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# **Unified Implementation of the Connected Vehicle Reference Implementation Architecture**

# Other Engineering Disciplines Have Graphical Tools

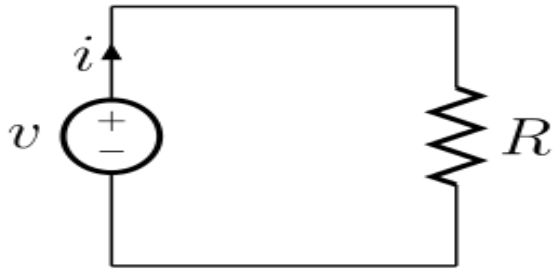


Image Source: Wikipedia

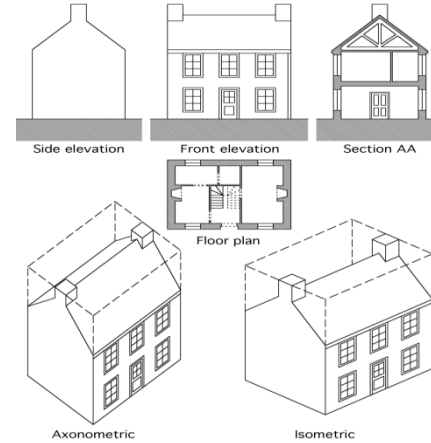


Image Source: Wikipedia

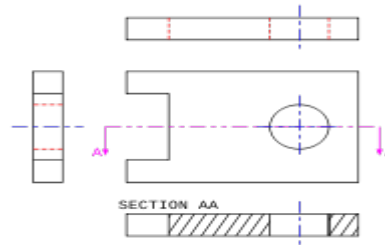


Image Source: Wikipedia

# ITS National Architecture

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

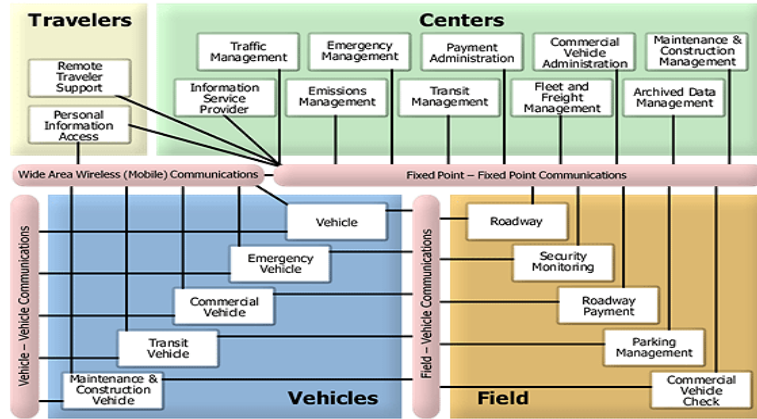


Image Source: USDOT

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

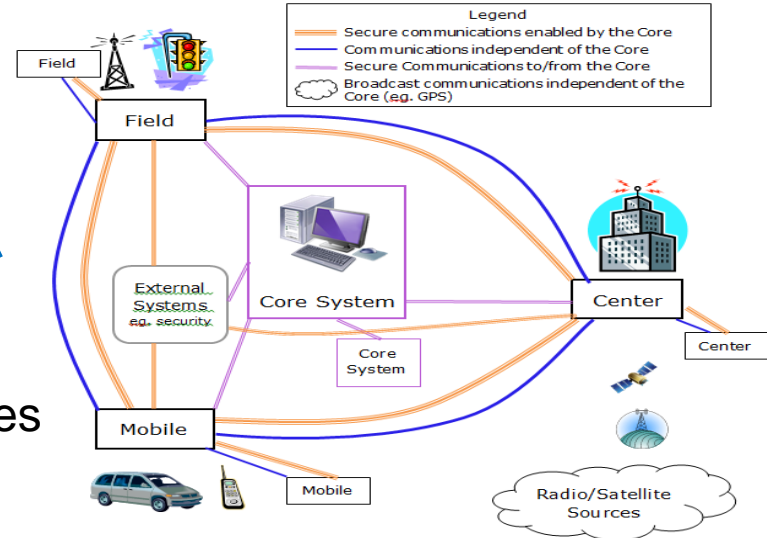


Image Source: USDOT

# 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 - layers

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- **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

