

Detailed ITS Architecture Training

November 29, 2023



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Webinar Tips and Protocols


- You can ask questions at any time using the question and answer box. We will answer as many questions as possible.
- You can also raise your hand to ask questions verbally if you wish.
- **Please keep your line muted.**
- You may also send your questions via email at ITSArchitecture-ArchitectureSTI@tc.gc.ca to be answered later.

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Acknowledgements



This presentation is based on training materials prepared by the United States Department of Transportation (USDOT).

Transport Canada would like to thank the ITS Architecture for Canada Stakeholder Advisory Committee and others that have graciously reviewed the training material and provided pictures, graphics and other material.

Pictures and graphics are attributed where possible.

Goals and Objectives

1

Deeper dive into the details of the U.S. National ITS Reference Architecture (ARC-IT)

2

Overview of available resources

3

Show where and how regional ITS Architecture development can be integrated into conventional planning efforts

4

Guided tour of the ARC-IT website and how to find desired information

Agenda

- Introduction to structure and components of ARC-IT
- Canadian elements accessible through ARC-IT
- Tour of the ARC-IT website

A note on spelling: U.S. spelling has been used in this presentation for consistency with ARC-IT



ARC-IT Introduction



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What is ITS?

Intelligent Transportation Systems (ITS) integrate different information and communications technologies into road transportation infrastructure and vehicles, to help make the transportation system safer and more efficient.



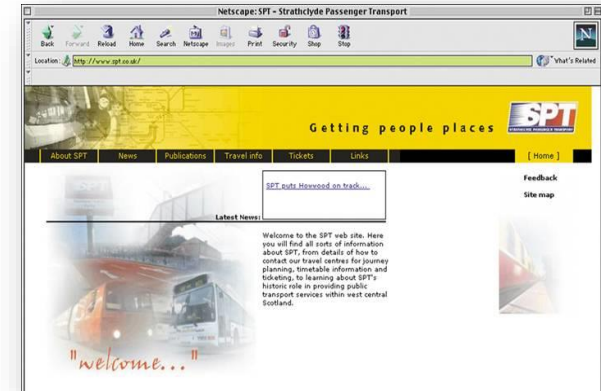
Role of Transportation Professionals

- Plan and provide solutions to transportation needs

What is an ITS Architecture?

- Framework for Developing Integrated Transportation Systems
- Identifies:
 - Organizations
 - Systems operated
 - Functions performed
 - Information exchanged
 - Communications
- **WITHOUT** getting into specifics
 - Technology and Design Neutrality are key

