Unified Implementation of the Connected Vehicle Reference Implementation Architecture

Other Engineering Disciplines Have Graphical Tools
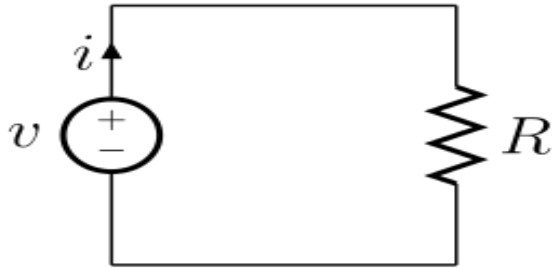

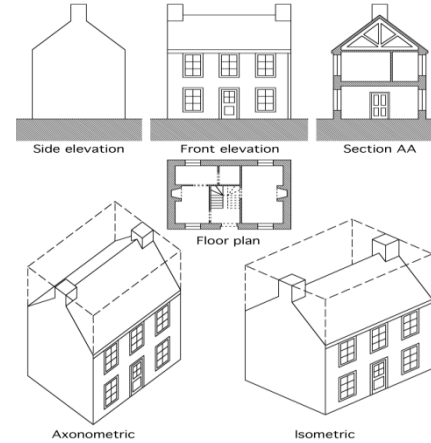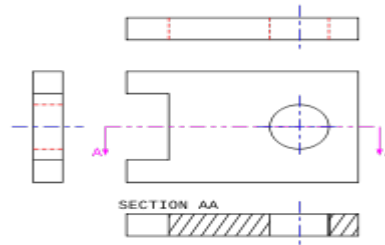Image Source: Wikipedia

Image Source: Wikipedia

Image Source: Wikipedia

ITS National Architecture

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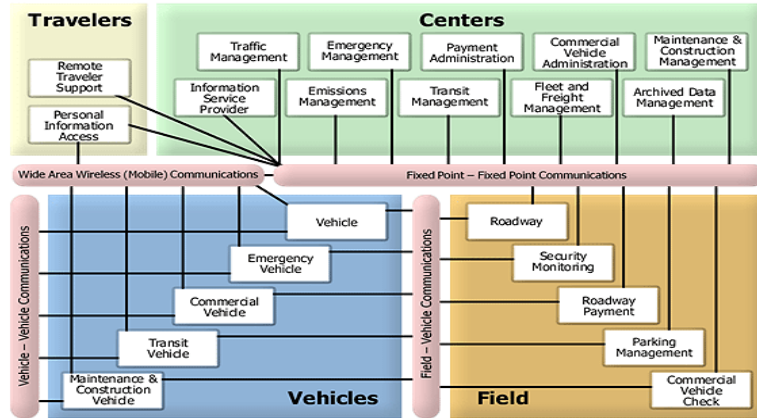

Image Source: USDOT
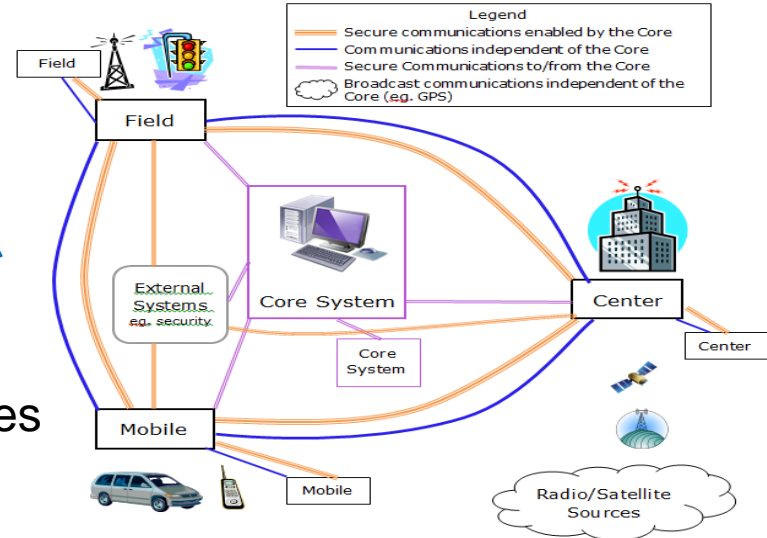

Image Source: USDOT

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

U.S. Department of Transportation　3

Southeast Michigan Connected Vehicle 2014 Project Architecture

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 <u>certification</u> diagrams for each physical diagram

