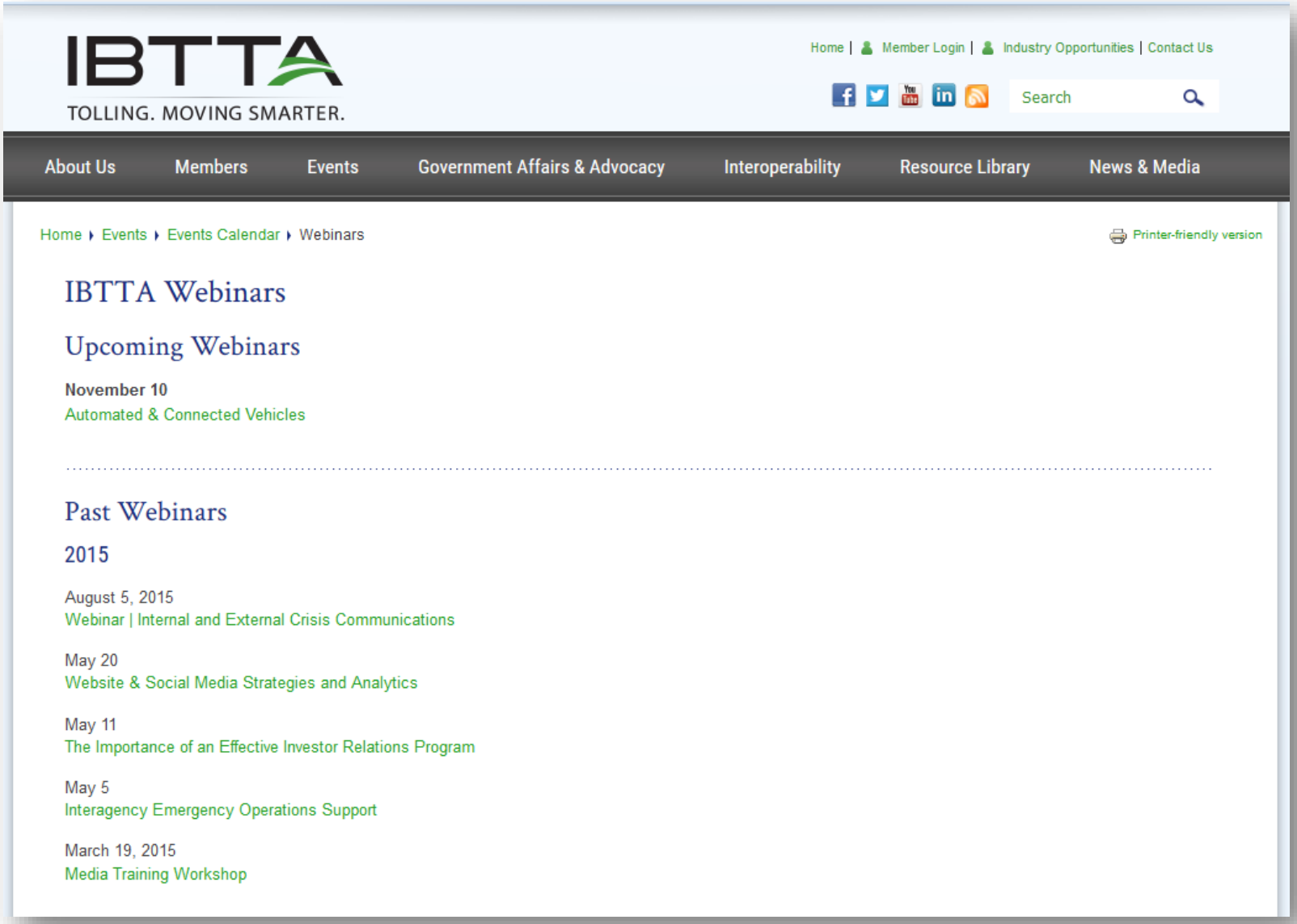
TOLLING. MOVING SMARTER.
INTERNATIONAL BRIDGE, TUNNEL AND TURNPIKE ASSOCIATION

IBTTA
2015 WEBINAR SERIES

AUTOMATED AND CONNECTED VEHICLES



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IBTTA Webinars

Upcoming Webinars

November 10
Automated & Connected Vehicles

Past Webinars

2015

August 5, 2015
Webinar | Internal and External Crisis Communications

May 20
Website & Social Media Strategies and Analytics

May 11
The Importance of an Effective Investor Relations Program

May 5
Interagency Emergency Operations Support

March 19, 2015
Media Training Workshop

2016 Meetings

www.ibtta.org/events

January 7 - 9, 2016 | Miami, FL
Winter Board and Committees Meeting
Open to all members

February 7 - 12, 2016 | Washington, DC
Leadership Academy –
Submission deadline passed

March 13 - 15, 2016 | Washington, DC
Summit on Transportation Finance, Road Usage Charging & Policy
www.ibtta.org/dc

May 12 - 14, 2016 | Newport, RI
Spring Board & Committee Meetings
Open to all members

May 15 - 17, 2016 | Newport, RI
Maintenance & Road Operations
www.ibtta.org/newport

July 23, 2016 | Boston, MA
2017 Conference Planning Ideas Roundtable
Get involved! Open to all members

July 24 - 26, 2016 | Boston, MA
Summit on AET, Managed Lanes & Interoperability
www.ibtta.org/boston

September 8 - 10, 2016 | Denver, CO
Fall Board & Committees Meeting
Open to all members

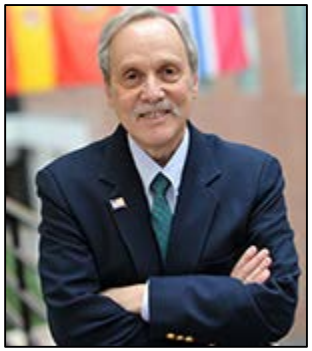
September 11 - 14, 2016 | Denver, CO
84th Annual Meeting & Exhibition
www.ibtta.org/denver

October 23 - 25, 2016 | Mexico City, MX
Global Summit of Mexico
www.ibtta.org/mexicocity

Professional Development Hours & Logistics for Today

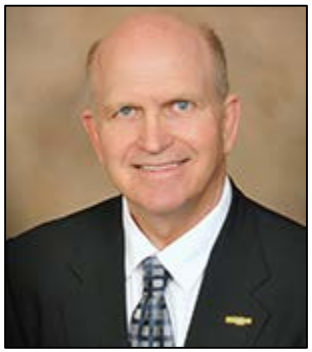
- Professional Development certificate
  - *email kdavis@ibtta.org*
- Two presenters
- Submit Questions via the Q&A Pod
- We'll be done by Noon
- Slides and audio will be on the website later today or tomorrow. www.ibtta.org/webinars

TOM BAMONTE
Assistant Executive Director,
Strategy and Innovation
North Texas Tollway Authority



