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SCIENCES · ENGINEERING · MEDICINE

TRANSPORTATION RESEARCH BOARD

State & Local Deployments of Connected & Automated Vehicle Infrastructure

June 21, 2021

@NASEMTRB
#TRBwebinar

PDH Certification Information:

- 2.0 Professional Development Hour (PDH) – see follow-up email for instructions
- You must attend the entire webinar to be eligible to receive PDH credits
- Questions? Contact Reggie Gillum at RGillum@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

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RCEP

REGISTERED CONTINUING EDUCATION PROGRAM

Learning Objective

Identify methods and frameworks to conside CAVIS within standard procurements

APA Credits

- This webinar is eligible for 2.0 AICP credits

- Log into the APA website after the webinar to claim your credits

#TRBwebinar

CAVIS Program Development and Deployment Example in Alabama

Shashi Nambisan, Ph.D., P.E.
Director, Transportation Research Center
Professor of Civil Engineering
University of Nevada, Las Vegas

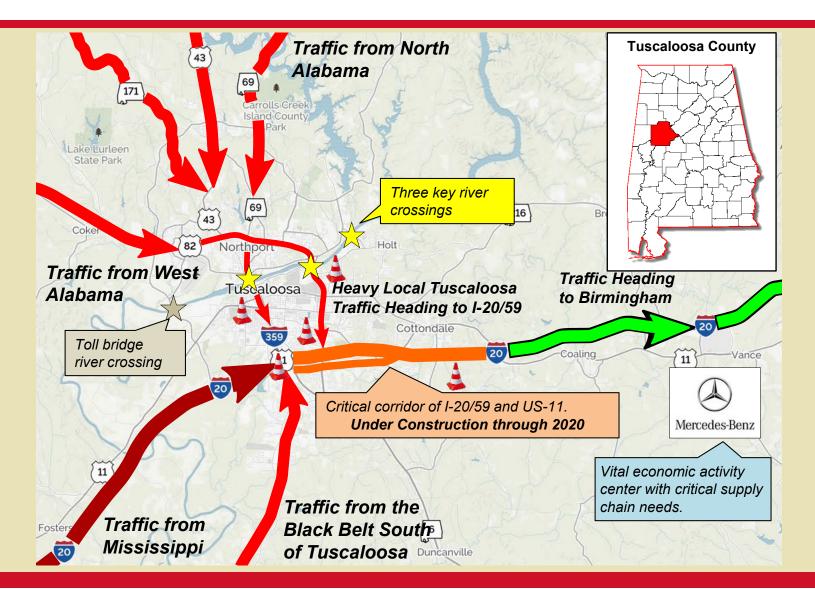Alex Hainen, Ph.D.
Associate Professor
The University of Alabama

The University of Alabama
Alabama Transportation Institute

University of Nevada, Las Vegas
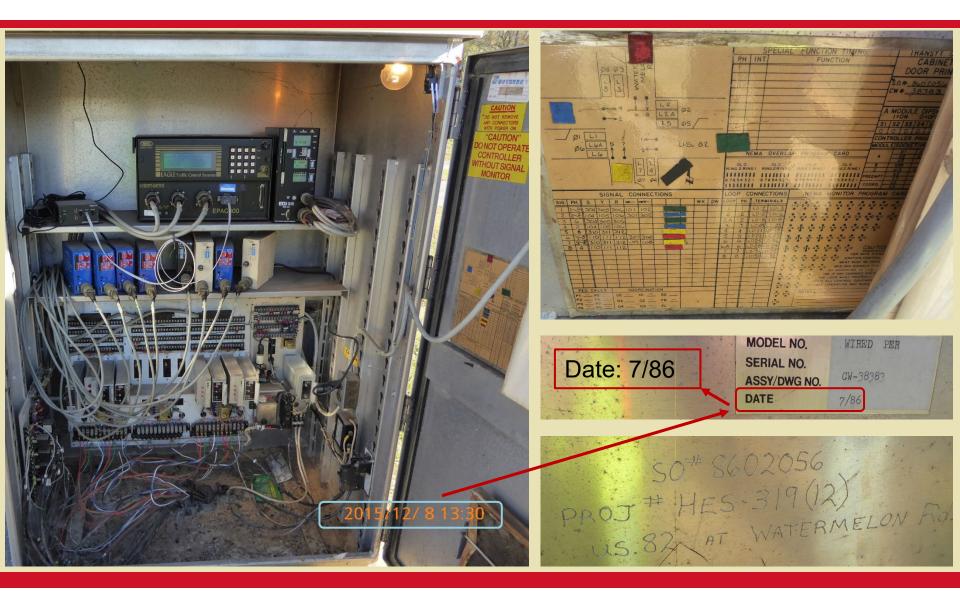Transportation Research Center

Introduction

- Economic growth
- Growing needs
  - Private sector, traveling public
  - Passenger, freight
- Legacy systems
  - Hardware, software, communications, operating procedures
- Opportunity for transformational change
- Challenges
  - Funding
  - Personnel
  - Return on Investment expectations

Motivation / Need

Traffic from North Alabama

Tuscaloosa County

Three key river crossings

Traffic from West Alabama

Heavy Local Tuscaloosa Traffic Heading to I-20/59

Traffic Heading to Birmingham

Toll bridge river crossing

Critical corridor of I-20/59 and US-11. **Under Construction through 2020**

Mercedes-Benz

Vital economic activity center with critical supply chain needs.