- □ Communication views **[*INFORMATION*]** – one for each information flow

Unified 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
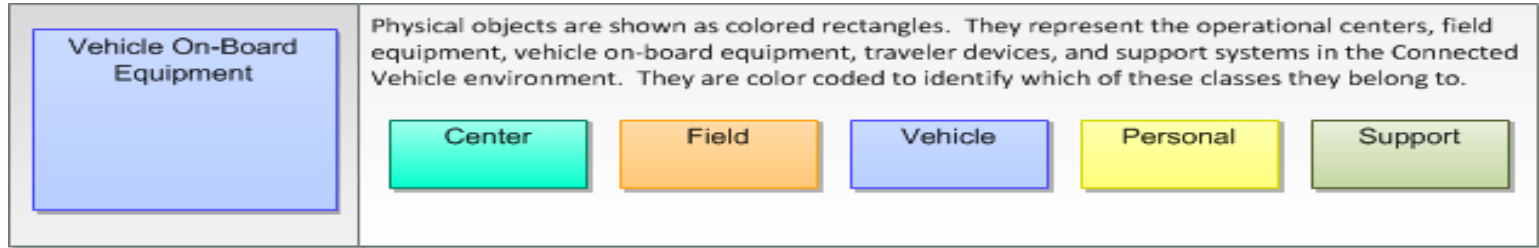- **Enterprise View**
  - Layer 0: The people and agencies that own and operate physical objects
  - Layer 1: The people and agencies that own and operate physical objects and application objects
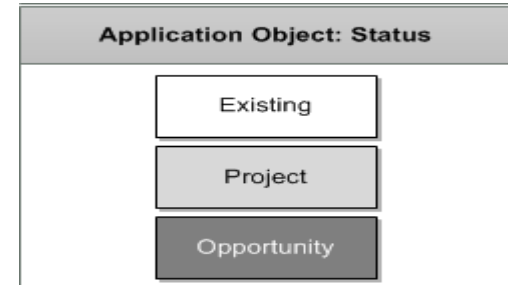- **Communications View**
  - For each information flow in the Physical View, the layered communications protocols necessary to implement the information flow
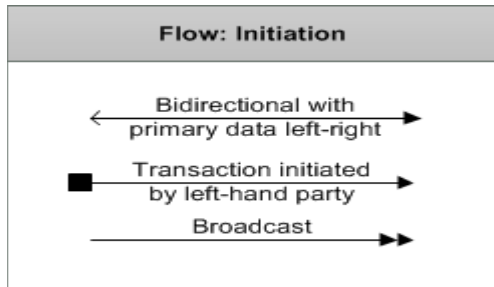
Physical View Architecture Constructs: Objects

Vehicle On-Board Equipment	Physical objects are shown as colored rectangles. They represent the operational centers, field equipment, vehicle on-board equipment, traveler devices, and support systems in the Connected Vehicle environment. They are color coded to identify which of these classes they belong to.
	Center · Field · Vehicle · Personal · Support

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

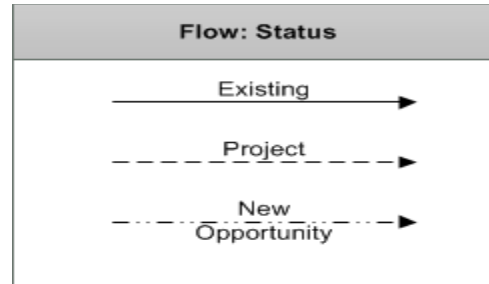**Application Object: Status**

- Existing
- Project
- Opportunity

Physical View Architecture Constructs: Flows

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

Flow: Initiation

Bidirectional with primary data left-right

Transaction initiated by left-hand party

Broadcast

- Does the flow exist?