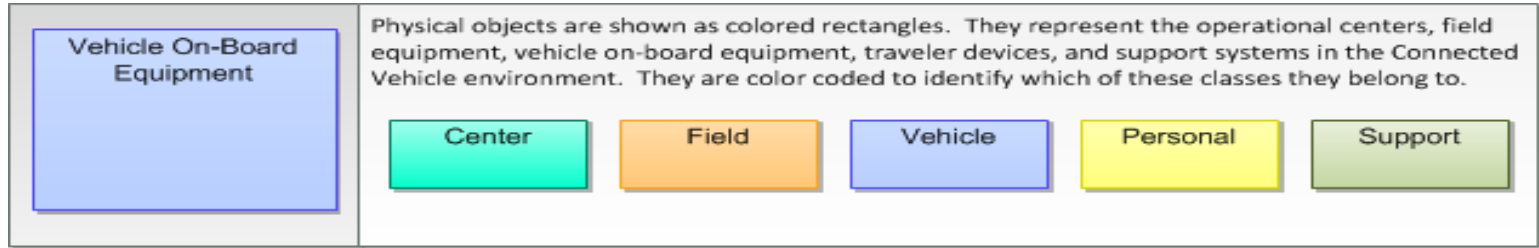
- **Enterprise View**

- 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

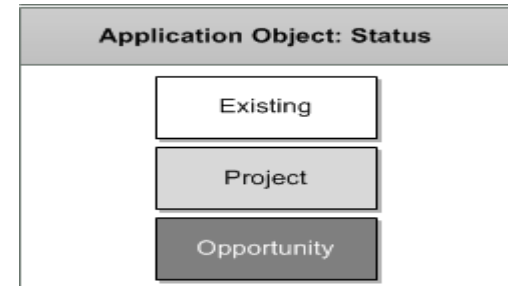
- **Communications View**

- For each information flow in the Physical View, the layered communications protocols necessary to implement the information flow

# Physical View Architecture Constructs: Objects

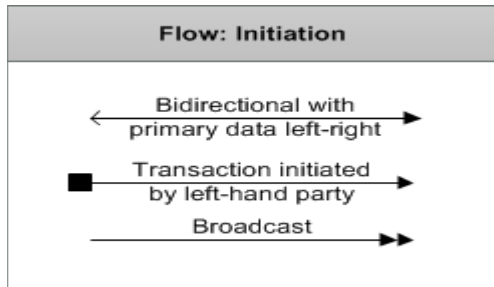


Application objects are also categorized according their implementation within the project.

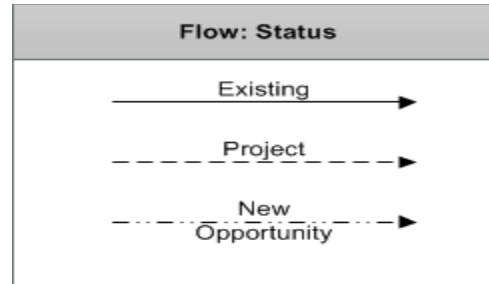


# Physical View Architecture Constructs: Flows

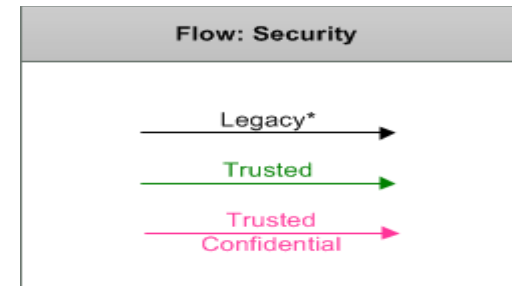
- Which device initiates the flow?
- What is the communication pattern?



