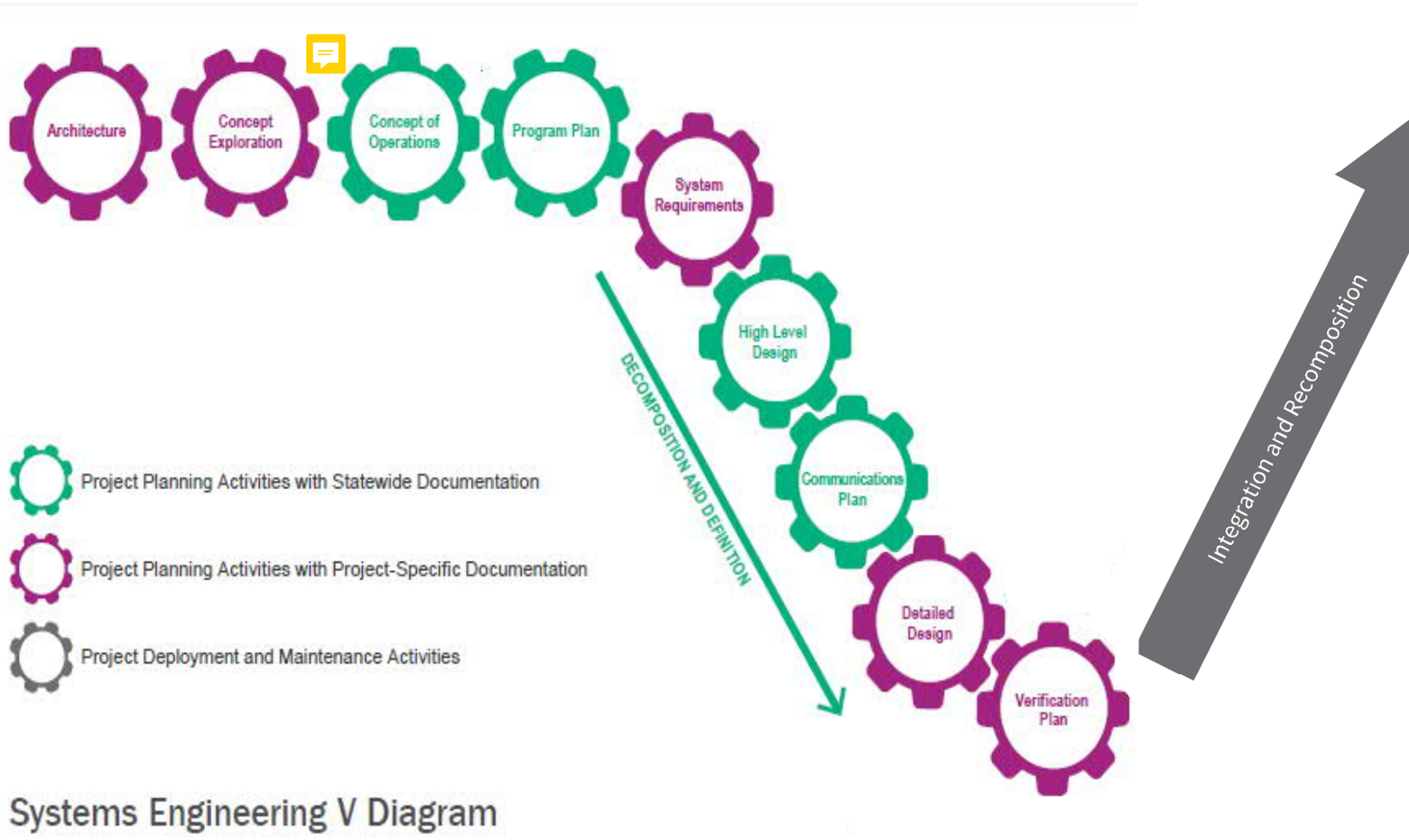
CV/AV Systems Engineering Guidebook

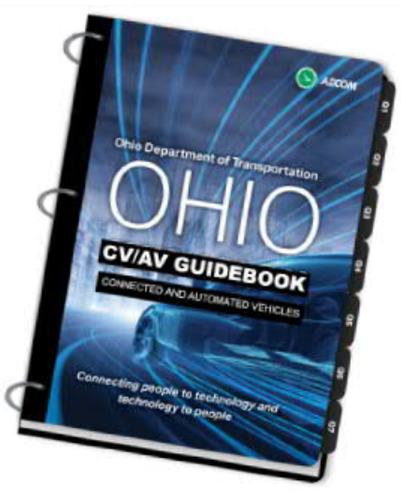
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Systems Engineering V Diagram

Ohio CV/AV Systems Engineering Guidebook

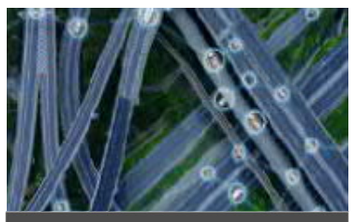
DriveOhio initiated a Systems Engineering Analysis (SEA) to create a statewide Guidebook for Connected and Automated Vehicle (CV/AV) technology deployments across the state. The tools provided in this Guidebook are a resource for planning and deploying CV/AV projects across urban, suburban, and rural communities. The Guidebook promotes consistency and interoperability among CV/AV technologies and supporting systems as they are implemented through ongoing, planned, and future projects by a wide range of stakeholders.



