RITA Research and Innovative Technology Administration

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

Topic – Day 1	Start	End
Welcome & Introduction	8:30	9:00
Background & Overview	9:00	10:00
Break	10:00	10:15
CVRIA Framework	10:15	11:45
Lunch	11:45	1:00
Application Introduction	1:00	1:15
Architecture View Discussions (Breakout Groups) (will include a 15 minute break)	1:15	4:15
Discuss results from Breakout Groups	4:15	4:30

CVRIA Stakeholder Workshop – Agenda

Topic – Day 2	Start	End
Welcome & Recap	8:30	8:45
Architecture View Discussions (Breakout Groups) (will include a 15 minute break)	8:45	11:30
Lunch	11:30	12:45
Report from Breakout Discussions	12:45	1:00
Connected Vehicle Policy Discussion	1:00	2:30
Break	2:30	2:45
Standardization Planning	2:45	3:30
Next Steps Discussion	3:30	4:00

Connected Vehicle Reference Implementation Architecture (CVRIA)

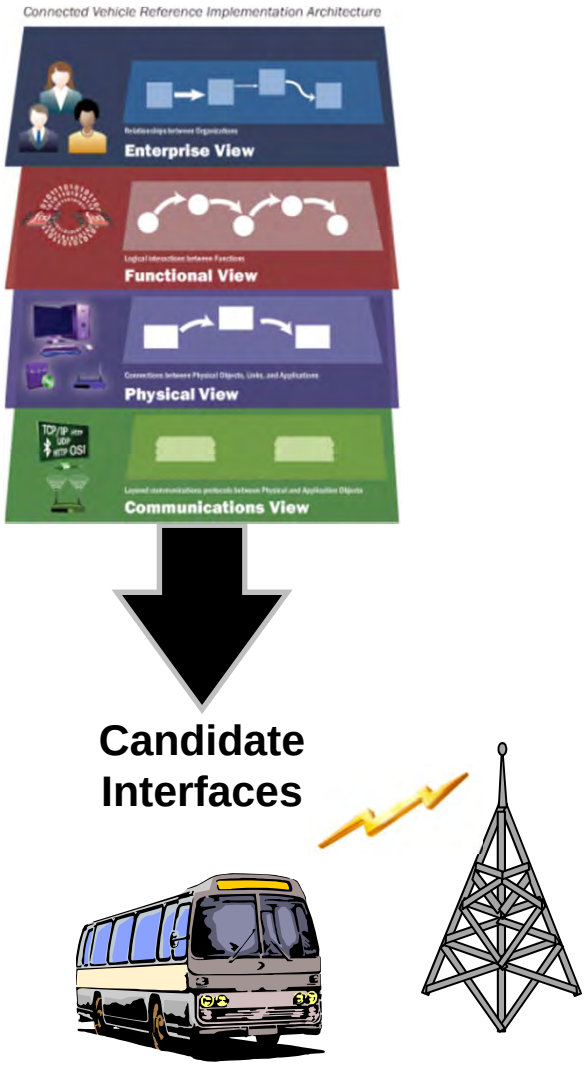
Landscape: Safety, Mobility, Environmental Applications with common supporting infrastructure

- 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

Architecture & Standardization Plan



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** **or** **Create**

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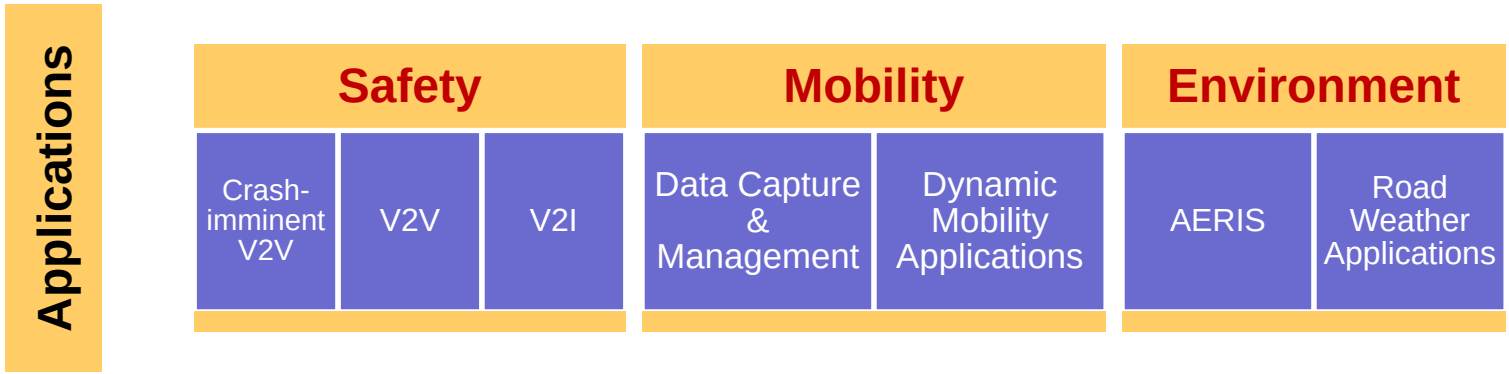
CVRIA Background and Overview

Topics

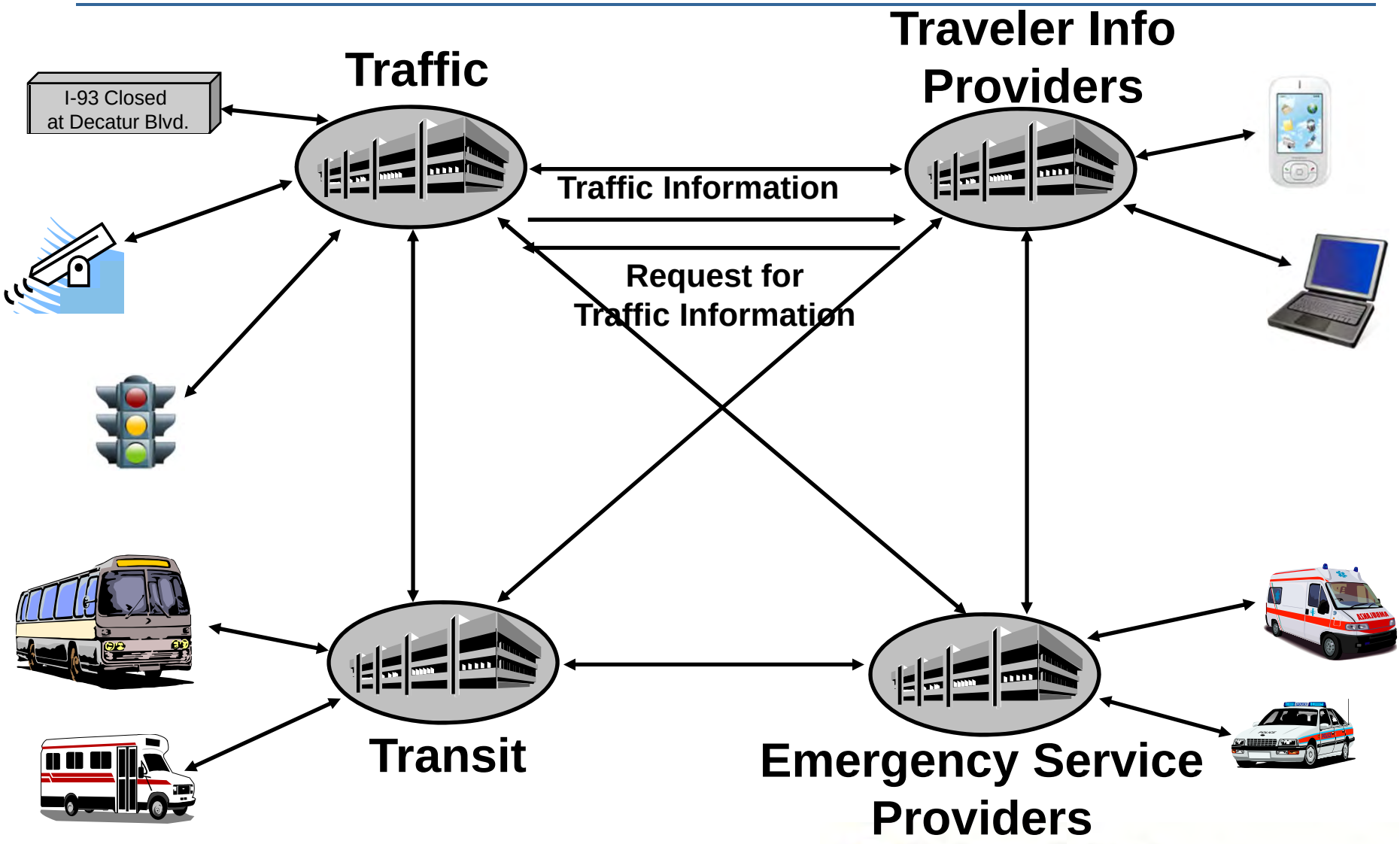
- Background & Purpose – Why do we need a CVRIA
- Uses of the CVRIA
- CVRIA Development Approach
- Scope
  - What's included
  - Where do we draw the line
- CVRIA Organization
  - Views
  - Linkages between views
- CVRIA & CV Focus Applications

CVRIA Background and Purpose

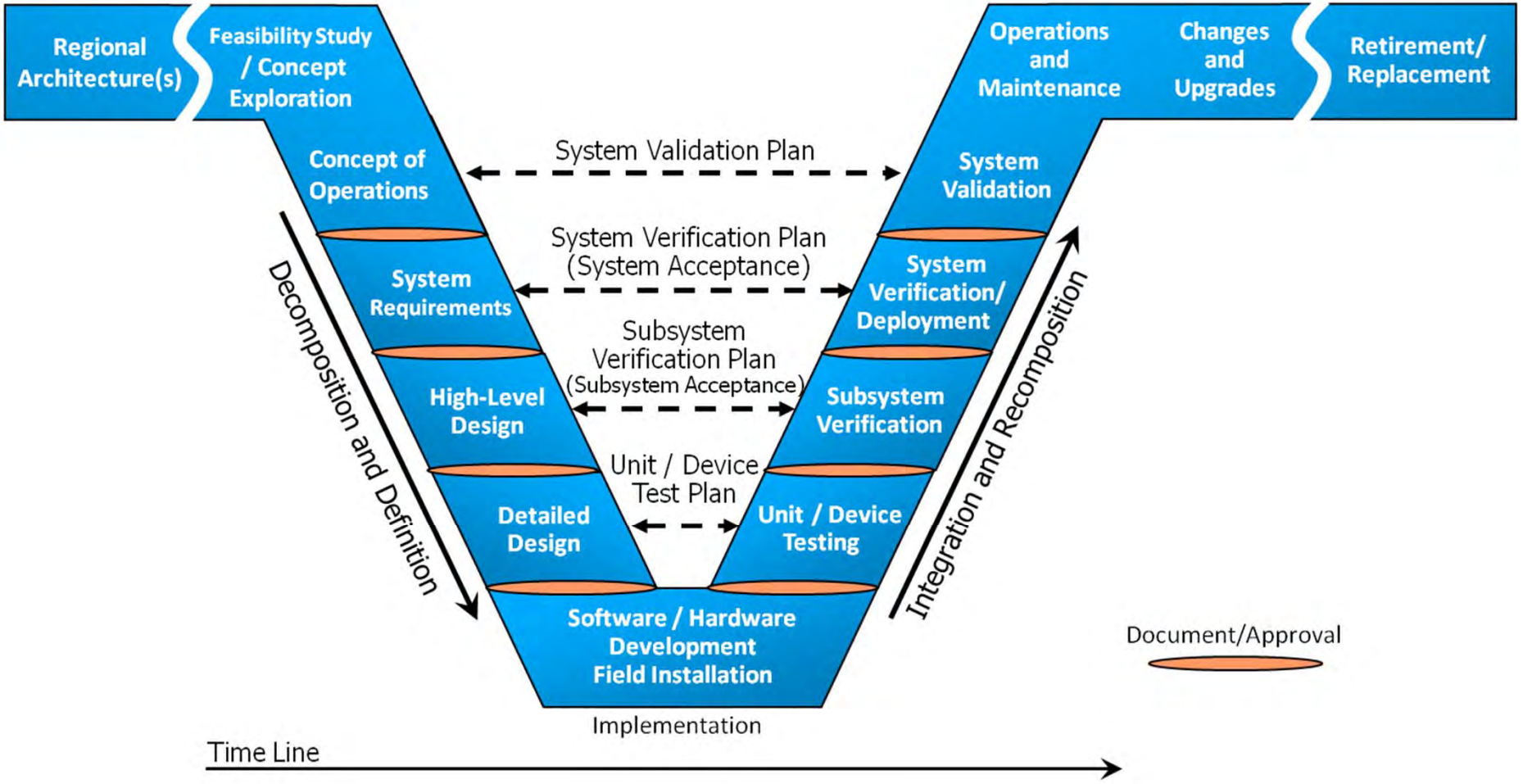


- Looking ahead …
  - 10-20 years from now when 80% of vehicles are equipped in some way – maintaining a robust CV environment
  - Shorter term – supporting the researchers and early deployers
- With so many applications exposing so many opportunities for integration an architecture is needed to put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

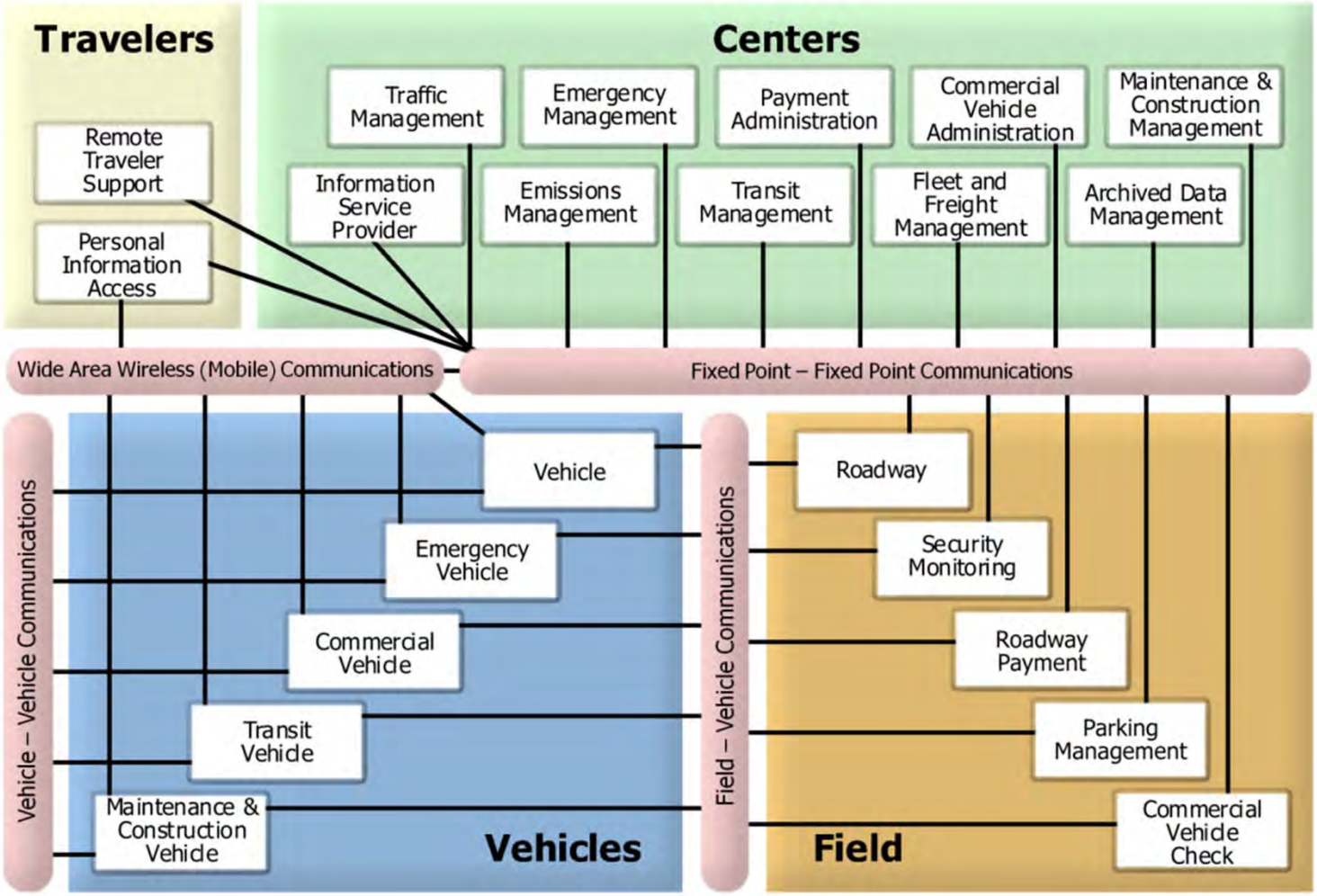
ITS Architectures are a Framework for Integration