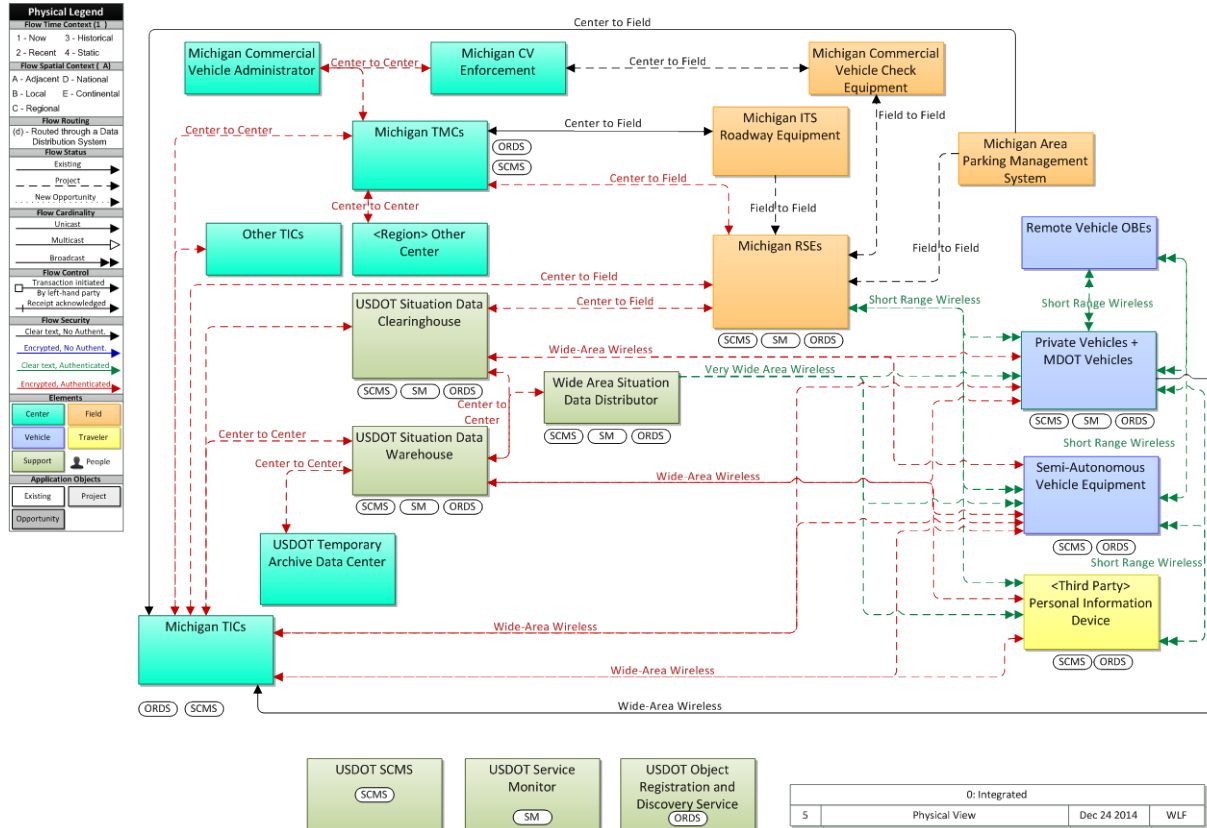
- Does the flow exist?



- What type of communication security does the flow require?

