Connected Vehicle Architecture Workshop

CVRIA Overview

June 16, 2016

Workshop Agenda

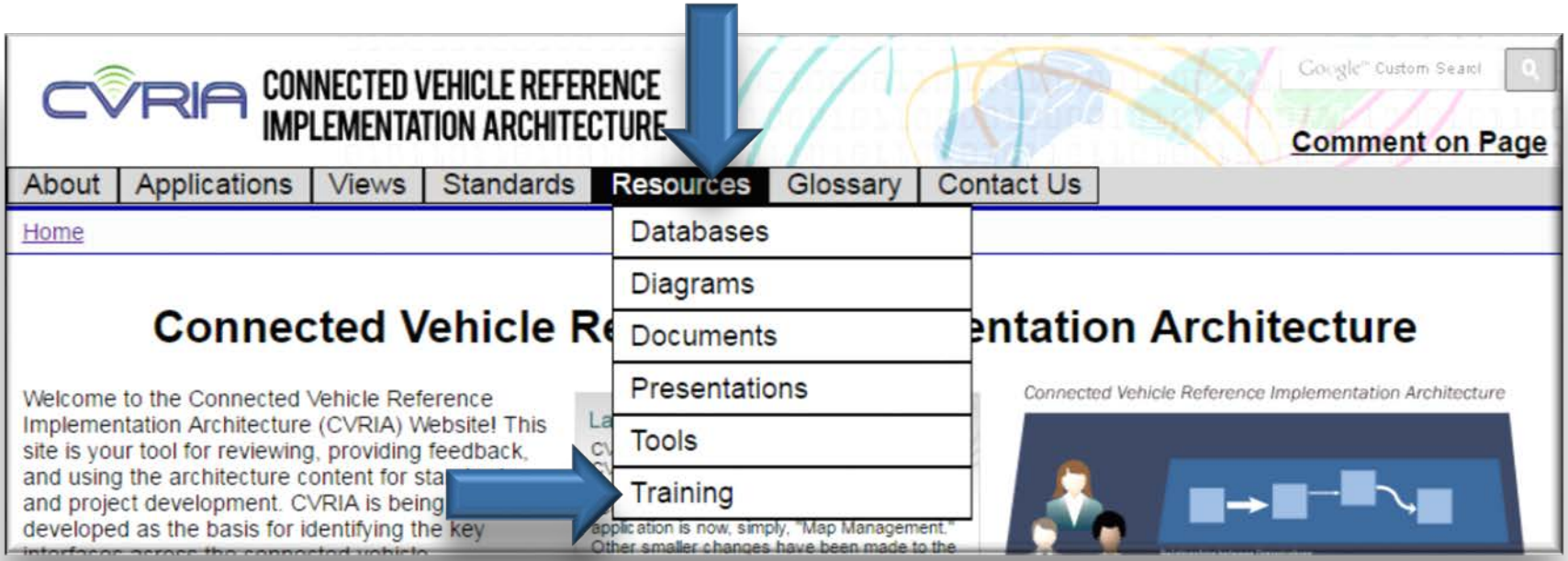
▪ Introduction	9:00 AM
▪ CVRIA Overview	9:20 AM
▪ CVRIA Website Tour	9:50 AM
▪ National ITS Architecture / CVRIA Integration	10:20 AM
▪ Break	10:35 AM
▪ Attendee Feedback on CVRIA	10:50 AM
▪ SET-IT Software Tour	11:20 AM
▪ SET-IT Use Example	11:50 AM
▪ Wrap-up	12:20 PM
▪ Adjourn	12:30 PM

Session Topics

- Training and Resources
- Connected Vehicle Background
- CVRIA Development
- CVRIA Purpose
- CVRIA Overview

CVRIA Training and Resources

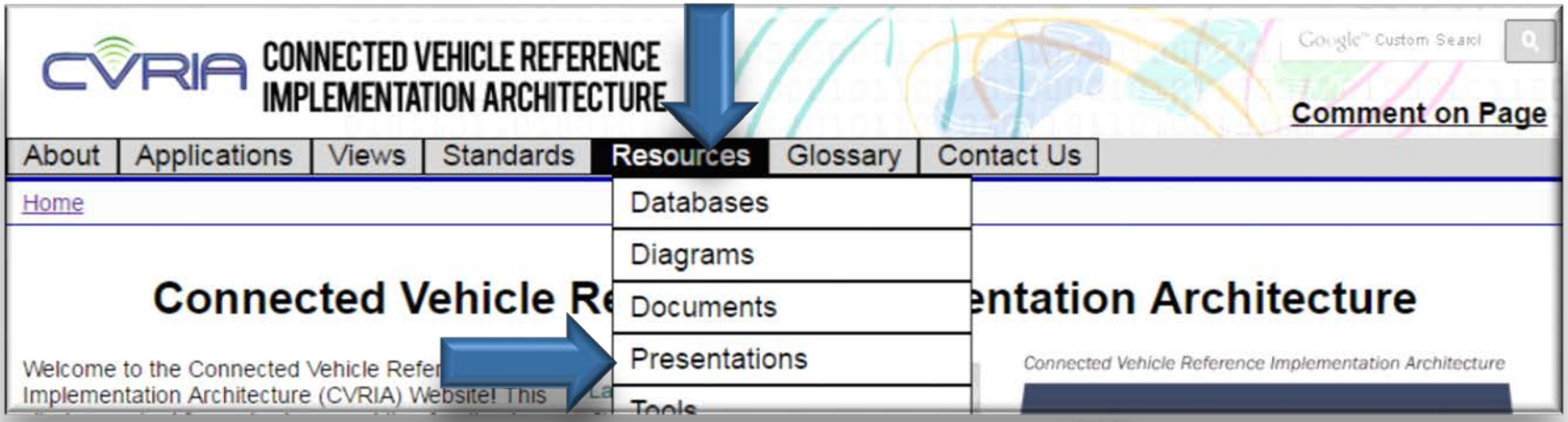
- CVRIA website at www.iteris.com/cvria/
- On-line Training Courses
  - Introduction to CVRIA
  - Introduction to SET-IT



CVRIA Training and Resources

- CVRIA Webinar Series
  - http://www.iteris.com/cvria/html/resources/presentations.html

1. **Red light Violation Warning**
2. **Curve Speed Warning**
3. **Speed Harmonization**
4. **Intelligent Traffic Signal System**
5. **Emergency Vehicle Priority**
6. **ECO Approach and Departure**
7. **Weather Responsive Traffic Management**
8. **Enhanced Maintenance Decision Support**
9. **Smart Roadside Initiative**
10. **Freight Advanced Traveler Information Systems**
11. **Data Distribution**
12. **Communications Support**
13. **Core Authorization**
14. **Pedestrian in Signalized Crosswalk Warning**
15. **Integrated Multi-Modal Payment**
16. **Incident Scene Pre-Arrival Staging Guidance for Emergency Responders**
17. **Incident Scene Work Zone Alerts for Drivers and Workers**