Traffic from Mississippi

Traffic from the Black Belt South of Tuscaloosa

Ripe for Upgrades: TS1 Tech from 1986-1993

Date: 7/86

2015/12/ 8 13:30

Opportunities

- Leverage resources
  - Local, state, and federal investments
  - Private sector contributions
- Build upon projects envisioned
  - State
  - Local
- Expand impacts of investments
- Harness technology
  - DSRC, CV2X, CV2N
  - Sensors and sensor networks
    - In vehicle: limited market penetration
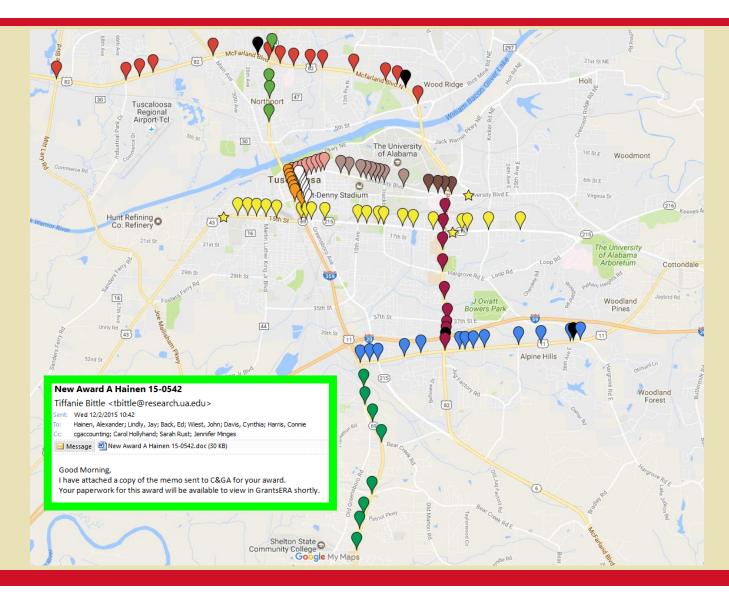   - Mobile phones: ubiquitous
- CAVIS

Process

- Collaborations and partnerships
- Build a program: integrate critical projects
- CAVIS
  - Urban roads
  - Freeways
  - *Public transit*
- Federal Programs
  - ATCMTD
  - BUILD
  - INFRA

Background: Initial Project (2015)
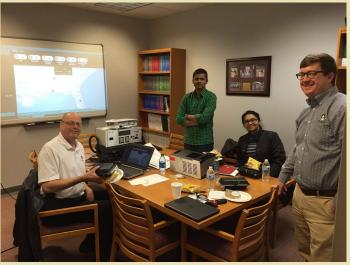
Training, Planning, and Installing (2015)
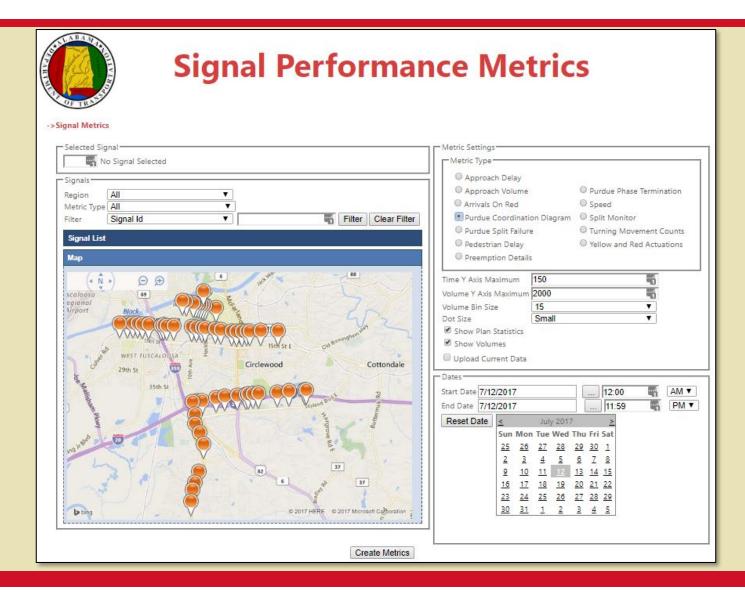
Results and Initial Success (2017)

US11	16:30	18:30	Before	SPM1	SPM2	SPM3		
LINK	FROM	TO	2/1/2017	3/9/2017	3/23/2017	5/11/2017	Difference	Improvement
1	SR-69S	Old Greensboro	40	48	47	49	9%	23%
2	Old Greensboro	Greensboro	47	66	65	67	20%	43%
3	Greensboro	Overhill	58	60	61	73	15%	26%
4	Overhill	3rd	76	89	90	89	13%	17%
5	3rd	McFarland	51	54	54	64	13%	25%
6	McFarland	Sams Club	48	58	59	72	24%	50%
7	Sams Club	Andrews	78	69	70	80	2%	3%
8	Andrews	Ervins	69	86	89	91	22%	32%
9	Ervins	18th	86	90	92	85	-1%	-1%
10	18th	26th	72	74	72	79	7%	10%
11	26th	31st	64	72	74	70	6%	9%
12	31st	36th	62	71	67	67	5%	8%
						Average	11%	20%