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

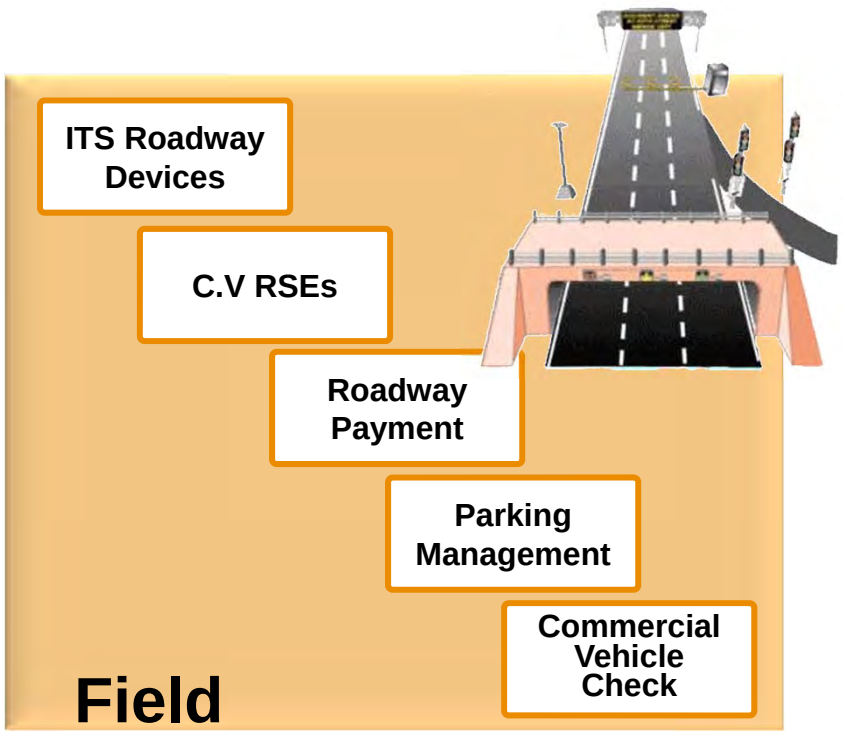
Centers / Back-offices

Centers

- Traffic Management
- Emergency Management
- Payment Administration
- Commercial Vehicle Administration
- Maintenance & Construction Management
- Information Service Provider
- Emissions Management
- Transit Management
- Fleet and Freight Management
- Archived Data Management
- Security Credentials Management

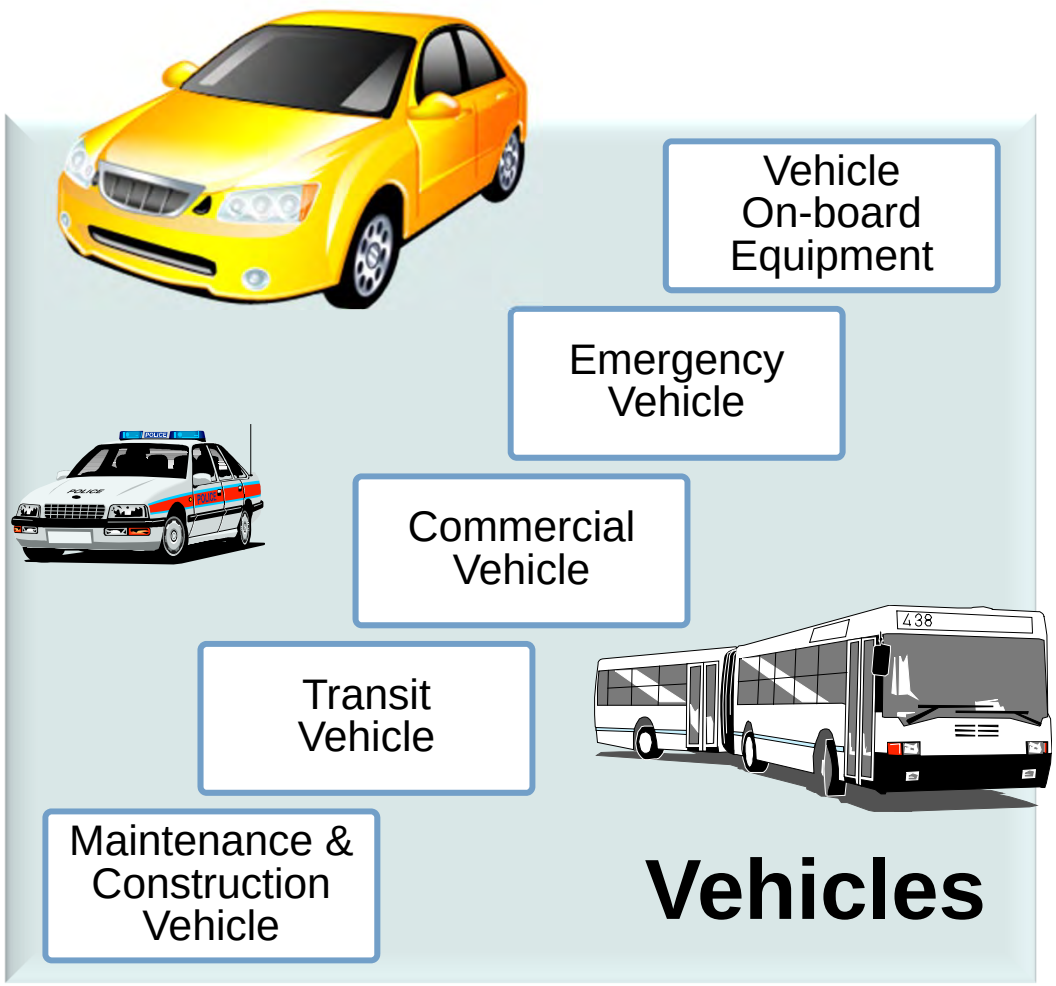
- Perform management and administration functions
- Supports connected vehicle – field and mobile devices
- Not necessarily a physical brick-and-mortar building
- Can be aggregated together or distributed across geographies or functionally

