History of Intelligent Transportation Systems (ITS)

Connected Vehicles and Smart Cities

NACo Peer Exchange

May, 2017

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U.S. Department of Transportation

Modal Partnerships

Intelligent Transportation Systems Joint Program Office

- U.S. Department of Transportation **Federal Highway Administration**
- U.S. Department of Transportation **Maritime Administration**
- U.S. Department of Transportation **Federal Transit Administration**
- U.S. Department of Transportation **Federal Motor Carrier Safety Administration**
- U.S. Department of Transportation **National Highway Traffic Safety Administration**

Automation

Grants to Architecture

Information Technology

Smart Infrastructure

SCMS: Security Credential Management System

Training

Big Data

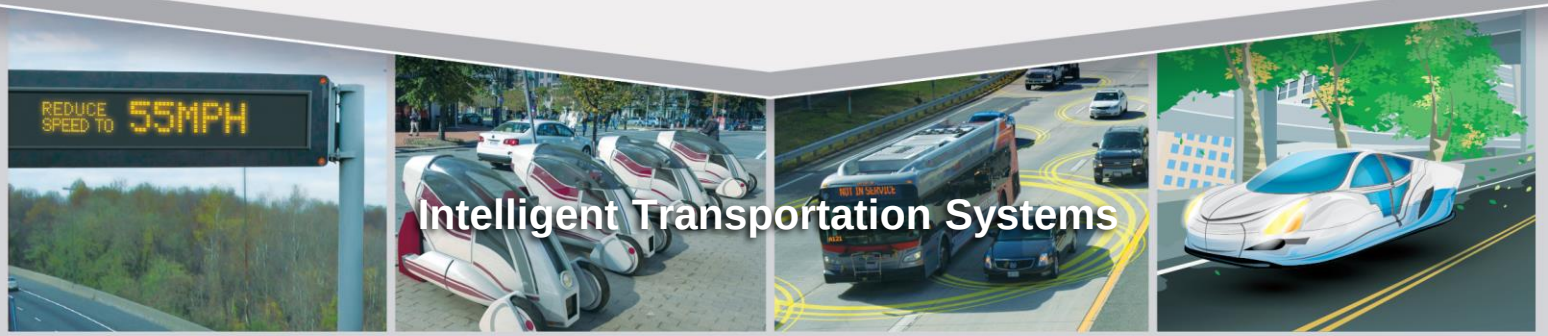
Evaluation

Spectrum

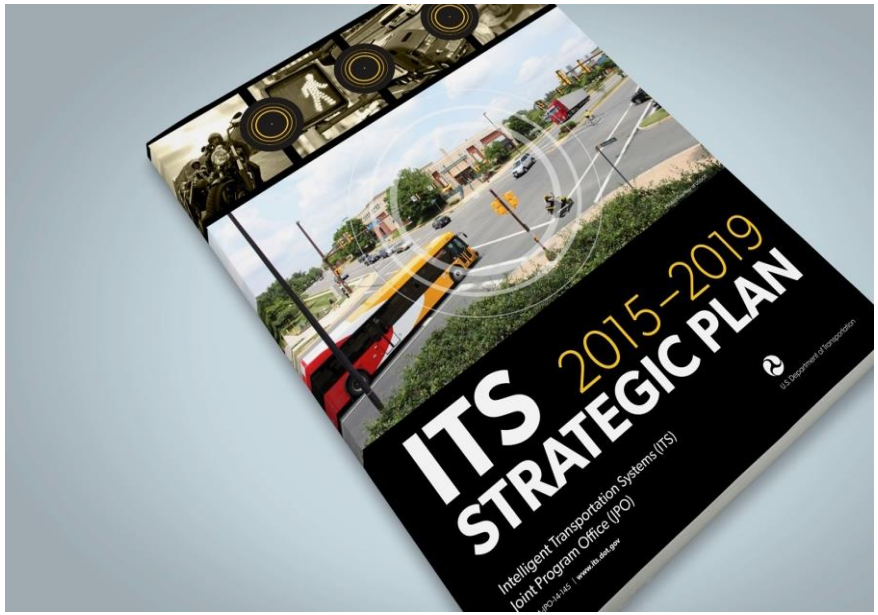
Certification

Knowledge Transfer

Research Grants



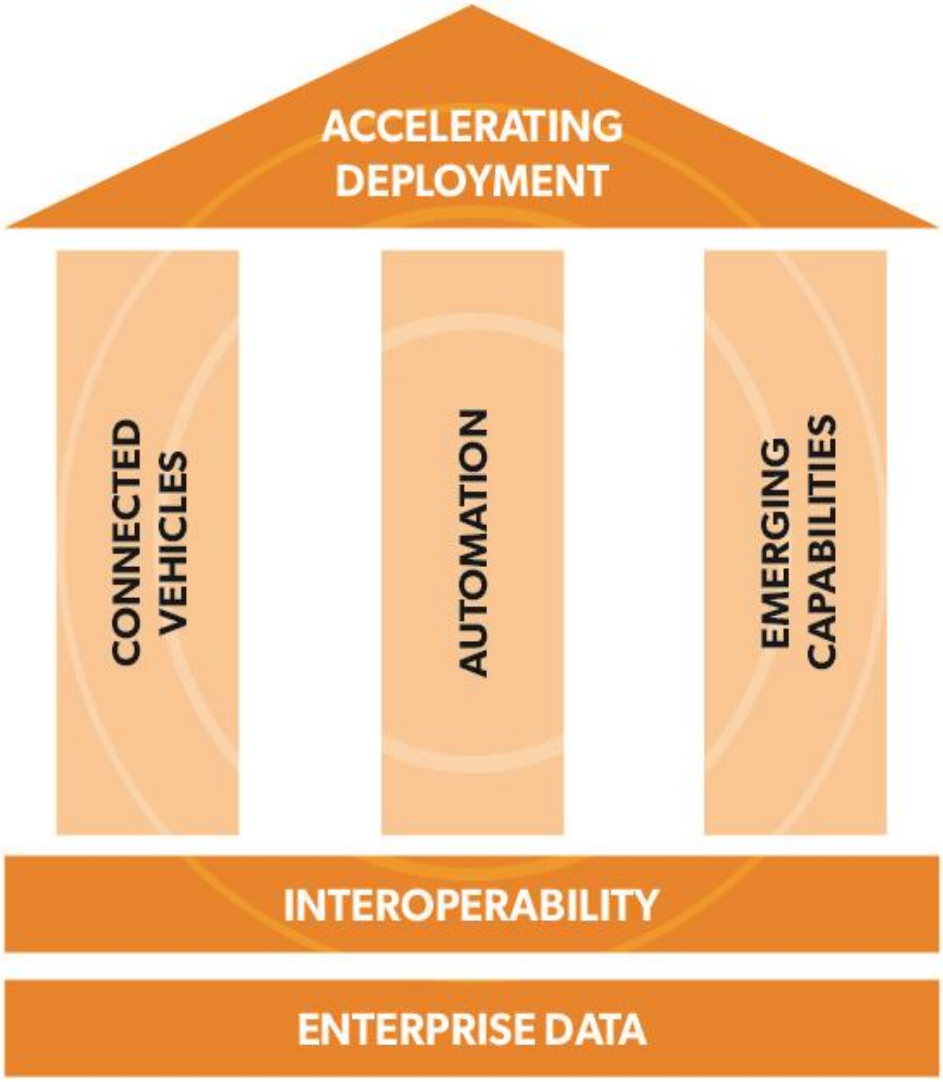
Strategic Plan



VISION

Transform the Way Society Moves