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Deploying DSRC & CV2N (2017)

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Continued Connected Vehicle Testing (2018+)

UA & ALDOT: Planning Future Projects (2017)

UA & ALDOT: ATCMTD Discussions (2017)

ALDOT RTMC Phase I on UA Campus (2017)

Continued Interest / Support (2017+)

ALDOT RTMC Phase II on UA Campus (2018)

ATCMTD Proposals 2017-2018

West Central Alabama ACTION

Advanced Connected Transportation Infrastructure and Operations Network
Improving Efficiency, Capacity, and Safety through Technology Deployment

Project Name	Advanced Connected Transportation Infrastructure & Operations Network (ACTION)	State(s) in which the project is located	Alabama	Technologies Proposed to be Deployed (briefly list)	Fiber optic communications, deep-learning camera detection and monitoring algorithms, DSRC radios, cellular communications, advanced data-logging traffic controllers, active signal control, wireless vehicle detection, traffic management centers, traveler information systems, cable median crash sensors, crowdsourced probe data, end-user mobile apps
Eligible Entity Applying to Receive Federal Funding	The University of Alabama	Is the project currently programmed in the: • Transportation Improvement Program (TIP) • Statewide Transportation Improvement Program (STIP) • MPO Long Range Transportation Plan • State Long Range Transportation Plan	Yes, the components contained within the ACTION initiative enhance projects identified in the TIP, STIP, regional MPO, and long range ITS roadmap for Alabama. The ACTION initiative unifies these efforts within the region and advances the deployment efforts to meet the needs of the rapidly growing area.		
Total Project Cost	$16,876,921				
ATCMTD Request	$8,034,003				
Are matching funds restricted to a specific project component? If so, which one?	No				

ATCMTD Initiative Application – Volume 1 | June 2019 (Revised)   The University of Alabama

FHWA Home | Feedback

U.S. Department of Transportation
Federal Highway Administration

OFFICE OF OPERATIONS   Drop Down Menu: Program Areas   Go

21ST CENTURY OPERATIONS USING 21ST CENTURY TECHNOLOGIES

FY 2018 Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Project Awards

Awards

Advanced Connected Transportation Infrastructure & Operations Network (ACTION)
University of Alabama
Award: $8,034,003
The funds will be used to deploy advanced technologies – including camera, communications, sensor, and data-collection technologies — on roadways in and around Tuscaloosa.

Testing Prototype Technologies (2019)

EVEN MORE Technology Testing (2019)

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ITSA: Peer Exchange (2019)

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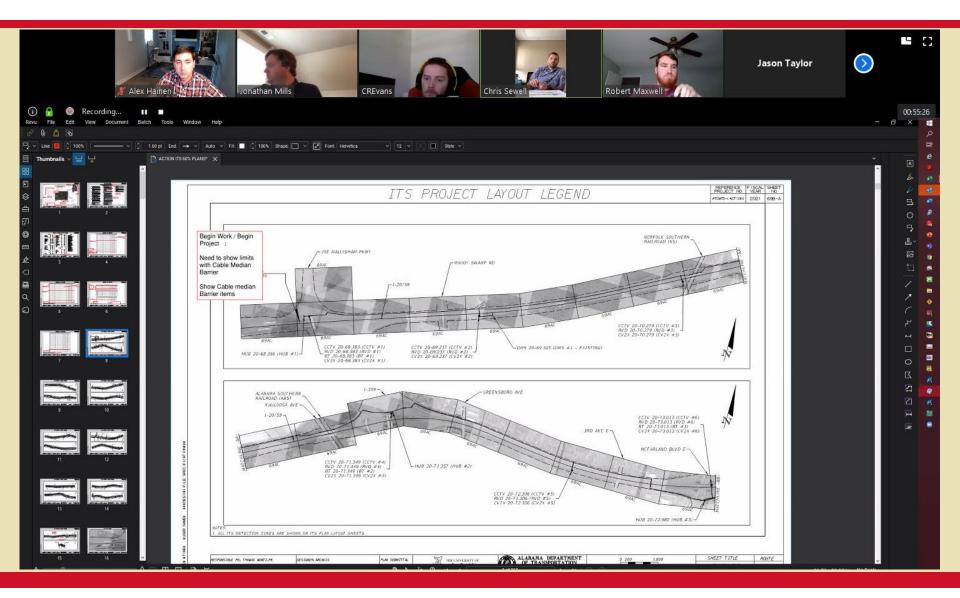
Learning from Others: WyDOT I-80 / AI (2020)

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Design Process: 8 HR Zoom (2020)

Flexibility! DSRC? What's next? (2020+)

- FCC ruling on 5.9 GHz
- DSRC
  - Limited fleet penetration
- CV2X, CV2N, Mobile phones
  - Ubiquitous
  - Accessible
  - Accelerate benefits
  - Equity
  - Vulnerable road users
- Infrastructure sensors
- Multiple uses
- Flexibility

FCC NEWS from the Federal Communications Commission

Media Contact:
Will Wiquist, (202) 418-0509
will.wiquist@fcc.gov

For Immediate Release

FCC MODERNIZES 5.9 GHz BAND FOR WI-FI AND AUTO SAFETY

New Plan Makes Additional Spectrum Available Immediately for Improved Indoor Wi-Fi Connectivity While Authorizing Market-Driven Transportation Safety Services

WASHINGTON, November 18, 2020—The Federal Communications Commission today adopted new rules for the 5.9 GHz band (5.850-5.925 GHz) to make new spectrum available for unlicensed uses, such as Wi-Fi, and improve automotive safety. Specifically, the new band plan designates the lower 45 megahertz (5.850-5.895 GHz) for unlicensed uses and the upper 30 megahertz (5.895-5.925 GHz) for enhanced automobile safety using Cellular Vehicle-to-Everything (C-V2X) technology.

