Intelligent Transportation Systems (ITS) Joint Program Office (JPO)

Connected Vehicle Reference Implementation Architecture

Stakeholder’s Workshop
San Jose, CA
April 30 – May 1, 2013
CVRIA Stakeholder Workshop Purpose

- Connected Vehicle Reference Implementation Architecture (CVRIA):
  - Identify a framework for integrating connected vehicle technologies and identify interfaces for standardization

- This workshop is to:
  - Discuss and solicit feedback on preliminary (draft) architecture views
  - Discuss policy analysis and standardization planning
  - Gain feedback from stakeholders manufacturing, developing, deploying, operating, or maintaining connected vehicle technologies and applications
Topics

- Connected Vehicle Reference Implementation Architecture (CVRIA)
  - Background and Overview
  - Framework – sources, process, organization
- Architecture View Discussion (Breakout Groups)
  - 6 Focus Applications
- Policy Activities based on CVRIA
- Interface Prioritization and Standardization Planning
# CVRIA Stakeholder Workshop – Agenda

<table>
<thead>
<tr>
<th>Topic – Day 1</th>
<th>Start</th>
<th>End</th>
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<tr>
<td>Welcome &amp; Introduction</td>
<td>8:30</td>
<td>9:00</td>
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<tr>
<td>Background &amp; Overview</td>
<td>9:00</td>
<td>10:00</td>
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<tr>
<td>Break</td>
<td>10:00</td>
<td>10:15</td>
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<tr>
<td>CVRIA Framework</td>
<td>10:15</td>
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<tr>
<td>Lunch</td>
<td>11:45</td>
<td>1:00</td>
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<tr>
<td>Application Introduction</td>
<td>1:00</td>
<td>1:15</td>
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<tr>
<td>Architecture View Discussions (Breakout Groups)</td>
<td>1:15</td>
<td>4:15</td>
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<tr>
<td>(will include a 15 minute break)</td>
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<tr>
<td>Discuss results from Breakout Groups</td>
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# CVRIA Stakeholder Workshop – Agenda

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<th>Topic – Day 2</th>
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<tr>
<td>Welcome &amp; Recap</td>
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<td>Architecture View Discussions (Breakout Groups)</td>
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<td>Lunch</td>
<td>11:30</td>
<td>12:45</td>
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<td>Report from Breakout Discussions</td>
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<tr>
<td>Connected Vehicle Policy Discussion</td>
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<td>Break</td>
<td>2:30</td>
<td>2:45</td>
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<tr>
<td>Standardization Planning</td>
<td>2:45</td>
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<tr>
<td>Next Steps Discussion</td>
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Connected Vehicle Reference Implementation Architecture (CVRIA)

*Landscape: Safety, Mobility, Environmental Applications with common supporting infrastructure*

- Collecting and aggregating connected vehicle needs
- Developing a multi-faceted architecture
- Identifying and prioritizing candidate interfaces for standardization
- Supporting policy analysis

- On-going dialogue with stakeholder community
  - Opportunities: workshops, websites, documents to be reviewed

CVRIA will support connected vehicle standardization and policy efforts
The CVRIA provides a reference for applications and systems as well as identifying candidate interfaces within the architecture.

But…

*how do we implement those interfaces?*

Standardization is a critical component of implementation. The standardization plan will provide a strategy for ensuring that there are sufficient standards to support implementation and ensure interoperability.

- **Adopt**
- **Adapt**
- **Create**
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CVRIA Background and Overview
Topics

- Background & Purpose – Why do we need a CVRIA
- Uses of the CVRIA
- CVRIA Development Approach
- Scope
  - What’s included
  - Where do we draw the line
- CVRIA Organization
  - Views
  - Linkages between views
- CVRIA & CV Focus Applications
CVRIA Background and Purpose

- Looking ahead …
  - 10-20 years from now when 80% of vehicles are equipped in some way – maintaining a robust CV environment
  - Shorter term – supporting the researchers and early deployers
- With so many applications exposing so many opportunities for integration an architecture is needed to put the elements together
- Identifies:
  - Organizations
  - Systems operated
  - Functions performed
  - Information exchanged
  - Communications protocols required
ITS Architectures are a Framework for Integration

Traffic

Traveler Info Providers

Transit

Emergency Service Providers

I-93 Closed at Decatur Blvd.