Conduct research, development, and education activities to facilitate the adoption of information and communication technology to enable society to move more safely and efficiently.



Presentation Overview

- Introduction
- Early History/Pre-1980s
- The 1980s
- The 1990s
- The 2000s
- The 2010s
- What's Real


Imagine a Transportation System in which
VEHICLES CAN SENSE & COMMUNICATE
Things That You Can't.

AUTONOMOUS VEHICLES

- Autonomous & Driverless Car
  - Array of sensors to detect other vehicles and obstacles
  - Requires Detailed map
  - Use machine learning to make software smarter
  - Doesn't rely on communication with other vehicles

Automated vehicle

CONNECTED VEHICLES

- Connected Vehicles (CV) are vehicles that can communicate with each other, roadside devices (traffic signals), or non-motorized users (smart phones and other advanced devices)
  - Vehicle to Vehicle (V2V)
  - Vehicle to Infrastructure (V2I)
  - Vehicle to Anything (V2X)

Illustration of communications between C/AV-enabled vehicles and infrastructure

Connected Automation - Greatest Benefits

Autonomous Vehicle

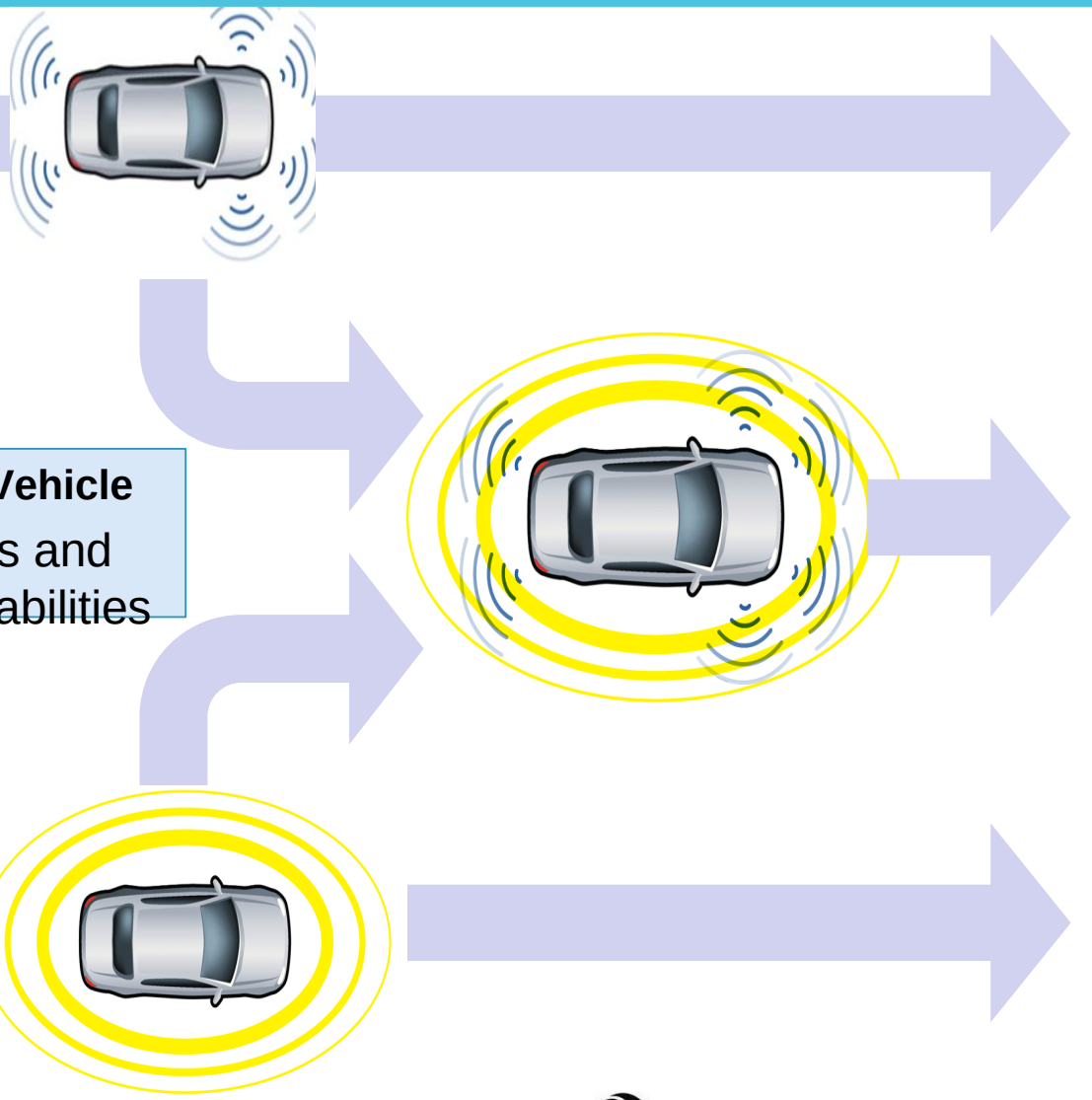
Operates in isolation from other vehicles using internal sensors

