CONNECTED AND AUTONOMOUS VEHICLES:

AGENCY ROADMAP SHOWCASE & CONDUCTING A CAPACITY MATURITY MODEL SELF-ASSESSMENT

November 14, 2018

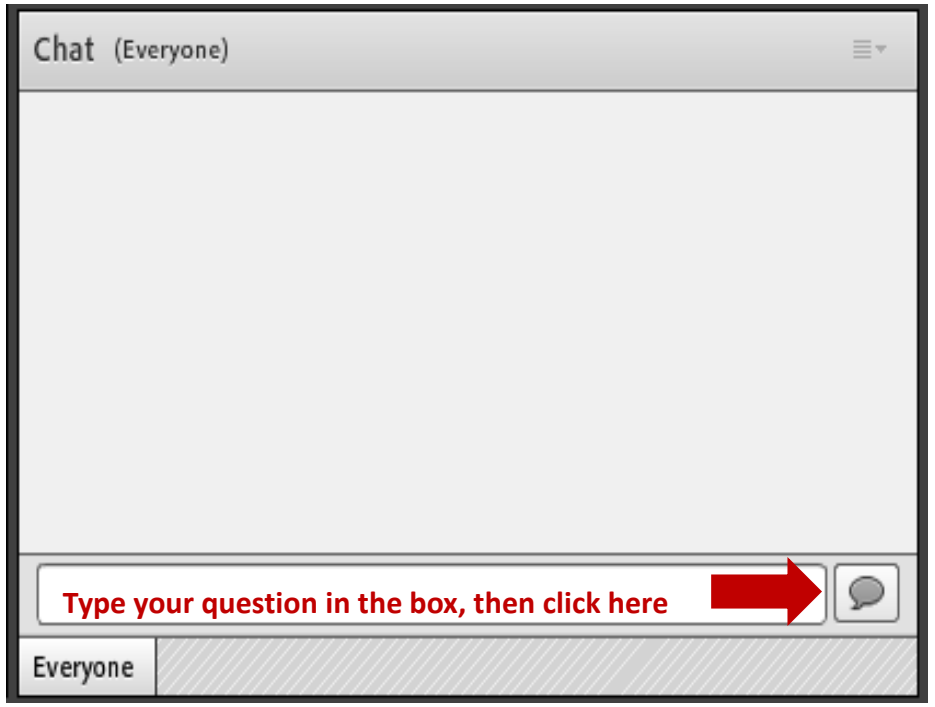
I - 95 CORRIDOR COALITION

Webcast and Audio Information

- The call-in phone number is: **x-xxx-xxx-xxxx & enter xxxxxxx# at the prompt**
- **Participants will be in "Listen Only" mode throughout the webinar**
- Please press *0 to speak to an operator for questions regarding audio
- Please call Justin (xxx-xxx-xxxx) for difficulties with the web or audio application
- **This webinar is being recorded**
- **All materials will be available to participants after the webinar**

Asking Questions

- Please pose your questions using the chat box
- Questions will be monitored then answered by the speakers either following the presentation or at the end of the webinar



Welcome & Introductions

Patricia Hendren, I-95 Corridor Coalition

Welcome!

Ginna Reeder, I-95 Corridor Coalition

Participants

Agencies			
Alabama DOT	FHWA	New Hampshire DOT	Rhode Island DOT
Anne Arundel County Office of Transp.	Florida DOT/Turnpike	New Jersey DOT	South Carolina DOT
Baltimore Metropolitan Council	Georgia DOT	New York State DOT	South Jersey Transportation Authority
City of Charlotte	Greenville County	New York State Thruway Authority	Southwestern Pennsylvania Commission
City of Frederick	Maine DOT	NJTPA	Tennessee DOT
City of Norwalk	Manatee County	North Carolina DOT	USDOT
Connecticut DOT	Maryland DOT – SHA & MVA	North Carolina Turnpike Authority	Vermont AOT
Delaware DOT	Massachusetts DOT	Pennsylvania DOT	Virginia DOT
District DOT	Maryland Transportation Authority	Pennsylvania Turnpike Commission	Virginia OIPI
DVRPC	MWCOG	Port Authority of NY & NJ	

Participants (continued)

Other Participants			
AECOM	INRIX	New Jersey Institute of Technology	Virginia Polytechnic Institute and State University
Florida International University	Iteris	Norus Innovation	Wolverton & Associates
Gannett Fleming	Jacobs Engineering	NREL	WSP
GEWI North America	Metric Engineering	TRANSCOM	
HNTB	Michael Baker International	Vannase Hangen Brustlin, Inc.	

Previous Working Group Activities

December 2017 Workshop

- More than 40 practitioners from 15 DOTs, several MPOs and other transportation agencies
- Workshop Goals: Share CAV activities, Identify challenges & potential solutions, Define implementation steps for member agencies and the Coalition
- Start small and build
- Final report distributed and available on Coalition website

May 2018 Web Meeting

- Presentations from Auto Insurance perspective on CAV and how a smaller town is embracing CAV technology for first and last mile travel.
- Agency Roundtable Discussion with 10 agencies providing updates on their CAV efforts
- The presentation and meeting summary are on the Coalition website

CAV Workshop Recommended Next Steps

	Action	May 2018 Webinar	Nov 2018 Webinar
Coalition	Create a working group to keep Coalition members informed about actions to take today	✓	✓
	Identify key insights applicable today	✓	✓
States	Create a strategic vision focused on the “why”		✓
	Start a stakeholder group to understand agency culture		✓

Agenda

1:00 pm - 1:05 pm	Introductions and Welcome
1:05 pm - 1:10 pm	Review of previous CAV Working Group activities
1:10 pm - 1:30 pm	Strategic Planning for CAVs in Massachusetts
1:30 pm - 1:50 pm	FDOT's CAV Program: Concept Development to Field Deployment
1:50 pm - 2:10 pm	Pennsylvania Joint Statewide Connected and Automated Vehicle Strategic Plan
2:10 pm - 2:25 pm	How to Conduct a Capability Maturity Model Self-Assessment
2:25 pm - 2:30 pm	Wrap Up

Speakers

Neil Boudreau

Massachusetts DOT

Assistant Administrator for Traffic and Safety

Raj Ponnaluri, PhD, PE, PTOE, PMP

Florida DOT

Connected Vehicles & Arterial Management Engineer

Mark Kopko

Pennsylvania DOT

Manager, Advanced Vehicle Technology

Strategic Planning for CAVs in Massachusetts

Neil Boudreau, Massachusetts DOT

Strategic Planning For Connected and Automated Vehicles in Massachusetts

I-95 Corridor Coalition CAV Webinar

November 14, 2018

I - 95 CORRIDOR COALITION

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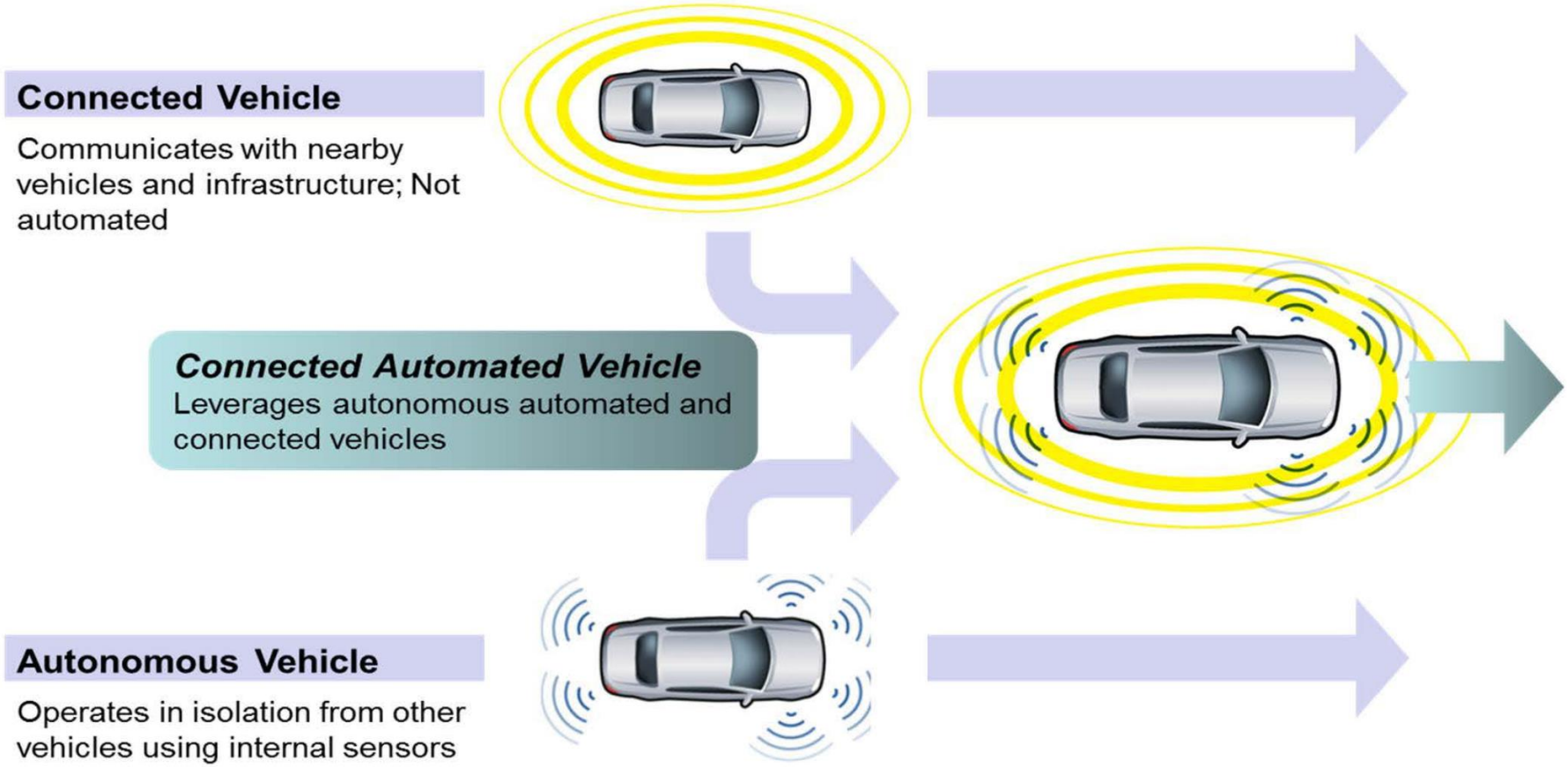
Strategic Recommendations

- Follow the USDOT's Vision of Connected Automated Vehicles
- Promote CV/AV Testing
- Modify Driving Training and Licensing Requirements
- Encourage Use of SAVs
- Invest in Infrastructure

Follow USDOT's Vision on CAVs



Promote CV/AV Testing

- Gain in depth understanding of function and performance of new technologies
- Improve implementation/operation procedures
- Establish partnerships with private sector for AVs
- Promote legislation for setting standards for testing CVs/AVs on public roads
- Establish testbeds to be used under a variety of conditions

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Modify Driver Training and Licensing Requirements

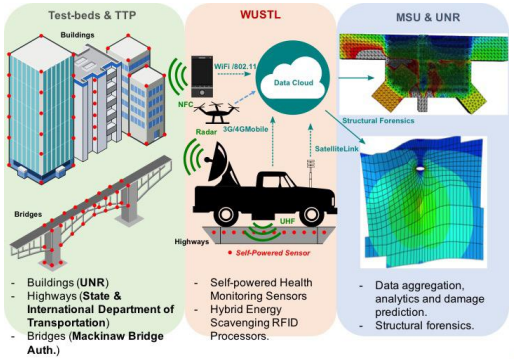
- Operator aware of capabilities/limitations of the vehicle
- L3-AVs operator must be able to recognize when and be able to engage/disengage automated driving
- L4-AVs rider may be expected to intervene in an emergency
- Long transition period – comprehensive or vehicle specific licensing

Encourage Use of SAVs

- Develop operating guidelines for SAVs
- Develop regulations for 0-occupant travel
- Coordinate with local authorities for uniform regulations/standards
- Most likely provider: local transit agencies – focus on:
  - ✓ First-mile/last-mile service to promote transit
  - ✓ Paratransit services to disabled and elderly
  - ✓ Service on rural/low density areas
- Promote partnerships with TNCs

Invest in Infrastructure

- Regular inspection/maintenance of pavement markings
- Establish standards and monitor retro-reflectance of traffic signs
- CV infrastructure (DSRC instrumentation, backhaul communications, data analytics, CV-equipped traffic signal controllers, etc.)
- Network of smart-sensors for monitoring roadway and traffic conditions



Additional Strategic Recommendations

- Implement Signal Priority Strategies of CVs and SAVs
- Provide Dedicated Lanes for AVs
- Invest in Data Analytics and Cyber Security
- Prepare the Workforce

Short-Term Action Plans

- Policy
- Testing and Deployment
- Research
  - Planning
  - Financing and Demand Management
  - Design, Construction and Maintenance
  - Mobility and Transit
  - Operations
  - Safety
  - Security and System Reliability
- Workforce Development
- Partnership

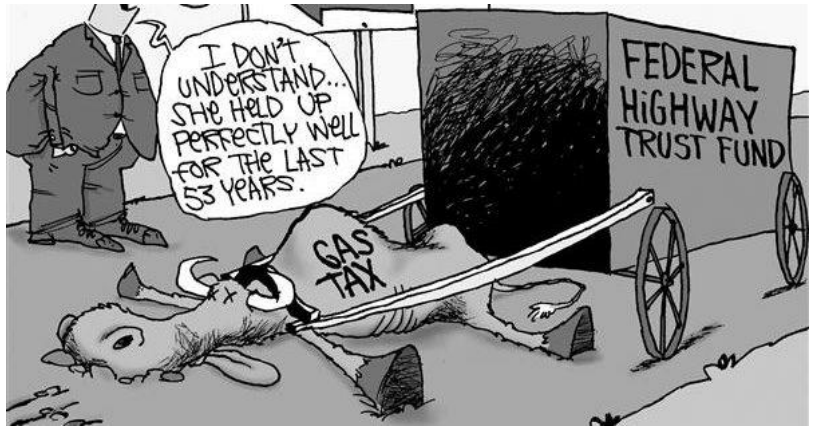
Initial Focus Areas

- Advance CV/AV working group within MassDOT to:
  - Coordinate policy and regulation issues
  - Follow CV/AV technology development trend and provide an annual update
  - Provide policy support and recommendations for CV/AV planning and developments

- Facilitate and participate in CV/AV testing to:
  - Gain first-hand experience and prepare for future deployments
  - Identify problems, opportunities, and research needs

Use a Smart Approach

- Deployment – take a conservative approach and learn from other states' experience
- Monitor and conduct research on
  - Planning: Impacts on new mobility solutions, multimodal transportation, VMT changes, land use, travel behavior, freight, etc.
  - Financing: CV/AV-enabled tolling and transportation financing strategies, etc.