Quick Links to Guidebook Materials



Starting a CV/AV Project



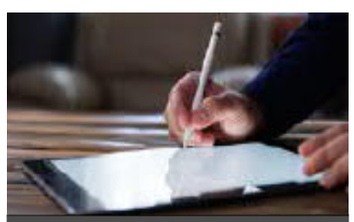
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Design and Verification



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Featured Content



Program Plan

Summarizes guidance for CV/AV deployers

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Statewide CV/AV Concept of Operations

Provides project-level ConOps template

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Requirements Guidance

Guidance on developing project-specific requirements based on the statewide framework

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Security Checklist

Security actions checklist based on project components

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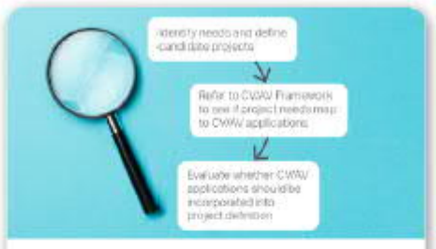
System Requirements Preparation

Security Guidance

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Starting a CV/AV Project



CV/AV Project Workflow

Depicts the project development process for Ohio CV/AV projects

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Candidate CV Applications for Ohio

Provides a listing of CV Applications that may address transportation project needs in the State of Ohio

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CV/AV Project Workflow

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Technology deployments, like CV/AV projects, apply the Systems Engineering process, which starts with identifying the project needs and goals and then establishes responsibilities and functional requirements before preliminary design starts. Combining the Systems Engineering process with the ODOT Project Development Process yields the CV/AV Project Development Workflow, below. A workflow diagram that identifies reference documents and deliverables for each step of the CV/AV Project Development Workflow may be found at the link below.

Project Identification

1 Identify primary needs

2 Establish goals and objectives

3 Map needs to CV/AV applications

Systems Engineering

4 Complete SERF

5 Select functional requirements

6 Confirm requirements meet goals/obtain project approval

Design and Procurement

7 Develop conceptual design

8 Develop final design documents

9 Procurement and construction

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CV/AV Project Development Workflow

View reference documents and deliverables for each step of the workflow

Candidate CV Applications for Ohio

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As part of the Statewide CV/AV systems engineering analysis, numerous candidate applications for the State of Ohio were identified. A catalog of these applications, including descriptions of each application's purpose and expected benefits is provided in the table, linked below. This information can be referenced when considering technology solutions that may benefit planned transportation projects.

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For more information

Ohio Candidate CV Applications

View catalog of Ohio CV applications

CV/AV Systems Engineering Guidebook

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Planning Tools

CV/AV Systems Engineering Review Form (SERF)

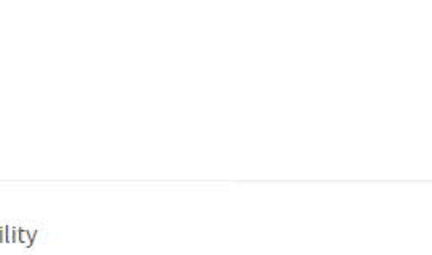
Includes project planning questionnaire and to initiate project approvals process

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Statewide CV/AV Architecture

Illustrates the integration of CV/AV and ITS projects

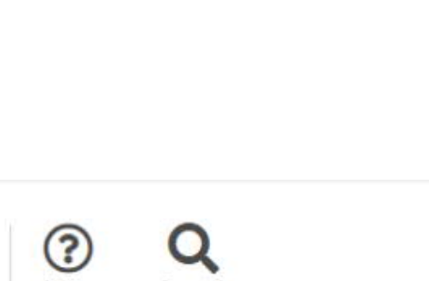
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Statewide CV/AV Concept of Operations

Provides project-level ConOps template

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Concept of Operations Template

Describes the suite of need-based CV/AV applications for potential implementation

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CV/AV Systems Engineering Review Form (SERF)

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CV/AV projects in the State of Ohio must undergo a Systems Engineering Analysis, which begins with the completion of the ODOT CV/AV System Engineering Review Form (SERF). The SERF must be completed during the Planning phase of the ODOT Project Development Process (PDP). This SERF shall be returned to DriveOhio, who will then determine if the project is Low Risk or High Risk:

Low Risk: The completed SERF and the Functional Requirements document for the selected Project Category in Number 4 above will then serve as the basis to determine the required documentation needed for the project.

High Risk: A project-specific Systems Engineering Analysis shall be performed per TEM Part 13 and additional discussion with the DriveOhio team is required.

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For more information

CV/AV Systems Engineering Review Form (SERF)

