



Connected Vehicle  
**PlugFest**

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# Southeast Michigan Project Architecture

PlugFest

January 29-30, 2014

Turner Fairbank Highway Research Center



# Connected Vehicle Project Architecture

- A Design **Tool**,  
not a Design



# Other Engineering Disciplines have Graphical Tools

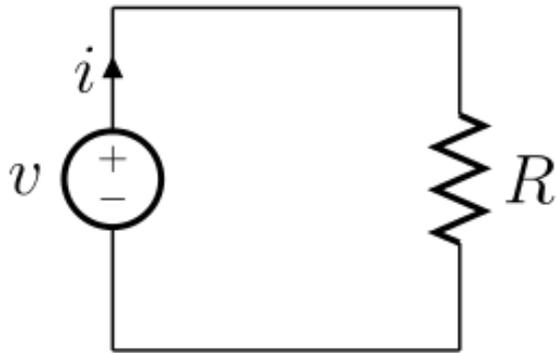


Image Source: Wikipedia

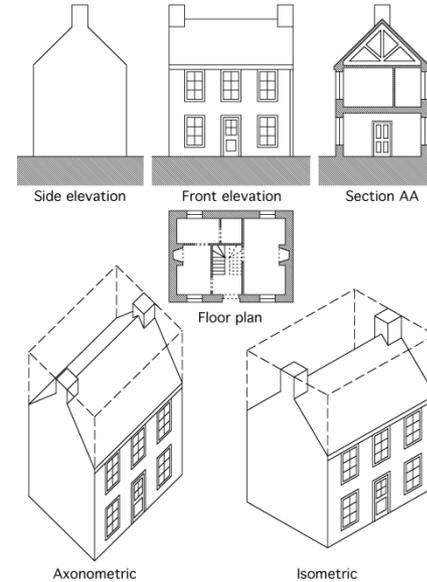


Image Source: Wikipedia

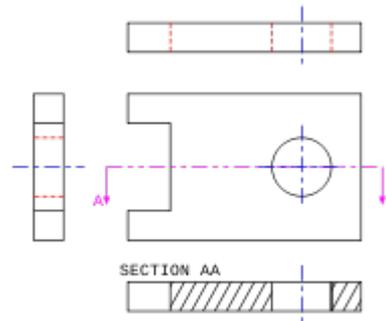


Image Source: Wikipedia



# ITS National Architecture

- <http://www.its.dot.gov/arch/index.htm>

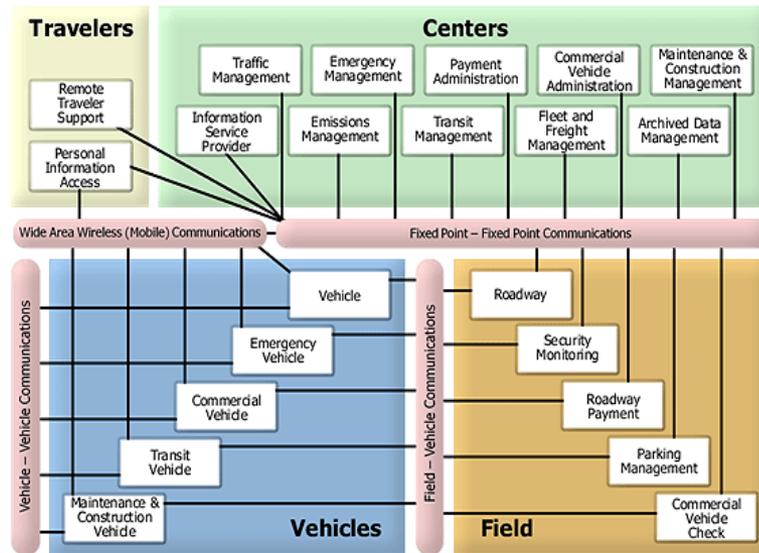


Image Source: USDOT

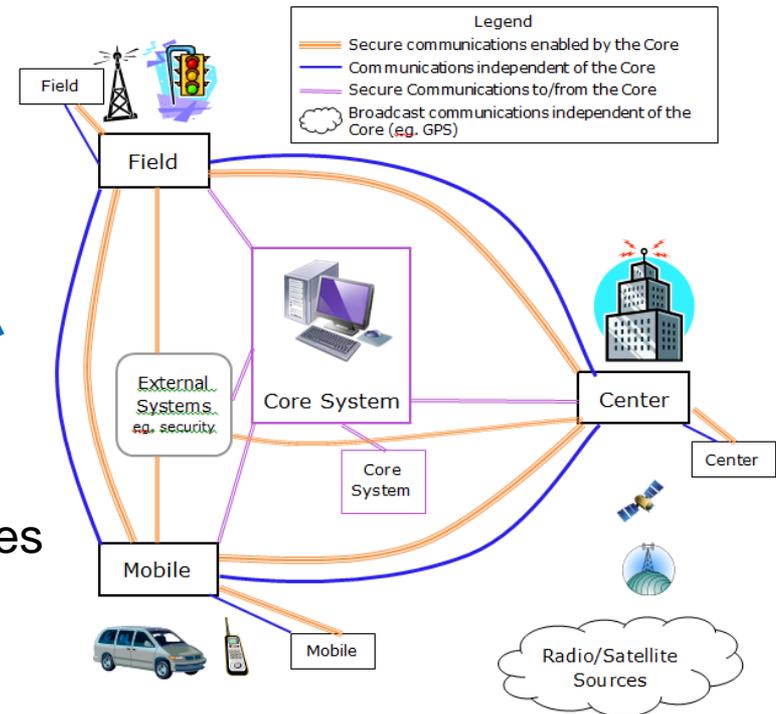


Image Source: USDOT

- Broadcast and Peer-to-Peer data exchanges
- Enable Big Data
- Multiple wireless communication media

