Vehicle-to-Infrastructure State of the Practice Review

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What's an Agency to do?

"The transportation community can choose to wait and react. Or, decision makers can reframe the conventional public policy discussion to responsibly and assertively advance AV and CV technologies…"

NCHRP Research Report 845, *Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies*

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CV State-of-the-Practice Review
Orange County Transportation Authority

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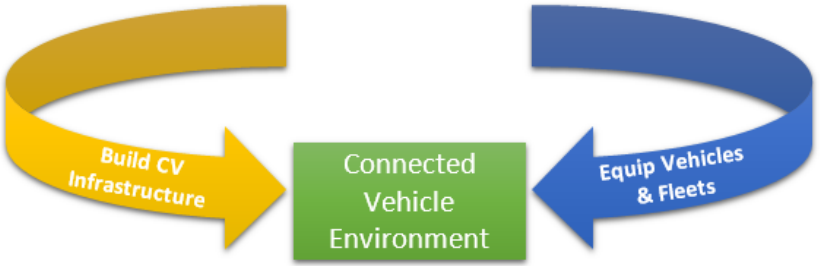
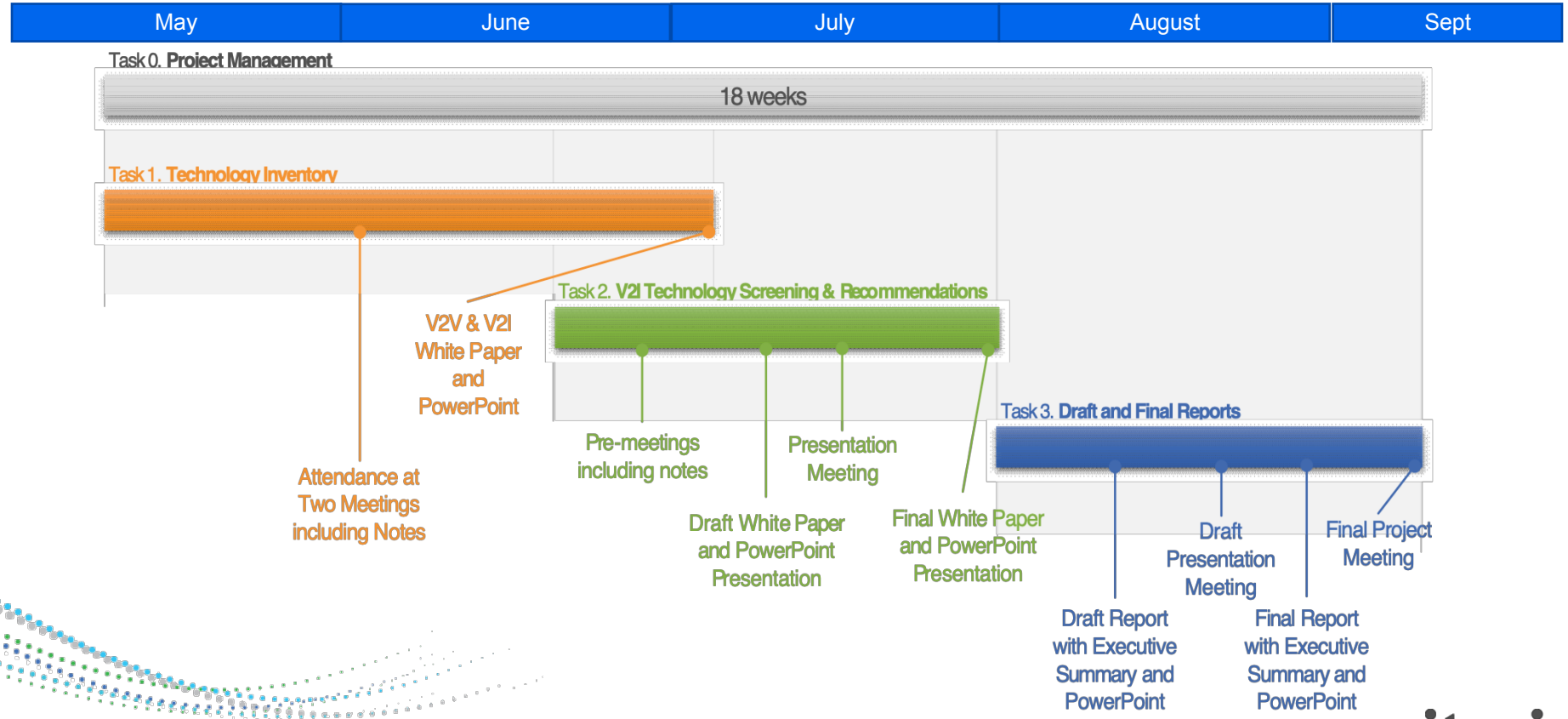
Project Goal