View ODOT CV/AV SERF

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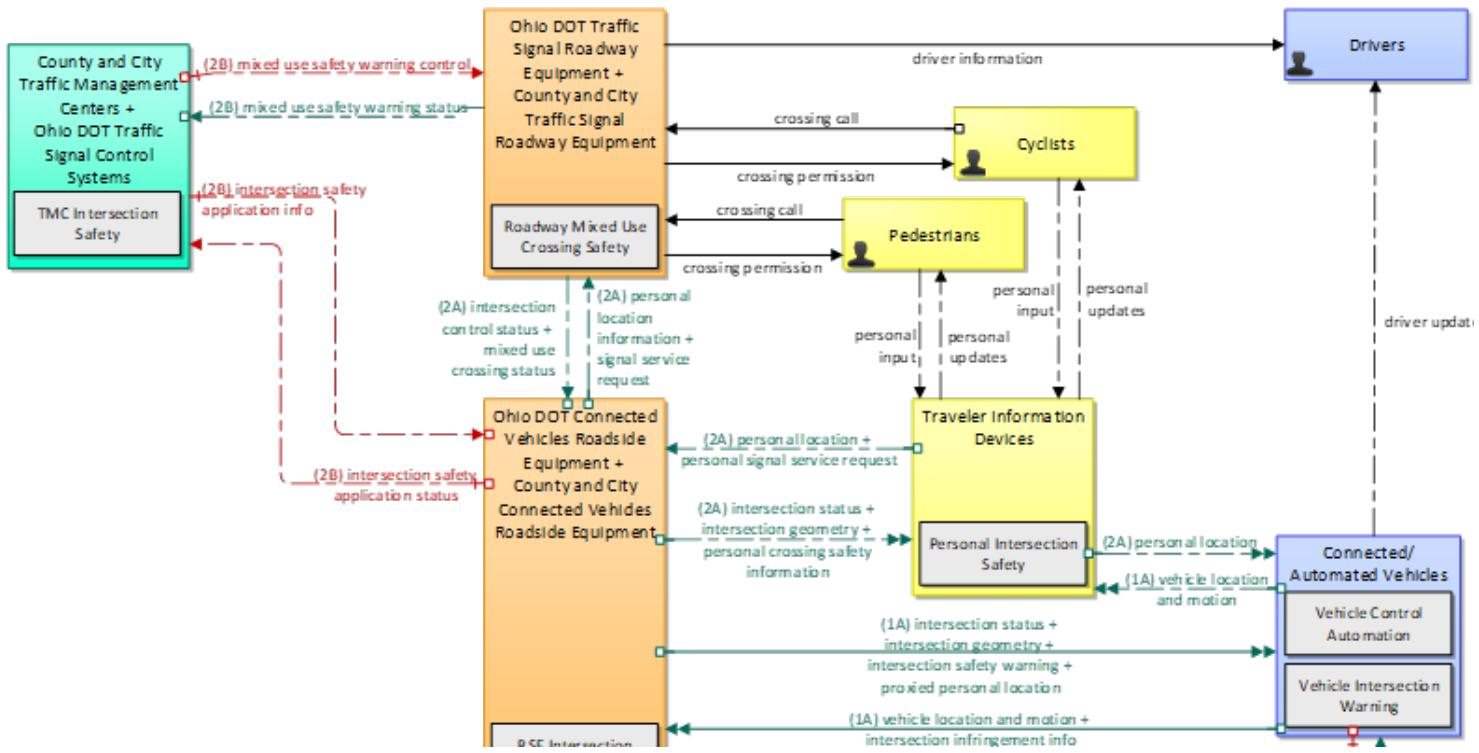
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Statewide CV/AV Architecture

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The Ohio Statewide CV/AV Architecture describes coordination of overall system operations by defining interfaces between equipment and systems which have been or will be deployed by different organizational or operating agencies in the state. The Architecture identifies the current and future CV/AV initiatives and how these systems interact and integrate with each other. It also builds on the existing CV/AV and ITS systems, addressing the additional components deemed necessary to grow the CV/AV applications in Ohio accommodate specific needs and issues of stakeholders.

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For more information

Ohio CV/AV Architecture Report

View Statewide CV/AV Architecture Report

Regional Architecture Development for Intelligent Transportation (RAD-IT) Software Outputs