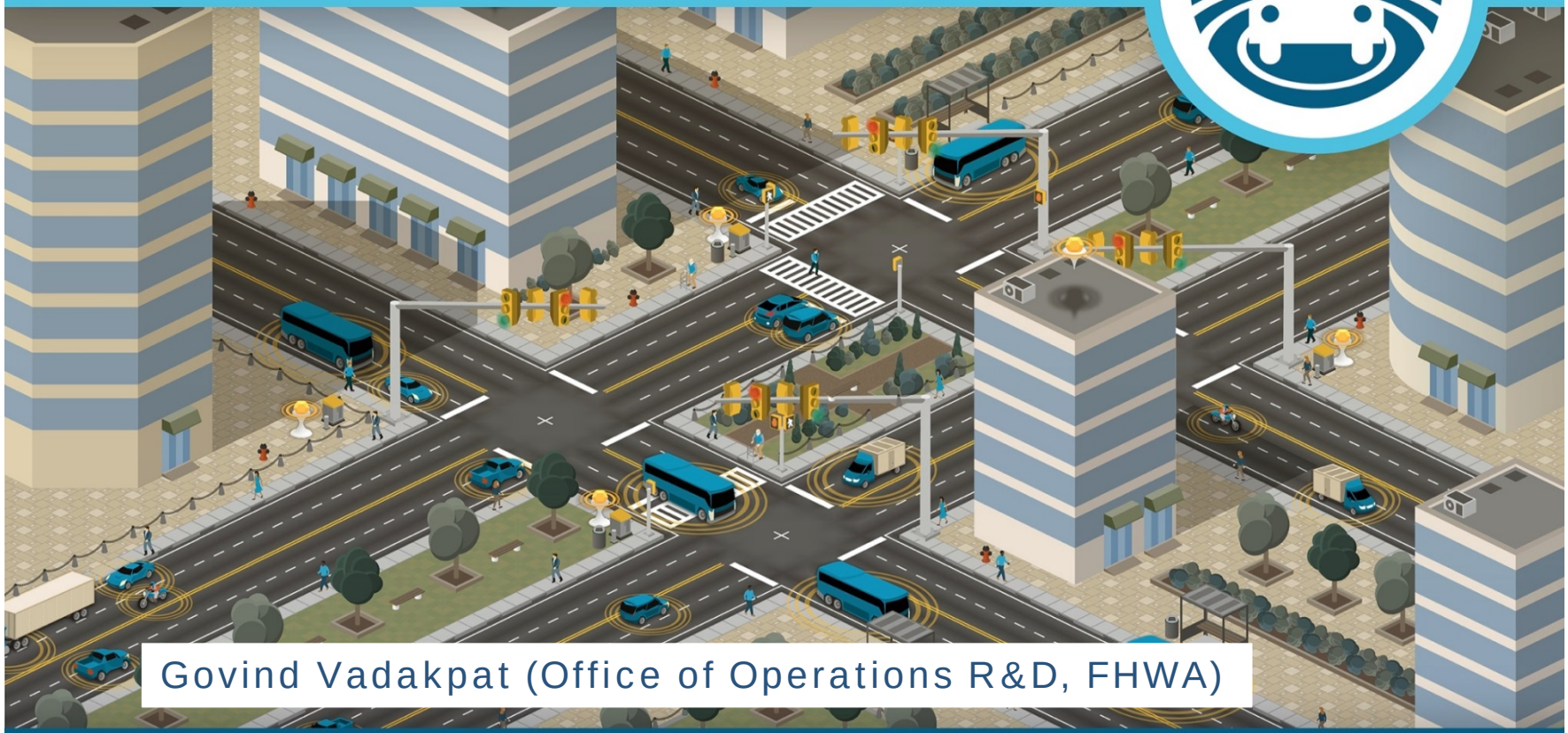
MICHAEL SHULMAN
Technical Leader
Ford Motor Company

GOVIND VADAKPAT
Research Transportation Specialist
Federal Highway Administration



JOSEPH WAGGONER
CEO & Executive Director
Tampa-Hillsborough Expressway Authority

CONNECTED VEHICLE PILOT
Deployment Program



Govind Vadakpat (Office of Operations R&D, FHWA)

ITS Joint Program Office

OVERVIEW

- Connected Vehicles Pilot Deployment Program Overview
  - Goals
  - Organizing Principles
  - CV Pilot Deployment Requirements
  - CV Applications

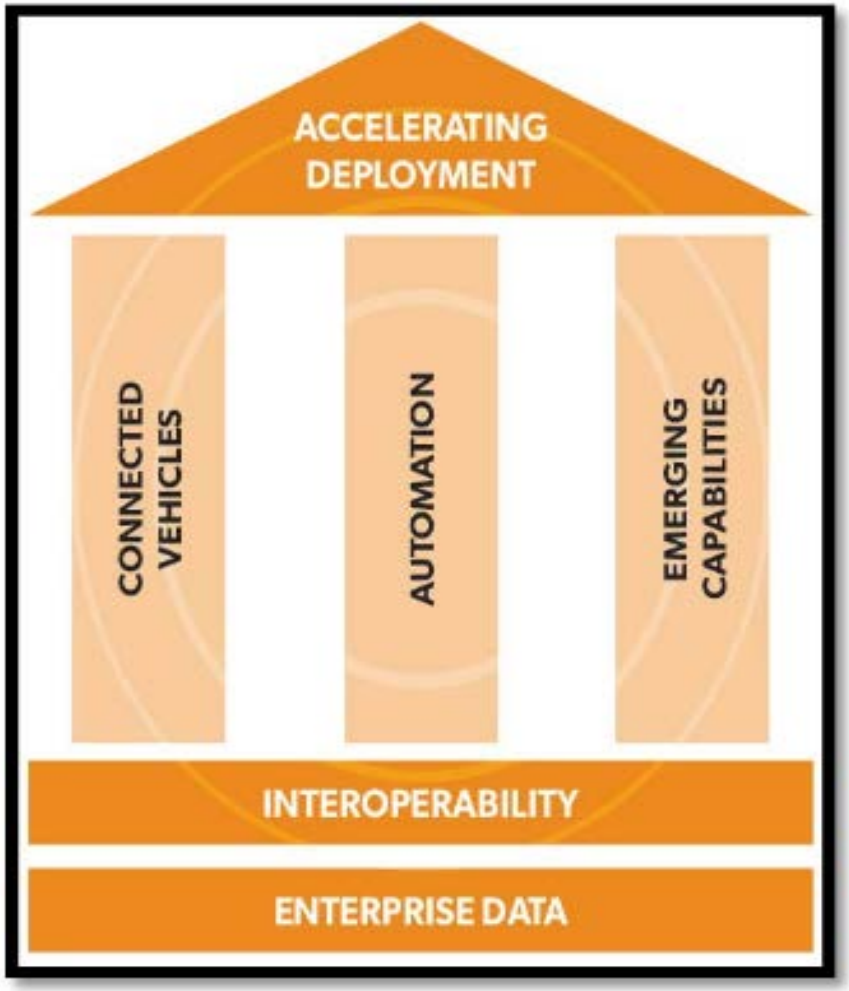
- How to Stay Connected

CV Pilot Deployment Program Within The USDOT ITS Strategic Plan

- The Connected Vehicle (CV) Pilot Deployment Program
  - Keystone effort in connected vehicle area
  - Also plays a key role in other strategic areas, including accelerating deployment, promoting interoperability, and enterprise data