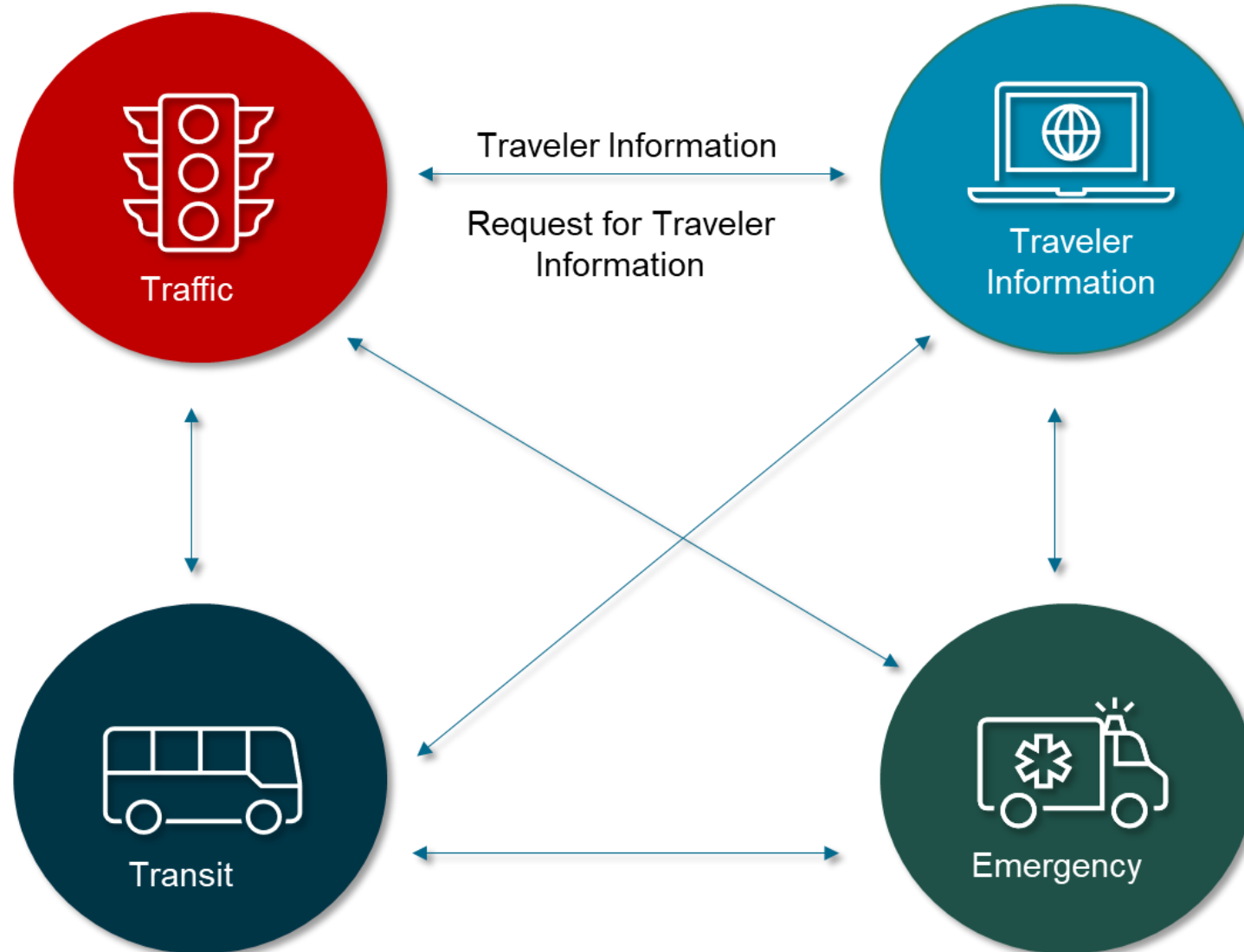




An ITS Architecture is NOT...

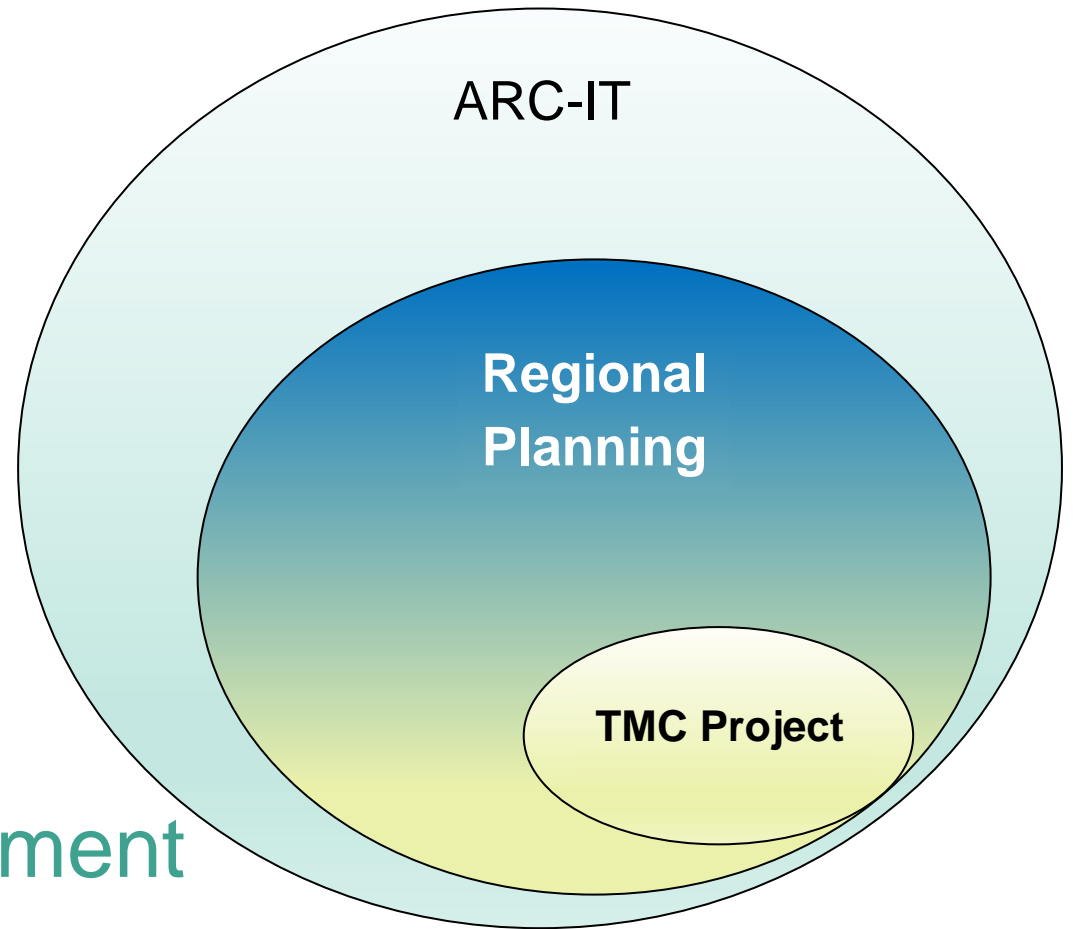
- A design document
- An institutional or development process
- Technology prescriptive . . .

