Connected Vehicle Reference Implementation Architecture (CVRIA) Workshop

June 11 and 12, 2015

Draper Labs

Workshop Objectives

- Update on CVRIA status
- Summarize Standards Development Activities
- Review Standards Analyses
- Break-Out Sessions: Technical Exchange

Overview – CVRIA Architecture

- **CVRIA provides a unifying framework and common language for the development and deployment of a wide variety of connected vehicle applications.**
  - **Supports flexibility and innovation**
  - **Allows project planning to be consistent with national ITS architecture**
  - **Enables CV deployments to be applied across jurisdictional boundaries**
  - **Critical structure to help all stakeholders manage the inherent complexity of CV development , deployment and operations**
  - **Helps identify institutional considerations**
- **CVRIA leverages the National ITS architecture**
- **Deployers can use CVRIA to experiment**
  - **Develop deployments that meet unique regional needs**
  - **USDOT has defined and tested a series of model implementations**

Overview - Standards

- CVRIA helps identify high-priority interfaces for standardization
- Some CV standards will be mandated by NHTSA
- Most will be voluntarily developed through collaboration
  - Wide variety of stakeholders
- Communications standards have matured
  - 5.9 GHz DSRC
  - J2735 message set – addresses Basic Safety Message
- USDOT and others have analyzed existing standards
  - Identified gaps

Breakout Sessions: We Need Your Ideas

- Initial design, development and testing are nearing completion
- Now, we are starting conversations with the people who are going to be doing the work of commercializing and deploying CV.
- Today's breakout sessions:
  - Architecture and Implementation
  - Standards and Priorities
  - Tools and Products

National ITS Architecture Team

CVRIA Update

June 11, 2015

Agenda

- Standards in CVRIA
  - Communications Viewpoint
  - Mapping to the OSI Model
  - Differences with NTCIP
- CVRIA version 2
- Next steps: versions 2.1, 2.2, 8.0 (!)
- Questions