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



- 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

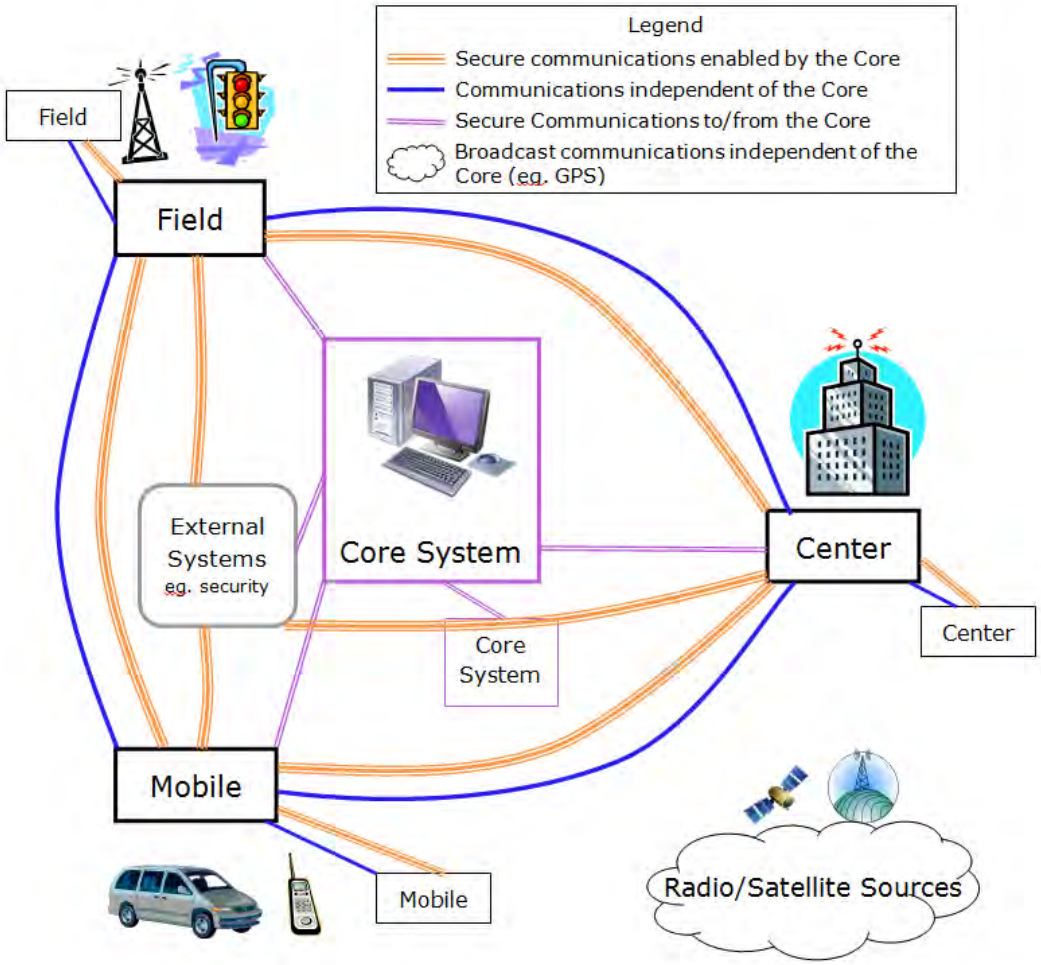
Travelers

- Fixed Personal Information Access
- Mobile Personal Information Access

- 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

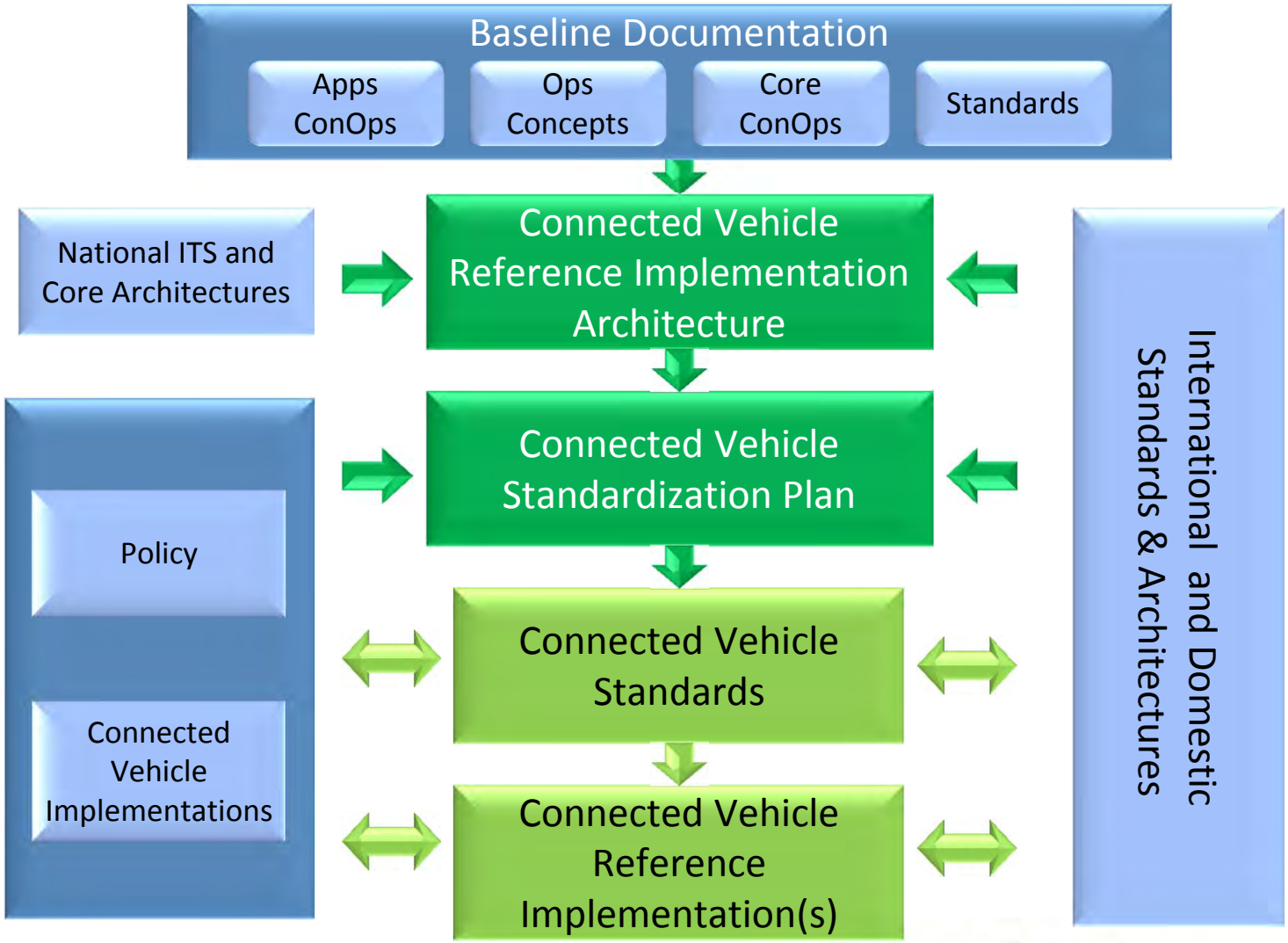
Standards Development Strategy & Plan

Define a roadmap to help USDOT meet its CV standardization objectives

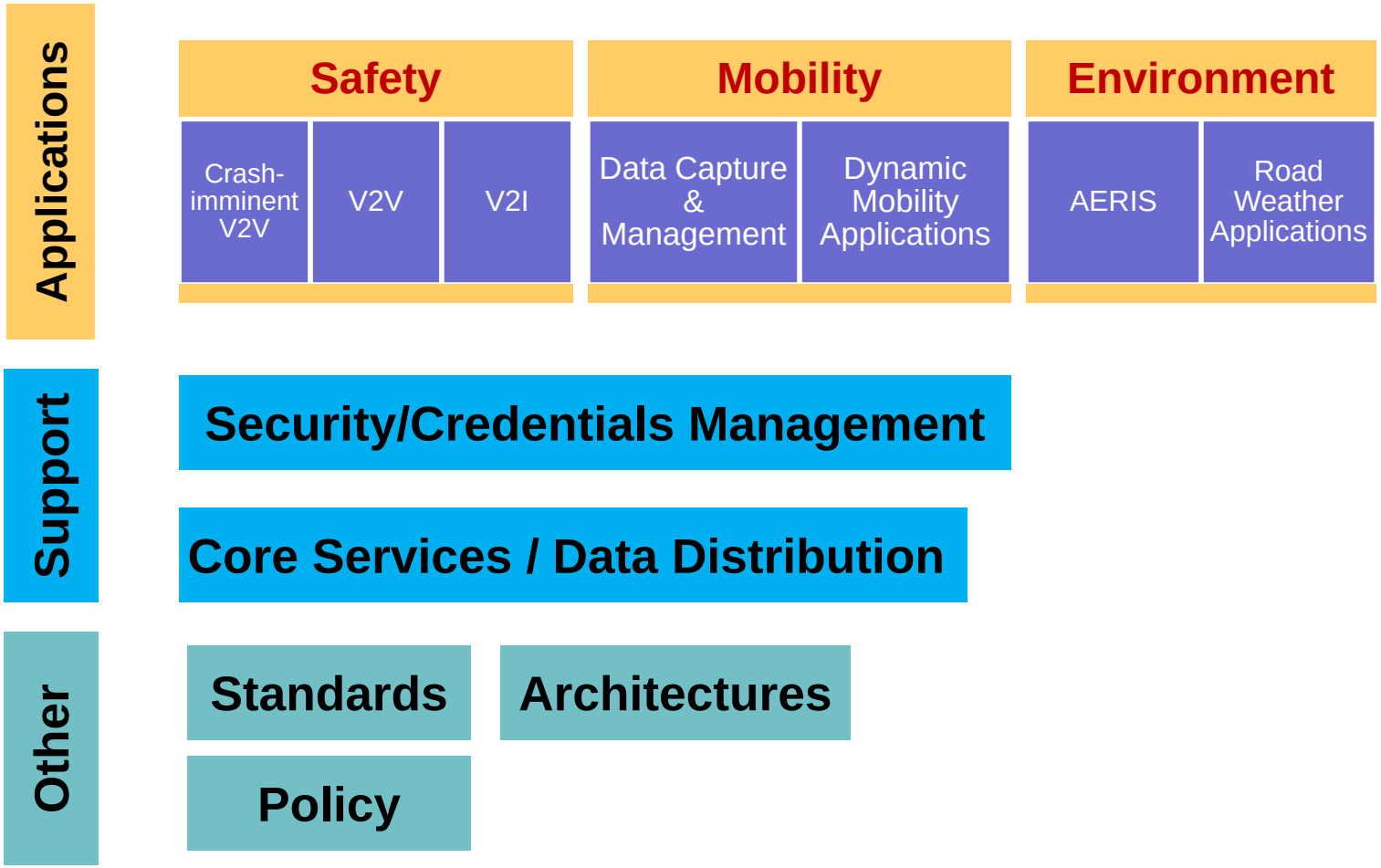
Policy Options

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

CVRIA Development Approach



CVRIA Source Docs > cover breadth of CV



CVRIA Source Documents

Category	Document	Version	Date
Safety	Vehicle Safety Communications Applications (VSC-A) Final Report	Final	9/1/2011
	V2I Safety Signal Phase & Timing (SPaT) ConOps	Draft revD	8/8/2011
	Accelerated Vehicle to Infrastructure (V2I) Safety Applications Concept of Operations Document and System Requirements	Revised Draft	5/29/2012
	Safety Pilot Security Credentials Management documentation	Draft v1.2	1/19/2011
Mobility	R.E.S.C.U.M.E. (Response, Emergency Staging and Communications, Uniform Management, and Evacuation) ConOps	Draft v1.0	5/29/2012
	Concept Development and Needs Identification for Intelligent Network Flow Optimization (INFLO), Functional and Performance Requirements, and High-Level Data and Communication Needs	Draft v5.0	11/1/2012
	Freight Advanced Traveler Information System (FRATIS) ConOps	Draft	4/20/2012
	Integrated Dynamic Transit Operations (IDTO) ConOps	Draft v3.0	5/11/2012
	Multi-Modal Intelligent Traffic Signal System (MMITSS) ConOps	Draft v2.0	9/14/2012
	Smart Roadside Initiative (SRI) ConOps	Draft	5/21/2012
	Vision and Operational Concept for Enabling Advanced Traveler Information Services (Enable ATIS)	Final	5/13/2012
	ConOps for Transit Connected Vehicle	Draft	3/31/2012
	Border Information Flow Architecture (BIFA)	Draft	5/16/2012
Environmental	AERIS Dynamic Eco-Lanes Operational Concept	Final v1.1	8/1/2012
	AERIS Dynamic Low Emissions Zones: Operational Concept	Final v1.1	8/1/2012
	AERIS Eco-Signal Operations: Operational Concept	Final v1.1	8/1/2012
	Concept of Operations For Road Weather Connected Vehicle Applications	Draft v1.4.2	6/26/2012
Support	Safety Pilot Security Credentials Management documentation	Draft	4/13/2012
	J2735 Candidate Systems Engineering Document	Draft	12/15/2012
	Harmonization Task Group #1 Service and Security Management to Support safety and sustainability applications: Current Status of Security Standards	Draft	8/29/2012
	Core System Concept of Operations and System Architecture	Final revE	10/24/2011

Scope of CVRIA

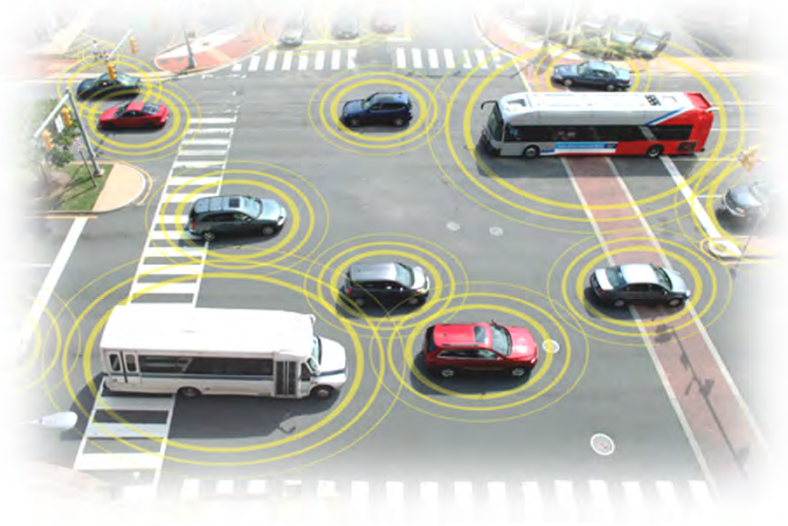
- What do we include?
- Looking across all CV-related applications provides a lot to work with…
  - Potentially all surface transportation systems
  - Plus, consumer personal mobility systems
- Does CVRIA need to include all possible transportation applications?
- Focus on the ‘connected vehicle/mobile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

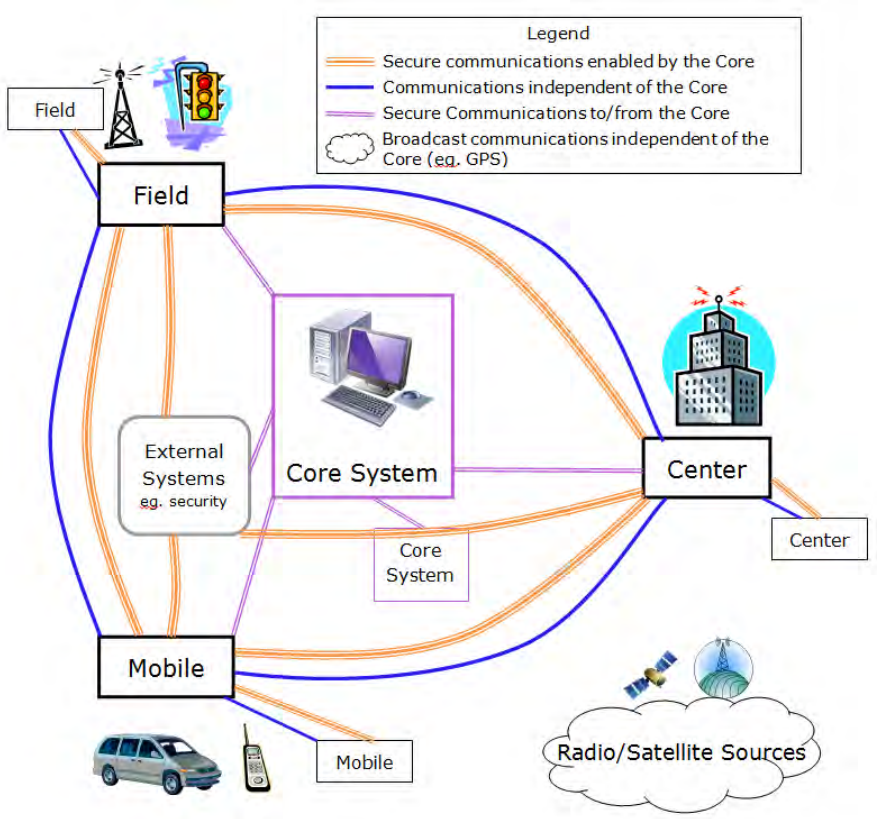
- *Life cycle of data* to support an end-use *application*
  - Data coming off a vehicle – where is it used
  - Data coming into a vehicle – where did it come from
  - → leads to questions to ensure all of the data is captured and can be standardized

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

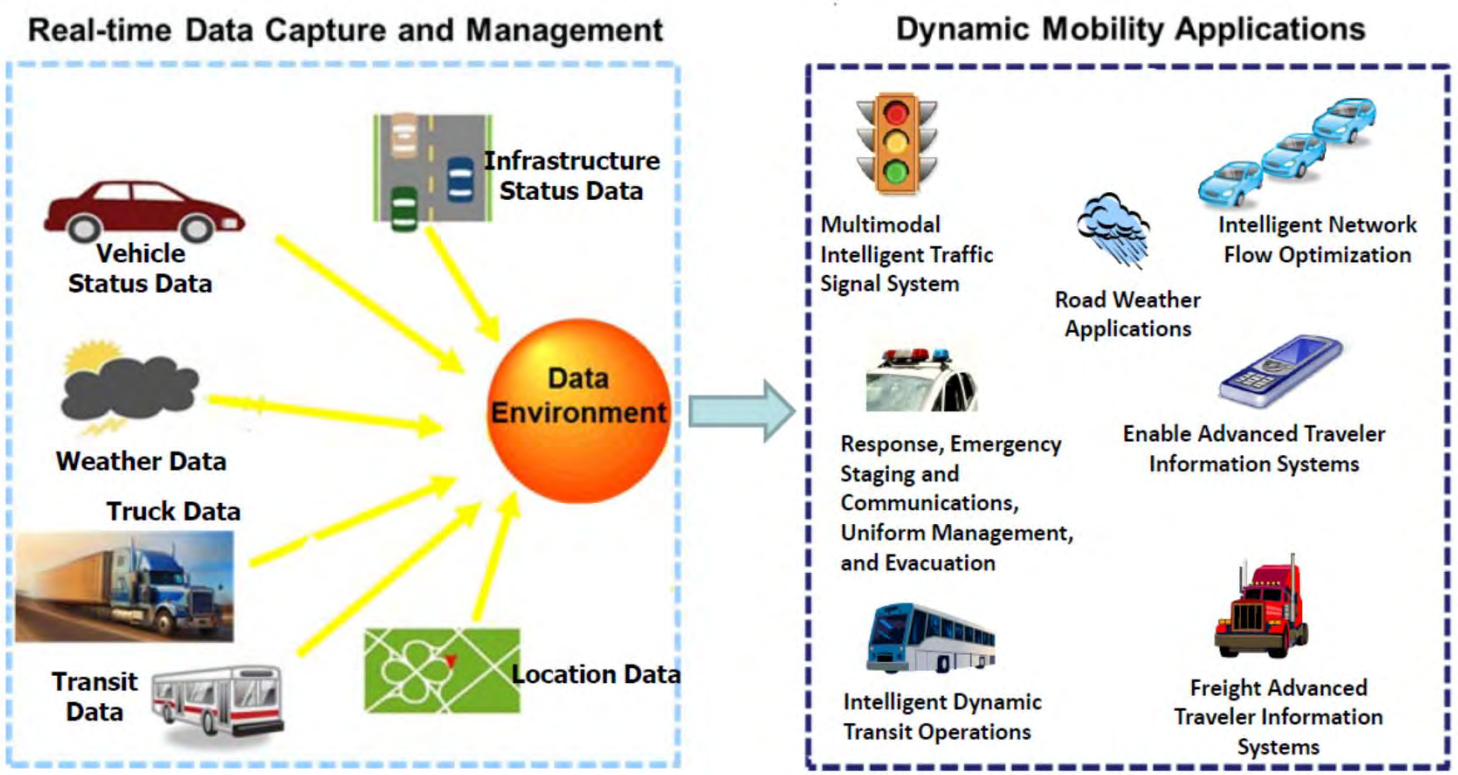
Connected Vehicle Scope

- 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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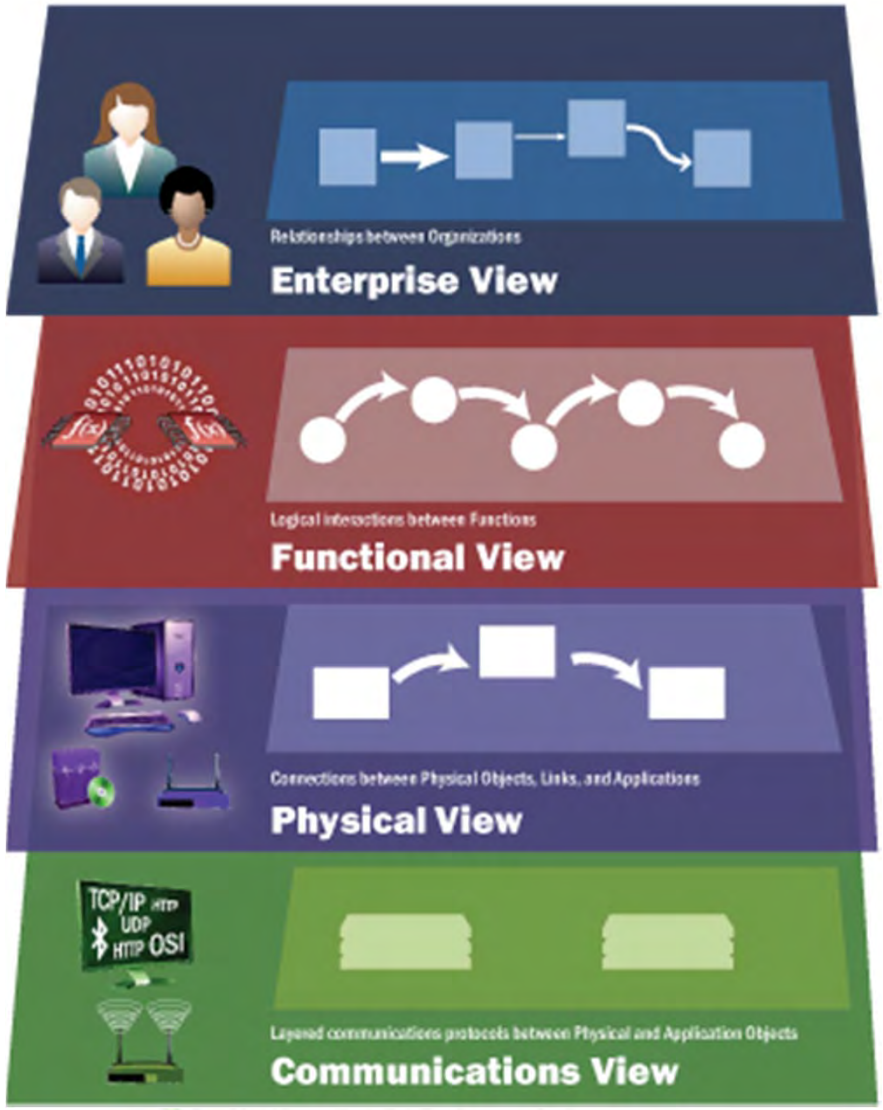
CVRIA Framework