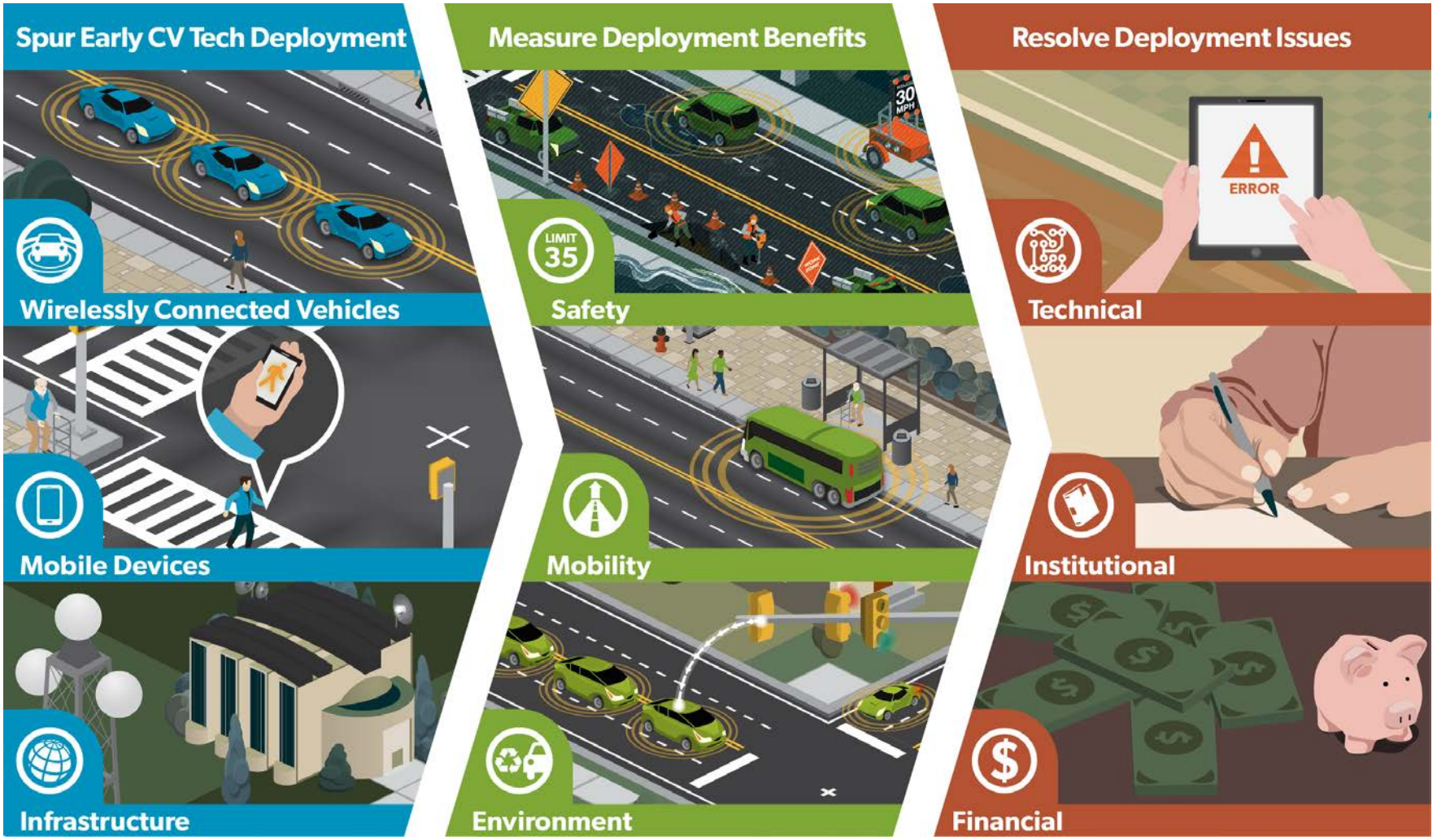
- CV Pilot Deployments offer a unique opportunity related to getting CV technology to the field and making a difference in many areas, including:
  - Needs-driven planning and investment
  - Integrated performance measurement
  - Lowering barriers to deployment

USDOT ITS Strategic Plan, pg. 14



http://ntl.bts.gov/lib/54000/54400/54481/Strat_Plan_Final_Version.pdf

CV Pilot Deployment Program Goals



CV Pilot Organizing Principles

- CV Pilots are *pilot deployments*, that is, real-world environment deployments
  - The successful, deployed technologies are expected to remain as permanent operational elements

- Deployment concepts are needs-driven
  - Each site has different needs, focus and applications
    - That is, each pilot deployment will address critical problem(s)
    - The needs of each site will drive the deployment process

- Pilot deployments are expected to be both *large-scale with multiple applications*
  - *Large-scale* implies pilot deployments will have measureable impact, not a specific minimum geographic or vehicle fleet size
  - Sites will deploy *multiple applications* drawing on the products of USDOT and other connected vehicle research

CV Pilot Deployment Requirements

- Multiple connected vehicle applications must be deployed together
- Pilot deployments should leverage USDOT-sponsored research
- Pilot deployments include the capture of data from multiple sources
  - Integrated or carry-in devices for connected vehicles capable of generating an SAE J2735 Basic Safety Message (BSM)
  - Share pilot deployment data while protecting privacy and intellectual property
- Multiple forms of communications technologies are desired
  - Dedicated Short Range Communications (DSRC) 5.9 GHz utilized as one communication technology
- Well-defined, focused, quantitative performance measures
  - Support an independent evaluation effort
- Security and credentialing management system

CONNECTED VEHICLE APPLICATIONS

- The USDOT has made a significant investment in foundational research and initial development of 50+ connected vehicle applications
  - Concepts of Operations
  - System Requirements
  - Prototype Design and Testing
  - Prototype Impacts Assessment
  - Analytics, Modeling and Simulation to Assess Potential Long-Term Impacts

- Not all CV Application efforts are in the same state of maturity, few are complete
  - But a large number of application development efforts across multiple programs have been completed
  - GOAL: move deployment-ready application concepts forward into integrated deployments addressing key performance concerns

Connected Vehicle Applications

V2I Safety

- Red Light Violation Warning
- Curve Speed Warning
- Stop Sign Gap Assist
- Spot Weather Impact Warning
- Reduced Speed/Work Zone Warning
- Pedestrian in Signalized Crosswalk Warning (Transit)

V2V Safety

- Emergency Electronic Brake Lights (EEBL)
- Forward Collision Warning (FCW)
- Intersection Movement Assist (IMA)
- Left Turn Assist (LTA)
- Blind Spot/Lane Change Warning (BSW/LCW)
- Do Not Pass Warning (DNPW)
- Vehicle Turning Right in Front of Bus Warning (Transit)

Agency Data

- Probe-based Pavement Maintenance
- Probe-enabled Traffic Monitoring
- Vehicle Classification-based Traffic Studies
- CV-enabled Turning Movement & Intersection Analysis
- CV-enabled Origin-Destination Studies
- Work Zone Traveler Information

Environment

- Eco-Approach and Departure at Signalized Intersections
- Eco-Traffic Signal Timing
- Eco-Traffic Signal Priority
- Connected Eco-Driving
- Wireless Inductive/Resonance Charging
- Eco-Lanes Management
- Eco-Speed Harmonization
- Eco-Cooperative Adaptive Cruise Control
- Eco-Traveler Information
- Eco-Ramp Metering
- Low Emissions Zone Management
- AFV Charging / Fueling Information
- Eco-Smart Parking
- Dynamic Eco-Routing (light vehicle, transit, freight)
- Eco-ICM Decision Support System

Road Weather

- Motorist Advisories and Warnings (MAW)
- Enhanced MDSS
- Vehicle Data Translator (VDT)
- Weather Response Traffic Information (WxTINFO)

