Connected and Automated Vehicles:

Elements, Applications and Deployment Considerations

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Agenda

1. What are Connected and Automated Vehicles (CAV)?
2. Why is CAV an Emerging Technology Area?
3. Role of CAV in Safety and Mobility
4. CAV Applications
5. CAV Deployment Focus Projects
6. Research, Development, Deployment
1. What are Connected and Automated Vehicles?

Source: www.fia.com
What are CAVs?

- CAVs:
  - enable safe interoperable networked wireless communication among vehicles, infrastructure, and other modes
  - enable vehicles and infrastructure to "talk" to each other
  - with vehicle to everything (V2X), they enable communication among vehicles and pedestrians, bicyclists, and other vulnerable road users
CAV V2X Communications

• Vehicle to Vehicle (V2V)
  - Vehicles sharing information with other vehicles
  - Wireless communication via DSRC 5.9GHz
  - Share basic safety messages (BSM) and basic information messages (BIM)

• Vehicle to Infrastructure (V2I)
  - Vehicles sharing road conditions, safety messages, etc. with infrastructure
  - Wireless communication via DSRC or Cellular
  - Share Traveler Information Messages (TIM) and advanced incident alerts

• Vehicle to Everything (V2X)
  - Vehicles sharing road conditions with other connected devices
  - Mainly uses cellular communications
2. Why CAV an Emerging Technology Area?

Source: www.fia.com
Why CAV?

- CAV enables
  - Crash prevention
  - Safety, mobility, and environmental benefits
  - Continuous real-time connectivity to system users

- Safety
  - CAV could prevent 80% of not-impaired driver crashes
  - 99% of crashes are caused by human error, and could be prevented with CAV
  - Potential to reduce pedestrian and bicyclist crashes

- Use of data and its potential benefits in safety and operation are being evaluated via pilot projects
3. What is the role of CAV in Safety and Mobility?

Source: www.fia.com
Why CAV?

• Mobility
  - Intelligent signals
  - Bicyclist-Pedestrian operation
  - Transit signal priority
  - Freight signal priority
  - Emergency vehicle pre-emption

• Other areas
  - Commercial vehicle operations
  - Data management
  - Maintenance and construction
  - Parking management
  - Transit operations
  - Weather
CAV Initiative

- Focus area in FDOT’s TSM&O Strategic Plan
- CAV leverages existing ITS systems with
  - Safety benefits – Vision Zero
  - Operational benefits – less congestion, reliable travel times
- Florida is 2\textsuperscript{nd} in the nation in bike-ped fatalities
- Bike-ped fatalities account for ~25\% of all fatalities
- CAV holds promise to improve bike-ped safety
Turner Fairbanks Pedestrian Application
4. CAV Applications

Source: www.fia.com
CAV Equipment

- **Roadside Units (RSUs)**
  - Installed on infrastructure side
  - Uses DSRC or cellular communications
  - Broadcasts information in a pre-set target zone
  - Provides Traveler Information Message

- **On-board Units (OBUs)**
  - Devices installed inside the vehicle
  - End user interface
  - Communicates with DSRC or cellular
  - Provides BSM and BIM
CAV Security

• Security Credential Management System (SCMS) is a Proof of Concept (PoC) message security solution for V2V and V2I communication

• SCMS uses trust certificates that makes exchange of information secure and trustworthy between:
  ▪ Connected vehicles
  ▪ Roadway infrastructure
  ▪ Traffic management centers
  ▪ Wireless mobile devices

• SCMS provides:
  ▪ Integrity
  ▪ Authenticity
  ▪ Privacy

Note: CA = Certification Authority; ICA = Intermediate Certification Authority; OBU = On-board Unit; RSU = Roadside Unit; PCA = Pseudonym Certification Authority
CAV Mobility Applications – Examples

- **Traffic Signal System**
  - Uses vehicle information to adjust signal timing

- **Signal Phase and Timing (SPaT)**
  - Provides SPaT data to vehicles and receives basic safety messages

- **Traffic Signal Control**
  - Provides the equipment and communication links that support traffic control at signalized intersections
  - Converts fixed-schedule control systems to fully traffic responsive systems
CAV Mobility Applications – Examples

• **Freight Signal Priority**
  ▪ Provides traffic signal priority for freight and commercial vehicles traveling in a signalized network
  ▪ Reduces stops and delays to increase travel time reliability for freight traffic

• **Transit Signal Priority**
  ▪ Allows a transit vehicle to request priority at intersections
  ▪ Improves operating performance of the transit vehicles by reducing the time spent stopped at a red light
CAV Safety Applications – Examples

- **Emergency Vehicle Preemption**
  - Covers both traditional signal preemption systems and *new systems* based on CAV technology
  - **Clears queues and holds conflicting phases** for emergency vehicles at intersections

- **Queue Warning**
  - Enables vehicle within the *queue event to automatically broadcast* their queued status information to nearby upstream vehicles and to TMC
  - Helps *minimize secondary crashes*
CAV Safety Applications – Examples

• **Dynamic Roadway Warning**
  - Includes systems that *dynamically warn drivers* approaching hazards on a roadway
  - *Alerts approaching drivers* via warning signs, flashing lights, in-vehicle messages, etc.