Determine current and future roles related to V2I technologies

Technology review of connected vehicle technologies with an emphasis on V2I for signal synchronization program

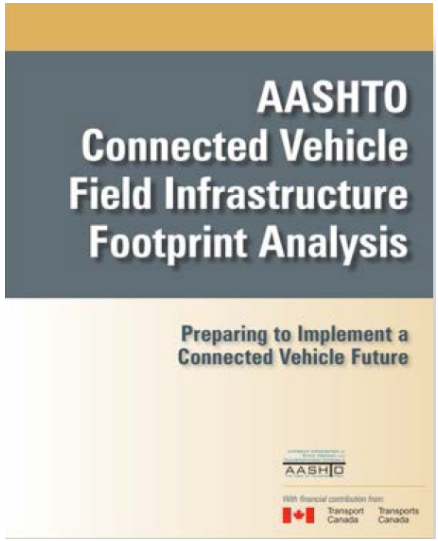


Project Schedule



Sources for Research

- CV Test Beds
- Pilot Deployments
  - NYCDOT
  - Tampa-Hillsborough Expressway Authority (THEA)
  - WYDOT
- Smart City Challenge
- OSADP - Open Source Application Development Portal (USDOT)
- RDE – Research Data Exchange
- AASHTO CV Field Infrastructure Footprint



CV Field Test and Deployment

SPaT deployment underway

SPaT deployment operational

*SPaT Challenge
**National Operations Center of Excellence

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Application Identification

- USDOT has identified numerous CV applications in various stages of development.
- Categorized into seven major areas:
  1. V2I Safety
  2. V2V Safety
  3. Agency Data
  4. Environment
  5. Road Weather
  6. Mobility
  7. Smart Roadside

1

V2I SAFETY

- Red Light Violation Warning
- Curve Speed Warning
- Stop Sign Gap Assist
- Spot Weather Impact Warning
- Reduce Speed/Work Zone Warning
- Pedestrian in Signalized Crosswalk Warning

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V2V SAFETY

- Emergency Electronic Brake Lights
- Forward Collision Warning
- Intersection Movement Assist
- Left Turn Assist
- Blind Spot/Lane Change Warning
- Do Not Pass Warning
- Vehicle Turning Right in Front of Bus Warning (Transit)

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AGENCY DATA

- Probe-based Pavement Maintenance
- Probe-enabled Traffic Monitoring
- Vehicle Classification Traffic Studies
- CV-enabled Turning Movement and Intersection Analysis
- CV-enabled Origin-Destination Studies
- Work Zone Traveler Information

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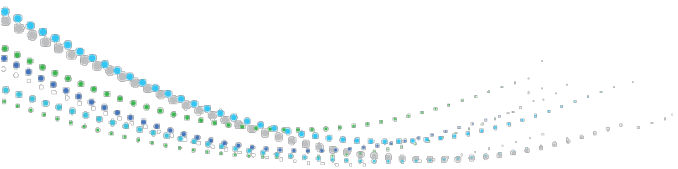

4 ENVIRONMENT

- Eco-Approach and Departure at Signalized Intersection
- Eco-Traffic Signal Timing/Priority
- Connected eco-Driving
- Wireless Inductive/Resonance Charging
- Eco-Lanes Management
- Eco-Cooperative Adaptive Cruise Control
- Eco-Speed Harmonization
- Eco-Traveler Information
- Eco-Ramp Metering
- Low Emissions Zone Management
- AFV Charging/Fueling Information
- Eco-Smart Parking
- Dynamic Eco-Routing (light vehicle, transit, freight)
- Eco-ICM Decision Support System

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ROAD WEATHER

- Motorists Advisories and Warnings
- Enhanced MDSS
- Vehicle Data Translator
- Weather Response Traffic Information

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MOBILITY

- Advanced Traveler Information
- Intelligent Traffic Signal System
- Signal Priority (transit, freight)
- Mobile Accessible Pedestrian Signal System
- Emergency Vehicle Preemption
- Dynamic Speed Harmonization
- Queue Warning
- Cooperative Adaptive Cruise Control
- Incident Scene Pre-Arrival Screening
- Emergency Responders Guidance
- Incident Scene Work Zone Alerts
- Drayage Optimization
- Emergency Communications and Evacuation
- Connection Protection
- Dynamic Transit Operations
- Dynamic Ridesharing
- Freight Specific Dynamic Travel
- Planning and Performance