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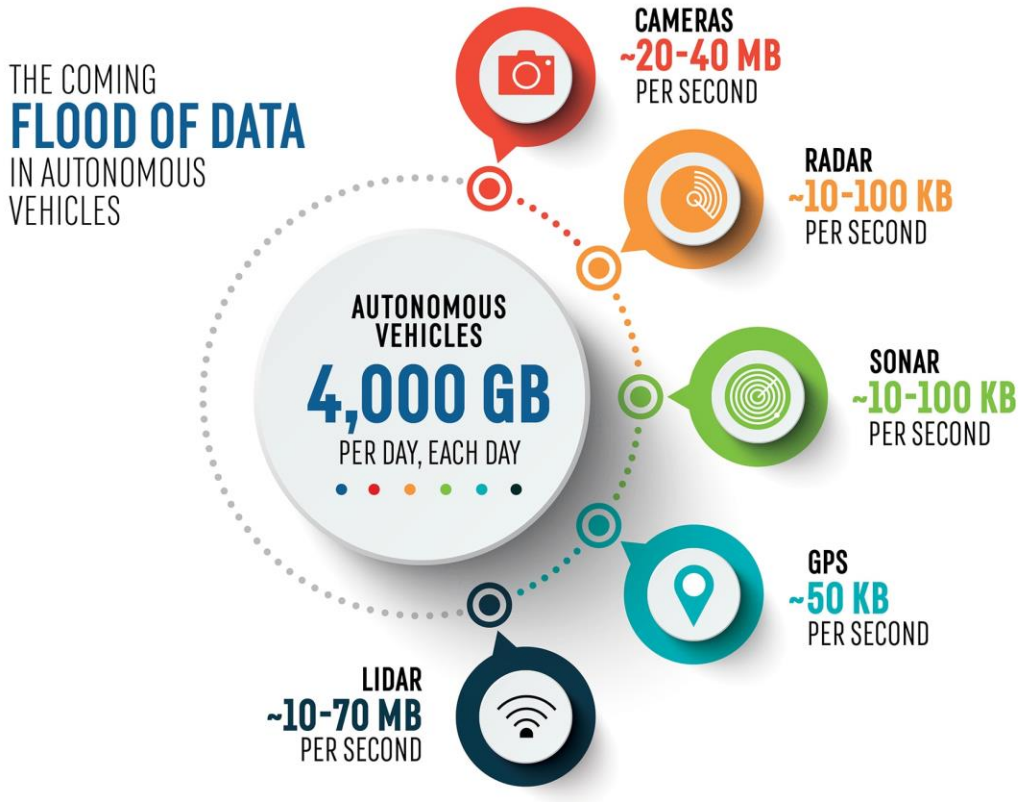
Long-Range Direction for DOT

- Demand Management: CV/AV enabled more precise and targeted strategies
- Infrastructure: review and update design, construction and maintenance standards. Take CV/AV into consideration when making major infrastructure investment decisions
- New Mobility Solutions and Transit: Impacts of SAVs and TNCs (e.g., Uber, Lyft). Will they compete with or complement existing transit services?

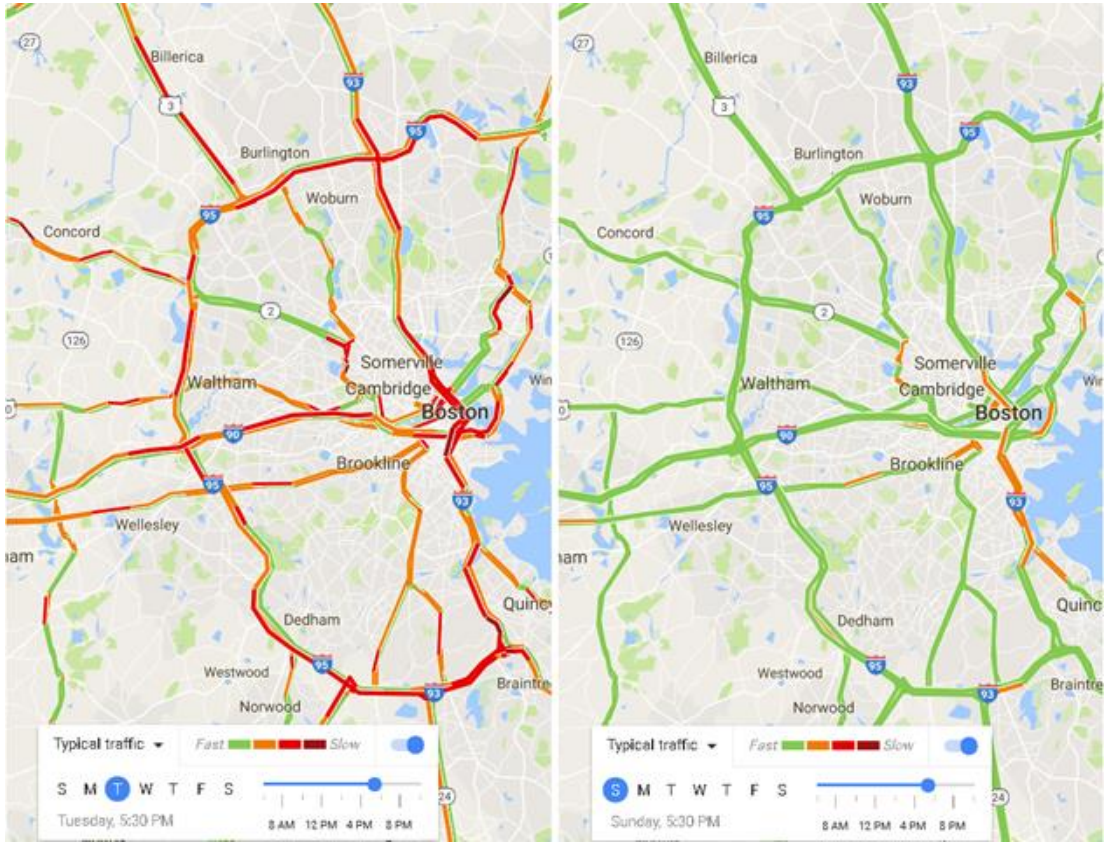
Understand What is Needed

- Safety: facilitate CV/AV-enabled safety technology development, testing, and deployment
- CV/AV Data related Issues: collection, management, analysis, sharing, privacy, security, etc.
- Operations: AV-only lanes, vehicle platooning, enforcement, integrated routing and signal control
- Security and System Reliability: Power outage, severe weather, fake/inaccurate traffic information
- Traffic Control: Devices, pavement marking, signage



Massachusetts Specific Needs

- Conduct research that addresses important needs of Massachusetts (e.g., severe snow storms, complicated intersections, heavy commuter traffic, cross-border traffic)



Workforce Development

- Conduct an annual briefing (e.g., a one-day workshop) to keep staff aware of the technology developments and for them to make informed decisions.
- Engage students from CAV related disciplines in MassDOT funded research.

Establish Partnerships

- Public Sector (National, State, Regional, and Local)
- Private Sector
  - OEMS
  - Industry
- Universities and Research Institutions

Public – National Level

- USDOT Intelligent Transportation Systems (ITS) Joint Program Office (JPO)
- US Department of Energy
- AASHTO, NHTSA, FMCSA, FTA, ITE, ITS America, etc.
- Funding opportunities:
  - Every Day Counts (EDC) program
  - Accelerated Innovation Deployment (AID) Demonstration program
  - State Transportation Innovation Council (STIC) Incentive program
  - Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)
  - Connected Vehicle Pilot Deployment Program
  - ARPA-E

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Public – State and Regional Levels

- Other Agencies in Massachusetts
- Other States
  - To learn from their experience and to ensure the interoperability of future transportation systems.
- Regional Organizations
  - Engage the I-95 Corridor Coalition to address the impacts of CAVs that require multistate cooperation.

Public – Local Level

- MassDOT should work with cities, towns, local transit agencies, etc. to:
  - understand their needs
  - provide technical support
  - leverage available resources
  - collaborate on CAV related projects
  - ensure future transportation system interoperability

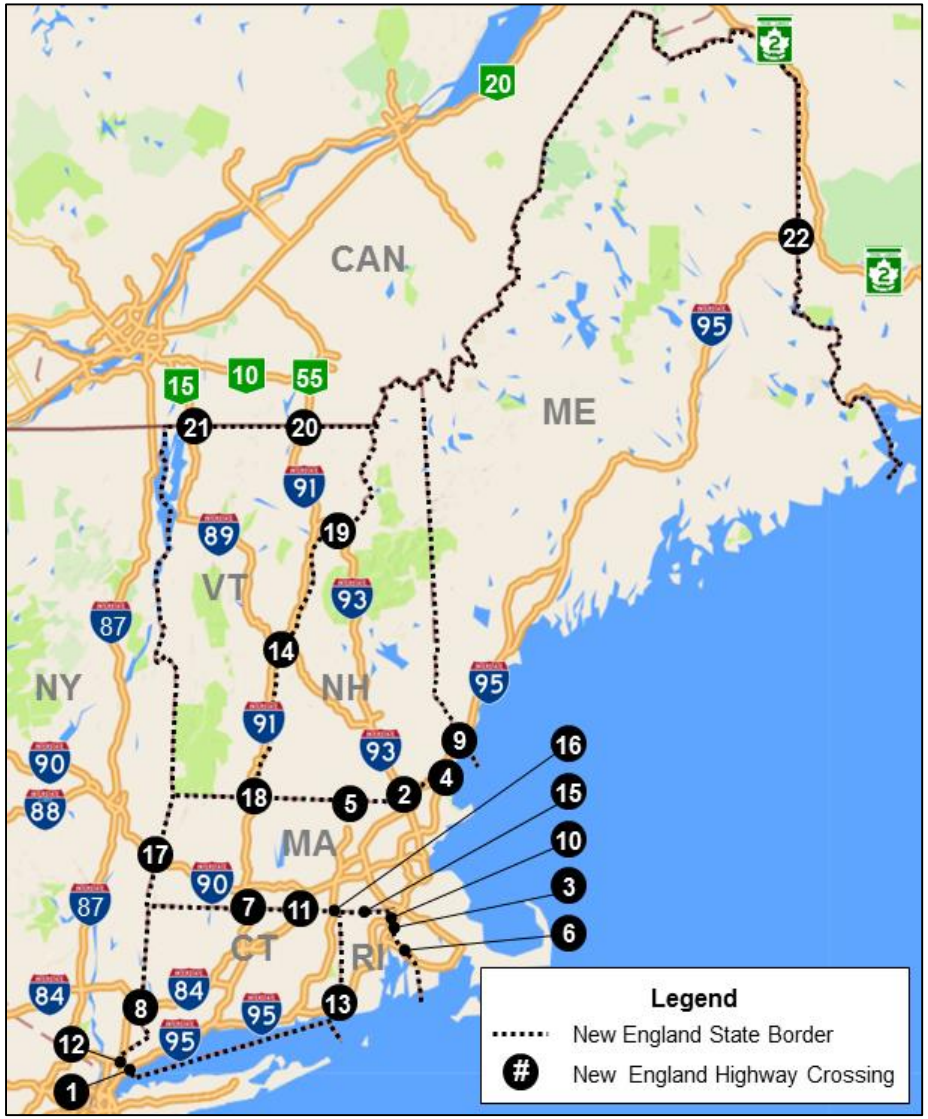
- For instance, traffic signals maintained by state and local agencies should be coordinated. Work with cities to increase pick-up/drop-off locations and reduce parking spaces.

Public – Other

- Partner with law enforcement agencies and first responders (e.g., signal preemption for emergency service CAVs).
- Reach out to organizations representing
  - aging and disabled populations
  - highway safety advocates
  - trucking associations
  - bike and pedestrian groups
  - taxi providers

"Does your car have any idea why my car pulled it over?"

New England Status



CV/AV Item	Status	CT	ME	MA	NH	RI	VT
AV Committee or Task Force	Pending				●		
	Established	●	●	●		●	●
CV/AV Legislation or Executive Order	Pending			●	●		
	Passed/Issued	●	●				●
	Executive Order		●	●			
CV Pilot Testing or Deployment	Planning	●		●			●
	Underway				●		
AV Pilot Testing	Planning	●				●	
	Underway			●			

Source: AECOM – NETC Quick Response QR17-1

Thank You!

Contact Information

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Acknowledgement: Chronis Stamatiadis, Nathan H. Gartner, Yuanchang Xie, and Danjue Chen

Department of Civil and Environmental Engineering

University of Massachusetts Lowell

FDOT's CAV Program: Concept Development to Field Deployment

Raj Ponnaluri, PhD, PE, PTOE, PMP, Florida DOT

FDOT's Connected and Automated Vehicles (CAV) Roadmaps & Capability Maturity Model (CMM) Self-Assessment

Raj Ponnaluri, Ph.D., P.E., PTOE, PMP

FDOT TSM&O
Transportation Systems Management & Operations

Agenda

- Florida’s Transportation System
- Capability Maturity Model (CMM) Workshop
- Connected and Automated Vehicles (CAV) Program
- Statewide CAV Workshop
- CAV Business Plan

FLORIDA'S TRANSPORTATION SYSTEM

3rd
Largest Population
21 MILLION RESIDENTS

1st
In Aging Population
10% OF FLORIDA POPULATION IS OVER AGE 65

12,099
Centerline Miles of State Roads

780
Airports

2,753
Centerline Miles of Rails

53
Transit Systems

15
Deep Water Seaports

2
Spaceports

FLORIDA RANKS

- **1st** With 10% of the population over age 65
- **11th** Nationally in infrastructure health
- **3rd** Nationally in fiscal stability
- **6th** New business startups
- **5th** Providing best business environment
- **18th** Nationwide in international trade freight gateways
- **7th** In exports among U.S. states
- **11th** Among U.S. states with Top 30 Ports

Introduction

FDOT's Statewide Arterial Management Program (STAMP) is developing Capability Maturity Model (CMM) assessment workshops.

This includes potential Connected and Automated Vehicles (CAV) applications.

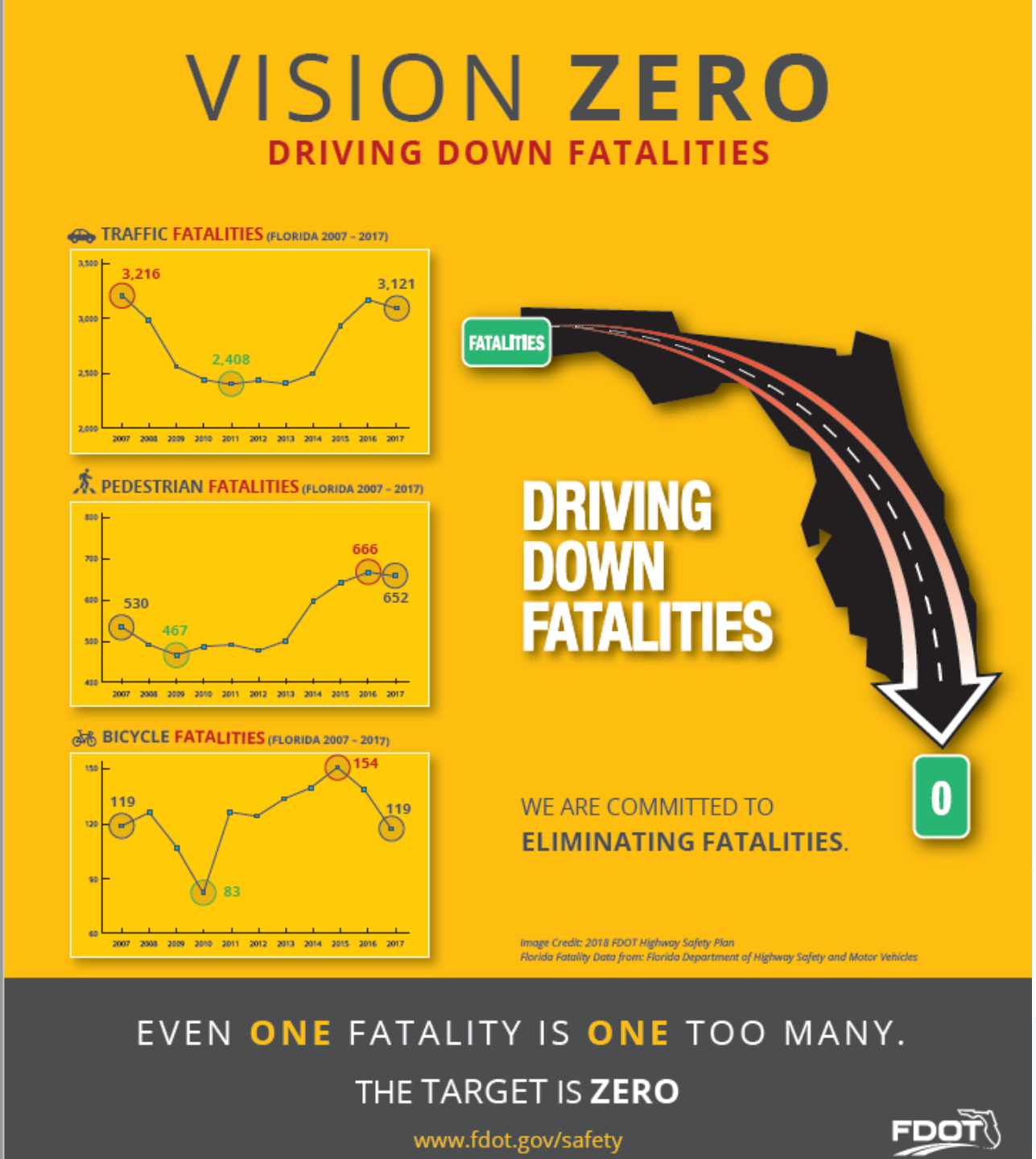
CMM Workshop Discussion Areas

Discussion Areas

- Active Arterial Management (AAM) Projects
- Integrated Corridor Management (ICM) Projects
- Automated Traffic Signal Performance Measures (ATSPM)
- Adaptive Signal Control Technologies (ASCT)
- Connected and Automated Vehicles (CAV)