View Statewide CV/AV Architecture RAD-IT outputs

Service Package Diagrams

View Statewide CV/AV Architecture service package diagrams

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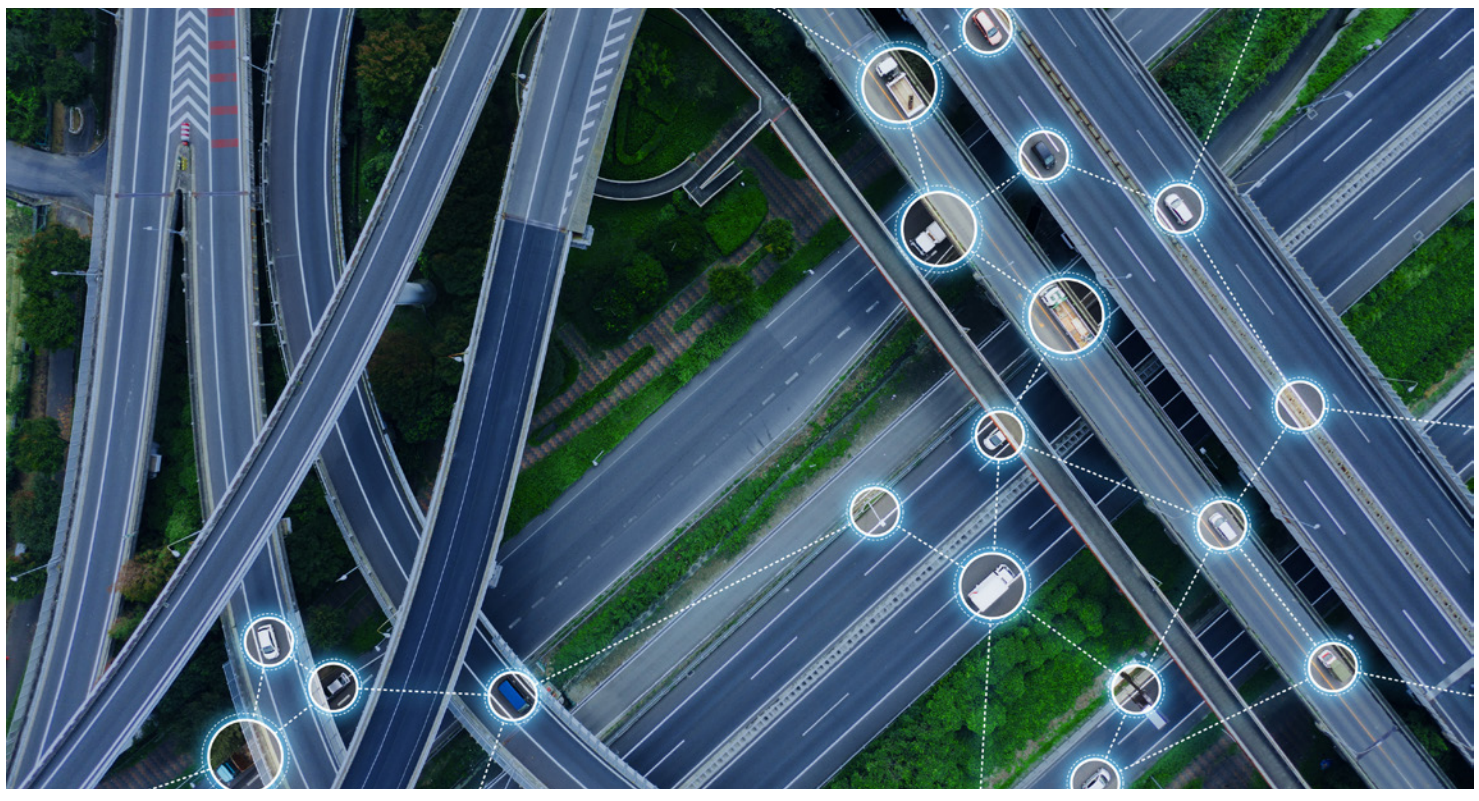
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Statewide CV/AV Concept of Operations

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The Ohio CV/AV Concept of Operations (ConOps) provides a high-level description of how CV/AV applications can be implemented in a coordinated manner to deliver needed transportation services. This includes the identification of stakeholder roles and responsibilities for CV/AV applications, including the data they share to deliver those services.

Building on the Ohio Statewide CV/AV Architecture, this ConOps describes the state of existing transportation systems in Ohio; presents the justification for changes to those systems in support of CV/AV; outlines a proposed system concept for identified CV/AV functions, including an ODOT Event Streaming Platform that will enable this functionality; details operational scenarios to demonstrate the influence of CV/AV in the delivery of transportation services; and describes anticipated impacts and performance measures for the proposed system concept.

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For more information

Ohio CV/AV Concept of Operations Report

View Statewide CV/AV ConOps Report

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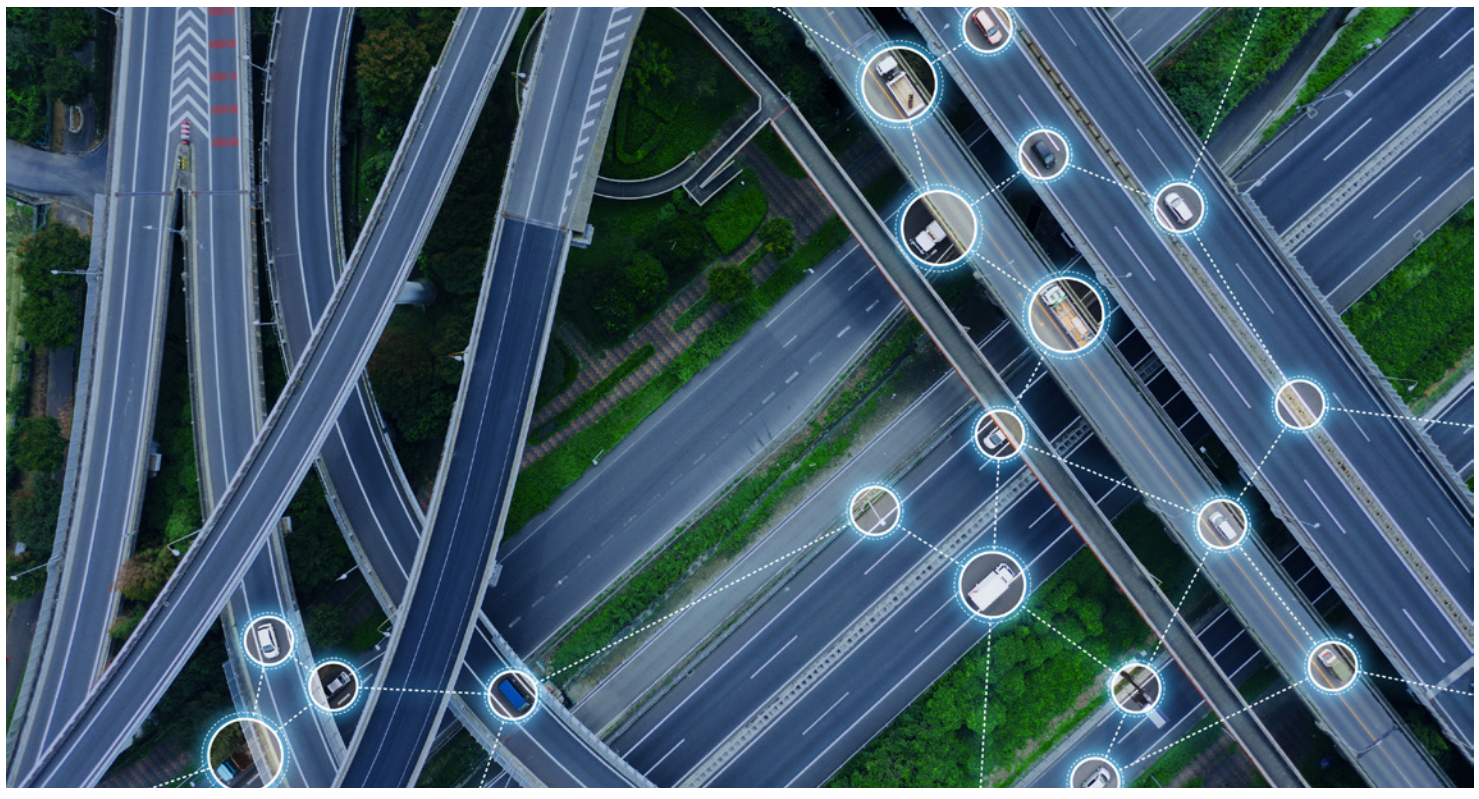
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Concept of Operations (Project Specific Template)

