



Intelligent Transportation Systems Joint Program Office

ITS Architecture and Standards Programs

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USDOT ITS Architecture and Standards Programs

- Architecture and Standards Programs directed by Congress
 - 1991 Intermodal Surface Transportation Equity Act (ISTEA)
 - 1995 Transportation Equity Act for the 21st Century (TEA-21)
 - 2005 Safe, Accountable, Flexible and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)
 - 2012 Moving Ahead for Progress in the 21st Century Act
 - 2015 Fixing America's Surface Transportation Act (FAST Act) – Title 23 Section 517

“...the Secretary shall develop and maintain a national ITS architecture and supporting ITS standards and protocols to promote the use of systems engineering methods in the widespread deployment and evaluation of intelligent transportation systems as a component of the surface transportation systems of the United States.”

Conformity with National Architecture - “...intelligent transportation system projects carried out using amounts made available from the Highway Trust Fund, including amounts made available to deploy intelligent transportation systems, conform to the appropriate regional ITS architecture, applicable standards, and protocols...”



Architecture, Standards & International Harmonization

- **Program Description** – **Architecture** provides a framework to guide planning and interoperable deployment of ITS (incl. connected vehicle) and identifies interfaces for standardization. **Standards** define interfaces with architectures to enable required interoperability and support efficient, non-proprietary ITS deployment. **International Harmonization** seeks to leverage global resources and expertise to (1) maximize commonality of ITS deployments, (2) share labor resources and (3) access best-available expertise in order to facilitate ITS deployment and open markets.
- **Program Goals** – Enable efficient, interoperable and cost-effective ITS infrastructure, connected vehicle and automated vehicle deployments across North America.



USDOT ITS Architecture and Standards Programs

- FHWA Rule 940 and FTA Policy on ITS Architecture and Standards (January 2001)
 - ◻ Regional ITS Architectures shall be developed in all regions deploying ITS with Federal Funds
 - Regional ITS Architectures shall use National ITS Architecture as a resource
 - Establishes common language for stakeholders to communicate ITS plans
 - ◻ ITS Projects shall be based on systems engineering analysis and identify portions of regional ITS architecture being implemented

- ITS Architecture and Standards Programs in ITS JPO established with legislative direction and guided by FHWA Rule/FTA Policy AND Good Engineering Practice



USDOT ITS Architecture and Standards Programs

■ ITS Architecture Program

- Define and evolve the National ITS Architecture
- Define interfaces for which standards are required
- Provide tools for regional ITS architecture development
- Develop Connected Vehicle Reference Implementation Architecture (CVRIA)

■ ITS Standards Program

- Cooperate with standards development organizations (SDO)
- Reduce costs and accelerate implementation of ITS standards
- Minimize duplication of standards development
- Increase opportunities for industry

■ International Cooperation

- Cooperate/share resources/harmonize internationally when beneficial



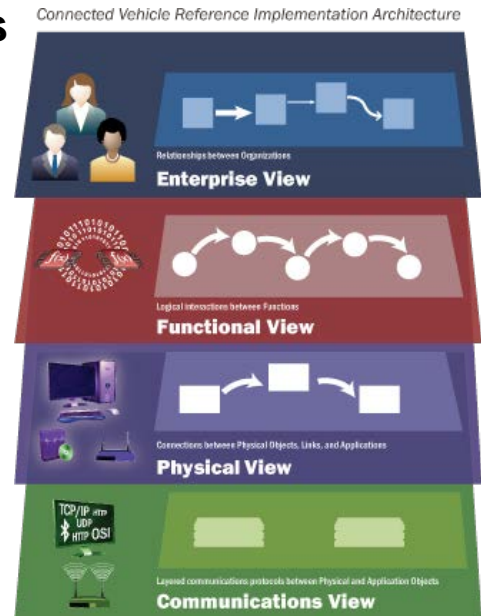
Standards Fit Within an Architecture

Good engineering practice for complex system of systems

- US maintains national reference architecture
 - Regional ITS architectures required to use US federal funds
- Facilitates interoperable, standards-based deployments

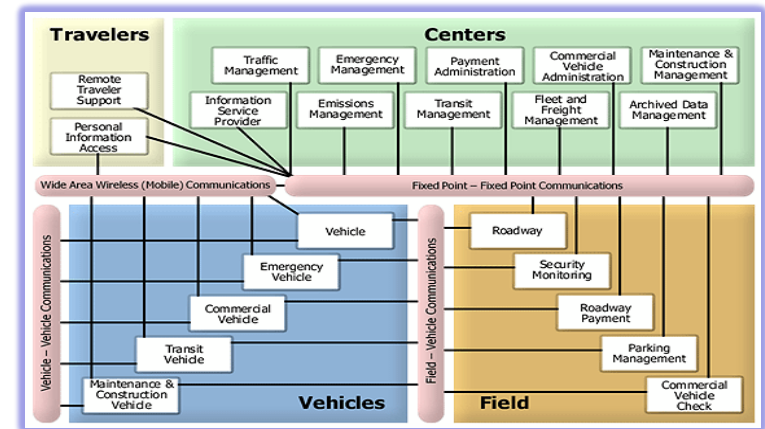
Enter the connected vehicle (C-ITS) ...