Mobility

- Advanced Traveler Information System
- Intelligent Traffic Signal System (I-SIG)
- Signal Priority (transit, freight)
- Mobile Accessible Pedestrian Signal System (PED-SIG)
- Emergency Vehicle Preemption (PREEMPT)
- Dynamic Speed Harmonization (SPD-HARM)
- Queue Warning (Q-WARN)
- Cooperative Adaptive Cruise Control (CACC)
- Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
- Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
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- Connection Protection (T-CONNECT)
- Dynamic Transit Operations (T-DISP)
- Dynamic Ridesharing (D-RIDE)
- Freight-Specific Dynamic Travel Planning and Performance
- Drayage Optimization

Smart Roadside

- Wireless Inspection
- Smart Truck Parking

STAY CONNECTED

- **Join us for the *Getting Ready for Deployment* Series (link to webinars)**
  - Discover more about the Wave 1 CV Pilot Sites
  - Learn the Essential Steps to CV Deployment
  - Engage in Technical Discussion

Contact for CV Pilots THEA

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G.Vadakpat@dot.gov

Contact for CV Pilots Program:

Kate Hartman, Program Manager

Kate.hartman@dot.gov

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Facebook: https://www.facebook.com/DOTRITA

Connected Transportation Environment: An OEM Perspective

Mike Shulman, Ford Motor Company

November, 2015

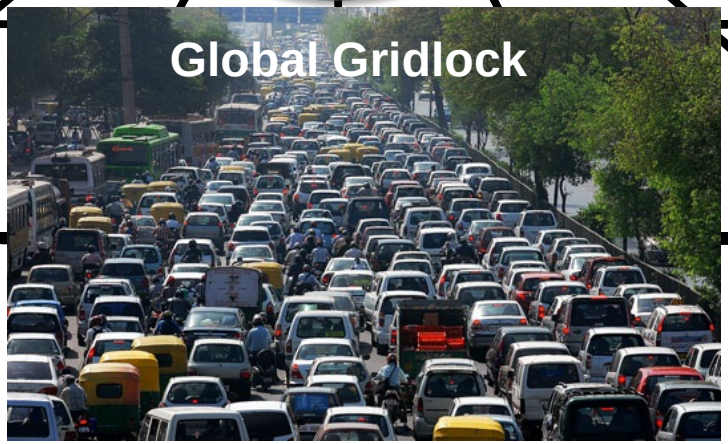
Go Further

Connected Transportation Systems: Future Vision

Mobility

Safety

Environment



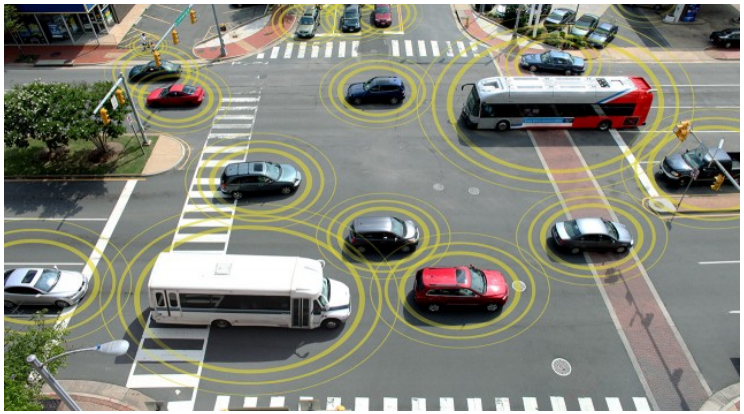
The Crash Avoidance Metrics Partnership, or CAMP for short, is focused on addressing the technical challenges with V2V and V2I from an OEM perspective.

US: Connected Vehicle Deployment Strategy

- In 2011, 5.3 million crashes > 2.2 million injuries > 32,000 fatalities.
- US DOT estimates that Vehicle-to-Vehicle (V2V) warnings could lead to driver warnings for up to 76% of vehicle-vehicle crashes
- NHTSA has announced that they will develop a regulation for V2V on new vehicles
- A NHTSA mandate breaks the “chicken and egg” problem.
- The US strategy is to expand V2V to include Vehicle-to-Infrastructure (V2I) safety, mobility, sustainability and automation applications, and include pedestrians, motorcycles, etc.

How Does V2V Work?

- Each vehicle acts as a beacon sending a signal to other vehicles. Equipped vehicles can detect each others' position and predicted path.
- Vehicle-to-Vehicle communication is done via DSRC (Dedicated Short-Range Communication), modified Wi-Fi on the 5.9 GHz frequency band, which has been allocated for V2x communication. A dedicated frequency is needed for high availability.
- DSRC provides the low latency needed for crash imminent safety-based functions.



V2V Uses Modified Wi-Fi And GPS On A Dedicated Frequency To Reduce Or Mitigate Potential Collisions.

Vehicle-to-Vehicle (V2V) Overview

DSRC

J2735 Basic Safety Message:

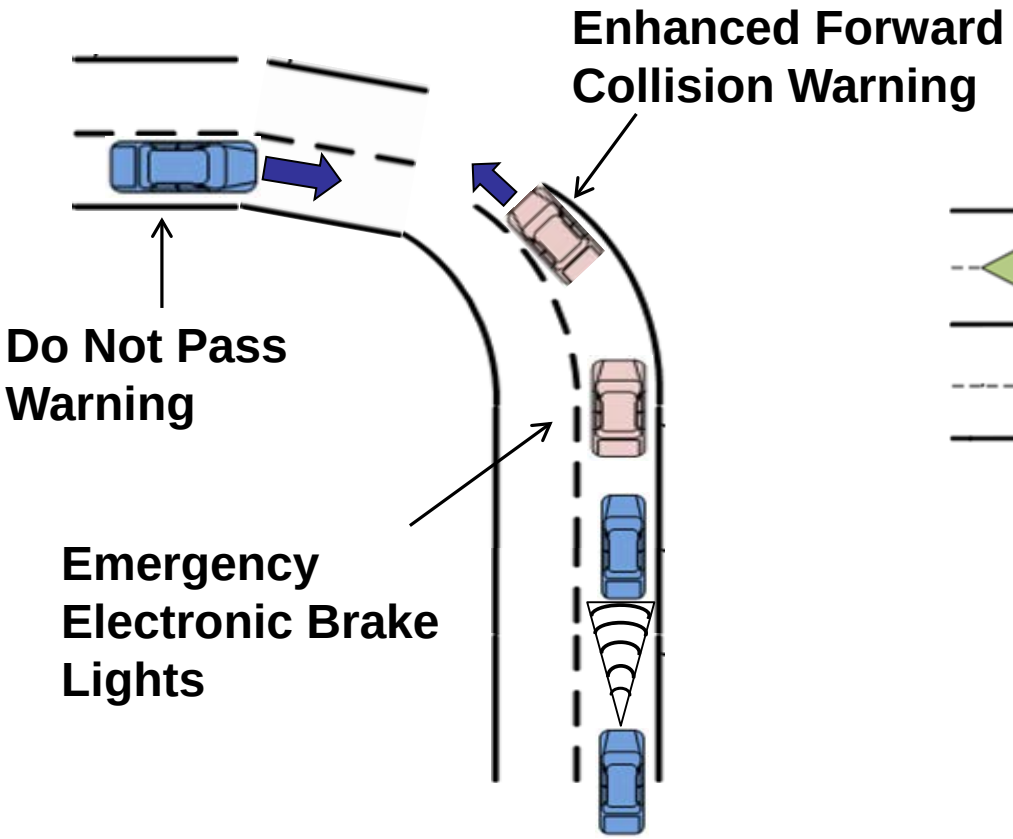
Information Transmitted
Random Vehicle ID, Sequence #, Time Stamp, Position (latitude, longitude, elevation, accuracy),
Motion (speed, transmission state, heading angle, brake, accel /decel),
Control (yaw rate), &
Vehicle Size (length, width)