Flow: Status

Existing

Project

New Opportunity

- What type of communication security does the flow require?

Flow: Security

Legacy*

Trusted

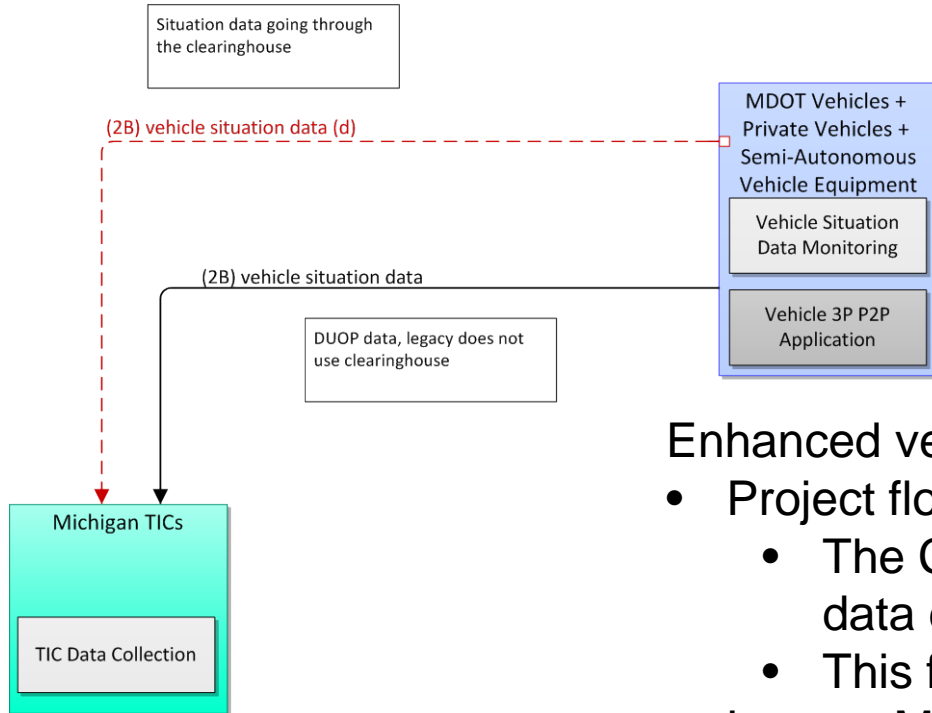Trusted Confidential