- Cross-regional interoperability now **essential**
 - Vehicles operate throughout the region
 - Must have access to standardized services/applications
 - Must assure non-interference
 - Otherwise, C-ITS benefits cannot be realized!
 - **CVRIA**: Unifying framework and common language for C-ITS development and deployment
 - Multi-view: Enterprise/Functional/Physical/Communications
 - Download software, provide input: www.iteris.com/cvria
- **CVRIA & National Architecture to be integrated** – est. early 2017



National ITS Architecture Overview and Status

- **National ITS Architecture - common framework for defining & planning ITS projects**
 - Version 7.1 released in April 2015
 - Supports ITS planning process
 - Turbo Architecture Version 7.1 software tool
 - Aids in tailoring of ITS Architecture content
 - Supports Rule 940 requirements
- **National ITS Architecture Program**
 - Facilitates Architecture evolution
 - Deployment support providing technical assistance and education
 - Workshops – 11 conducted in past year
 - Systems Engineering for ITS
 - ITS Architecture Development
 - Turbo Architecture Training
 - Border Architecture and Systems Engineering support
 - Connected Vehicle Architecture development



Connected Vehicle Architecture

- **Connected Vehicle Reference Implementation Architecture (CVRIA)**
 - Identifies key interfaces and functionality across the connected vehicle environment
 - Supports identification and prioritization of standards development activities
 - CVRIA Version 2.2 released in May, 2016
- **Systems Engineering Tool for Intelligent Transportation (SET-IT) software**
 - Provides tools for tailoring CVRIA content
 - Connected Vehicle project planning
 - Connected Vehicle project development
 - Systems engineering process
 - Concept of Operations
 - Requirements

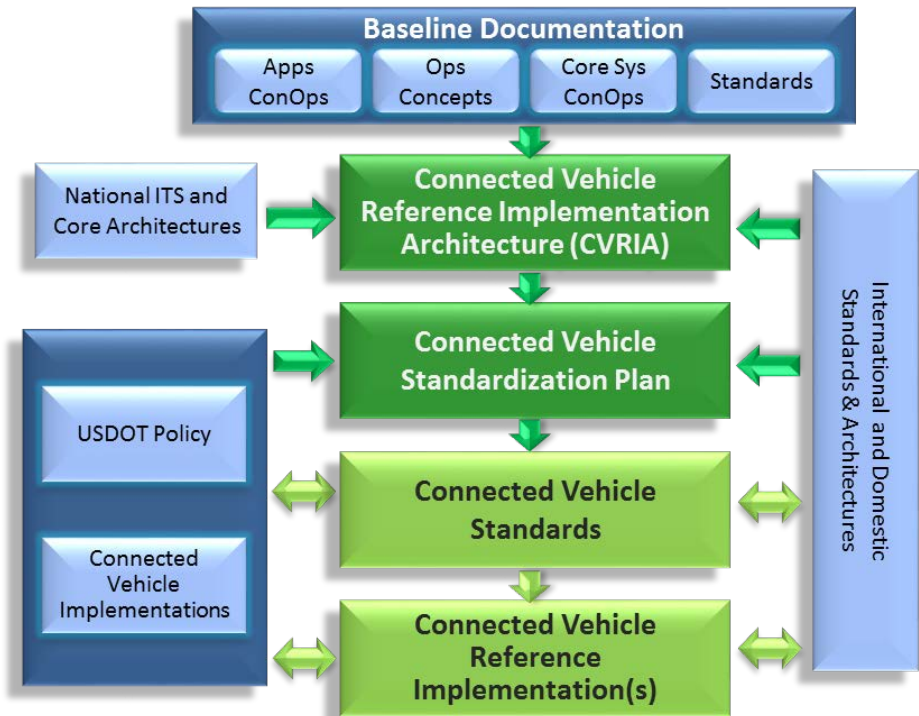
CVRIA Website: www.iteris.com/cvria

The screenshot shows the CVRIA website homepage. The header includes the CVRIA logo and the title 'CONNECTED VEHICLE REFERENCE IMPLEMENTATION ARCHITECTURE'. A navigation menu contains links for 'About', 'Applications', 'Views', 'Standards', 'Resources', 'Glossary', and 'Contact Us'. The main content area features a 'Welcome' message, a 'Latest News' section with a link to 'What's changed in CVRIA v.1.1', and a 'Stakeholder Feedback' section. On the right side, there is a vertical stack of four colored boxes representing different views: 'Enterprise View' (blue), 'Functional View' (red), 'Physical View' (purple), and 'Communications View' (green). Each view box contains a small diagram and a brief description of its focus.