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CV/AV projects in the State of Ohio will require a project-specific Concept of Operations (ConOps) to describe the proposed project from a user's perspective. A ConOps template is provided here to give project owners a head start in identifying expected components to be included in project-level ConOps documentation.

Systems Engineering documentation, including a project-specific ConOps, was prepared for the I-90 Lake Effect Corridor project in accordance with the approach and guidelines featured in the Statewide CV/AV Systems Engineering Guidebook, Under this project, ODOT seeks equip 60 miles of I-90 with road side units (RSUs) that send and receive data from properly-equipped public service vehicles, potentially including snow plows, and other connected vehicles (CVs). The data, combined with new variable speed limit signs, will help local officials and law enforcement better manage the roadway to reduce crashes and fatalities, especially during heavy snow events. Exemplary documents from this project-specific SEA are provided here.

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For more information

Ohio CV/AV Project ConOps Template

View CV/AV ConOps Template

I-90 Lake Effect Corridor (Phase 2) project SERF

View project-specific SERF for I-90 project

I-90 Lake Effect Corridor (Phase 2) existing and proposed maps

View I-90 project existing conditions map and conceptual RSU site location map

I-90 Lake Effect Corridor (Phase 2) ITS Architecture Update

View I-90 project ITS architecture update

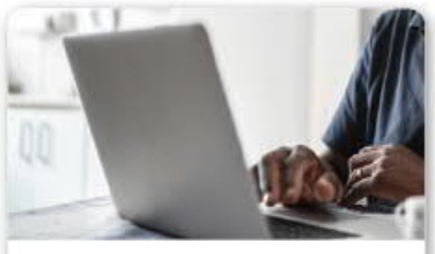
I-90 Lake Effect Corridor (Phase 2) ConOps

View I-90 project ConOps

CV/AV Systems Engineering Guidebook

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System Requirements Preparation



Requirements Guidance

Guidance on developing project-specific requirements based on the statewide framework

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System Requirements Workbook

Provides line by line requirements for the systems, applications and supporting software

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Requirements Modification Form

Approval form for additions/ modifications to the System, Software and Security Requirements

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Ohio Standards for 5.9 GHz Channel Use, PSIDs and SSP

Guidance on Ohio standards for communication messages

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Requirements Guidance

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The Requirements Guidance document introduces the line-by-line requirements workbook and other materials that support project-level system requirements development.

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Ohio CV/AV System and Software Requirements Report

View report providing guidance on developing project-specific requirements documentation

System, ~~Software and Security~~ Requirements Workbook

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The Ohio CVAV Requirements Workbook gives users a collection of functional requirements for all CV/AV deployments in the State of Ohio. Project owners should utilize requirements from this document as a baseline for assembling project-specific requirements and procurement documentation. These requirements support overall function of any CV application and set the stage for interoperability among different deployments.

Support environment requirements for the CV/AV system are organized into three focus areas will corresponding subsets of requirements: General, System Security and Privacy, and Core Services. Functional requirements for each candidate Ohio CV application are categorized into eight application groups with corresponding subsets of requirements.

Refer to the Requirements Guidance for additional information on how to use the requirements workbook.

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For more information

Ohio CV/AV System, Software and Security Requirements Workbook

View complete set of CV/AV system, software and security requirements

Ohio CV/AV General Requirements

View subset of general requirements

Ohio CV/AV System Security and Privacy Requirements

View subset of security requirements

Ohio CV/AV Core Service Requirements

View subset of core service requirements

Ohio CV/AV V2I Application Requirements

View subset of V2I application requirements

Ohio CV/AV Environmental Application Requirements

View subset of environmental application requirements

Ohio CV/AV Road Weather Application Requirements

View subset of road weather application requirements

Ohio CV/AV Mobility Application Requirements

View subset of mobility application requirements

Ohio CV/AV Smart Roadside Application Requirements

View subset of smart roadside application requirements

Ohio CV/AV Agency Data Application Requirements

View subset of agency data application requirements

Requirements Modification Form

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The Ohio CV/AV Requirements Workbook provides baseline specifications for Statewide CV/AV deployments. CV/AV Project owners may need to define additional requirements to identify performance and data requirements specific to their deployment or include requirements defined by the project location and local use of the application. All proposed additions and modifications to the Requirements Workbook will require approval by DriveOhio to ensure Statewide consistency and allow for incorporation, where appropriate, into the Statewide Requirements Workbook. The CV/AV Requirements Modification Form can be downloaded below.