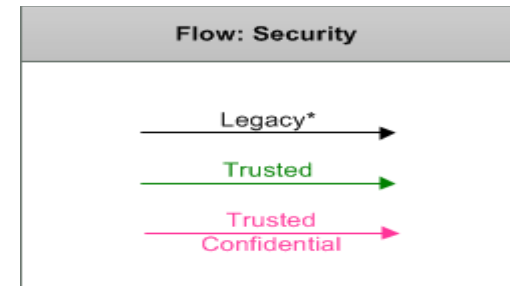
Physical View – Unified Implementation Layer 0
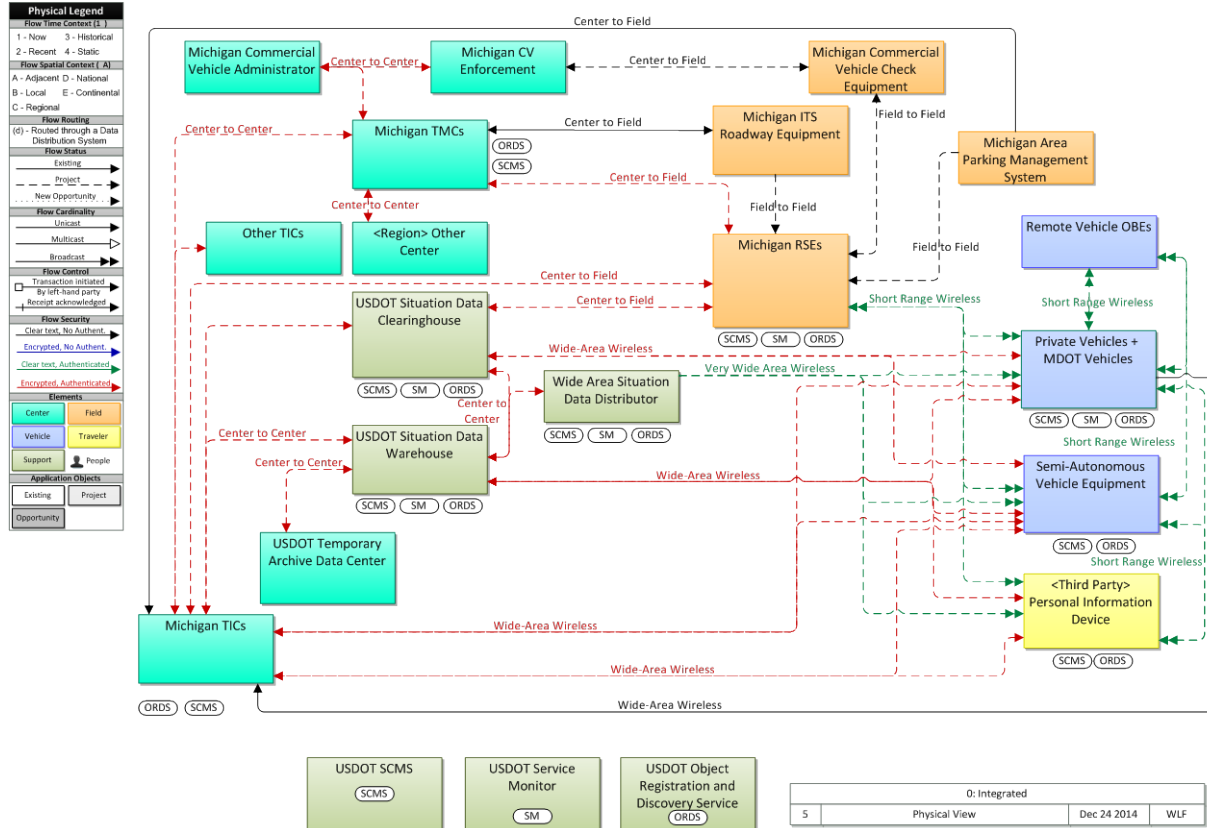
Physical View Layer 0 Example
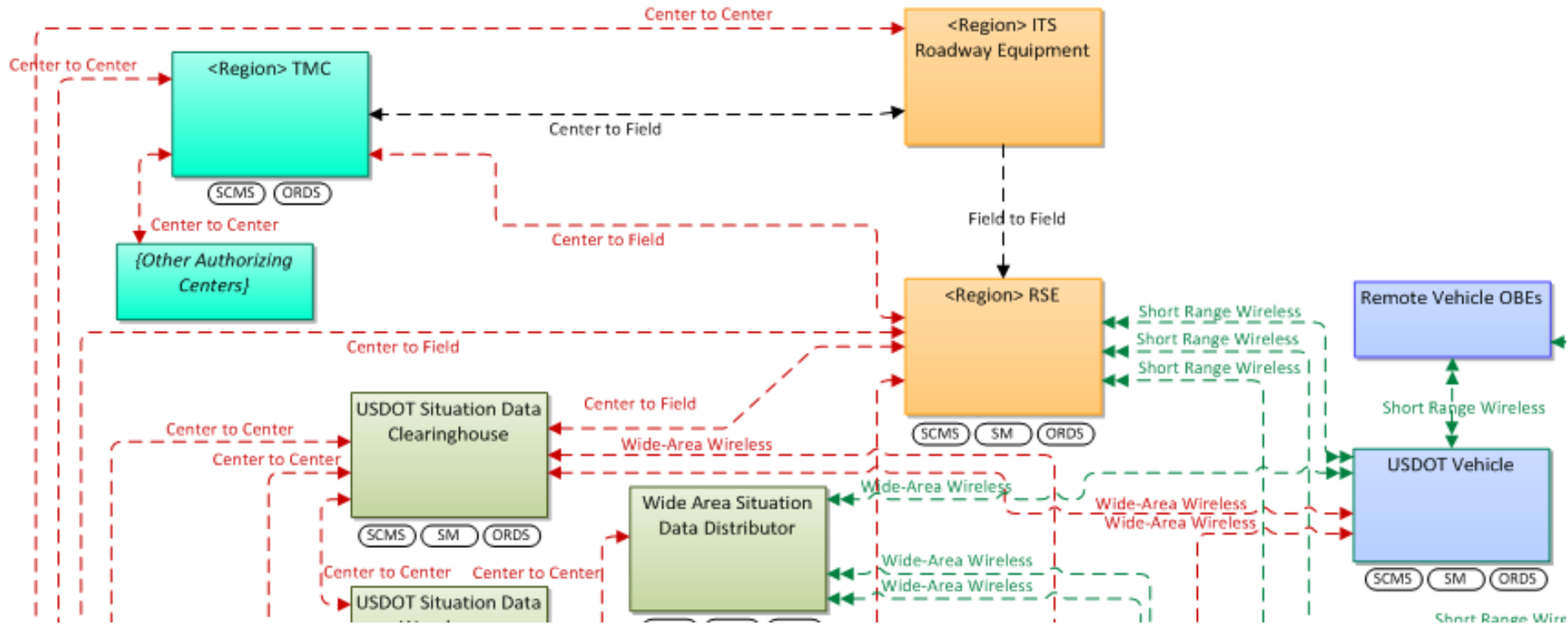
Physical View – Vehicle Situation Data