Connected Vehicle Training/Resources

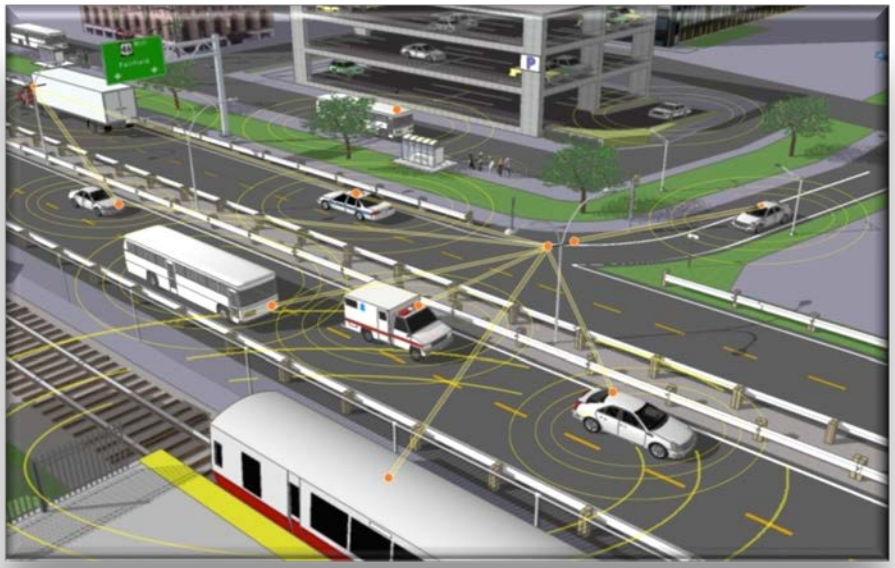
- ITS ePrimer, Chapter 13: Connected Vehicles
  - http://www.pcb.its.dot.gov/eprimer/module13.aspx - USDOT's Professional Capacity Building (PCB) program
- Connected Vehicle Basics (an overview of the connected vehicle program)
  - http://www.pcb.its.dot.gov/t3/s140424_cv_basics.asp - USDOT's Talking Transportation Technology (T3) series
- National Connected Vehicle Field Infrastructure Footprint Analysis
  - http://stsmo.transportation.org/Pages/Connected-Vehicles.aspx

Connected Vehicle (CV) Concept is Not New

- User Service Bundle for concept of Advanced Vehicle Safety Systems (AVSS) in early 1990s United States National Program Plan for the Intelligent Transportation System (ITS)
- Early National ITS Architecture inclusion of Vehicle Collision and Crash Avoidance, Vehicle Safety and Automated Vehicle Operation
- Automated Highway System (AHS) Testing in San Diego, August 1997
- Ongoing USDOT Research Program evolving from AHS, Vehicle Infrastructure Integration (VII) & Connected Vehicle

Enabling Connected Vehicle Environment

- Communications Technology
  - Wide-Area Wireless Communication
  - Short Range Wireless Communication
  - Internet
- Institutional
  - Rise of the Smart Device
  - Expectation of Connectivity
  - Privacy
  - Security



Why Connect Vehicles Now?

- Improve vehicle safety
- Communications standardization
  - 5.9 GHz Dedicated Short Range Communications Family
  - SAE J2735 Message Set for Wireless Communication to/from the Vehicle
    - Basic Safety Message (BSM)
    - Various Vehicle Probe Data Communications
    - Others…
- Motivated coalition of stakeholders including automakers

USDOT Proposed Rule-Making

- "Light Vehicle" Vehicle-to-Vehicle (V2V) Communications Advance Notice of Proposed Rulemaking (ANPRM) issued
- Others expected

Connected Vehicle is inherently complex

Improve Transit Reliability
- Connection Protection
- Transit Signal Priority

Improve Pedestrian Safety
- Pedestrian in Signalized Crosswalk Warning
- Intersection Movement Assist

Improve Air Quality
- Eco-Approach and Departure at Signalized Intersections
- Eco-Traffic Signal Timing

We Need a Common Language

- CVRIA is in response to managing the complexity of Connected Vehicle
- CVRIA models the Connected Vehicle functions and communications on a number of levels