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For more information

Ohio CV/AV Requirements Modification Form

View form for requesting modifications to CV/AV requirements

Ohio Standards for 5.9 GHz Channel Use, PSIDs and SSPs

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5.9 GHz channel utilization, message Provider Service Identifiers (PSIDs) and message Service Specific Priorities (SSPs) currently vary by deployment throughout the country. A consistent standard for each of these parameters in the State of Ohio was determined based on an examination of CV channel utilization for current and planned deployments within Ohio, as well as information gathered from nationwide deployments and standardization efforts. CV applications deployed in the State of Ohio will be required to conform with these parameters to ensure interoperability of applications across the state.

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Ohio Standards for 5.9 GHz Channel Use, PSIDs and SSPs

View guidance on Ohio CV project message communications and channel utilization

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Security Guidance



Security Requirements Workbook

Provides line by line security and privacy requirements

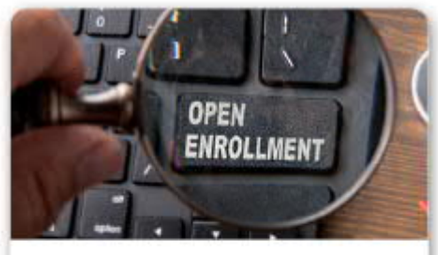
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Security Checklist

Security actions checklist based on project components

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Ohio CV Device Enrollment Process

Enrollment process to ensure operational project devices

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Security Checklist

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The CV/AV Security Checklist provides guidance on the security actions required for all CV/AV project stages including planning, design, procurement, deployment and operations.

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Ohio CV/AV Security Checklist

View project checklist to guide required security actions

Ohio CV Device Enrollment Process

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All CV devices that participate in the SCMS, including onboard units, roadside units and back-office computing systems, must go through an enrollment process to establish a trust relationship between the CV device and the SCMS infrastructure. The integrity of the connected vehicle system requires that only authorized devices are enrolled and that each device receives the correct credentials to operate within the infrastructure. The device enrollment procedures for infrastructure owner operators (IOOs) and contractors may be downloaded below.

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Ohio CV Device Enrollment Process

View guidance on CV device enrollment process

CV/AV Systems Engineering Guidebook

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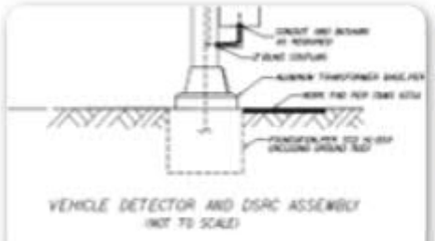
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Design and Testing



Detailed Design

Provides construction drawings for infrastructure components

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Test Plan Template

Provides test plan template to verify application requirements

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Detailed Design

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Know Our Projects

A set of standard ODOT construction drawings for roadside CV ITS equipment was compiled for use on Statewide CV projects. Additional, location-specific drawings may need be developed to provide site-specific installation details.

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Ohio Standard Construction Drawings for CV ITS Equipment

View set of standard CV project construction drawings

~~Verification~~ Plan Template

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CV/AV projects require the development of ~~verification~~ plans to confirm that the deployed project meets project objectives and requirements. A ~~verification~~ plan template for Ohio CV projects was developed to provide deployers with a guide and format for project-specific test plans.

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Ohio CV/AV Verification Plan Template