Connected Automated Vehicle

Leverages autonomous and connected vehicle capabilities

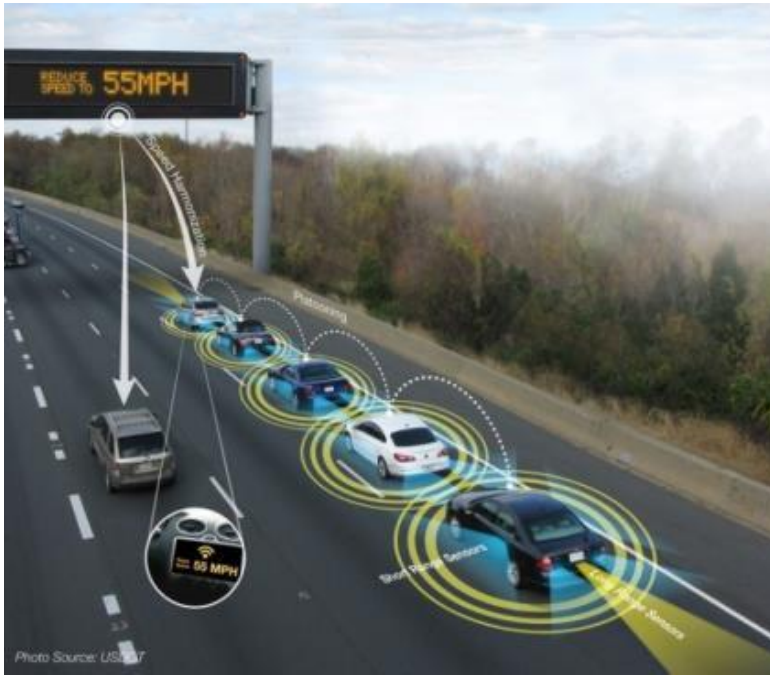
Connected Vehicle

Communicates with nearby vehicles and infrastructure

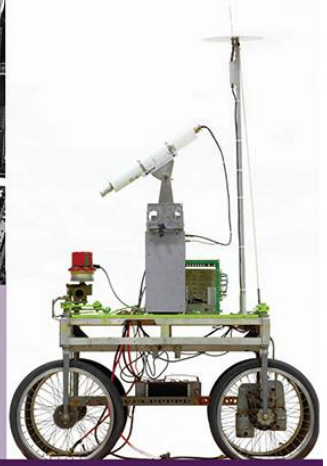


CONNECTED AUTOMATION - GREATEST BENEFITS

- **Improving safety**
  - Reduce and mitigate crashes
- **Increasing mobility and accessibility**
  - Expand capacity of roadway infrastructure
  - Enhance traffic flow dynamics
  - More personal mobility options for disabled and aging population
- **Reducing energy use and emissions**
  - Aerodynamic “drafting”
  - Improve traffic flow dynamics



*…**connectivity is critical to achieving the greatest benefits***



Pre-1980s

1914 | The first three-colored traffic signal is deployed in Ohio

1935 | The first parking meter is deployed in Oklahoma

1956 | Congress passes the Federal-Aid Highway Act (Eisenhower Highway Bill) and the U.S. interstate network is created

1963 | The first ramp meters are deployed on the Eisenhower Expressway in Illinois

Mid-1960s | General Motor's Driver Aided Information and Routing System is deployed

1960s | The first mobile robots are developed

1960s | The first dynamic message signs are deployed

1967 | Government agencies begin setting vehicle and highway safety standards; seat belts, padded dashboards, standard bumper heights, and dual braking systems become mandatory for new cars in 1967

Late 1960s | The first North American traffic management centers are deployed

1966 | The U.S. Department of Transportation (USDOT) is established

1968 | The first 911 system is installed in Alabama

Late 1960s | The Federal Highway Administration (FHWA) Electronic Route Guidance System is deployed

1970 | The National Highway Traffic Safety Administration (NHTSA) is established by the Highway Safety Act

1972 | Minneapolis introduces a bus bypass lane at metered ramps to promote use of mass transit

1970s | Early generation bus automatic vehicle location mapping technology is deployed

KEY

Policy/Anniversary

Technology/Deployment

Research/Academia

Stakeholder Champion or Meeting

1980s

1984 | Los Angeles Automated Traffic Surveillance and Control System integrates vehicle detectors, closed-circuit TV, and coordinated signal timing data

1985 | The Defense Advanced Research Projects Agency (DARPA) Autonomous Land Vehicle demonstrations begin

Mid-1980s | The Crescent Demonstration Project researches ways to pre-screen and weigh commercial trucks at highway speeds

1986 | The TRANSCOM coalition forms to improve incident notification, regional incident management, and construction coordination

Mid-1980s | The Automatic Route Control System is the first autonomous route guidance system utilizing on-board computer with digitized maps, map-matching software, and dead-reckoning subsystem

Mid-1980s | The FHWA Traffic Systems Division partners with several universities to conduct exploratory projects on freeway management, advanced traffic control, computer simulation, and driver information systems

1987 | U.S. Congress establishes the University Transportation Centers through the Surface Transportation and Uniform Relocation Assistance Act

1987 | Northeast corridor states embark on electronic toll collection interoperability (NY, NJ, PA)

1988 | Mobility 2000 is created — a collaboration with the American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board, Highway Users Federation for Safety and Mobility, and FHWA

1989 | Mobility 2000's first meeting is held in Dallas, Texas

1989 | Weigh-in-motion technology is deployed for commercial vehicle operations

1989 | Operation Greenlight addresses vehicle congestion in the Illinois area and includes freight modes: trucking, rail, marine terminals, airlines, and freight associations

1989 | The World Wide Web is invented by Tim Berners-Lee

KEY MILESTONES IN THE HISTORY OF INTELLIGENT TRANSPORTATION SYSTEMS

1990s

1990 | Intelligent Vehicle Highway Society of America (IVHS America) incorporates in Washington, DC

1990 | In California, the Pathfinder in-vehicle information system assesses communications technology for route guidance and in-car traffic navigation

1991 | The Intelligent Vehicle Highway System (IVHS) Joint Program Office (JPO) is established as part of the FHWA

1991 | IVHS America holds its First Annual Meeting in Reston, VA

1991 | The Intermodal Surface Transportation Efficiency Act (ISTEA) is passed by Congress, and the federal ITS research program is established