CVRIA Viewpoints

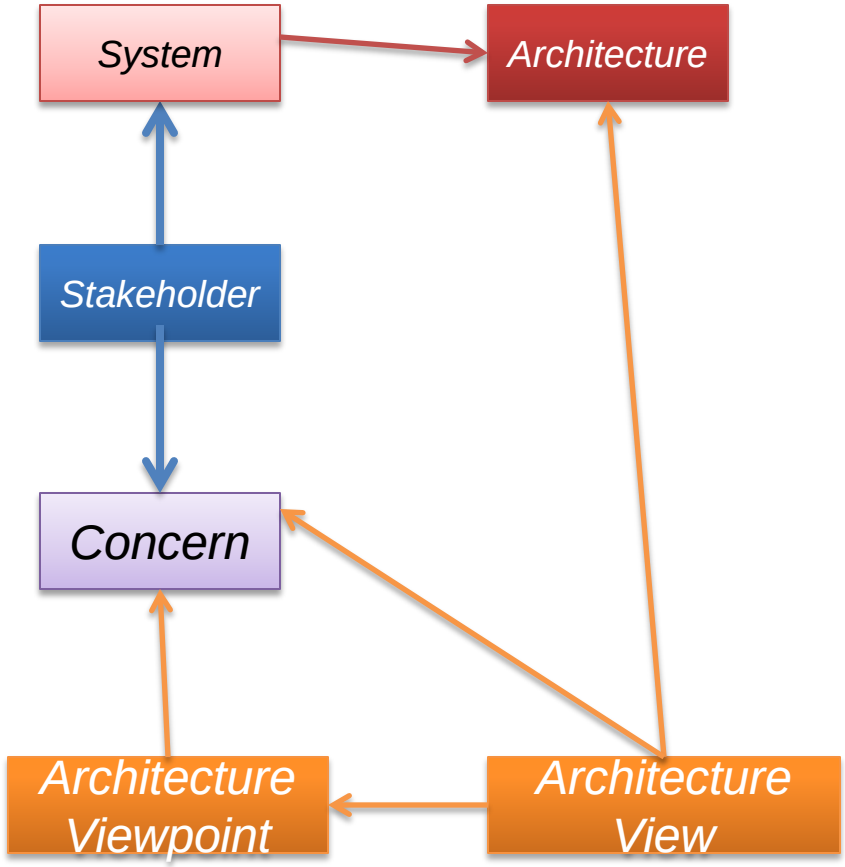
A System..has an Architecture

Stakeholders..have interests in the system

Stakeholders ... have concerns

Architecture viewpoints ... frame concerns

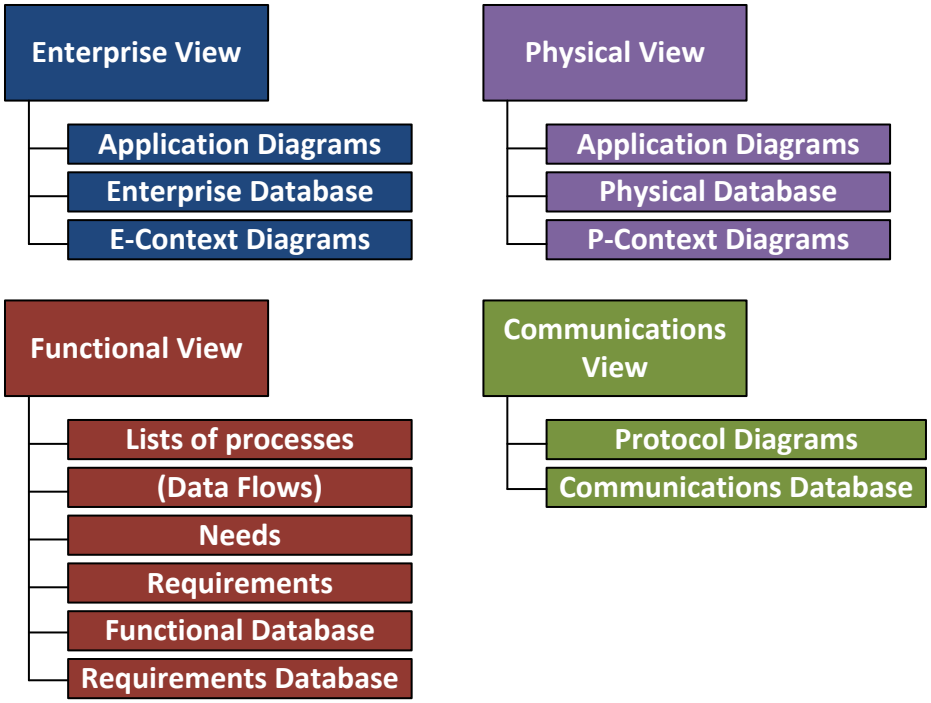
Architecture views ... address concerns



The sum of architecture views make up the architecture

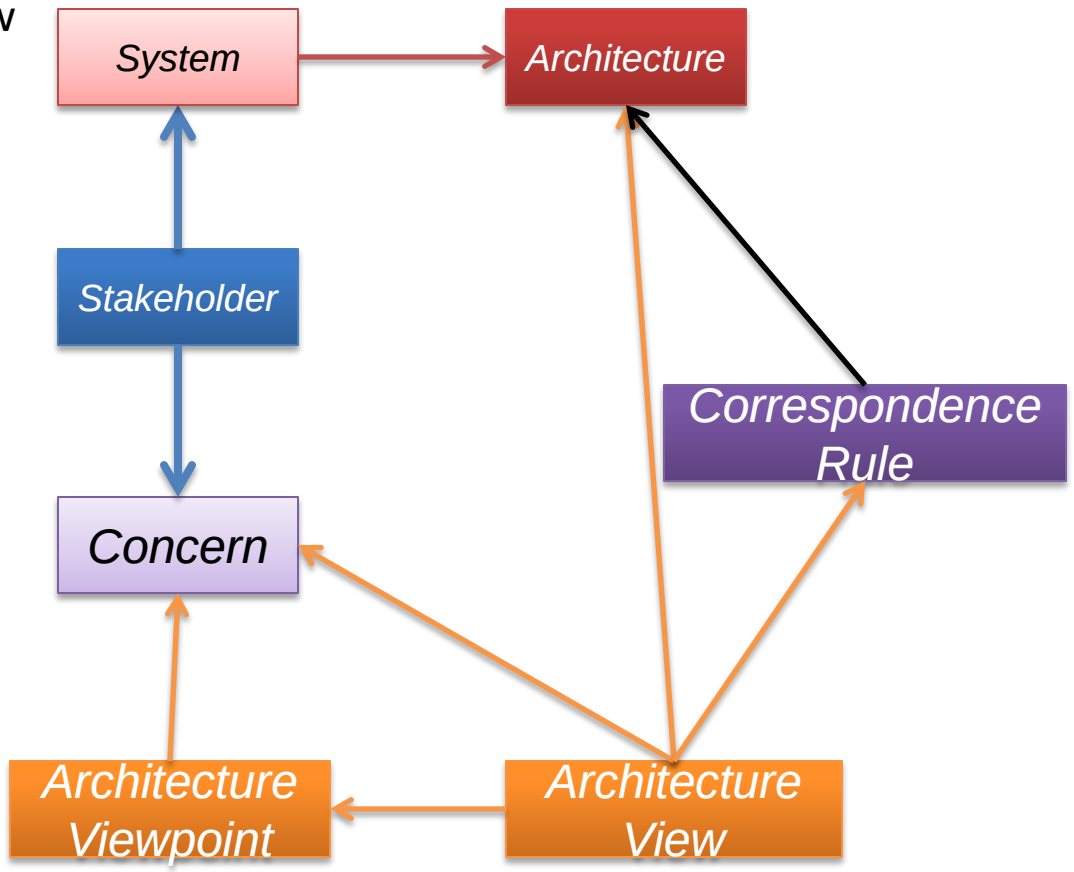
CVRIA Viewpoints cont'd

Enterprise, Physical, Functional and Communications Viewpoints

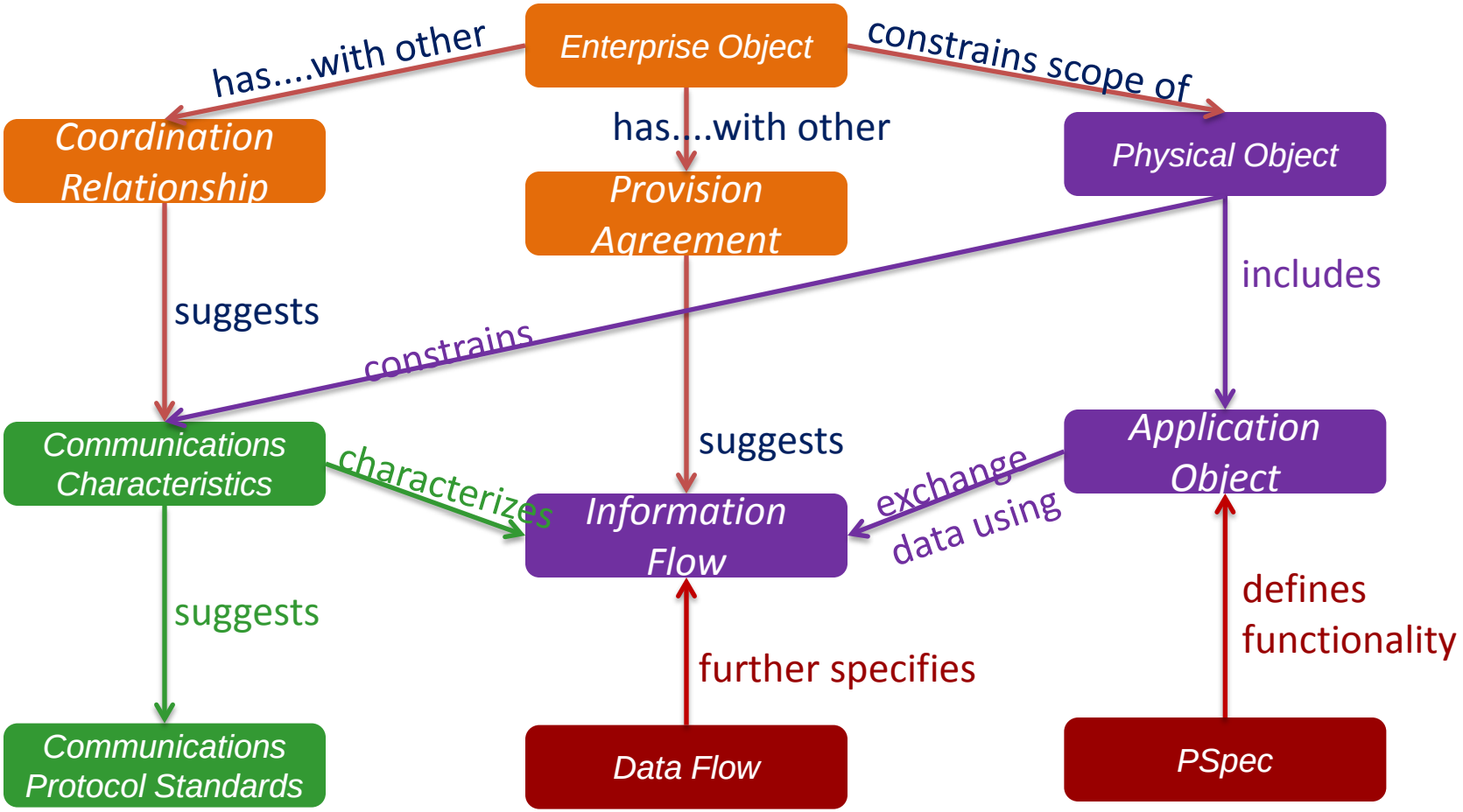


Viewpoint Correspondence

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



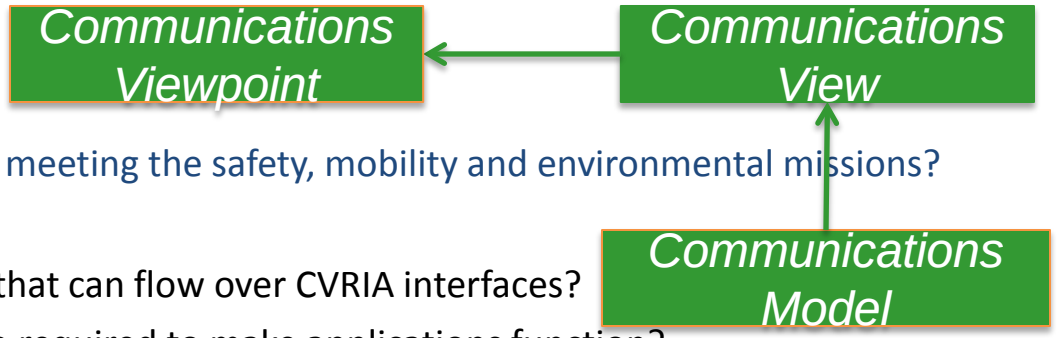
Viewpoint Correspondence cont'd



Communications Viewpoint Concerns

- Do communications protocols exist to support meeting the safety, mobility and environmental missions?
- What data flows across CVRIA interfaces?
- Are there any restrictions to the kinds of data that can flow over CVRIA interfaces?
- What are the physical interfaces in each device required to make applications function?
- What physical interfaces are shared between functions?
- Do appropriate communications protocols exist at all layers?
- Are these protocols standards?
- What provisions for ensuring the privacy of communications are included in the communications protocols?
- What provisions for ensuring the anonymity of originators are included in the communications protocols?
- How do the communications protocols protect the integrity of messages?

Communications Model



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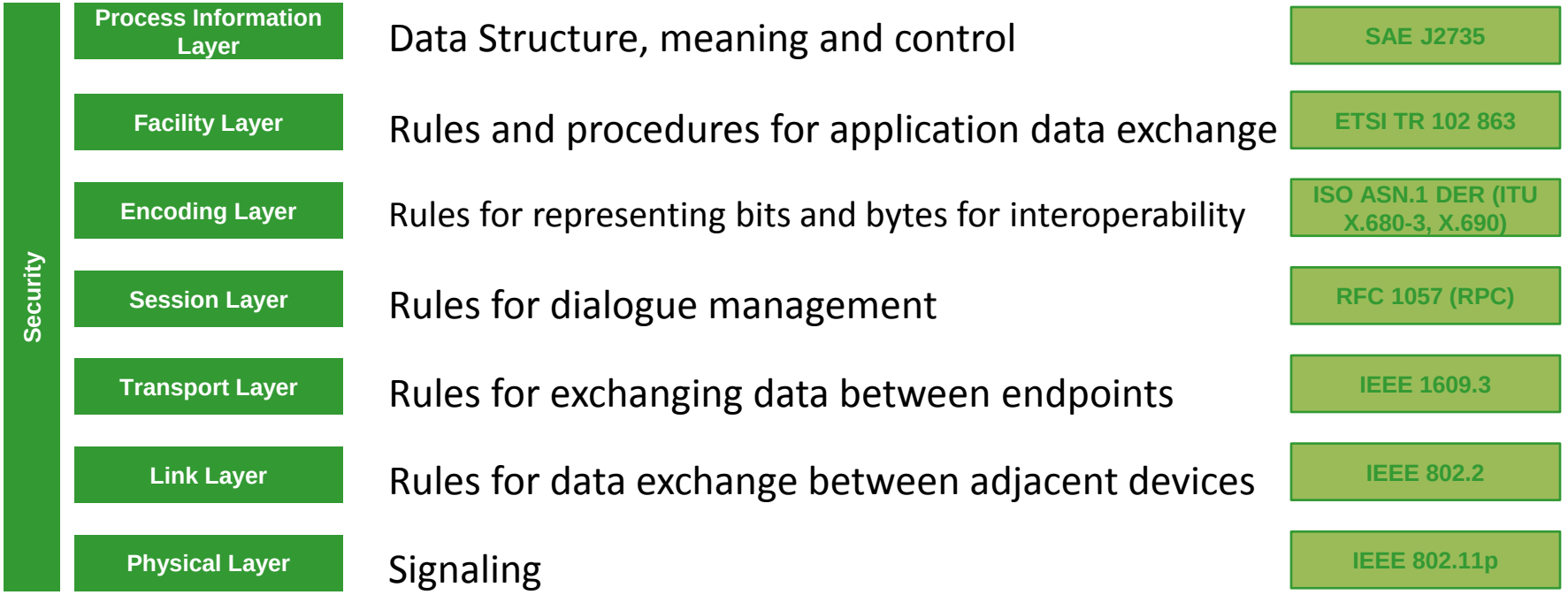
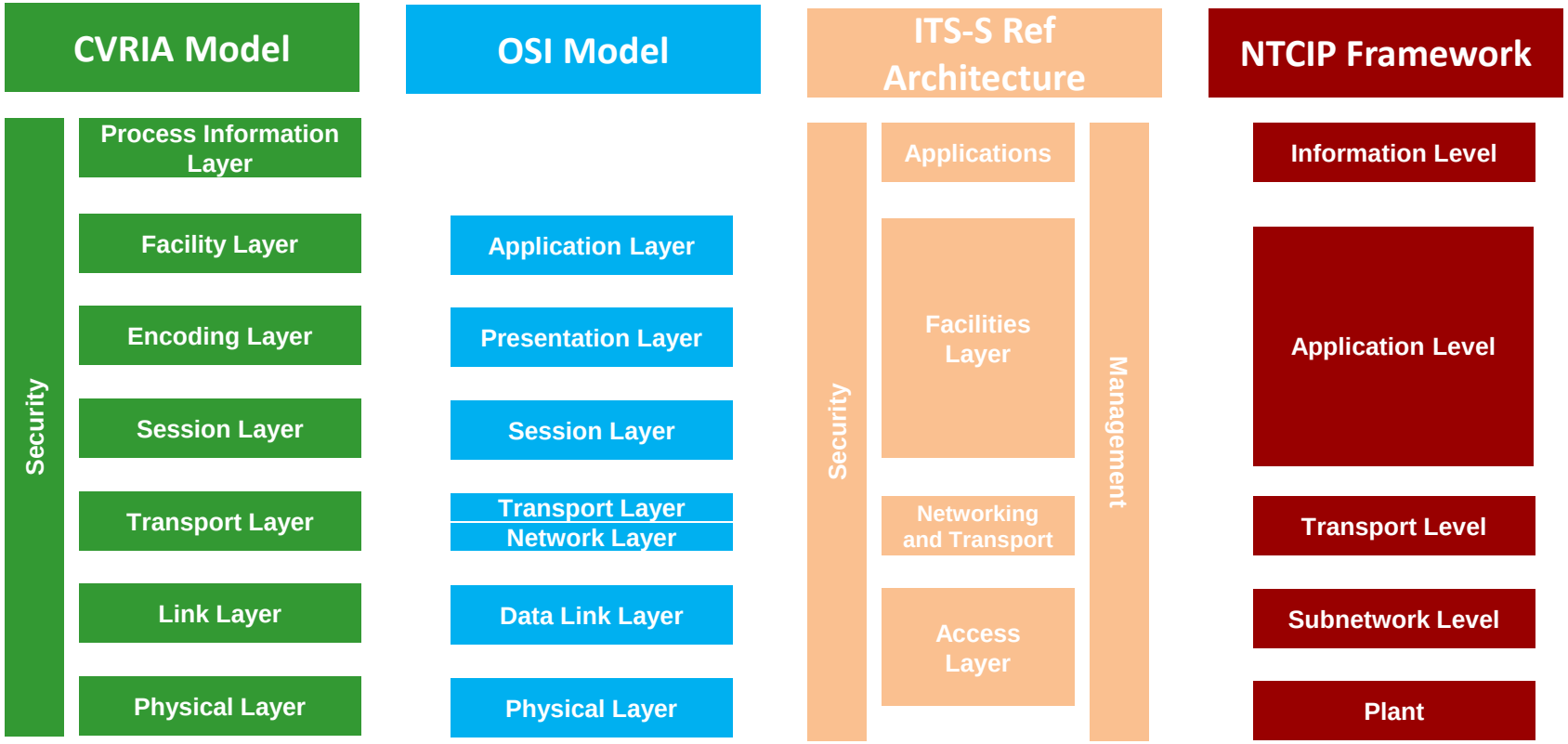
Communications Diagrams

