



Connected Vehicles – Reference Architecture and Tools

For Safety and Mobility

Welcome

Presenters –

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Topics –

- DOT and Connected Vehicles
- Systems Engineering basis for CVRIA
- CVRIA Web site access
- SET-IT Tool installation
- Basics of CVRIA
- Basics of the SET-IT tool

Transportation Challenges

- Safety
 - 33,000 killed in US in 2014
 - Leading cause of death in young people
- Mobility:
 - 5.5 billion hours of travel delay
 - \$121 billion cost of urban congestion
- Environment
 - 2.9 billion gallons of wasted fuel
 - 56 billion lbs. of additional CO2



Connected Vehicle Systems

Connected vehicles have the potential to address approximately 80% of vehicle crash scenarios involving unimpaired drivers.

- The overall purpose of connected vehicle – Save Lives
 - Reduce number of accidents and severity using vehicle to vehicle communications
- Onboard systems provide Greater situational awareness:
 - Your vehicle can “see” nearby vehicles and knows roadway conditions you cannot see
- Reduce or even eliminate crashes through:
 - Driver advisories
 - Driver warnings
 - Vehicle control



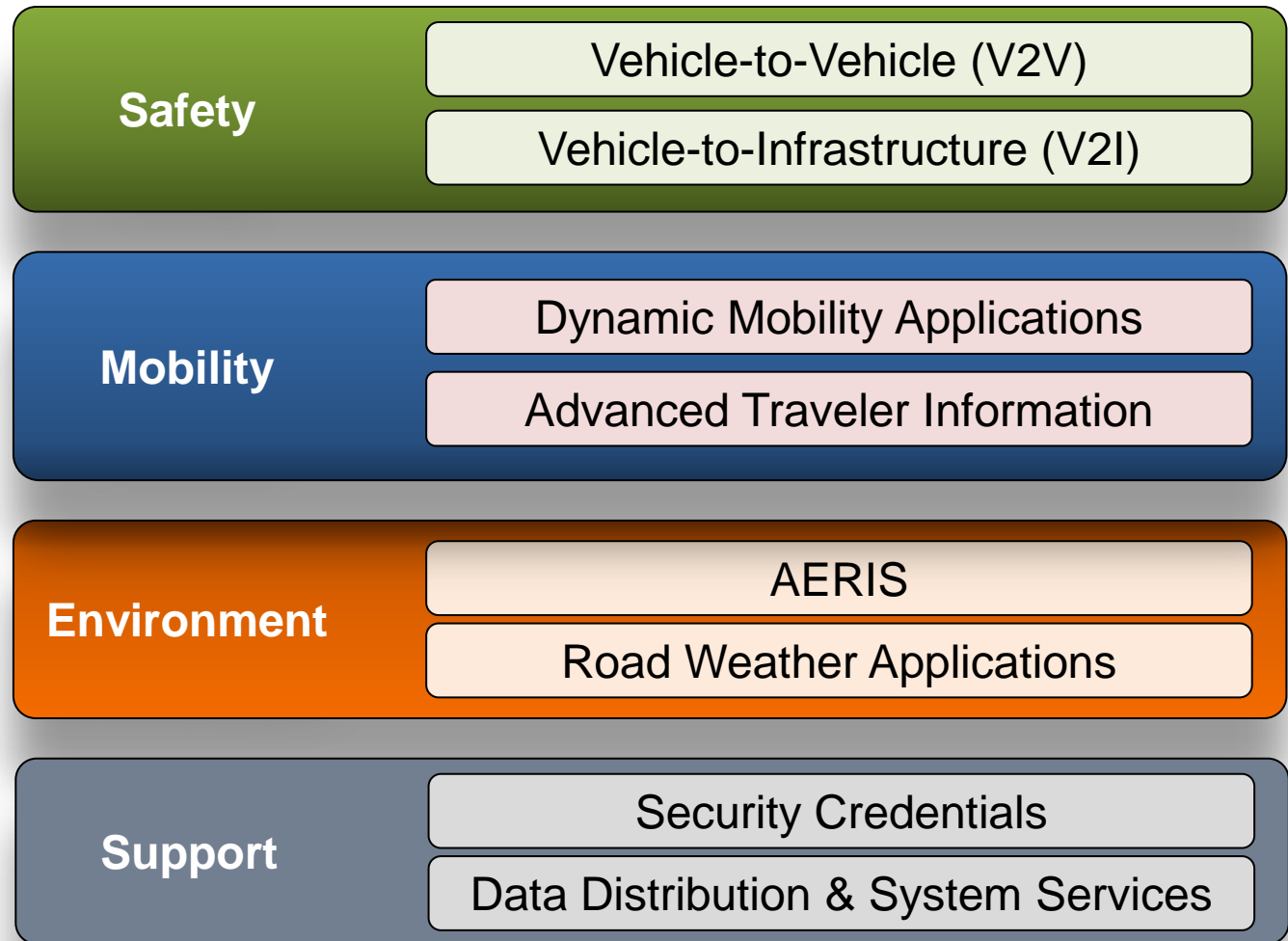
Communications Technologies

- Connected Vehicle applications make use of emerging standards based 5.9 GHz Dedicated Short-range Communications (DSRC)
 - Primarily for vehicle-to-vehicle and infrastructure safety, ~300m
 - IEEE 1609 comm, SAE J2735 message set, J2945 performance spec
- Cellular networks provide high-bandwidth data communications
- Wi-Fi, satellite, HD radio, etc. may also be useful
- Devices may be built-in to a vehicle but could include hand-held (pedestrians, passengers) or after-market safety devices
- Secure, trusted communications is key:
 - Trust the information coming to you
 - Know that your privacy is maintained