Workshop Objectives

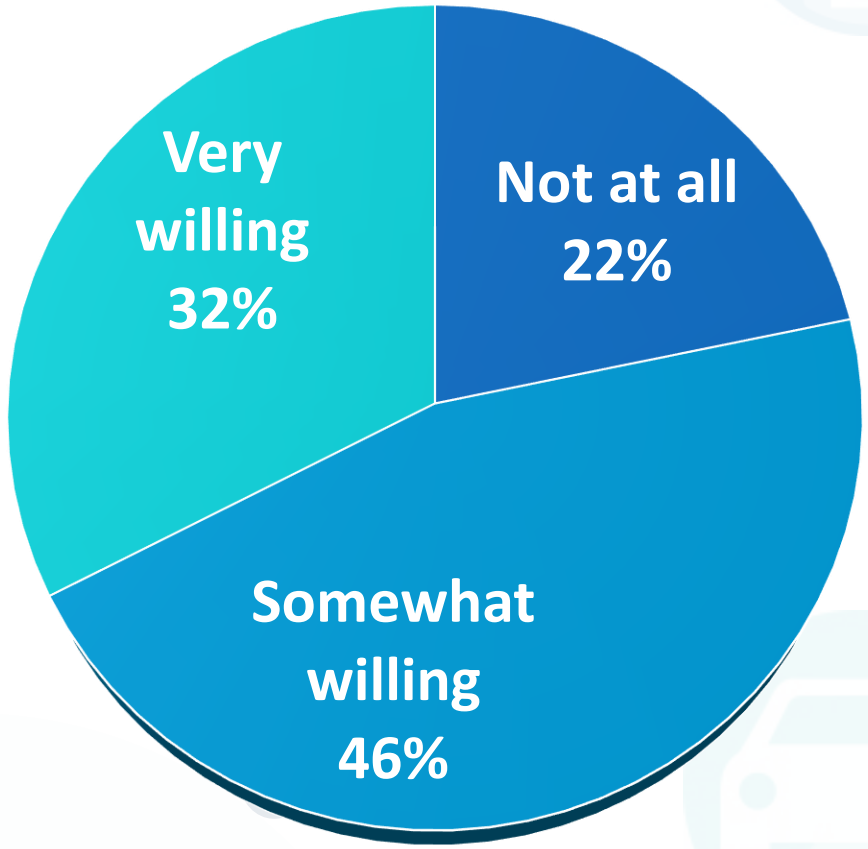
Develop Strategies	Develop strategies for arterial management project improvements and build consensus
Identify Priorities	Identify immediate priorities for improvements to each area or strategy
Identify Actions	Identify concrete actions to continuously improve capabilities to plan, design, and implement arterial management project strategies
Identify CAV Applications	Identify potential CAV applications for actively and proactively managing arterial corridors



Focus on Safety and Mobility Benefits

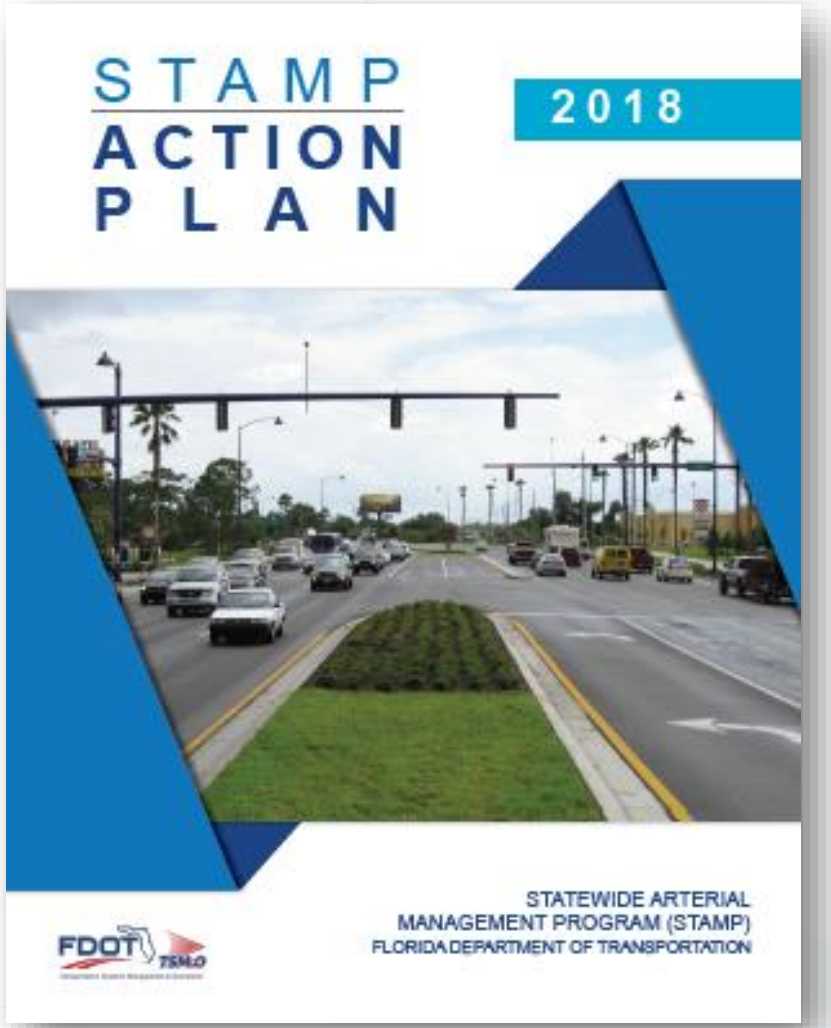
CAV Outreach: FDOT's Safe Mobility for Life Program