# Connected Vehicle Reference Implementation Architecture (CVRIA)

- **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
- [www.iteris.com/cvria](http://www.iteris.com/cvria)

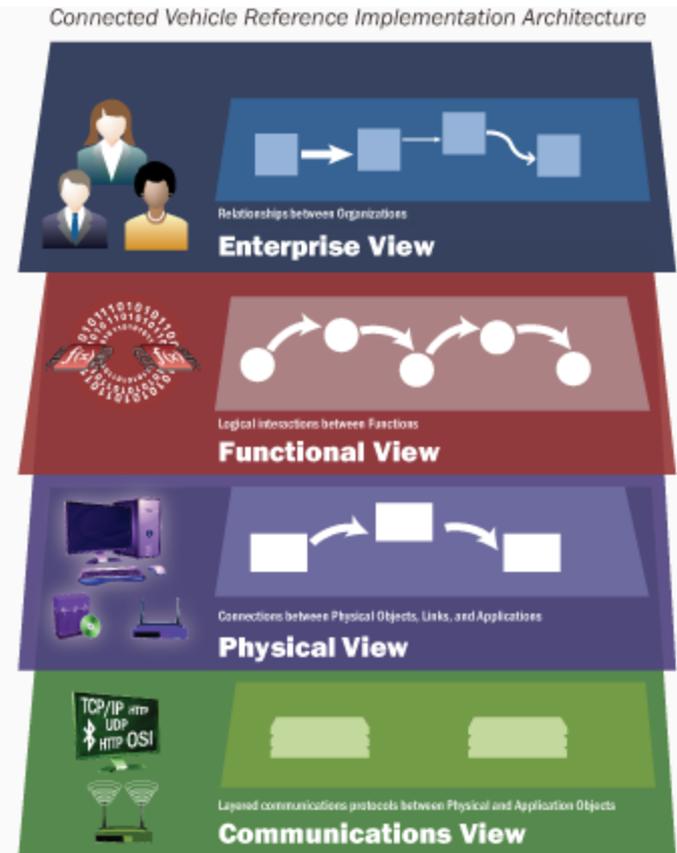
**Latest News**  
[CVRIA Workshop in San Francisco](#)  
February 19-20, 2014

In continuation of CVRIA efforts, USDOT will present and seek input on candidate Connected Vehicle interfaces for standardization at a free public workshop in San Francisco, California on February 19-20, 2014. [Read more...](#)

**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.



# Southeast Michigan Connected Vehicle 2014 Project Architecture

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Complete Architecture shown in a set of views

- Physical view [**THINGS**] – overviews and specifics of objects and the information that flows between them, hierarchically arranged to show varying levels of detail.
- Enterprise view [**PEOPLE**] – includes installation, operations, maintenance and certification diagrams for each physical diagram
- Communication views [**INFORMATION**] – one for each information flow



# Project Architecture Scope

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- An Implementation, not THE Implementation
- Finite, well-defined scope that is part of the implementation process