Focus on Traffic! Infrastructure Control (2020)

Keep Improving: 2nd Generation (2021)

Other ALDOT Need: CV Freight Priority (2021)

Goal: Traffic Data on Common Platform (2022)

Conclusions / Takeaways

- Partnering
  - Stakeholders
  - State, County, City agencies (DOT)
  - MPO
  - Vendors
  - Manufacturers
  - Consultants (RTOP)
- Balancing research needs with immediate needs
- Adapting to disruptive technology
  - Radios: DSRC / CV2X / CV2N / 900MHz
  - Emerging data sources: Probe data
- Keep working / tinkering!
  - Persistence: Multiple project / program proposals (ATCMTD)
  - Other opportunities (DOE, NSF, NCHRP)
  - Innovation: Try new / wild ideas
  - Peer exchange: ideas, experiences, lessons learned, …

TEAM EFFORTS

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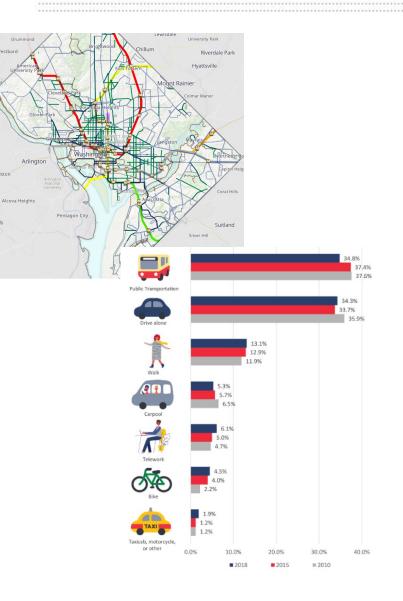
Urban CAV Deployments – DDOT's Perspective

TRB Webinar: Deploying Connected and Automated Infrastructure
June 21, 2021

DDOT's Approach

- Shaped by unique characteristics
  - Highly visible environment
  - High proportion of out-of-state travel
  - Many stakeholders
  - High non-vehicle mode share
  - Arterial roadway network

- Guiding principles
  - Strategic, goal-oriented planning and coordination
  - Limited physical infrastructure investment
  - Piloting before full-scale implementation
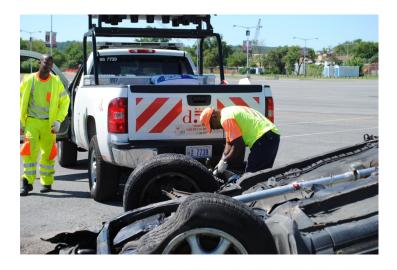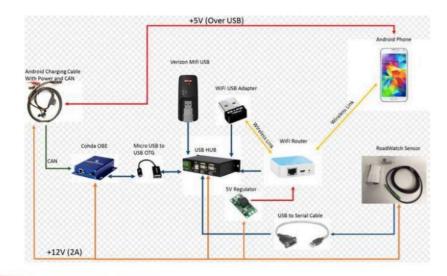
DEPLOYMENTS

Multi-Functional OBU

- Technology:
  - On-board units (OBUs) for five state safety patrol vehicles with V2V, V2I, AVL, pothole detection, and road surface temperature detection
- Procurement:
  - 2017 pilot
  - Funded through research program
  - Performed by university consultant in coordination with DDOT staff
  - Data integration into existing software systems performed by DDOT staff

SPaT Portal
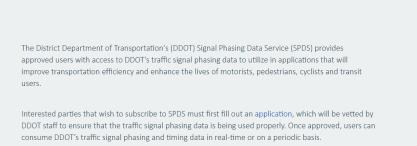
- Technology:
  - Portal includes API for real-time traffic signal data, shared with third parties who sign data use agreement
  - 600+ intersections, 4 third parties with access
  - Notable use case: "time-to-green" provided to drivers via in-vehicle display
- Procurement:
  - Stood up in early 2018 via in-house effort
  - Followed months of vendor and signal consultant discussions on functional requirements and testing
  - Follow up 2020 study explored value proposition, financial, policy, and institutional implications of continued investment, and peer agency approaches

Signal Phasing Data Service

Register   Log in

The District Department of Transportation's (DDOT) Signal Phasing Data Service (SPDS) provides approved users with access to DDOT's traffic signal phasing data to utilize in applications that will improve transportation efficiency and enhance the lives of motorists, pedestrians, cyclists and transit users.

Interested parties that wish to subscribe to SPDS must first fill out an application, which will be vetted by DDOT staff to ensure that the traffic signal phasing data is being used properly. Once approved, users can consume DDOT's traffic signal phasing and timing data in real-time or on a periodic basis.