Connected Vehicle Applications

Since 2003, USDOT-sponsored research has identified ~100 applications to address Safety, Mobility, Environmental needs As well as address security/privacy concerns and other system support services



We Need a Common Language

- Looking ahead ... 10-20 years from now when 80% of vehicles are equipped in some way – maintaining a robust connected vehicle environment
- With so many applications exposing so many opportunities for integration
- The US DOT's Intelligent Transportation System (ITS) Joint Program Office (JPO) realized that a Reference Architecture was needed
 - Connected Vehicle Reference Implementation Architecture (CVRIA)
 - To establish a *framework* for integrating connected vehicle technologies and identify interfaces for standardization

in four slides....

SYSTEM ARCHITECTURE

System Architecture

A System... has an Architecture

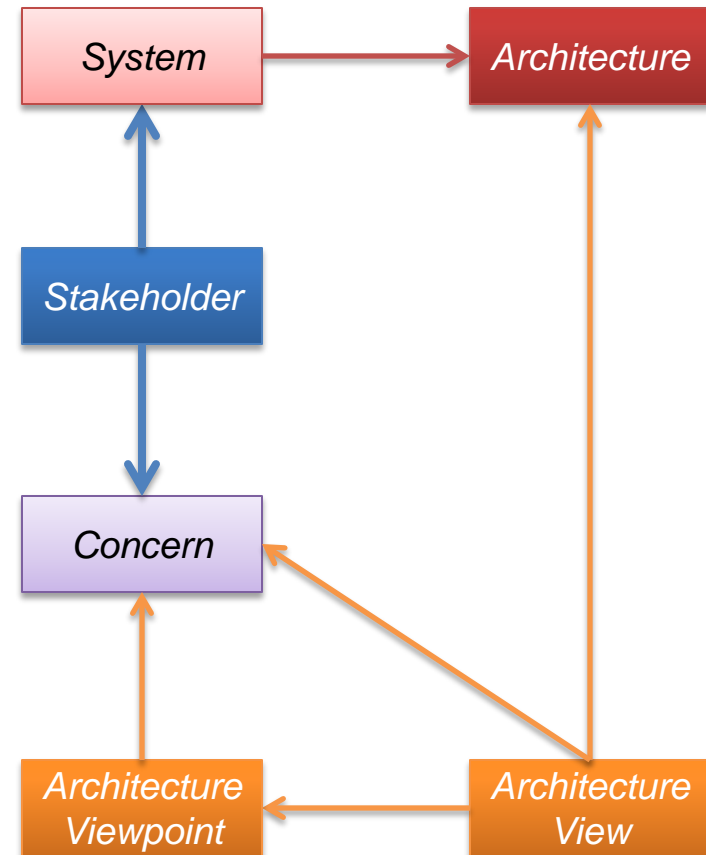
Stakeholders... have interests in the system

Stakeholders... have concerns

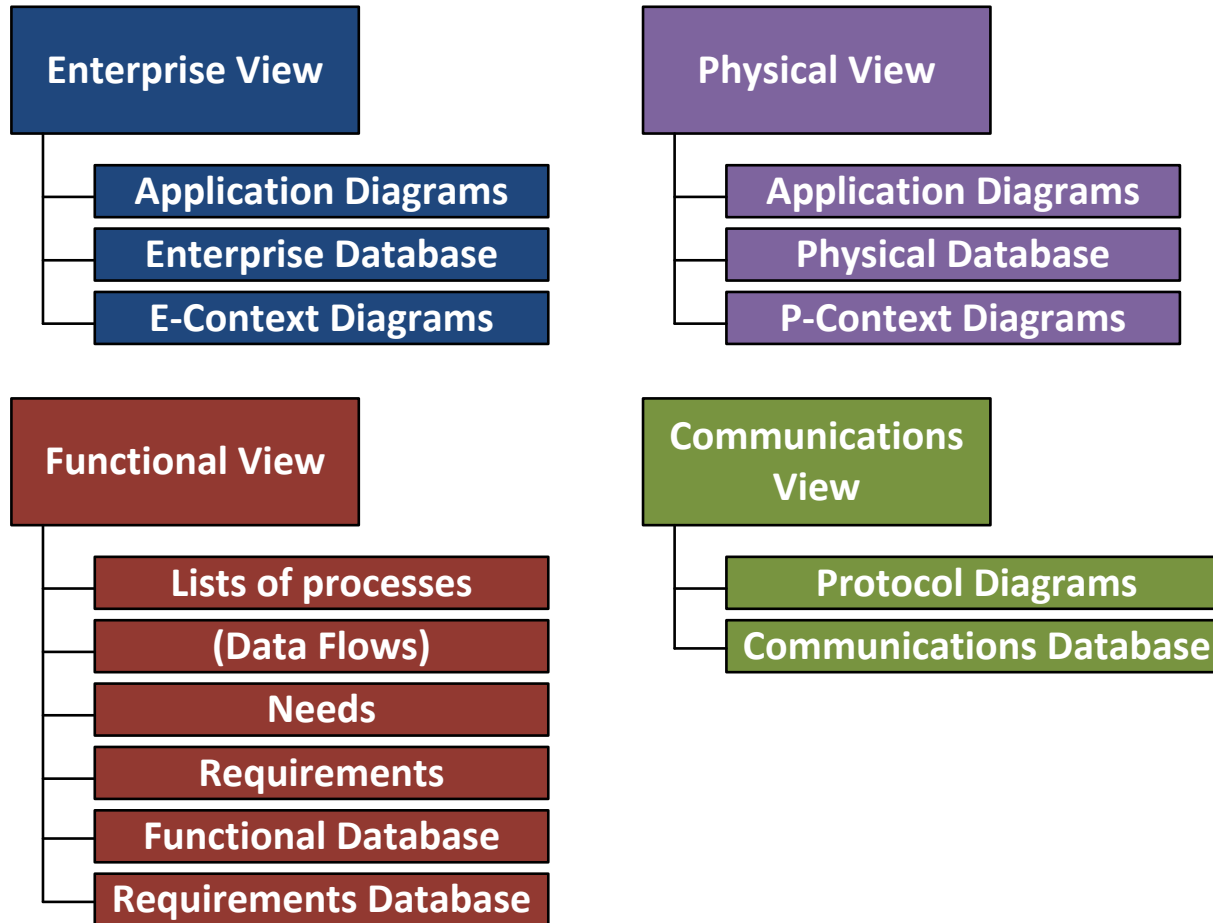
Architecture viewpoints... frame concerns