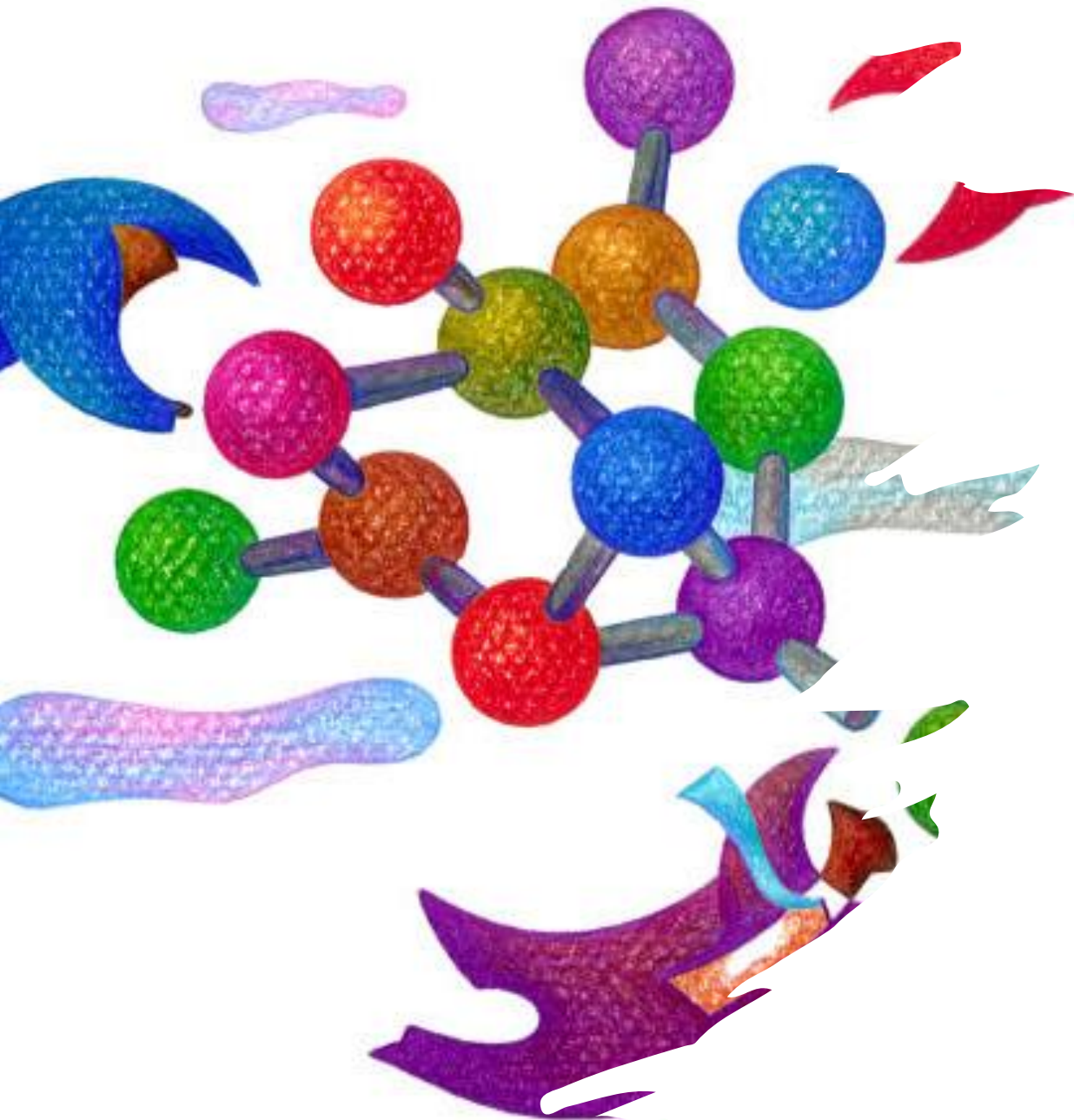
ITS Architectures Provide a Framework for Integration