System Architecture

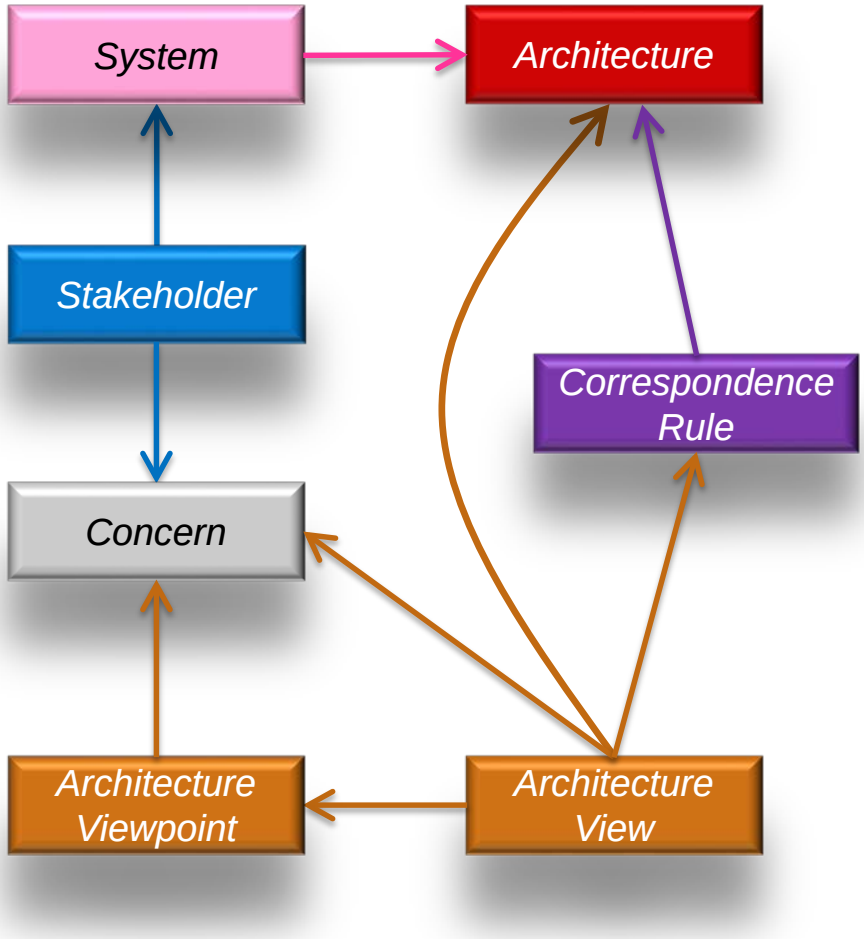
A System... has an Architecture

Stakeholders... have interests in the system

Stakeholders... have concerns

Architecture viewpoints... frame concerns

Architecture views... address concerns

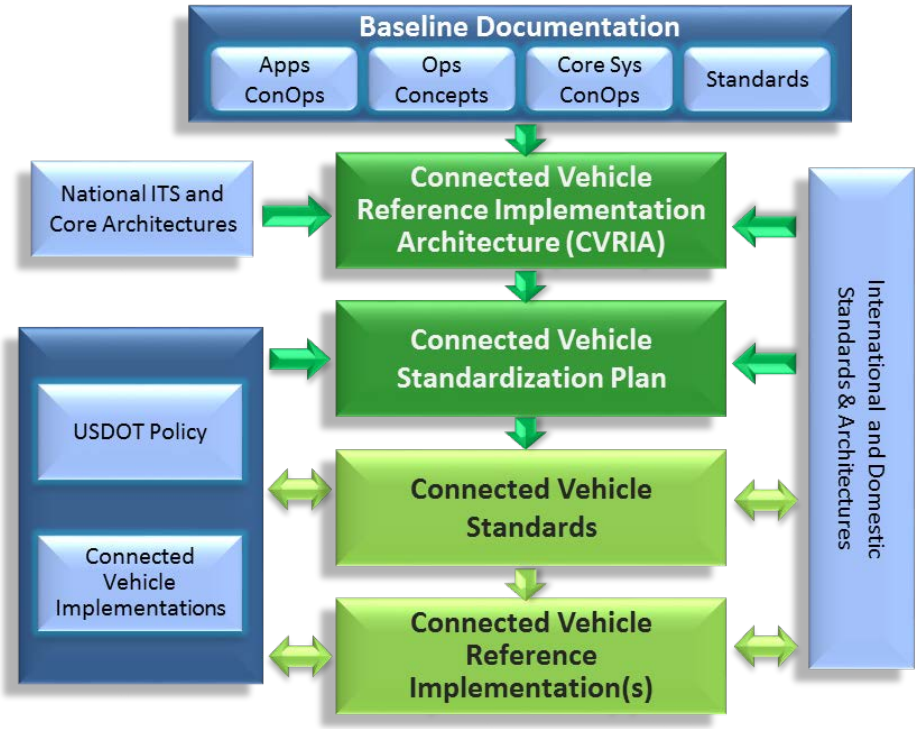


Correspondence rules define how artifacts in one viewpoint are related to artifacts in another.

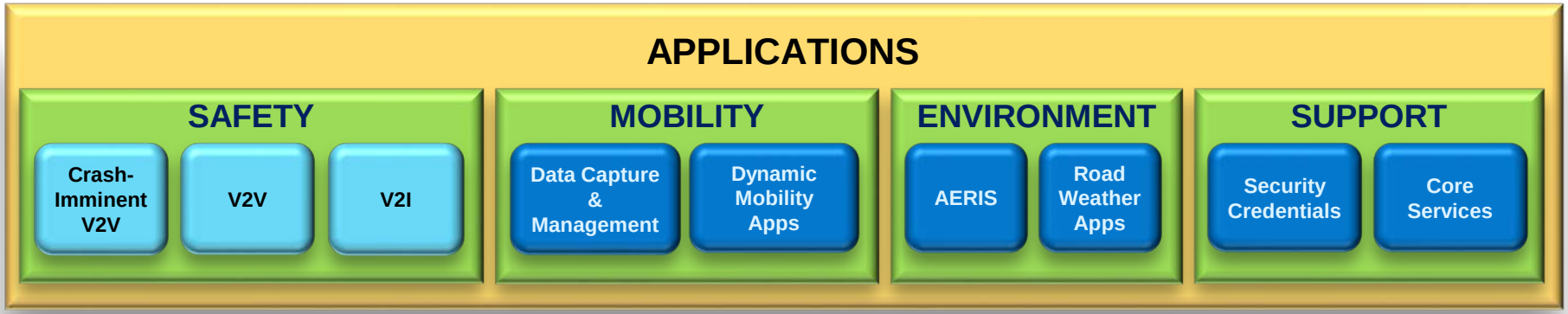
The sum of architecture views make up the architecture

CVRIA

- Connected Vehicle Reference Implementation Architecture (CVRIA) development
  - Followed ISO/IEC/IEEE 42010-2011 Systems and Software Engineering – Architecture Description
  - Collected needs and requirements from connected vehicle research work (Applications) and other sources
  - Developed a multi-faceted architecture



Background of CVRIA



- Landscape: Safety, Mobility & Environmental Applications with common supporting infrastructure
- 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 an architecture is needed to put the components together