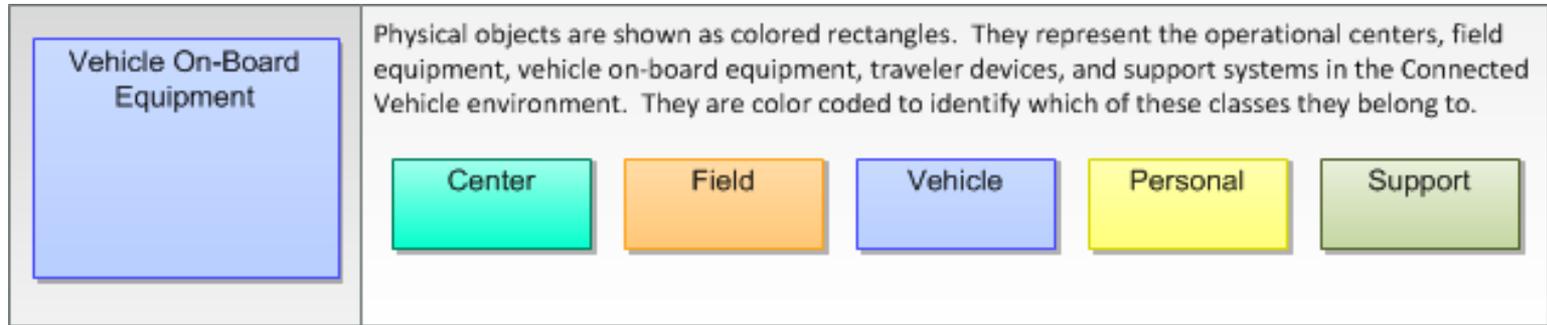


# Southeast Michigan Project Architecture

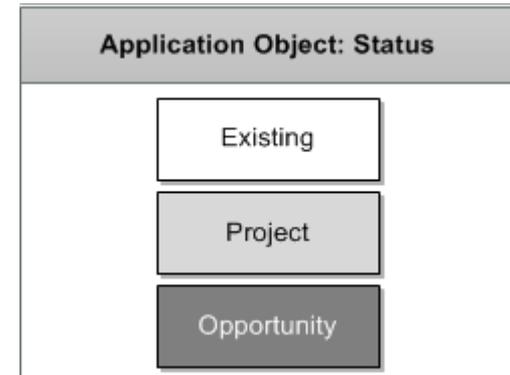
- Physical View
  - Layer 0: The physical objects that participate, the interconnects between them
  - Layer 1: The project-specific functions performed by each physical object, and the data exchanged between them
  - Layer 2: Application-specific; shows only those objects that are part of the application, with more detail on the flow of data
- Enterprise View
  - Layer 0: The people and agencies that own and operate physical objects
  - Layer 1: The people and agencies that own and operate physical objects and application objects
- Communications View
  - For each information flow in the Physical View, the layered communications protocols necessary to implement the information flow



# Physical View Architecture Constructs: Objects

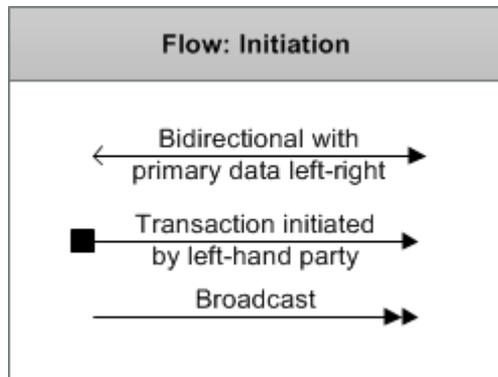


Application objects are also categorized according to their implementation within the project.

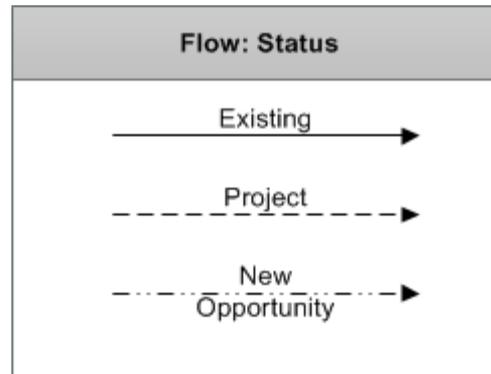


# Physical View Architecture Constructs: Flows

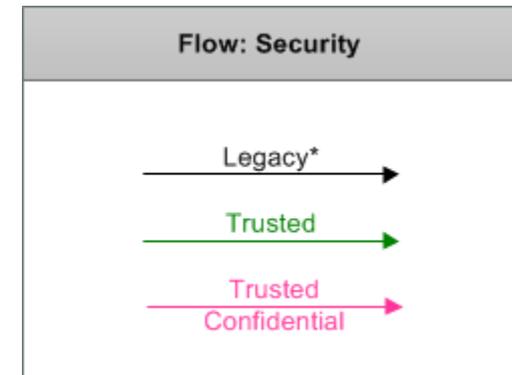
- Which device initiates the flow?
- What is the communication pattern?