Connected Vehicle Reference Implementation Architecture

- Scope used to capture the right NEEDS and REQUIREMENTS derived from the source documents
- Now lets 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

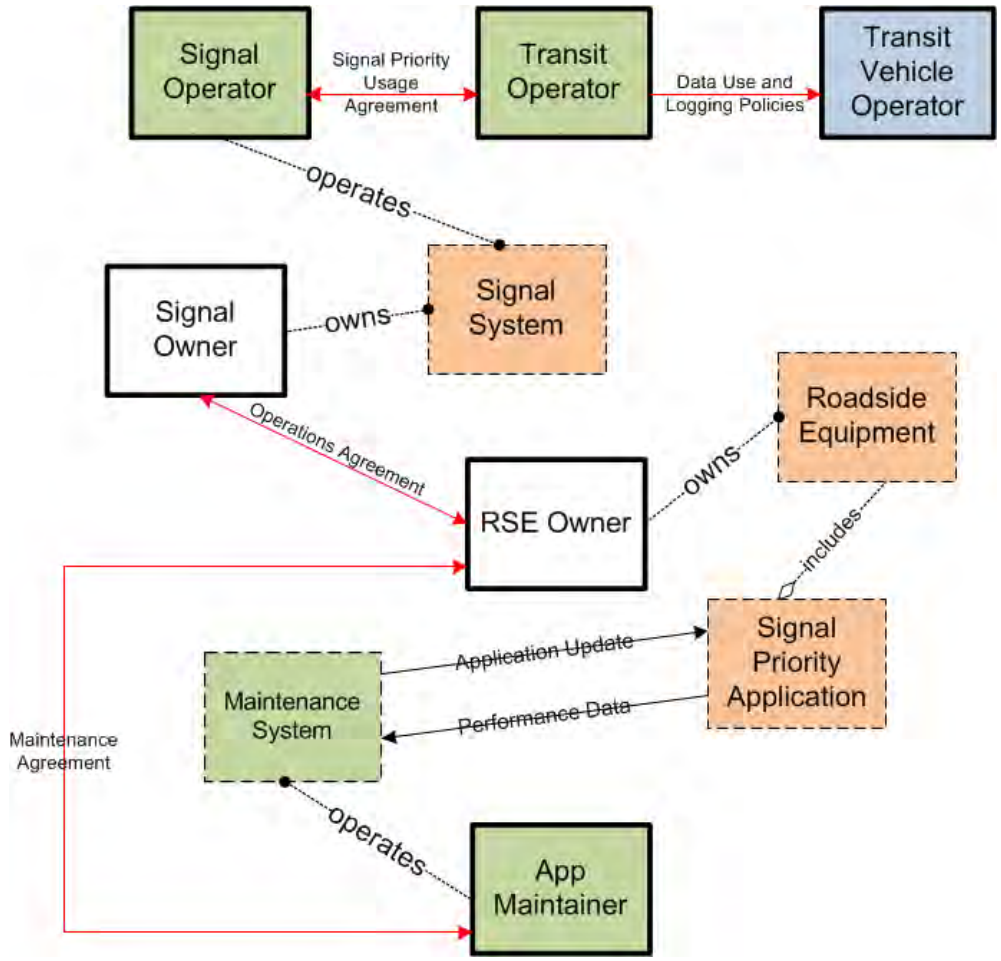
- Connected Vehicle Reference Implementation Architecture (CVRIA) uses multiple viewpoints to capture stakeholders' concerns
  - Enterprises to carry out applications
  - Functions to satisfy requirements,
  - Physical objects to implement that functionality
  - Communications protocols necessary



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?

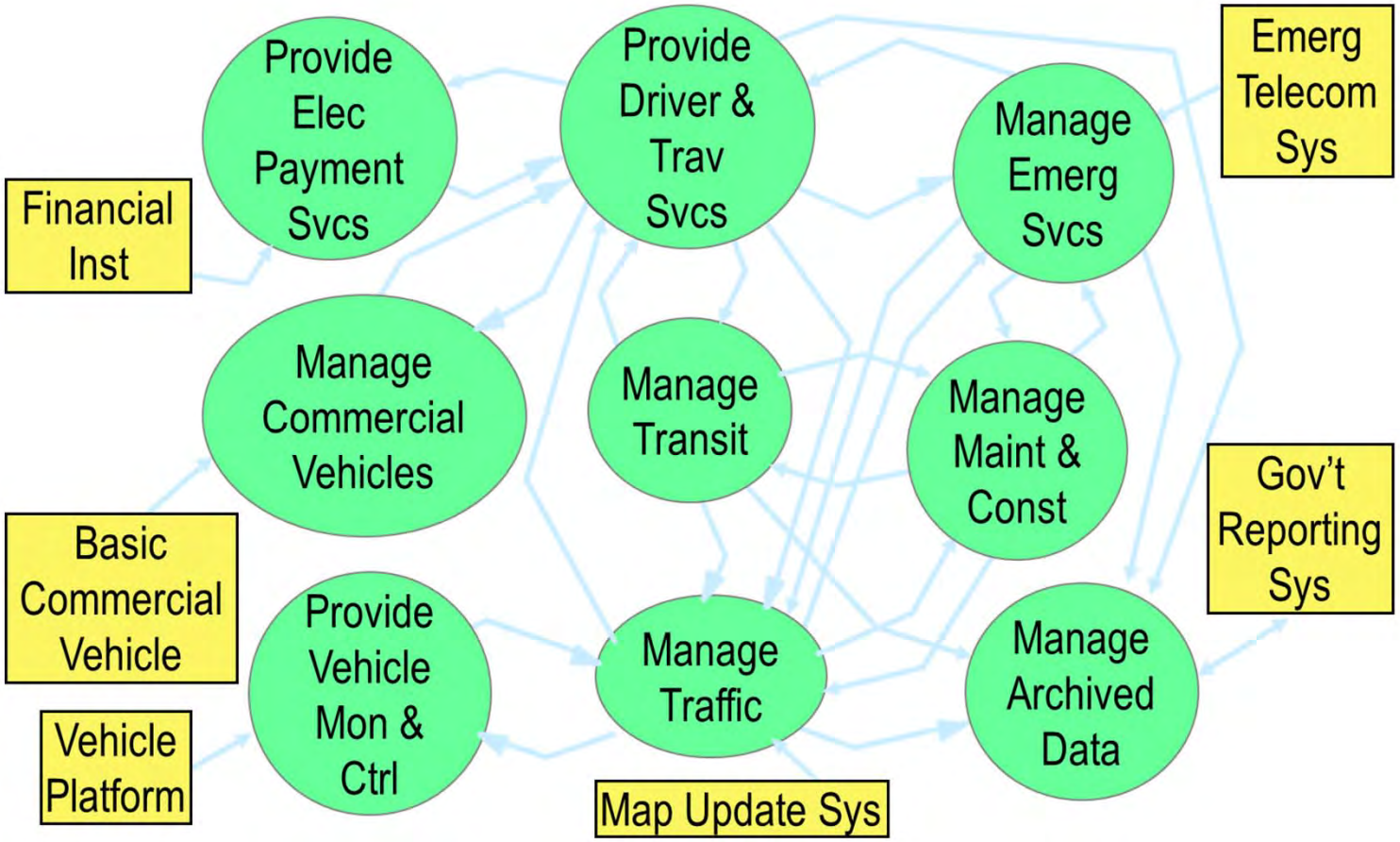
CVRIA Enterprise View Example



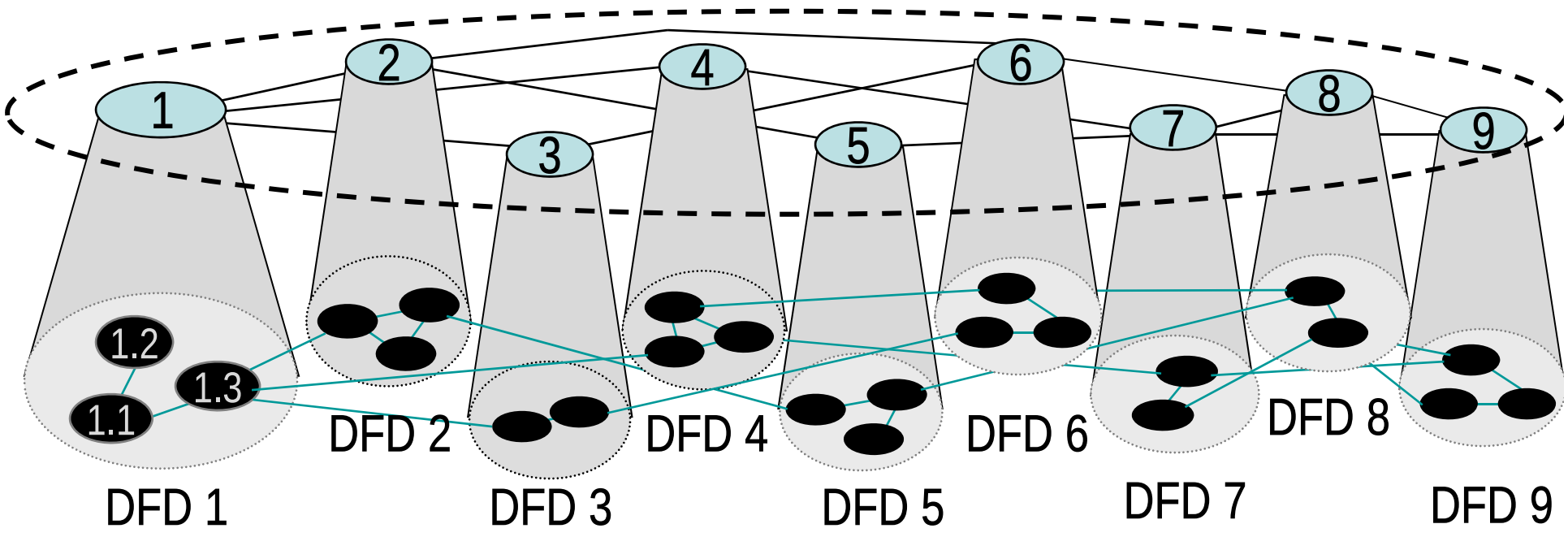
CVRIA Functional View

- 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)

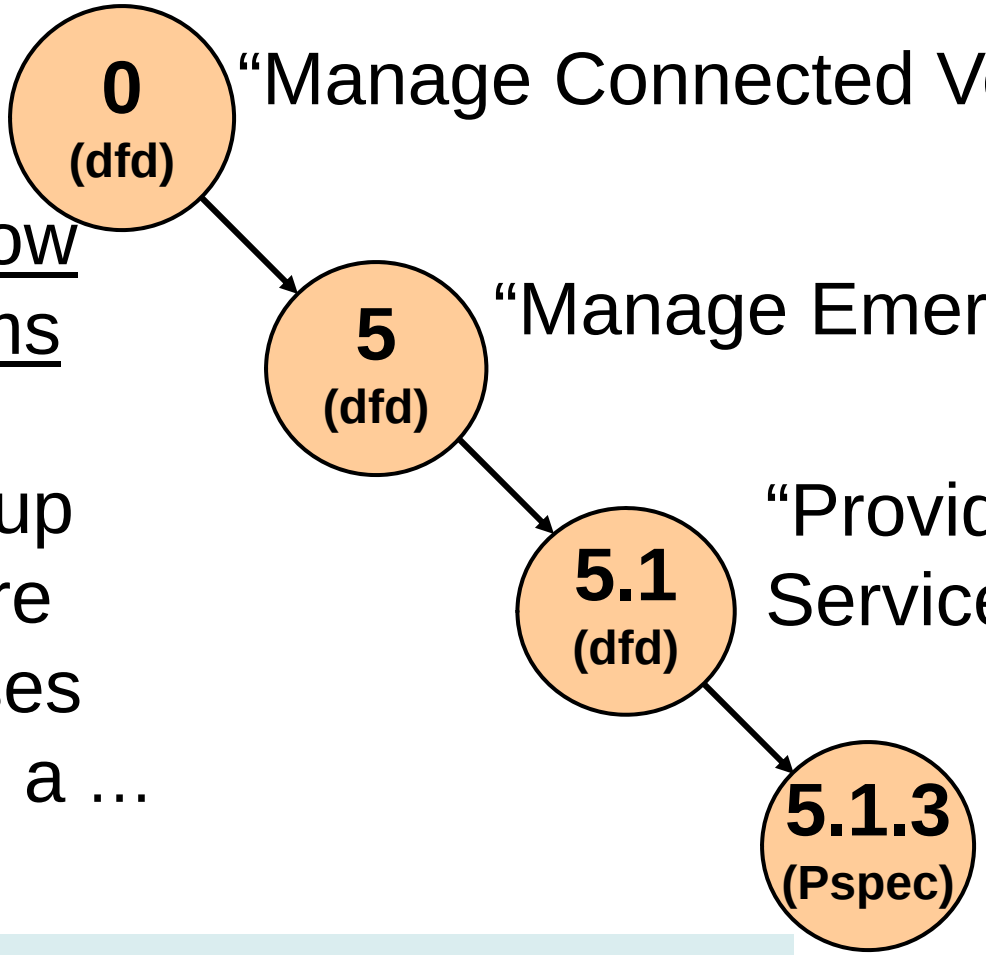


Hierarchical Data Flow Diagrams



Definition continues through successively lower levels of functional detail

Functional Decomposition down to a Process Specification



"Manage Connected Vehicles"

"Manage Emergency Services"

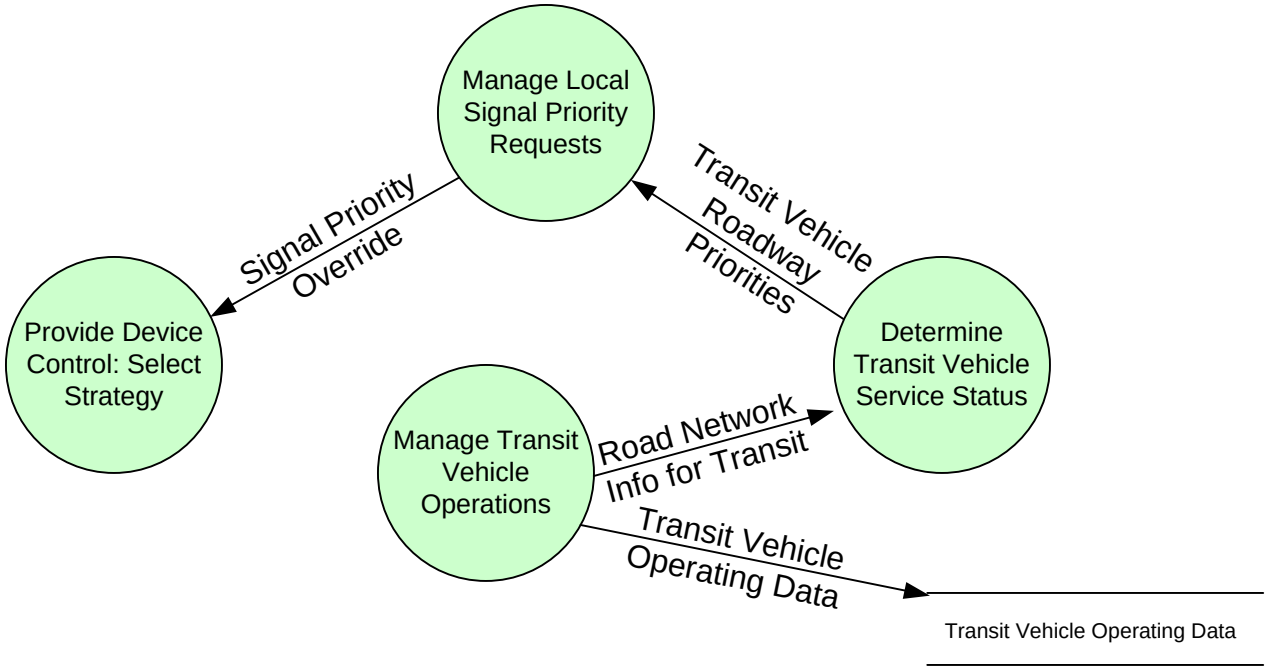
"Provide Emergency Service Allocation"