Situation data going through the clearinghouse

(2B) vehicle situation data (d)

(2B) vehicle situation data

DUOP data, legacy does not use clearinghouse

MDOT Vehicles + Private Vehicles + Semi-Autonomous Vehicle Equipment

Vehicle Situation Data Monitoring

Vehicle 3P P2P Application

Michigan TICs

TIC Data Collection

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

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				IEEE 1609.2	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[2]		Backhaul PHY[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

Support Center	Center	Undefined

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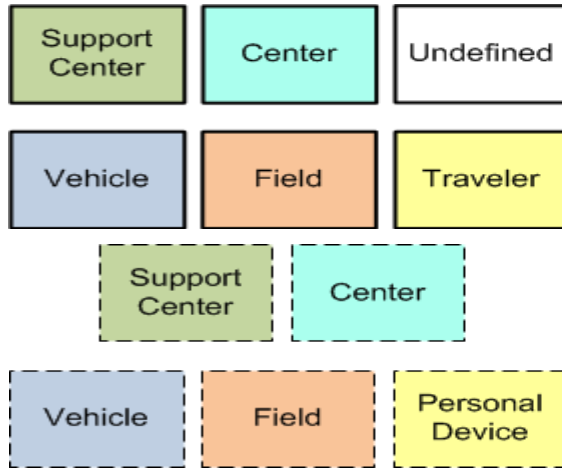
Enterprise objects (people, organizations) are shown as boxes with thick black borders, color coded by their relationship to the transportation environment

Support Center	Center

Vehicle	Field	Personal Device

Physical objects are color coded the same as in physical view diagrams, but shown as rectangles with dashed lines.
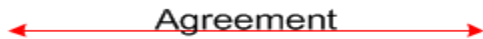
← Agreement →
Formal coordination between people and/or organizations, documented in some contract or other form of written agreement that both parties acknowledge.
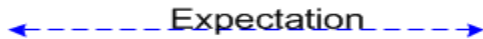
← - - Expectation - - →
Information coordination between people and/or organizations, usually undocumented.