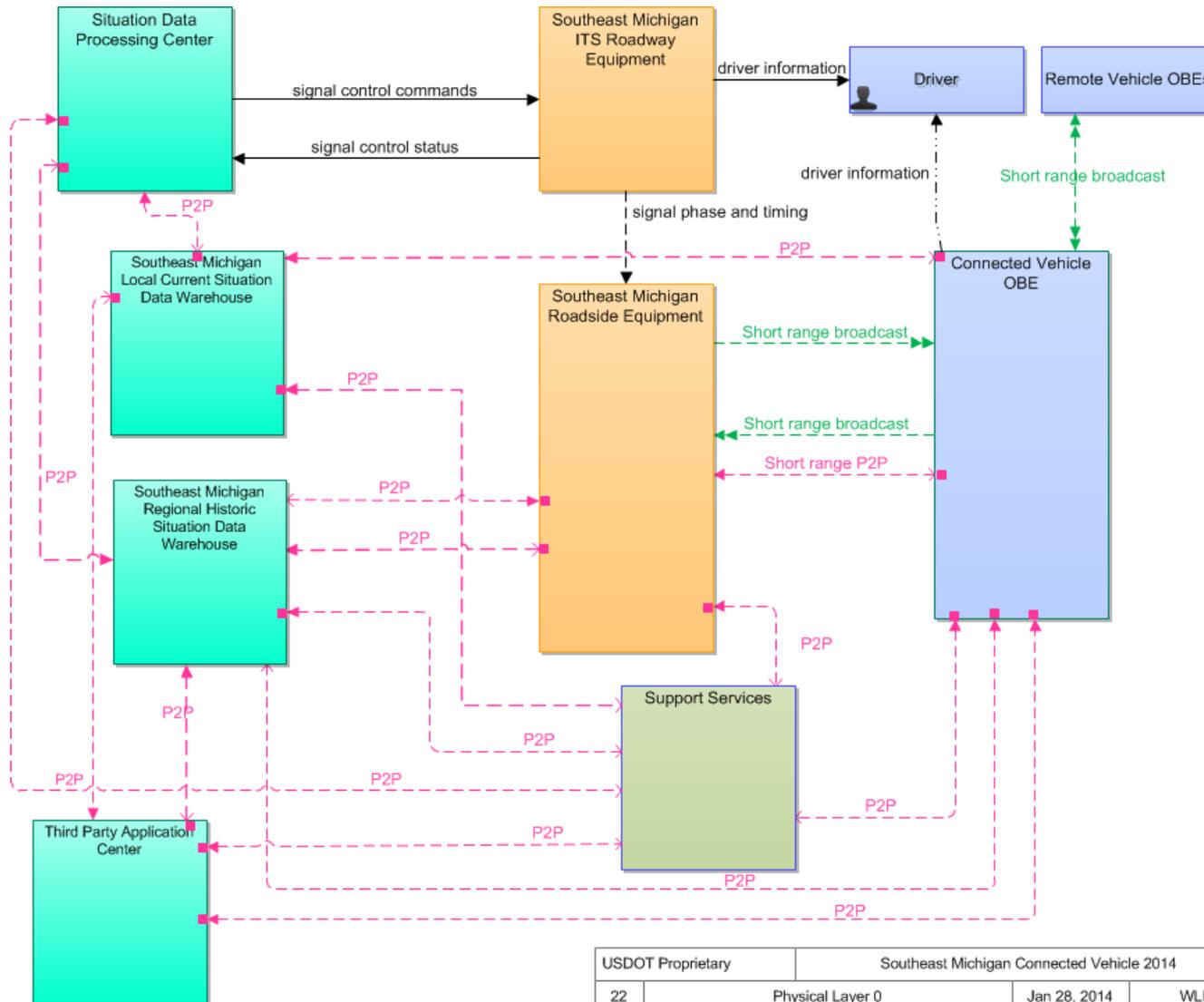
- Does the flow exist?



- What type of security does the flow require?

