CAV Technology Foundations & State DOT Implementation

Breakout Session #1: 9:20 AM - 10:00 AM | March 14, 2019
Presented by: Maureen Paz de Araujo, FAICP CTP CEP
International Trends: CAV Preparedness

- The Netherlands - #1
  - Policy – 3
  - Technology/Innovation – 4
  - Infrastructure – 1
  - Consumer Acceptance – 2

- Japan - #11
  - Policy – 12
  - Technology/Innovation – 7
  - Infrastructure – 3
  - Consumer Acceptance – 16

International Trends: Preparedness Details

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- **The Netherlands - #1**
  - Policy/Legislation – 3
  - Technology/Innovation – 4
  - Infrastructure – 1
  - Consumer Acceptance – 2

- **United States - #3**
  - Policy/Legislation – 10
  - Technology/Innovation – 1
  - Infrastructure – 7
  - Consumer Acceptance – 4
National Trends: CAV Testing & Deployment

- States Passed Legislation Allowing CAV Testing and/or Deployment (29)
  - Enacted Legislation (25)
  - Executive Orders (4)
  - Both Legislation and Executive Orders (4)

Source: Governor’s Advisory Council on Connected & Autonomous Vehicles Executive Report, MnDOT, December 2018.
States Allow Truck Platooning on Public Roads (23)

- Platooning Allowed (23)
- Limited Commercial Deployment (4)
- Platoon Testing Allowed (3)
- Legislation Pending (2)

Currently 23 states allow truck platooning on public roads. Platooning laws typically allow vehicles with truck platooning technology to follow closer than the minimum following distance allowed in law.

Source: Governor’s Advisory Council on Connected & Autonomous Vehicles Executive Report, MnDOT, December 2018.
Connected Vehicle Pooled Fund Study

PROGRAM TO SUPPORT THE DEVELOPMENT AND DEPLOYMENT OF CONNECTED VEHICLE APPLICATIONS

- Arizona DOT
- Caltrans
- Colorado DOT
- Connecticut DOT
- Delaware DOT
- FHWA
- Florida DOT
- Georgia DOT
- Idaho DOT
- Maryland DOT
- Michigan DOT
- Minnesota DOT
- Mississippi DOT
- New Hampshire DOT
- New Jersey DOT
- New York DOT
- Ohio DOT
- Pennsylvania DOT
- Tennessee DOT
- Texas DOT
- Transport Canada
- New Jersey DOT
- New York DOT
- Ohio DOT
- Washington DOT
- Wisconsin DOT
- UVA Transportation Research Center
- Virginia DOT
Colorado | Smart 70

CDOT – PANASONIC: I-70 MOUNTAIN CORRIDOR PARTNERSHIP

Colorado | Vehicle Ecosystem

V2X | C-V2X Connectivity

Colorado | Vehicle Ecosystem

HERE | C-V2X & CLOUD-BASED ANALYTICS

A Partnership of CDOT, QUALCOMM, Ford Motor Company & Panasonic
INTERNET OF ROADS

- Stage 1 Timeline: 2019-2022
- 14 Corridors: 500+ miles
- Ready for Automaker Rollout
- Smart Systems Approach
- Aligns with V2X timeline
Colorado | DAISy

DATA INTELLIGENCE SYSTEM (DAISy) IS A CLOUD-BASED DATA ANALYTICS PLATFORM THAT BRINGS:

- Near-term intelligence, efficiency and interoperability of existing network
- Long-term enablement of world-leading automated transportation systems

- Internet of Roads improves safety and efficiency
- Smart Mobility uses data to apply technology
- Data Intelligence enhances safety and operations
MANAGED ROADWAY PILOT

- Upgrade 19 ramps along northbound I-25 in metro Denver
- Connects freeway operations to ramp metering systems for coordinated entrance of vehicles to keep interstate flowing
- Technology partnership with Australia with cloud-based traffic management; first in U.S.; reduces congestion without adding lanes
2,600 Submissions
10 Routes Selected
4 U.S. Routes
- Chicago - Columbus - Pittsburgh
- Cheyenne - Denver - Pueblo
- Dallas - Laredo - Houston
- Miami - Orlando
SOUTHEAST MICHIGAN CONNECTED VEHICLE ASSETS

MDOT’s CV infrastructure investments are key to creating an environment supportive of V2I testing.

MDOT's Data Use Analysis and Processing (DUAP) program is pioneering the collection and fusion of CV data with a wide range of data sources.

TRUCK PARKING INFORMATION & MANAGEMENT SYSTEM (TPIMS)

WORK ZONE WARNING - MANAGEMENT

Michigan | Partnerships

M O B I L I T Y
TRANSFORMATION CENTER

Photo Courtesy of the University of Michigan.
PUBLIC OUTREACH

- Automated Shuttle Demonstrations
- CAV Strategic Plan Outreach

Source: Governor’s Advisory Council on Connected & Autonomous Vehicles Executive Report, MnDOT, 12-2018.
MINNESOTA | CAV INITIATIVES

RESEARCH AND TESTING

- Cold Weather Testing
- Connected Corridor (Trunk Highway 55) Interstate 494 to Minneapolis
- Connected Corridor (Trunk Highway 52) St. Paul to Rochester
- Private Industry R & D: VSI Labs, 3M’s Connected Roads, Polaris CAV Technologies

Source: Governor’s Advisory Council on Connected & Autonomous Vehicles Executive Report, MnDOT, December 2018.
INNOVATIVE PARTNERSHIPS

- Strategic Visioning
  - MnDOT, Hennepin County, Metropolitan Council and the McKnight Foundation to host a two-day strategic visioning workshop on automated vehicles in June 2018.