Willingness to Use an Autonomous Vehicle

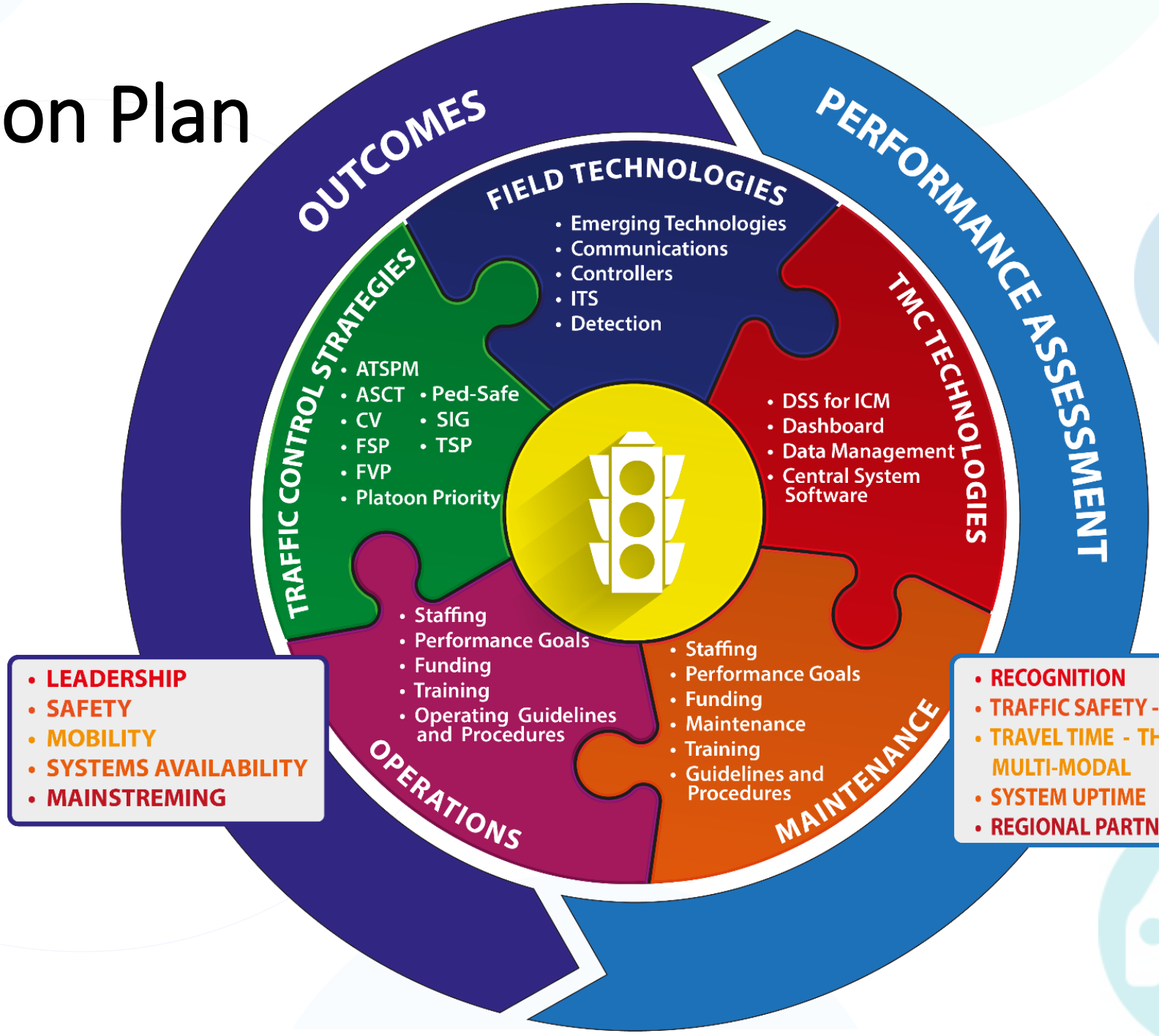


Source: 2016 Aging Road User Survey

CAV Consistent with Other Plans



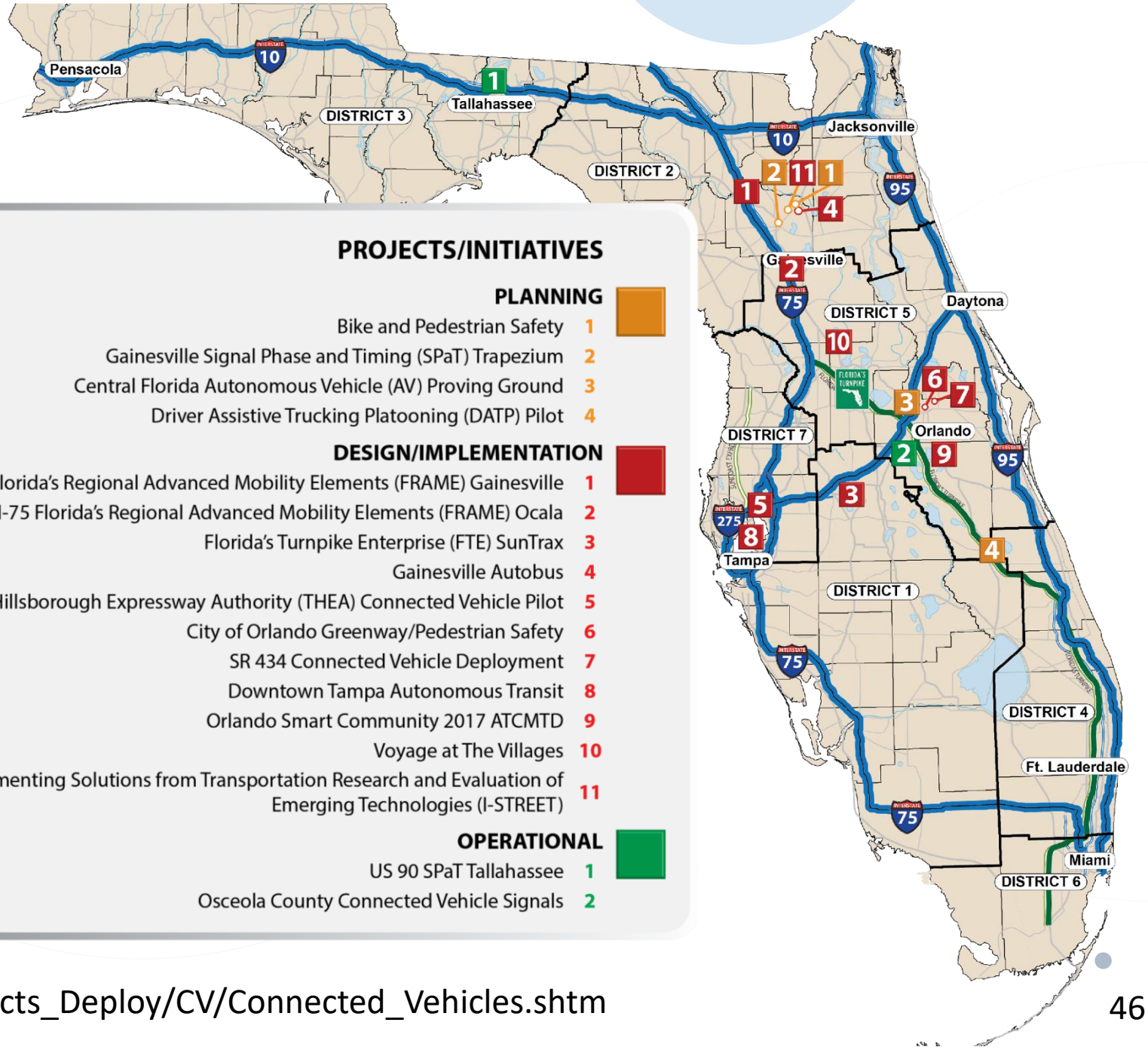
STAMP Action Plan



CAV Website

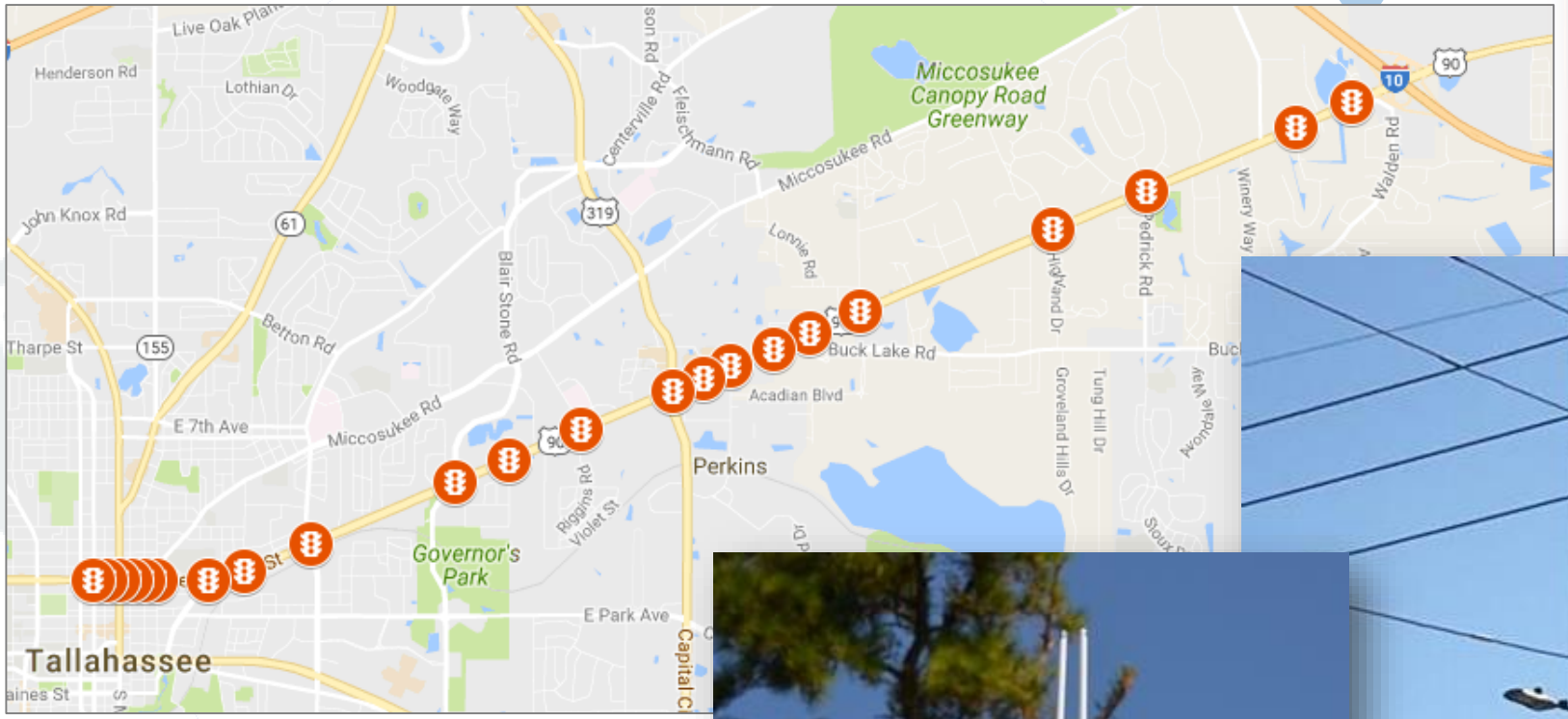
Projects/Initiatives

- Planning
- Design or Implementation
- Operational



- http://www.fdot.gov/traffic/ITS/Projects_Deploy/CV/Connected_Vehicles.shtm

Tallahassee US 90 Signal Phase and Timing (SPaT) Pilot Project



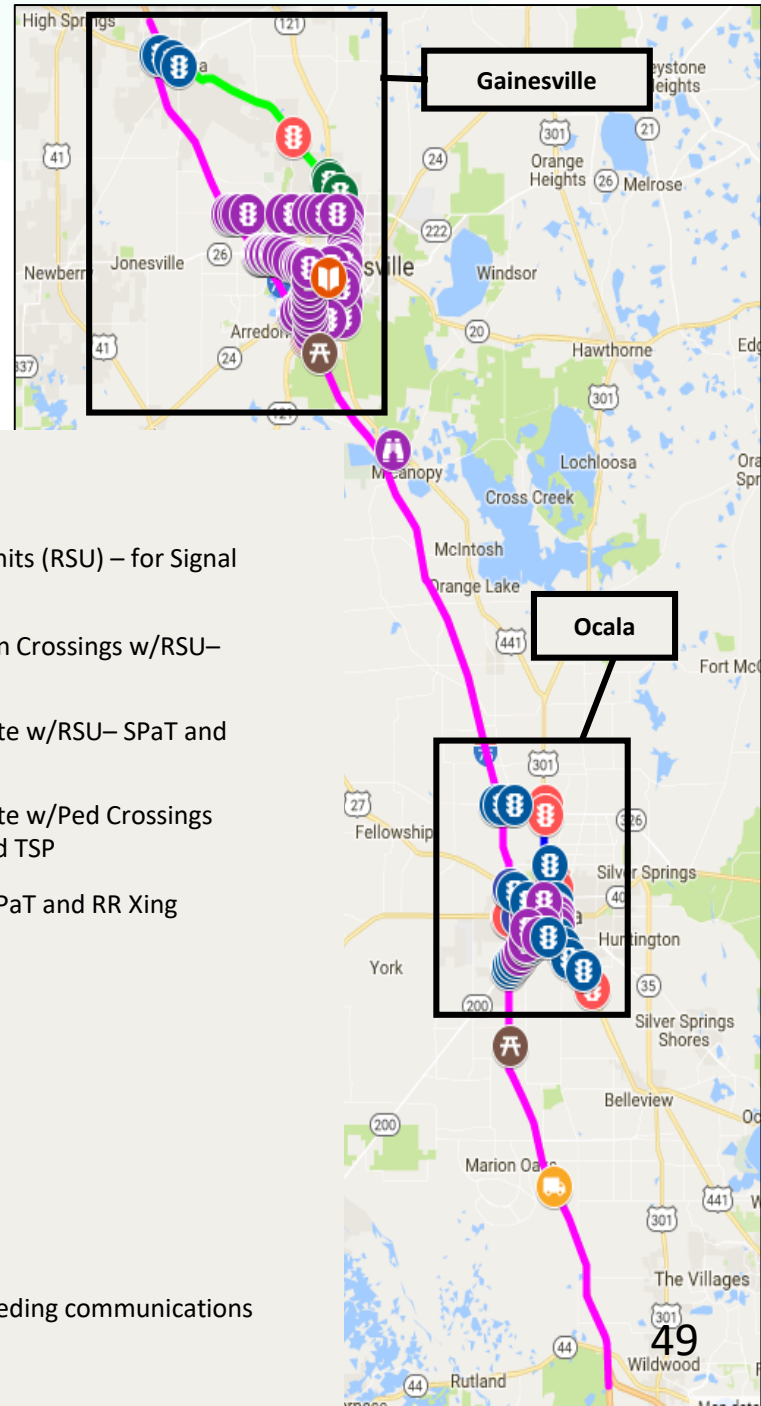
SPaT Lessons Learned

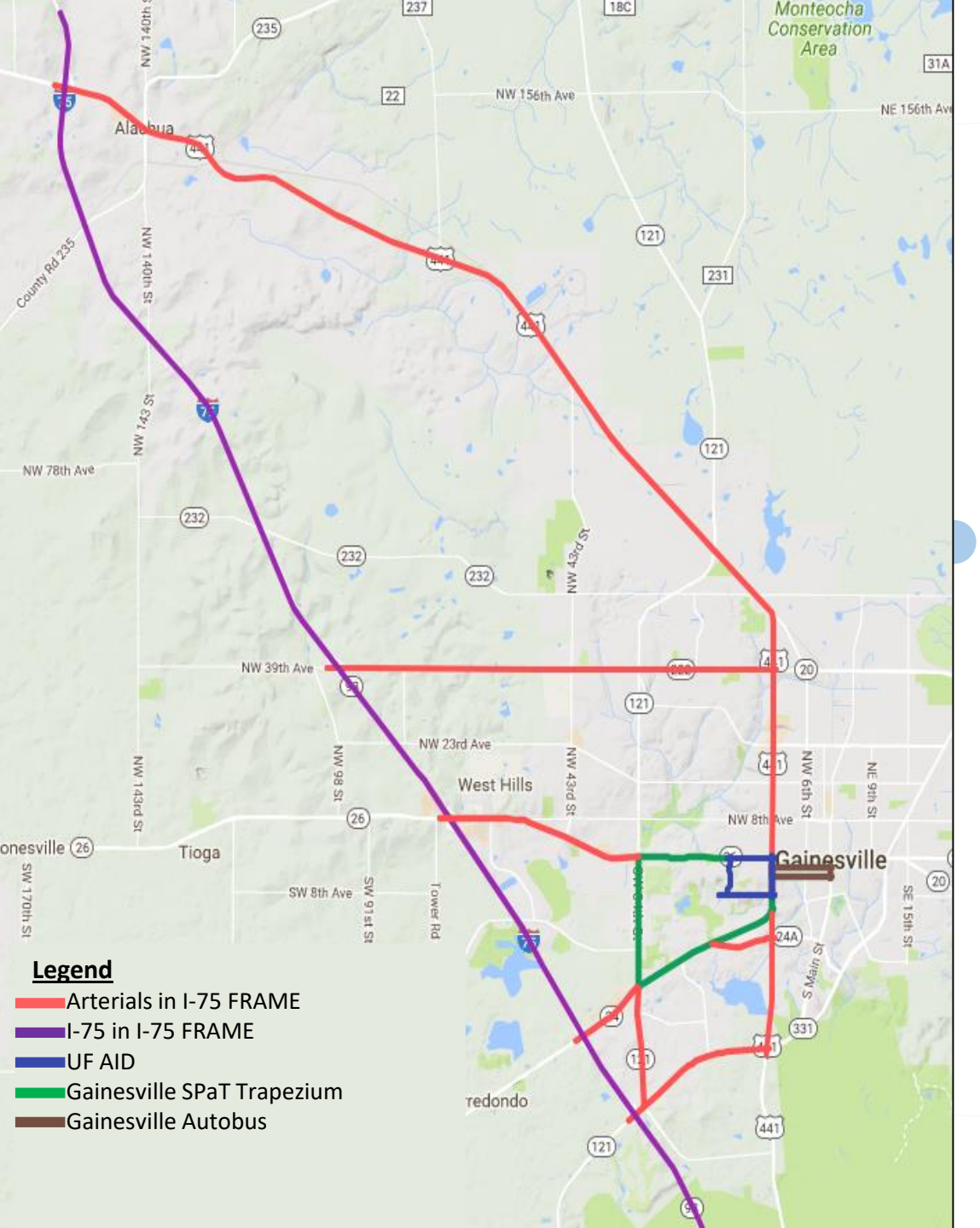
- CAV technology procurement at a public agency
- Value-added services in the Request for Proposal document
- Equipment testing prior to vendor selection
- USDOT Map Data Tool requires field refinement
- Roadside Units/On-Board Units require field fine tuning
- Data collection, storage and maintenance
- SPaT-Plus…? What's next for safety and mobility?

I-75 FRAME Update

Florida's Regional Advanced Mobility Elements (FRAME)

- Concept of Operations refinement underway
- Stakeholder coordination
- Active industry/vendor engagement
- Equipment testing for reliable deployment
- Deployment starts in 2019





I-STREET

- Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies (I-STREET)
- Strong response from vendors and industry to partner with FDOT, University of Florida, and City of Gainesville for testing safety and mobility applications

I-STREET
Transportation Institute
UNIVERSITY OF FLORIDA

Goal Areas

- Safety
- Mobility
- Data Management

CITY OF GAINESVILLE
every path starts with passion
FLORIDA

FDOT

UF UNIVERSITY of FLORIDA

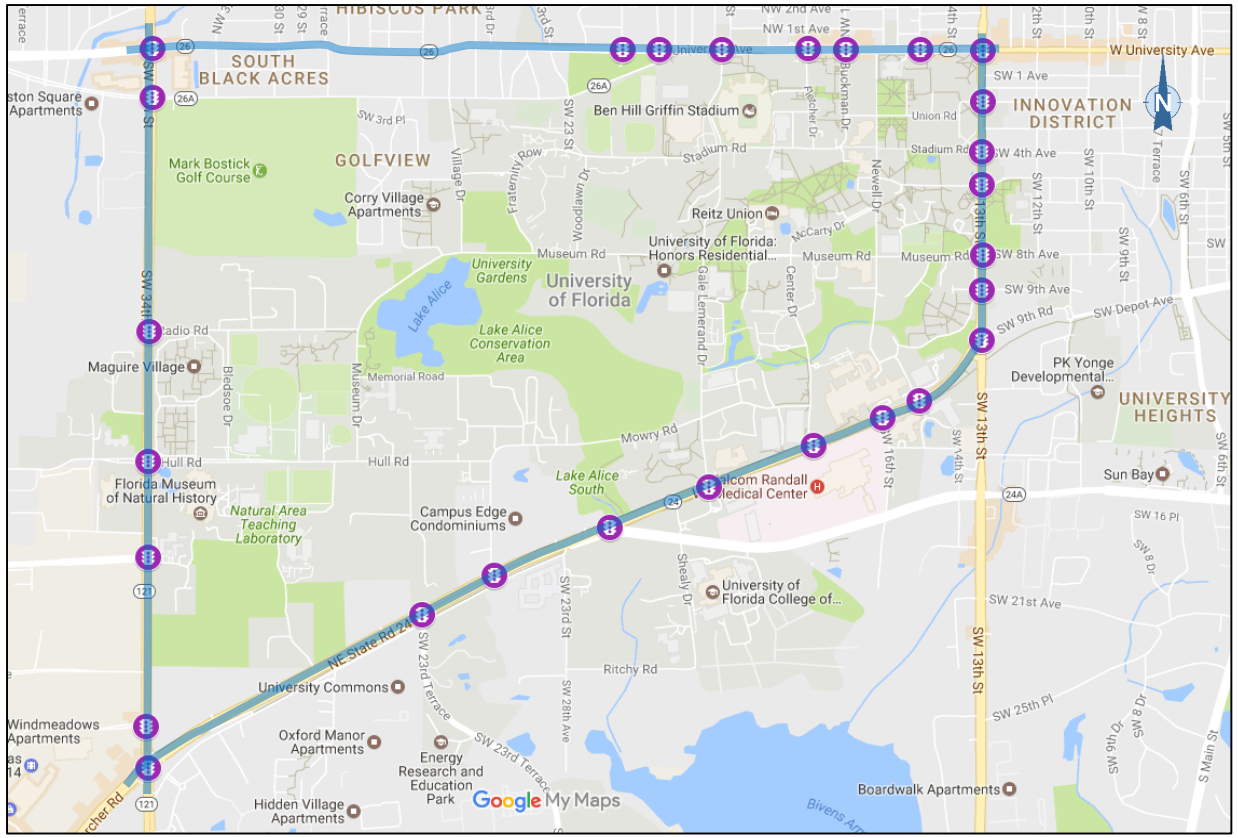
Gainesville SPaT Trapezium

27 Traffic Signals

Roadside Units
On-Board Units
CAV Applications

Bike/Ped Safety

Procurement Underway
Deployment in 2019



Legend

Traffic Signals (27)
Project Corridor

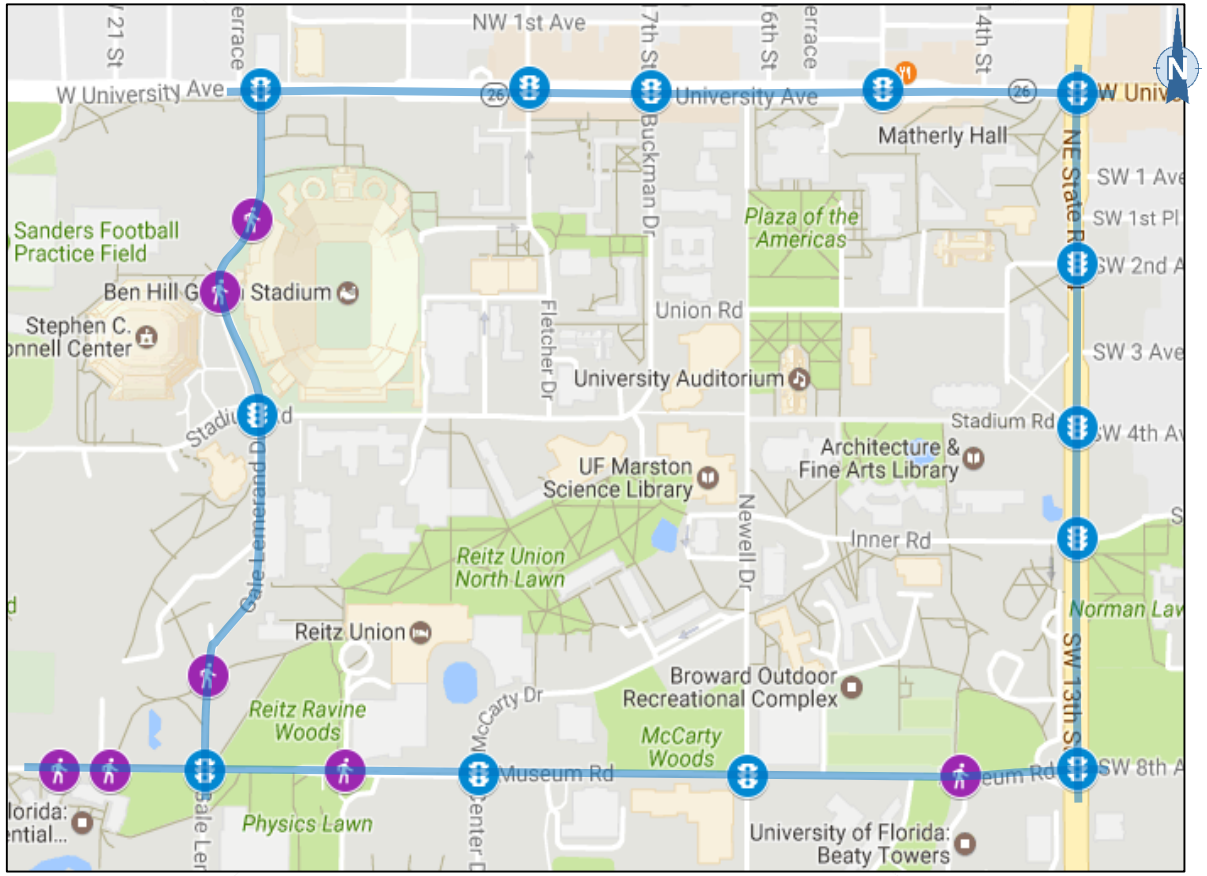
FHWA AID Award:
Bike and Pedestrian Safety Application

