ARC-IT – The Architecture Reference for Cooperative and Intelligent Transportation

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Architecture and US DOT

- USDOT’s ITS Join Program Office (JPO) supports ITS deployment across US Department of Transportation surface modes
  - Strategic goal: Enable efficient, interoperable, secure and cost-effective ITS infrastructure, connected vehicle and automated vehicle deployments across North America.
  - Legislative mandate to (1) maintain an ITS National reference architecture and (2) to cooperate with standards organizations to develop standards in support of ITS deployment.

- Various forms of international cooperation seek to leverage global resources and expertise
  - Maximize commonality of ITS deployments
  - Share labor resources
  - Access best-available expertise in order to facilitate ITS deployment and open markets
National ITS Architecture is a “Living Document”

- Continuing evolution of the architecture over 20 years
ARC-IT Scope

- ARC-IT combines services of National ITS Arch with connected vehicle content of CVRIA
Combined/Merged Architecture

- Continue to support regional planning and project implementation

Monitoring & Evaluation

Operations & Maintenance

Transportation Planning

Funded Projects

Implemented Projects

Project Development
ARC-IT Structure and Organization
Correspondence between Views

Correspondence rules define how artifacts in one viewpoint are related to artifacts in another.
Physical View - Interconnect Diagram
Service Package Example – Transit Signal Priority

- Defining characteristics
- Security requirements
- Data and communications protocols

<table>
<thead>
<tr>
<th>PT09: Transit Signal Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
</tr>
<tr>
<td>Physical</td>
</tr>
<tr>
<td>Oct 14, 2016</td>
</tr>
<tr>
<td>NAT</td>
</tr>
</tbody>
</table>
Flow Characteristics

- For every flow... (> 1700)
  - Description of underlying data
  - Data time context (relevance)
  - Data spatial relevance
  - Communications requirements
    - Initiator
    - Acknowledgement
    - Cardinality
    - Range
    - Latency
# Security Requirements

- Security requirements based on standardized methodology: FIPS-199
- Provides a basis for deployers’ security requirements

## Transit Vehicle OBE --> Connected Vehicle Roadside Equipment: local signal priority request

<table>
<thead>
<tr>
<th>Security</th>
<th>Confidentiality</th>
<th>Integrity</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
<td>Not Applicable</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Basis</td>
<td>This information can be observed.</td>
<td>Only approved vehicles should be allowed to make these requests to the RSE. A corrupted request may lead to a transit vehicle not receiving a green light after requesting it. In this case, this may lead to traffic delays. If an unapproved vehicle is able to forge these requests, they may cause larger scale traffic delays.</td>
<td>If the RSE does not receive any requests, the vehicle may not receive the priority it requested. In the worst case scenario the transit vehicle would be forced to wait at some lights until they turned green. It would be more useful for a device to support this application, and only have some messages received, than to not support this application at all.</td>
</tr>
</tbody>
</table>

## Security Characteristics

<table>
<thead>
<tr>
<th>Security Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authenticable</td>
<td>True</td>
</tr>
<tr>
<td>Encrypt</td>
<td>False</td>
</tr>
</tbody>
</table>
Data and Communications Protocols

• Similar in structure to OSI, ITS-S
• Basis for international harmonization and standards gap identification activities
• Provides a basis for deployers’ interface control documents
Physical Device Requirements

- Analysis of information flows leads to “rollup” requirements for devices implementing those flows
  - Sum of requirements for inputs and outputs
  - Generally, “worst case” for each requirement must be met
- Aggregation of requirements and logical grouping suggests five levels of device security requirements
## Physical Device Requirements

### Security

In order to participate in this service package, each physical object should meet or exceed the following security levels.

<table>
<thead>
<tr>
<th>Physical Object</th>
<th>Confidentiality</th>
<th>Integrity</th>
<th>Availability</th>
<th>Security Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected Vehicle Roadside Equipment</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Class 1</td>
</tr>
<tr>
<td>ITS Roadway Equipment</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
<td>Class 3</td>
</tr>
<tr>
<td>Traffic Management Center</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
<td>Class 3</td>
</tr>
<tr>
<td>Transit Management Center</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Class 1</td>
</tr>
<tr>
<td>Transit Vehicle OBE</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Class 1</td>
</tr>
</tbody>
</table>

### Information Flow Security

In order to participate in this service package, each information flow triple should meet or exceed the following security levels.

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
<th>Information Flow</th>
<th>Confidentiality Basis</th>
<th>Integrity Basis</th>
<th>Availability Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected Vehicle Roadside Equipment</td>
<td>ITS Roadway Equipment</td>
<td>signal priority service request</td>
<td>Not Applicable</td>
<td>Moderate</td>
<td>Low</td>
</tr>
</tbody>
</table>
ARC-IT Information Access

- ARC-IT is a publicly available product
  - All content is published at [arc-it.org/](http://arc-it.org/)
  - Content relevant for planning, deployment and systems engineering is included in the companion toolset
    - Regional Architecture Development for Intelligent Transportation (RAD-IT)
    - Systems Engineering Tool for Intelligent Transportation (SET-IT)
- Training in architecture methodology and tool use is also published

[ARC-IT logo]  [SET-IT logo]
Scope of Tools

- RAD-IT focuses on regional planning and the development of Operations Concepts,
  - Stakeholders, Physical Objects, Service Packages, Interfaces for the region

- SET-IT is project-focused
  - scope specified in the regional architecture
  - graphical tool,
    - providing visual feedback and tools to manipulate service package diagrams
    - develop communications stack templates, specify standards at all protocol layers,
  - Outputs – documents, diagrams, tables
Using ARC-IT: Framework for ITS Standards

- Interfaces defined in ARC-IT identify what to standardize
  - Many ITS standards documents contain a section mapping their outputs to the interfaces of ARC-IT
  - Foundation for expandability and interoperability
- Use of Architecture as a framework for standardization continued with CVRIA and connected vehicle standards
- ARC-IT pulls all of these standardization efforts into one common framework
- ARC-IT is compatible with current international standards harmonization efforts
Contact Info

- Questions/Discussion?

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