"Communicate Emergency Status"

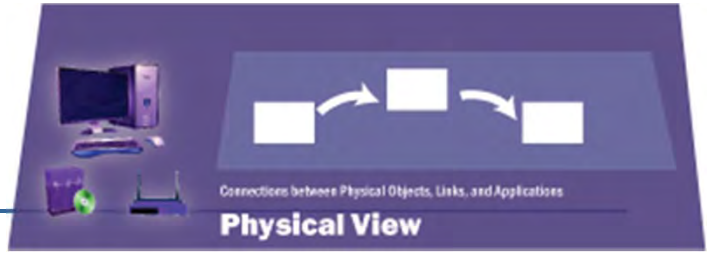
Data Flow Diagrams Can be broken up into more processes down to a …

Process Specification
- trace to Requirements
- map to physical view Application Objects

CVRIA Functional View Example

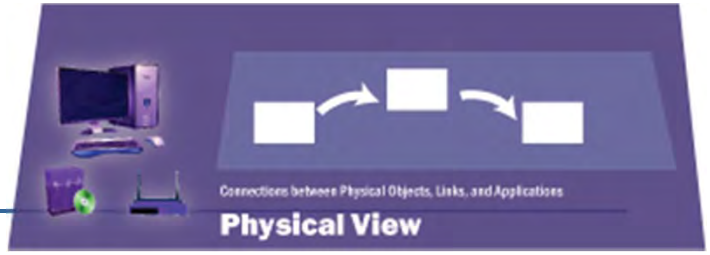


CVRIA Physical View



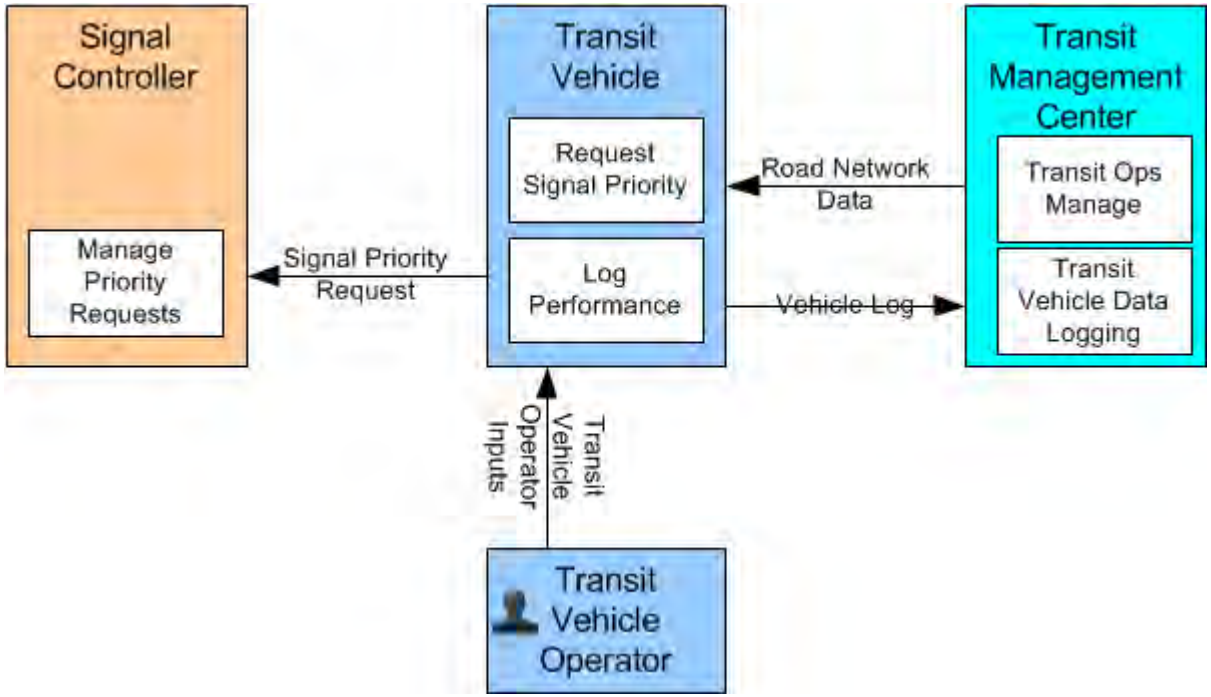
- Depicts:
  - Physical elements that interact to deliver services
  - Interfaces and flows of information between those physical elements
- Identifies options for…
  - What devices are involved in delivering safety, mobility, environmental applications?
  - What are the physical interfaces in each device?
  - 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

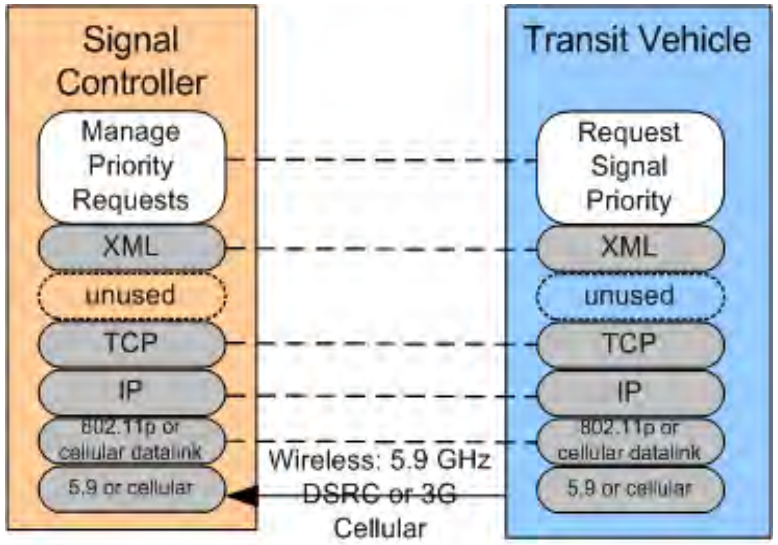
CVRIA Physical View Example



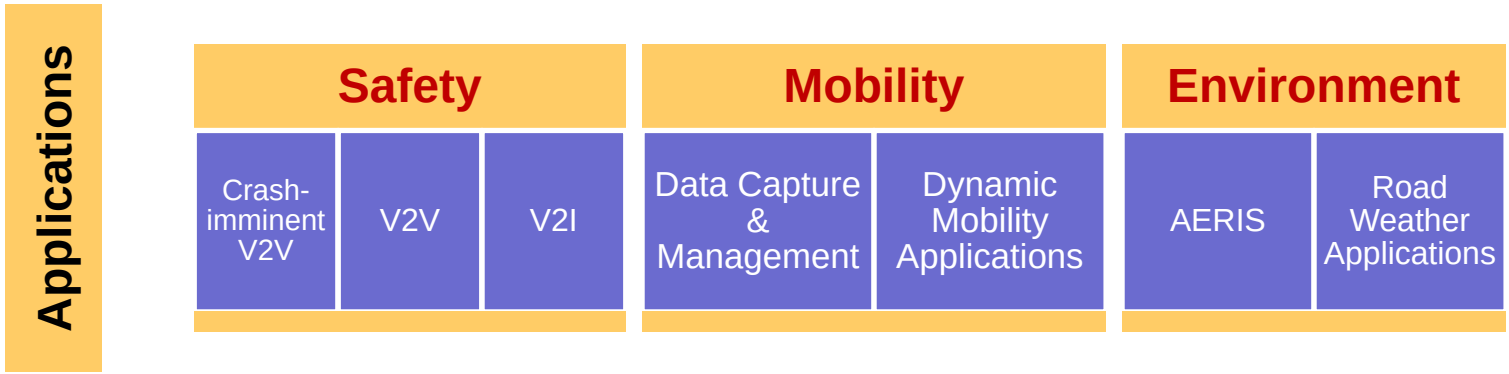
CVRIA Communications View

- 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

CVRIA CONNECTED VEHICLE REFERENCE IMPLEMENTATION ARCHITECTURE

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Home

Connected Vehicle Reference Implementation Architecture

Welcome to the Connected Vehicle Reference Implementation Architecture (CVRIA) Website! This site is your tool for reviewing, providing feedback, and using the architecture content for standards and project development. CVRIA is being developed as the basis for identifying the key interfaces across the connected vehicle environment which will support further analysis to identify and prioritize standards development activities. CVRIA will also support policy considerations for certification, standards, core system implementation, and other elements of the connected vehicle environment.

As shown in the figure, CVRIA is developed in 4 Viewpoints:

- Functional - Describes abstract functional elements (processes) and their logical interactions (data flows)that satisfy the system requirements
- Physical - Describes physical objects (systems and devices) and their application objects as well as the high-level interfaces between those physical objects
- Enterprise - Describes the relationships between organizations and the roles those organizations play within the connected vehicle environment
- Communications - Describes the layered sets of communications protocols that are required to support communications among the physical objects that participate in the connected vehicle environment

Latest News

- Connected Vehicle Reference Implementation Architecture Workshop in San Jose, California (April 30 - May 1, 2013)

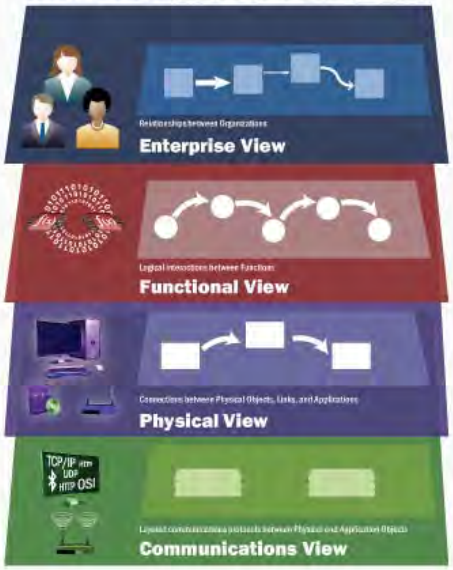
Stakeholder Feedback

Feedback is encouraged as the CVRIA is developed and maintained. Key stakeholder activities include:

- Reviewing the architecture viewpoints
- Reviewing the standards development plan
- Providing inputs for policy development and review policy options

Please use the Contact Us page to ask questions or provide comments to the team.

Connected Vehicle Reference Implementation Architecture



Another way to view the architecture is from the perspective of the connected vehicle safety, mobility, environmental, and support applications. Each application page shows the subset of each of the viewpoints that pertain to that application.

The project is sponsored and led by the USDOT's ITS JPO, under the management of the ITS Architecture and Standards Programs and in cooperation with the Systems Engineering and Test Bed Programs.

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Last Updated 4/2/2013

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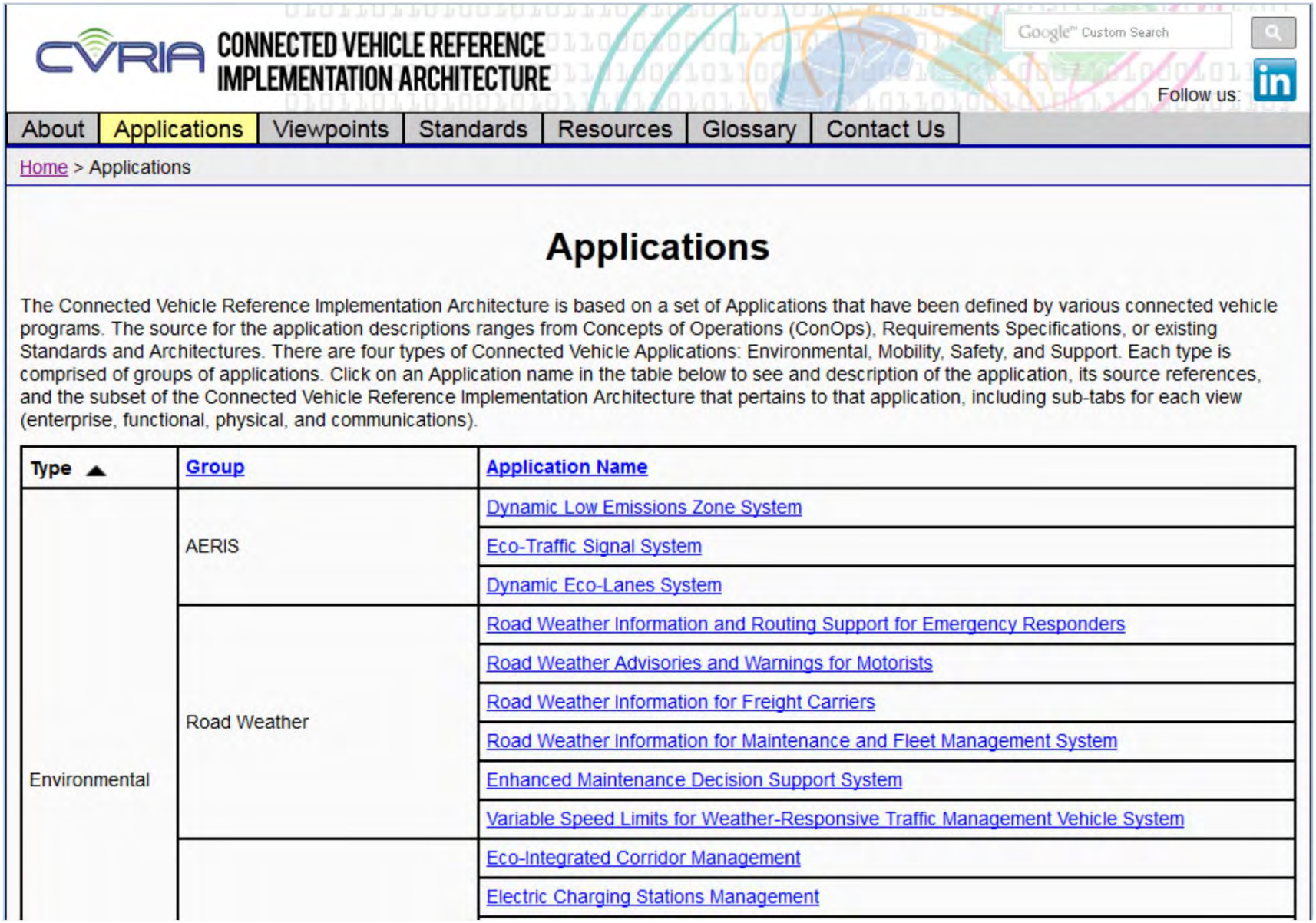
CVRIA Website – Applications Page