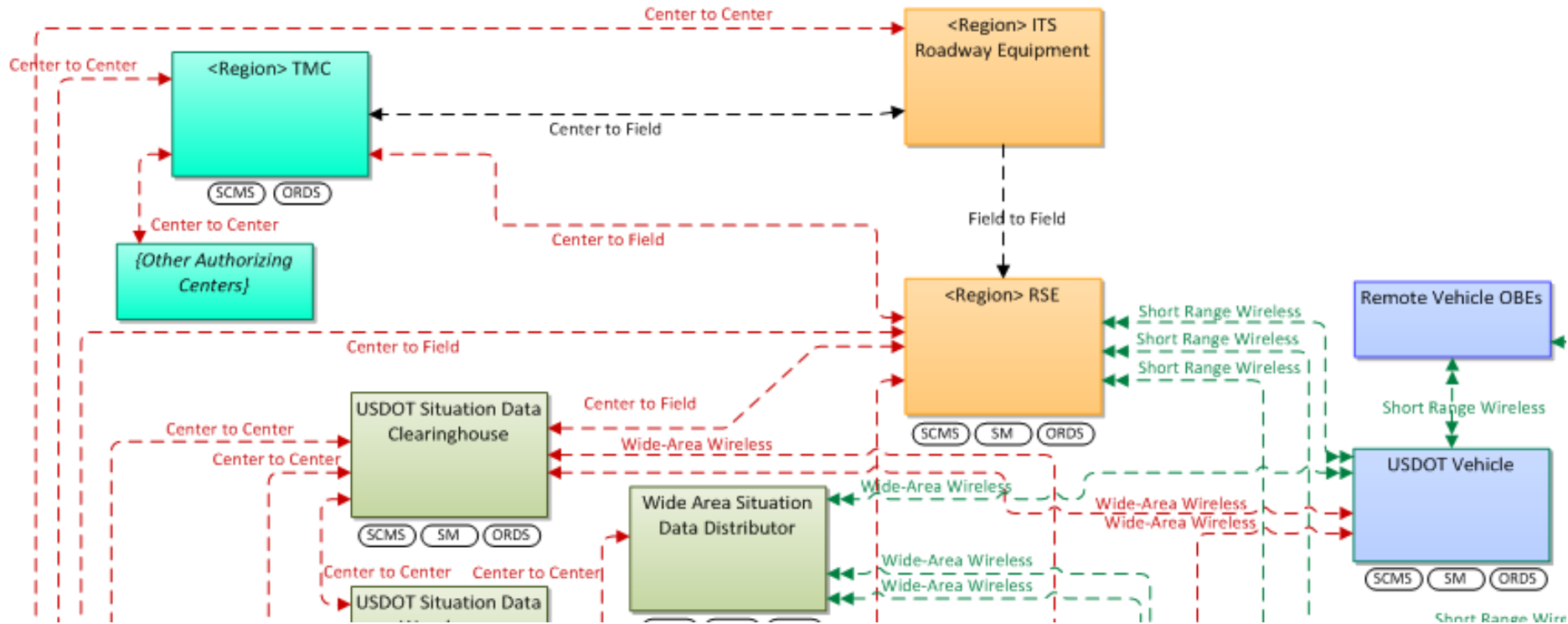


# Physical View – Unified Implementation Layer 0

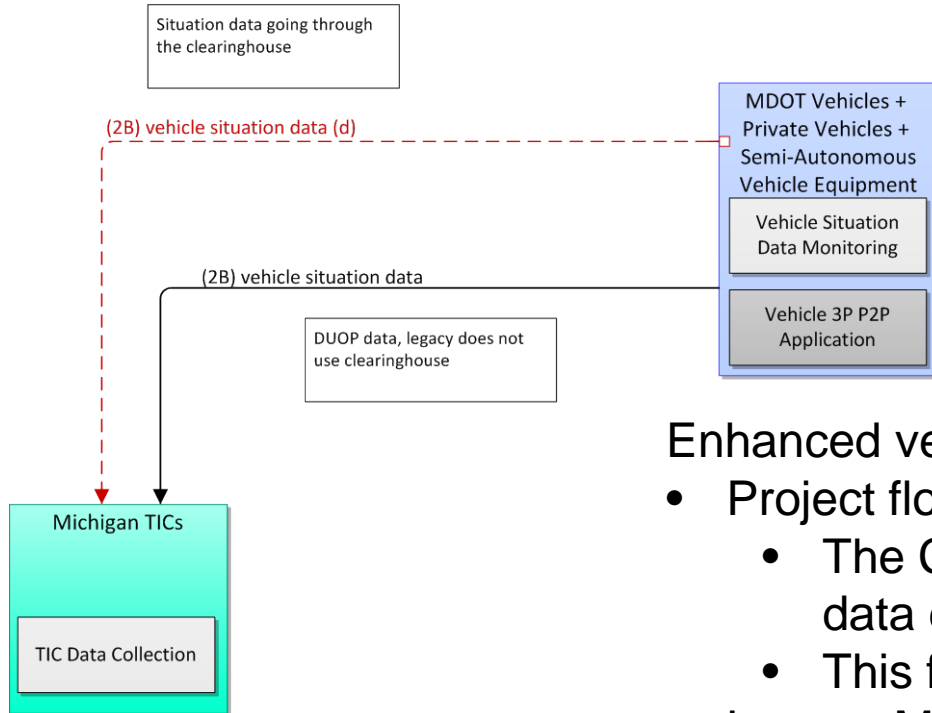




# Physical View Layer 0 Example



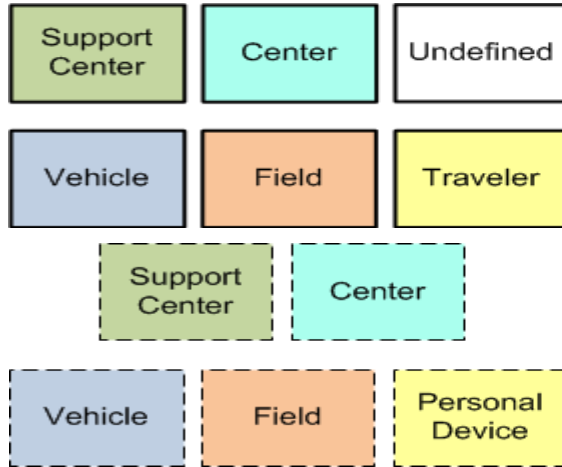
# Physical View – Vehicle Situation Data



Enhanced vehicle situation data flow has two forms

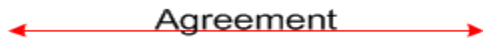
- Project flow
  - The Connected Vehicle OBE initiates this data exchange
  - This flow is encrypted and signed
- Legacy MDOT DUAP project flow