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

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

Enterprise View – Life Cycle
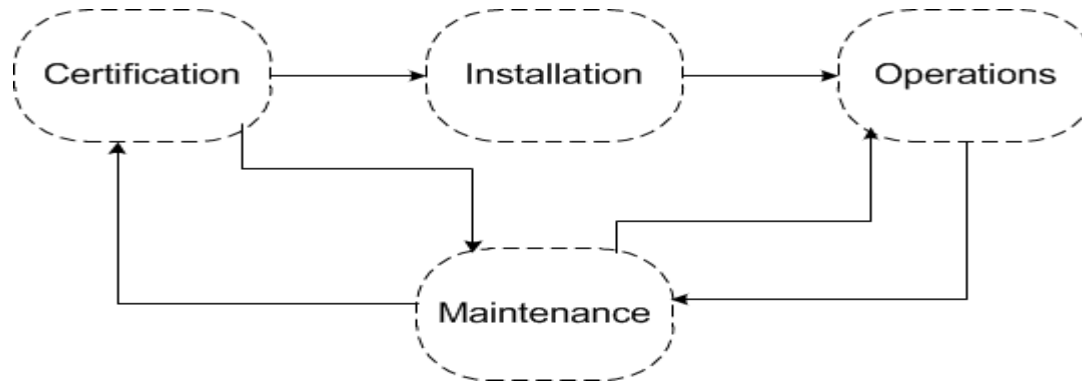
- Certification Phase: application and device approval, adherence to standards