- Information Sharing
  - Minnesota County Engineers Association, Minnesota Guidestar and ITS Minnesota

- Regional and National Sharing
  - MnDOT and other state and local agencies are collaborating with other states in “pooled fund” studies to research CAV technology.

- Innovative Procurement and Ideas

Source: Governor’s Advisory Council on Connected & Autonomous Vehicles Executive Report, MnDOT, December 2018.
Virginia | CV Test Beds

NO RTHERN VIRGINIA

“Urban” Test Bed Features:

- High-operating capacity roadways (I-66, I-495, U.S. 29, and US 50)
- Recurring congestion
- Top 25 “crash hot spots”
- 49 roadside units (RSUs) located within Northern Virginia test bed

VIRGINIA SMARTROADS – BLACKSBURG, VA

Smart Roads Test Bed Features:

A controlled, “laboratory” environment that allows CV applications to be developed and proven safely before they are deployed on public roadways.

Virginia | V2X Infrastructure

VCC CLOUD

- Centralized System - To manage CV message traffic
- Connected Vehicles - Connect to VCC Cloud via cellular or DSRC communications
- Interfaces - Pull traffic, incident, weather and dynamic message sign data from VDOT data-sharing website

DEDICATED SHORT RANGE COMMUNICATIONS (DSRC)

- 64 Roadside Units (RSUs) - Located throughout the Northern Virginia Test Bed
- 10 Roadside Units - On the Virginia Smart Roads
- 45 Arterial/Intersection RSUs – Cohda MK5, located on arterials
- 19 Freeway RSUs - Cohda MK5, located on the freeways

Virginia | Deployed Vehicle Fleet

CONNECTED VEHICLE FLEET

- Fleet of 50 Vehicles - Highly instrumented light vehicles was deployed within the Northern Virginia Test Bed
- Level 2 Automation - Vehicles with features such as adaptive cruise control and lane-keeping assist
- Instrumented with Data Collection Equipment - To capture video of the vehicles’ automation features at work as well as driver responses

V2X (EVERYTHING) COMMUNICATIONS

- (V2V) Vehicle to Vehicle
- (V2I) Vehicle to Infrastructure
- (V2P) Vehicle to Pedestrian
Panasonic | Vehicle Technology

ADAS (ADVANCED DRIVER ASSISTANCE SYSTEMS)
 CONNECTED VEHICLES V2X COMMUNICATION TECHNOLOGY

V2X Communication System

New Driving Support System utilizing V2V (Vehicle-to-Vehicle), V2I (Vehicle-to-Infrastructure), and V2P (Vehicle-to-Pedestrian) wireless communication technology.

V2X Standards in US, EU and Japan

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<th>EU</th>
<th>Japan</th>
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<td>Frequency (channel)</td>
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<td>5.85 to 5.955 MHz (7 channels)</td>
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<td>Data rate</td>
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Specification of V2X Communication Unit

- Size: 48 x 225 x 50 mm
- Antenna port: V2X x 2, BIS x 1, CAN x 1, and ONS x 1
- Other interface: CAN, bus, Power
- Transmit power: 25 dBm, ETSI / 27 dBm (Japan)
- Input voltage: DC 12 V

Example Application

- A vehicle is approaching
- V2I: Crash avoidance
- Attention to incoming vehicle
- A pedestrian is approaching
- V2P: Alerting drivers
- Blind spot

Panasonic AUTOMOTIVE

Panasonic AUTOMOTIVE

Panasonic AUTOMOTIVE

CAV PREPAREDNESS - POLICY, TECHNOLOGY, INFRASTRUCTURE & CONSUMER ACCEPTANCE
C-V2X reduces cost of infrastructure deployment

Combined RSUs and 4G/5G small cell, benefiting from cellular network densification

Source: Accelerating C-V2X Commercialization, QUALCOMM, 2017. www.qualcomm.com
QUALCOMM | Connected Car Platform

Paving the road to tomorrow's autonomous vehicles
Offering essential technologies for the connected car platform

Autonomous car
Power optimized processing for the vehicle
Fusion of information from multiple sensors/sources

Unified connectivity with C-V2X
3D mapping and precise positioning
On-board intelligence

Source: Accelerating C-V2X Commercialization, QUALCOMM, 2017. www.qualcomm.com
On-board intelligence: C-V2X complements other sensors

Providing higher level of predictability and autonomy

ADAS
Advanced Driver Assistance Systems

Brain of the car to help automate the driving process by using:
- Immense compute resources
- Sensor fusion
- Machine learning
- Path planning

V2X wireless sensor
See-through, 360° non-line of sight sensing, extended range sensing

3D HD maps
HD live map update, sub-meter level accuracy of landmarks

Precise positioning
GNSS positioning, dead reckoning, VIO

Conclusions

- Smart Mobility is part of the “Industrial Revolution 4.0”
- The Timeline:
  - 2019 – 8 Billion devices are already “connected” - There are now more devices than there are people
  - 2020 – 20 Billion connected devices
  - 2050 – “Trillions” of connected devices predicted
Conclusions

- The infrastructure in the electronics realm is already “Part of the Economy” so it is not hard to envision that:
  The “Physical Infrastructure” and the “Electronic Infrastructure” will soon become unified into “Smart Countries” versus “Developing Countries”.
- Response on all fronts (Government, Academic, Ethics and Business, etc.) is already part of the equation.
- Our profession ignores this new “Organization of Society” at great peril.
Thank You

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Senior Transportation Planner
Wilson & Company

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