Architecture Tools and Deployment Support

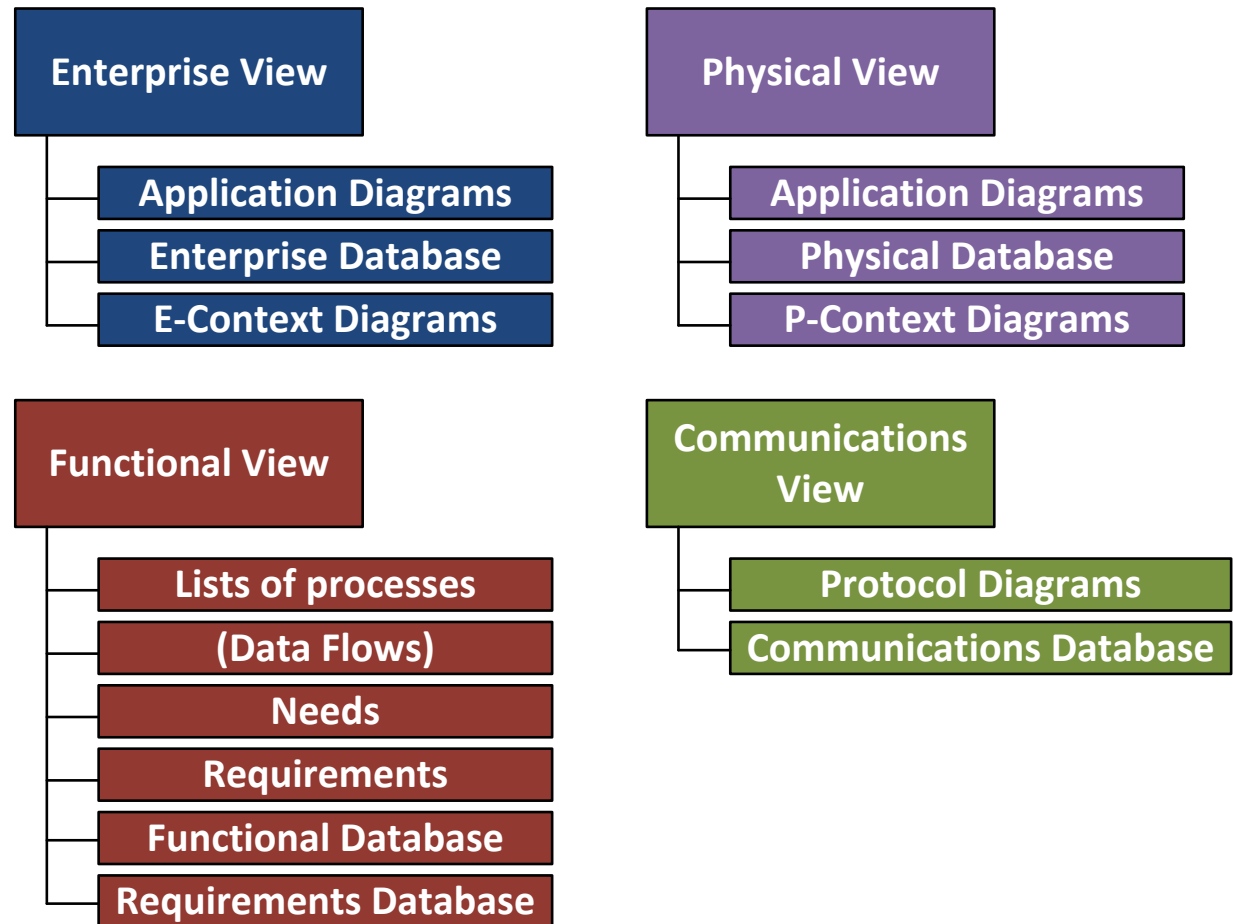
- Connected Vehicle Reference Implementation Architecture (CVRIA) development
 - Followed ISO/IEC/IEEE 42010-2011 Systems and Software Engineering – Architecture Description
 - Collected needs and requirements from connected vehicle research work (Applications) and other sources
 - Developed a multi-faceted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



Architecture Tools and Deployment Support

Four viewpoints:

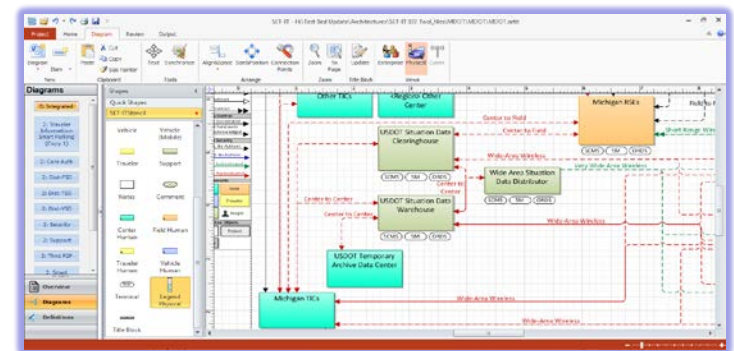
- Enterprise – Institutional relationships
- Functional – Processes and their interactions
- Physical – Physical objects and their interfaces
- Communications – Protocols among physical objects



Architecture Tools and Deployment Support

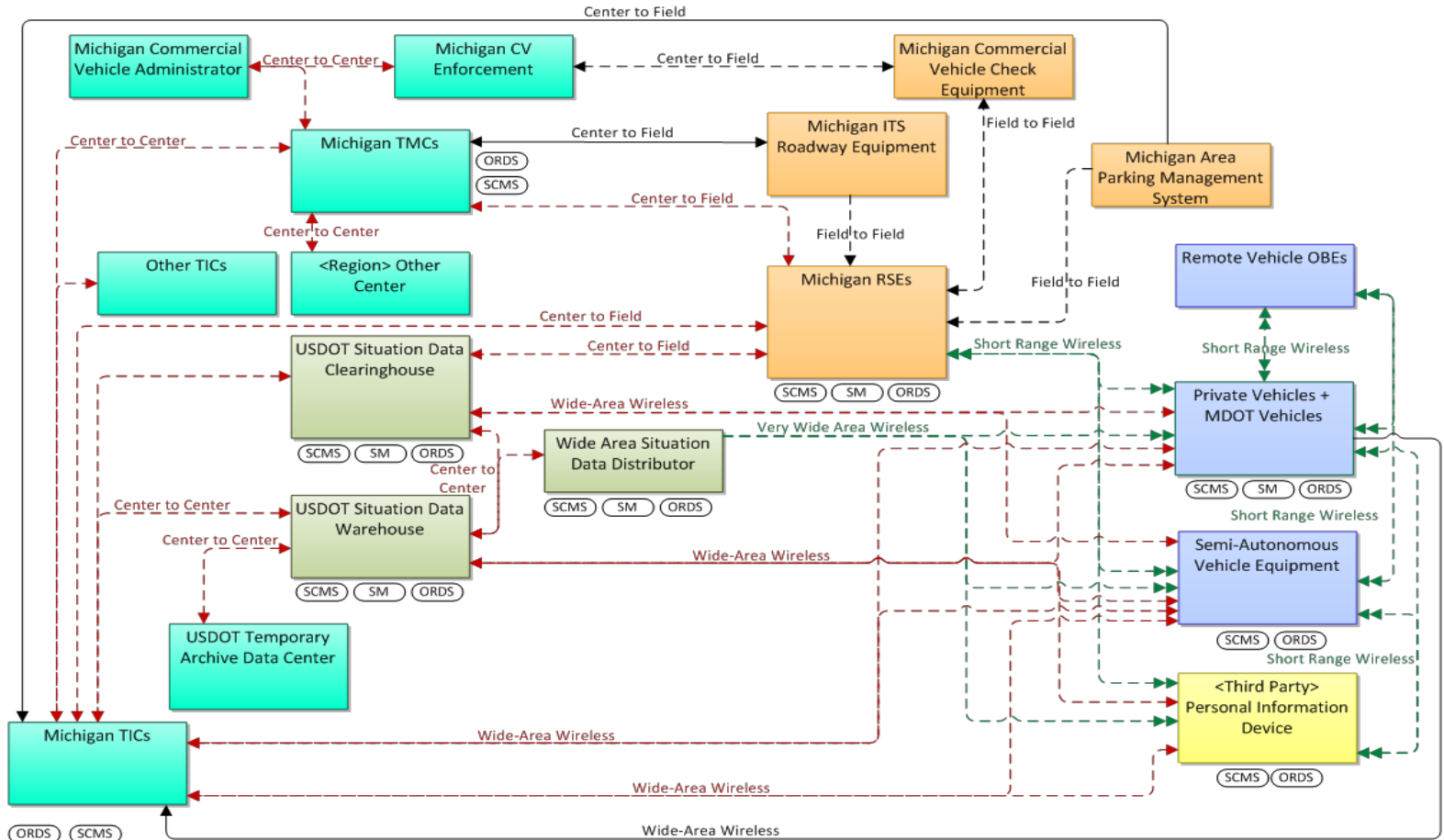
▪ Systems Engineering Tool for Intelligent Transportation (SET-IT)