• **Active Traffic Management**
  - *Variable Speed Limits*: limits speed along a roadway to create more uniform speeds, to promote safer driving behavior during adverse weather conditions
  - *Dynamic Lane Management and Shoulder Use*: provides *active management of travel lanes and shoulder* to improve mobility and safety
5. CAV Deployment Focus

Source: www.fia.com
Connected vehicles (CAV)
- 16 CAV projects in development and planned statewide, to date
- Signal Phase and Timing (SPaT),
- Dedicated short-range communication (DSRC)
- Pedestrian safety systems

Connected Vehicle Website:
CAV Initiative Progress

- US 90 SPaT deployment in progress
- Gainesville SPaT Trapezium RFP finalized
- Bike-Ped Safety project on UF Campus
- District 5 ATCMTD Grant Awarded
- University of Florida (UF) I-STREET Test Bed
- Data Sharing Agreement
US 90 Signal Phase and Timing (SPaT) Pilot Project

- 22 signalized intersections along US 90 (Mahan Drive) in Tallahassee
  - FDOT and City of Tallahassee Partnership
  - City to install
- Pre-deployment testing at the Traffic Engineering Research Laboratory (TERL)
- Deployment to complete Feb 2018
- Florida State University (FSU) to perform before and after evaluation
US 90 Signal Phase and Timing (SPaT) Deployment
SPaT Pilot Project – Pre-Deployment Testing
US 90 SPaT Deployment
I-75 FRAME Update

District 2 Update
• Systems Manager was selected
• Current Production Date: 3rd Q of 2018

District 5 Update
• Systems Manager was selected
• Current Production Date: 1st Q of 2019

Seamless Integration/Combined Effort
• Testing coordination complete
• Vendor meetings
• Mock set-ups
• Data collection/survey underway
Gainesville SPaT Trapezium Project

- RFP for deploying CAV technologies on 27 signals along four corridors forming a trapezium around UF campus:
  - University Avenue; SW 13th Street; Archer Road (NE SR 24); SW 34th Street
- RFP being developed in collaboration with the City of Gainesville and UF
- Potential technologies to deploy and test
  - Roadside Units
  - On-board Units
  - Web-based and/or smartphone app for ped and bike safety
  - Two-way communications: RSUs and OBUs
District 5 ATCMTD Grant

- Received the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant.
- Requested $11.9 million
- Three program areas:
  - PedSafe
  - GreenWay
  - Smart community
Bike-Ped Safety Project on UF Campus

- FDOT applied for 2017 Accelerated Innovation Deployment (AID) Demonstrationgrant application
- UF and City of Gainesville connected vehicle pilot project
Tampa Hillsborough Expressway Authority (THEA)

- THEA participating in USDOT CV Pilot
  - Currently in implementation phase
- 10 CV and traffic operation/safety improvement applications
  - > 40 RSUs
  - > 1,600 OBUs
  - > 500 smartphone app users
6. Research, Development, Deployment
University of Florida I-STREET

I-STREET = Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies

- **Purpose:** to provide a real-world Test Bed facility where FDOT can collaborate and assist the industry to demonstrate and evaluate a wide range of connected vehicle solutions.

- **Goal:** to test and evaluate different technologies and solutions within the areas of safety, mobility, and data management.

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**Goal Areas**
- Safety
- Mobility
- Data Management

**Partners**
- FDOT
- UF
- City of Gainesville

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R&D – Transferring Lessons Learned to Practice

• Develop a statewide CAV deployment plan and perform time-bound implementation
• Develop training and outreach materials
• Educate general public on CAV on the roads and their benefits
• Partner with universities to provide education on CAV design and operation
• Fund operations and maintenance of the CAV equipment especially on arterials
• Identify private partners for data sharing and pilot implementation
• Identify private partners for cellular communication deployment in lieu of data and right-of-way sharing
• Develop data security and SCMS plan ahead of time
• Develop and implement data management plan
• Upgrade signal and infrastructure to IPv6
In Summary

• Florida’s CAV Initiative is an ongoing effort and is focused on deployments with support of research and development

• Implementation challenges are listed as a way to understand and mitigate risks while exploring the institutionalized leadership at FDOT as an Opportunity to advance CAV

• Industry interaction is key to FDOT’s CAV program.

• Research and development has become the central element to assist with projects

• CAV for Safety and Mobility; Deployments
Thank you

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