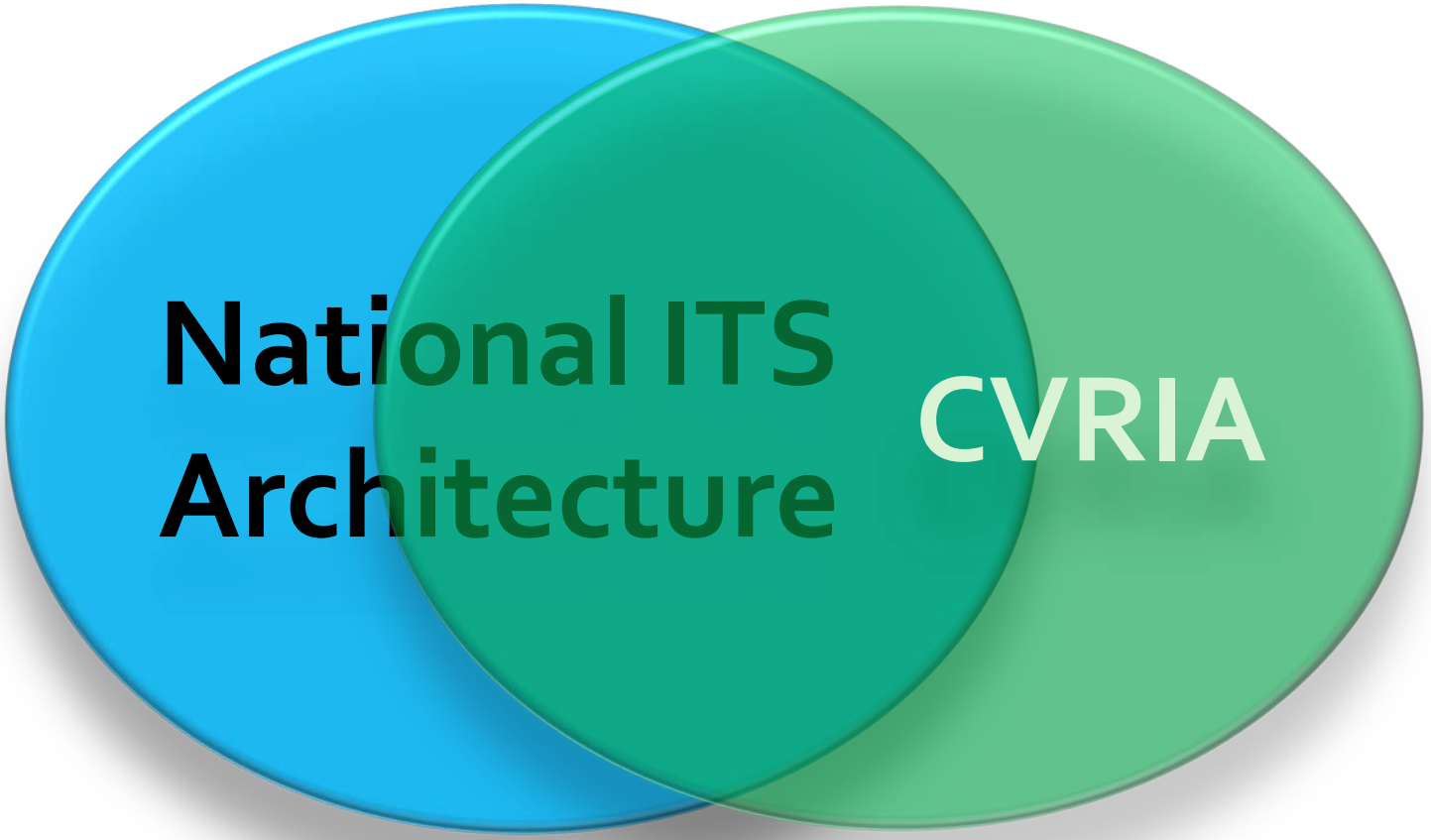
Purpose of CVRIA

- To establish a framework for
  - integrating connected vehicle technologies and
  - identifying interfaces for standardization
- By...
  - Identifying connected vehicle needs/requirements
  - Developing a multi-faceted system architecture
  - Identifying and prioritizing candidate interfaces for standardization

CVRIA Uses

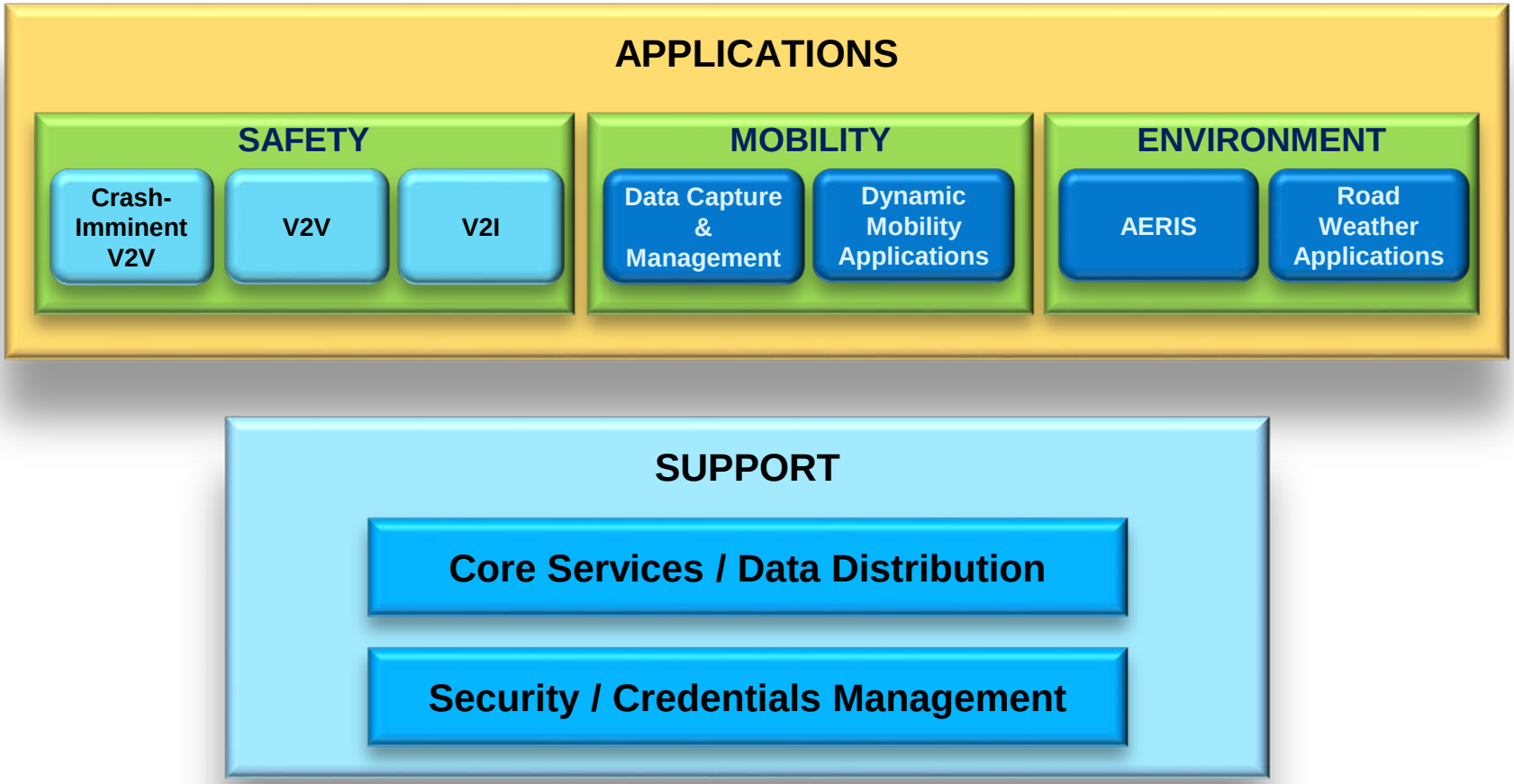
- In near term – Define interfaces/functions/standards to support early deployments, e.g. SE Michigan 2014, CV Pilot Deployments, etc.
- In longer term – CVRIA will be integrated with the National ITS Architecture to include connected vehicles in regional ITS architectures/plans and future transportation projects