- 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
 - Over 90 connected vehicle applications
 - Establish common language between deployers, developers, stakeholders
 - Drawings and database definitions organized into one framework
 - Document generator builds Concepts of Operation using data and diagrams
- Start with CVRIA and customize it with your names for Elements and Stakeholders
- Free download from CVRIA website



Architecture Tools and Deployment Support

Physical Legend	
Flow Time Context (T)	
1 - Now	3 - Historical
2 - Recent	4 - Static
Flow Spatial Context (A)	
A - Adjacent	D - National
B - Local	E - Continental
C - Regional	
Flow Routing	
(d) - Routed through a Data Distribution System	
Flow Status	
Existing	Project
New Opportunity	
Flow Cardinality	
Unicast	Multicast
Broadcast	
Flow Control	
Transaction initiated	By left-hand party
Receipt acknowledged	
Flow Security	
Clear text, No Authn	Encrypted, No Authn
Clear text, Authenticated	Encrypted, Authenticated
Elements	
Center	Field
Vehicle	Traveler
Support	People
Application Objects	
Existing	Project
Opportunity	



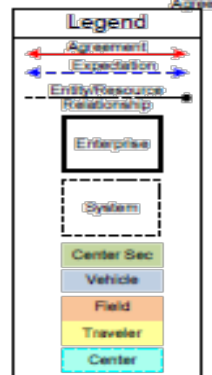
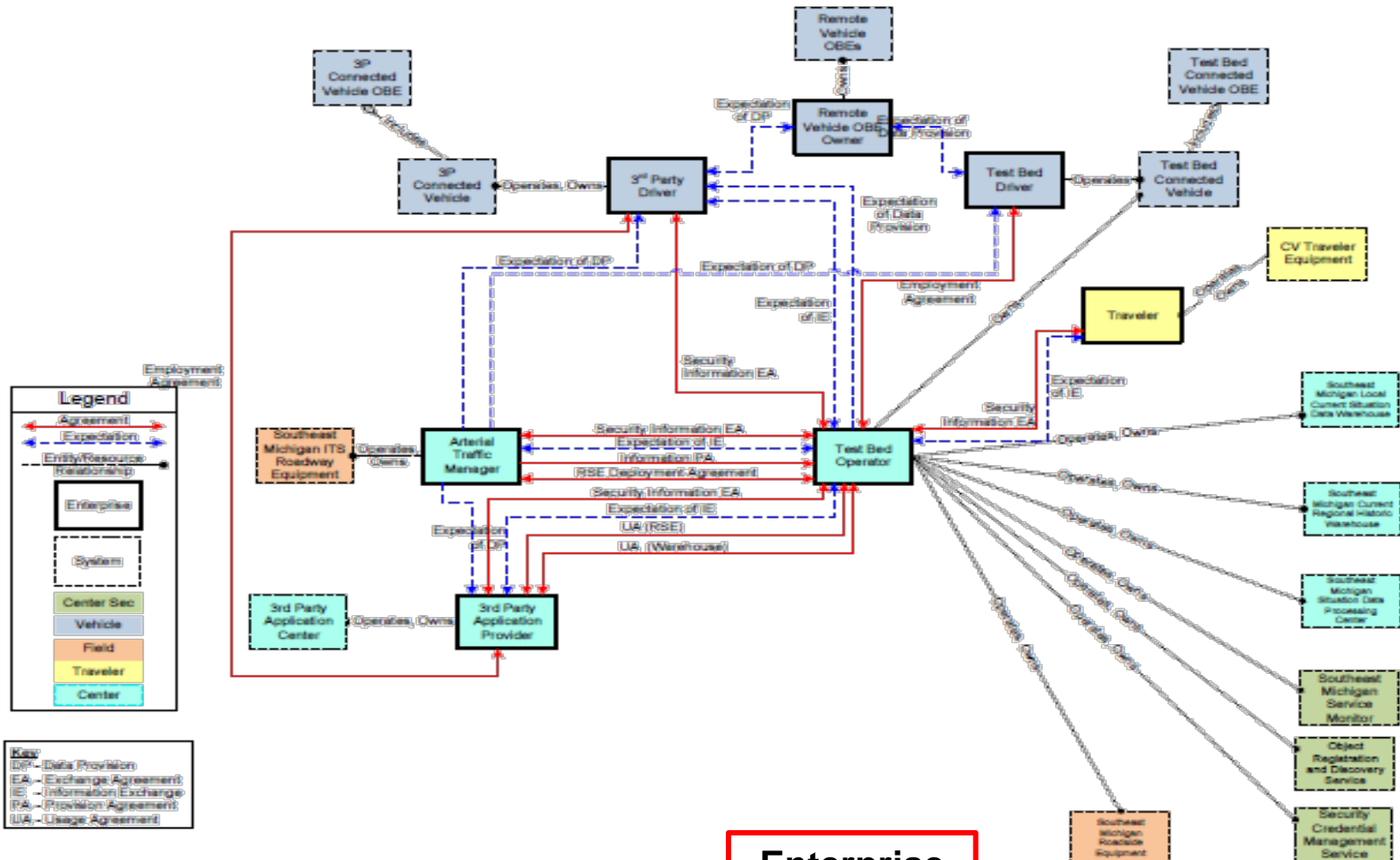
Physical View Diagram



