Connected Vehicles (CV) and the Internet of Things (IoT)

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Beginning of Connected Automated Vehicles

• I first Presented at ITS America 1994
• It was one of the FHWA Concept Families
• Showed how the infrastructure communications and vehicle sensor technology would evolve to give us Connected Automated Vehicles
Connected/Automated Vehicle Projects

- NJDOT Statewide CV Connectivity & Transit Signal Priority
- PennDOT CV/AV Oncall
- PANYNJ XBL CAV System Engineering
- Treasure Island AV Deployment
- Tampa CV Pilot & HART Automated Shuttle
- Jacksonville Ultimate Urban Connector (U2C)
- City of Columbus Smart City Challenge
- Florida Turnpike Enterprise Automated Vehicle Proving Ground
- Michigan DOT Connected Vehicle Support Program
- Florida DOT Connected Vehicle Program Support Services
- Tennessee DOT CAV Plan
- U.S. DOT Vehicle-to-Infrastructure (V2I) Reference Implementation
- U.S. DOT DSRC Standards Support
- Florida DOT Transportation Systems Management & Operations Program Support

- Florida DOT Automated Vehicle General Engineering Contract
- U.S. DOT ITS Strategic Plan
- Michigan DOT Truck Parking Information and Management System
- Miami-Dade Expressway Authority Connected Vehicle Program Support
- Central Florida Expressway Authority CAV Plan
- U.S. DOT Connected Vehicle Test Bed Operations Management Support
- Safety Pilot Connected Vehicle Model Deployment
Tampa Connected Vehicle Pilot

- Multi-modal suite of applications collocated at intersections
- Bus, streetcar, vehicle, pedestrians and bikes
- Expressway and arterial streets
SPaT Challenge

32 States Committed
Number of states committed to respond to SPaT Challenge.

216 Signals Operating
Current number of operating signals. Number of signals planned for 2018, 2019, and 2020+.

2,036 Signals Planned
Connected Vehicles in NYC

- Urban canyon, tunnels, reflectivity of buildings create challenge for GPS
- NYC pilot showed UWB is needed to provide better location accuracy in the city
- Lane level accuracy needed for most applications
- Automated vehicle applications need 5-10 centimeter accuracy

Source: USDOT
Lincoln Tunnel Exclusive Bus Lane (XBL) Automation

Eastbound Lanes
To NYC

Westbound Lanes
To NJ

Contra-Flow Lane

Limits of X

XBL Bus Only Access Ramps

Eastbound Lanes

Westbound Lanes
Automated Vehicles and Automated Highways

- PC Control Computer
- Vehicle to Vehicle Communication System: (With Accelerometer & Gyro)
- Vision/Lidar/Radar
- SAE Level 2 Steering Actuator
- Mobileye System in the cab
- OnGuard Active Throttle & Braking Actuator
- Uber self-driving car
- Speedometer showing 74 mph, 40.0 mpg, 8,740.2 miles, and 63°F
NYC Smart Cities

• Provide centimeter location accuracy in urban canyon and tunnels
  – Enhanced CV applications
  – Improved logistics
  – Improved mobile applications
  – Automated vehicle applications

• Projects include
  – Open Road Tolling on all tunnels and bridges
  – CV citywide deployment
  – NYC Fleets Telematics Deployment
  – Exclusive Bus Lane (XBL) Automated Bus Deployment
  – MTA Subway Signal Modernization with UWB
  – Automated vehicles at airports
NYC CV Pilot use of Ultra-wideband

https://youtu.be/ZycoQmnNo18
Enhanced GPS vs UWB on 6th Ave
CBTC and Ultrawideband

High accuracy low latency UWB

Total Situational Awareness

On-board Equipment (OBE)

CV/UWB On-board Unit & Antenna

VOBC

Emergency Brake

Door Controller

Maintenance Bus

Advanced Cab Signaling Display

Train to Wayside Communication (Location/Signal-Switch Indications)

Train to Train Communication

Up/Down Stream Location Data

Co-location

UWB Wayside Transponder in Existing Lighting

Existing/New CBTC Zone Controller or Signals Field End Point

DSRC/CV Radio Wayside Unit

Total Situational Awareness

Situational Awareness

High accuracy low latency UWB
Industry Implementation of Micropositioning

- Sprint is Deploying as Part of 5G
- CV Vendor MAP message generation at intersections
- Automated Vehicle Position Accuracy
- GPS Deprived Locations
  - Indoors (Stations, Bus Garages, Maintenance Facilities)
  - Tunnels
  - Urban Canyons
**IoT Powered by**

5G Positioning

- 5G enables common time synchronization

- Cross-cutting: IoT positioning fuses ranges from diverse sensors

- No sole-source: Open, interoperable solution works across proprietary ranging sensors
Waitless Applications

Better wayfinding in cities

Deliver: Reduce urban “lost time” for drop-off to 2 minutes

Ridesharing: Reduce urban “lost time” for pickup from 10 to 5 minutes

Seamless cross-modal transportation

Parking Coordination
- Turn-by-turn directions to park
- Move cars out of congested areas
- 50% reduction in “circling”
- Increase lot utilization rates

Connected Vehicles
- Predictive braking
- Support Autonomy
- 40% reduction in congestion
- 50% reduction in accidents
- Pedestrian Safety applications

GPS enhancement
- Micro-positioning: worst case error of one half meter
DOT Coordination for Micropositioning

- Access to Traffic Signals
- Access to Fiber backhaul
- Access to Street Light Poles/Power
- Coordination on CV Deployments