CVRIA & National ITS Architecture



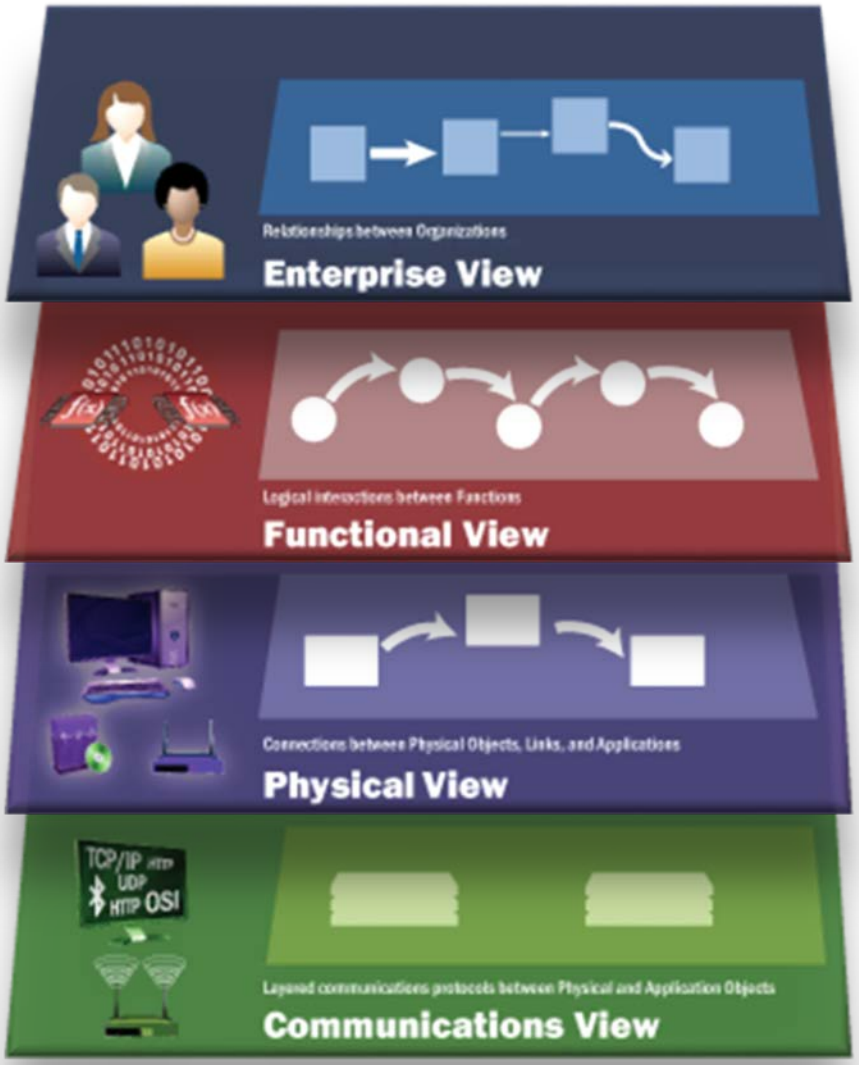
- CVRIA takes advantage of the National Architecture defined entities, interfaces, and definitions

CVRIA Covers Breadth of CV

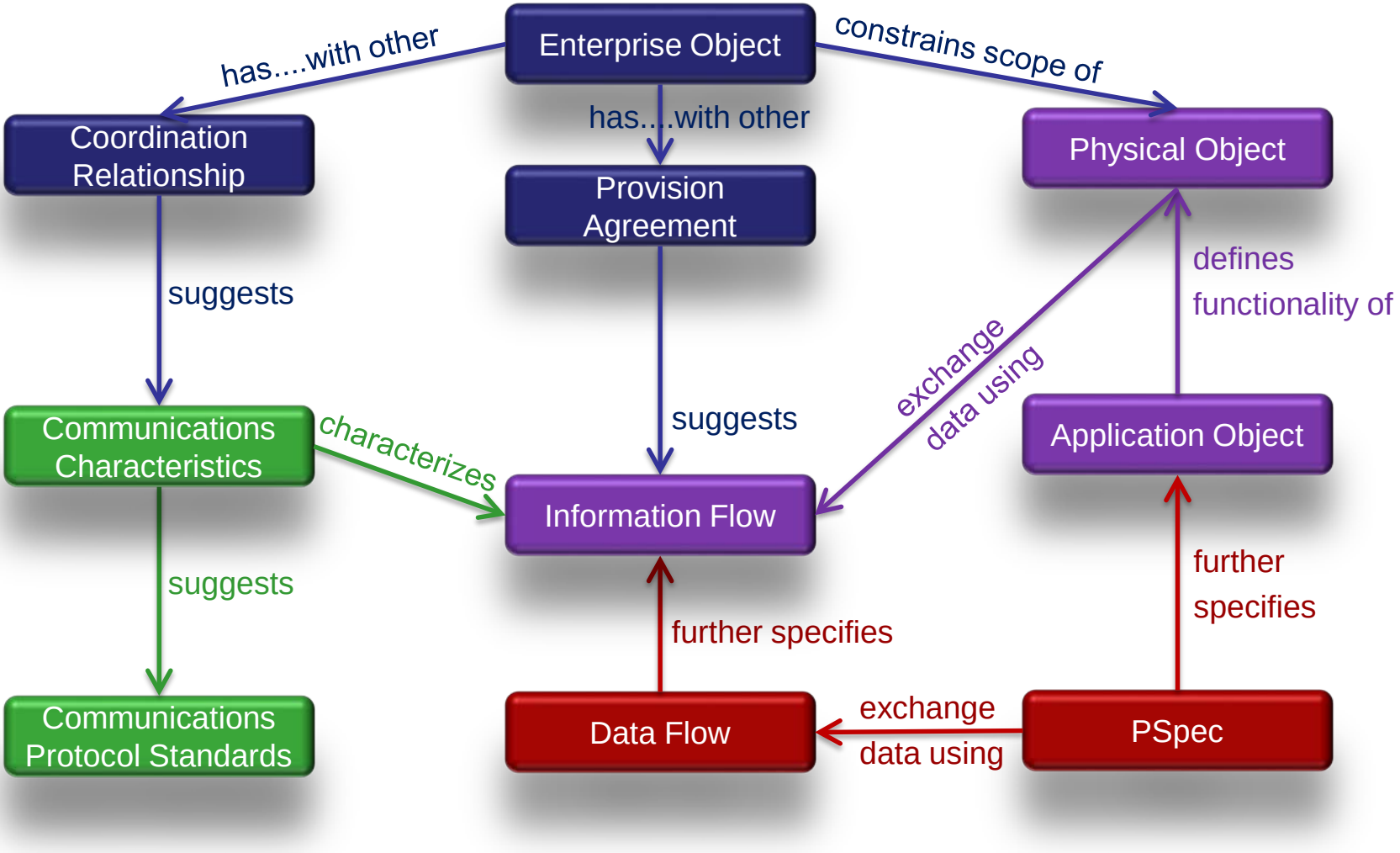


CVRIA Views

- Used to capture stakeholders' concerns
  - Enterprises to carry out applications
  - Functions to satisfy requirements
  - Physical objects to implement that functionality
  - Communications protocols necessary