For more information, please view this program's Terms and Conditions.

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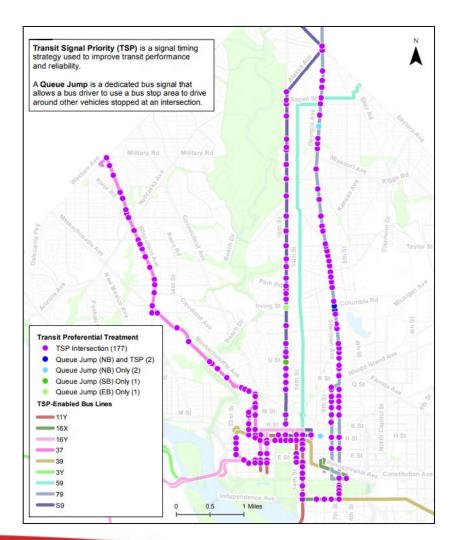
Transit Signal Priority

- Technology:
  - Cellular-based transit signal priority for buses on three corridors comprising 179 intersections
  - Up to 12% reduction in runtime on some segments, 4-7% decrease in runtime variability overall
- Procurement:
  - 2017
  - Testing, procurement, installation and ongoing evaluation in conjunction with WMATA
  - Evaluation biannually to refine system parameters and identify new opportunities
  - Upcoming procurement of 4G equipment to replace legacy 3G

Transit Signal Priority (TSP) is a signal timing strategy used to improve transit performance and reliability.

A Queue Jump is a dedicated bus signal that allows a bus driver to use a bus stop area to drive around other vehicles stopped at an intersection.

Transit Preferential Treatment
- TSP Intersection (177)
- Queue Jump (NB) and TSP (2)
- Queue Jump (NB) Only (2)
- Queue Jump (SB) Only (1)
- Queue Jump (EB) Only (1)

TSP-Enabled Bus Lines
- 11Y
- 16X
- 16Y
- 37
- 39
- 3Y
- 59
- 79
- S9

"Sandbox" for Pedestrian and Cyclist Safety

- Technology:
  - Demonstration of emerging technology solutions for pedestrian and cyclist safety in intersections, including
    - Technology that enhances agency situational awareness of intersection activity
    - Technology that provides auditory or visual alerts for pedestrians, cyclists, and/or drivers approaching crosswalks based on real-time activity in the intersection
  - Up to five vendors to demonstrate technology at a "sandbox" intersection or corridor
- Procurement:
  - Funded by research program
  - Consultant support established late 2020 for solicitation outreach, facilitation of incentive awards, facilitation of installation, maintenance, and removal, and evaluation
  - RFI to capture vendor solutions/interest closed June 2021
  - Approach envisioned as a way to quickly bring on multiple vendors to address specific agency need; hopefully first of many!

DC.gov Office of Contracting and Procurement

Solicitation Details

Solicitation:	DCKA-2021-I-0049
Caption:	Emerging Technology Solutions for Pedestrian and Cyclist Safety in Intersections
Subcontracting Requirement:	N/A
Status:	Open
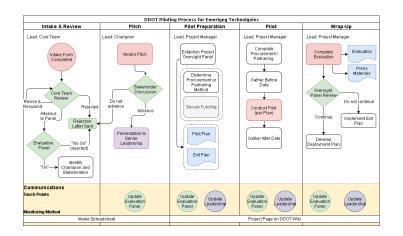
CHALLENGES AND LESSONS LEARNED

Challenges

- Procurement sometimes driven by political pressure, what "looks cool", rather than strategic approach
- Often fail to fully consider prior to procurement
    - Use cases
    - Inter-agency coordination
    - Infrastructure investment
    - Long-term maintenance
    - Evaluation
- Further exacerbated by staff capability and/or capacity
- Even non-traditional procurement is slow

Lessons Learned

- Other emerging technology solutions provide framework and insight for future CAV deployment
  - Dedicated pick-up/drop-off zones for use by transit, taxis, and TNCs
  - Demand-based parking
  - Personal delivery device and dockless vehicle permitting and operations
  - Probe vehicle data to inform planning and operational decision making
- Supportive programming and policy often more impactful than infrastructure
  - Pilot Evaluation & Screening – strategic, agency-wide approach for emerging technology pilots
  - AV Testing Program Rulemaking (Draft) – permitting process and framework for testing
  - Partnership with Ford/Argo – on-road testing, data exchange

Framework for CAV Deployments

**Preeti Choudhary, PE
AECOM**

TRB Webinar: Deploying Connected and Automated
Vehicle Infrastructure Systems (CAVIS)

6/21/2021

AGENDA

1 CAVIS Deployment Challenges

2 Framework Objectives

3 Framework Examples

4 Lessons Learned

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01 CAVIS Deployment Challenges
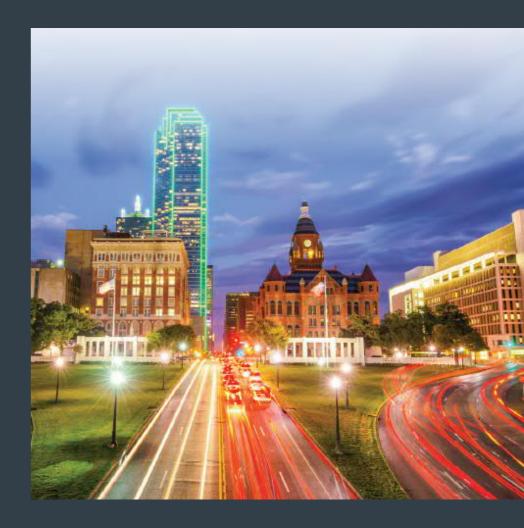
- Deployments typically occur on a **project-by-project basis**

- Lack of **institutional preparedness** (planning and deployment processes, procurement rules, staff to manage and support, training programs, etc.)