1991 | ISTEA designates IVHS America a Utilized Federal Advisory Committee to the USDOT's IVHS Joint Program Office

1991 | The Oklahoma Turnpike Authority's Pikepass becomes the first electronic toll collection system in the United States

1991 | The E-ZPass Interagency Group is created to develop an interoperable tolling system among seven independent toll agencies throughout New York, New Jersey, and Pennsylvania

1992 | FAST-TRAC integrates advanced traffic management systems and advanced traveler information systems in Oakland County, Michigan

1992 | TravTek deploys in-vehicle traveler information system and navigation device

1992 | The Guidestar Program Genesis project deploys wireless personal communications devices to send drivers alpha-numeric text travel information in the Twin Cities area

1992 | INFORM Project presents traffic flow and alternate routing information through changeable message signs in Long Island, New York

1993 | Truck rollover warning system is deployed

1993 | The Chicago Transit Authority integrates smart card technology into its automated fare collection system

1993 | The I-95 Corridor Coalition is formed as a partnership of transportation agencies, toll authorities, public safety, and related organizations

1993 | E-ZPass is deployed at the New York State Thruway

1993 | The USDOT identifies four intelligent transportation system (ITS) priority corridors, including Gary-Chicago-Milwaukee Corridor, Northeast Corridor, Southern California, and Houston

1994 | IVHS America becomes the Intelligent Transportation Society of America (ITS America)

1994 | The National Automated Highway System Consortium is established to address ISTEA AHS Automated Highway System (AHS) mandate

1994 | The term "ITS" is officially sanctioned by USDOT as a replacement for IVHS

1994 | Bluetooth is invented

1995 | The first implementation of congestion pricing using electronic variable tolling is deployed in Orange County, CA

1995 | "No Hands Across America": Researchers from Carnegie Mellon University drive a specially outfitted car with autonomous capabilities from Pittsburgh to Los Angeles

1995 | GPS is commercially available

1995 | The Crash Avoidance Metrics Partnership (CAMP) is launched by Ford and General Motors

Mid-1990s | The IVHS Program develops a national systems architecture and standards to promote interoperability and coordinated national approach

1996 | The USDOT selects four Metropolitan Model Deployment Initiative locations with public private partnerships in regional transportation systems

1996 | The USDOT establishes the ITS Standards Program

1997 | Congressionally mandated AHS Demonstration is held in San Diego, California

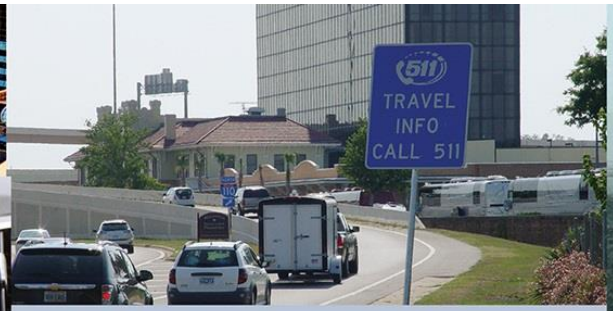
1998 | Speed cameras are deployed as a traffic surveillance method

1998 | The USDOT's Intelligent Vehicle Initiati (IVI) Program is establishe

1998 | U.S. Congress passes the Transportation Equity Act for the 21st Century (TEA-21)

1999 | The Commercial Vehicle Information Systems and Networks Deployment Grant Program is initiated

1999 | ITS America successfully petitions the Federal Communications Commission (FCC) to allocate 75 MHz of spectrum in the 5.9 GHz band for ITS



2000s

2000 | The Federal Motor Carrier Safety Administration is established as a separate operating administration within the USDOT

2000 | FCC designates 511 as the single travel information telephone number across the country

2000 | Travel time information is displayed on dynamic message signs as part of 511

2002 | The USDOT releases the *National ITS Program Plan: A Ten Year Vision*

2003 | The USDOT launches the Vehicle-Infrastructure -Integration (VII) Program

2003 | First forward collision warning system is offered in the United States on a Toyota Lexus LS 430

2004 | The Research and Innovative Technology Administration is established within the USDOT to support ITS initiatives

2004 | The USDOT's Clarus initiative is established to reduce the impact of adverse weather conditions on surface transportation users

2004 | The first lane departure warning system available in the United States is developed by Iteris and Valeo for the Nissan Infiniti FX

2004 and 2005 | The DARPA Grand Challenge is conducted to accelerate the development of technology for autonomous vehicles

2005 | The National 911 Program Office is established by NHTSA and the National Telecommunications and Information Administration

2005 | The USDOT initiates a 5.9 GHz-based VII proof of concept; a continuation of the Advanced Vehicle Control Systems envisioned by Mobility 2000

2005 | The Mobility Services for All Americans initiative begins

2005 | The Integrated Vehicle-Based Safety Systems initiative is established to develop and test integrated safety systems on light vehicles and commercial trucks

2005 | The first high occupancy toll lanes are deployed in Orange County, CA

2005 | U.S. Congress passes the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)

2006 | The USDOT partners with CAMP to develop and test prototype vehicle-to-vehicle (V2V) safety applications

2006 | The USDOT launches an integrated corridor management initiative to improve corridor performance

2007 | Blind spot detection is offered on vehicles

2007 | Apple's iPhone 1.0 is released

2007 | Lane departure warning, blind spot monitoring, and collision avoidance systems are available on luxury vehicles

2008 | The USDOT conducted a proof-of-concept test to investigate the technical feasibility of V2V and V2I applications in Michigan and California test beds

2009 | Google's Self-Driving Car project starts

2010s

2010 | Crowdsourcing apps are developed for use in transportation

2011 | The first public connected vehicle demonstration is held at the 18th ITS World Congress in Orlando, FL

2012 | U.S. Congress passes the Moving Ahead for Progress in the 21st Century Act (MAP-21)

2012 | The USDOT launches the 2012–2013 Safety Pilot Model Deployment demonstrating V2V communication

2014 | General Motors announces semi-autonomous driving features and V2V communication capability in some 2017 Cadillacs

2014 | NHTSA mandates back-up cameras

2014 | The USDOT issues Advanced Notice of Rulemaking for V2V communication technology for light vehicles

2014 | Google unveils driverless car without pedals or a steering wheel

2014 | ITS JPO releases the *ITS Strategic Plan 2015–2019*

2015 | Connected Vehicle Pilot Deployment awards are announced

2015 | President Obama signs the Fixing America's Surface Transportation (FAST) Act into law