Protocol stacks identify the standards at various layers

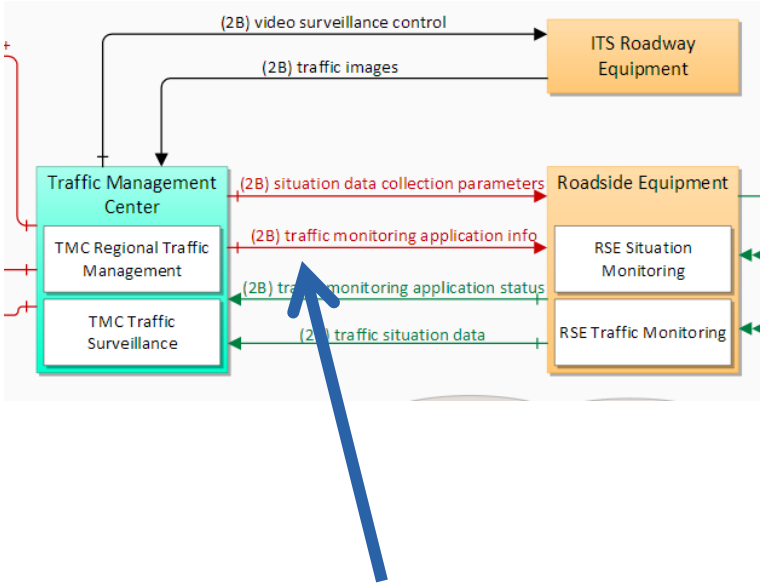


Model Comparisons



CVRIA Communications Model Diagrams

- Easiest access – through Physical!
  - Navigate to the physical diagram of your choosing
  - Click on the information flow you are interested in
  - Stack options appear

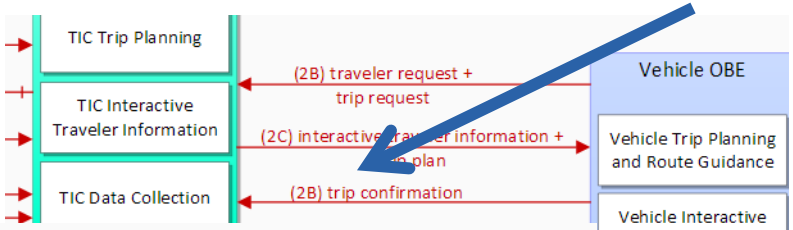


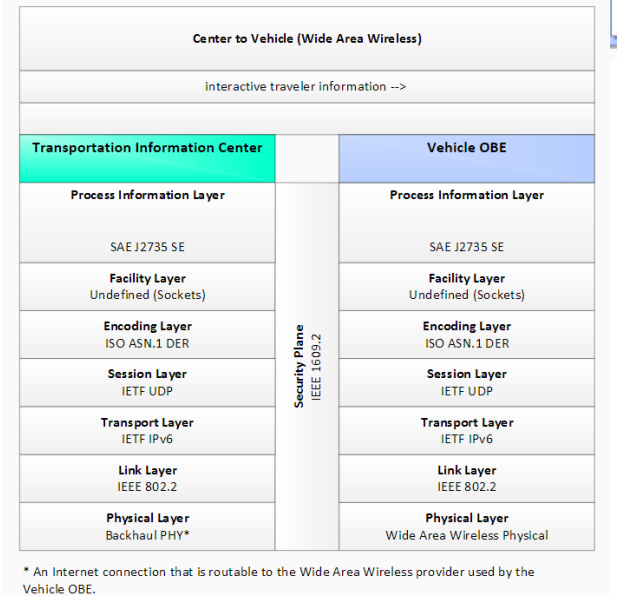
Center to Field (RSE)		
situation data collection parameters -->		
Traffic Management Center		**Roadside Equipment**
Process Information Layer Undefined	**Security Plane** IEEE 1609.2	**Process Information Layer** Undefined
Facility Layer Undefined (Sockets)		**Facility Layer** Undefined (Sockets)
Encoding Layer ISO ASN.1 DER		**Encoding Layer** ISO ASN.1 DER
Session Layer IETF UDP		**Session Layer** IETF UDP
Transport Layer IETF IPv6		**Transport Layer** IETF IPv6
Link Layer IEEE 802.2		**Link Layer** IEEE 802.2
Physical Layer Backhaul PHY*		**Physical Layer** Backhaul PHY*

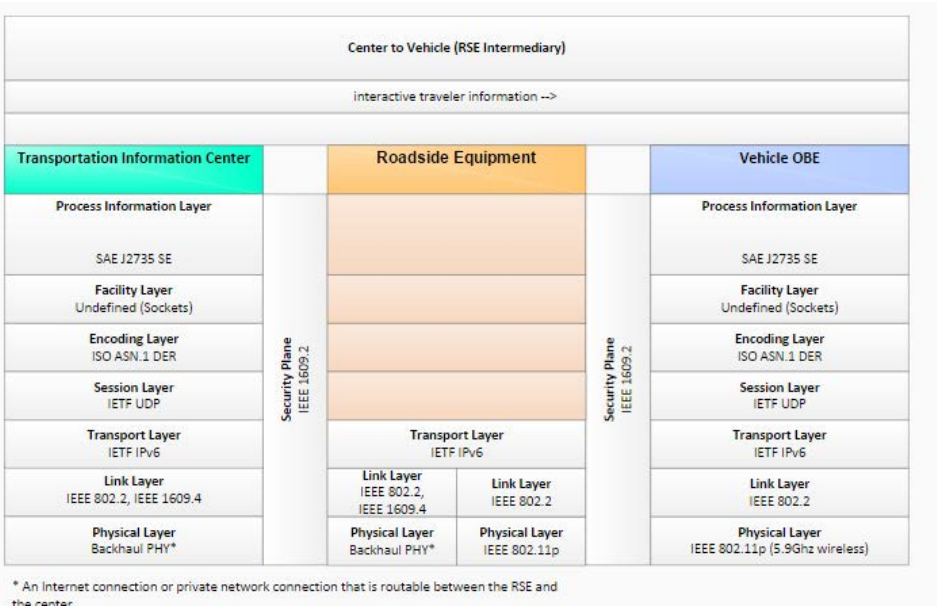
* An Internet connection or private network connection that is routable between the RSE and center.