View template for CV/AV project verification plans

CV/AV Systems Engineering Guidebook

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Program Plan

Summarizes guidance for CV/AV deployers

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Communications Master Plan

Evaluates communications capacity and projected demand

SHARE



Feasibility and Exploration

Provides the readiness status of known CV/AV application

SHARE



Partnership Participation

Explores cost and effort sharing opportunities

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ITS Knowledge Base

Repository for all Ohio ITS and technology-related projects

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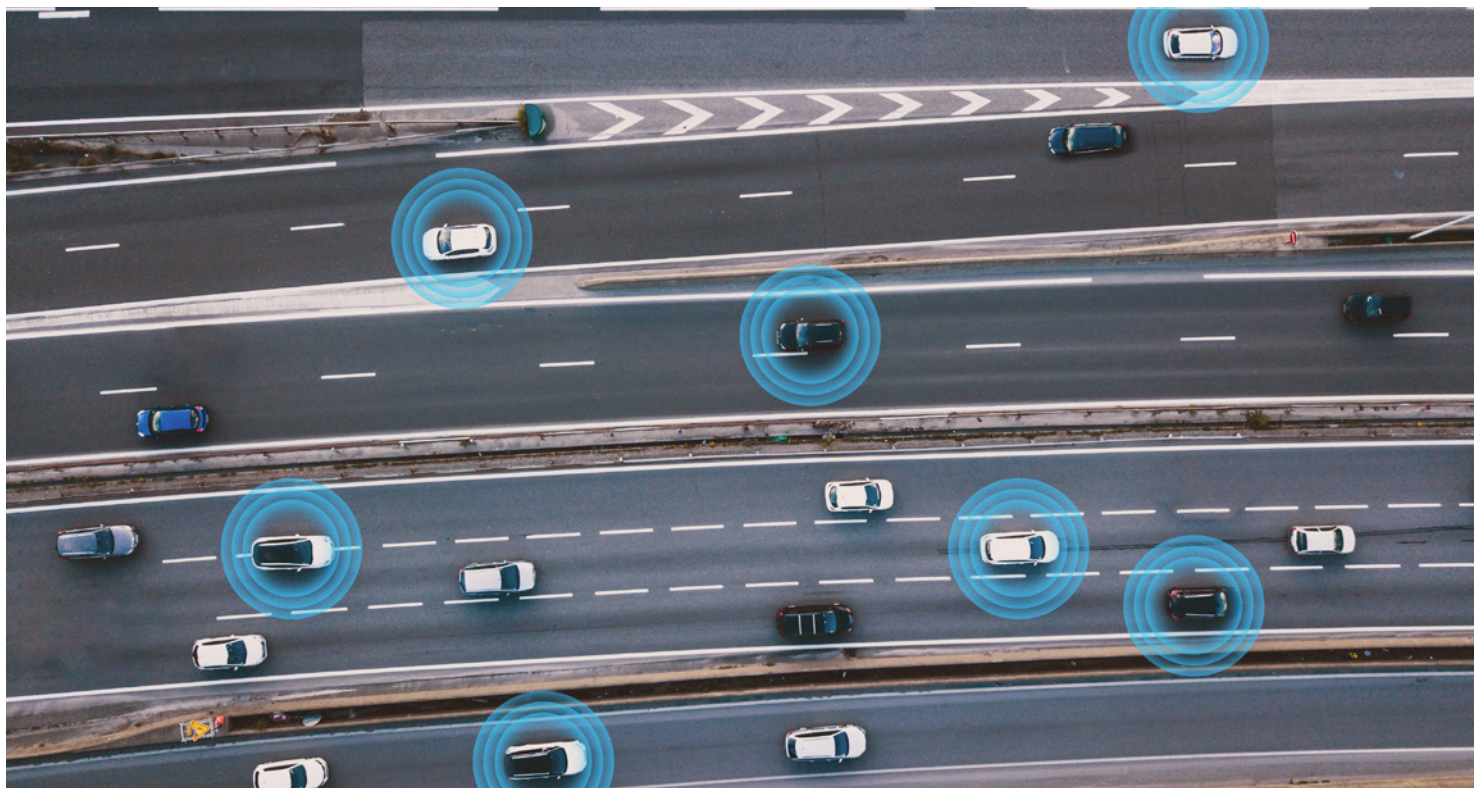
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Program Plan

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The objectives of the CV/AV Program Plan are to 1) provide CV/AV project owners with guidance on how to apply the CV/AV framework, which may help to streamline project planning and deployment, 2) provide Ohio Department of Transportation (ODOT) and DriveOhio with a process for prioritizing CV/AV projects that may be eligible for statewide funding, and 3) identify statewide CV/AV projects for the near-, mid-, and long-term, as well as "quick win" projects that can implement CV/AV applications to realize some of the benefits that these technologies can offer to Ohioans.

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Ohio CV/AV Program Plan Report

View report providing guidance on applying the CV/AA framework

Planned Ohio Transportation Projects with a Technology Component

View listing of planned Ohio projects with a technology component

Communications Master Plan

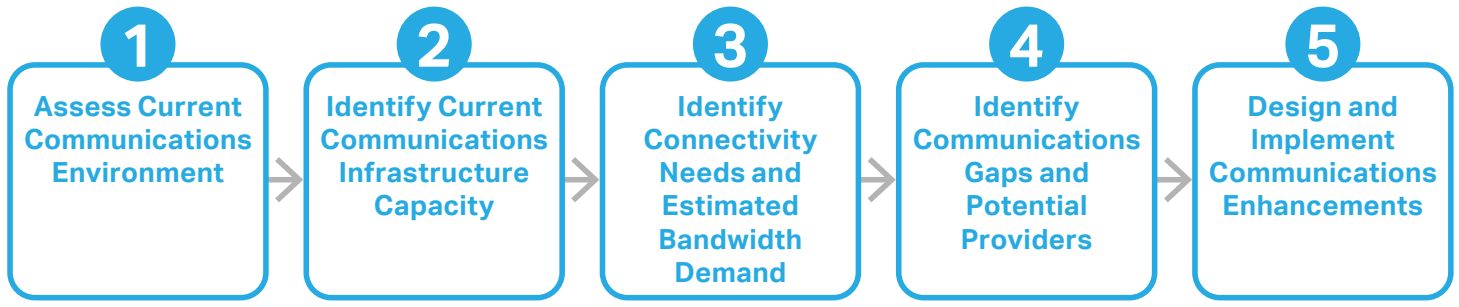
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Ohio CV/AV Communications Plan Framework

View Ohio CV/AV communications plan to guide communications enhancements

The purpose of the CV/AV Communications Plan is to provide guidance to statewide CV/AV deployers on strategic implementation of local communications enhancements that will support planned CV/AV projects.