- Lacking **data management systems** to support for widespread, coordinated deployments

- **Funding** challenges

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02 CAVIS Framework Example Objectives

- Take steps to **institutionalize program**

- **Standardize processes** and documentation where possible (i.e., systems engineering, procurement contracts, partnership agreements)

- Promote **consistency and interoperability** across projects

- CAVIS **integration** into planning and operational processes

- Improve **agency readiness** for CAV efforts

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03 Framework Examples
Texas CAT Strategic and Program Plans

- Texas DOT (TxDOT) developed Cooperative Automated Transportation (CAT) Strategic and Program Plans to guide strategic long-term investment in technology initiatives

- Goals:

  - Provide foundation for policy and procedural decisions related to CAT

  - Prepare the institution for CAT project advancement

  - Ensure continuous alignment of future CAT initiatives

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- TxDOT's CAT Strategic and Program Plans established 8 focus areas based on a Capability Maturity Model assessment to reflect TxDOT's organizational and business functions

POLICY: Legislation, standardization, institutional culture and practices

FISCAL RESPONSIBILITY: CAT implications for TxDOT funding, revenues, and budgeting

COLLABORATION: Internal and external outreach, skill development and pursuing partnerships

INFRASTRUCTURE READINESS: Potential for the built environment to enable and enhance CAT

SYSTEMS READINESS: Potential for TxDOT digital and institutional systems to enable and enhance CAT

MULTIMODAL: Implications for CAT to impact travel of all manners and modes
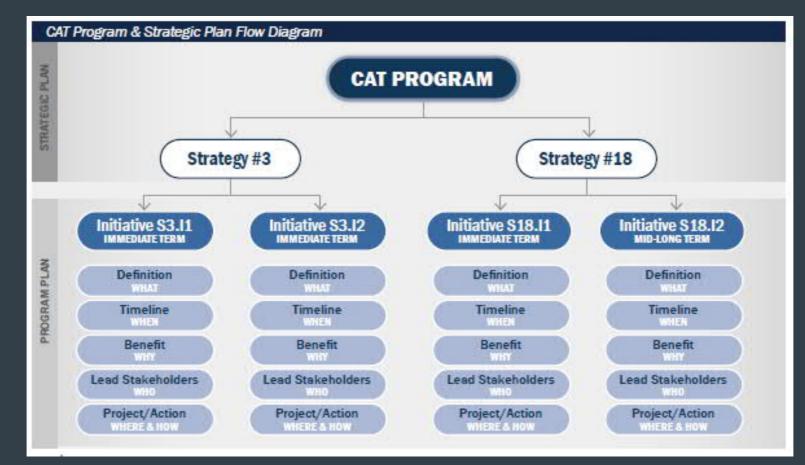
MAINTENANCE & OPERATIONS: CAT implications for TxDOT's day-to-day functions of traffic management, maintenance and operations

PROCUREMENT: Purchasing of goods and services necessary for CAT

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03 Framework Examples
Texas CAT Strategic and Program Plans
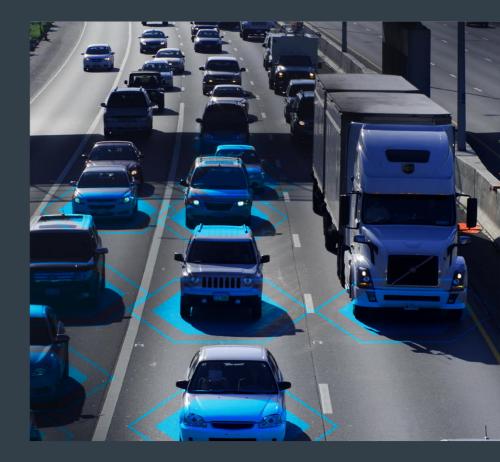
- Developed a roadmap to initiate institutional changes that support CAT Program

CAT Program & Strategic Plan Flow Diagram

03 Framework Examples
Ohio Statewide Framework for CV/AV Deployments
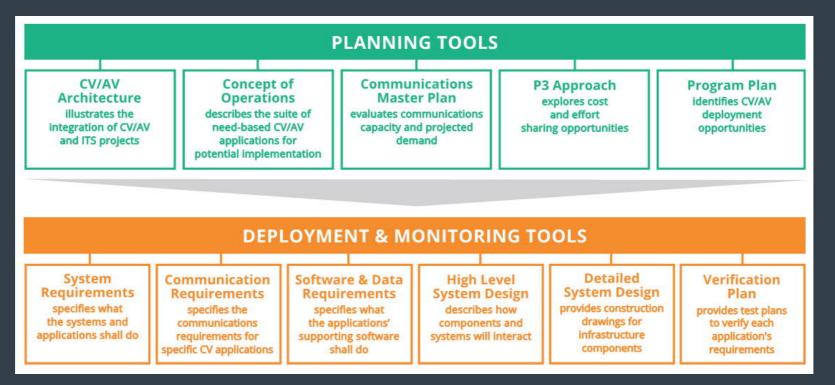
- DriveOhio is developing a first of its kind Statewide CV/AV systems engineering analysis framework to guide technology deployments