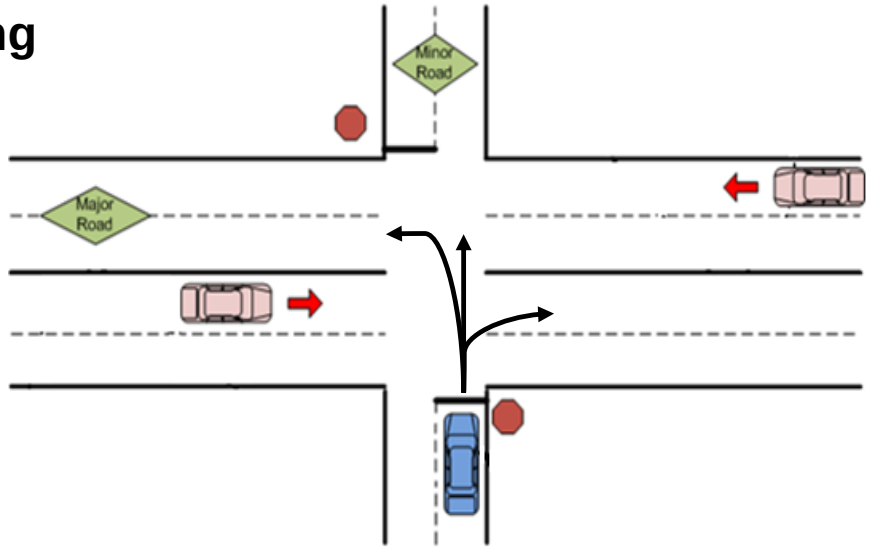
Security Credentials

DSRC = Dedicated Short Range Communication

V2V technology could enhance existing driver assistance systems.

Example V2V Safety Applications





- **Intersection Movement Assist**
- **Left Turn Assist**
- **Right Turn Into Path**

With greater field of view and greater data content, V2V will outperform current “forward collision” technologies and reduce “cross-path” collision risk

General Requirements for Interoperability

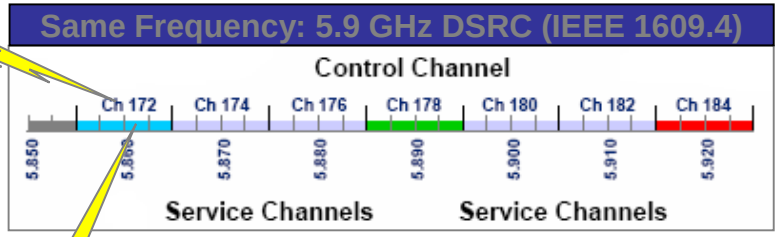
Required for Deployment:
Different Manufacturers

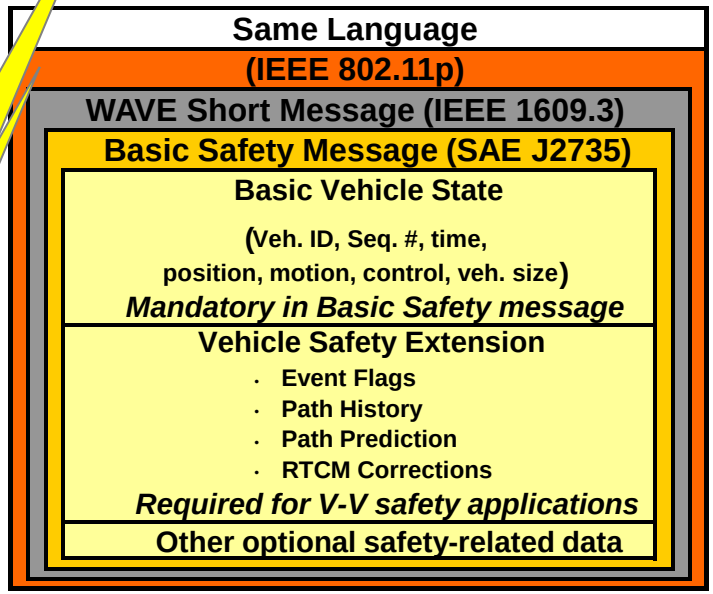
– Communicating on the Same Frequency
→ *Where do we go to talk*

– Using the Same Language
→ *We understand each other*
→ *Data in messages meets same minimum requirements*

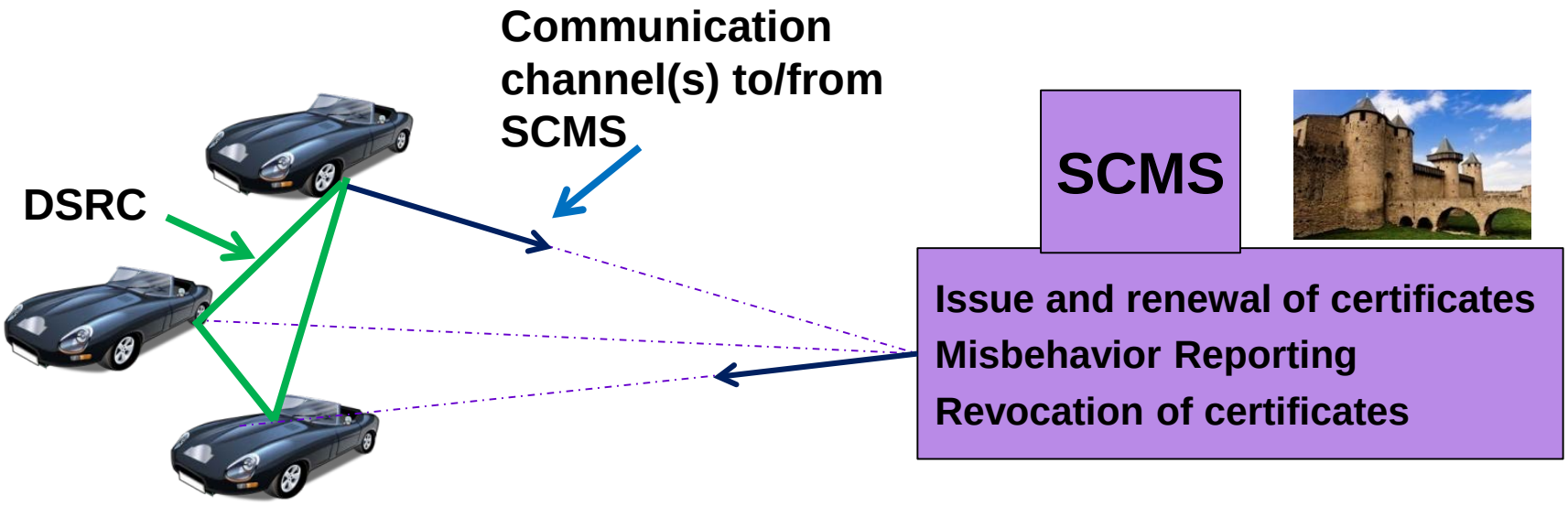
- With Security
→ *We trust what we say to each other*

- Managing Channel Loading
→ *We vary message frequency and power together*





V2V Security Communications



A key enabler for V2V is the Security "Back-End" which develops the security certificates required for vehicles to authenticate the message between each other along with providing misbehavior reporting and revocation mechanisms.