Architecture views... address concerns

The sum of architecture views make up the architecture

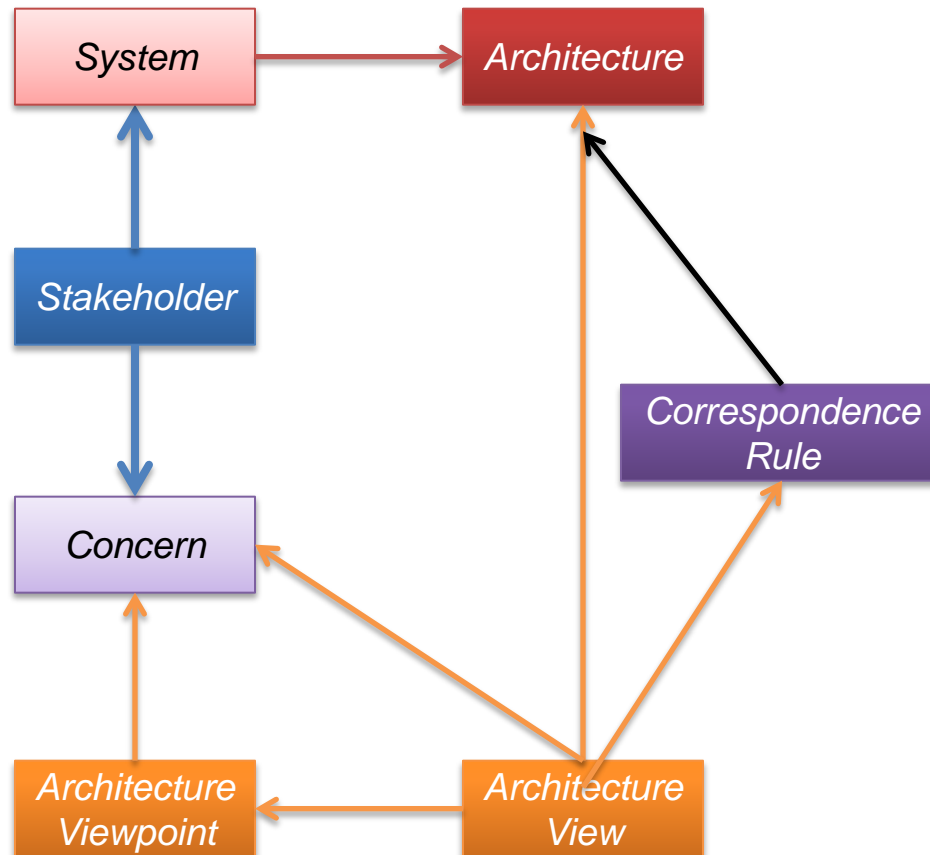


CVRIA Viewpoints

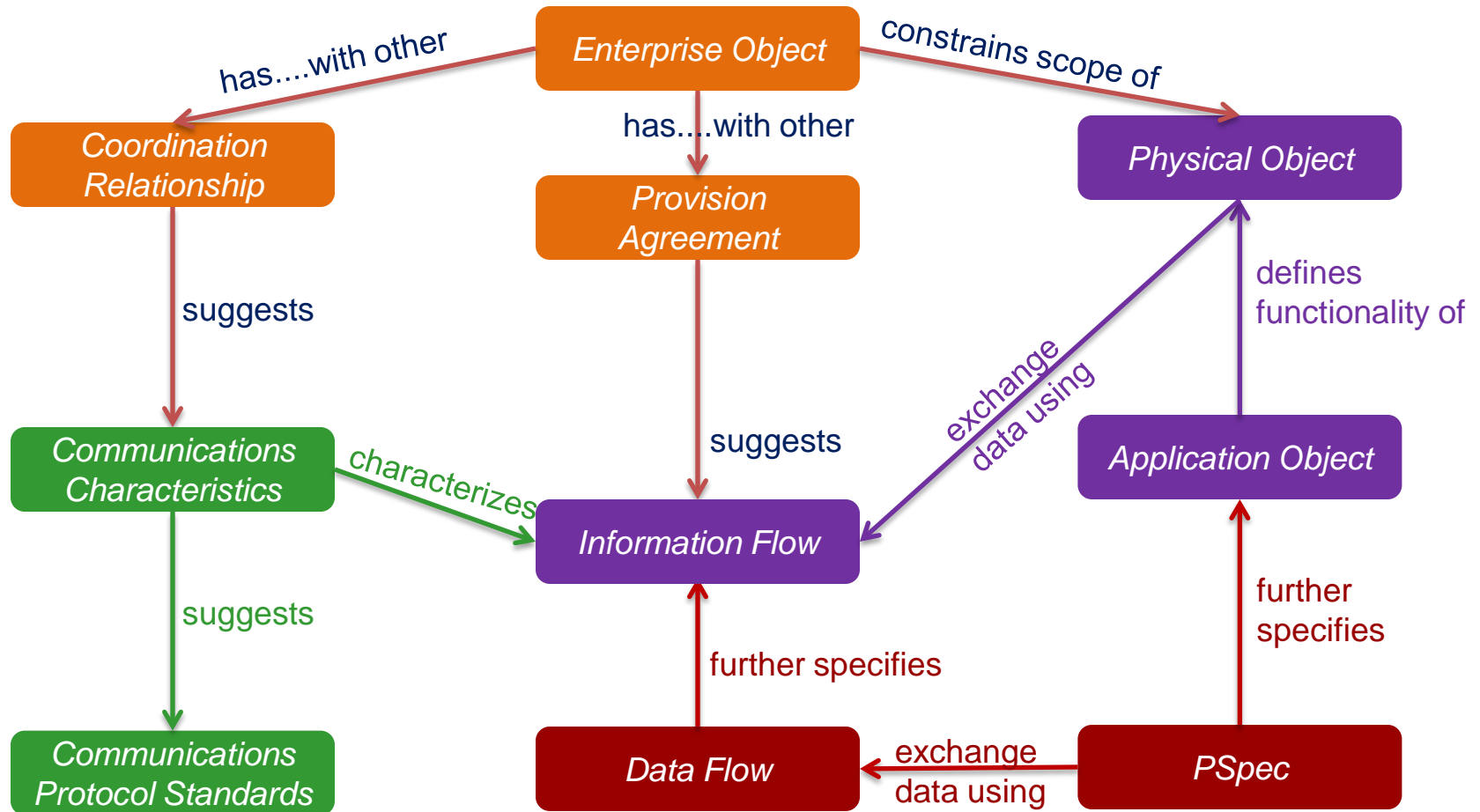


CVRIA Viewpoint Correspondence

Correspondence rules define how artifacts in one viewpoint are related to artifacts in another.



CVRIA Viewpoint Correspondence, Cont'd



CVRIA WEBSITE

CVRIA Website

- Organizes the architecture content in a layered hypertext format
- Think of CVRIA as the *reference book* on the engineer's shelf
 - Use the website as we start using the SET-IT software tool to better understand what something is and its context within the larger CV environment
- Allows for easy and quick targeted access to topics of interest
 - Applications: ~100 from US, EU, Australia
 - Views: Physical, Enterprise, Functional, Communications
 - Other Resources: databases, training, documents
- Is updated as CVRIA evolves

CVRIA Website: www.iteris.com/cvria

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 Views:

- Enterprise - Describes the relationships between organizations and the roles those organizations play within the connected vehicle environment
- 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
- 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