0: Integrated			
5	Physical View	Dec 24 2014	WLF



Architecture Tools and Deployment Support



Key

- DP - Data Provision
- EA - Exchange Agreement
- IE - Information Exchange
- IA - Provision Agreement
- UA - Usage Agreement

Enterprise View Diagram

Southeast Michigan Connected Vehicle 2014			
1	Enterprise Layer 3	May 8, 2014	JLM



Architecture Tools and Deployment Support

- CVRIA website at www.iteris.com/cvria
 - CVRIA content exploration
 - Free SET-IT tool download
 - On-line training access for CVRIA and SET-IT

The screenshot shows the CVRIA website with the navigation menu: About | Applications | Views | Standards | **Resources** | Glossary | Contact Us. The 'Resources' link is circled in red. The main content area is titled 'Connected Vehicle Reference Implementation Architecture' and includes a welcome message, a list of views, and a 'Latest News' section.

CVRIA CONNECTED VEHICLE REFERENCE IMPLEMENTATION ARCHITECTURE

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[About](#) | [Applications](#) | [Views](#) | [Standards](#) | [Resources](#) | [Glossary](#) | [Contact Us](#)

[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 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.

Latest News

CVRIA has been updated to Version 2.1. This version includes updates to the Communications View with new communications profiles to support different choices in protocols and communications technology for connected vehicle projects. The Enterprise View has been updated to include Business Interaction Matrix (BIM) tables for each application. The Applications pages now include higher-level, Application Interconnect drawings. Application pages now also include a Security tab to show the considerations for physical object and information flow security. This version also includes updates to improve the linkages between the different Views. There is also a Primer document describing some basic principles for deploying in the connected vehicle environment. [Click here to see the details of What's changed in CVRIA 2.1!](#)

The Systems Engineering Tool for Intelligent Transportation (SET-IT) Version 2.1.27 is available as a download from the [Tools page](#). In addition to supporting all of the updated and newly added CVRIA content, this version includes updates to the ConOps generation so that it includes all diagrams with sequences, and all scenarios. 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

The diagram illustrates the four views of CVRIA as a vertical stack of colored boxes:

- Enterprise View** (Blue): Relationships between Organizations
- Functional View** (Red): Logical Interactions between Functions
- Physical View** (Purple): Connections between Physical Objects, Links, and Applications
- Communications View** (Green): Layered communications protocols between Physical and Application Objects



Architecture Evolution – What's Next?

- The National ITS Architecture and CVRIA are being integrated into common framework
 - Using database and diagram schema from CVRIA
 - Providing support for infrastructure and CV project architecture development and planning
- New software toolset
 - Regional Planning Tool with similar functionality to Turbo Architecture
 - Support for Regional ITS Architecture development and maintenance
 - Project Development Tool with similar functionality to SET-IT
 - Support for project architecture definition and systems engineering process
 - Concept of Operations
- New Architecture and Toolset scheduled for release early 2017



US DOT ITS Standards Activity

- Support NHTSA V2V Safety rulemaking, CV V2x requirements
- Continued support of infrastructure standards family:
 - NTCIP 1103 v03 (Transportation Management Protocols w. Traps), May 2016
 - NTCIP 1202 v03 (Actuated Signal Controller), May 2016
 - NTCIP 1204 v04 (Environmental Sensor Station), Feb 2016
 - NTCIP 1213 v03 (Electrical and Lighting Management Systems), Feb 2016
 - ATC 5201 v06 (Advanced Transportation Controller), Mar 2016
 - ATC 5401 v02 API RI Software and Documentation, Dec 2015
 - ITS Cabinet v02, Feb 2017
- Automation Standards Roadmap project underway
- Monitoring/participation in oneM2M, other activities of interest
- USDOT will support further infrastructure and CV standards development
 - Prioritized in accordance with analysis using broad input