CVRIA Model Diagram Options

- Many links have multiple stacks
- Many stacks have standards choices at some layers
- As the architecture is further developed, the number of choices will expand and selection criteria added







CVRIA Communications Database

- Graphics are nice...but the architecture is mostly database-driven
- Some statistics:
  - 490 Information Flows
  - 1725 Information Flow Triples (Object-Flow-Object), each with unique characteristics
    - Data time relevance
    - Data spatial relevance
    - Message acknowledgement required?
    - Data/message encryption required?
    - Message authentication required?
    - Cardinality
    - Initiator

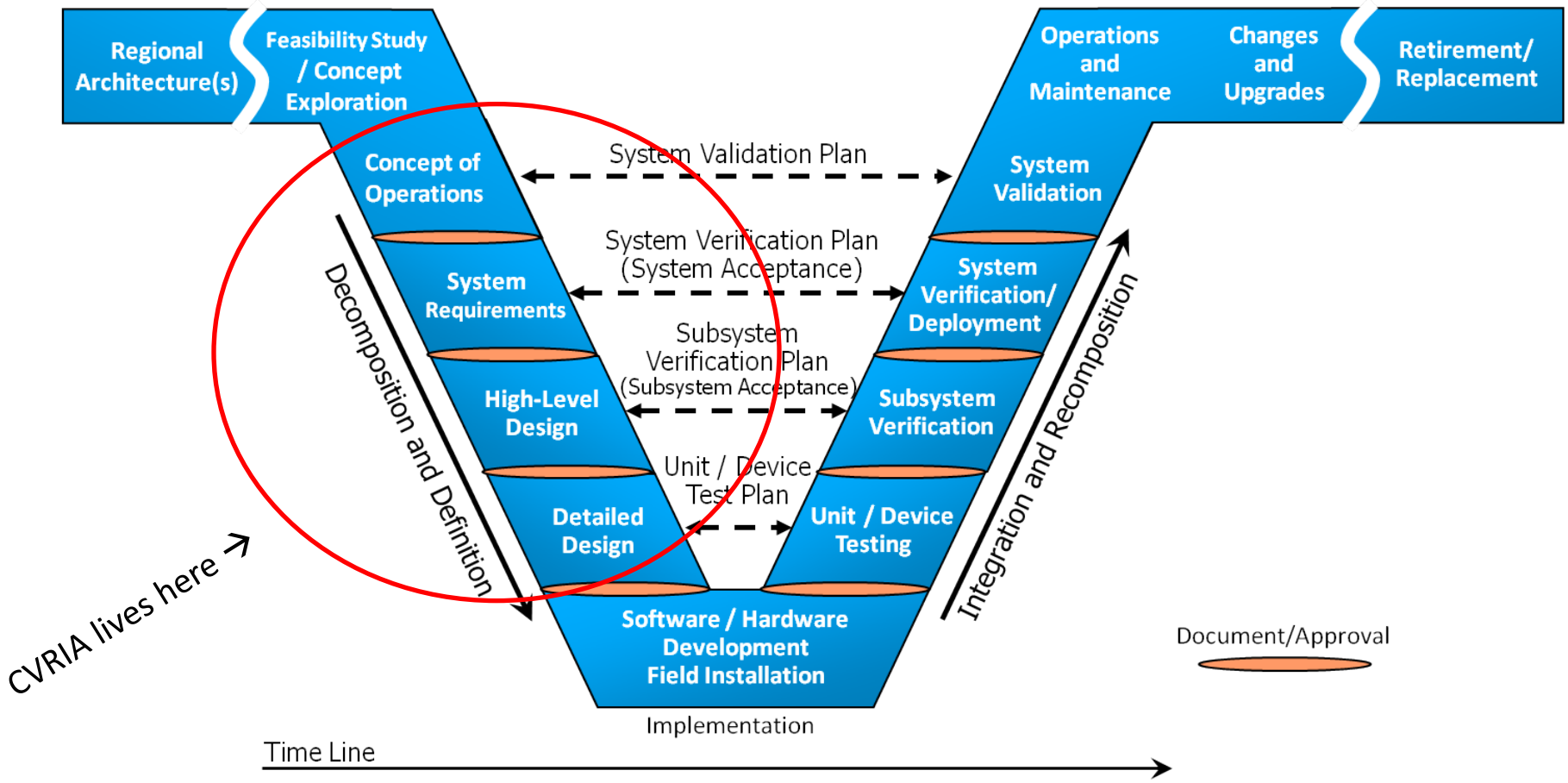
CVRIA Communications Model Simplification for Analysis

- Boil it down a bit. There are seven types of links in the CVRIA
  - Fixed Point C2C and C2I
  - Wireless C2V, C2P
  - Short Range Wireless V2I, V2V, V2P, P2I
  - Fixed Point or Wireless (typically C2P)
  - Human Interfaces
  - On-board Interfaces
  - Contact/proximity interfaces
- With various requirements and constraints, we end up with 17 communications ‘profiles’, each of which has a few choices in the stack
- Most choices go like this:
  - Pick Physical-> pick Link & Transport
  - Pick Encoding
  - Pick Process Information Layer

CVRIA Version 2.0

- New Applications and Changes to Existing Applications
  - New Physical objects
  - New Flows
  - New Requirements
  - New Communications Profiles
  - Increased correspondence between Functional and Physical
  - Revisions to document sources, definitions, standards
  - Increased focus on ‘Support’ applications
- Additional supporting information
- SET-IT Release V2.0 in parallel
- Expected late June / early July 2015

CVRIA Version 2.x



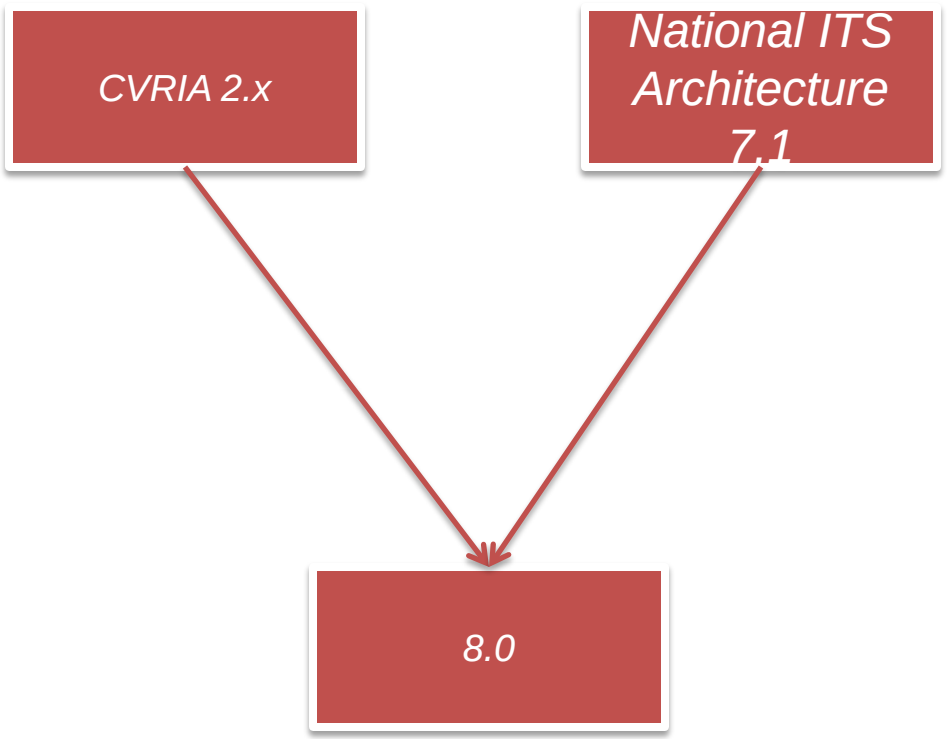
CVRIA 2.x Communications Enhancements

- **New Questions – Interfaces:**
  - Are there any restrictions to the kinds of data that can flow over CVRIA interfaces?
  - What are the physical interfaces in each device required to make applications function?
  - What physical interfaces are shared between functions?
  - What dialogs are part of a given information flow?
  - What messages are part of the dialog, and what is the format and contents of those messages?
  - What is the state of an interface or dialog, given the state of message exchange?
- **New Questions – Information Security:**
  - What provisions for ensuring the anonymity of originators are included in the communications protocols?
  - How do the communications protocols provide non-repudiation of messages?
  - How do the communications protocols protect the integrity of messages?

CVRIA 2.x Communications Enhancements cont'd

- **New Questions – Performance:**
  - What are the Quality of Service requirements for a given message delivery?
  - What are the (message, object) Positioning accuracy requirements?
  - What are the (message, object) Timing accuracy requirements?
  - What is the maximum latency of a message transmission?
  - What is the maximum time delay from measurement to reception (incorporates latency, but also internal delays)?
  - What is the minimum required communications distance of the message?
  - What is the maximum expected communications distance of the message?
  - If the message is to be multicast or broadcast, what is the geo-dissemination area for the message?
  - What is the minimum throughput required to support the flow?
  - What is the size of the APDU?

8.0



Two separate architectures—related, but different, with different specifications that address some different concerns

One unified architecture, with one set of tools, that address the superset of concerns

Questions?

- CVRIA can be explored at www.iteris.com/cvria
- SET-IT is available for download at www.iteris.com/cvria/html/resources/tools.html
- Contact Information
  - CVRIA Team: cvriacomments@iteris.com
  - SET-IT Team: setit@iteris.com
  - Tom Lusco: ctl@iteris.com
  - David Binkley: dnb@iteris.com

ITS JPO
ITS Standards Program

Status Summary of Connected Vehicle Related ITS Standards

Presented by Blake Christie
Noblis, Inc.
June 11, 2015

Purpose

- Provide development status of the ITS standards related to connected vehicles

ITS Standards Related to Connected Vehicles

- Characterized as:
  - Vehicle to Vehicle/Infrastructure/Device (V2V, V2I, V2x) standards:
  - Infrastructure related standards
  - Protocol standards

Standards related to connected vehicle

- SAE J2945/0, /1, /2 and others to be identified, related to specific applications
- SAE J2735 only a data dictionary
- ISO 19091 V2I applications for intersections
- IEEE 1609.2 Security Services
- IEEE 1609.3 WAVE Network Services
- IEEE 1609.4 WAVE Multi-channel Operations
- IEEE 1609.12 Identifier allocations
- IEEE 802.11 DSRC Radio

Other commercial mediums can be used 3G, 4G, LTE, etc.