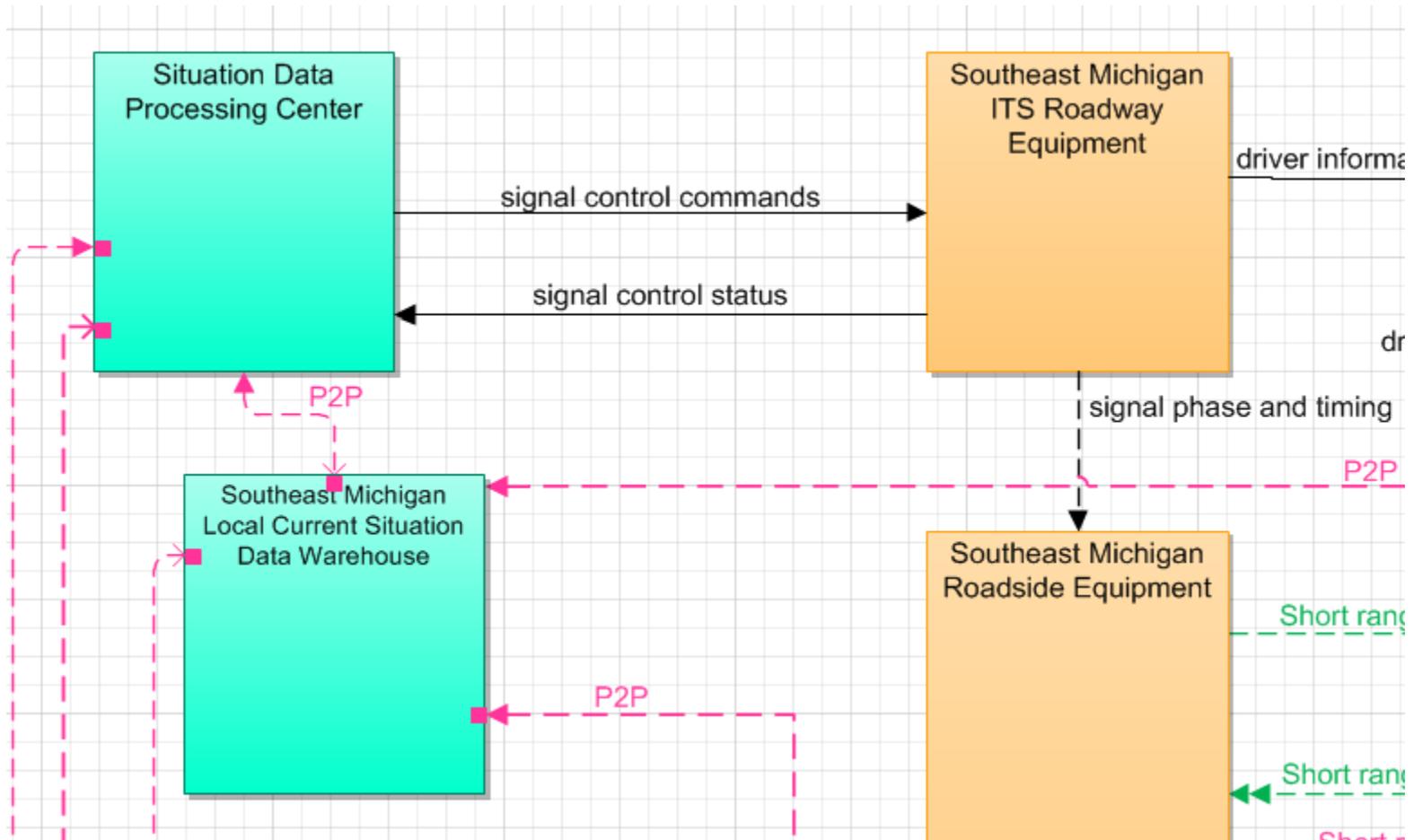


# Physical View – Southeast Michigan 2014 Layer 0

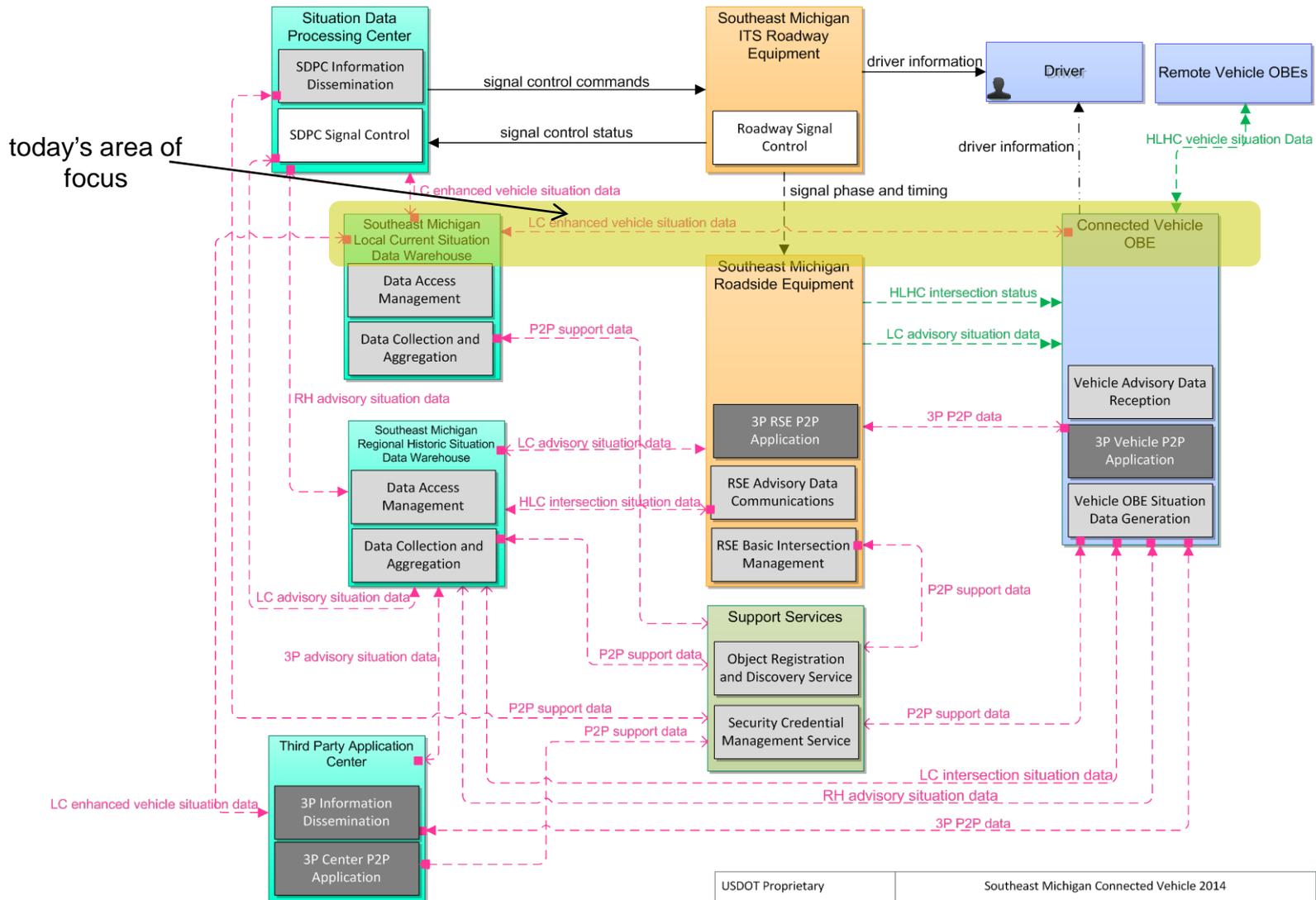


USDOT Proprietary		Southeast Michigan Connected Vehicle 2014	
22	Physical Layer 0	Jan 28, 2014	WLF