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SMART ROADSIDE

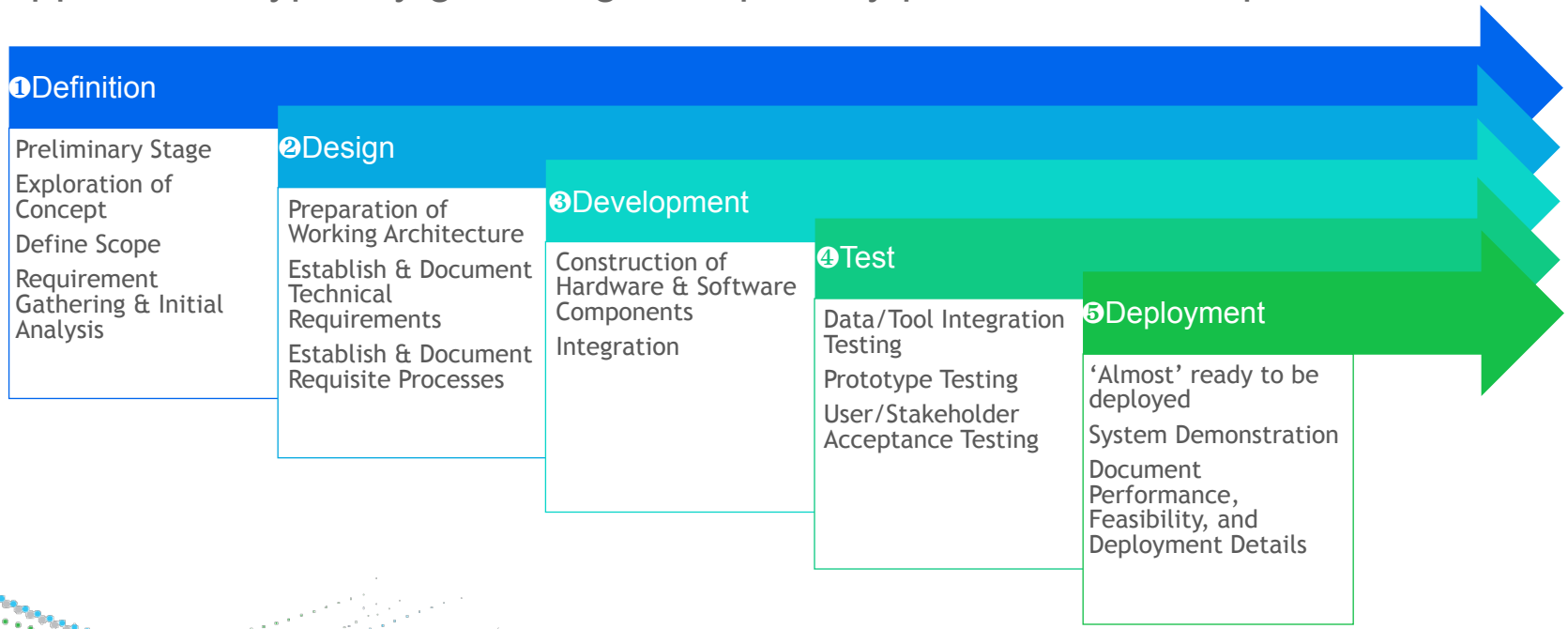
- Wireless Inspection
- Smart Truck Parking

Shortlist of Applications

APPLICATION GROUP	APPLICATION BUNDLE	APPLICATION
Mobility	Enable ATIS	Advanced Traveler Information System (mobility)
	Multimodal Intelligent Traffic Signal Systems (MMITSS)	Intelligent Traffic Signal System (I-SIG)
		Freight Signal Priority (FSP)
		Transit Signal Priority (TSP)
		Mobile Accessible Pedestrian Signal System (PED-SIG)
		Emergency Vehicle Preemption (PREEMPT)
	Integrated Network Flow Optimization (INFLO)	Dynamic Speed harmonization (SPD-HARM)
		Queue Warning (Q-WARN)
		Cooperative Adaptive Cruise Control (CACC)
	Response, Emergency Staging and Communications, Uniform Management, and Evacuation (R.E.S.C.U.M.E.)	Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
		Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
		Emergency Communications and Evacuation (EVAC)
Mobility	Integrated Dynamic Transit Operations (IDTO)	Connection Protection (T-CONNECT)
		Dynamic Transit Operations (T-DISP)
		Dynamic Ridesharing (D-RIDE)
	Freight Advanced Traveler Information Systems (FRATIS)	Freight-Specific Dynamic Travel Planning and Performance (FRATIS)
		Drayage Optimization (DR-OPT)

Evaluation

Applications typically go through five primary phases of development



Evaluation

1. Application readiness:
   - Concept of Operations had been developed and published
   - Simulation or modeling had been undertaken
   - Field tested or demonstrated
   - Application was incorporated as part of the USDOT Pilot Deployment Program or the Smart City Challenge

When is an application considered to be “ready”?

- When there is a clear understanding of the functionality of the application
- When it has the same expected degree of performance over time
- When limitations are known and could be addressed

Evaluation

2. Complexity

Three high-level concepts:

- Institutional – Stakeholder participation, documentation,…
- Technical – Functionality of the application, development processes/ schedule,…
- Risk – Application complexity, feasibility of the application,...