Traffic Information

Request for Traffic Information

U.S. Department of Transportation Research and Innovative Technology Administration
A Systems Architecture for ITS Is Part of an Overall Systems Engineering Approach
National ITS Architecture Framework

- Basis for FHWA Rule 940 Compliant ITS Deployment
- CVRIA will take advantage of Elements, Interfaces, Definitions
Centers / Back-offices

- Perform management and administration functions
- Supports connected vehicle – field and mobile devices
- Not necessarily a physical brick-and-mortar building
- Can be aggregated together or distributed across geographies or functionally
Field Subsystems

- ITS infrastructure *on* or *along* the transportation network
- Surveillance
- Control devices
  - Signal control
  - Lane controls
  - Ramp meters
- Connected vehicle roadside equipment (RSE)
- Supply information
  - Signage
- Support payment
- Support credential/safety checks
Vehicle Subsystems

- Vehicle On-board Equipment
- Emergency Vehicle
- Commercial Vehicle
- Transit Vehicle
- Maintenance & Construction Vehicle

- **Covers the intelligent/cooperative on-board systems**
  - Advanced Safety Systems
  - Navigation
  - Remote data collection
  - Information

- **Fleet –type vehicles include special functionality:**
  - Dispatch
  - Signal preemption/priority
  - Monitoring activities
  - Fleet management
  - Passenger services
  - Fare payment
Traveler Subsystems

- Equipment to access transportation services
- “Personal” Devices
  - Fixed personal computers
  - Personal mobile devices
Connected Vehicle Core System Definition

- Definition of general services
  - Data Distribution
  - Secure/Trusted Communications
  - System Integrity
- Capabilities / Principles:
  - Secure exchange of trusted data between users and applications without pre-existing relationship or entering into a permanent relationship.
  - Assurance of privacy between users and from third parties.
  - More efficient data collection from various sources and distribution to many users
- Input to CVRIA Support Systems
Connected Vehicle Reference Implementation Architecture (CVRIA)

Basis is the National ITS Architecture and Core System Architecture

Requirements derived from a series of CV-related concepts of operations developed by the USDOT through 2012

CVRIA Development Project

USDOT project now underway:

- Develop connected vehicle reference implementation architecture
- Systematically document and prioritize interfaces, available standards, and standards gaps
- Tactically engage key stakeholders for input and communication
- Identify policy and institutional issues
- Consider potential harmonization benefits/opportunities

Interface Architecture

Enhance the National ITS Architecture, providing users with a framework for implementation

Standards Development Strategy & Plan

Define a roadmap to help USDOT meet its CV standardization objectives

Policy Options

Provide input to analysis to produce a policy foundation for architecture, standards, and certification
CVRIA Development Approach

- Baseline Documentation
  - Apps ConOps
  - Ops Concepts
  - Core ConOps
  - Standards

- National ITS and Core Architectures

- Policy

- Connected Vehicle Implementations

- Connected Vehicle Reference Implementation Architecture

- Connected Vehicle Standardization Plan

- Connected Vehicle Standards

- Connected Vehicle Reference Implementation(s)

- International and Domestic Standards & Architectures
CVRIA Source Docs > cover breadth of CV

- **Applications**
  - Safety
    - Crash-imminent V2V
    - V2V
    - V2I
  - Mobility
    - Data Capture & Management
    - Dynamic Mobility Applications
  - Environment
    - AERIS
    - Road Weather Applications

- **Support**
  - Security/Credentials Management
  - Core Services / Data Distribution

- **Other**
  - Standards
  - Architectures
  - Policy
<table>
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<th>Category</th>
<th>Document</th>
<th>Version</th>
<th>Date</th>
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<td>Safety</td>
<td>Vehicle Safety Communications Applications (VSC-A) Final Report</td>
<td>Final</td>
<td>9/1/2011</td>
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<td></td>
<td>Safety Pilot Security Credentials Management documentation</td>
<td>Draft v1.2</td>
<td>1/19/2011</td>
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<td>Concept Development and Needs Identification for Intelligent Network Flow Optimization (INFLO), Functional and Performance Requirements, and High-Level Data and Communication Needs</td>
<td>Draft v5.0</td>
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<td>Freight Advanced Traveler Information System (FRATIS) ConOps</td>
<td>Draft</td>
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<td>AERIS Dynamic Low Emissions Zones: Operational Concept</td>
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<td>AERIS Eco-Signal Operations: Operational Concept</td>
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<td>Concept of Operations For Road Weather Connected Vehicle Applications</td>
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<td>J2735 Candidate Systems Engineering Document</td>
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<td>Harmonization Task Group #1 Service and Security Management to Support safety and sustainability applications: Current Status of Security Standards</td>
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<td>Core System Concept of Operations and System Architecture</td>
<td>Final revE</td>
<td>10/24/2011</td>
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Scope of CVRIA