2015 | President Obama announces the Smart Cities Initiative and Secretary Foxx launches the Smart City Challenge

2015 | National Operations Center for Excellence is unveiled as a collaboration between ITS America, AASHTO, and Institute of Transportation Engineers, with support from FHWA

2016 | The USDOT announces seven finalists for Smart City Challenge; the winning city will be announced in June 2016

CONNECTED VEHICLE PILOT
Deployment Program

ITS Joint Program Office

https://www.its.dot.gov/pilots/

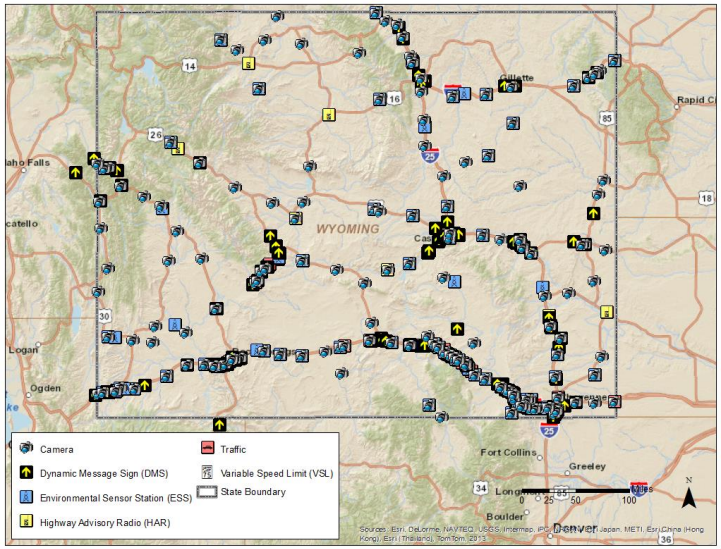
WYOMING PILOT DEPLOYMENT OVERVIEW

Objective:

- Reduce the number and severity of adverse weather-related incidents (including secondary incidents) in the I-80 Corridor to improve safety and reduce incident-related delays.
  - Focused on the needs of the commercial vehicle operator in the State of Wyoming

Approach:

- Equip fleet vehicles (combination of snow plows, maintenance fleet vehicles, emergency vehicles, and private trucks) that frequently travel the I-80 corridor to transmit basic safety messages (BSMs), collect vehicle and road condition data and provide it remotely to the WYDOT TMCs
- Deploy DSRC roadside equipment (RSE) to supplement existing assets and initiatives
- Provide shared road weather data with freight carriers who will then transmit this data to their trucks using existing in-vehicle systems



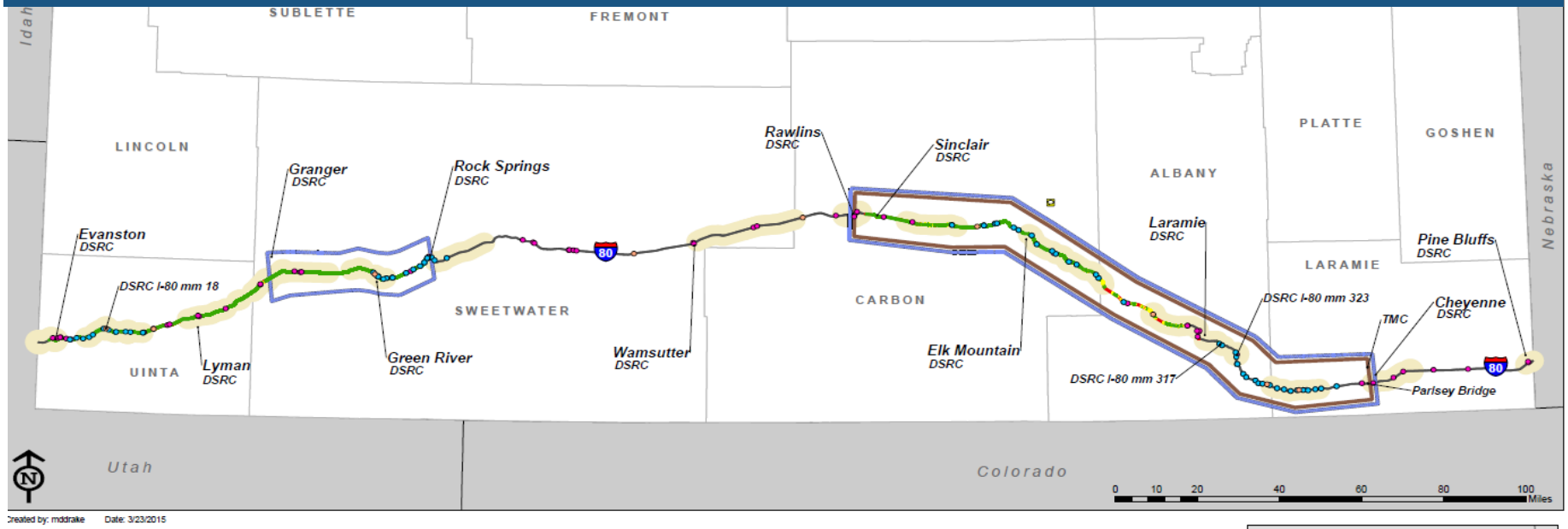
Source: Wyoming DOT

Deployment Team:

- Prime Consultant: ICF International; Partner State: Wyoming DOT
- Sub Consultants: Trihydro Corporation, National Center for Atmospheric Research, University of Wyoming, Catt Laboratory and McFarland Management

Wyoming Pilot Deployment Site: High Priority Corridor

Wyoming I-80 Corridor – Connected Vehicle Map



Created by: mddrake Date: 3/23/2015

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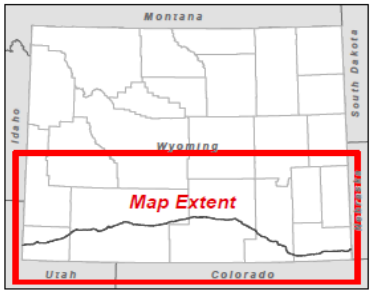
Legend

- High Profile Wind Warning Area
- AVL/Tablet Snow Plows
- STIP Areas 2015-2018

WyoLink - Signal Strength

- Good
- Spotty
- Unreliable

- I-80, Wyoming
- Possible Locations Roadside DSRC *(Going into/out ofeach town off I-80 for supportingVSL Application. These include locations with mm labels)*
- WiFi Locations (9 within 500 ft of I-80)
- VSL Devices (122 on I-80)
- Truck Parking (55 on I-80)



Source: Wyoming CV Pilot Deployment Team

TAMPA (THEA) PILOT DEPLOYMENT OVERVIEW

Objective:

- The primary objective of this deployment is to alleviate congestion and improve safety during morning commuting hours.
  - Deploy a variety of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) safety, mobility, and agency data applications to create reinforcing benefits for motorists, pedestrians, and transit operation.