- Framework goals:

  ➢ Guide CV/AV project planning and deployment

  ➢ Provide resources that streamline required documentation

  ➢ Ensure all CV/AV projects are interoperable

03 Framework Examples

Ohio Statewide Framework for CV/AV Deployments

- Performed robust stakeholder engagement at project start to establish Statewide user needs for CV/AV projects

- Ohio's Statewide framework for CV/AV deployments will generate planning, deployment and monitoring tools

PLANNING TOOLS

CV/AV Architecture	Concept of Operations	Communications Master Plan	P3 Approach	Program Plan
illustrates the integration of CV/AV and ITS projects	describes the suite of need-based CV/AV applications for potential implementation	evaluates communications capacity and projected demand	explores cost and effort sharing opportunities	identifies CV/AV deployment opportunities

DEPLOYMENT & MONITORING TOOLS

System Requirements	Communication Requirements	Software & Data Requirements	High Level System Design	Detailed System Design	Verification Plan
specifies what the systems and applications shall do	specifies the communications requirements for specific CV applications	specifies what the applications' supporting software shall do	describes how components and systems will interact	provides construction drawings for infrastructure components	provides test plans to verify each application's requirements

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03 Framework Examples
Ohio Statewide Framework for CV/AV Deployments

- Identified CV/AV Project Development Workflow that builds on existing ODOT Project Development Process

- Developed CV/AV systems engineering review form to initiate project approvals process

1 Identify Primary Needs and Project Objectives
Identify needs and define candidate project(s) that meet those needs. Establish project goals and objectives based on the project needs.
- **Deliverables:** Listing of project needs, Listing of project objectives
- **ODOT PDP Phase:** Planning

2 Map needs to CV/AV applications
Refer to the Concept of Operations to see if project needs map to CV/AV applications. Evaluate whether CV/AV applications should be incorporated into project definition.
- **Deliverables:** Listing of project CV/AV applications
- **Reference document:** CV/AV Concept of Operations
- **ODOT PDP Phase:** Planning

3 Complete CV/AV Systems Engineering Review Form (SERF)
Complete SERF with the previously identified project objectives and project applications. Refer to the CV/AV Architecture to identify which Service Packages will be used for the project. Determine whether the project will be low-risk or high-risk.
- **Deliverables:** CV/AV SERF
- **Reference document:** Listing of project objectives, Listing of project CV/AV applications, CV/AV Architecture
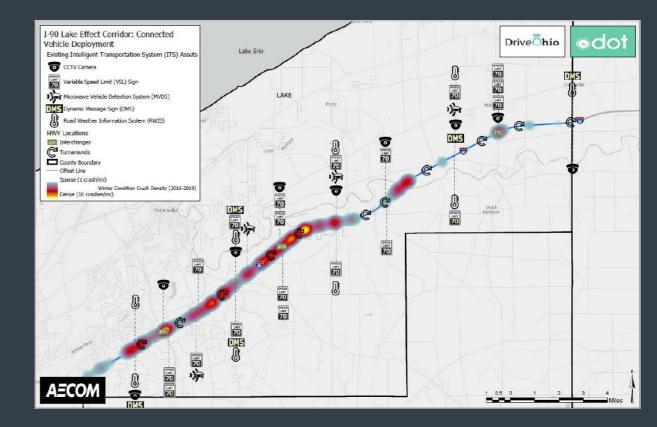- **ODOT PDP Phase:** Planning

3B Develop project-specific SEA documentation
Develop project-specific ITS architecture and concept of operations. Customize the CV/AV Architecture to complete a project-specific ITS architecture. Use the Concept of Operations (ConOps) Template to complete the project-specific ConOps. Refer to the CV/AV ConOps for general information.
- **Deliverables:** Project architecture and concept of operations
- **Reference document:** CV/AV Architecture, Concept of Operations Template, CV/AV Concept of Operations
- **ODOT PDP Phase:** Preliminary Engineering

4 Select relevant functional requirements
Refer to the CV/AV System Requirements to select project requirements that meet the project objectives.
- **Deliverables:** Initial draft of project requirements
- **Reference document:** CV/AV System Requirements
- **ODOT PDP Phase:** Preliminary Engineering

5 Refine requirements as needed
Review initial draft of project requirements. Revise, as necessary, to meet project objectives. Review proposed revisions with DriveOhio to obtain approval.
- **Deliverables:** Final project requirements
- **Reference document:** CV/AV System Requirements
- **ODOT PDP Phase:** Preliminary Engineering

6 Develop conceptual design
Review CV/AV System Requirements document and CV/AV High-Level System Design to identify the system components (hardware and software), interfaces and relevant standards needed to execute the project.
- **Deliverables:** Conceptual design document
- **Reference document:** CV/AV System Requirements, CV/AV High-Level System Design
- **ODOT PDP Phase:** Preliminary Engineering, Environmental Engineering (if needed)