- What do we include?
- Looking across all CV-related applications provides a lot to work with…
  - Potentially all surface transportation systems
  - Plus, consumer personal mobility systems
- Does CVRIA need to include all possible transportation applications?
- Focus on the ‘connected vehicle/mobile platform’
Connected Vehicle Scope

What makes an application a Connected Vehicle application?

- An application is a Connected Vehicle application if:
  - it uses an interface that passes data originating from a party whose identity is independently authenticated (but not necessarily known), and
  - that interface includes at least one party in the transportation environment.
Connected Vehicle Scope

What does that MEAN?
- V2V? – yes
- V2I? – yes
- Any Mobile? If it’s using independent authentication (cert)
- Field to Center? – if (and only if) it’s supporting a V2x
- Center to Center? - just to get the data to support the V2x environment
Connected Vehicle Scope

- *Life cycle of data* to support an end-use *application*
  - Data coming off a vehicle – where is it used
  - Data coming into a vehicle – where did it come from
  - → leads to questions to ensure all of the data is captured and can be standardized
Connected Vehicle Scope

- "independently authenticated" another major theme
  - Use of digitally ‘signed’ credential based on recognized standard/practice that allows the receiver to ‘trust’ the legitimacy of the sender
  - Does not include traditional ITS projects
    - On closed/private networks (DMS, transit dispatch)
    - Unless we need data in a certain format, or additional elements added to an existing interface to ensure data is available for the connected vehicle/mobile
Connected Vehicle Scope

- Mobile includes Vehicles (all types) & Personal/Mobile connected devices
- Interfaces between/among
  - Mobile devices
  - Field/infrastructure
  - Centers (supporting the mobile interfaces)
  - Supporting systems
Connected Vehicle Scope

- Mobility Applications provide a good example of the ‘life-cycle of a connected vehicle application’
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CVRIA Framework
Connected Vehicle Reference Implementation Architecture

- Scope used to capture the right NEEDS and REQUIREMENTS derived from the source documents
- Now let’s put together multi-faceted architecture that addresses stakeholders’ concerns
  - Mission – Safety, Mobility, Environmental
  - Interfaces
  - Functionality
  - Security – Information, Operational, Personnel
  - Organizations/Resources
  - Risks
  - Deployability
CVRIA Viewpoints

- Connected Vehicle Reference Implementation Architecture (CVRIA) uses multiple viewpoints to capture stakeholders’ concerns
  - Enterprises to carry out applications
  - Functions to satisfy requirements,
  - Physical objects to implement that functionality
  - Communications protocols necessary
CVRIA Enterprise View

- Depicts:
  - Relationships between organizations
  - Roles organizations play in delivery of services within the CVE

- Identifies options for…
  - Who is responsible for delivering services?
  - Who uses, operates, owns and manages the systems that deliver services?
  - Who is responsible for securing data?
  - Who is responsible for detecting malfunction and misbehavior?
  - Who is responsible for physical device protection?
  - Who has to deal with personnel security?
  - Who contributes to development, testing, maintenance and transition?
  - How do support application providers interact with and support end-application providers?
CVRIA Enterprise View Example
CVRIA Functional View

- Depicts:
  - Abstract functional elements (processes)
  - Flows of data between those processes
- Identifies options for…
  - What functionality is in the CVE?
  - What are the interfaces between logical elements?
  - What data flows over those elements?
  - Information Security, including
    - Trust management
    - Privacy protection
    - Anonymity protection
    - Information integrity assurance
Functional View Data Flow Diagrams (DFDs)
Hierarchical Data Flow Diagrams

Definition continues through successively lower levels of functional detail
Functional Decomposition down to a Process Specification

```
0 (dfd)  "Manage Connected Vehicles"
      ^          |
      |          v
5 (dfd)  "Manage Emergency Services"
      ^          |
      |          v
5.1 (dfd) "Provide Emergency Service Allocation"
      ^          |
      |          v
5.1.3 (Pspec) "Communicate Emergency Status"
```

Data Flow Diagrams can be broken up into more processes down to a...