CVRIA CONNECTED VEHICLE REFERENCE IMPLEMENTATION ARCHITECTURE

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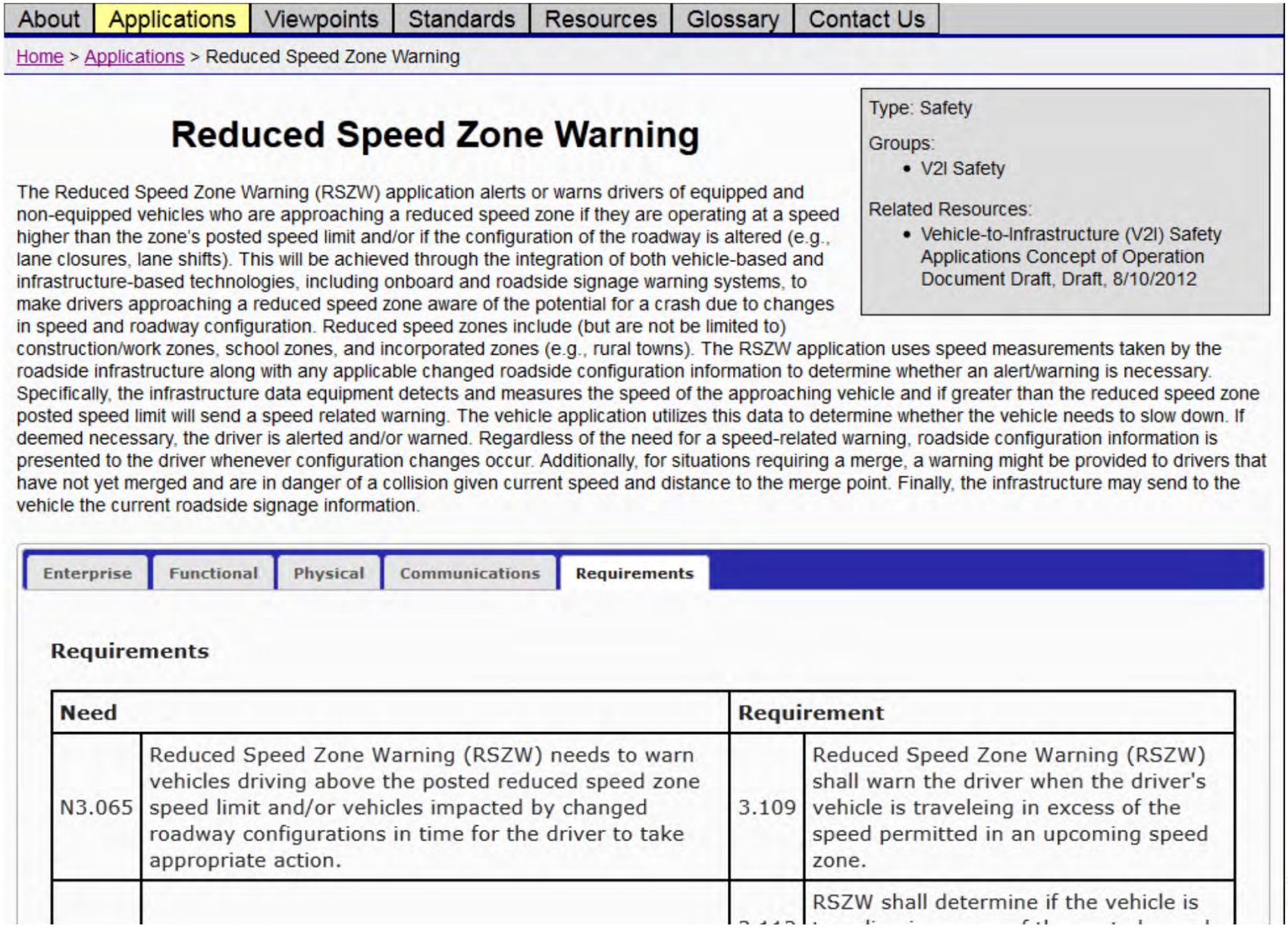
Applications

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).

Type ▲	Group	Application Name
Environmental	AERIS	Dynamic Low Emissions Zone System
		Eco-Traffic Signal System
		Dynamic Eco-Lanes System
	Road Weather	Road Weather Information and Routing Support for Emergency Responders
		Road Weather Advisories and Warnings for Motorists
		Road Weather Information for Freight Carriers
		Road Weather Information for Maintenance and Fleet Management System
		Enhanced Maintenance Decision Support System
		Variable Speed Limits for Weather-Responsive Traffic Management Vehicle System
		Eco-Integrated Corridor Management
		Electric Charging Stations Management

CVRIA Website – Reduced Speed Zone Warning (RSZW)



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Reduced Speed Zone Warning

Type: Safety

Groups:
- V2I Safety

Related Resources:
- Vehicle-to-Infrastructure (V2I) Safety Applications Concept of Operation Document Draft, Draft, 8/10/2012

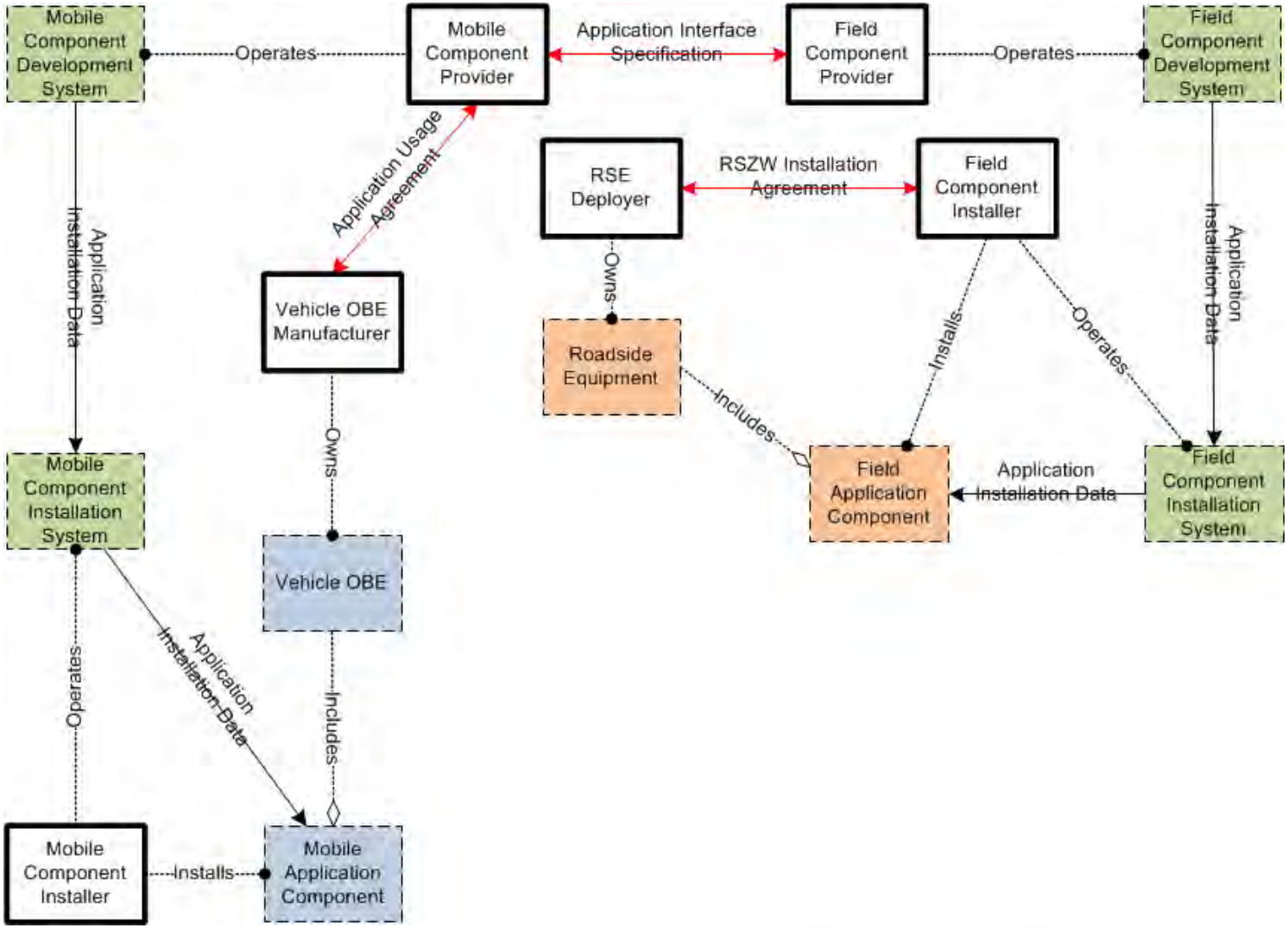
The Reduced Speed Zone Warning (RSZW) application alerts or warns drivers of equipped and non-equipped vehicles who are approaching a reduced speed zone if they are operating at a speed higher than the zone's posted speed limit and/or if the configuration of the roadway is altered (e.g., lane closures,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

Enterprise | Functional | Physical | Communications | Requirements

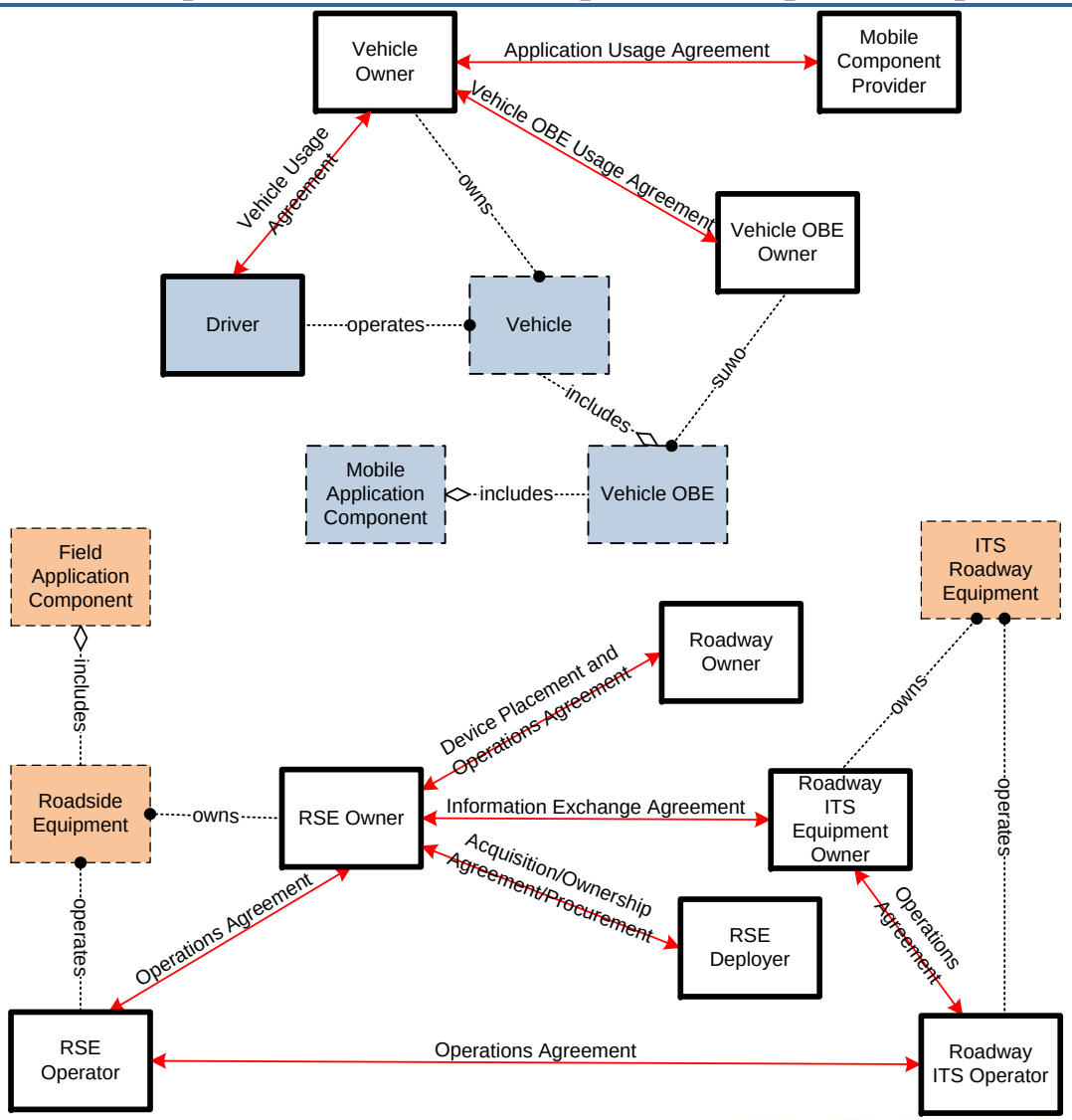
Requirements

Need		Requirement	
N3.065	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.	3.109	Reduced Speed Zone Warning (RSZW) shall warn the driver when the driver's vehicle is traveleing in excess of the speed permitted in an upcoming speed zone.
			RSZW shall determine if the vehicle is