13 Traffic Signals
7 Mid-block Crossings

Roadside Unit
On-Board Unit
Passive Pedestrian
Detection System

Bike/Pedestrian Safety

ConOps/PSEMP/RFP Underway
Deployment in 2019-2020



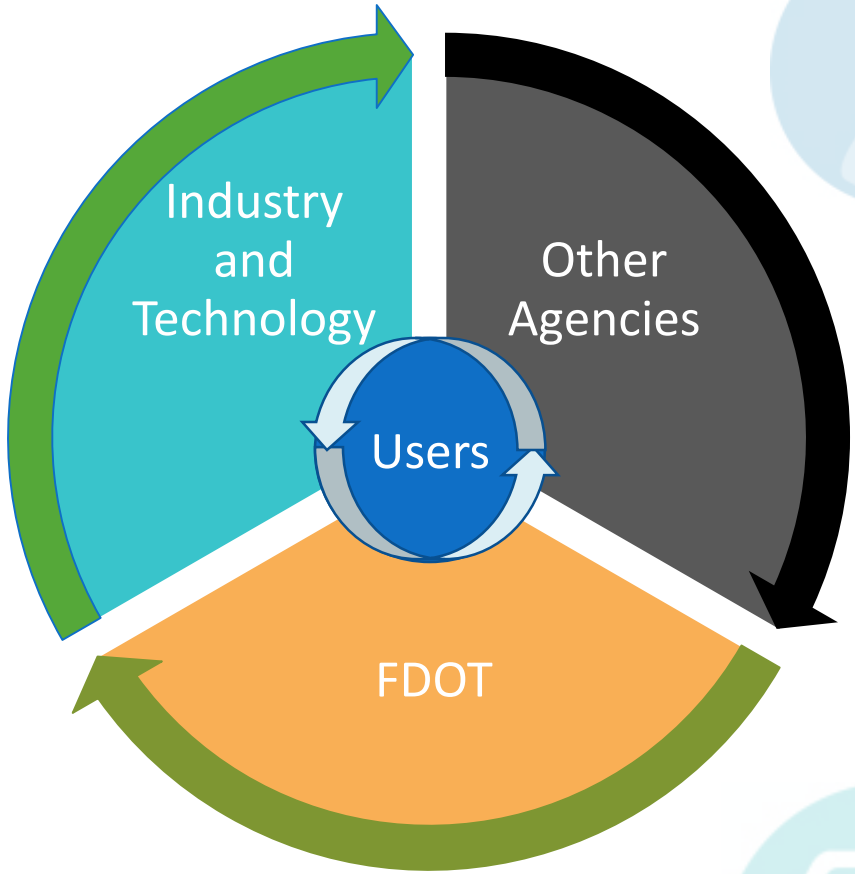
Legend

- Traffic Signals (13)
- Mid-block Crossings (7)
- Project Corridor

Statewide CAV Workshop

CAV Workshop Goals

- Focus on Deployment
- ***Framework for Collaboration and Coordination***
- Understand
  - Opportunities
  - Challenges
  - Roles
- Statewide Workshop Ideas
- Action Plans



CAV Opportunities and Challenges

Opportunities

Challenges

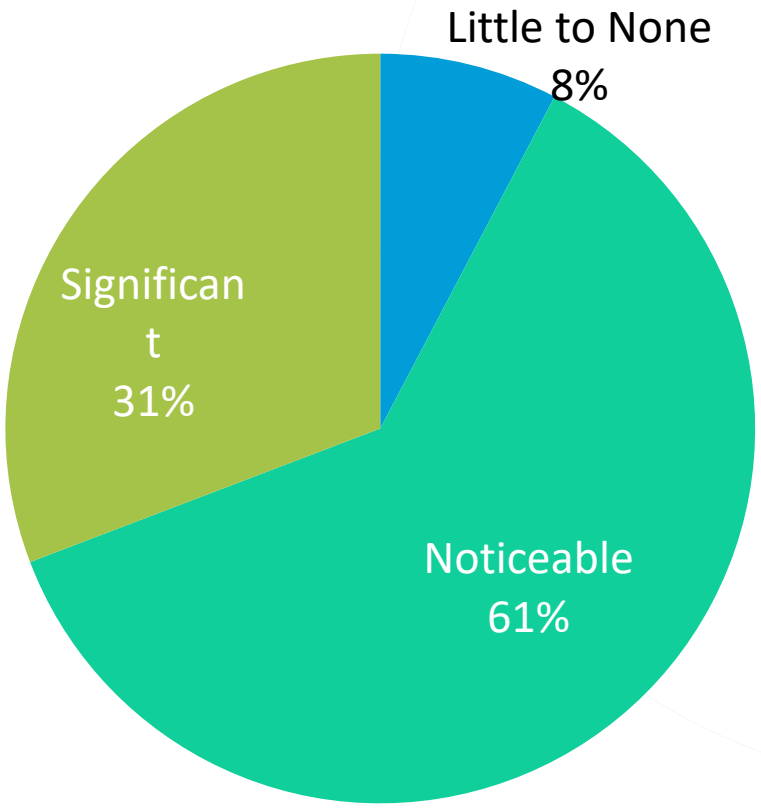
CAV Expectations and Moving Forward

Expectations from CAV Program

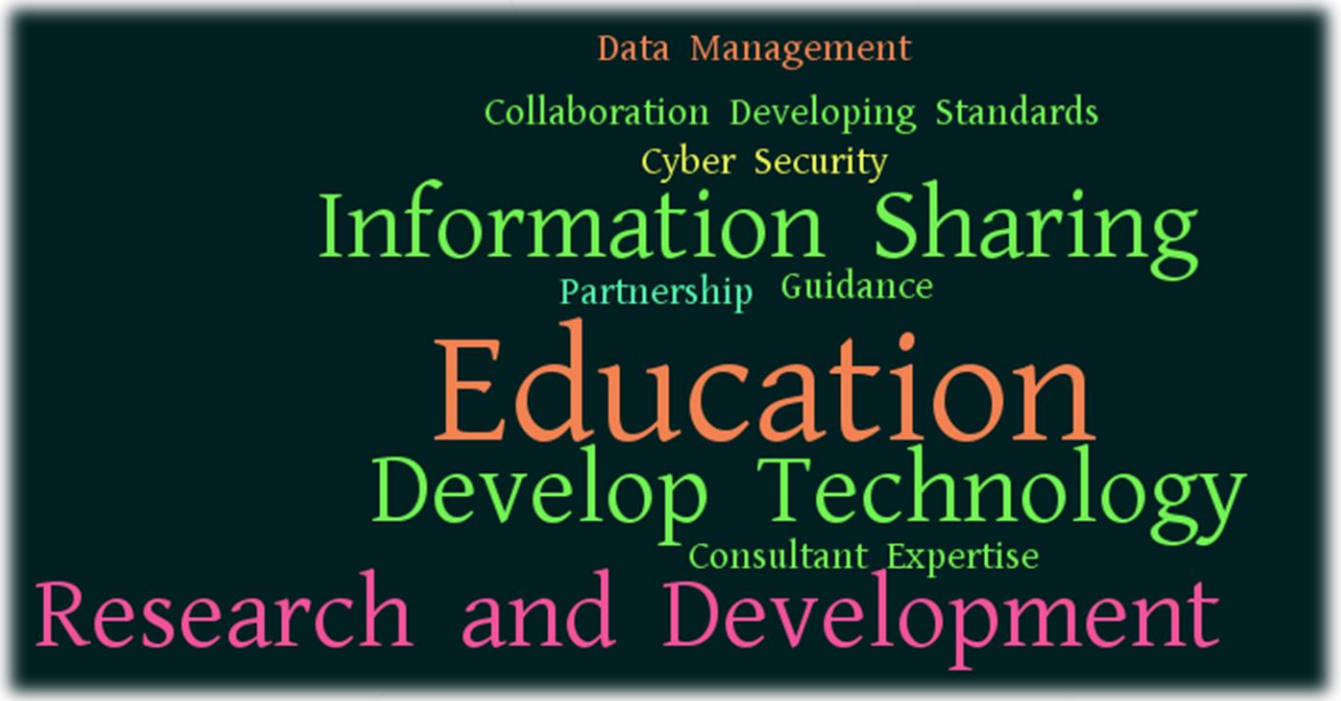
Reasons for Moving Forward CAV

FDOT and Private Industry

Involvement with Automobile Industry



Role of Private Industry

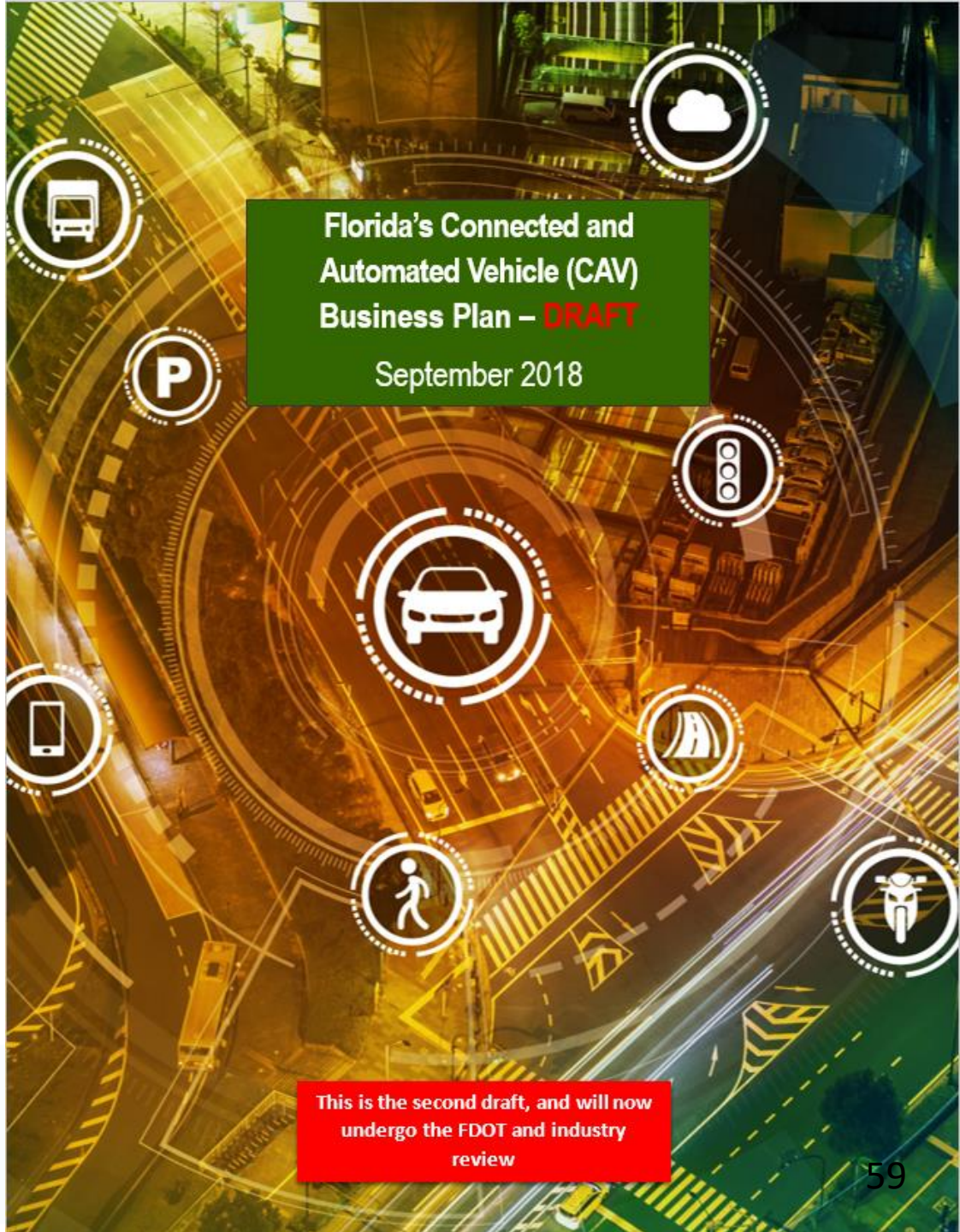


Local Agency Roles in CAV

CAV Business Plan – Draft

Seven focus areas for Safety, Mobility, and Economic Development (SME) benefits:

1. Policies and Governance
2. Program Funding
3. Education and Outreach
4. Industry Outreach and Partnerships
5. Technical Standards and Specifications
6. Implementation Readiness
7. Deployment and Implementation



THANK YOU

Raj Ponnaluri, Ph.D., P.E., PTOE, PMP

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Pennsylvania Joint Statewide Connected and Automated Vehicle Strategic Plan

Mark Kopko, Pennsylvania DOT

Pennsylvania Joint Statewide Connected and Automated Vehicle Strategic Plan

Mark Kopko
Advanced Vehicle Technology Manager
717.783.1903
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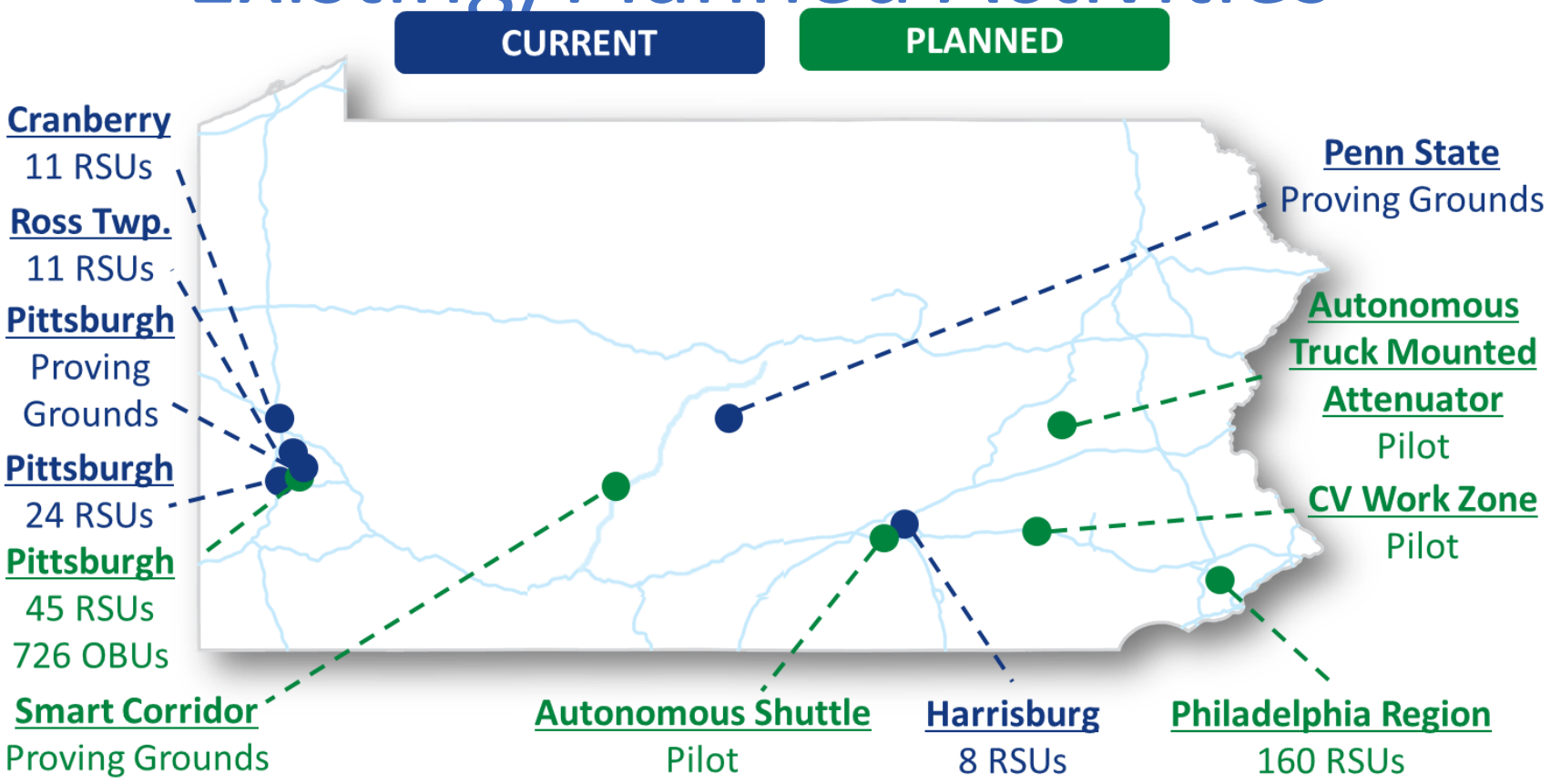
11/14/18