The plan provides a framework for project owners to:

- Identify existing communication infrastructure and tabulate the available bandwidth and capacity of public and private systems. Understand gaps in the publicly owned system that may necessitate private communication coordination.
- Identify opportunities that can benefit ODOT and/or the local agency, such as using excess communication capacity in the near term for P3 use or lease. This will optimize the use of communication assets and create revenue potential for unused assets.

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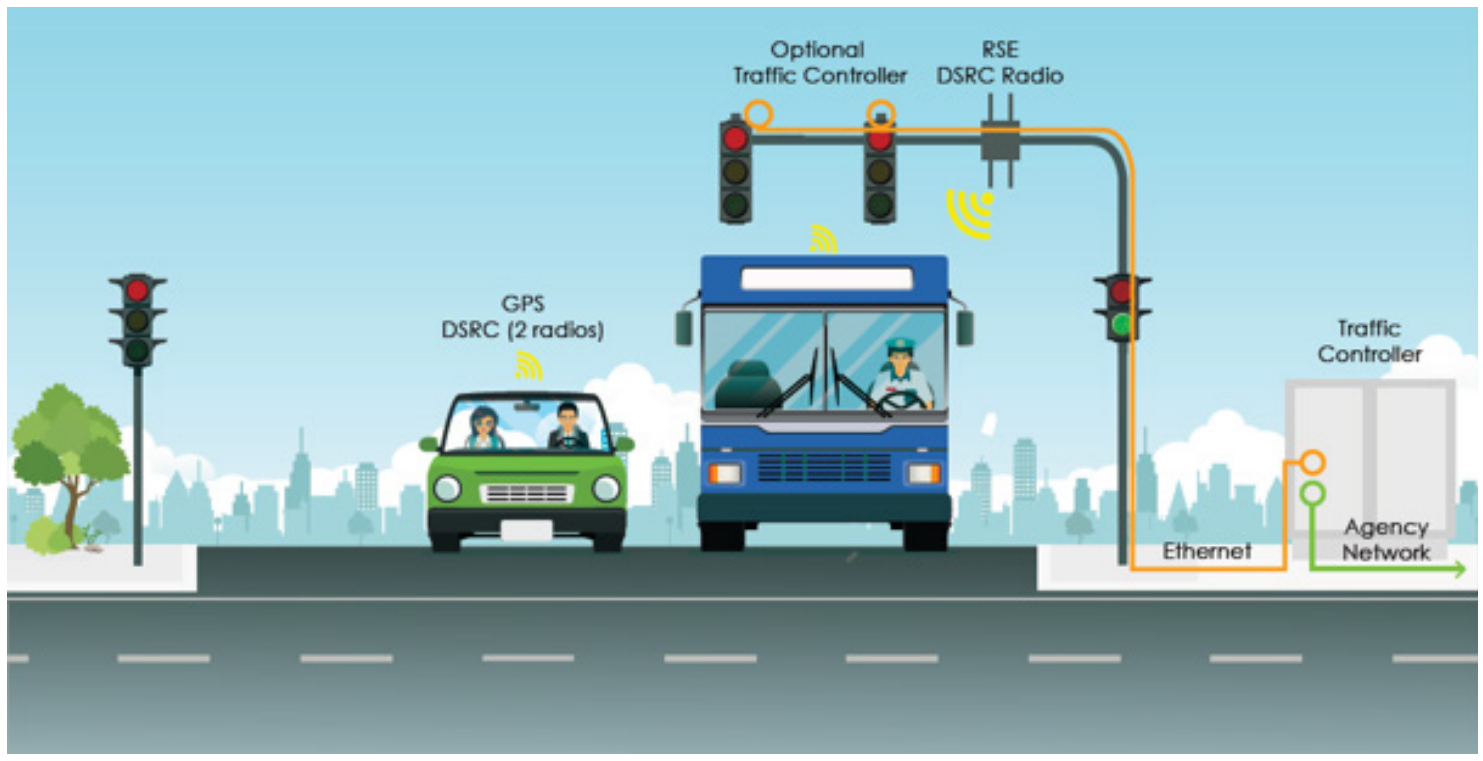
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Feasibility and Exploration

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This Feasibility and Exploration Report describes the range of currently known CV/AV application concepts, based on a scan of United States Department of Transportation (USDOT) CV/AV pilot program information, the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) and research on state-specific CV/AV efforts. The goal of this document is to provide an overview of each known CV/AV application, as well as their readiness for deployment based on the stage of development they were in at the time this report was prepared.

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Ohio CV/AV Application Feasibility & Exploration Report

View scan of nationwide CV/AV applications and deployment status

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Partnership Participation

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The purpose of the Partnership Participation Plan is to provide a high-level analysis of partnership opportunities specifically related to CV/AV technology and provide strategic recommendations for promoting future partnerships and structuring those partnerships in a manner that best protects the interest of the public.

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DriveOhio CV/AV Partnership Participation Plan

View high-level partnership participation plan for DriveOhio

ITS Knowledge Base

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The ITS Knowledge Base is a system to capture project information for all Ohio ITS projects, including projects with CV/AV components. The system will be used to house and carry project information from initial approval stages through implementation and performance evaluation. It will serve as a repository for ITS project documentation, accessible to internal ODOT users as well as external stakeholders.

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Ohio ITS Knowledge Base

View Knowledge Base system for viewing and entering ITS and CV/AV project information