Source: THEA

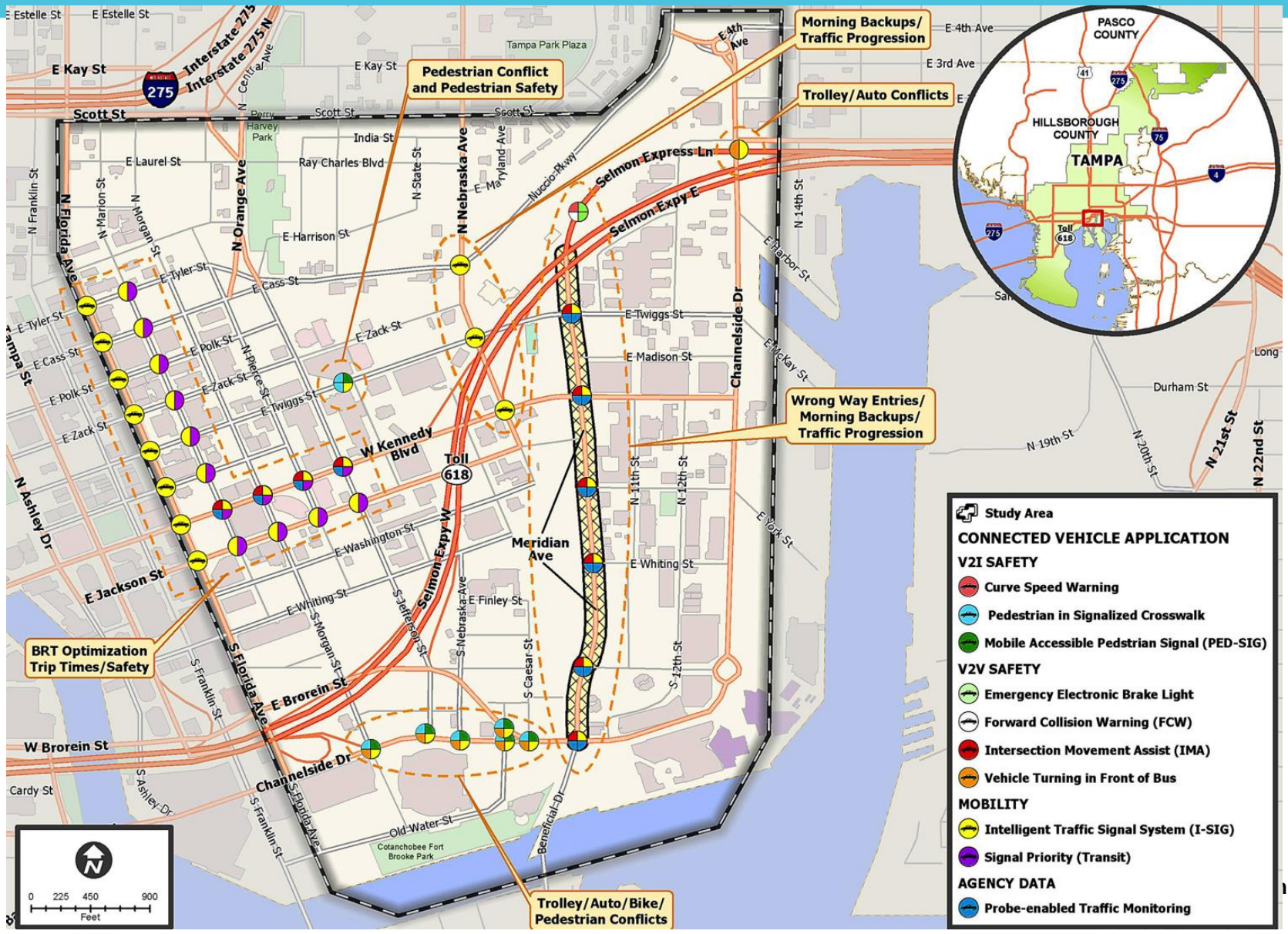
Approach:

- Deploy a variety of connected vehicle technologies on and in the vicinity of reversible express lanes and three major arterials in downtown Tampa to solve the following transportation challenges:
- Morning peak hour queues, wrong-way entries, pedestrian safety, bus rapid transit (BRT) signal priority optimization, trip time and safety, streetcar trolley conflicts, and enhanced signal coordination and traffic progression.

Deployment Team:

- Prime Consultant: Tampa Hillsborough Expressway Authority (THEA)
- Sub Consultants: HNTB Corporation, Siemens Industry, Inc., Booz Allen Hamilton, Center for Urban Transportation Research at University of South Florida and Global-5 Communications

Tampa (THEA) Pilot Deployment Site
An Overview of Downtown Tampa



New York City (NYC) Pilot Deployment Overview

Objective:

- Improve safety and mobility of travelers in New York City through connected vehicle technologies
  - Aligned with the NYC's Vision Zero initiative, which seeks to reduce crashes and pedestrian fatalities, and increase safety of travelers in all modes of transportation

Approach:

- Equip up to 8,000 vehicles (taxis, buses, commercial fleet delivery trucks, and City-owned vehicles) that frequently travel in Midtown Manhattan and Central Brooklyn to transmit and receive connected vehicle data
- Install V2I technology at high-accident rate arterials:
  - Upgrade 239 traffic signals along 1st, 2nd, 5th, and 6th Avenues in Manhattan and Flatbush Avenue in Central Brooklyn (emergency evacuation route)
  - Deploy Roadside equipment (RSE) along FDR Drive

Source: NYC DOT

Deployment Team:

- Prime Consultant: NYC DOT
- Sub Consultants: JHK Engineering, Battelle, Cambridge Systematics, KLD Engineering, Security Innovation and Region 2 University Transportation Research Center