40,000
Miles of Roadway
25,400
Bridges
$10.1 Billion
Budget
$2.4+ Billion
Annual Construction Contracts Awarded
11,500 Employees
7,400 Maintenance Employees
56
Transit Systems
65
Operating Railroads
pennsylvania
DEPARTMENT OF TRANSPORTATION
3
Ports
130
Public Use Airports
10.7 Million
Licensed Drivers & ID Holders
11.9 Million
Registered Vehicles
102 Billion
Annual Vehicle Miles Traveled
2,100
Miles of BicyclePA Routes
LB (5-18)

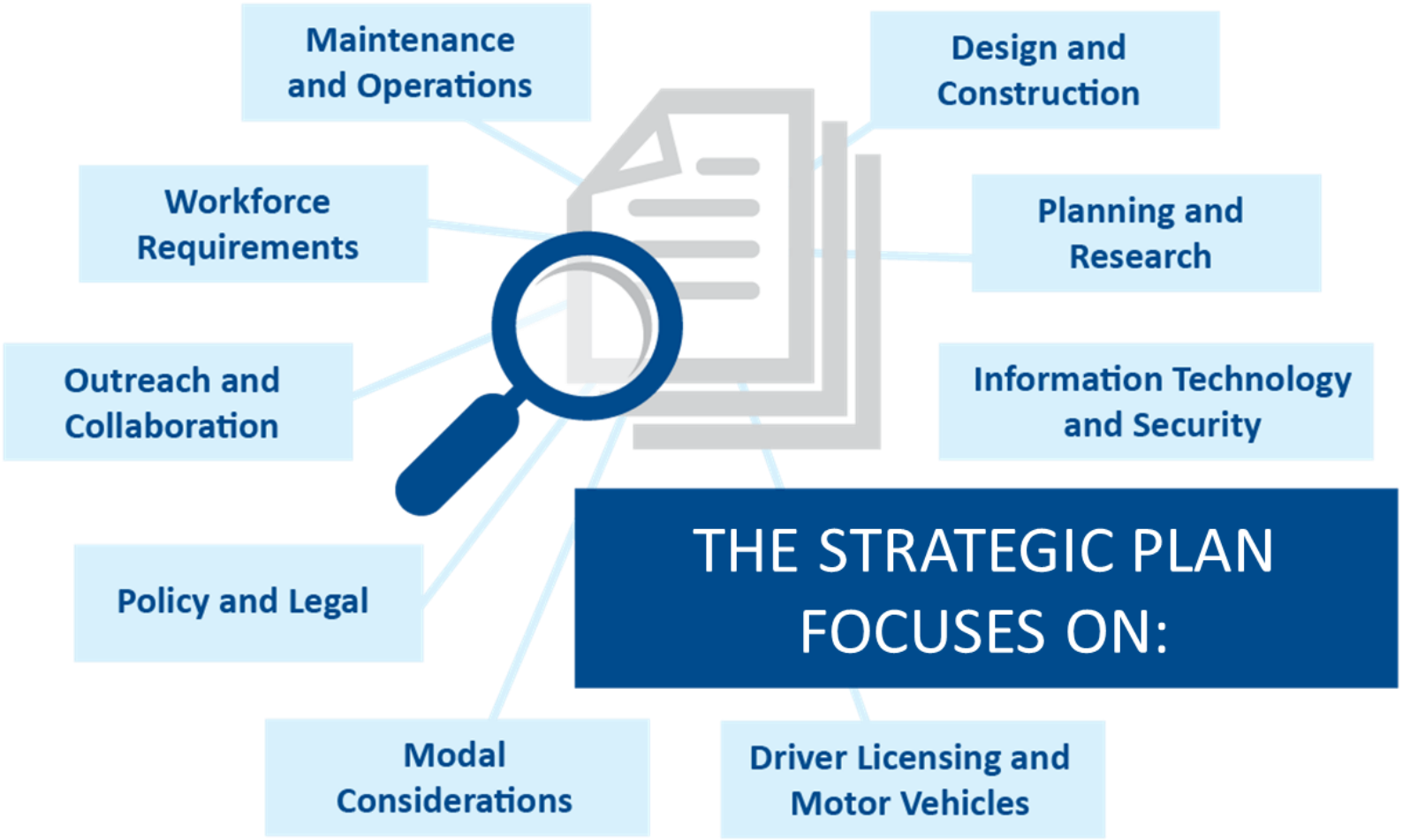
Existing/Planned Activities



Other Activities

- AV Testing Guidance
  - 2 approved testers
- AV Advisory Committee
- AV Policy Task Force
- PennSTART training facility
- Annual AV Summit
- Platooning Program

CAV Strategic Plan Business Areas



Strategic Planning Process

Data Gathering

Internal

- Review of documents
- Interviews
- Workshops
- Current Initiatives

External

- Review of national/ federal level documents
- PA Policy Task Force
- Early Successes & Best Practices

Capability Maturity Model (CMM)

Analyzing PennDOT's CAV maturity in 6 CMM "dimensions"

Vision & Mission

Goals

1. Improve Safety
2. Enhance Mobility
3. Prepare Workforce
4. Foster and Sustain Partnerships
5. Increase Public Awareness of Benefits and Risks
6. Support Economic Competitiveness

Data Gathering

Gaps

- Internal Coordination
- Public Sector Coordination
- Private Sector Coordination
- Funding
- Guidance
- Knowledge, Skills, Abilities
- Policy and Regulation
- Organizational Structure

Objectives & Recommended Steps

Strategic Planning Process

Data Gathering

Internal

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- Interviews
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- Current Initiatives

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- Private Sector Coordination
- Funding
- Guidance
- Knowledge, Skills, Abilities
- Policy and Regulation
- Organizational Structure

Objectives & Recommended Steps

Internal Data Gathering

- Review of applicable Pennsylvania documents.
- Facilitation of two workshops with senior staff.
- Completion of several interviews with selected PennDOT offices and other Pennsylvania agencies

Interviews were a Significant Source of Internal Information Gathered	
Interviewed Agencies	**Topics Addressed** *(Not all topics were addressed with each agency)*
Pennsylvania Department of Transportation	Maintenance and Operations
Pennsylvania Turnpike Commission	Design and Construction
Department of Community and Economic Development	Planning and Research
State Police	Information Technology and Security
Insurance Federation	Driver Licensing and Motor Vehicles
Delaware Valley Regional Planning Commission	Modal Considerations
Southwestern Pennsylvania Planning Commission	Workforce Requirements
Harrisburg Area Transportation Study	Policy and Legal
City of Philadelphia	Outreach and Collaboration

External Data Gathering & Best Practices

- Review of national guidance, research, existing projects, and organized groups helped ensure this plan enables Pennsylvania to build on examples of success.
- Early successes and best practices in the preparation and deployment of CAV technology helped identify opportunities for Pennsylvania.

North American CAV Locations	International CAV Locations
Tampa, Florida	European Union L3Pilot
New York, New York	United Kingdom MERIDIAN
Wyoming	United Kingdom SCOOP@F
SMART Columbus	Finland, Norway, Sweden and Denmark Nordic Way
Ann Arbor, Michigan	United Kingdom GATEway
MCity, Michigan	European Union eCall
	United Arab Emirates Dubai Autonomous Transportation Strategy

Capability Maturity Model Framework

Process Matters
Projects fail or do not achieve desired functionality for a variety of reasons unrelated to the technology.

Prioritizing the Right Actions
Is your agency ready?
How would you know?
What should you do next?

Focus on the Weakest Link
What is holding the agency back in becoming a leader in this area?

Capability Maturity Model Frameworks

Processes

- Adapted from software development world
- A consensus-driven, consistent, structured evaluation or assessment
- Guides an agency towards a higher level of implementation, standardization, and return on investment

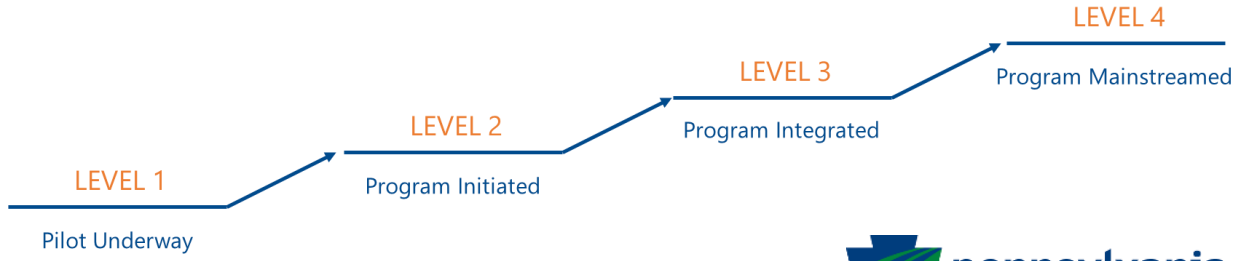
Outcomes

- Clear identification of weak links in the process
- Prioritization of areas of improvement
- List of process-oriented actions that an agency can implement

Capability Maturity Model Framework

Business Processes	Formal scoping, planning, programming, and budgeting
Systems and Technology	Use of systems engineering, systems architecture standards, interoperability, and standardization
Performance Measurement	Definition of measures, data acquisition, and data utilization
Culture	Technical understanding, leadership, outreach, and program legal authority
Organization and Staffing	Programmatic status, organizational structure, staff development, recruitment and retention
Collaboration	Relationships with public safety agencies, local governments, metropolitan planning organizations (MPOs), and the private sector.

CONNECTED VEHICLE PROGRAM & AUTOMATED VEHICLE PROGRAM CMM LEVELS



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Connected Vehicle CMM Ranking

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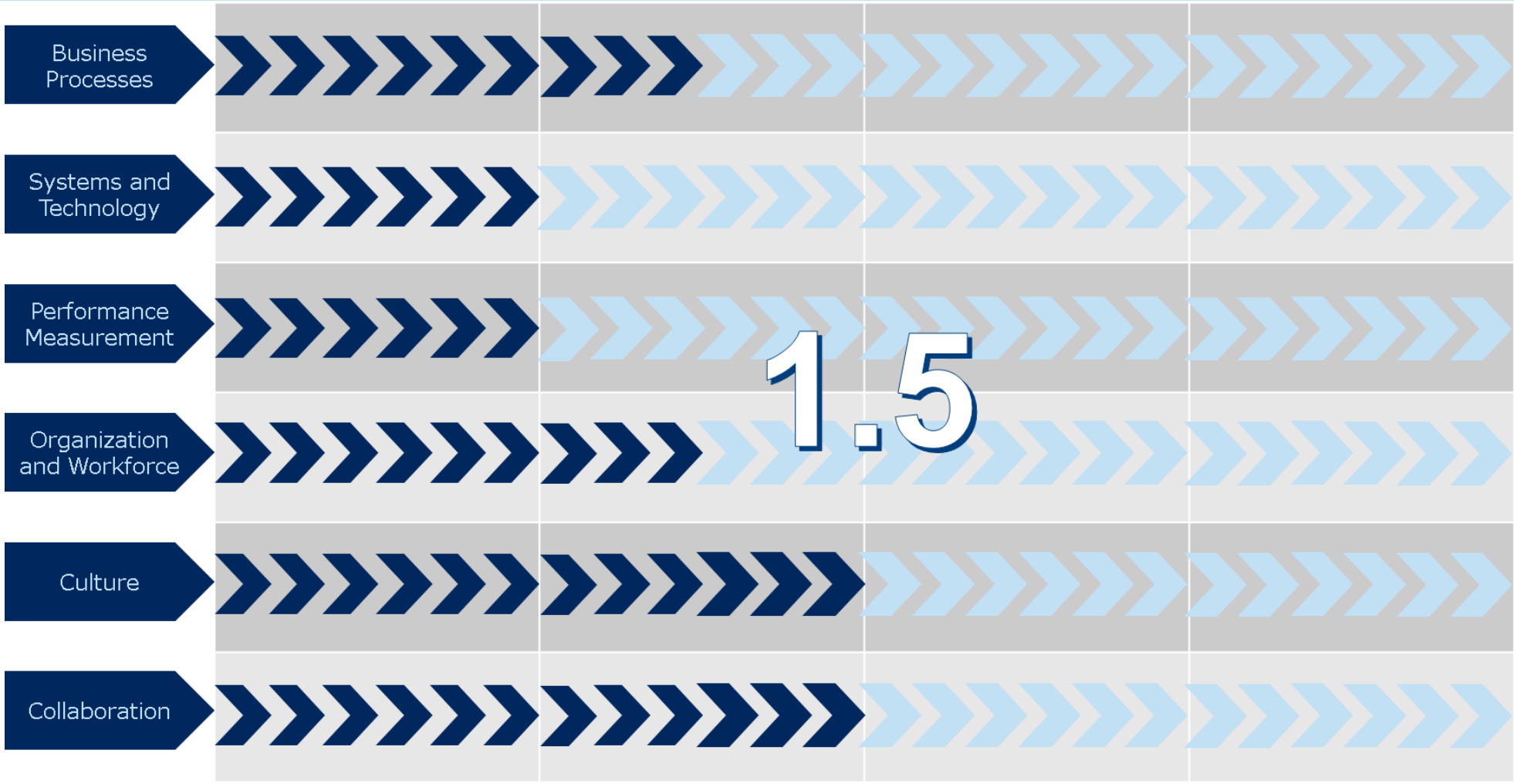
Automated Vehicle CMM Ranking



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Strategic Planning Process

Data Gathering

Internal

- Review of documents
- Interviews
- Workshops
- Current Initiatives

External

- Review of national/ federal level documents
- PA Policy Task Force
- Early Successes & Best Practices

Capability Maturity Model (CMM)

Analyzing PennDOT's CAV maturity in 6 CMM "dimensions"

Vision & Mission

Goals

1. Improve Safety
2. Enhance Mobility
3. Prepare Workforce
4. Foster and Sustain Partnerships
5. Increase Public Awareness of Benefits and Risks
6. Support Economic Competitiveness

Objectives & Recommended Steps

Data Gathering

Gaps

- Internal Coordination
- Public Sector Coordination
- Private Sector Coordination
- Funding
- Guidance
- Knowledge, Skills, Abilities
- Policy and Regulation
- Organizational Structure

Gaps

INTERNAL COORDINATION

Strengthening internal communication to support coordination within PennDOT at the District or Central Office level

PRIVATE SECTOR COORDINATION

It is imperative to engage technology firms, suppliers, and automobile manufacturers early on and begin coordination efforts

GUIDANCE

Establishing technical standards & leading the creation of guidance surrounding the integration of new technology within existing systems

POLICY AND REGULATION

Decision-making surrounding the role of CAV within federal, state, and local legal regulatory frameworks and infrastructure funding

PUBLIC SECTOR COORDINATION

Regular engagement between PennDOT and its planning partners can help in identifying pilot projects and bolster the visibility of CAV.

FUNDING

New infrastructure investments could be necessary to maximize the benefits, and many of these projects would require resources and funding.

KNOWLEDGE, SKILLS AND ABILITIES

Without upskilling and cross-training, the current workforce may render itself obsolete when CAV become the norm

ORGANIZATIONAL STRUCTURE

Coordination and support for CAV will require dedicated staffing and resources to create structure for reporting relationships and formal communication channels.

Strategic Planning Process

Data Gathering

Internal

- Review of documents
- Interviews
- Workshops
- Current Initiatives

External

- Review of national/ federal level documents
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- Early Successes & Best Practices

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- Private Sector Coordination
- Funding
- Guidance
- Knowledge, Skills, Abilities
- Policy and Regulation
- Organizational Structure

Objectives & Recommended Steps

Vision & Mission

VISION

Safe integration of connected and automated vehicles technologies within Pennsylvania's transportation system.

MISSION

Proactively contribute resources to support a safe and sustainable transportation system through adoption of connected and automated vehicles technologies across Pennsylvania.