Process Specification
- trace to Requirements
- map to physical view Application Objects
CVRIA Functional View Example

- Manage Local Signal Priority Requests
  - Signal Priority Override
  - Transit Vehicle Roadway Priorities
- Provide Device Control: Select Strategy
- Manage Transit Vehicle Operations
  - Road Network Info for Transit
  - Transit Vehicle Operating Data
- Determine Transit Vehicle Service Status
  - Transit Vehicle Operating Data
CVRIA Physical View

- Depicts:
  - Physical elements that interact to deliver services
  - Interfaces and flows of information between those physical elements

- Identifies options for...
  - What devices are involved in delivering safety, mobility, environmental applications?
  - What are the physical interfaces in each device?
  - What functions do those interfaces support?
  - What functionality is allocated to devices, and what is allocated to humans?
CVRIA Physical View

- Additional Considerations:
  - What devices require information security safeguards and what are they?
  - Operational security
    - Device physical security
    - Environmental protections for devices
    - Contingency planning for failure
    - Maintenance
    - Security prior to disposal
CVRIA Physical View Example
CVRIA Communications View

- Depicts:
  - Layered communications protocols that support communications between physical devices
  - Identifies options for…
    - Identity and appropriateness of protocols at all layers.
    - How these protocols ensure or support:
      - Anonymity preservation
      - Non-repudiation
      - Message integrity
    - Status of protocols as standards or privately provided protocols and the implications of their use from an evolve-ability perspective
CVRIA Communications View Example
CVRIA Applications Perspective

- Stakeholders tend to think in terms of their application, their set of needs. The applications pages exploit that to create subset views.

- 6 applications selected to start the conversation:
  - V2V Safety: Intersection Movement Assist (IMA)
  - V2I Safety: Reduced Speed Zone Warning (RSZW)
  - Mobility: Freight Drayage Optimization
  - Mobility: Transit Connection Protection
  - Environment: Dynamic Eco-Lanes Management
  - Environment: Road Weather Advisories and Warnings for Motorists
CVRIA Website

http://www.iteris.com/cvria/index.html
The Connected Vehicle Reference Implementation Architecture is based on a set of Applications that have been defined by various connected vehicle programs. The source for the application descriptions ranges from Concepts of Operations (ConOps), Requirements Specifications, or existing Standards and Architectures. There are four types of Connected Vehicle Applications: Environmental, Mobility, Safety, and Support. Each type is comprised of groups of applications. Click on an Application name in the table below to see and description of the application, its source references, and the subset of the Connected Vehicle Reference Implementation Architecture that pertains to that application, including sub-tabs for each view (enterprise, functional, physical, and communications).

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<tr>
<th>Type</th>
<th>Group</th>
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<tr>
<td></td>
<td>AERIS</td>
<td>Dynamic Low Emissions Zone System</td>
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<tr>
<td></td>
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<td>Eco-Traffic Signal System</td>
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<td>Dynamic Eco-Lanes System</td>
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<td>Road Weather</td>
<td>Road Weather Information and Routing Support for Emergency Responders</td>
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<td>Road Weather Information for Freight Carriers</td>
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<td>Road Weather Information for Maintenance and Fleet Management System</td>
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<td>Enhanced Maintenance Decision Support System</td>
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<td>Variable Speed Limits for Weather-Responsive Traffic Management Vehicle System</td>
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<td>Eco-Integrated Corridor Management</td>
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<tr>
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<td>Electric Charging Stations Management</td>
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CVRIA Website – Reduced Speed Zone Warning (RSZW)