SCMS = Security Credential Management System

Security will require a new paradigm. For vehicles to provide feature operation, they will require periodic security updates while in service.

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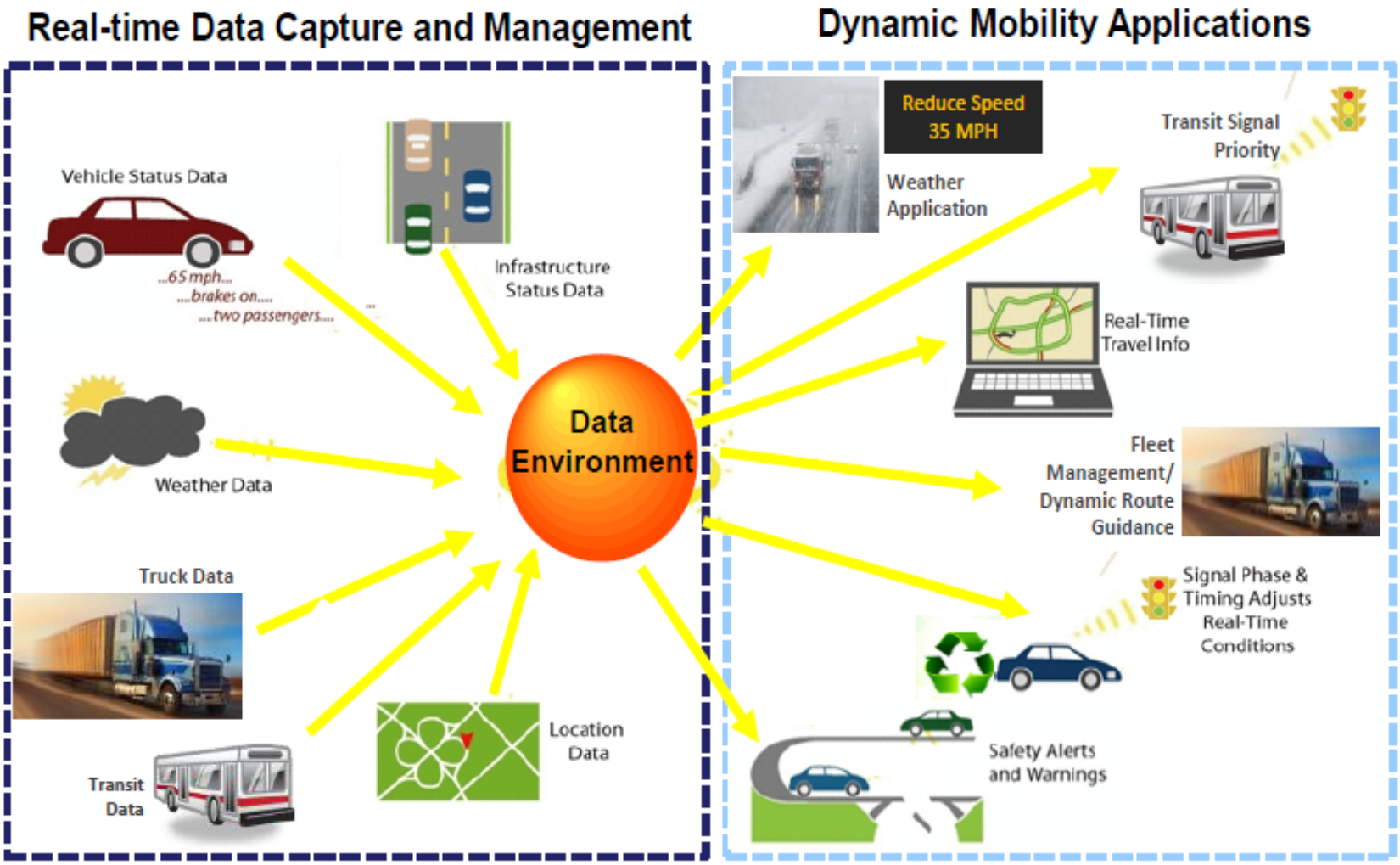
Mobility Program



CAMP V2I Projects with FHWA

Fiat-Chrysler, Ford, GM, Honda, Hyundai-Kia, Mercedes, Mazda, Nissan, Subaru, VW/Audi and Volvo Truck

- V2I Safety: Red Light Violation Warning, Curve Speed Warning and Reduced Speed/Work Zone Warning

- Cooperative Adaptive Cruise Control
- Applications for the Environment: Real-Time Information Synthesis (AERIS): Eco Approach and Departure
- Data Capture and Management for Dynamic Mobility Applications
- Road Weather Management

AASHTO FOOTPRINT ANALYSIS

- The vision for the infrastructure footprint anticipates a mature connected vehicle environment by 2040, by when a large majority of vehicles on the roadway will be connected. From an infrastructure perspective:
  - 80% (250,000) or more of traffic signal locations will be vehicle-to-infrastructure (V2I)-enabled.
  - 25,000 other roadside locations will be V2I-enabled.
  - Accurate real-time localized traveler information will be available on 90% or more of roadways.
  - Next-generation multimodal information-driven active traffic management will be deployed system-wide.

- Total Cost over 20 years deployment (2013 $): $13,800 million

  Average Annual Cost (2013 $): $690 million

Connected Transportation Environment

- **Connected Vehicles offer the promise of transformative improvements in safety and other aspects of the transportation system**

- **An initial focus in the US is on a NHTSA regulation which will require V2V on new vehicles. OEMs at CAMP have been working with NHTSA on the technical gaps for the V2V NPRM. OEMs and NHTSA will then expand V2V safety to trucks, motorcycles, pedestrians, etc.**

- **The OEMs at CAMP are also working with FHWA, States and Universities on V2I for safety, mobility and sustainability, developing V2I applications and planning pilots and early deployments. This will allow validated estimates of V2I costs and benefits.**

Automated Vehicles

DISRUPTIVE TECHNOLOGY

ADVANCES THAT WILL TRANSFORM LIFE, BUSINESS AND THE GLOBAL ECONOMY

Joe Waggoner, Executive Director
Tampa-Hillsborough Expressway Authority

Self Driving Cars: the Next Revolution

DISRUPTIVE TECHNOLOGY - ADVANCES THAT WILL TRANSFORM LIFE, BUSINESS AND THE GLOBAL ECONOMY

"The new technology could provide solutions to some of our most intractable social problems—the high cost of traffic crashes and transportation infrastructure, the millions of hours wasted in traffic jams, and the wasted urban space given over to parking lots, just to name a few."

"Everything, from how we move goods to how we move ourselves around, is ripe for change."

"For those who embrace innovation and opt to lead rather than follow, a new frontier is opening in the realm of mobility services."

Gary Silberg, Partner, KPMG LLP
National Sector Leader Automotive

Richard Wallace, KPMG LLP
Director, Transportation Systems Analysis
Center for Automotive Research

Source: KPMG: Self-driving cars: The next revolution

"For those who embrace innovation and opt to lead rather than follow, a new frontier is opening in the realm of mobility services."