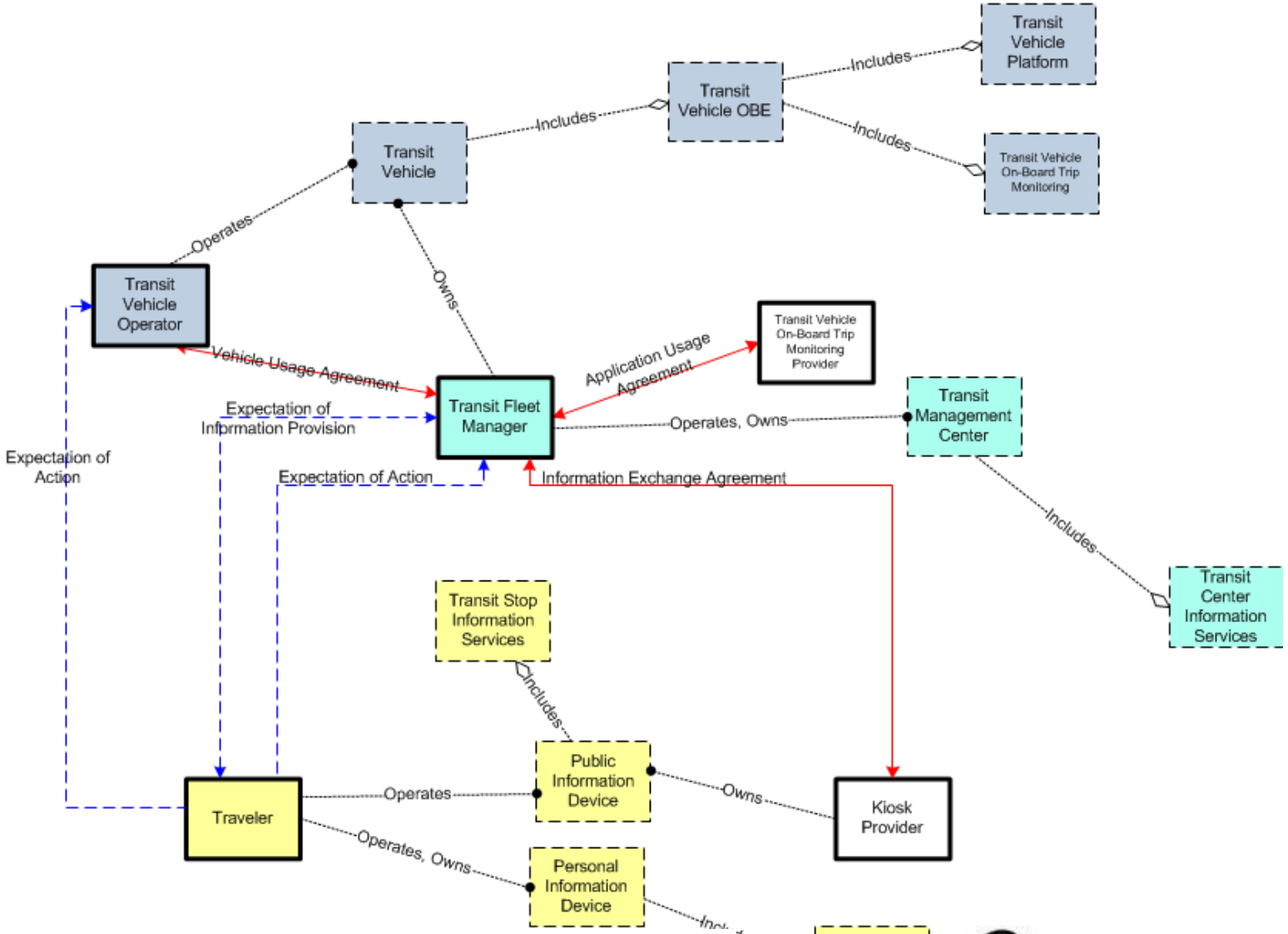
CVRIA Viewpoint Correspondence



CVRIA Enterprise View

- Depicts:
  - Relationships between organizations
  - Roles organizations play in delivery of services within the connected vehicle environment
- Addresses system life cycle

CVRIA Enterprise View Example



Transit Stop Request			
1	Enterprise: Operations	Nov 11, 2013	NAT

CVRIA Functional View

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

CVRIA Functional View Example

Includes Processes:

Level	Name	Type	Allocated to Application Object
4.1	Operate Transit Vehicles and Facilities	Collection	
4.1.1	Process On-Board Systems Data	Pspec	- Transit Vehicle On-Board Trip Monitoring - Transit Vehicle On-Board Information Services
4.1.2	Determine Transit Vehicle Service Status	Pspec	- Transit Vehicle On-Board Trip Monitoring - Transit Vehicle On-Board Information Services
4.1.3	Provide Transit Vehicle Location Data	Pspec	- Transit Vehicle On-Board Trip Monitoring
4.1.4	Manage Transit Vehicle Deviations	Pspec	- Transit Center Information Services
4.1.6	Manage Transit Vehicle Operations	Pspec	- Transit Center Information Services
4.1.7	Provide Transit Advisory Interface on Vehicle	Pspec	- Transit Vehicle On-Board Information Services
4.1.8	Manage Individual Service Requests	Pspec	- Transit Center Information Services

Includes Data Flows:

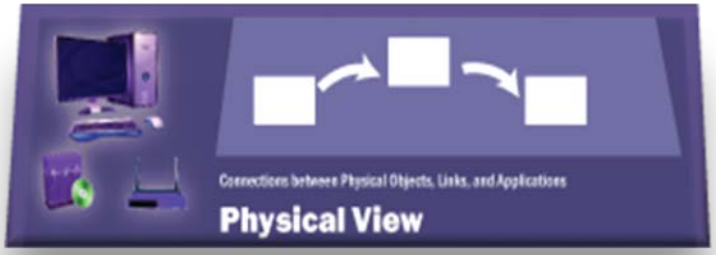
Source Pspec	Data Flow	Destination Pspec
Determine Transit Vehicle Service Status	transit_vehicle_deviations_from_schedule	Manage Transit Vehicle Deviations
Determine Transit Vehicle Service Status	transit_vehicle_passenger_connection_request	Manage Transit Vehicle Deviations
Determine Transit Vehicle Service Status	transit_vehicle_connection_request_mode	Manage Transit Vehicle Deviations
Determine Transit Vehicle Service Status	transit_service_status	Manage Transit Vehicle Operations
Determine Transit Vehicle Service Status	transit_vehicle_schedule_deviation	Manage Transit Vehicle Operations
Determine Transit Vehicle Service Status	transit_vehicle_eta	Manage Transit Vehicle Operations
Determine Transit Vehicle Service Status	transit_vehicle_service_update	Manage Transit Vehicle Operations

CVRIA Physical View

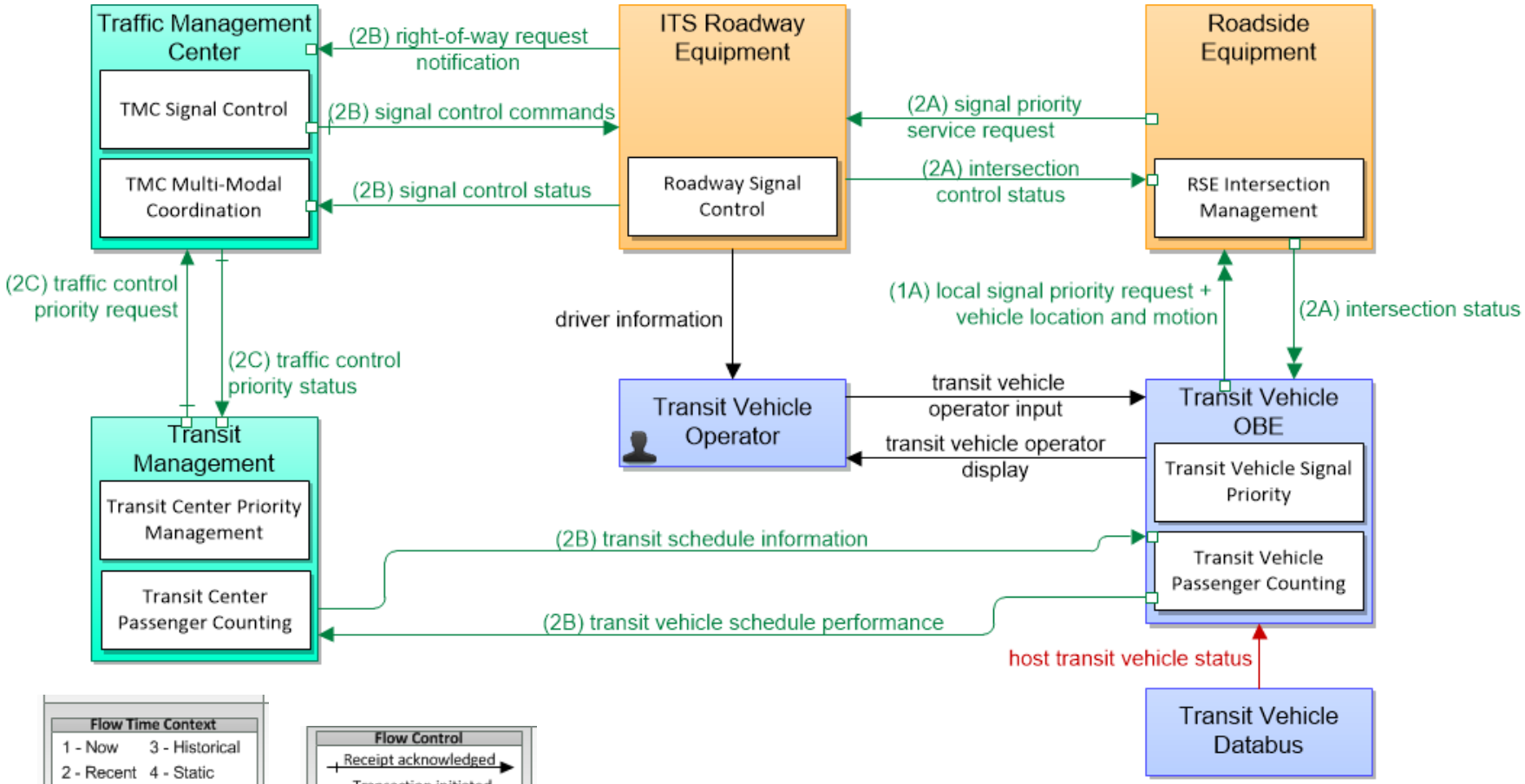
- Depicts:
  - Physical objects that interact to deliver services
  - Interfaces and flows of information between those physical objects
- Identifies options for…
  - What devices are involved in delivering safety, mobility, environmental applications?
  - What are the physical interfaces in each device?
  - What functions do those interfaces support?
  - What functionality is allocated to devices, and what is allocated to humans?

CVRIA Physical View (cont.)

- 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 - Transit Signal Priority Application