Reduced Speed Zone Warning

The Reduced Speed Zone Warning (RSZW) application alerts or warns drivers of equipped and non-equipped vehicles who are approaching a reduced speed zone if they are operating at a speed higher than the zone’s posted speed limit and/or if the configuration of the roadway is altered (e.g., lane closures, lane shifts). This will be achieved through the integration of both vehicle-based and infrastructure-based technologies, including onboard and roadside signage warning systems, to make drivers approaching a reduced speed zone aware of the potential for a crash due to changes in speed and roadway configuration. Reduced speed zones include (but are not be limited to) construction/work zones, school zones, and incorporated zones (e.g., rural towns). The RSZW application uses speed measurements taken by the roadside infrastructure along with any applicable changed roadside configuration information to determine whether an alert/warning is necessary. Specifically, the infrastructure data equipment detects and measures the speed of the approaching vehicle and if greater than the reduced speed zone posted speed limit will send a speed related warning. The vehicle application utilizes this data to determine whether the vehicle needs to slow down. If deemed necessary, the driver is alerted and/or warned. Regardless of the need for a speed-related warning, roadside configuration information is presented to the driver whenever configuration changes occur. Additionally, for situations requiring a merge, a warning might be provided to drivers that have not yet merged and are in danger of a collision given current speed and distance to the merge point. Finally, the infrastructure may send to the vehicle the current roadside signage information.

Requirements

<table>
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<th>Need</th>
<th>Requirement</th>
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<tr>
<td>N3.065</td>
<td>Reduced Speed Zone Warning (RSZW) needs to warn vehicles driving above the posted reduced speed zone speed limit and/or vehicles impacted by changed roadway configurations in time for the driver to take appropriate action.</td>
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<td>3.109</td>
<td>Reduced Speed Zone Warning (RSZW) shall warn the driver when the driver’s vehicle is traveling in excess of the speed permitted in an upcoming speed zone.</td>
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<tr>
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<td>RSZW shall determine if the vehicle is traveling in excess of the speed permitted in an upcoming speed zone.</td>
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RSZW Enterprise View (1 of 4) – Install
RSZW Enterprise View (2 of 4) – Operations
RSZW Enterprise View (4 of 4) – Certification
RSZW Physical View

Traffic Management

Maintenance and Construction Management

RSE Location Data Source

ITS Roadway Equipment

Roadway Speed Monitoring and Warning

Roadside Equipment

RSE Reduced Speed Zone Warning

Map Update System

Driver

Vehicle OBE

Vehicle Location Data Source

Vehicle Platform

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Research and Innovative Technology Administration
RSZW Functional View (Summary)

1.1 Provide Traffic Surveillance

1.2 Provide Device Control

6.7 Provide Driver Personal Services

3.1 Monitor Vehicle Status

9.3 Manage Work Zones

From_Location_Data_Source
From_Map_Update_System

To_Driver

sensor_data

speed_data + device_status

vehicle_signage_data

safety_warnings

vehicle_location

probe_data + safety_data

From_Map_Update_System

From_Location_Data_Source

From_Vehicle_Platform

U.S. Department of Transportation
Research and Innovative Technology Administration
CVRIA Connectivity/Traceability Between Views

- Using the hyperlinked architecture users can jump between views...
  - For example, from the RSZW application, users can select one of the physical objects and get a more complete description of that object and its relationship to other objects and traceability to the functional view.
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CVRIA Architecture Focus
Applications

Breakout Group Discussions
CVRIA Focus Applications

- Represent spectrum of services, devices, interfaces
- Use lessons from these applications to develop remaining architecture components
- Safety
  - V2V Safety: Intersection Movement Assist (IMA)
  - V2I Safety: Reduced Speed Zone Warning (RSZW)
- Mobility
  - Mobility: Freight Drayage Optimization
  - Mobility: Transit Connection Protection (T-CONNECT)
- Environment
  - AERIS Dynamic Eco-Lanes Management
  - Road Weather Advisories and Warnings for Motorists
CVRIA Breakout Group Discussion

- Split into 2 groups – just to create smaller groups to increase conversation
- Take each application
  - Description, needs/requirements addressed
  - Physical view
  - Enterprise view
    - Installation phase
    - Operations
    - Maintenance
    - Certification
  - Functional view
- Goal is to identify deficiencies / opportunities
CVRIA Breakout Group Discussion

- Start with Intersection Movement Assist (IMA) in both rooms
- Then split off so all applications get covered
  - Room 1: IMA, RSZW, Drayage, T-CONNECT, Eco-Lane Mgt, Road Weather
  - Room 2: IMA, Road Weather, Eco-Lane Mgt, T-CONNECT, Drayage, RSZW
- Take breaks, Take notes, we’ll reconvene at the end of the day and after lunch Wednesday to discuss our findings
The Intersection Movement Assist (IMA) application is intended to warn the driver of a vehicle when it is not safe to enter an intersection due to high collision probability with other vehicles. Initially, IMA is intended to help drivers avoid or mitigate vehicle collisions at stop sign-controlled and uncontrolled intersections. This application enables the vehicle to anticipate impacts where other vehicle paths cross and then perform crash prevention actions to reduce the likelihood of crashes at the intersections.
Intersection Movement Assist (IMA)