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 views 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.

Latest News

CVRIA has been updated to Version 2.0. This version includes updates to many of the original applications based on user feedback in areas like V2V Safety, V2I, transit, road weather, freight, public safety, environment, etc.. 2.0 also includes support for new applications from international users including Australia and the European Union. This version updates and expands the support applications including Security, System Monitoring, and Object Registration/Discovery. [Click here to see the details of What's changed in CVRIA 2.0!](#)

The Systems Engineering Tool for Intelligent Transportation (SET-IT) Version 2.0 is available as a download from the [Tools page](#). In addition to supporting all of the updated and newly added CVRIA applications, this version adds the ability to develop Communications View diagrams based on CVRIA. Version 2.0 includes a Search function, Spell Check utility, and Synchronize has been simplified and runs automatically. See the [Tools page](#) and [Readme file](#) for more details.

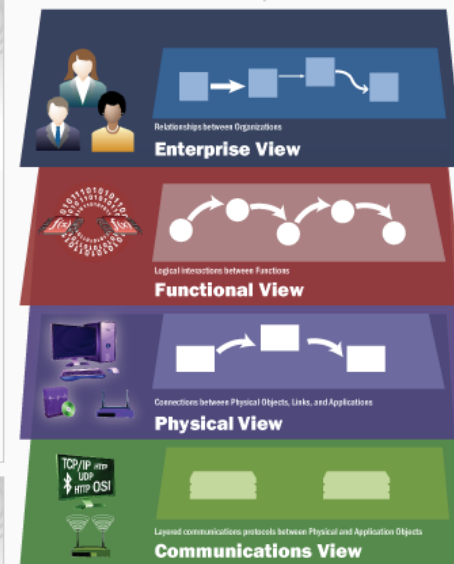
Stakeholder Feedback

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

- Reviewing the architecture views
- 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