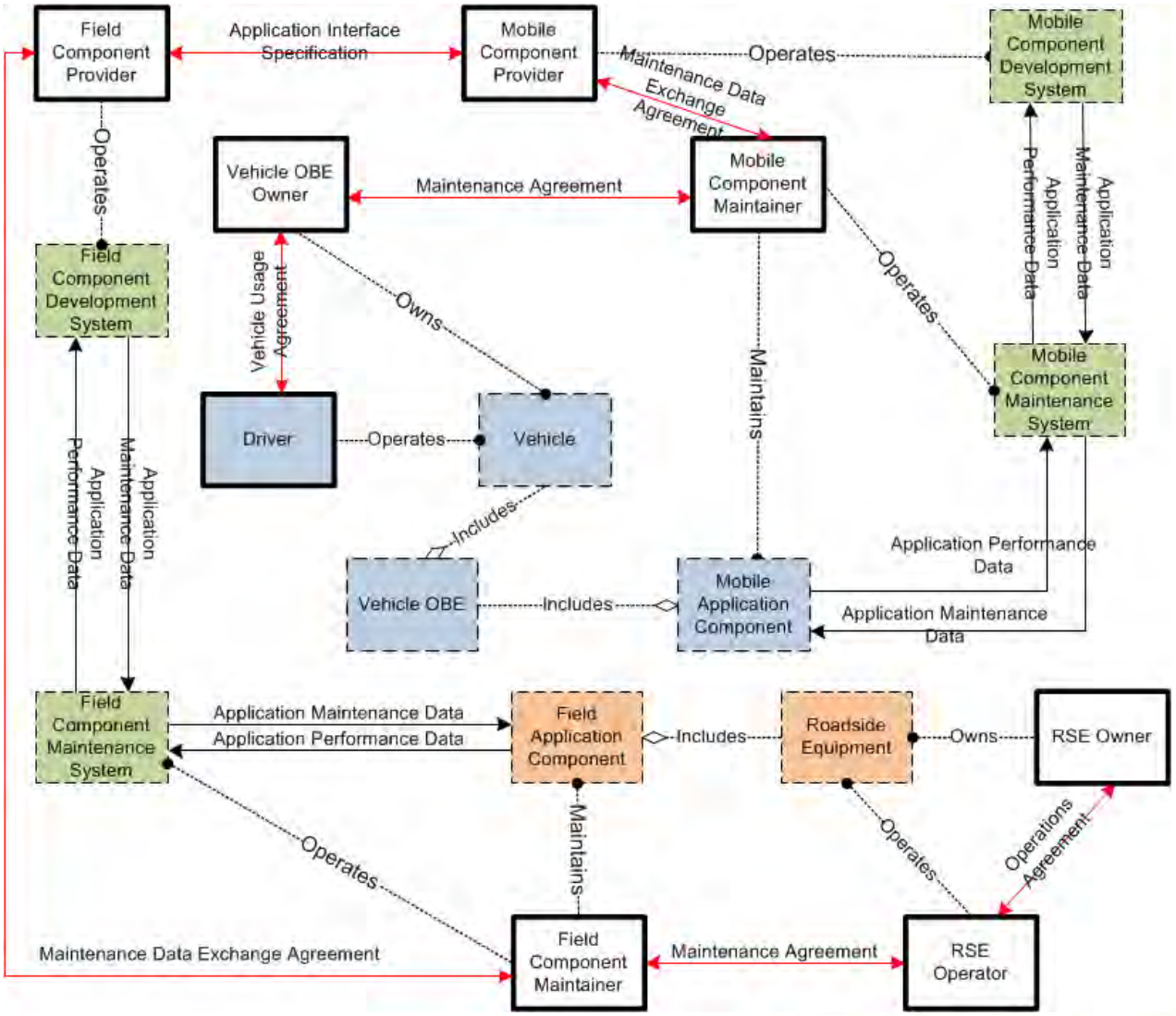
RSZW Enterprise View (1 of 4) – Install



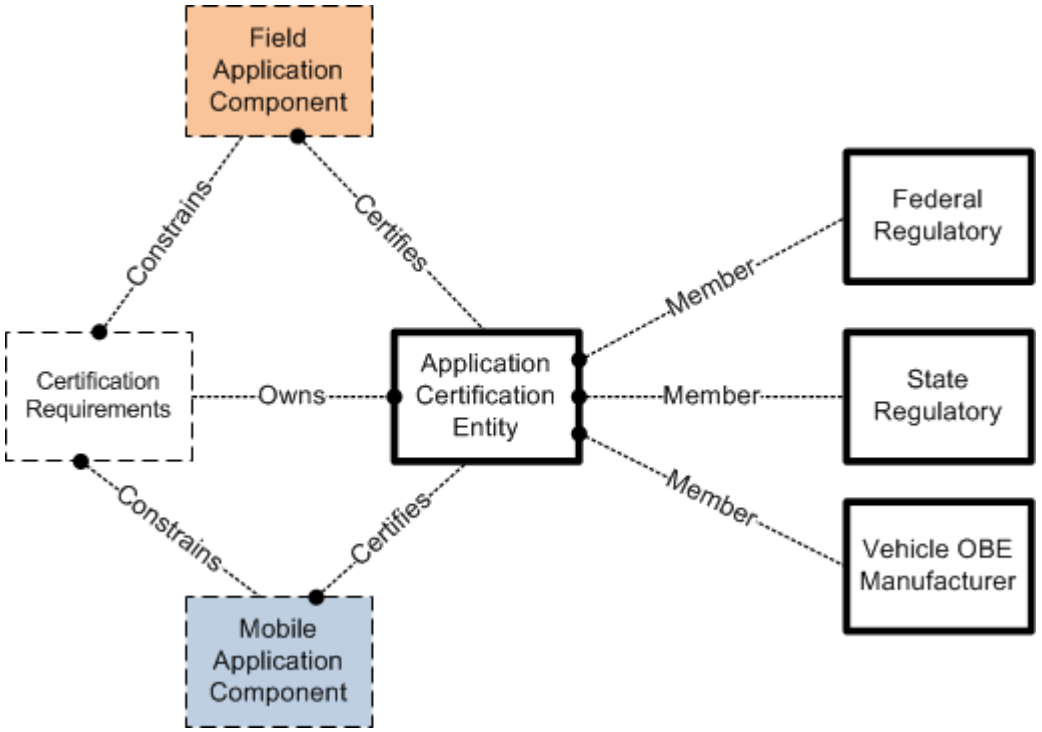
RSZW Enterprise View (2 of 4) – Operations



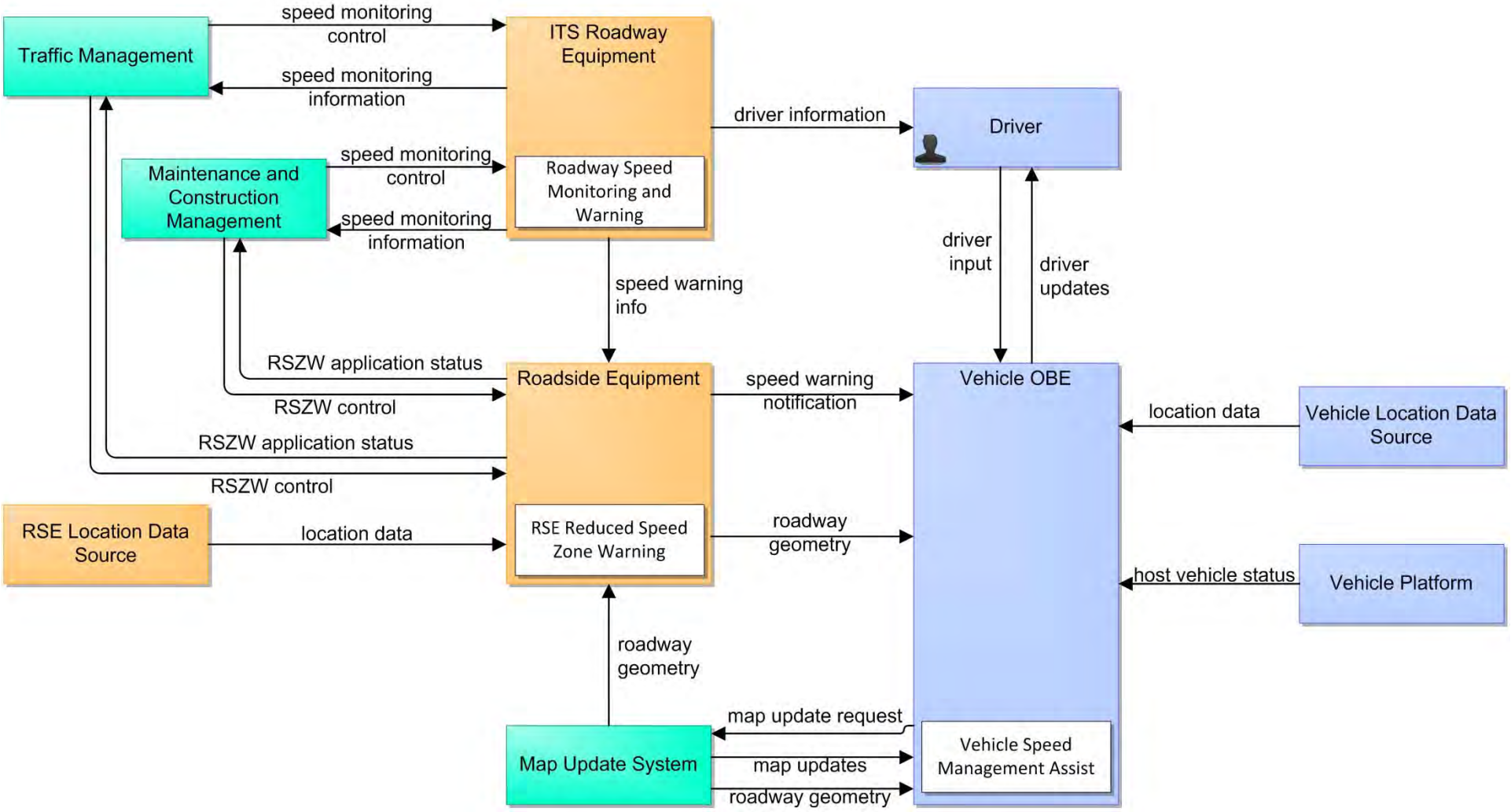
RSZW Enterprise View (3 of 4) – Maintenance



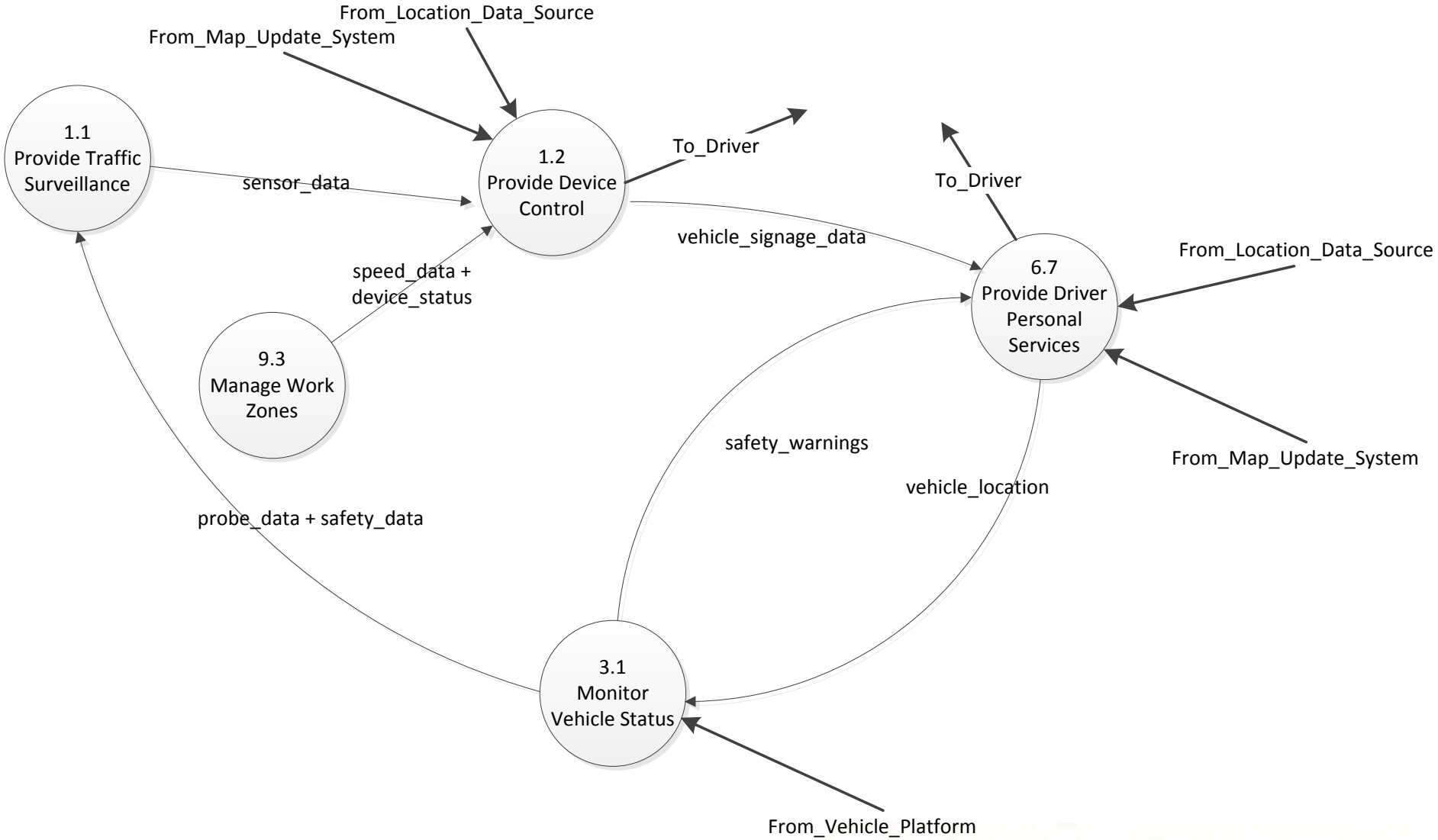
RSZW Enterprise View (4 of 4) – Certification



RSZW Physical View

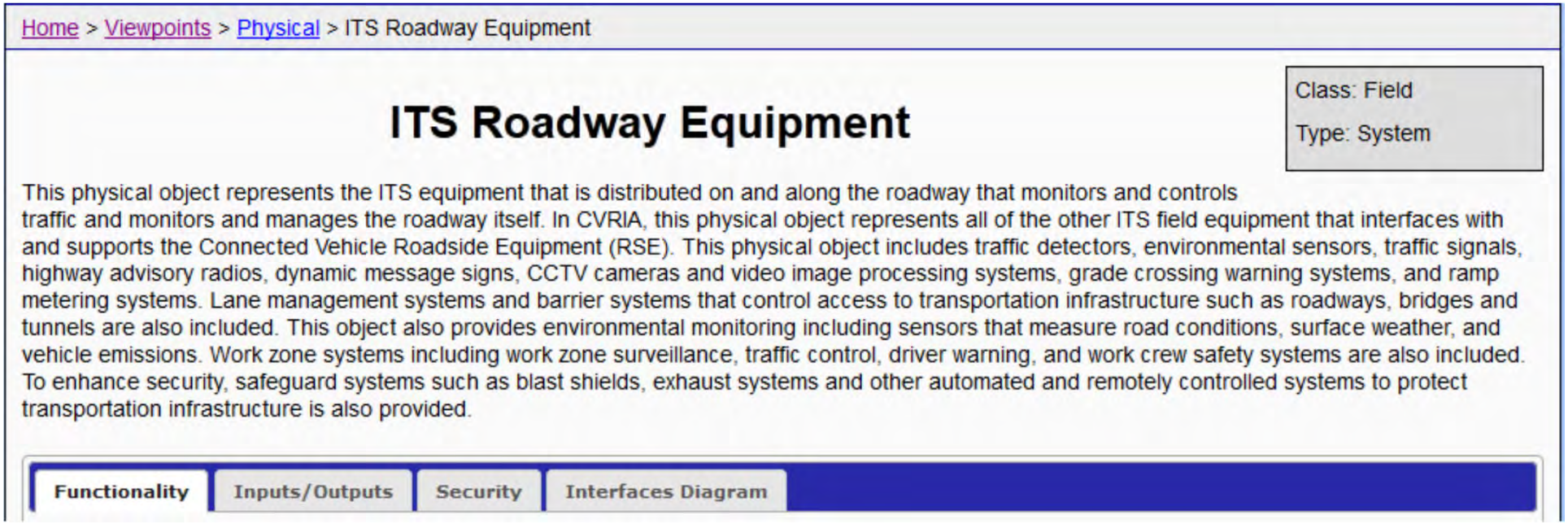


RSZW Functional View (Summary)



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



RITA Research and Innovative Technology Administration

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

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

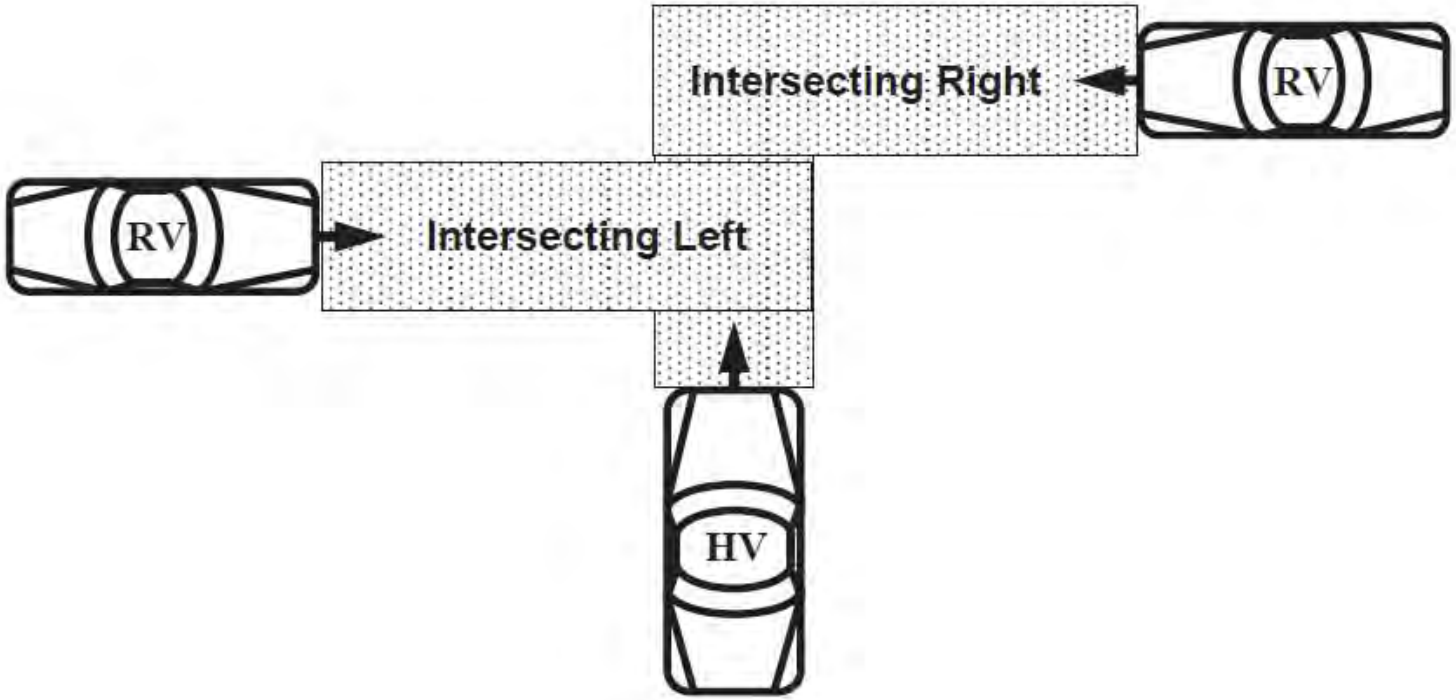
- Split into 2 groups – just to create smaller groups to increase conversation
- Take each application
  - Description, needs/requirements addressed
  - Physical view
  - Enterprise view
    - Installation phase
    - Operations
    - Maintenance
    - Certification
  - Functional view
- Goal is to identify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

Intersection Movement Assist

- 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.