NYC Pilot Deployment Site

Manhattan Grid

- Closely spaced intersections (600' x 250')
- Day vs. Night conditions
- Residential/commercial mix
- High accident rate (red dot) (2012-2014)
  - 20 fatalities
  - 5,007 injuries
- 204 intersections

Central Brooklyn – Flatbush Ave

- Over-Height restrictions
  - Tillary St.; Brooklyn Bridge
- High accident rate (red dots) (2012-14)
  - 1,128 injuries
  - 8 fatalities
- Average AM speed 15 mph
- 35 intersections

Manhattan – FDR Drive

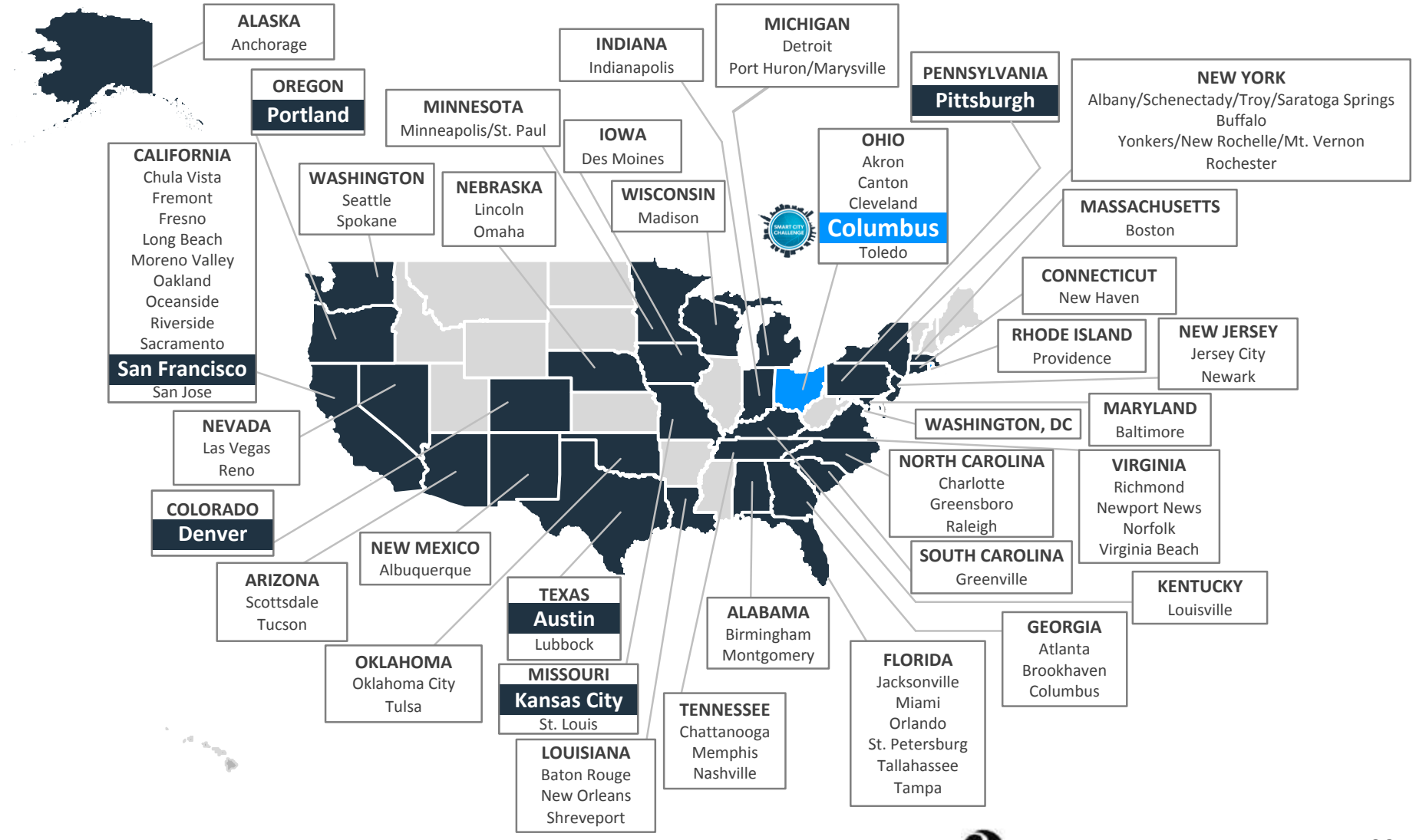
- Limited access highway
- Excludes trucks/buses
- Short radius of curvature
- Over-Height restrictions
- $1,958,497 in Over-Height incident delay costs (2014)
  - 24% of City-wide total

Source: NYC DOT

The Smart City Challenge

- Encourage cities to put forward their best and most creative ideas for innovatively addressing the challenges they are facing.
- Demonstrate how advanced data and intelligent transportation systems (ITS) technologies and applications can be used to reduce congestion, keep travelers safe, protect the environment, respond to climate change, connect underserved communities, and support economic vitality.

Smart City Challenge



VISION | ACCESS TO JOBS | SMART LOGISTICS | CONNECTED RESIDENTS | CONNECTED VISITORS | SUSTAINABLE TRANSPORTATION

ENABLING TECHNOLOGIES

Columbus Connected Transportation Network (CCTN)