Any single one of the above is insufficient to judge whether the application is ready for deployment, but their combination provides real insights on the actual state of the application.

Evaluation - Complexity

Institutional – covers aspects pertaining to but not restricted to stakeholder involvement. It represents the sustainability of the defined application. The aspects categorized under institutional concept are:

- Management of Collected Data
- Back Office Services/Applications
- Benefits vs. Deployment Level
- Other Dependency

Evaluation - Complexity

Technical – covers aspects which contribute to the functionality of the application. It represents the workability of the application and includes:

- Physical RSU Installation
- Roadside Interface to Local Systems
- Backhaul Communications
- Vehicle Data Connection
- Data Needs from OBU
- Data Needs from Infrastructure

Evaluation - Complexity

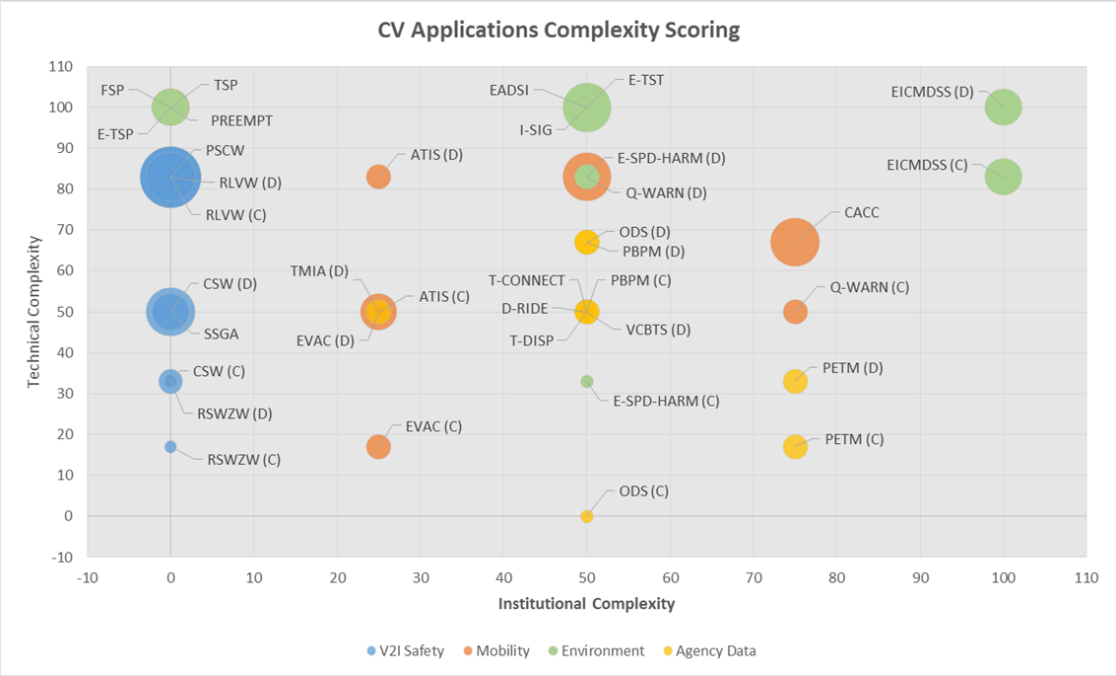
Risk – covers aspects pertaining to application complexity, which would make the application harder to deploy. It represents the feasibility of the application. The aspects categorized under risk concept are:

- Backhaul Restriction
- Mapping Support
- Siting Dependency
- Latency

Complexity Score

- Computed for each application
- Data Availability:
  - 2014 AASHTO CV Field Infrastructure Footprint Analysis
  - Open Source Application Development Portal (OSADP)
  - Research Data Exchange (RDE)
- Components:
  - Institutional complexity
  - Technical complexity
  - Risk Level
- Lower score = Easier deployment

Complexity Score Visualization



Recommendations

- Standardize Traffic Signal Controller Equipment
  - Only 11.8% of all traffic signal controllers currently deployed are ATCs
- Provide Guidance in Communications Technology
  - OCTA should remain technology agnostic
- Support Local Agency Technology Deployment & Management
  - OCTA as a broker or program manager
  - OCTA could provide support services via existing on-call bench contracts

Recommendations (Cont'd)

- Continue to Invest in a Communications Backbone
  - OCTA should evaluate the expansion of fiber optic communications links
  - OCTA could facilitate streamlined permitting for private wireless broadband
- Gather and Use Data
  - OCTA should foster relationships with local academic institutions
- Maintain a State of Good Repair
  - OCTA to lead/guide local agency prioritization and funding of O&M

Thank You!