Types (or levels) of ITS Architectures

- Reference
 - National/Resource
- Regional
 - Used for planning
- Project
 - Used for design/deployment



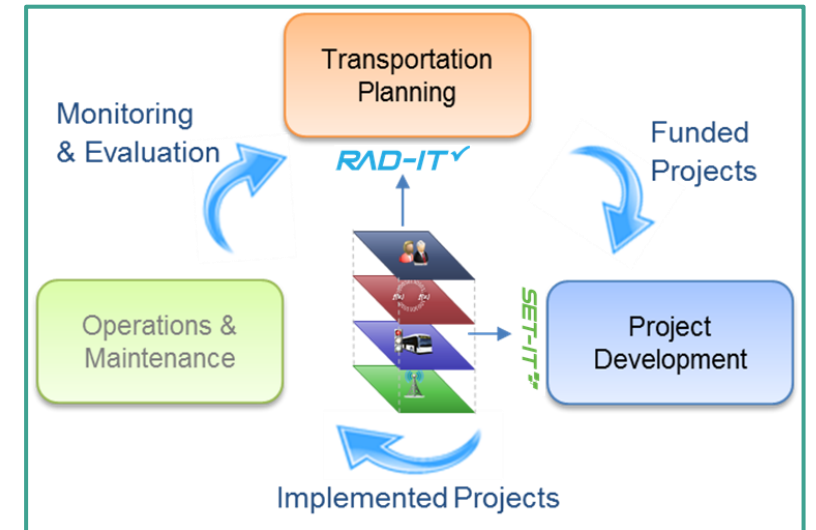
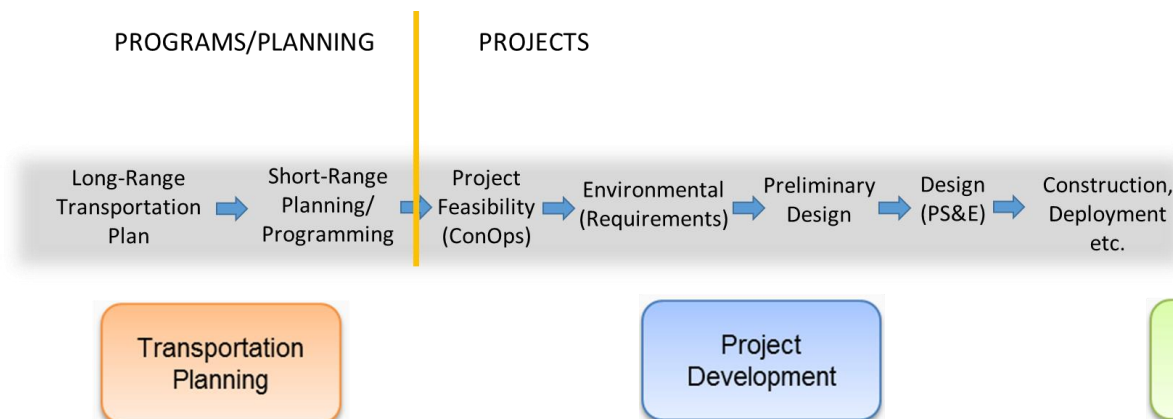


Reasons for Architecture Use in Transportation Planning and Programming

- Architecture represents a consensus vision of Operations and Planning stakeholders for deployment of ITS systems
- Addresses both short-range projects and long-range strategies