Integrated Data Exchange

Enhanced Human Services

Electric Vehicle Infrastructure

DEPLOYMENT DISTRICTS

Residential District
Linden

Commercial District
Easton

Downtown District
Urban Core

Logistics District
Rickenbacker

OUTCOMES

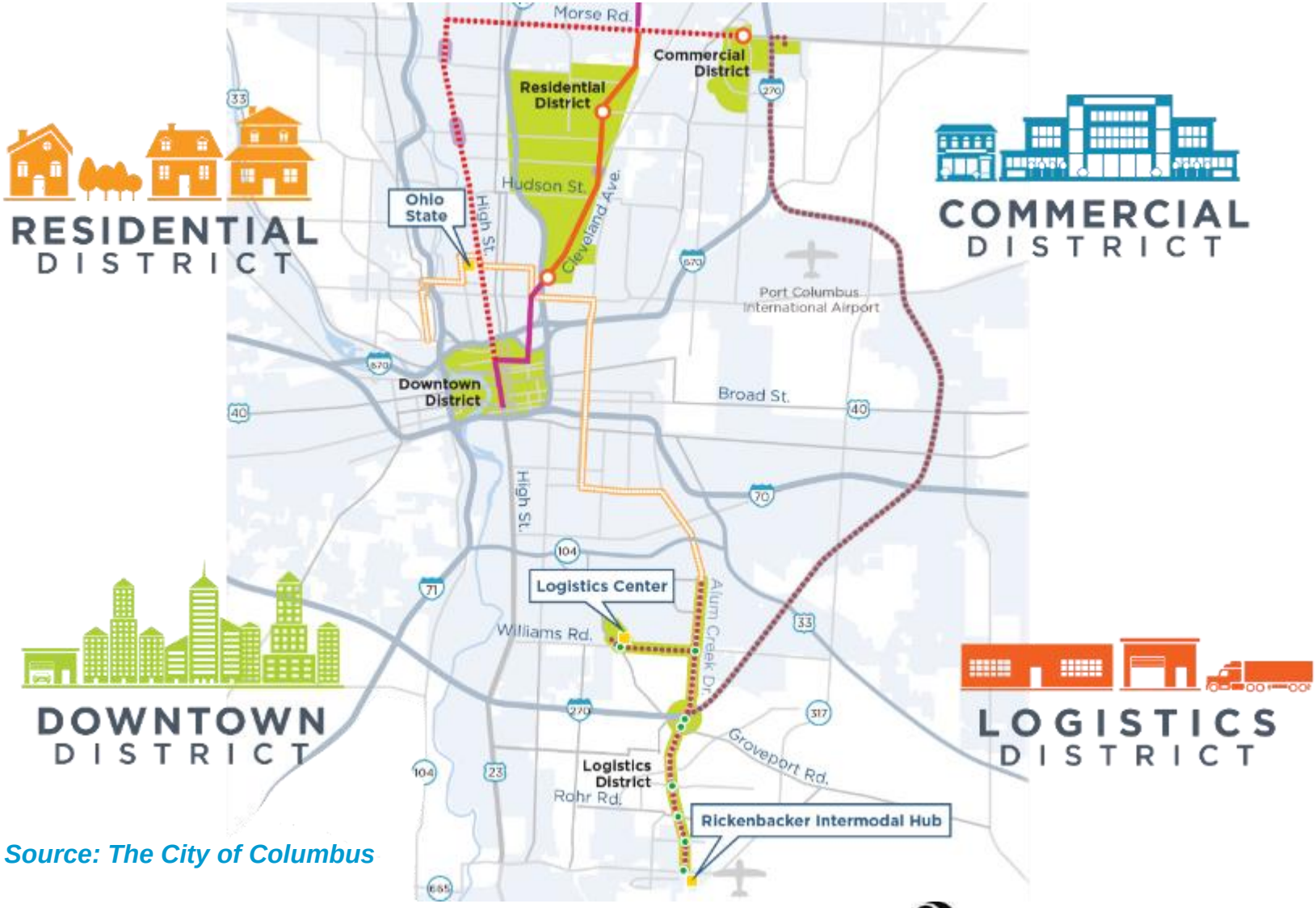
Safety

Mobility

Fuel Efficiency

Jobs

SMARTCOLUMBUS Districts



Source: The City of Columbus

SMARTCOLUMBUS Solutions

RESIDENTIAL DISTRICT

- Leverage the new COTA CMAX Bus Rapid Transit (BRT) Line
- Equip intersections with Dedicated Short Range Communications (DSRC) technologies
- Provide new mobility and safety applications
- Create neighborhood hubs providing transportation options
- Deploy Smart Lighting and free public Wi-Fi to improve safety, make the neighborhood more walkable, and provide access to information

Proposed Applications

- Dynamic Transit Operations
- Connection Protection
- Dynamic Ridesharing
- Integrated Multi-Modal Electronic Payment
- Transit Signal Priority
- Transit Stop Pedestrian Warnings
- Pedestrian in Signalized Crosswalk Warnings
- Vehicle Turning Right in Front of Bus Warnings
- Forward Collision Warning
- Emergency Brake Light Warning
- Eco-Approach and Departure

SMARTCOLUMBUS Solutions

Autonomous Vehicles

Three fixed routes supporting first mile / last mile (FMLM) equipped with inductive charging stations

Enhanced Human Service

Available via both a smartphone application and deployed kiosks

CCTN Build Out

Signal Phase and Timing (SPaT), Emergency Vehicle Preemption, and Transit Signal Priority

Source: The City of Columbus

SMARTCOLUMBUS Solutions

Event Parking Management

- Partnership with Experience Columbus and associated agencies that collectively manage more than 42,000 parking spaces
- Multilingual, multi-modal trip planning application allowing travelers to "reserve and book" parking

Loading Zone Parking Management

- Video equipment capable of monitoring loading zones
- Install and operate a real-time parking availability service for freight delivery

Permit-Only Parking

- Radio frequency identification (RFID) stickers to collect information on the permitted vehicles in zones

Transit Benefit Program

SMARTCOLUMBUS Solutions

LOGISTICS DISTRICT

- Intelligent truck warning and routing application to minimize incidents due to low bridges or narrow roads
- Regional Truck Parking Information and Management System

Source: The City of Columbus

Other USDOT Efforts to Enable Connected, Smart Communities

Advanced Transportation and Congestion Management Deployment (ATCMTD) Program Grant Winners (http://transportation.house.gov/fast-act/technology-grants.htm)

Denver, CO

Denver will implement three intelligent vehicle projects: a Connected Traffic Management Center (TMC) and Connected Fleets; Travel Time Reliability as a City Service for Connected Freight; and Safer Pedestrian Crossings for Connected Citizens

Pittsburgh, PA

Deploy “Smart Spine” corridors in Pittsburgh that improve connections between isolated neighborhoods and major centers of employment, education and healthcare.

Professional Capacity Building - Objective

Early Deployer Technical Assistance: Accelerate testing and deployment of interoperable connected ITS technologies during the early stages of deployment when development of standards, best practices, and support systems and processes are also ongoing and collaboratively build upon the state of the practice.


ITS
STRATEGIC PLAN
2015–2019
Intelligent Transportation Systems (ITS)
Joint Program Office (JPO)
U.S. Department of Transportation
ICF/Wyoming
Tampa (THEA)
New York City
SMART CITY
CHALLENGE

Thank You

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https://www.its.dot.gov/pilots/