CONNECTED VEHICLES 101

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THE SCALE OF THE PROBLEM IN THE U.S.

SAFETY
- 37,461 highway deaths in 2016
- 6.29 million crashes in 2015
- Leading cause of death for ages 11, 16-24

MOBILITY
- 6.9 billion hours of travel delay
- $160 billion cost of urban congestion

ENVIRONMENT
- 3.1 billion gallons of wasted fuel
- 56 billion lbs of additional CO₂

Data Sources:
Quick Facts: 2016 Data, National Highway Traffic Safety Administration (October, 2017); 2015 Annual Urban Mobility Report, Texas Transportation Institute (Aug 2015); Centers for Disease Control
WHAT IS CONNECTIVITY?

- **Vehicle-to-vehicle** and **vehicle-to-infrastructure** communications enable the vehicle to exchange data with nearby vehicles and roadside infrastructure.
- Different communications technologies (e.g., LTE, DSRC, Satellite) are utilized depending on the performance requirements of the applications.
CONNECTIVITY OFFERS POTENTIAL SOLUTIONS

- More accurate detection of nearby vehicles, pedestrians, objects
- More accurate signal phase and timing (SPaT) information from traffic signals
- More cooperation between vehicles for smoother traffic flow
CONNECTIVITY CAN PROVIDE ADDITIONAL DATA

On-board sensors only collect data within their line-of-sight. Connectivity can extend upon and provide additional information.

Non-Connected Automated Vehicles

Vehicle slowing 300 feet ahead

Connected Automation

Object detected 0.2 miles ahead; traffic slowing
Imagine a Transportation System in which

VEHICLES CAN SENSE
Things That You Can’t.
How Connected Vehicles Work

1. A wireless device in a car sends basic safety messages 10 times per second

2. Other nearby cars and roadside equipment receive the messages

3. Drivers get a warning of a potential crash

*Source: NHTSA

Connected vehicles have the potential to reduce non-impaired crash scenarios by **80%**
INTERSECTION MOVEMENT ASSIST:

 Warns the driver when it is not safe to enter an intersection—for example, when something is blocking the driver’s view of opposing or crossing traffic.
CONNECTED VEHICLES: SAVING LIVES

**Queue Warning and Speed Harmonization:**

Warns drivers of upcoming congestion and provides speed recommendations.
CONNECTED VEHICLE PILOT DEPLOYMENT PROGRAM

Spur Early CV Tech Development
Wireless Connected Vehicles
Mobile Devices
Infrastructure

Measure Deployment Benefits
Safety
Mobility
Environment

Resolve Deployments Issues
Technical
Institutional
Financial

Connected Vehicle Pilot Deployment (Up to 50 Months)
Sites: New York City DOT Pilot, Tampa (THEA) Pilot, Wyoming DOT Pilot

**Phase 1** (Up to 12 Months)
Concept Development
Completed Sept 2016

**Phase 2** (Up to 20 Months)
Design/
Build/Test
Began Oct 2016

**Phase 3** (Minimum 18 Months)
Maintain/
Operate Pilot

Routine Operations
Post-Pilot Operations (Ongoing)
CONNECTED VEHICLES ARE ON THE ROAD TODAY

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

- Improve safety and mobility of travelers in New York City through connected vehicle technologies.
- Vehicle to vehicle (V2V) technology installed in up to 10,000 vehicles in Midtown Manhattan, and vehicle to infrastructure (V2I) technology installed along high-accident rate arterials in Manhattan and Central Brooklyn.

- Alleviate congestion and improve safety during morning commuting hours
- 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 transportation challenges.
**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.
- Road weather data shared with freight carriers who will transmit to their trucks using existing in-vehicle systems.
WYDOT Pilot Deployment Vision

- 400 Equipped Trucks:
  - 100 WYDOT Fleet
  - 150-200 Integrated Commercial Trucks
  - 20-30 Retrofit Vehicles
  - 100-150 Basic Vehicles

- 402 Miles of I-80

- 122 VSL Signs

- Low Visibility / VSL

- Low Visibility Zone Ahead

- On-site Meteorology

- 75 RSU

- Truck Parking Notification

- Truck Parking Available

- Low Visibility Zone Ahead

- Available Truck Parking

- 55 Parking Locations
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 310 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.
NYCDOT Pilot Deployment Vision