# Enterprise View Architecture Constructs

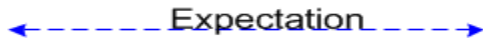


Enterprise objects (people, organizations) are shown as boxes with thick black borders, color coded by their relationship to the transportation environment

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.



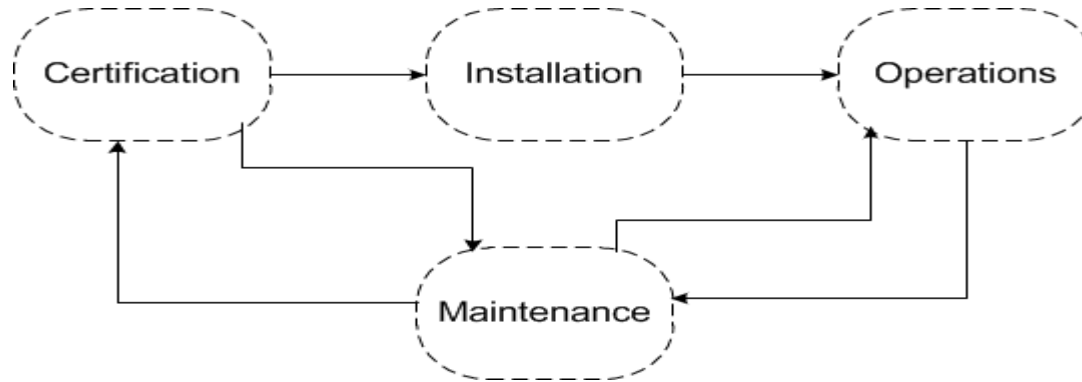
Relationship between people and/or organizations (e.g., member of) or between people/organizations and physical objects (owns, operates, maintains, installs, certifies etc.)