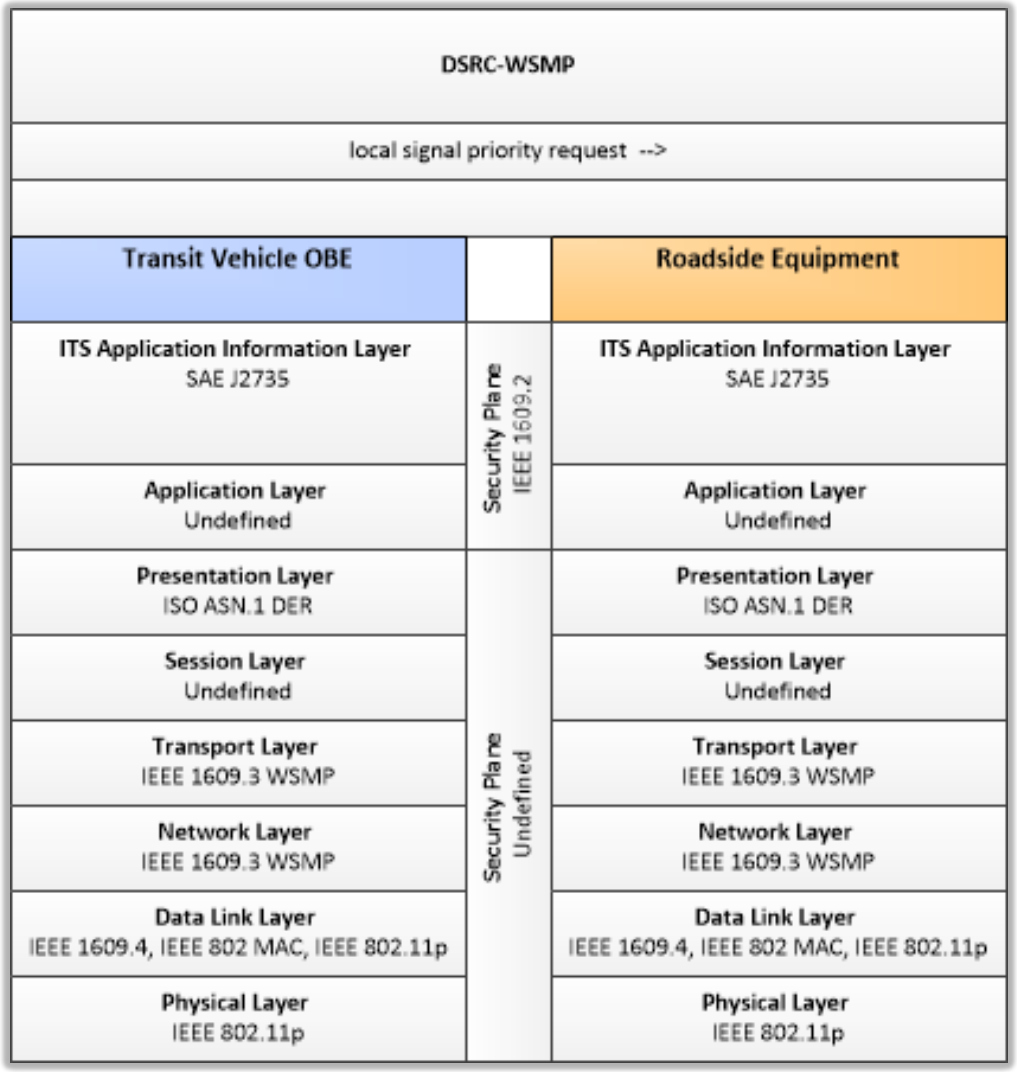


CVRIA Communications View

- Depicts:
  - Layered communications protocols that support communications between physical devices

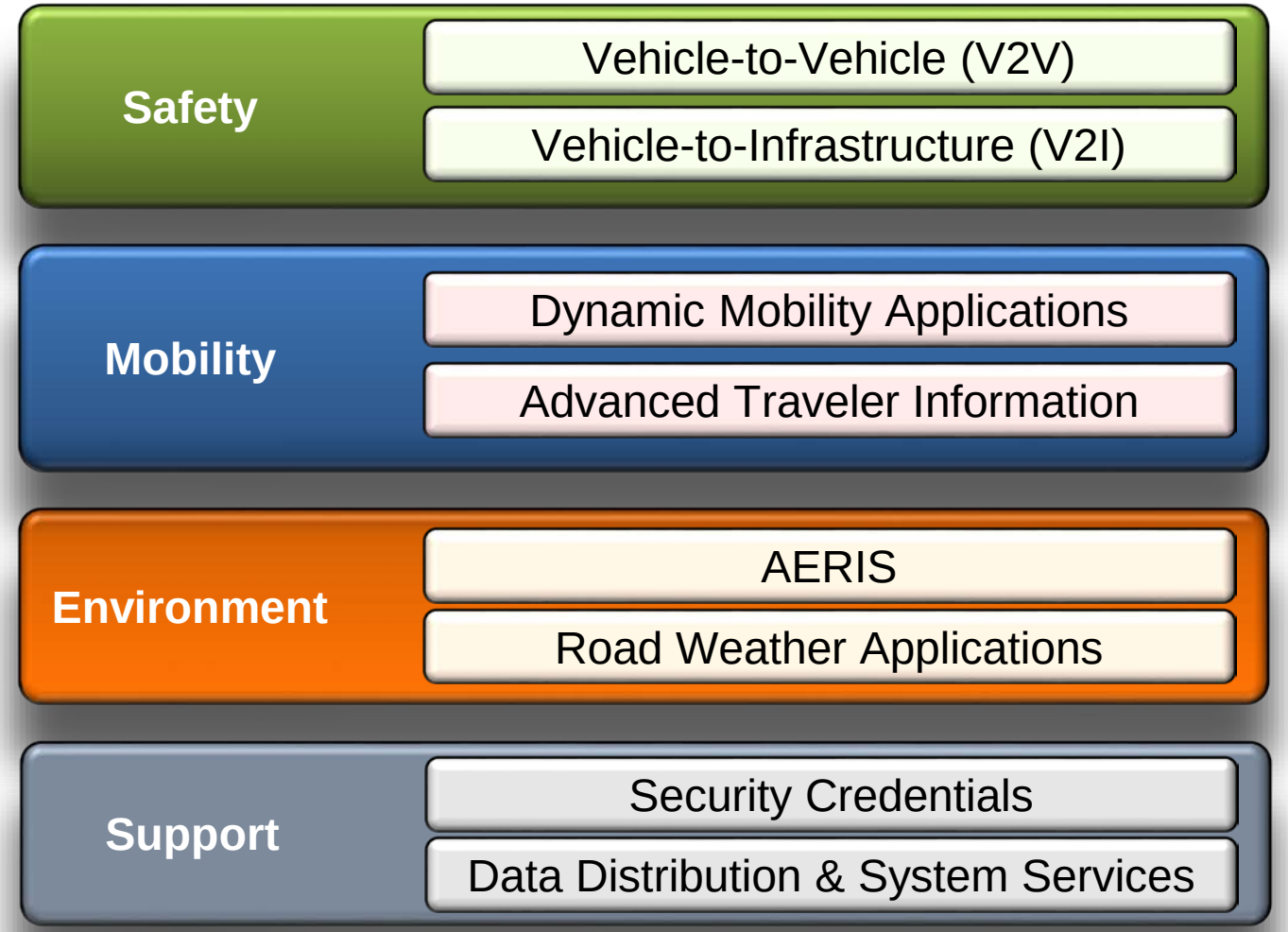
- Identifies options for…
  - Identity and appropriateness of protocols at all layers
  - How these protocols ensure or support:
    - Anonymity preservation
    - Non-repudiation
    - Message integrity
  - Status of protocols as standards or privately provided protocols and the implications of their use from an evolve-ability perspective

CVRIA Communications View Example



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



CVRIA Website Links Views to Applications