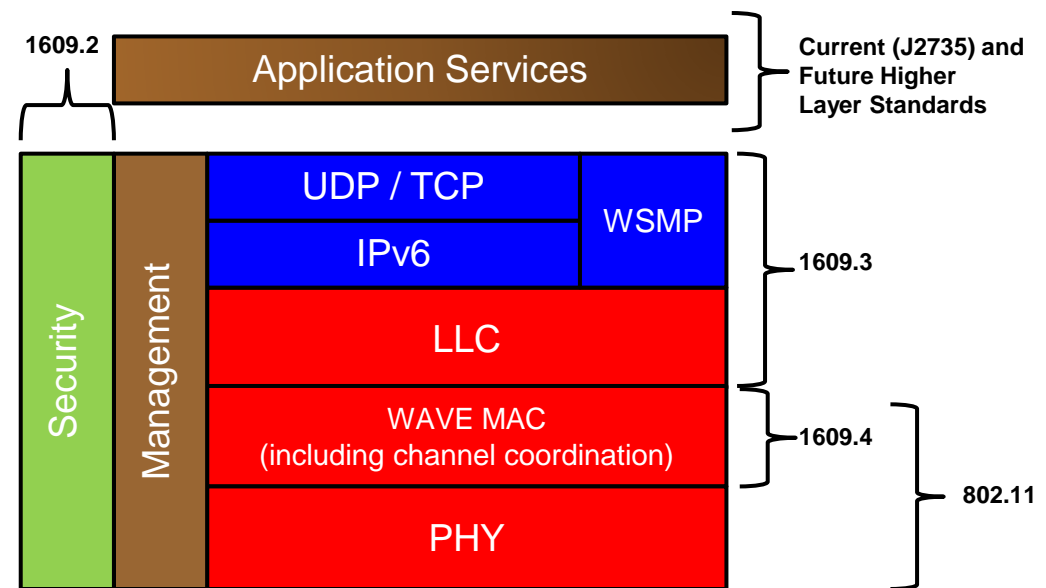


CV Standards: Overview and Status

- Vehicle to infrastructure (V2I), vehicle to device (V2D), and vehicle to vehicle (V2V)
 - 5.9 GHz Channel 172 for crash-imminent safety applications
 - DSRC and other wireless technologies (e.g. LTE) for non-safety applications
 - SAE J2735 – message and dialog definitions for V2V, V2I and V2D
- SAE J2945/1 – Basic Safety Message (BSM) performance requirements for NHTSA rule-making

- IEEE 1609.x – standards covering network and transport layer protocols and security management
- IEEE 802.11 – wireless PHY and MAC protocols for DSRC that IEEE 1609 and SAE J2735 ride on

All standards are recently published



Selecting CV Standards

- **To deploy a large scale Connected Vehicle system today, a systems architect needs a basis in architecture and interface definitions**
- Multiple architectures and tools are available: CVRIA/SET-IT, FRAME and the ITS-Station in the EU
 - Standards selection recommendations for interfaces are currently identified at only highest level
 - In some cases, standards do not yet exist
 - No guidance on which interfaces are best when multiple options exist
 - In many cases, it is a significant effort to identify the requirements necessary to specify a given interface
 - Development of individual specifications can lead to an increased risk of proprietary solutions and less interoperability



International Cooperation: “HTG#7”

Standards Selection Recommendations and Gaps, Identifiers

- **What standards needed for key interfaces in a complete CV architecture?**
 - Multiregional requirement -> cooperate and share workload
 - Achieve harmonized results, deployments evolve more similarly
 - Australia, Europe and US cooperating
 - Which interfaces are of public interest? Most urgent?
- **Most interfaces not-ITS unique:**
 - Recommend available standards to **adopt**, with profiles when known
- **ITS-unique interfaces:**
 - Where is **adapting** extant standards is best?
 - Where is there a need to **create** new content?
 - Key opportunities for cooperative standards development
 - Optimize number of standards to assure an overall efficient system
- **Assure *globally unique* identifies for any CV application/service**
 - Formalize current informal arrangement with multi-SDO agreement