# Physical View Layer 0 Example



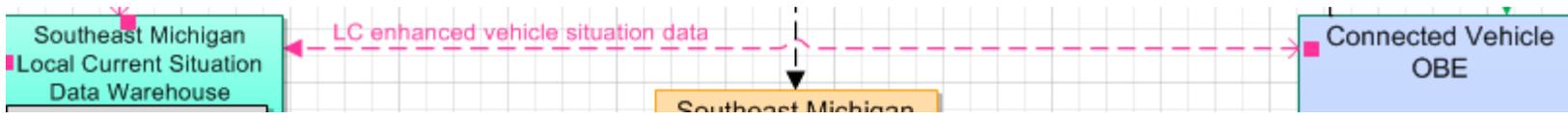
# Physical View – Southeast Michigan 2014 Layer 1



USDOT Proprietary		Southeast Michigan Connected Vehicle 2014	
19	Physical Layer 1 - Comprehensive	Jan 28, 2014	WLF



# Physical View – LC Enhanced Situation Data



From this snippet we can see that the LC enhanced vehicle situation data flow has the following characteristics:

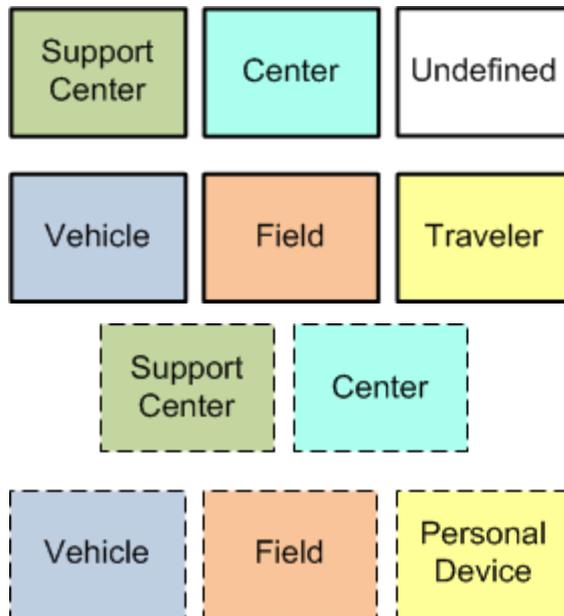
- The Connected Vehicle OBE initiates this data exchange
- This flow is encrypted and signed
- This flow is part of the testbed development

# Communications View – LC Enhanced Situation Data

Vehicle-Center (RSE)				
LC Enhanced Vehicle Situation Data ->				
Southeast Michigan Connected Vehicle OBE Vehicle OBE Situation Data Generation		Roadside Equipment		Southeast Michigan Local Current Situation Data Warehouse Data Collection and Aggregation
SAE J2735 (2009) – Sequence Design				SAE J2735 (2009) – Sequence Design
ASN.1 BER				ASN.1 BER
(session layer unused)				(session layer unused)
UDP				UDP
IPv6		IPv6	IPv6	IPv6
1609.3, 802.2, 802.11p		1609.3, 802.2, 802.11p	IEEE 802.2	IEEE 802.2
5.9 Ghz wireless (802.11p) / 1609.4		5.9 GHz wireless (802.11p), 1609.4	Backhaul PHY <sup>2</sup>	Backhaul PHY <sup>2</sup>
		IEEE 1609.2	IEEE 1609.2	

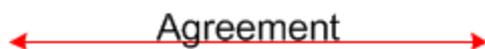
2: An Internet connection or private network connection that is routable between the RSE and the Southeast Michigan Local Current Situation Data Warehouse

# Enterprise View Architecture Constructs



Enterprise objects (people, organizations) are shown as boxes with thick black borders, color coded by their relationship to the transportation environment

Physical objects are color coded the same as in physical view diagrams, but shown as rectangles with dashed lines.



Formal coordination between people and/or organizations, documented in some contract or other form of written agreement that both parties acknowledge.



Information coordination between people and/or organizations, usually undocumented.



Relationship between people and/or organizations (e.g., member of) or between people/organizations and physical objects (owns, operates, maintains, installs, certifies etc.)