7 Develop final design documents
Compile construction drawings relevant to the project from the CV/AV Standard Drawings. Develop or gather additional drawings, as necessary, that may specify local regulations or project-specific design needs.
- **Deliverables:** Final design documents
- **Reference document:** CV/AV Standard Drawings, ODOT Construction & Material Specifications
- **ODOT PDP Phase:** Final Engineering

8 Develop procurement and construction documentation
Develop procurement documents in coordination with ODOT/DriveOhio, which will include project final design documents.
- **Deliverables:** Project procurement and construction documents
- **Reference document:** Final design documents
- **ODOT PDP Phase:** Construction

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03 Framework Examples
Ohio Statewide Framework for CV/AV Deployments

- Developed project-specific systems engineering documents for sample Ohio CV project

- Provided opportunity to walk through workflow and document templates from user's perspective

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04 Framework Development Lessons Learned

- Build **support**
  - Put people and systems in place to work on framework development and implementation
  - Demonstrate meeting practical transportation challenges
- Promote **agility**
  - Do your best to accommodate evolving technology
  - Ensure traditional processes are not hindering technology procurement
- Make the framework **actionable**

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Thank you!

Contact

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13

ARTS
Automated Road
Transportation Symposium

June 21, 2021

History

ARTS is...

mission-driven to inform without bias and to engage participants across sectors, disciplines, and borders

Collaborative. Breakout sessions are intentionally participatory, to include contributions from the C-suite to the summer interns (and there is a student discount)

an **influential platform** for developing new ideas. Informed by science and research; attendees gain insight through discourse into the future of automated road transportation.

building annually with evolving discussions on access and equity, urban mobility planning, environmental impacts, artificial intelligence, and road vehicle automation technology issues

Program
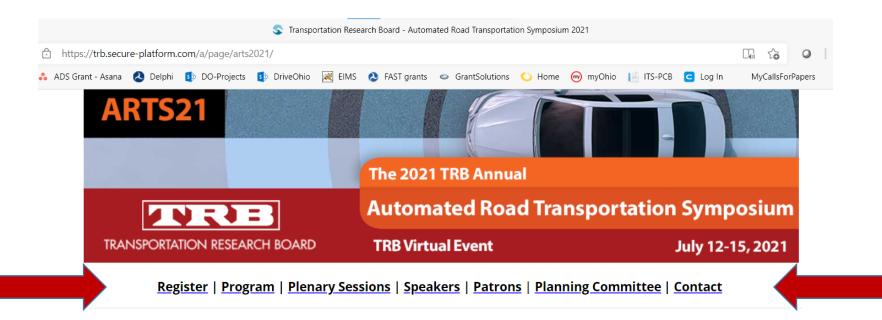
- Keynote Speakers
  - Secretary Pete Buttigieg, U.S. Department of Transportation
  - Honorable Robert L. Sumwalt, National Transportation Safety Board - Chairman
  - Chris Urmson, Aurora – Co-Founder and CEO
- Diverse Plenary Sessions
- 30+ Breakout Sessions
  - safety assurance
  - business developments
  - roadway operations
  - human factors
  - public acceptance
  - Trucking
  - Transit
  - Legislative
  - regulatory affairs
  - and more.

https://trb.secure-platform.com/a/page/arts2021/

ADS Grant - Asana | Delphi | DO-Projects | DriveOhio | EIMS | FAST grants | GrantSolutions | Home | myOhio | ITS-PCB | Log In | MyCallsForPapers

ARTS21

The 2021 TRB Annual
Automated Road Transportation Symposium

TRB TRANSPORTATION RESEARCH BOARD

TRB Virtual Event | **July 12-15, 2021**

Register | Program | Plenary Sessions | Speakers | Patrons | Planning Committee | Contact

Welcome!

Convened by TRB, the 2021 Automated Road Transportation Symposium (ARTS21) will be held July 12-15, 2021 online. It is the continuation of TRB's annual summer symposia on automated vehicle systems.

We are delighted to announce that ARTS21 keynote speakers will include US Department of Transportation Secretary Pete Buttigieg (invited), National Transportation Safety Board Chairman Robert Sumwalt, and Aurora Innovation CEO Chris Urmson. The full program of plenary speakers and 32 breakout sessions is being frequently updated and is shown on the Program tab on this webpage.

The 2021 TRB Annual
Automated Road Transportation Symposium

TRB TRANSPORTATION RESEARCH BOARD

www.trb.org/ARTS

Moderated by:
Matt Miller,
Texas A&M TTI

Kelli Raboy,
District DOT

Preeti Choudhary,
AECOM

Shashi Nambisan,
*University of
Nevada, Las Vegas*

Alex Hainen,
*The University of
Alabama*

Cynthia Jones,
DriveOhio, Ohio DOT

#TRBwebinar

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Be a Friend of a Committee bit.ly/TRBcommittees
– Networking opportunities
– May provide a path to Standing Committee membership

Join a Standing Committee bit.ly/TRBstandingcommittee

Work with CRP https://bit.ly/TRB-crp

Update your information www.mytrb.org