- From here we’ll go look the Architecture View diagrams using the draft website and the handouts of the diagrams.
- Physical View
  - Physical Objects
  - Application Objects
  - Flows
- Enterprise View
  - Enterprise Objects
  - Facilities
  - Resources
  - Roles & Relationships
- Functional View
  - Processes / High Level interfaces
Reduced Speed Zone Warning (RSZW)

- The Reduced Speed Zone Warning (RSZW) application alerts or warns drivers of equipped and non-equipped vehicles who are approaching a reduced speed zone if they are operating at a speed higher than the zone’s posted speed limit and/or if the configuration of the roadway is altered (e.g., lane closures, lane shifts).

- Includes:
  - Construction/work zones
  - School zones
  - Incorporated zones (e.g., rural towns)

- May vary by:
  - Time of Day
  - Season of year
  - Current activity/situation
Reduced Speed Zone Warning (RSZW)

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- Physical View
  - Physical Objects
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  - Flows

- Enterprise View
  - Enterprise Objects
  - Facilities
  - Resources
  - Roles & Relationships

- Functional View
  - Processes / High Level interfaces
The Freight Drayage Optimization application bundle covers the information exchanges between all intermodal parties to provide current drayage truck load matching and container availability and appointment scheduling at railroad and steamship line terminals. The application bundle includes a link from drivers and freight management systems dispatchers to an intermodal terminal reservation system and integrates an appointment function with Terminal Queue Status and Load Matching.
Freight Drayage Optimization (DR-OPT)

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- Functional View
  - Processes / High Level interfaces
The Transit Connection Protection application allows travelers to initiate a request for connection protection. Connection protection examines the arrival status of a transit vehicle and to transmit a hold message to a vehicle or other mode (e.g. rail) to make a successful transfer from one vehicle to another.

- Can be performed within a single agency, across multiple agencies, and across multiple modes.
Transit Connection Protection (T-CONNECT)

- From here we’ll go look the Architecture View diagrams using the draft website and the handouts of the diagrams.
- Physical View
  - Physical Objects
  - Application Objects
  - Flows
- Enterprise View
  - Enterprise Objects
  - Facilities
  - Resources
  - Roles & Relationships
- Functional View
  - Processes / High Level interfaces
Dynamic Eco-Lanes Management

- Dynamic Eco-Lanes Management gathers traffic and environmental information from multiple sources. The system then processes these data and determines whether an eco-lane should be created or decommissioned along a roadway. The application manages the eco-lanes with the objective of reducing fuel consumption and overall emissions along the roadway segment. Data considered in the creation or decommissioning of an eco-lane includes real-time and predicted traffic and environmental conditions, location and duration of special events, or other data. The Dynamic Eco-Lanes System evaluates traffic and environmental parameters for a roadway in real-time and adapts environmental applications to meet the real-time needs of the roadway. The system also predicts future traffic and environmental conditions using historical data and real-time data, which allows the system to predict future problem areas.
Dynamic Eco-Lanes Management

- From here we’ll go look the Architecture View diagrams using the draft website and the handouts of the diagrams.

- Physical View
  - Physical Objects
  - Application Objects
  - Flows

- Enterprise View
  - Enterprise Objects
  - Facilities
  - Resources
  - Roles & Relationships

- Functional View
  - Processes / High Level interfaces
Road Weather Advisories and Warnings for Motorists

- Using data road-weather information gathered from connected vehicles, including information on deteriorating road and weather conditions on specific roadway segments, this application will send alerts and advisories to travelers through a variety of means within a few minutes. In combination with observations and forecasts from other sources and with additional processing, medium-term advisories of the next two to twelve hours to long-term advisories for more than twelve hours into the future can also be provided.
Road Weather Advisories and Warnings for Motorists

- From here we’ll go look the Architecture View diagrams using the draft website and the handouts of the diagrams.
- Physical View
  - Physical Objects
  - Application Objects
  - Flows
- Enterprise View
  - Enterprise Objects
  - Facilities
  - Resources
  - Roles & Relationships
- Functional View
  - Processes / High Level interfaces
## CVRIA Breakout Group Discussions

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