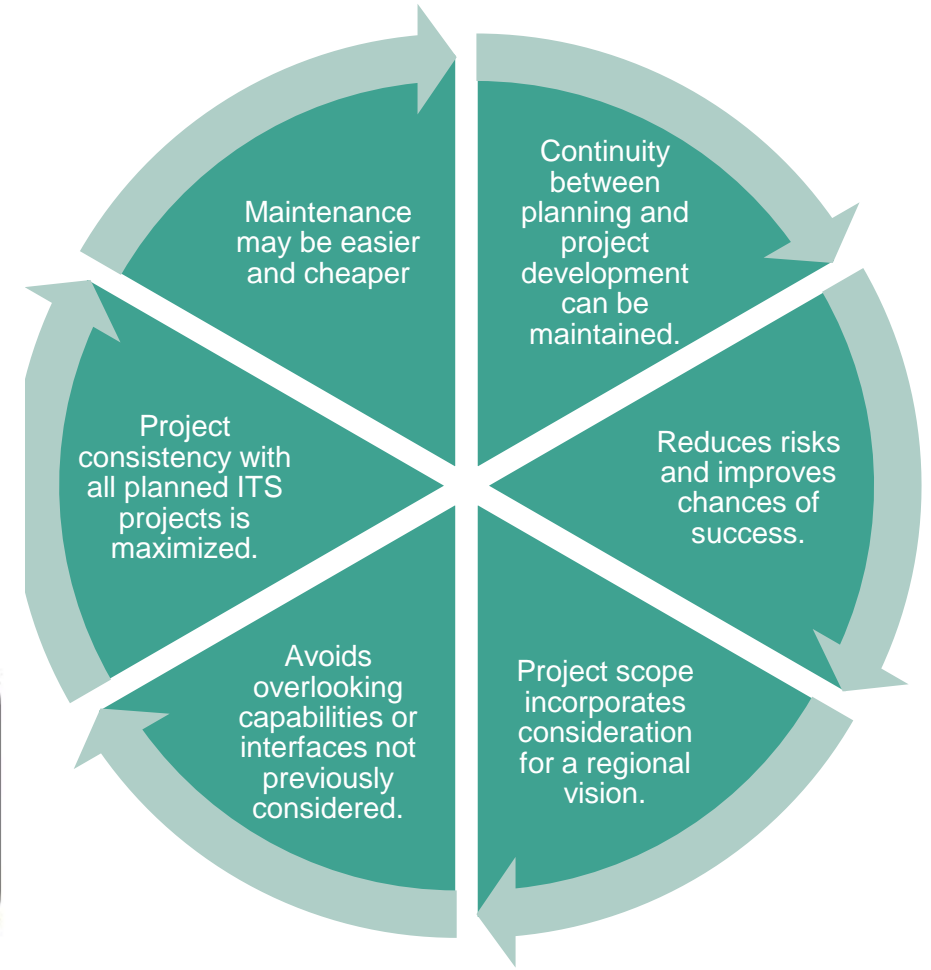
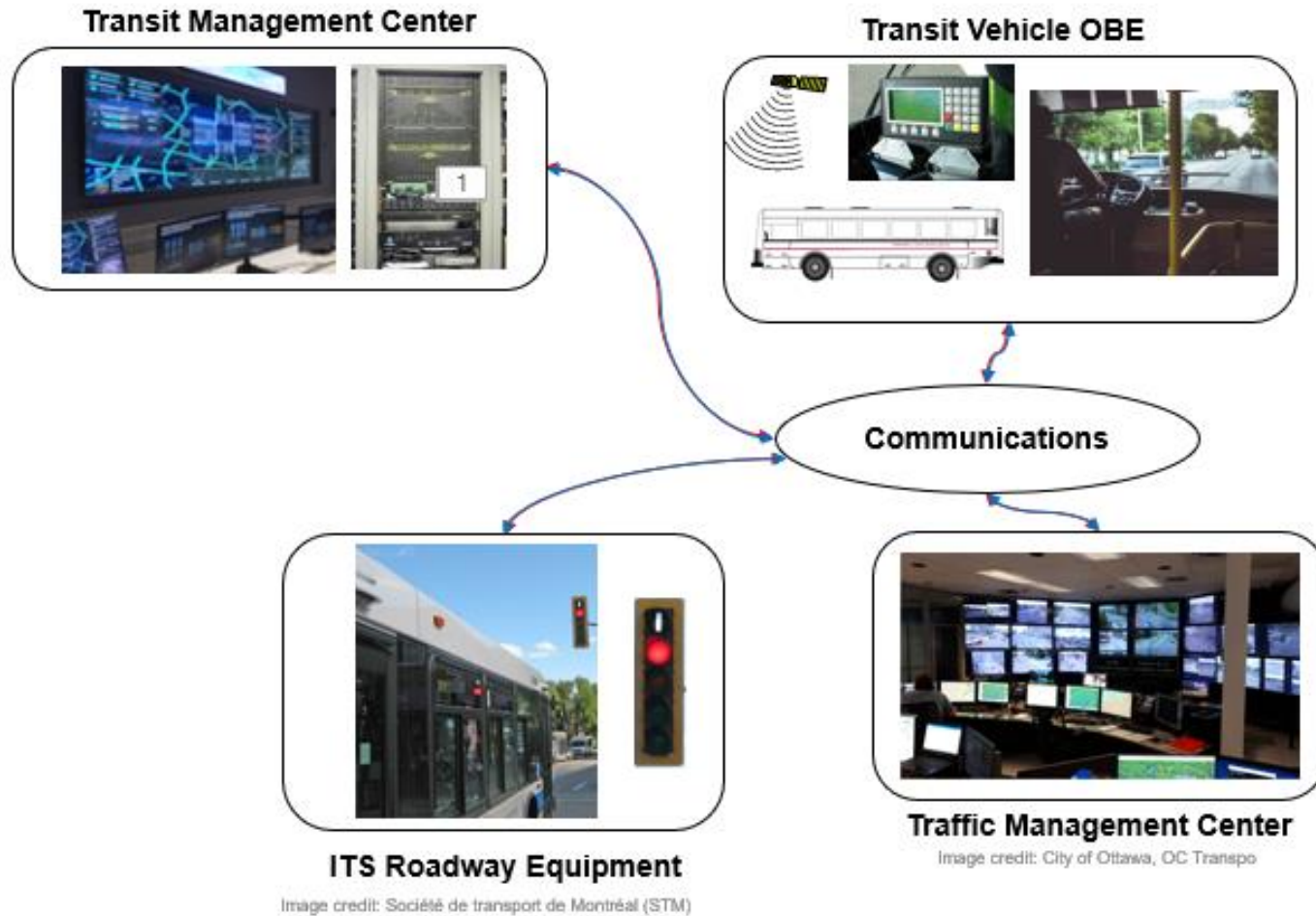
Make Architecture Useful for Programming/Budgeting