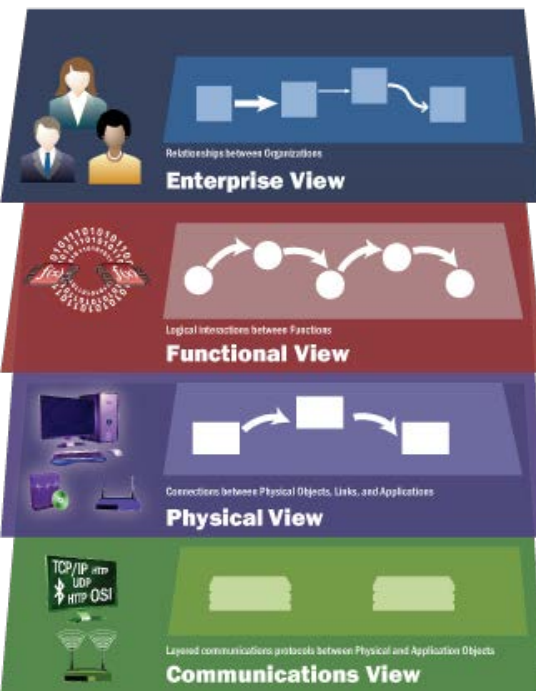
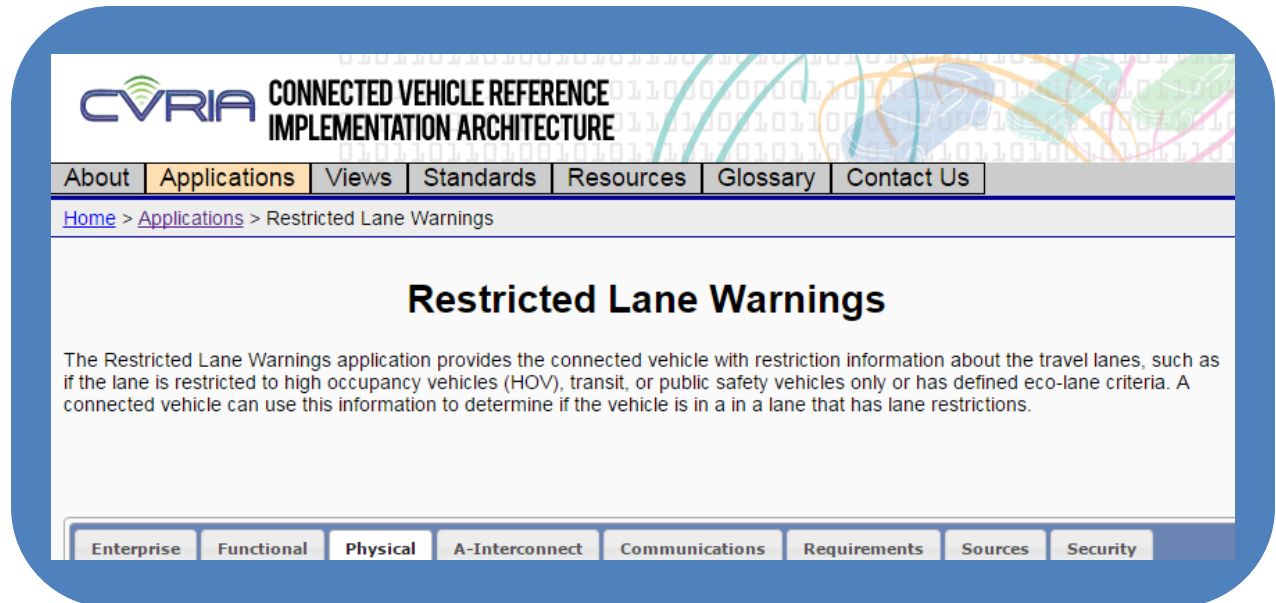
CVRIA Website Links Views to Applications

<http://www.iteris.com/cvria/index.html>

Applications

Safety			Mobility		Environment		Support	
Crash-imminent V2V	V2V	V2I	Data Capture & Management	Dynamic Mobility Applications	AERIS	Road Weather Applications	Sec Credentials	Core Services

Connected Vehicle Reference Implementation Architecture

The screenshot displays the CVRIA website interface. At the top, the CVRIA logo is followed by the text "CONNECTED VEHICLE REFERENCE IMPLEMENTATION ARCHITECTURE". Below this is a navigation bar with links: About, Applications (highlighted), Views, Standards, Resources, Glossary, and Contact Us. A breadcrumb trail reads: Home > Applications > Restricted Lane Warnings.

Restricted Lane Warnings

The Restricted Lane Warnings application provides the connected vehicle with restriction information about the travel lanes, such as if the lane is restricted to high occupancy vehicles (HOV), transit, or public safety vehicles only or has defined eco-lane criteria. A connected vehicle can use this information to determine if the vehicle is in a lane that has lane restrictions.

At the bottom of the page, there is a secondary navigation bar with links: Enterprise, Functional, Physical, A-Interconnect, Communications, Requirements, Sources, and Security.

