Unified Implementation of the Connected Vehicle Reference Implementation Architecture
Other Engineering Disciplines Have Graphical Tools


ITS National Architecture


- Broadcast and Peer-to-Peer data exchanges
- Enable Big Data
- Multiple wireless communication media
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 certification diagrams for each physical diagram
- Communication views [INFORMATION] – one for each information flow
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
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 communication security does the flow require?

**Flow: Initiation**
- Bidirectional with primary data left-right
- Transaction initiated by left-hand party
- Broadcast

**Flow: Status**
- Existing
- Project
- New Opportunity

**Flow: Security**
- Legacy*
- Trusted
- Trusted Confidential
Physical View Layer 0 Example
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 USDOT development
# Communications View – Vehicle Situation Data

<table>
<thead>
<tr>
<th>Vehicle-Center (RSE)</th>
<th>LC Enhanced Vehicle Situation Data -&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Southeast Michigan Connected Vehicle</strong></td>
<td><strong>Roadside Equipment</strong></td>
</tr>
<tr>
<td><strong>OBE</strong></td>
<td><strong>Southeast Michigan Local Current Situation Data Warehouse</strong></td>
</tr>
<tr>
<td>Vehicle OBE Situation Data Generation</td>
<td>Data Collection and Aggregation</td>
</tr>
<tr>
<td>ASN.1 BER</td>
<td>ASN.1 BER</td>
</tr>
<tr>
<td>(session layer unused)</td>
<td>(session layer unused)</td>
</tr>
<tr>
<td>UDP</td>
<td>UDP</td>
</tr>
<tr>
<td>IPv6</td>
<td>IPv6</td>
</tr>
<tr>
<td>1609.3, 802.2, 802.11p</td>
<td>1609.3, 802.2, 802.11p</td>
</tr>
<tr>
<td>5.9 Ghz wireless (802.11p) / 1609.4</td>
<td>IEEE 802.2</td>
</tr>
<tr>
<td>5.9 GHz wireless (802.11p), 1609.4</td>
<td>Backhaul PHY²</td>
</tr>
<tr>
<td>IEEE 1609.2</td>
<td>IEEE 1609.2</td>
</tr>
</tbody>
</table>

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

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[Image of the page]
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.

Agreement

Expectation

Entity/Resource Relationship

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.

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 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.
Architecture Tool
Contact Information

- Tom Lusco
- ctl@iteris.com
- CVRIA: [http://www.iteris.com/cvria](http://www.iteris.com/cvria)