- **Today, the auto manufacturing industry routinely integrates new safety features into vehicles**
  - Obstacle detection
  - Lane keeping assistance;
  - Automated parking;
  - Autonomous route guidance;
  - Information systems and services coupled with route guidance;
  - Automatic cruise control with 'Stop & Go' capability;
  - Location (GPS) and navigation systems;
  - Intelligent speed adaptation.
- **Legislation by California, Nevada, *and Florida* allow operation of driverless vehicles**
- **Developers predict implementation in 20 years**

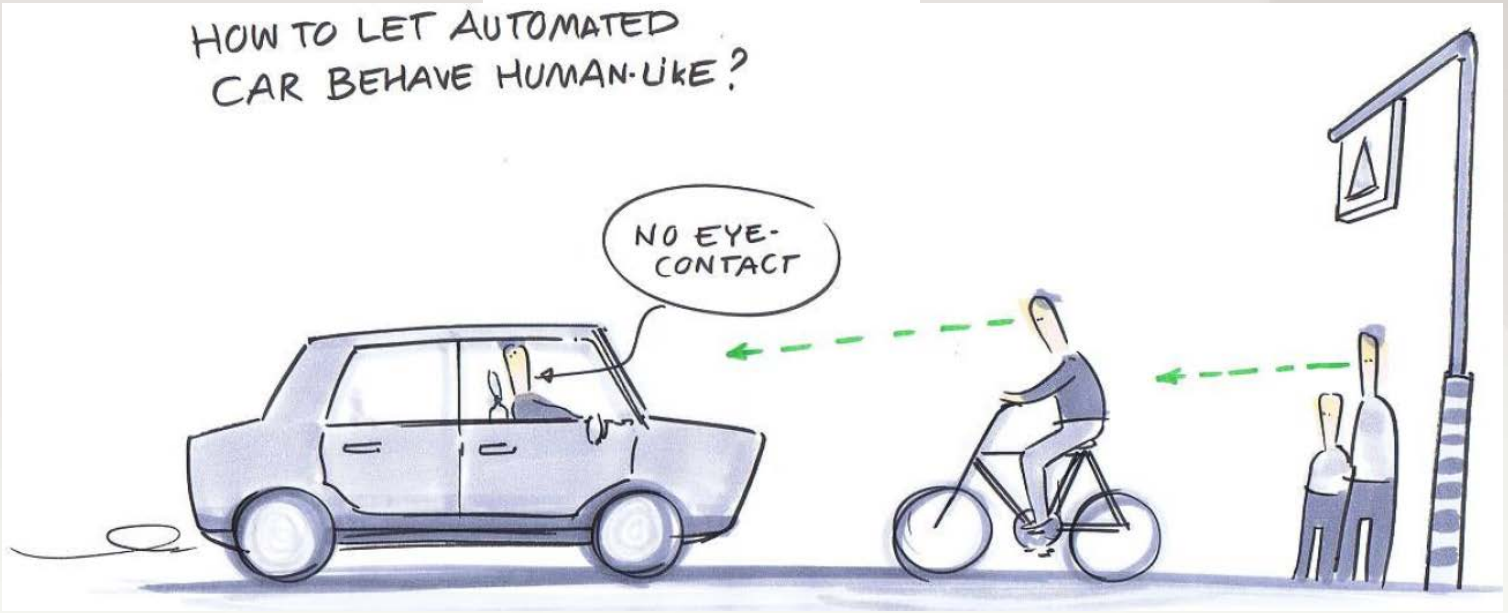
Opportunities

… eliminate the injuries and property damage associated with vehicle crashes and save more than 30,000 lives a year.

KPMG: Self-driving cars: The next revolution

… emergency rooms would lose more than two million crash victims annually and the resulting 240,000 annual hospitalizations.

KPMG: Self-driving cars: The next revolution



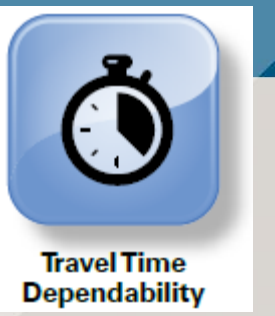
with Automobiles that see… safer streets for pedestrians and cyclists

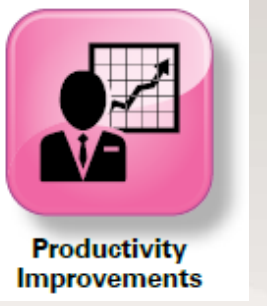
(Graphic source: SMART: Definition of necessary Vehicle and Infrastructure Systems for Automated Driving)

Opportunities

Implementation

- **THEA assets as test bed for Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) Systems**
  - Selmon Expressway
  - Brandon Parkway
  - Meridian Boulevard
- **Bus Toll Lanes and future benefits**
  - Vehicle Platooning
  - Capacity enhancement with no decline in speed or reliability