- 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

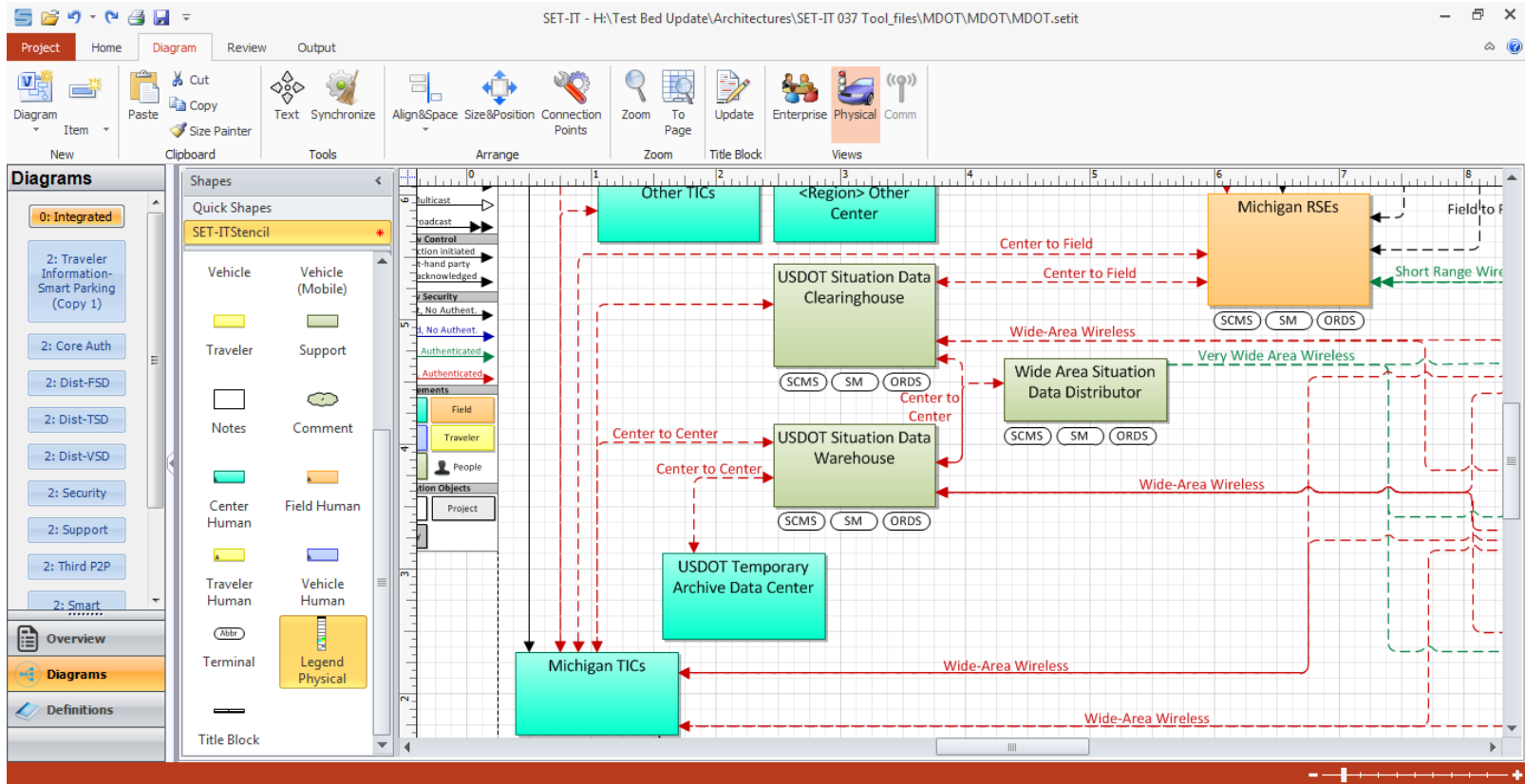# Enterprise View – Unified Implementation
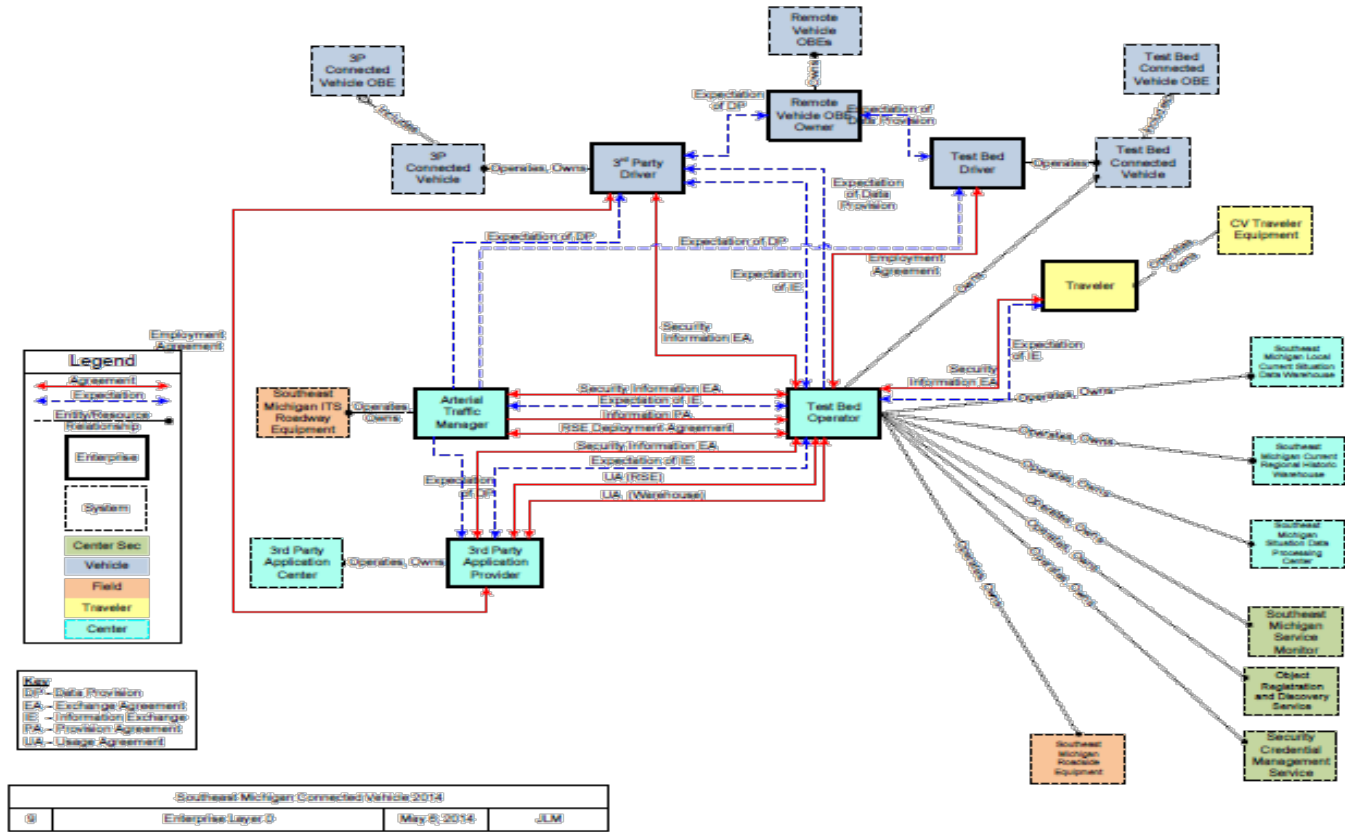
Enterprise View Layer 0 Example
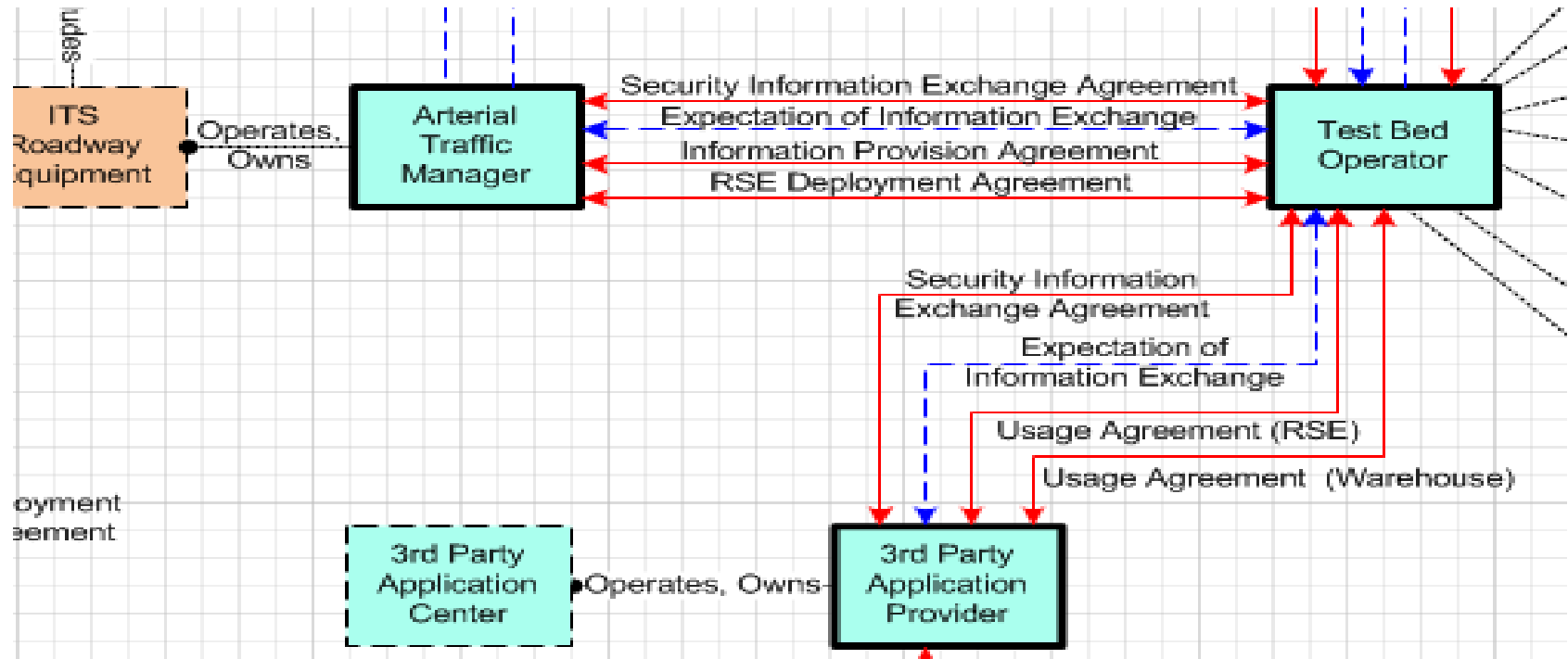
Project Architecture Tool Support

- 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

Contact Information

- Tom Lusco ctl@iteris.com
- Project Architecture SET-IT Tool: http://www.iteris.com/cvria/html/resources/tools.html
- CVRIA: http://www.iteris.com/cvria