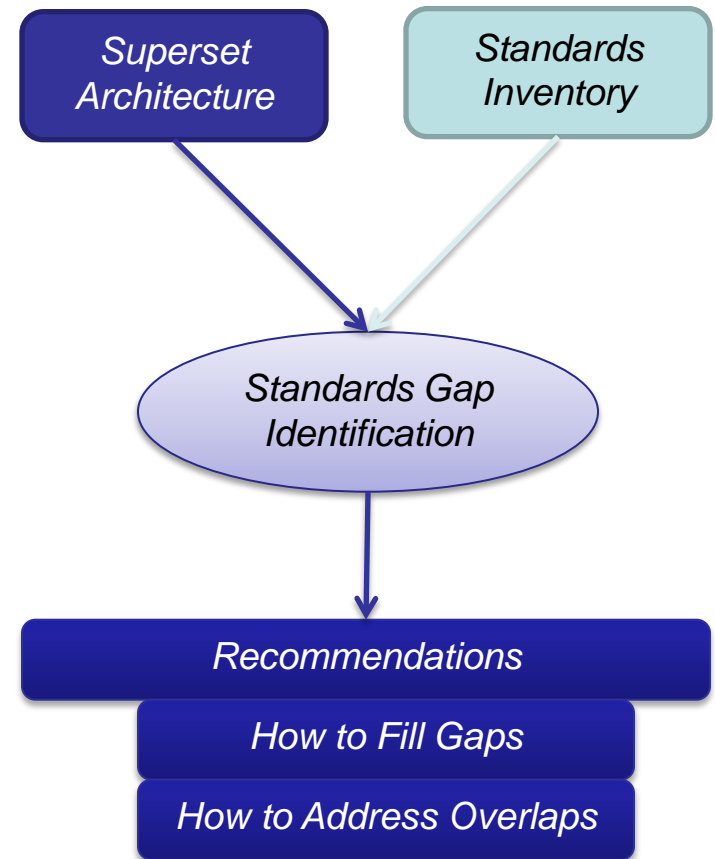
HTG7 Traceability and Process

- **HTG7 starts with a significant body of work:**

- More than 1000 relevant standards
- Architectures from the US, EU and AU

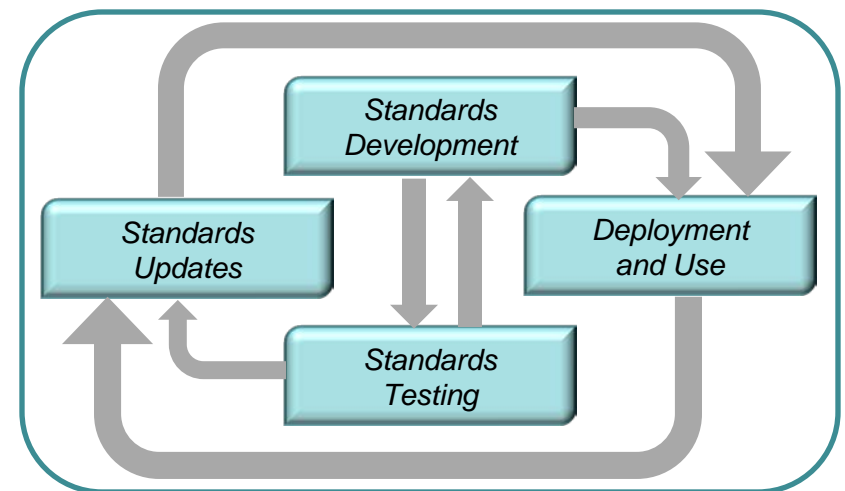
- **HTG7 will produce:**

- A comprehensive CV architecture that is inclusive of its major sources
- A set of tools for identifying and specifying the standards appropriate to satisfy interfaces
- A set of tools including an interactive website enabling *interaction and feedback* with and from the broader stakeholder community
- An assessment of gaps in CV standards
 - Support future cooperative development



Standards Participation

- **Standards are living documents**
 - Require inputs from stakeholders, testers and deployers
 - Participation in working groups developing and updating standards contributes to complete and correct broadly acceptable standards
- **Stakeholder engagement options integrated into CV programs**
 - Standards participation language incorporated into statements of work
 - Travel reimbursement for select international standards efforts and public sector standards participation
- **All stakeholders are encouraged to participate!**





Questions?

- ITS Architecture: http://www.its.dot.gov/research_archives/arch/index.htm

- Explore CVRIA: www.iteris.com/cvria
 - CVRIA web training: <http://www.iteris.com/cvria/html/resources/cvriatraining.html>

- Download SET-IT: www.iteris.com/cvria/html/resources/tools.html
 - NOTE: Requires 32-bit version of Microsoft Vision 2010/2013
 - SET-IT web training: <http://www.iteris.com/cvria/html/forms/setittrainingform.php>

- Input to improve CVRIA or SET-IT? Questions? Comments?
 - CVRIA Team: cvriacomment@iteris.com
 - SET-IT Team: setit@iteris.com

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