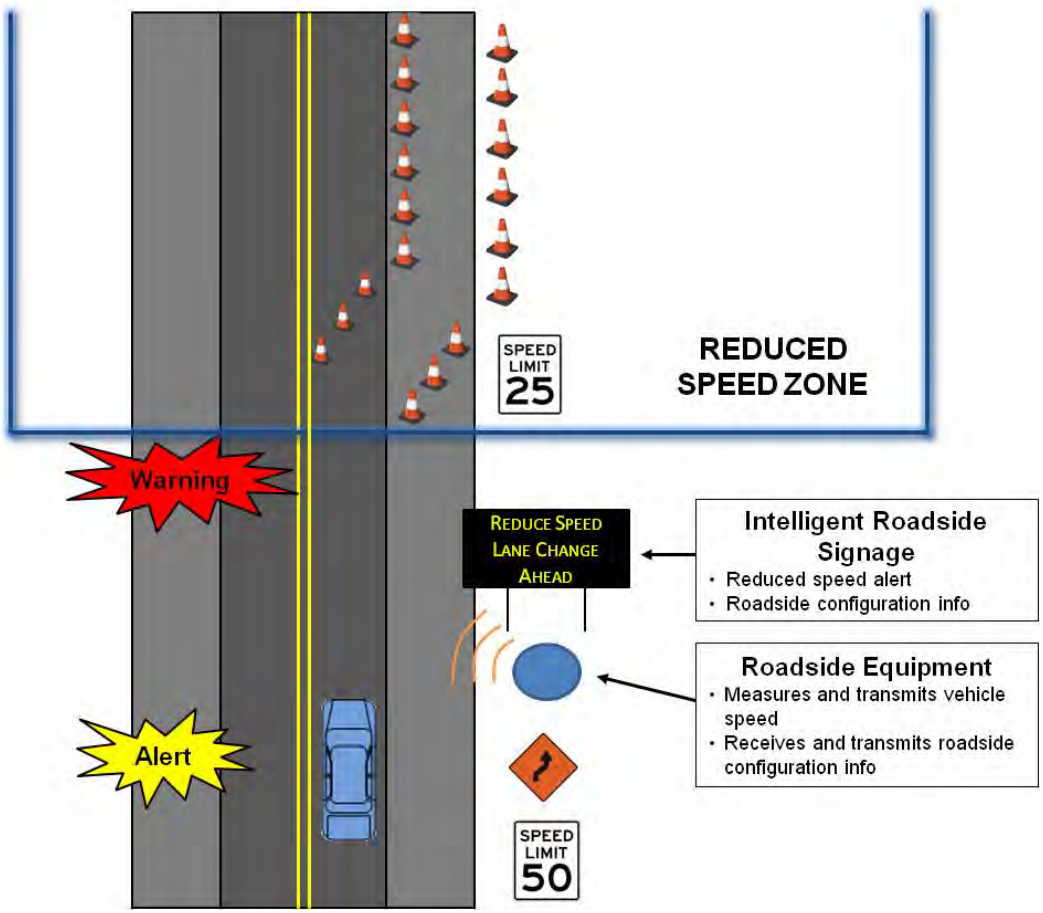


Intersection Movement Assist (IMA)

- 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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  - Enterprise Objects
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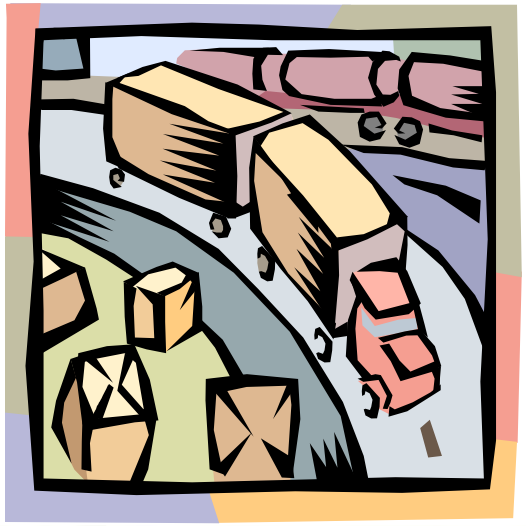
  - Resources
  - Roles & Relationships
- Functional View
  - Processes / High Level interfaces

Freight Drayage Optimization (DR-OPT)

- 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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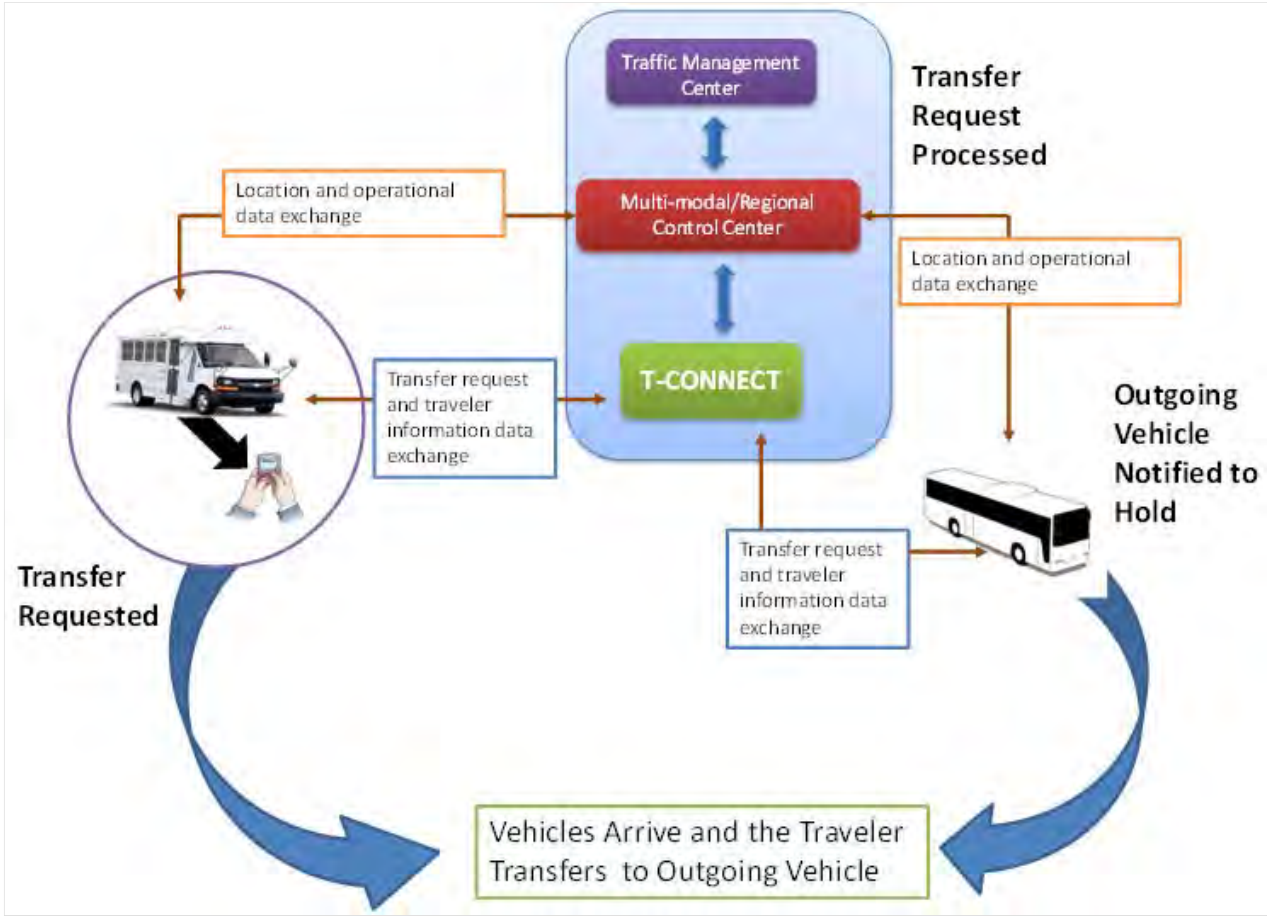
- Enterprise View
  - Enterprise Objects
  - Facilities
  - Resources
  - Roles & Relationships
- Functional View
  - Processes / High Level interfaces

Transit Connection Protection (T-CONNECT)

- 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)

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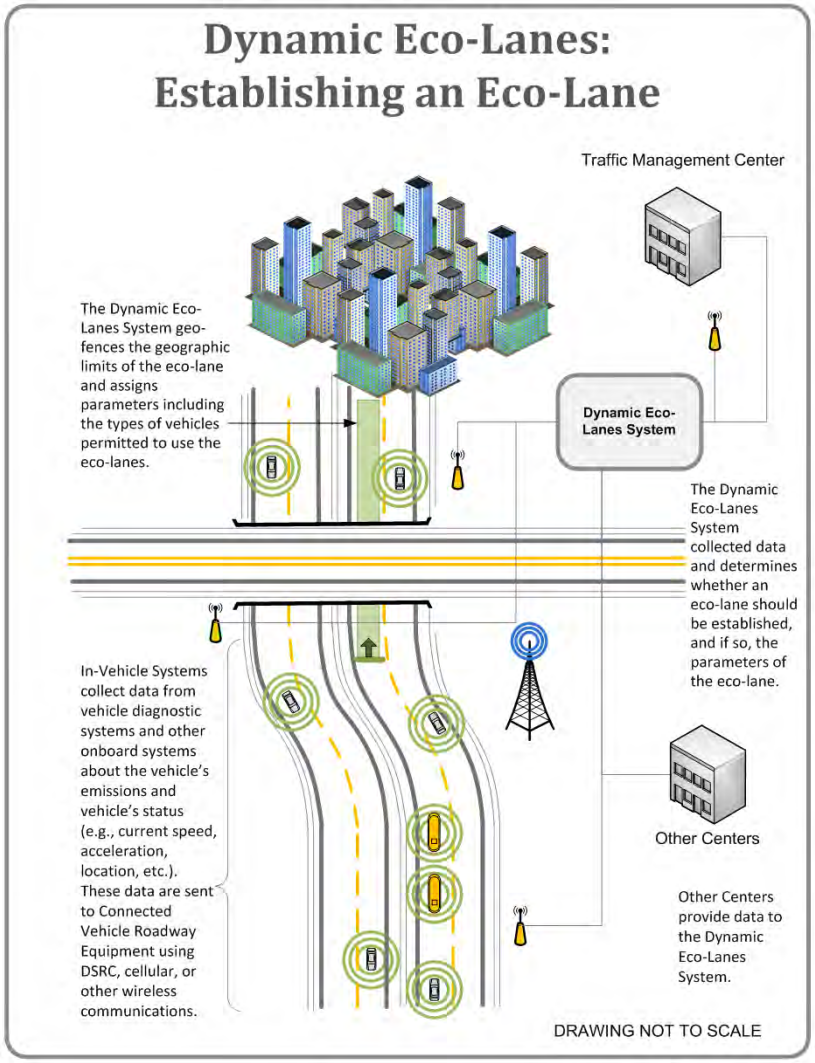
  - Enterprise Objects
  - Facilities
  - Resources
  - Roles & Relationships
- Functional View
  - Processes / High Level interfaces

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

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- 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.

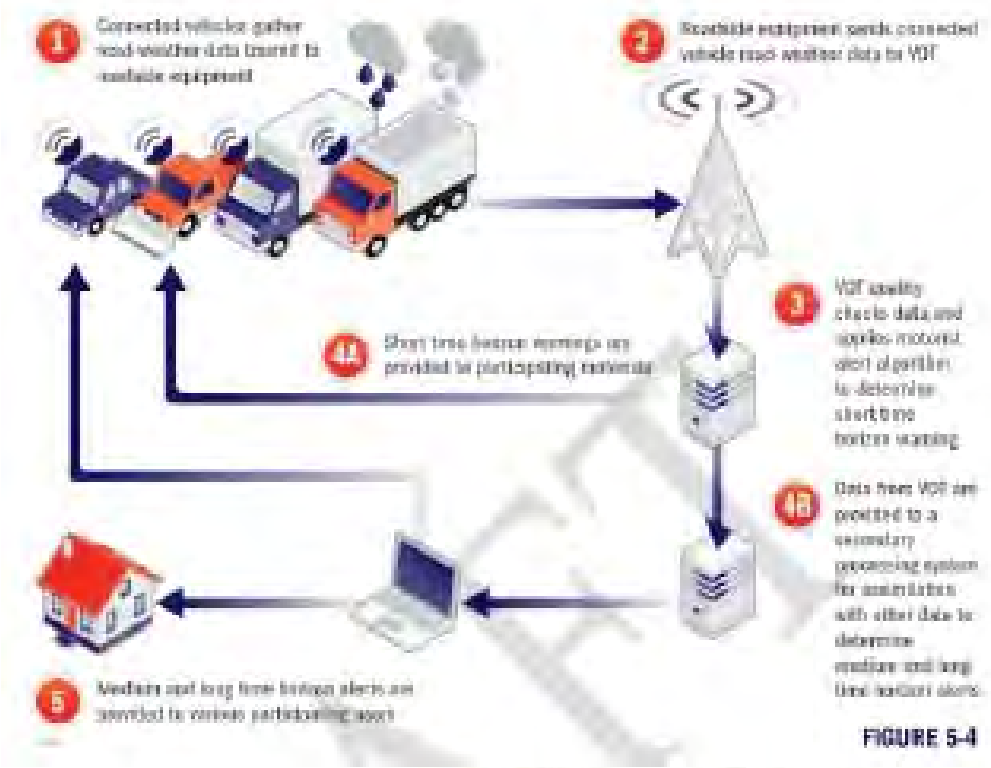

FIGURE 5-4

Road Weather Advisories and Warnings for Motorists

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  - Application Objects
  - Flows
- Enterprise View
  - Enterprise Objects
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- Functional View
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CVRIA Breakout Group Discussions

Room 1 Findings	Room 2 Findings