Infrastructure Standards Related to Connected Vehicles

- NTCIP 1202 v3 for signalized intersection control
- NTCIP 1209 v2 for transportation sensor systems
- NTCIP 1103 v3 required for exception handling for CV
- NTCIP 1204 v4 for environmental and road way conditions
- NTCIP 1211 v2 for prioritization control at intersections
- NTCIP 1213 v3 for smart roadway lighting and electric charging
- TMDD v3.03c to traffic conditions
- NTCIP 2306 v1.69 protocol standard for TMDD

Predominantly interfaces between the RSE and roadside equipment

Summary Status

Standard	Status (as of 6/5/2015)
SAE J2945/0	▪ First full draft now in review, and ▪ Ballot draft expected Sept. 2015
SAE J2945/1	▪ Version 2 now in review, ▪ Additional capabilities to be added in version3, and ▪ Ballot draft (version 4) expected Sept. 2015
SAE J2945/2	▪ Rough draft in review, and ▪ Ballot draft October 2015
SAE J2735-2015xx	▪ UPER draft in review, ▪ V2V Safety, ▪ V2I support, and ▪ Ballot draft September 2015

Summary Status

Standard	Status (as of 6/5/2015)
IEEE 802.11	▪ Completed ▪ Additional capabilities being considered
IEEE 1609.2	▪ Published in 2013, ▪ Being revised (Various minor corrections, use of ASN.1, Peer-to-Peer CRL, Mis-binding/Proof of Possession, Sync identifier changes, Certificate attachment rate, WSA Security) ▪ Ballot draft expected September 2015
IEEE 1609.3	▪ Published in 2010 ▪ Being revised (Congestion Control, WSA Enhancements, WSMP Modifications, WSA broadcast on SCH, Privacy Considerations) ▪ Ballot draft expected October 2015
IEEE 1609.4	▪ Published in 2010 ▪ Being revised (UPER draft in review, V2V Safety, V2I support) ▪ Ballot draft expected September 2015

Summary Status

Standard	Status (as of 6/5/2015)
IEEE 1609.12	▪ Published in 2010 ▪ PSID allocations may cause modifications
ISO 19091	▪ Working Group final review underway, ▪ References J2735-2015xx, and ▪ Ballot draft expected October 2015

Summary Status

Standard	Status (as of 6/5/2015)
NTCIP 1202 v3	▪ ConOps & Requirements done, and ▪ Ballot draft after March 2016
NTCIP 1204 v4	▪ Started design stage for additional capabilities, ▪ Design Walkthrough July 2015, and ▪ Ballot draft expected fall 2015
NTCIP 1209 v2	▪ Completed
NTCIP 1103 v3	▪ First draft reviewed, and ▪ Ballot draft expected Jan 2015

Summary Status

Standard	Status (as of 6/5/2015)
NTCIP 1211 v2	▪ Completed ▪ May require modifications to meet CV needs
NTCIP 1213 v3	▪ Completed ConOps and Requirements, ▪ In design stage now, and ▪ Ballot draft expected in late 2015
NTCIP 2306 v1.69	▪ Completed
TMDD v3.03c	▪ Completed

Questions?

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Blake Christie – Noblis, Inc. blake.christie@noblis.org

Connected Vehicle & Cooperative ITS Standards Gap Analysis:

A Summary of Recent Research Initiatives

June 11, 2015

Topics for Discussion

- Overview and update on standards gap analyses
- Overview of Recent Research Initiatives on standards for connected vehicle environments
- Key findings Similarities & Distinctions
- Relevance

Overview and Update

- **Most gaps are at OSI layer 7 (Application layer)**
  - **Some issues/questions at layers 4 and 5**
- **Rulemaking is prioritizing standards development needs**
  - **Goal: complete, correct, and stable standards for V2V**
  - **All other development work being deferred to meet NHTSA requirements**
- **USDOT expects to provide guidance to SAE regarding the next J2945.x later this summer**
  - **Evaluation of next standards to fund is nearing completion**
- **Expect to address all critical items in the next 2-3 years**

There is Global Interest in Cooperative Systems & Standards Harmonization

- In 2009 DOT and EC signed agreement to promote cooperative systems and standards harmonization
- Identifying where standards are most needed is a critical element in standards harmonization
- US, EU, Netherlands and Australia have supported standards research
- Research has recommended an approach that can possibly lead to the development of a core set of application standards

Overview of Research Initiatives

- Seven (7) recent research initiatives to examine CV standards have been supported by U.S., EU, Netherlands and Australia with a focus on:
  - Cooperative ITS
  - Connected Vehicle
- Studies examined existing standards and standards currently under development
  - Some studies proposed standards frameworks
- Research outcomes and recommendations need to be examined

Research Initiatives

- *Interface Standardization Analysis* (Booz, Allen Hamilton)
  - Identifies and prioritizes CVRIA interfaces for standardization
  - Identifies gaps between CVRIA interfaces (and their functional needs) and the existing standards that would be used to implement them
- *Cooperative Intelligent Transport Systems: Standards Assessment* (Austroads)
  - Identifies a U.S. standards scenario and an EU standards scenario
  - Discusses differences, commonalities, and how each set of standards might be applicable to Australia and New Zealand.
- *Data Capture and Management Program Standards–related Requirements Collected* (Consensus Systems Technology)
  - Presents standards-related functional and performance requirements for DMAs, AERIS and road weather apps
  - Identifies inconsistent and/or duplicative standards

Research Initiatives (continued)

- *Development of the Long-Term Connected Vehicle Standards Framework* (SAE International)
  - Identifies CV applications that are strongest candidates for near-term standardization
  - Provides a framework and process to guide the development of connected vehicle standards – specifically the SAE J2735.x data dictionary and SAE J2945.x standards
- *D3.6b Report on Standards Activities* (ERTICO-ITS Europe)
  - Describes the on-going global and European Intelligent Transportation Systems standardization efforts – including iMobility Forum Standards Working Groups and standards activities that occurred in 2014
- *Overview of Standards for First Deployment of C-ITS – Prioritization Framework for the Netherlands* (Rijkswaterstaat WVL)
  - Provides an overview of standardization needs for C-ITS Services (Cooperative Intelligent Transportation Systems Services) to be deployed in The Netherlands in the near and mid-long term, with a focus on the Cooperative ITS Corridor

Research Initiatives (continued)

- *ITS Security – ITS Communication Security Architecture and Security Management* (European Telecommunications Standards Institute)
  - Specifies a security architecture for Intelligent Transport System (ITS) communications and is based upon the security services defined in TS 102 731
  - Identifies and describes the functional entities required to support security in an ITS environment and the relationships that exist between the entities themselves and the elements of the ITS reference architecture defined in EN 302 665

Similar Findings / Common Themes

- Mapping “priority applications” to standards crucial in identifying gaps
- Application prioritization is the recommended approach to identifying a set of core applications for standardization
- “Mixing and matching” standards not a feasible methodology
- The issue of “backwards” compatibility will need to be addressed

Differences

- Communication systems disparities exist
- Significant differences in US and EU security approach and security system designs
- Functional and performance requirements are not consistently defined across applications

Conclusions

- Research outcomes suggest there is some general agreement on developing a set of core application standards
- Findings suggest further discussion in several key areas (including communications & security) needs to occur for a level of cooperative systems and standards harmonization to be possible
- Research outcomes may assist the DOT in identifying and agreeing upon a set of first round “candidate” applications for near-term standards development

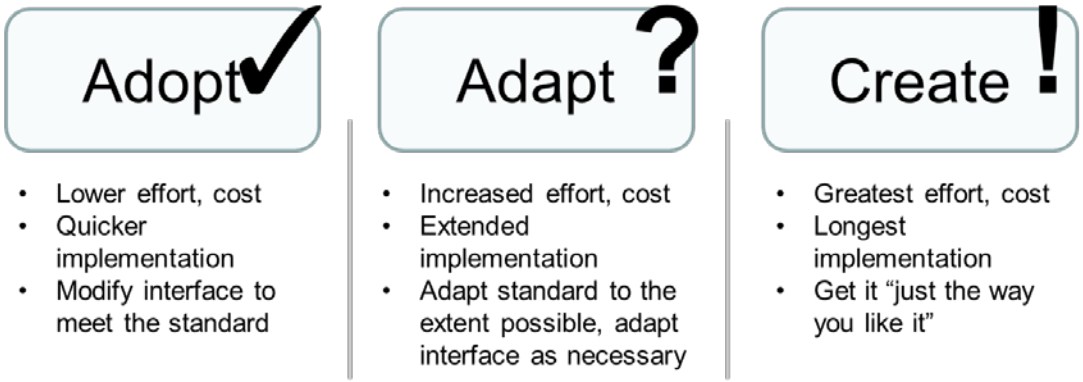
Intelligent Transportation Systems (ITS) Joint Program Office (JPO)

Prioritization of Connected Vehicle Interface Standards

June 11, 2015

CVRIA and Standards

- The USDOT's Intelligent Transportation Systems (ITS) Joint Program Office (JPO) has developed a standards plan to inform ITS standards-related efforts and investment decisions. The plan will support:
  - the USDOT ITS connected vehicle research program, and
  - broad deployment of connected vehicle (CV) technologies
- The plan is based on the information exchanges and interfaces identified in the CVRIA
- The plan will evolve with technologies, implementation strategies, and policies
- The plan will help USDOT assure that the most critical CV standards needs are met