CVRIA Physical View Example

Enterprise Functional **Physical** A-Interconnect Communications Requirements Sources Security

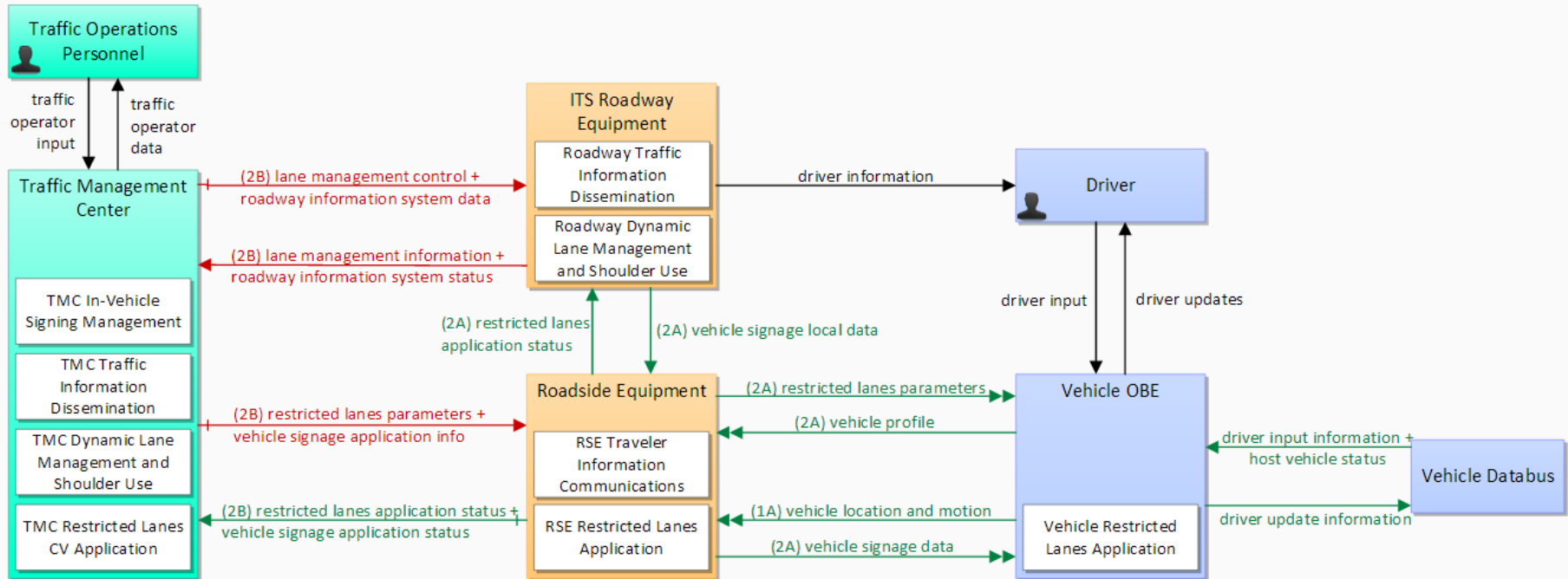
Physical

This is one way this application may be realized, but not the only way. There are other ways to build a given application and accomplish a stated objective.

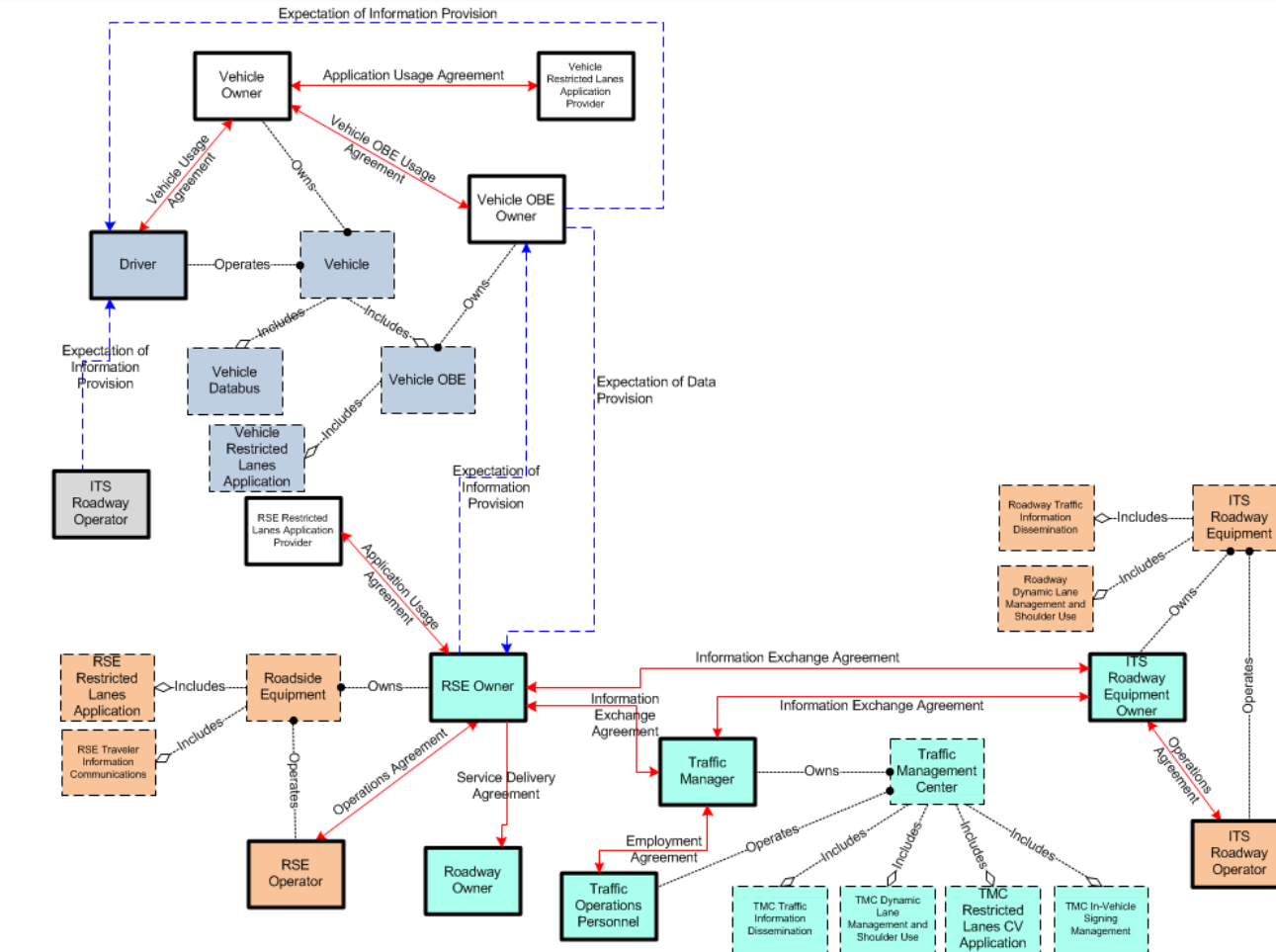
The physical diagram can be viewed in SVG or PNG format and the current format is SVG.