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

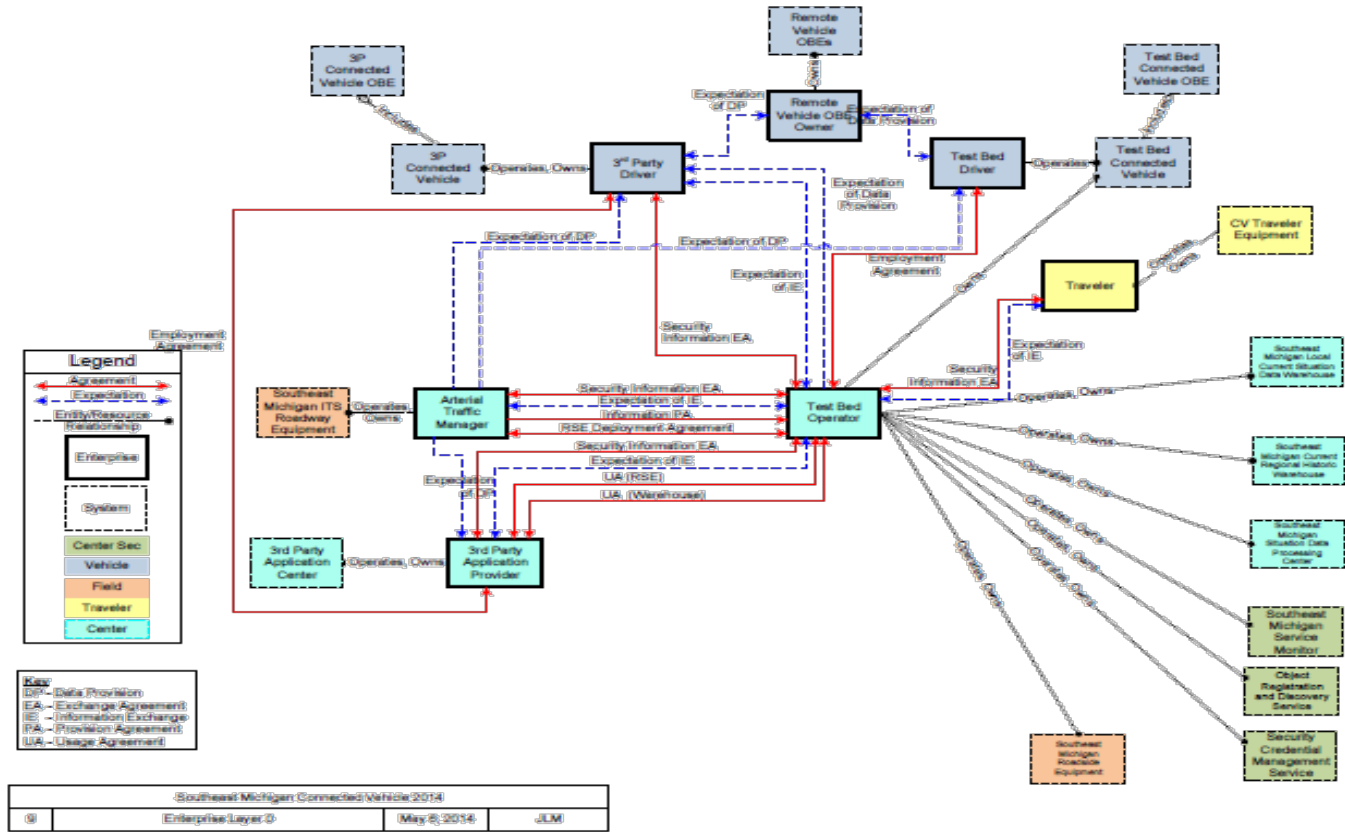
# Enterprise View – Life Cycle

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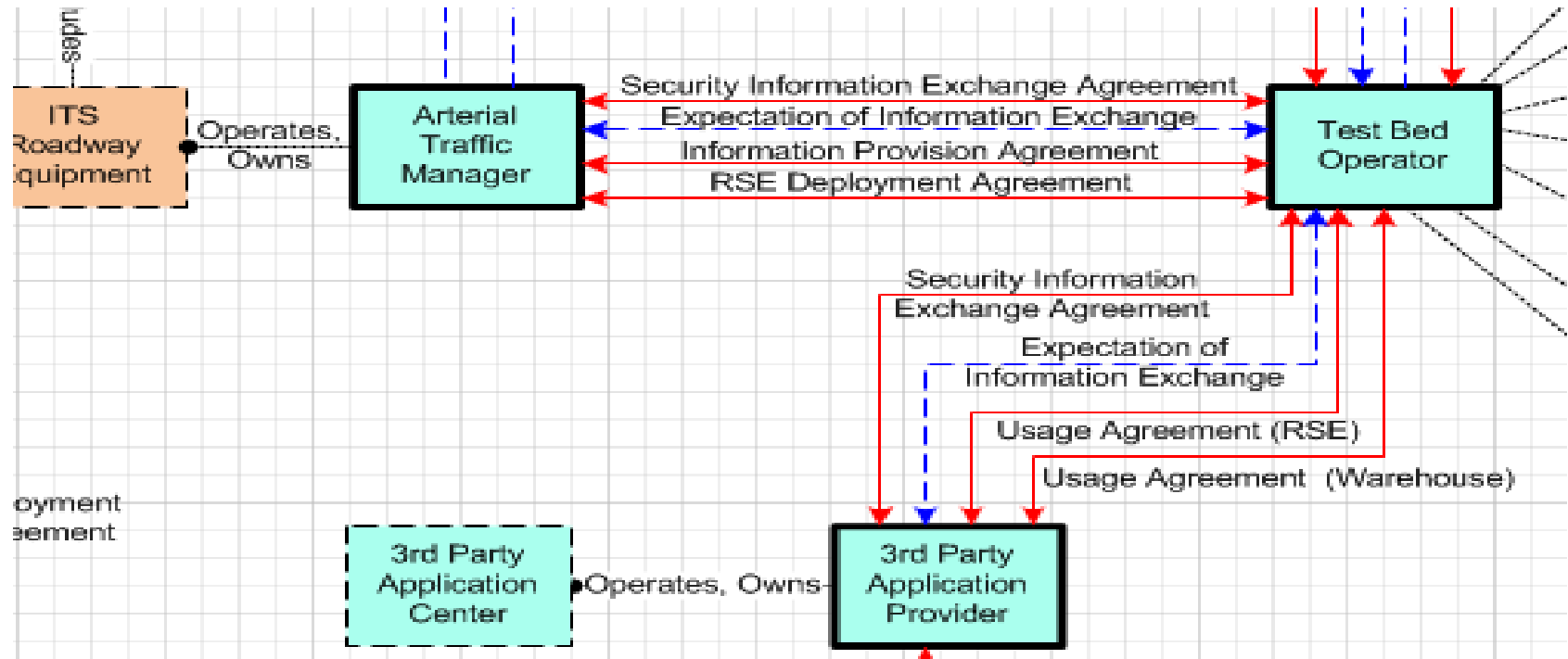


- Certification Phase: application and device approval, adherence to standards
- Installation Phase: deployment of applications and devices
- Operations Phase: operation of applications to provide benefits to end users
- Maintenance Phase: maintenance of applications and devices, and feedback of performance

# Enterprise View – Unified Implementation



# Enterprise View Layer 0 Example



# Communications View – Vehicle 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	IEEE 1609.2			UDP
IPv6		IPv6	IPv6	IPv6
1609.3, 802.2, 802.11p		1609.3, 802.2, 802.11p		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	