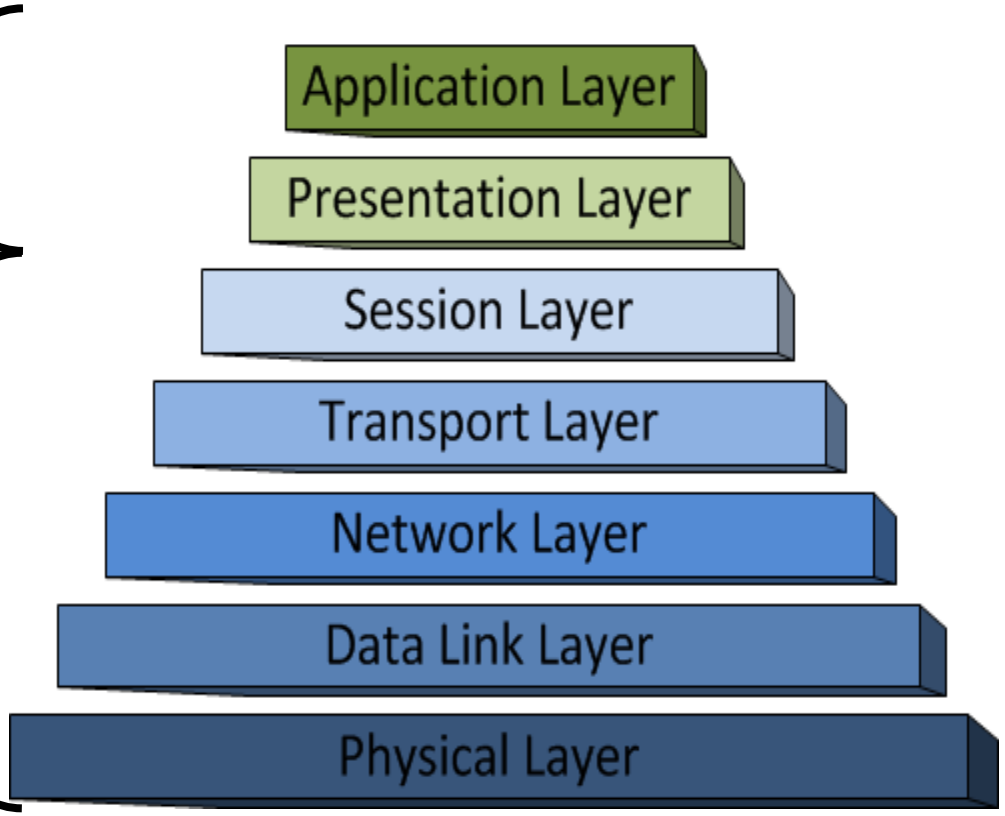
Standards at Different Layers of the OSI Stack

- New standards or portions may be needed when *off-the-shelf* standards unavailable

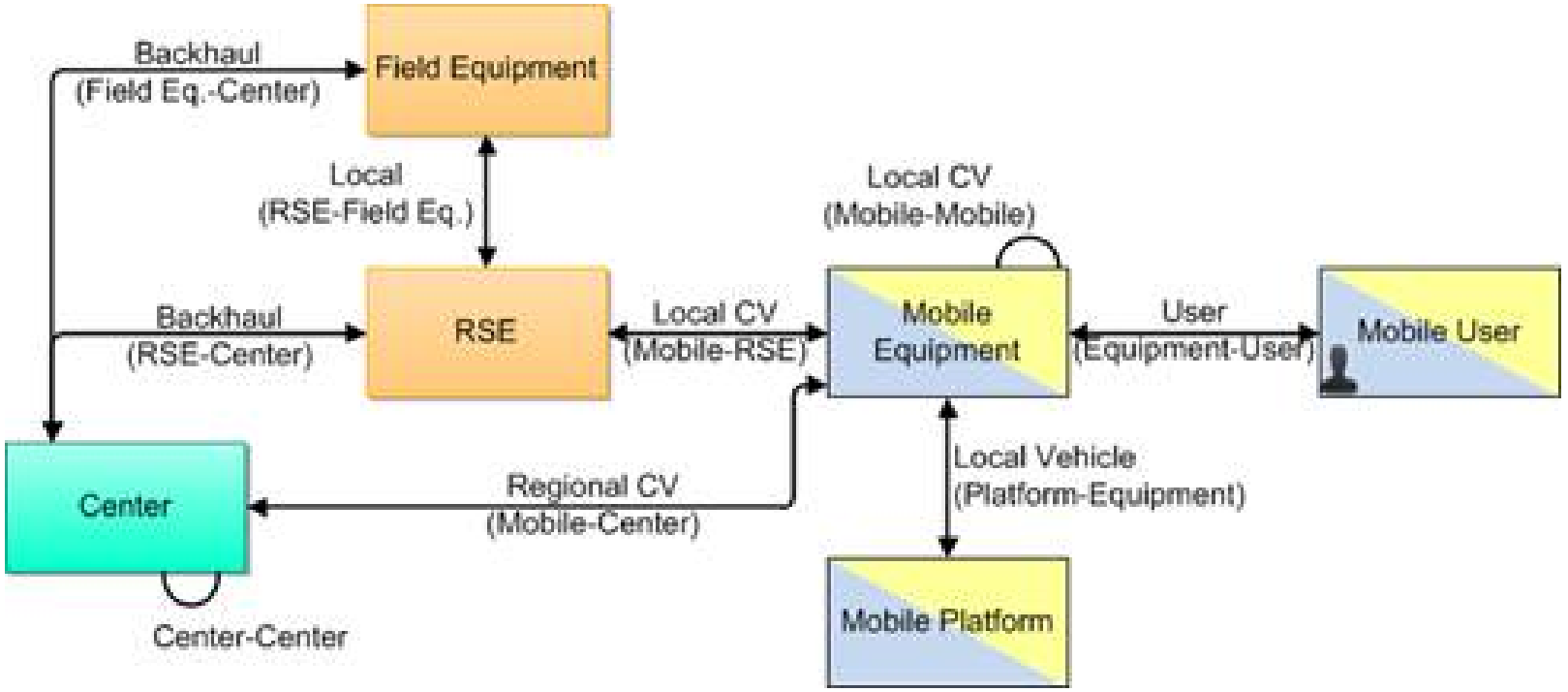
Adopt ✓ Adapt ? Create !

- At the lower layers, the most common approach will be to select *off-the-shelf* implementations

Adopt ✓ Adapt ?

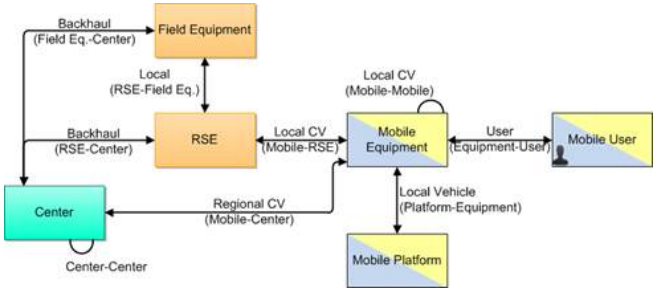


Analysis Framework: CV Objects & Interfaces



- Only seven defined interfaces in our model
- Each “object” represents multiple CVRIA object types
- Limited set of communication stacks for any interface
- We identify standards for each interface
- The “User” interface is outside of the scope of this effort

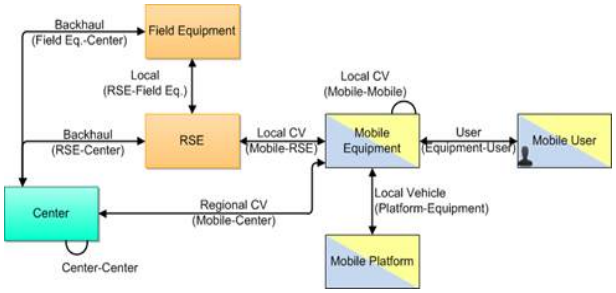
Analysis Framework: Object Descriptions



- The objects listed represent categories consisting of multiple CVRIA objects

Object	Examples
Center	*Data Center, Emergency Management Center, Traffic Management Center*
Field	*Border Inspection System, Electric Charging Station, Intermodal Terminal*
RSE	*DSRC Transceiver (roadside, fixed)*
Mobile Equipment	*Commercial Vehicle OBE, Transit Vehicle OBE, Personal Electronic Device*
Mobile Platform	*Commercial Vehicle, Transit Vehicle, Light Vehicle, Freight Equipment*
Mobile User	*Vehicle Operator, Pedestrian (with mobile equipment)*

Analysis Framework: Interface Descriptions

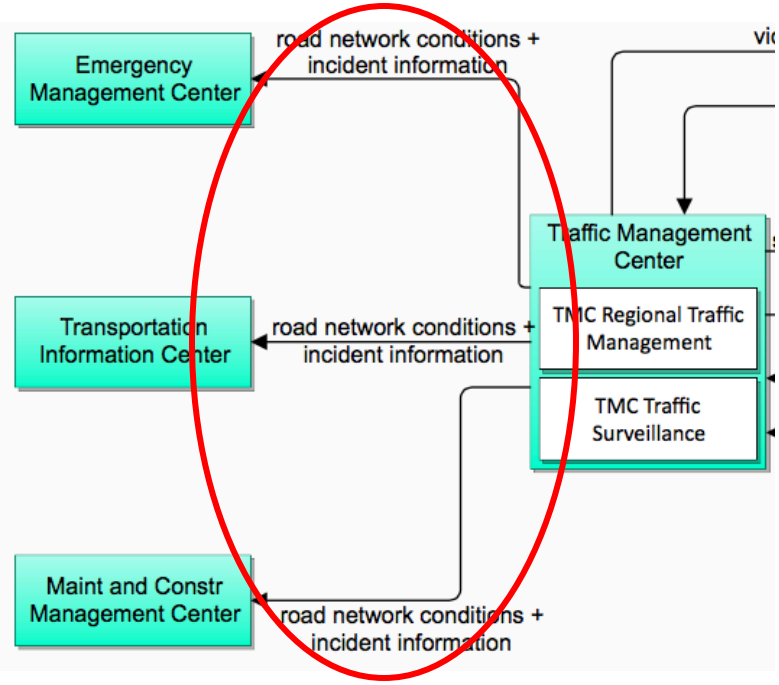


- Interfaces can typically be implemented using different technologies, which run the gamut from mature (stable) to emerging.
- Each technology will have a suite of standards that specify most, if not all of the five lower layers of the OSI protocol stack.
- For the most part, the standards at the lower layers are stable and mature.