[SVG Diagram](#)

[PNG Diagram](#)



CVRIA Enterprise View Example



Restricted Lane Warnings			
5	Enterprise: Operations	Nov 20, 2015	NAT

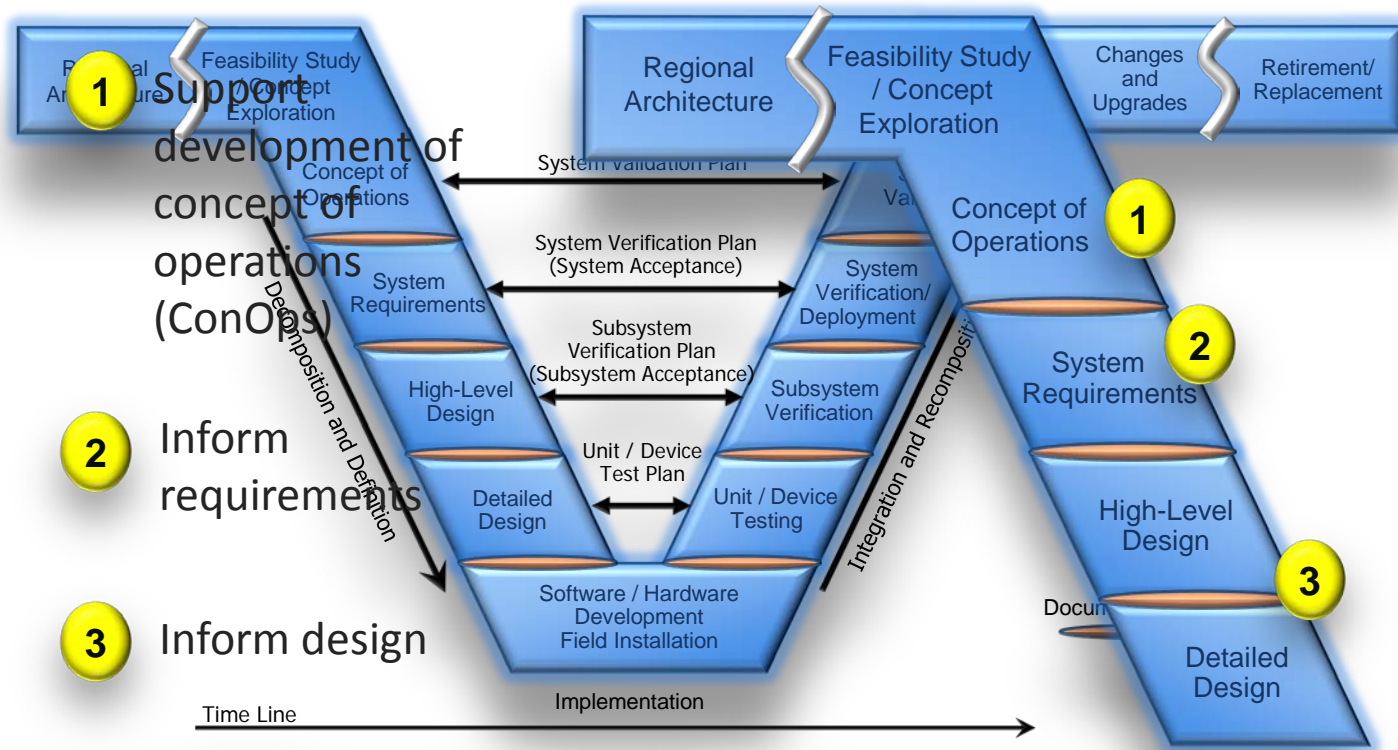
SET-IT SOFTWARE TOOL

Systems Engineering Tool for Intelligent Transportation



- Purpose: Develop project architectures for pilots, test beds and early deployments of connected vehicles
- Applies CVRIA – build project specific architectures based on a common reference
 - Take advantage of prior research, updated with CVRIA
 - Establish common language between deployers, developers, stakeholders
 - Drawings and database definitions organized into one framework
 - Document generator builds ConOps using data and diagrams
- Start with CVRIA and customize it with your names for Elements and Stakeholders