Strategic Planning Process

Data Gathering

Internal

- Review of documents
- Interviews
- Workshops
- Current Initiatives

External

- Review of national/ federal level documents
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- Early Successes & Best Practices

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Gaps

- Internal Coordination
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- Private Sector Coordination
- Funding
- Guidance
- Knowledge, Skills, Abilities
- Policy and Regulation
- Organizational Structure

Objectives & Recommended Steps

Detailed Pennsylvania CAV Strategic Plan Outline Development

- Key Point:

For each of the nine business areas, the consultant team shall identify at least five (5) near- and long-term recommendations. The recommendations shall include:

  - Identify Foundational Needs
  - Identify Gaps
  - Identify Applicable Day 1 Uses
  - Recommend Actionable Steps
  - Identify Appropriate Level of Investment
  - Identify Timeframe
  - Document Impact to Existing and Planned Initiatives
  - Identify Metrics
  - Provide Justifications
  - Impacts to the Capability Maturity-Model

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Format of Objectives

Guide to Reading the Objectives and Strategies Section

Goals that are being addressed by each objective illustrated in blue boxes.

Lead identifies the PennDOT Office in charge of carrying out actionable steps to achieve the described objective.

Key Stakeholders identifies the key stakeholders that will and should be involved when carrying out the actionable steps under each objective.

Within the narrative, a ***justification*** for the recommendation is explained. ***Foundational needs***, ***current gaps***, applicable ***"Day 1 Benefits"*** which provide beneficial returns at the outset of work on the objective and ***potential impact*** to existing and planned initiatives.

Level of Investment identifies the appropriate level of investment including monetary, staffing, and training. This is categorized into three levels as follows:

Level	Expertise	Training	Procurement
Level 1	Low	No additional training	Likely through open-end consultant support
Level 2	Medium	Moderate training of existing staff	Likely through open-end consultant support
Level 3	Medium	Moderate training of existing staff	Stand-alone project using traditional methods
Level 4	Highly Specialized	Workforce impact analysis required	Non-traditional procurement methods, such as design-build, P3, etc.

Expertise indicates the expertise needed by the PennDOT staff to accomplish this objective. Training indicates the necessary training that will be needed to accomplish this objective. Procurement indicates the kind of procurement method that should be used to accomplish this objective.

A timeline illustration of the ***Recommended Steps*** together with ***Metrics*** (🕐) for each of these steps is identified, with the result being the accomplishment of the outlined objective. ***Immediate actions*** are noted with an asterisk (*).

CMM Impact identifies the expected dimension of the capability maturity model (CMM) that will be impacted by accomplishing this objective.

Assumptions made when developing the objectives.

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Objectives

Maintenance and Operations

- Objective 1: Identify, Document, and Address Impacts to TMC Operations
- Objective 2: Identify, Document, and Address Gaps in Roadway Maintenance Procedures
- Objective 3: Prepare Current ITS and Signal Infrastructure for CAV
- Objective 4: Establish a Roadway Conditional Data Collection Program for CAV
- Objective 5: Establish a Traffic Data Management Program for CAV

Design and Construction

- Objective 6: Assess and Update PennDOT Design and Construction Standards to Account for CAV
- Objective 7: Assess and Update PennDOT Qualified Products List for Construction to Account for CAV
- Objective 8: Assess Applicability of CAV to Grade Crossings
- Objective 9: Integrate Advanced Technologies in to Design Process
- Objective 10: User New Data Analytics Capabilities During Construction

Planning and Research

- Objective 11: Continue Strategic Planning for CAV Technologies
- Objective 12: Conformance with Systems Engineering Analysis (SEA) for CAV
- Objective 13: Establish CAV Pilot Programs That Require Inter-Agency and Cross-Sector Collaboration
- Objective 14: Integrate CAV into Long-Range Transportation Planning Across the Commonwealth
- Objective 15: Utilize PennDOT's Research Program to Advance Deployment of CAV Applications Expertise

Objectives

Information Technology and Security

- Objective 16: Modernize Communications Infrastructure for CAV
- Objective 17: Modernize IT Legacy Systems to Prepare for CAV
- Objective 18: Identify CAV Data Storage Needs/Sharing and Reporting Requirements
- Objective 19: Enhance Security
- Objective 20: Improve Service Management

Driver Licensing and Motor Vehicles

- Objective 21: Establish a Framework for Safe and Proper Testing of CAV
- Objective 22: Identify Changes to Driver Licensing Program
- Objective 23: Identify Changes to the Inspection Program
- Objective 24: Modernize Current Inspection Program Business Processes
- Objective 25: Improve the Driver and Vehicle Services Data Management System

Modal Considerations

- Objective 26: Engage and Work with Transit Partners for CAV Advancement
- Objective 27: Assess Impacts of CAV on Truck and Rail Freight
- Objective 28: Assess Impacts of CAV on Airport and Seaport Operations
- Objective 29: Assess Safety and Mobility Considerations for Pedestrians and Bicyclists
- Objective 30: Engage Disadvantaged Modal Partners in CAV Efforts

Objectives

Workforce Requirements

- Objective 31: Adjust Organizational Structure to Support CAV
- Objective 32: Provide Appropriate Training for Agency Workforce
- Objective 33: Strengthened Partnerships with Talent Sources
- Objective 34: Accelerate Technology Acceptance Through Third Party Training
- Objective 35: Create an In-Reach Plan for PennDOT Districts

Policy and Legal

- Objective 36: Coordinate with the Pennsylvania Assembly to Establish Political/Legislative Climate to Support CAV Deployments
- Objective 37: Institutionalize a Procurement Process For CAV
- Objective 38: Evaluate Effects of CAV on PennDOT Policies
- Objective 39: Identify Funding Level
- Objective 40: Create Policies to Incentivize CAV Deployment and Use

Outreach and Collaboration

- Objective 41: Increase Public Awareness of Benefits and Risks
- Objective 42: Increase External Awareness of Ongoing CAV Activities within Pennsylvania
- Objective43: Initiate Outreach to Planning Partners for CAV
- Objective 44: Create Strategic Partnerships for CAV Development (Public Sector)
- Objective 45: Create Strategic Partnerships for CAV Development (Private Sector)

Proposed Low Speed Automated Shuttle Pilots

- Implement Automate Paratransit Shuttles
- Implement Driverless Shuttles in Pennsylvania State Parks
- Deploy CAV technologies as First/Last Mile Connections in Communities with High Transit Ridership
- Deploy Driverless Shuttles at Airport Facilities between Gates

Proposed CV Freight Application Pilots

- Install Advanced Curve Speed Warning Systems
- Prioritize Freight Using CAV Technologies

Proposed Outreach Pilots

- Develop a CAV Awareness Campaign
- Develop a Community CAV Challenge
- Designate Smart Corridors

Proposed Work Zone and Fleet Vehicles Pilots

- Deploy Automated Truck Mounted Attenuators in Work Zones
- Implement a Maintenance Plan using CAV Technologies
- Implement Response Management CV Technology at Work Zones

QUESTIONS?

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How to Conduct a Capability Maturity Model Self-Assessment

Mark Kopko, Pennsylvania DOT

Pennsylvania Joint Statewide Connected and Automated Vehicle Strategic Plan

Capability Maturity Model Workshop

Capability Maturity Model Frameworks

Process Matters
Projects fail or do not achieve desired functionality for a variety of reasons unrelated to the technology.

Prioritizing the right actions
Is your agency ready? How would you know? What should you do next?

Focus on the weakest link
What is holding the agency back in becoming a leader in this area?

Capability Maturity Model Frameworks for Connected and Automated Vehicles

Process

- Adapted from software development world.
- A consensus-driven consistent structured evaluation or assessment of a process.
- Guides an agency towards a higher level of implementation, standardization, and return on investment.

Outcomes

- Clear identification of weak links in the process.
- Prioritization of areas of improvement.
- List of process-oriented actions that an agency can implement.

SHRP2 and AASHTO SOM Guidance

- **SHRP2 L06**
  - Undertook a comprehensive and systematic examination of the way agencies should be organized to successfully execute operations programs that improve travel time reliability.
  - Developed a version of Capability Maturity Model for highway operations and in turn travel time reliability.
- **AASHTO**
  - Support the conversion of the SHRP 2 Reliability Project L06 research into a web-based tool that would be user friendly, easy to access, and updatable. (NCHRP Project 03-94, Transportation Systems Operations and Management Guide).

AASHTO Guidance

http://www.aashtotsmoguidance.org/

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Capability Maturity Framework

Process Improvement Areas

Capability Levels

Dimensions or Process Area	What is it	Level 1 Ad-Hoc. Low Level of Capability	Level 2	Level 3	Level 4 Optimized. High level of capability
Business Process	Plans, Programs, Budgets	Statement of capability	..		
Systems & Technology	Approach to building systems	..	..		
Performance Measurement	Use of performance measures	..	..		
Workforce	Improving capability of workforce	..	..	..	..
Culture	Changing culture and building champions	..	..	..	..
Collaboration	Improving working relationships	..			..

Step 1. Self-assessment to assess where you are in terms of the capabilities in each area

Step 2. Identify areas of improvement and the desired levels of capability to improve program effectiveness

Identify actions that you need to take to move to the desired levels of capability

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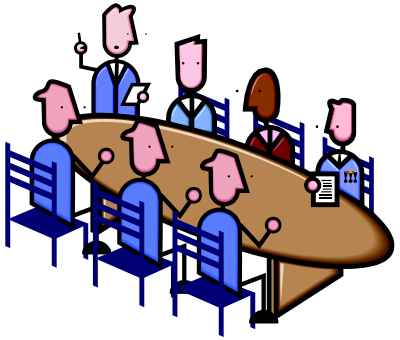
Products

- Specific agency or regional findings related to capability for various aspects of traffic management.
- Capability assessment by dimension.
- Suggested actions for improvement and advancement.



Consensus-based assessment

Dimensions or Process Area	What is it	Level 1 Ad-Hoc. Low Level of Capability	Level 2	Level 3	Level 4 Optimized. High level of capability
Business Process	Plans, Programs, Budgets	Statement of capability	..	..	..
Systems & Tech	Approach to building systems	..	..	..	..
Perf. Measurement	Use of performance measures	..	..	..	..
Workforce	Improving capability of workforce	..	..	..	..
Culture	Changing culture and building champions	..	..	..	..
Collaboration	Improving working relationships	..	..	..	..

Current capability

Prioritized actions for improvement

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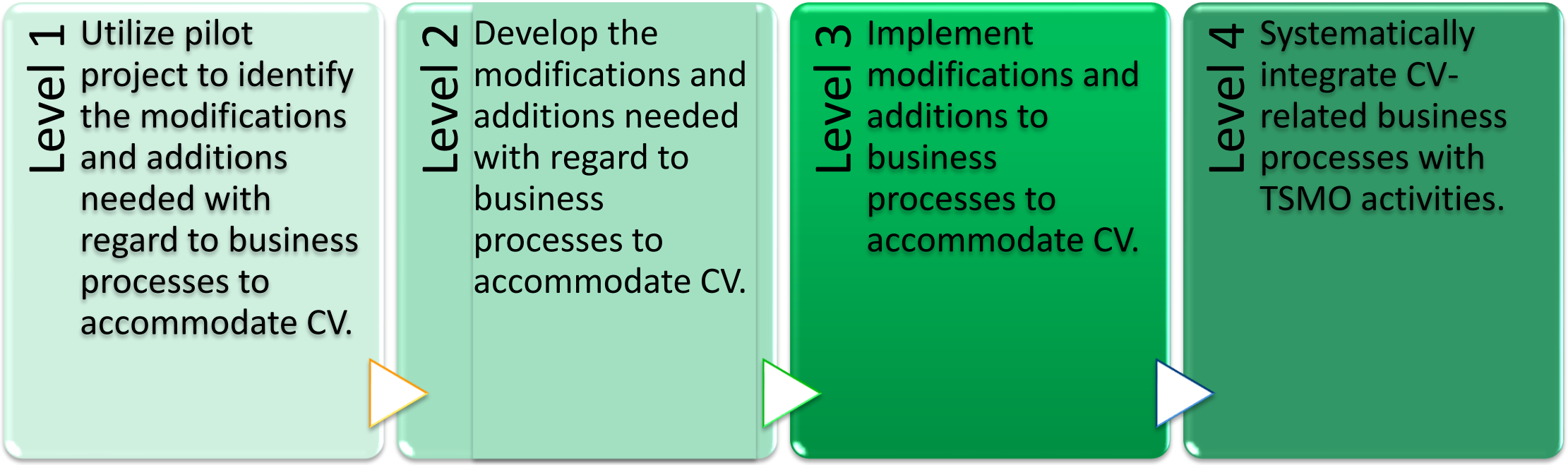
Outcomes

- Jumpstarts the improvement process.
  - Focus is on immediate weaknesses.
  - Helps prioritize key organizational changes that can have major impact.
- Provide justification for actions.
  - Actions are based on sound rationale and a consistent assessment of capability.
- Improve consistency and collaboration.

Business Processes Dimension – Connected Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: agency is conducting an initial CV pilot project(s)	State of play: agency is developing CV-oriented plan, program, budget, and project development processes	State of play: agency has developed and is in the process of implementing CV operations plan together with programing, budgeting and project develop process	State of play: a CV program is established as the basis for continuing improvement – including plan, program, and funding updates



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Systems and Technology Dimension – Connected Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: taking existing applications that are open source and/or experimental, readily available and try out a whole suite of things are not necessarily connected to each other as a system. May be more V2V safety oriented applications.	State of play: start trying 2 or 3 applications together; expand the breadth to cover a broader physical area;	State of play: start to develop standard deployment systems and/or conops for applications; more complex V2I applications	State of play: 1-3 but may also introduce PPP to incorporate more innovative and/or higher-end or cutting edge technologies; more V2X applications

Level 1 Get an agency started; build KSAs associated with the new applications and technologies; learn about the technologies and their capabilities; lessons learned.

Level 2 Build public support for technologies and systems; expand in an area or address a wider scale of operational issues beyond a localized area on the network; corridor level.

Level 3 Identify which best meet overall regional operational goals; expand the systems to the entire region and identify applications for specific needs in corridors.

Level 4 Systematically integrate CV-related business processes with TSMO activities.

Performance Measurement Dimension – Connected Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: collecting and analyzing data for specific applications; any broader benefits are simulated or extrapolated and met with low level of confidence	State of play: collecting and analyzing data for projects / corridors; less simulation needed to assess potential benefits; moderate level of confidence in performance measurement data.	State of play: using performance measurement to refine deployments and change operational parameters associated with your applications;	State of play: performance measurement is systematic, looking a multiple applications, users, and modes and the interplay between applications

Level 1 Ability to being to understand the potential benefits of the applications to address operational problems.

Level 2 To begin to understand the relationship between the CV applications and other TSMO operations and strategies.

Level 3 Establish PfM that enable agency to assess both the performance of individual CV applications in concert with TSMO strategies and the interrelationship between them.

Level 4 Use the complete suite of PfM to optimize overall system performance by mode.