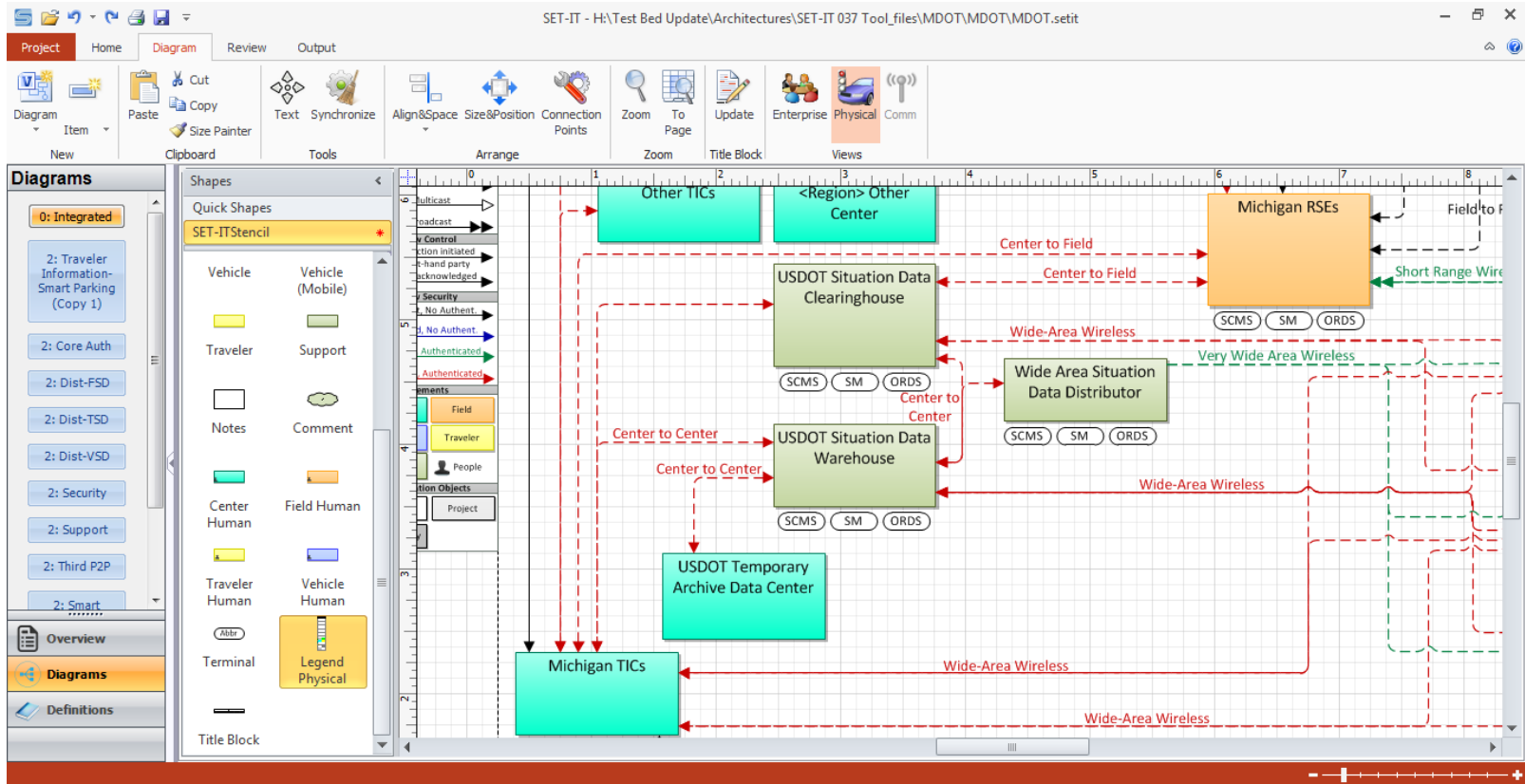
2: An Internet connection or private network connection that is routable between the RSE and the Southeast Michigan Local Current Situation Data Warehouse

# Project Architecture Tool Support

- All Southeast Michigan project architecture diagrams were drawn using the SET-IT
- 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



# Architecture Tool - example



# Contact Information

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- Project Architecture SET-IT Tool:  
<http://www.iteris.com/cvria/html/resources/tools.html>
- CVRIA: <http://www.iteris.com/cvria>