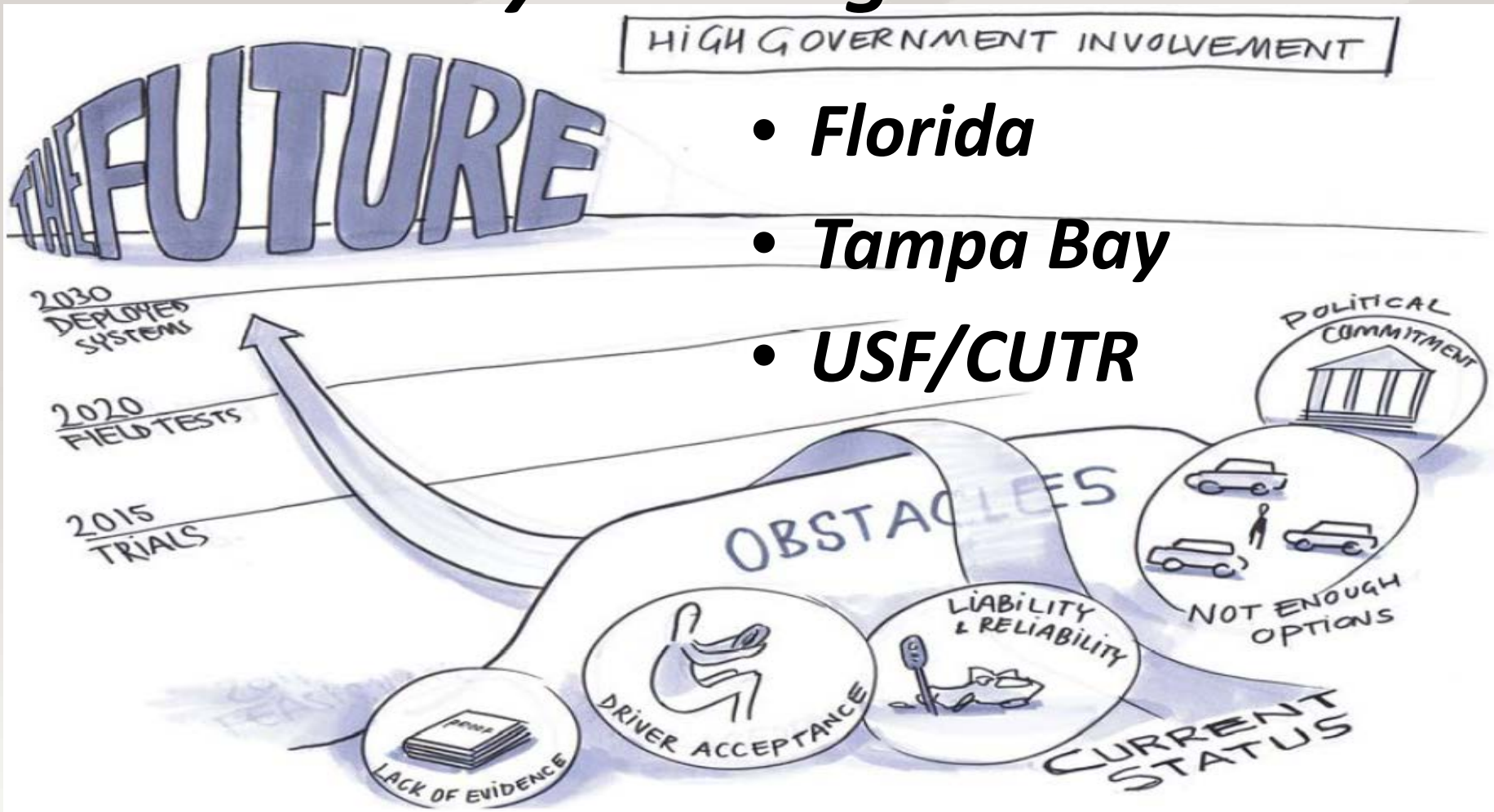




(Graphic source: KPMG: Self-driving cars: The next revolution)

Opportunities

Policy and Regulation



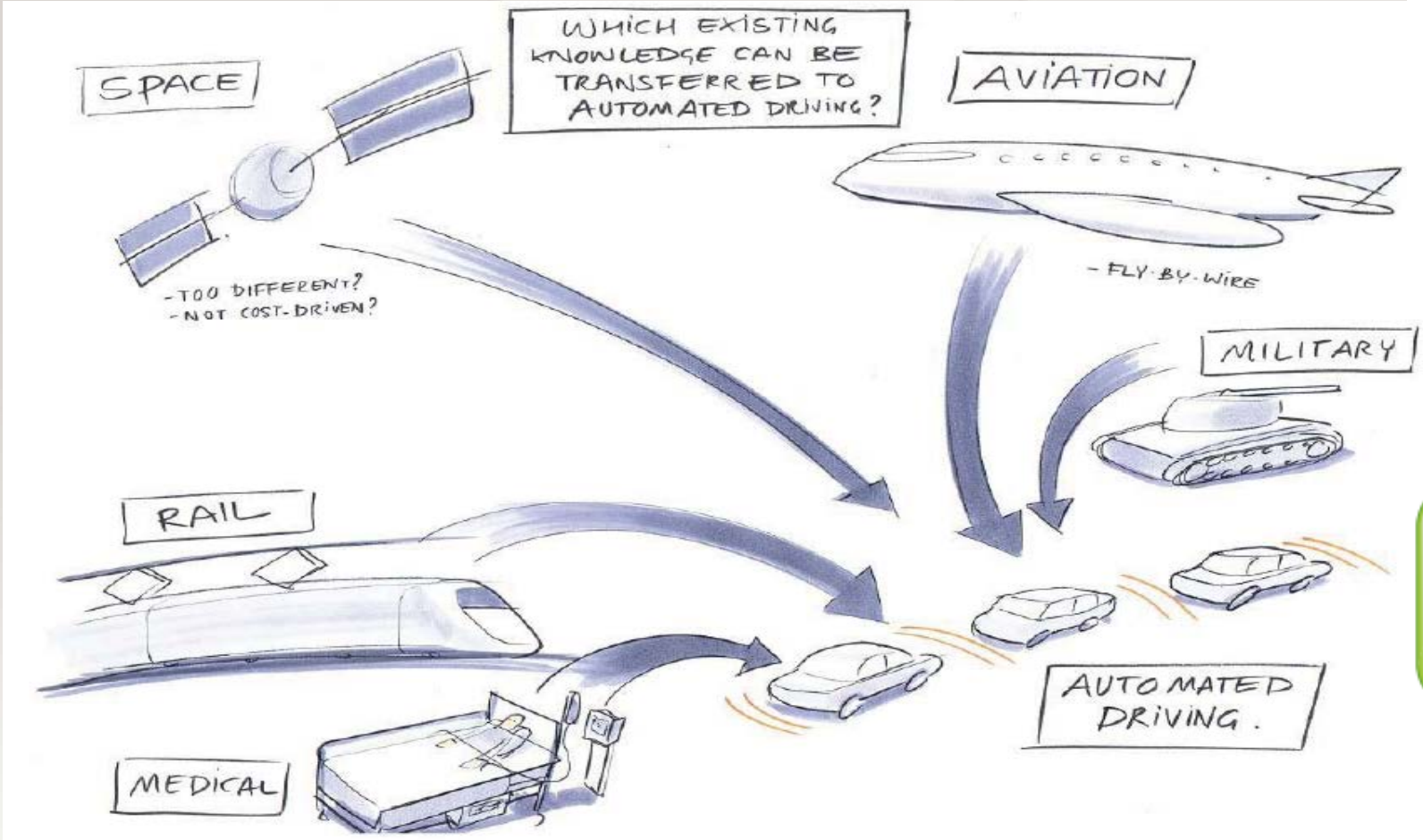
- ***Florida***
- ***Tampa Bay***
- ***USF/CUTR***

Facilitating role of government

Graphic source: SMART: Definition of necessary Vehicle and Infrastructure Systems for Automated Driving)

Opportunities

Hi-Tech Business



New Business Models & Scenarios

New Models for Vehicle Ownership

Knowledge Transfer from other sectors might help in finding new opportunities for automated driving. Graphic source: SMART: Definition of necessary Vehicle and Infrastructure Systems for Automated Driving)

THEA… A Bold (audacious) Vision

Opportunity for Tampa Bay to Lead

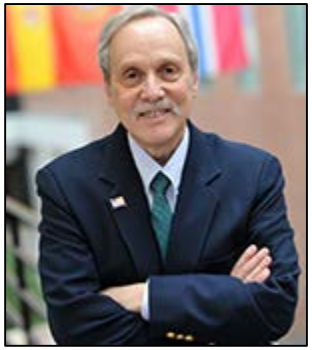
- Automated Vehicle Technologies Implementation
- Policy Development (USF-CUTR)
  - Policy and Regulatory Development
  - Product Research and Development
- Hi-Tech Business Opportunities

Action

THEA Autonomous Vehicle Technology Progression

- Board approves contract for AV White Paper Study "Tampa Bay: An Automated Vehicle Catalyst?" (6/24/13)
- THEA partners with FDOT for a Tampa Bay Summit (November 14-15, 2013)
- Selmon Expressway offered as AV-CV Test Bed (January 2014)
- Audi A-7 Testing (June 2014)
- CV Contract Awarded to THEA (September 2015)

TOM BAMONTE
Assistant Executive Director,
Strategy and Innovation
North Texas Tollway Authority



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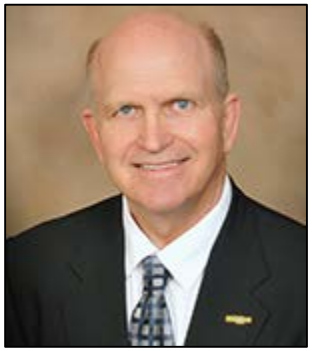

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