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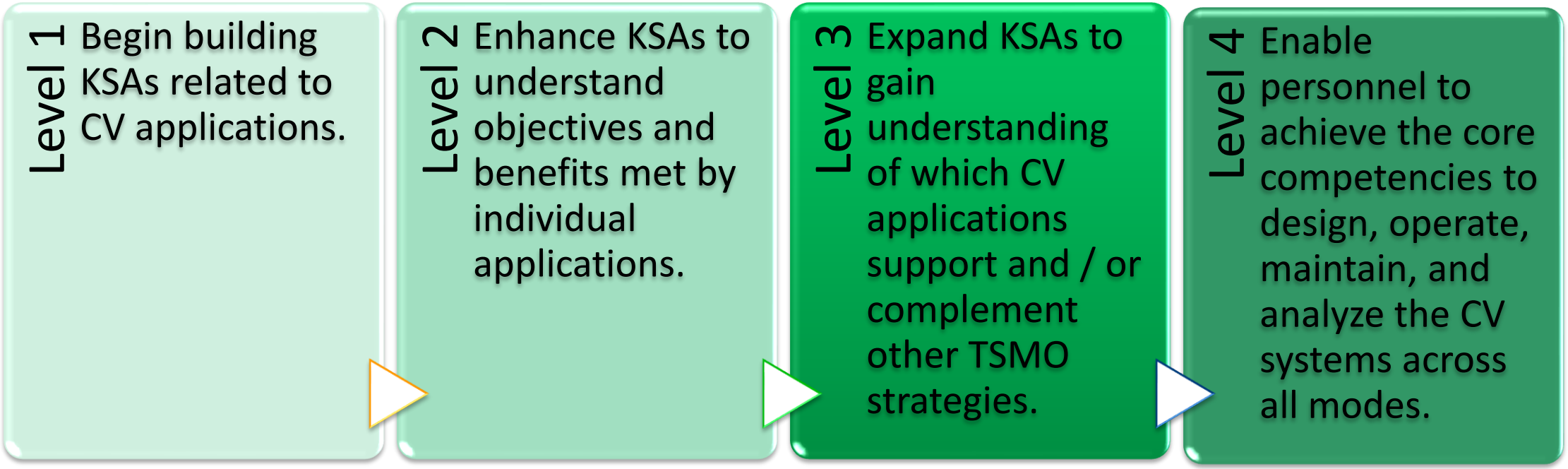
Organization and Workforce Dimension – Connected Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: will need to accomplish pilot project with existing workforce and skill sets or specialized skill sets are contracted	State of play: begin to build in-house expertise; first areas of enhanced skill sets likely to be in maintenance to keep the system operational	State of play: beginning to build expertise in operations and management; have analysts capability of managing PfM data;	State of play: have a broad spectrum of personnel to design, operate, maintain, and analyze the systems on the network and relevant data; could be outsourced;



Culture Dimension – Connected Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: CV "program" is primarily an assortment of loosely related projects and strategies; only a few champions lead the efforts.	State of play: CV technologies are recognized as valuable and a key role of the agency. Select agency managers lead efforts for CV deployments	State of play: CV technologies are recognized as a core program that coordinates with other programs on an ongoing basis.	State of play: CV program is highly integrated with related core functions, such as planning, design, construction, maintenance, etc. All agency staff members, from leadership to rank and file, embrace the importance and value of CV technologies.

Level 1 Begin the process of entering the CV arena through individual champions and projects.

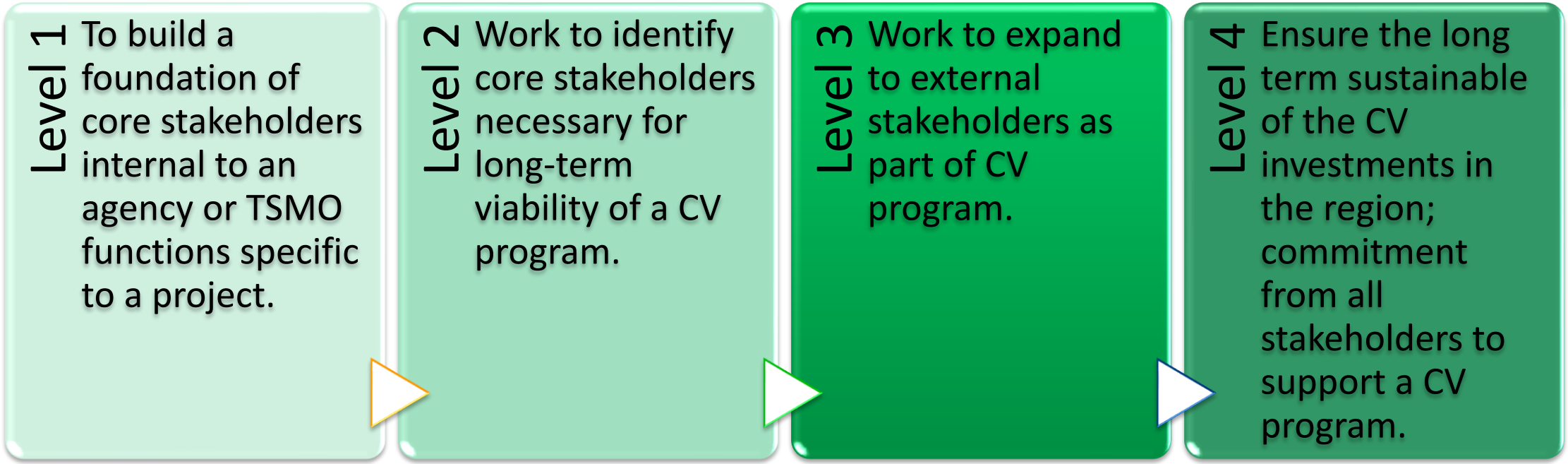
Level 2 Begin to expand the awareness and buy-in of CV program within the organization through targeted managers and/or leaders.

Level 3 Solidify the role of CV as a tool for addressing operational problems through a core program.

Level 4 Entire spectrum of organization supports and buys into CV from rank and file to agency leaders.

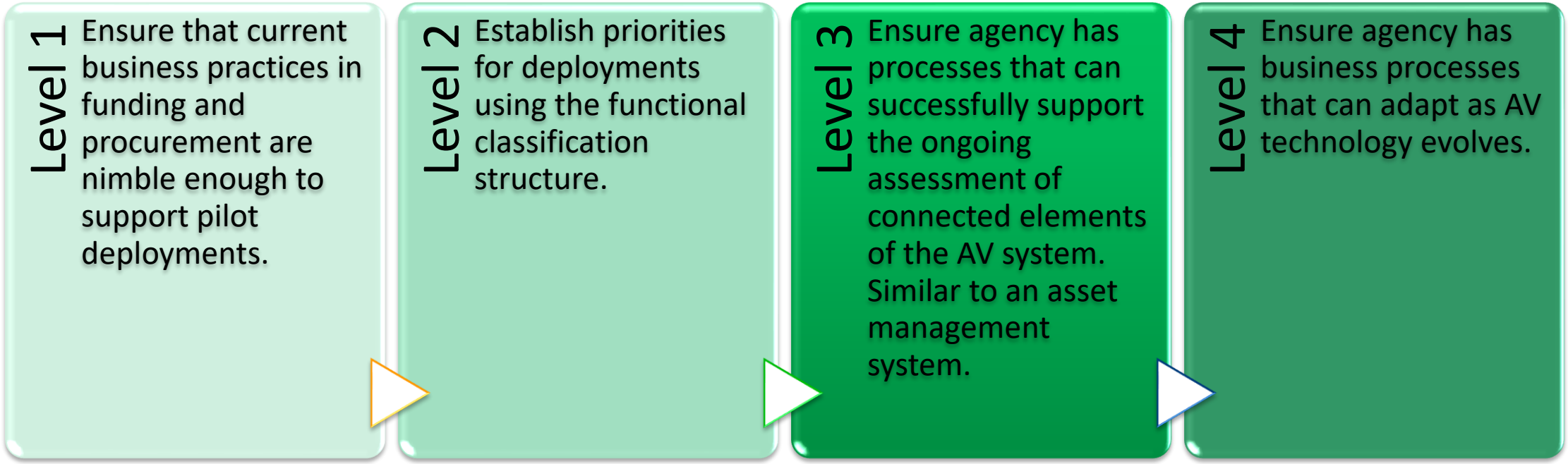
Collaboration Dimension – Connected Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: Relationships and collaboration between stakeholder organizations are informal and ad hoc.	State of play: Collaboration with stakeholders is more formal and related to specific CV projects.	State of play: Agencies collaborate on CV projects at a high level via engagement of regional stakeholders.	State of play: Agencies approach CV applications and deployments at the regional level and across modes. Ongoing strong partnerships.



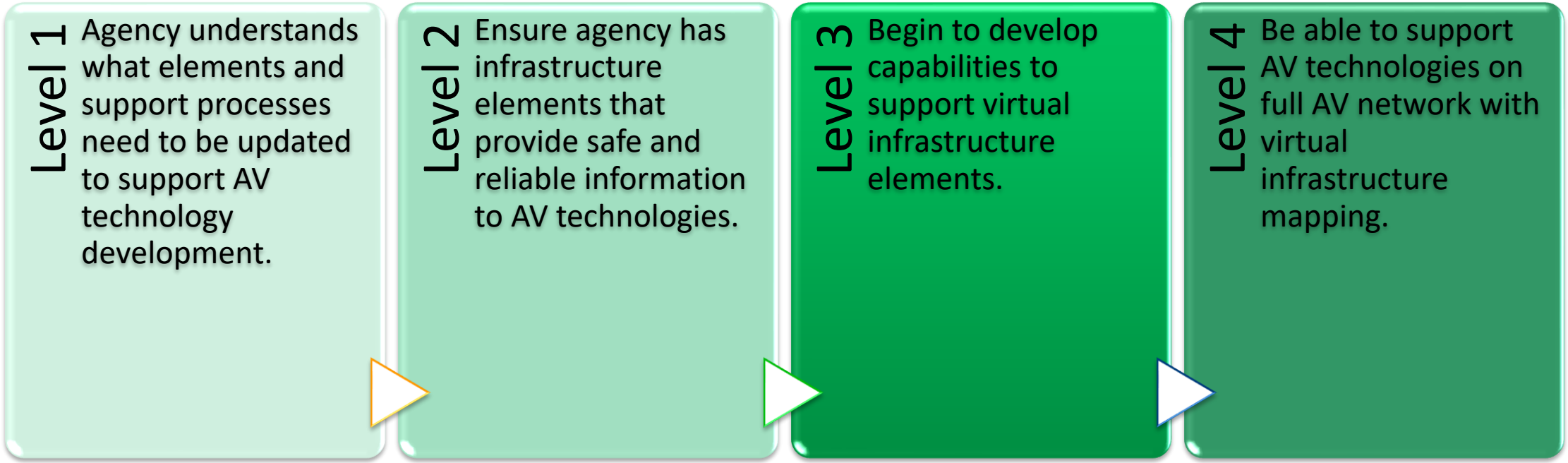
Business Processes Dimension – Automated Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: Have existing business practices that are well established for procurements and ongoing maintenance and operations.	State of play: Agency is trying to identify locations that are suitable for testing and deployment. Supported by functional classification.	State of play: Agency is developing processes to support broader deployments with respect to the connected elements and data capture.	State of play: AVs are deployed everywhere with a high market penetration. Agency needs to be able to support broad operations.



Systems and Technology Dimension – Automated Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: AV technologies deployed rely heavily on infrastructure elements of the roadway (e.g., signs, markings). Driver fully engaged in the driving process.	State of play: Automation still relies on the driver in the decision-making process. S&T play a larger role in consistent operation of AV technologies.	State of play: Beginning to replace physical infrastructure elements with virtual ones in high priority corridors.	State of play: Most physical infrastructure elements replaced with virtual ones on full AV network. Virtual maps essential.



Performance Measurement Dimension – Automated Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: Having to use existing simulation and analyses tools to determine the impacts of AV on system operations.	State of play: Performance measurement primarily event-based (e.g., weather, congestion, planned special events).	State of play: Performance measurement likely to be more trip based rather than system based in nature for the high priority corridors. Some multimodal and mobility as a service assessment possible for the corridors.	State of play: Performance measurement likely to be more trip based rather than system based in nature. Multimodal and mobility as a service assessment possible for the entire network.

Level 1 Beginning to understand the potential benefits of AV on overall system performance.

Level 2 Be able to understand the impacts/benefits of AV technologies during real-world events.

Level 3 Be able to understand the impacts/benefits of AV technologies on individual trips along high priority corridors.

Level 4 Be able to understand the impacts/benefits of AV technologies across all trips, including multimodal and mobility as a service trips, across the network.

Organization and Workforce Dimension – Automated Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: OEMs will be driving the development of the technology. Agencies will need to be able to express capabilities and limitations of existing systems and personnel.	State of play: Starting to see a shift in workforce needs that specialize in managing data and performance complex data analytics.	State of play: Workforce is changing from one responsible for a physical environment to one responsible for a virtual environment.	State of play: Workforce transformation essentially complete. KSAs in-house or outsourced to support broad AV deployments.

Level 1 Understand the roles and responsibilities of agency in supporting AV technologies and deployments.

Level 2 Identify organizational/governance structure that will facilitate and support long-term AV deployment, operations, and data analytics.

Level 3 Ensure that agency has qualified staff needed to support AV deployments in multiple corridors. Staff could be outsourced if necessary.

Level 4 Ensure agency has program for ongoing professional development and technology transfer to personnel in response to evolving technologies.

Culture Dimension – Automated Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: Limited understanding of AV technologies and potential impacts on organization and transportation infrastructure.	State of play: Agency awareness and understanding of AV technologies is fairly common at higher levels across management groups. Engagement with pilot deployments expanded beyond initial champions.	State of play: Management and key support personnel actively involved in AV deployments. Teams actively engaged in establishing direction of and engagement in AV deployments and supporting operational responsibilities.	State of play: Personnel at all levels have comprehensive understanding of AV technologies and impacts on operations. Internal groups support AV and understand roles and responsibilities and work with counterparts effectively.

Level 1 Educate staff, stakeholders, and decision-makers about AV technologies. Identify champions within organization.

Level 2 Ensure agency has the ability to facilitate and support long-term AV deployment, operations, and data analytics.

Level 3 Ensure messages and goals and objectives related to AV technologies, deployments, and supporting systems are consistent across the organization.

Level 4 Ensure agency messages and AV understanding is comprehensive and consistent across all internal groups and from leadership to rank and file personnel.

Collaboration Dimension – Automated Vehicles

Achieving Level 1 – Pilot	Achieving Level 2 – Initiated	Achieving Level 3 – Integrated	Achieving Level 4 – Mainstreamed
State of play: Limited understanding of potential benefits associated with AV technologies. Hard to distinguish reality from hype.	State of play: AV technologies generally applied to similar type facilities. Most collaborations will be public private. Automation generally proven reliable and safe in certain applications.	State of play: AV technologies are beginning to be deployed in numerous high priority facilities that cross jurisdictional boundaries More need to collaborate across multiple public agencies	State of play: AV technologies are beginning to be deployed in numerous high priority facilities that cross jurisdictional boundaries More need to collaborate across multiple public agencies

Level 1 Assist the OEMs to understand now current systems and technologies work to support AV deployment.

Level 2 Facilitate the development of public-private partnerships for showcasing technologies.

Level 3 Build relationships with private and other public entities to promote development of growth of AV technologies.

Level 4 Maintain relationships and collaborations to utilize new advances in automation.

pennsylvania DEPARTMENT OF TRANSPORTATION

QUESTIONS?

Mark Kopko
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Poll Question #1

1

Please select your top **three** recommended CAV activities (pulled from the December Workshop report) that the Coalition should focus on next:

___ Develop a CAV Academy (like the Operations & Freight Academy)
___ Compile lessons learned for pilots
___ Share key research insights
___ Harness regional funding opportunities
___ Promote data consistency and interoperability
___ Develop a member document library
___ Gather examples of open data portals

Poll Question #2

2 Are there any other activities (not listed in poll 1), that you think the Coalition should focus on as next steps?

___ Type in your response!

Poll Question #3

3 Has your agency completed a CAV roadmap, strategic plan, or business plan?

___ Yes
___ No
___ I am not sure

Poll Question #4

4 If your agency has <u>not</u> completed a CAV plan, what are the top three reasons why you have not undertaken this:

___ Our leaders are not focused on this area
___ We don't see a need for this right now
___ We would like to, but don't have the resources (either internally or to hire a consultant) to do this
___ We are planning to, but have not gotten started yet
___ Other

Poll Question #5

5

If the Coalition could help facilitate the contracting for a CAV capability maturity model, would your agency be interested in learning more about that?

___ Yes
___ No
___ Maybe

Open Discussion & Wrap Up

Ginna Reeder, I-95 Corridor Coalition

Questions?

In Closing….

Thank you for joining today

For Additional Information, please contact:

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Update on AMPO CAV Work Group

Please direct questions to:

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AMPO CAV Work Group Overview

- Purpose: develop National Framework for Regional Connected and Automated Vehicle Planning
  - Framework will assist MPOs with incorporating CV/AVs into metropolitan transportation planning process
- 15-20 members from range of MPOs and FHWA
- Held 4 meetings over last 18 months
  - summaries of each meeting are posted as white papers on AMPO web page, www.AMPO.org
- Holding CAV Summit Nov 14-15 with CAV Work Group members as well as reps from other MPOs and other organizations
  - Purpose to discuss and refine Framework document

Framework Overview

- Introduction and importance of MPO
- Summary of potential impacts of CV/AV technologies on transportation and mobility
- High level recommendations in general areas relevant to all MPOs:
  - Engagement, coordination, and collaboration
  - Metropolitan Transportation Plan
  - Investment decisions and the TIP
  - Other planning products and processes
  - Institutional readiness
- Includes list of resources