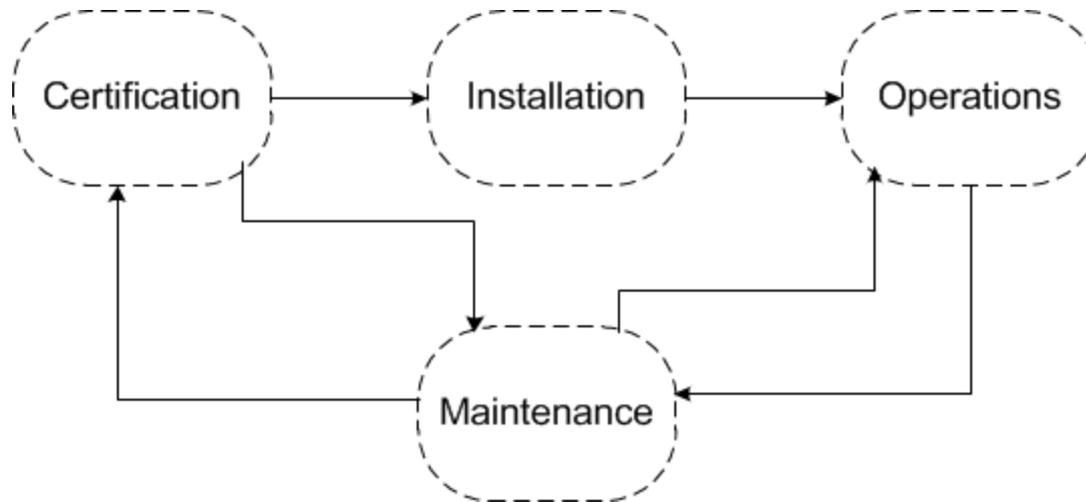


Relationship between physical objects that is relevant to people and/or organizations: includes, extends