- 1,250 MTA Buses
- 500 Sanitation & DOT vehicles
- 5,850 Taxis
- 400 UPS Vehicles
- 353 RSU
- 11 PED Detection System
- 100 Vulnerable Road User Device
- 400 Advanced Traffic Controllers
- NYC Wireless Network
- Data Collection
- Commercial Vehicle Warning Device
- Smartphone
- Modified Aftermarket Safety Device (ASD)
- Vulnerable Road User Device

Security Credential Management System
Other CV Support
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.
Tampa (THEA) Pilot Deployment Vision

1,500 vehicles equipped with OBU

10 equipped buses
10 equipped trolleys

500 equipped pedestrians

40 intersections (I-SIG, TSP, PED-SIG)

Data exchange will use DSRC (Dedicated Short Range Communications) or other wireless media. SCMS (Security Credential & Management System) will be used where appropriate.
Cooperative Automation

- Uses vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) connectivity.
- Enhances the safety and efficiency of Automated Driving Systems.
- Provides greater situational awareness and efficiency.

CONNECTIVITY ENABLES COOPERATIVE AUTOMATION

**Connected Vehicle**
Communicates with nearby vehicles and infrastructure; Not automated

**Connected Automated Vehicle**
Leverages automated and connected vehicles

**Autonomous Vehicle**
Operates in isolation from other vehicles using internal sensors
ADVANCED TECHNOLOGIES AND SMART CITIES

Technology convergence will revolutionize transportation, dramatically improving safety and mobility while reducing costs and environmental impacts.

Connected Vehicles
Vehicle Automation
Internet of Things
Machine Learning
Big Data
Sharing Economy

Connected-Automated Vehicles

Benefits
- Order of magnitude safety improvements
- Reduced congestion
- Reduced emissions and use of fossil fuels
- Improved access to jobs and services
- Reduced transportation costs for gov’t and users
- Improved accessibility and mobility

SMARTCOLUMBUS

Source: The City of Columbus  
https://www.columbus.gov/smartcolumbus/
SMART COLUMBUS PROJECTS

- Connected Vehicle Environment (CVE)
- Smart Street Lighting
- Transit-Pedestrian Collision Avoidance System
- Integrated Data Exchange (IDE)
- Common Payment System
- Multimodal Trip Planning Application
- Smart Mobility Hubs
- Mobility Assistance for People with Cognitive Disabilities
- Connected Electric Automated Vehicles
- Delivery Zone Availability
- Enhanced Parking Permit
- Event Parking Management
- Truck Platooning
- Oversize Vehicle Routing
- Interstate Truck Parking Availability
CONNECTED AND AUTOMATED VEHICLES CAN BENEFIT THE DISABLED
DEVELOPING THE ATTRI APPLICATIONS

Wayfinding and Navigation:
- CITY COLLEGE OF NEW YORK
- ABLELINK
- PATHWAYS SOLUTIONS
- TRX SYSTEMS

Pre-Trip Concierge and Virtualization:
- ABLELINK

Safe Intersection Crossing:
- CARNEGIE MELLON UNIVERSITY

Robotics and Automation:
- CARNEGIE MELLON UNIVERSITY
TO ENABLE THE COMPLETE TRIP

1. Plan and Book a Trip
Andy uses a pre-trip concierge application.

2. Travel to Transit Station
An automated shuttle (rideshare service) is dispatched.

3. Ride the Bus
While on the bus, Andy receives direction on when to pull the Stop Request cord from his wayfinding and navigation application.

4. Cross the Street
As Andy approaches an intersection, his safe intersection crossing application communicates with the traffic signal.

5. Arrival at Destination
Andy safely arrives at his destination, while the pre-trip concierge application plans his return trip home.
ATTRI AND OTHER POSSIBILITIES
Reduced barriers to the mobility of people with disabilities could result in a positive impact to GDP of 0.6%, valued at around $460 billion.
CONNECTED VEHICLE ANIMATION
QUESTIONS?