Object	Examples
Center	*Data Center, Emergency Management Center, Traffic Management Center*
Field	*Border Inspection System, Electric Charging Station, Intermodal Terminal*
RSE	*DSRC Transceiver (roadside, fixed)*
Mobile Equipment	*Commercial Vehicle OBE, Transit Vehicle OBE, Personal Electronic Device*
Mobile Platform	*Commercial Vehicle, Transit Vehicle, Light Vehicle, Freight Equipment*
Mobile User	*Vehicle Operator, Pedestrian (with mobile equipment)*

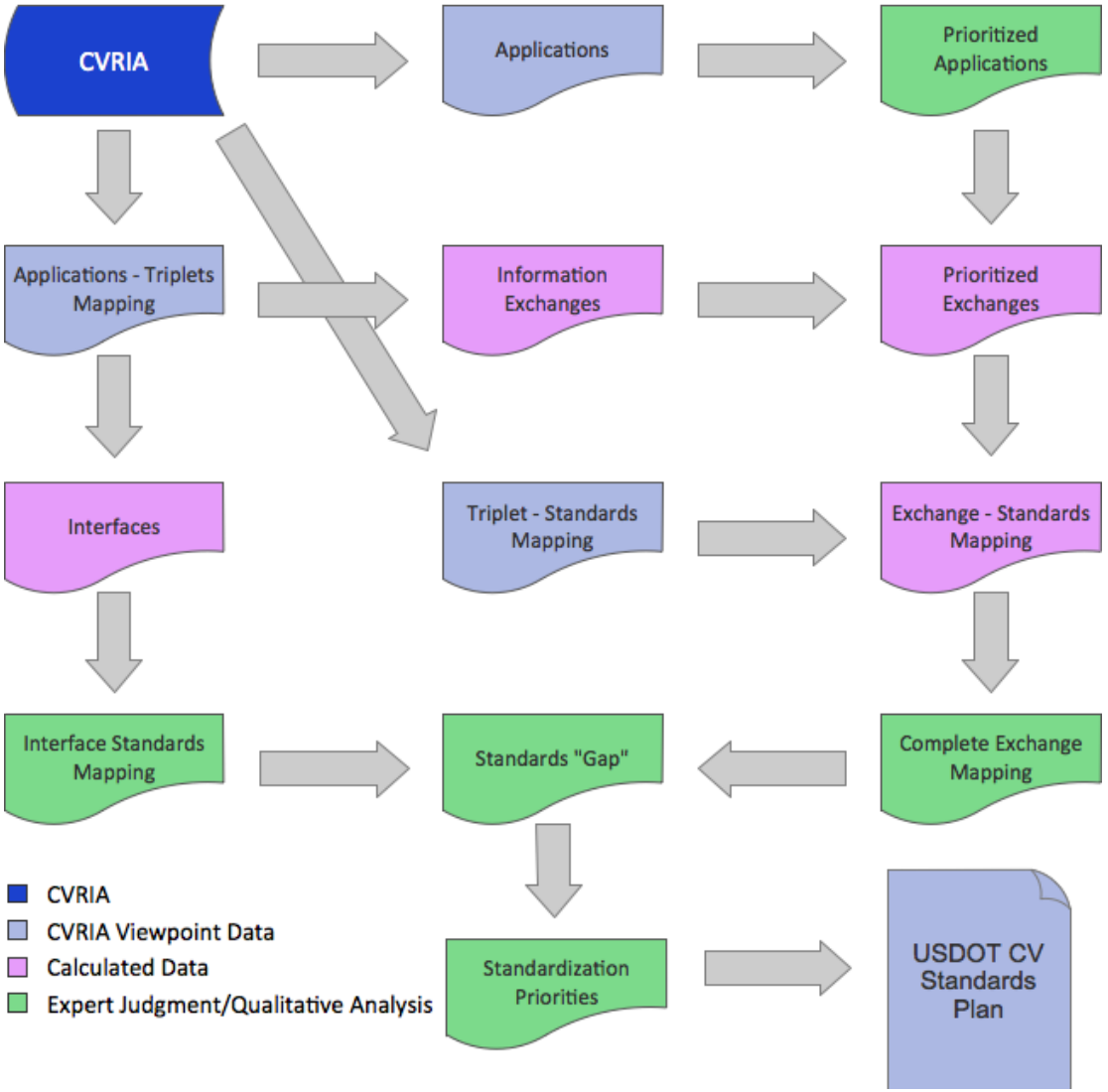
Analysis Framework: Information Exchange

- Definition: An information flow across a defined interface
  - CVRIA defines information flows from a specific source to a specific destination
  - Exchanges group flows that occur over the same type of interface (e.g., center-to-center)
    - These should use the same standard
  - A given information flow may occur across multiple interfaces
    - These ~may~ need different standards (e.g. due to aggregation issues, etc)



Flow	Priority	BH	LF	LCV	RCV	C2C	Local
situation data collection parameters	15.87	X					
traffic images	15.87	X				X	
traffic monitoring application info	15.87	X					
traffic monitoring application status	15.87	X					
traffic situation data	15.87	X	X				
vehicle location and motion for surveillance	15.87			X			
vehicle situation data	15.87			X	X		
vehicle situation data parameters	15.87			X	X		

Overview of Process



A "triplet" in the CVRIA is a combination of an information flow, its source, and its destination.

Summary of Findings

- Interfaces scored, sensitivity analysis performed: *Interface rankings accepted as reasonable (slide 10)*

- Interfaces aligned to standards: *Standards identified in terms of USDOT involvement in standardization (slides 11-13)*

- CVRIA analysis compared to other-party and international analyses: *More similarities than differences—validation of the analysis (slide 14)*

- Interfaces cross-walked to standards: *A number of outstanding technical issues identified for future investigation and resolution (slides 15-17)*

Identified Priority Applications

- 5 Core Applications
  - 13 security related gaps
  - 14 other gaps
- 11 Top Tier Applications
  - 49 gaps
- 13 Low Hanging Fruit Applications
  - 11 have no additional gaps
  - 2 have one additional gap each
- Total: 78 gaps in 18 of the above 29 applications
- 4 Marginal Applications
  - 2 additional gaps for vehicle emergency response
  - 4 additional gaps for warnings about upcoming work zones
  - 6 additional gaps for traveler information – smart parking
  - 36 additional gaps for border management systems

Gap Analysis Reporting

- Exchange description is derived directly from CVRIA information flow description
- For each gap identified:
  - Highlighted text of gap in description
  - Rated the USDOT interest in the gap (critical, important, useful, free market)
  - Identified related activities and relationship
  - Provided explanatory comments

Exchange		Description	USDOT Interest	Related Activities	Notes
RCV	Emergency vehicle tracking data	A regional connected vehicle exchange that provides the ***current location*** and operating status of the emergency vehicle.	Critical	SAE J2735: Defines messages for emergency vehicles and is supplemented with SAE J2945 (under development)	SAE J2945 should define rules that require the Emergency Vehicle Alert message to include the optional field for the location of the vehicle.

USDOT Interest Ratings

- Critical Exchange
  - Central concept of connected vehicle program
  - Between Physical Objects owned by disparate sources
  - Example: LCV – Vehicle Location and Motion
    - Central concept for providing various safety applications
    - Exchange among vehicles owned by disparate sources
    - Connected Vehicles not realized without standard
- Important Exchange
  - Central concept of connected vehicle program
  - Between Physical Objects owned by coordinated sources
  - Example: BH – Traffic Situation Data
    - Being able to collect and process data in real-time is a central concept of the connected vehicle program
    - Central system and RSEs typically owned by same entity
    - Agency specification could work in theory, but a standard would encourage a competitive market

USDOT Interest Ratings (cont.)

- Useful Exchange
  - Ancillary to concept of connected vehicles
  - Standard preferred for competition and integration
  - Example: C2C – Equipment Maintenance Status
    - Real-time reporting of maintenance activities between centers is not a requirement to realize connected vehicles
    - Standardizing this reporting would improve information
    - Information is directly related to public sector operations
- Commercial Interest Exchange
  - Standard not needed for successful connected vehicle program, from USDOT perspective
  - Advantages primarily accrue to private sector
  - Example 1: RCV – Map Updates
    - NOTE: This is separate from local roadway geometry
    - Appears to be for navigation/automation uses, rather than core connected vehicle concepts
    - Market appears to be service-based
  - Example 2: All Local Vehicle exchanges
    - Manufacturer-specific interface

Harmonization with SAE, Australia, and ETSI

- SAE, Australia, and European Telecommunications Standards Institute (ETSI) conducted independent, but similar prioritization efforts
  - Significant agreement was found among the four reports
- The Standards Plan provides a proposed harmonization of these four independent studies, resulting in a list of:
  - 5 Consolidated Core Applications
  - 17 Consolidated Top Tier Applications
  - 10 Consolidated Low Hanging Fruit Applications
    - 8 require no additional nominal work
  - Total: Consensus on 32 Applications (~70% agreement)
  - 9 Consolidated Marginal Applications
  - 7 applications/uses cases that could not be mapped to CVRIA applications

Consolidated Ranking	Application	This Paper	SAE	AU	ETSI 102 638
Top Tier	Forward Collision Warning	Top Tier	V2V Safety Awareness	Collision Warning	Slow vehicle warning / car breakdown warning
	Incident Scene Work Zone Alerts for Drivers and Workers	Top Tier		In-vehicle Signage	Limited access warning / In-vehicle signage

Outstanding Issues

These technical issues were identified by stakeholders and workshop participants as near-term priorities for standardization

- Backwards Compatibility
  - Some standards not designed for graceful upgrades or even current interoperability
  - Standards should be reviewed prior to balloting
- Vehicle Security
  - DSRC security protects the wireless interface, but not the ITS Station equipment
  - A corrupt ITS Station can send validated messages
  - “Misbehavior” is not well defined and likely would not cover some types of attacks
  - Need to continue the NHTSA work to define a fully robust connected vehicle system

Outstanding Issues (cont.)