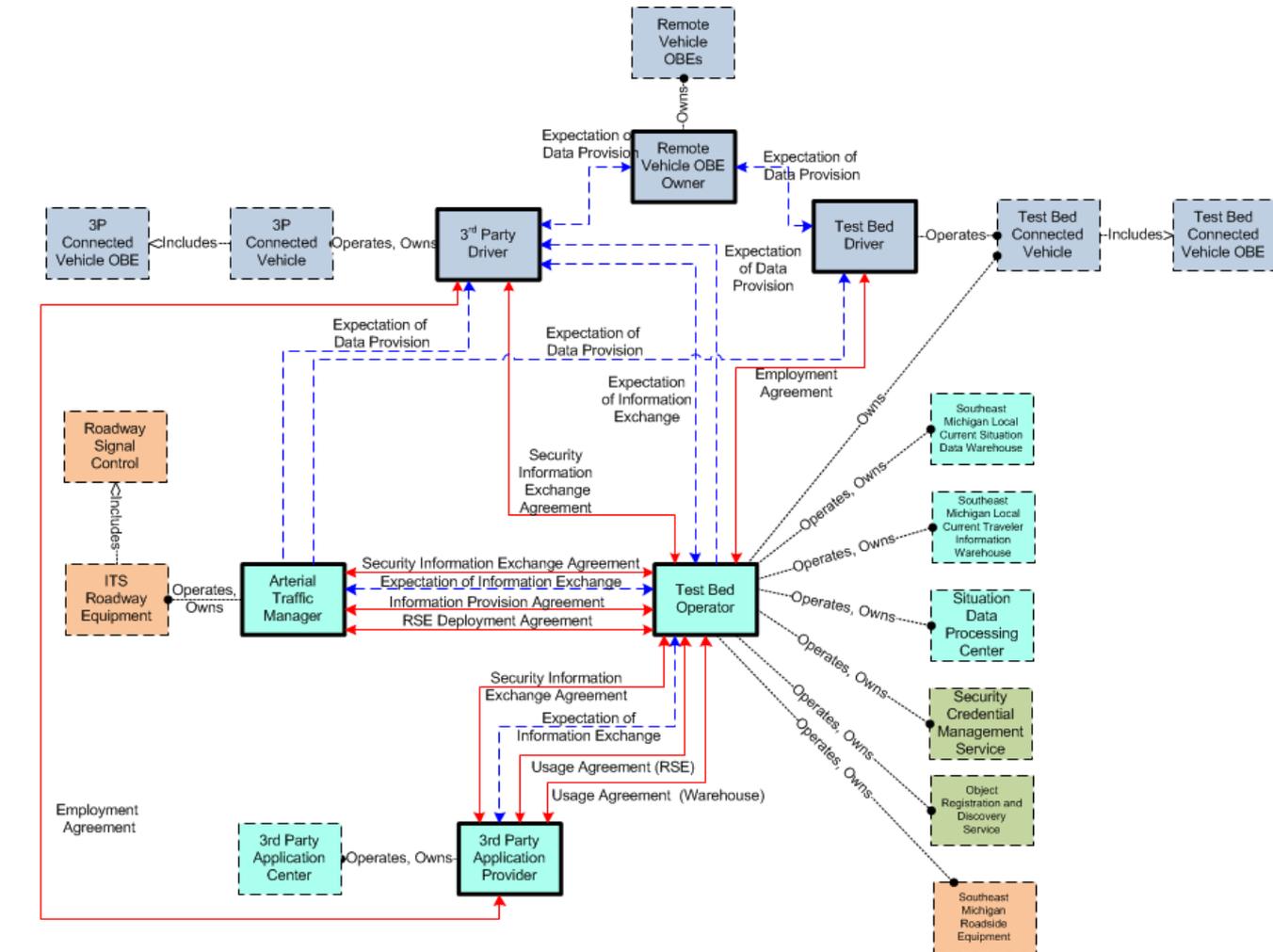
# Enterprise View – Life Cycle

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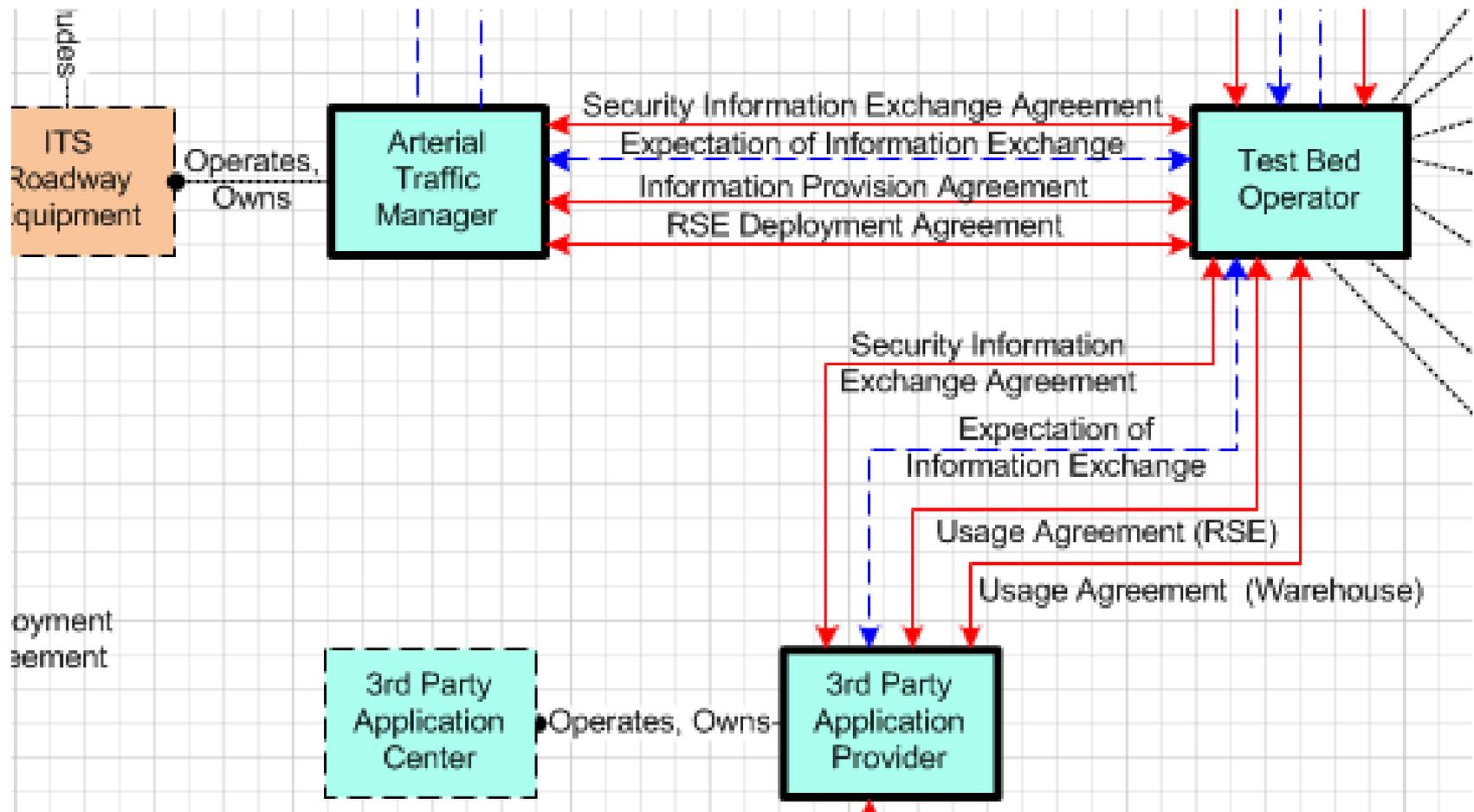
- Certification Phase: application and device approval, adherence to standards
- Installation Phase: deployment of applications and devices
- Operations Phase: operation of applications to provide benefits to end users
- Maintenance Phase: maintenance of applications and devices, and feedback of performance

# Enterprise View – Southeast Michigan 2014



Southeast Michigan Connected Vehicle 2014			
7	Layer 0 Enterprise	Jan 24, 2014	JLM

# Enterprise View Layer 0 Example



# Project Architecture Tool Support

- All Southeast Michigan project architecture diagrams were drawn using the CVRIA Mini-Tool
- Short-term use method for drawing CVRIA-like diagrams, using the viewpoint specifications defined in the CVRIA
- Enables a common language
- Enables information exchange and re-use
- Provides a rich backdrop of work that has already been done to define the 85+ applications USDOT has already considered in some fashion



# Contact Information

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- Tom Lusco
- [ctl@iteris.com](mailto:ctl@iteris.com)
- Project Architecture CVRIA Mini-Tool:  
<http://www.iteris.com/cvria/html/resources/tools.html>
- CVRIA: <http://www.iteris.com/cvria>