CVRIA, Systems Engineering, & SET-IT

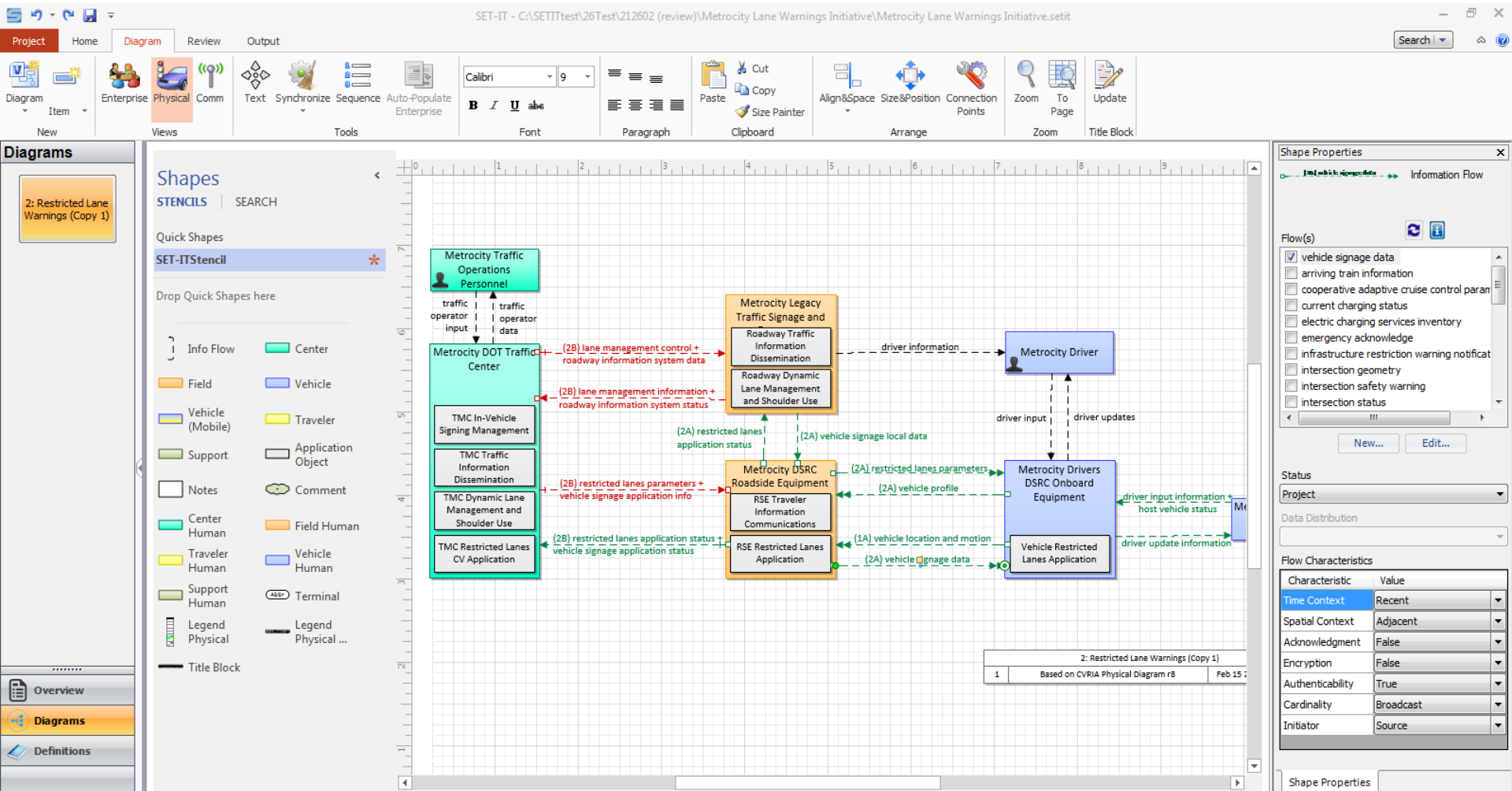


SET-IT is a systems engineering tool to aid in the definition of a project within the context of an architecture

SET-IT Tool

- Supports project architecture development and systems engineering analysis
- Provides a drawing and database tool for CVRIA-related diagrams
- Based on MS Visio 2010 or 2013 (32-bit) with MS Word & Excel for outputs
- Facilitates project definition in terms of CVRIA views
- Enables a common language for connected vehicle development
- Provides a rich backdrop of work that has already been done to define over 85 connected vehicle applications

SET-IT



Features of SET-IT

- Create physical and enterprise views of a connected vehicle project architecture based upon CVRIA
- Copy and customize connected vehicle applications and needs from CVRIA
- Customize Communications profiles
- Output diagrams and tables of architecture components
- Create a concept of operations document for a project

CVRIA, SET-IT, & Other Resources

- CVRIA can be explored at www.iteris.com/cvria
- SET-IT is available for download at www.iteris.com/cvria/html/resources/tools.html
 - Support services at (800) 260-1001 or SETIT@iteris.com
- Contact Information
 - CVRIA Team: cvriacomment@iteris.com
 - SET-IT Team: setit@iteris.com
 - Tom Lusco: ctl@iteris.com
 - David Binkley: dnb@iteris.com
- US DOT website: www.its.dot.gov