- Vehicle Station Gateway (VSG)
  - The current on-board diagnostics (OBD) port specification is inadequate for CV needs
  - Standardizing this interface would better enable after-market devices and define data quality
  - US Efforts should coordinate with ISO efforts to standardize VSG
- Human Machine Interface (HMI)
  - Historically has been a proprietary feature
  - New HMI features have real-time safety implications
  - Development of guidelines may be appropriate
- Warehousing Data
  - The CV environment will result in the production of a massive amount of data
  - Demonstration projects might help build consensus around the best way to handle the volume of data

Outstanding Issues (cont.)

- Smart Roadside Initiative
  - Commercial vehicle operations are not addressed in standards (and only partially in SAE J3067)
  - Need research to focus on needs, especially to recommend messages for backhaul and center-to-center exchanges
- Data Format for Adaptive Signal Control
  - New technology offers potential for new algorithms, such as using trajectory data
  - Research may be warranted into new algorithms that might propose new messages
- Emissions
  - Environmental applications aim to reduce emissions; best source for data is vehicle
  - Research is needed to determine what emissions data should be included in messages and at what frequency

Current and Near-Term Activities

- Industry Review of Tentative First Round Applications
- Formalize position on whether the USDOT should encourage and/or assist in the standardization of the Vehicle Platform to OBE interface
- Determine interface standardization activities

Consolidated Results – Marginal Applications

- Environmental
  - Road Weather Advisories and Warnings for Motorists
  - Road Weather Info and Routing Support for Emergency Responders
  - Road Weather Info for Freight Carriers
  - Road Weather Info for Maintenance and Fleet Management
- Mobility
  - Border Management Systems
  - Queue Warning
  - Traveler Information Smart Parking
- Safety
  - Oversized Vehicle Warning
  - Vehicle Emergency Response

Other Suggestions

- Fleet management
- Insurance and financial services
- Level (rail) crossing warning
- Local electronic commerce
- Rest area booking
- Road-vehicle to Rail-vehicle Collision Warning
- Vehicle software provisioning and update

Connected Reference Implementation Architecture (CVRIA) Workshop:

Breakout Sessions

June 11, 2015

Break-Out Instructions

- **Two Discussions:**
  1. Architecture and Implementation Technical Exchange / Connected Vehicles Tools/Products
  2. Standards Priority Technical Exchange

1. Architecture and Implementation Technical Exchange

- **ARCHITECTURE:**
  - How do you currently make use of your ITS Regional or Statewide Architecture?
  - What is the value of that tool?
  - What features do you wish it had?
  - Do you see these features in CVRIA and SET-IT? What other features would you find valuable?
- **IMPLEMENTATION:**
  - Have you begun the process of planning or developing project plans for Connected Vehicle implementations?
  - What are the major challenges you are running into?
  - What are key questions about interoperability that you would like to discuss?

1. Connected Vehicles Tools/Products

- What type of products best support your use of ITS?
- What type of products/tools do you think you need to support Connected Vehicle environment implementation, operations, and maintenance?
- Where do you think your greatest implementation challenges are likely to be?
- Are you aware of the FHWA Guidance and reference documents and tools under development?

2. Standards Priority Technical Exchange

- **STANDARDS PRIORITIES**:
  - What are your thoughts about the identification of gaps in the four categories presented?
  - Is the alignment of standards to exchanges correct and complete?
  - What are your top standards and were they represented?
  - How do you perceive that standards will enable your implementations…in other words, what do you think that standards will do for your operations?
  - What are your thoughts regarding the harmonization of priorities in this analysis and in the ETSI, AU and SAE analyses?

- **STANDARDS DEVELOPMENT:**
  - Our summary included thoughts on gaps associated with existing standards. Are you in agreement with those gaps? Can you add detail to our analysis?
  - Are there other industry standards that we should be considering as we contemplate the set of standards needed for a complete connected vehicle environment? If so, what are they and why?

Connected Reference Implementation Architecture (CVRIA) Workshop:

Breakout Session Responses

June 12, 2015

1. Notes - Architecture and Implementation Technical Exchange

- **ARCHITECTURE:**
  - How do you currently make use of your ITS Regional or Statewide Architecture?
    - **Identify projects**
    - **Roadmap for systems deployment**
    - **Next Steps**
  - What features do you wish it had?
    - **With CVRIA, more of a top-down approach**
    - **Start with planning view (Turbo arch) and then go to project level (SET_IT layer 2)**
    - **Be able to show data going through the cloud**
    - **Tie Layer 0/1 with Layer 2 to sync changes between them**
    - **Import diagrams (and its data, including interfaces) from other projects as a starting point**
    - **Import a listing of default names of core elements for a region/agency**
    - **Distinguish between objects/elements that are being built as part of the project vs those that are supporting the project and we are leveraging (gray out the physical box, but not the enterprise)**
    - **Show the Needs more (in training/help/outreach) but the Needs should include more high-level Need for the app itself. Some needs show needs for a CSW app but not why do I need CSW to begin with**
    - **Add link to Benefits for each app once they're available.**
  - What else should be considered?
    - **Guidelines for Naming, Placement, usage of architecture – to drive consistency**
    - **Interim guidance on architecture coordination – Regional vs CV**
    - **Be able to 'export' the methodology of CVRIA development for other domains**

- **IMPLEMENTATION:**
  - What are the major challenges you are running into?
    - **How do we sync Regional ITS Architecture with CV Arch**
    - **Not sure what purpose of layers (0) are**
    - **Blending multiple applications (and support services) into 1 diagram**
    - **Back-haul comm isn't sufficient today (much less tomorrow)**

1. Notes - Connected Vehicles Tools/Products

- Where do you think your greatest implementation challenges are likely to be?
  - **Misinformation or incomplete information about what this technology can do**
  - **Back-haul – today's infrastructure is lacking sufficient backhaul to support CV data**
    - **Will require discussions with carrier, guaranteed bandwidth, funding,**
  - **Security – addressing vulnerabilities (DoS, safeguards), securing the entire end-to-end system**
  - **Certification – especially of things like Traffic Signal Controllers**
  - **Maintenance – defining performance requirements, applied to Certification**
  - **What happens when it doesn't work – driver still responsible, liability**
  - **Consider planned obsolescence,**
- Are you aware of the FHWA Guidance and reference documents and tools under development?
- Of the list,
  - **Where's a Sales Document – something to help engineers 'sell' or 'justify' this to agency management**
  - **Where's the DSRC Channel Use Guide**
    - **Channel 172 – what can go on it? Just BSMs? Congestion control issues**
    - **Where is DSRC Channel 184 guidance (public safety)? What is allowed on that channel?**
  - **Expand Siting Guide - Service Channel Planning? For deployments – density, placement**
  - **Guidance on what is considered a "Successful Deployment"**
  - **Mitigation techniques for technology turnover (varying lifecycles)**
  - **Gap between V2V vs V2I research**
  - **Performance Requirements**
  - **Where are the big picture questions answered? Policy**
  - **Add NHTSA V2V Readiness Report (with ANPRM); CV101, CV102**
  - **Simulation, Cost Benefit Models – is it up-to-date and used consistently to see benefits / impacts of applications**

2. Notes - Standards Priority Technical Exchange

- Security-related Standards
  - Certificates
    - Standardization
    - Testbed implementations
    - Roles and responsibilities (i.e., authorities)
  - Encryption scheme
    - Currently adequate, but for how long?
    - Appropriateness to CV environment
  - FISMA
    - Uncertain compliance requirements
    - Appropriateness of existing NIST guidance for CV

2. Notes - Standards Priority Technical Exchange

- Standards vs Capabilities
  - Bidirectional influence and relationship between policy and technical limitations (bandwidth, processing, storage)
  - Concern about ability to implement certain requirements [standards] with existing technology, particularly with OBE
  - Revocation lists (3GB revocation lists)

- Scaling effects:
  - Effect of congestion (transit; highway)
  - Impact of temporally and spatially dense usage (e.g., bus depot start-up)
  - Relates back to relationship between standards and capabilities

2. Notes - Standards Priority Technical Exchange

- Priorities
  - US/European comparison
    - Initially appeared to be disparate priorities
    - Upon further consideration, more in common than not
  - Importance of common language
  - Safety/Mobility/Environment Priorities
    - Current strategy is safety-centric
    - Need to communicate net benefits to the public in *realistic* quantifiable manner (“what’s in it for me?”)
    - Need to consider how “safety” applications may improve mobility, “mobility” apps may have environmental benefits, etc.

2. Notes - Standards Priority Technical Exchange

- Consider more exhaustive and conclusive congestion impact testing for peak usage scenarios:
  - Transit
  - Highways
  - Pedestrian crowds
  - Overlapping messages
- Standards Strategy & CVRIA
  - Ensure that analysis and standards strategy keeps pace with CVRIA (e.g., Left-Turn Assist is added to CVRIA v2.0)
- Consider technology maturity when developing standards, requirements, policy
- Determine what additional public communications may be needed (i.e., outreach, education, advocacy)