- Define near term projects in more specificity to feed into programming and budgeting processes
- Promote integration projects in region
- Establish process that uses architecture



Adapted from: U.S. DOT

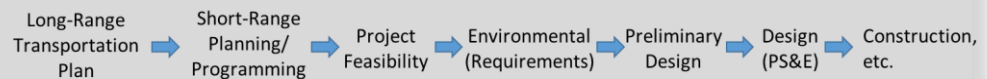
Benefits of Regional and Project ITS Architectures





Stakeholder Involvement is Key

- ITS Architecture development provides an excellent opportunity for linking operations and planning stakeholders, during development and later during maintenance or update activities
- Committee that supported architecture development should also take a leading role in overseeing architecture use and maintenance



Reference ITS Architectures

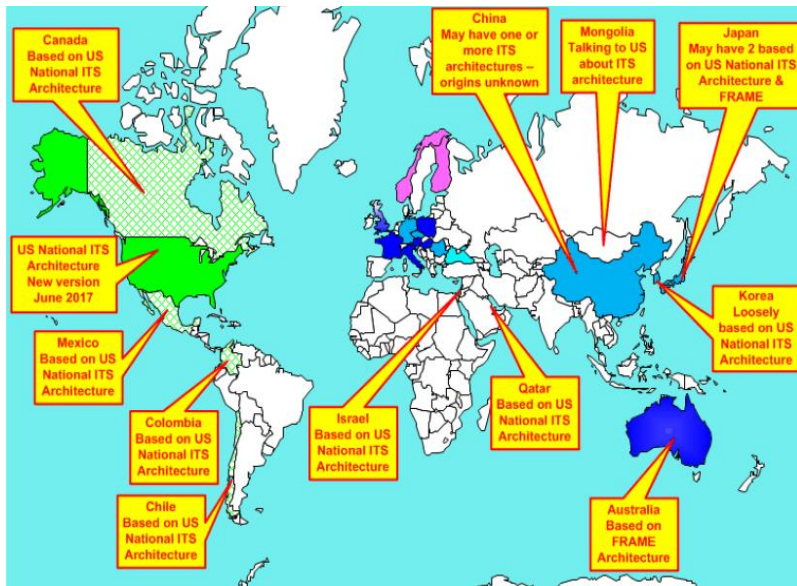
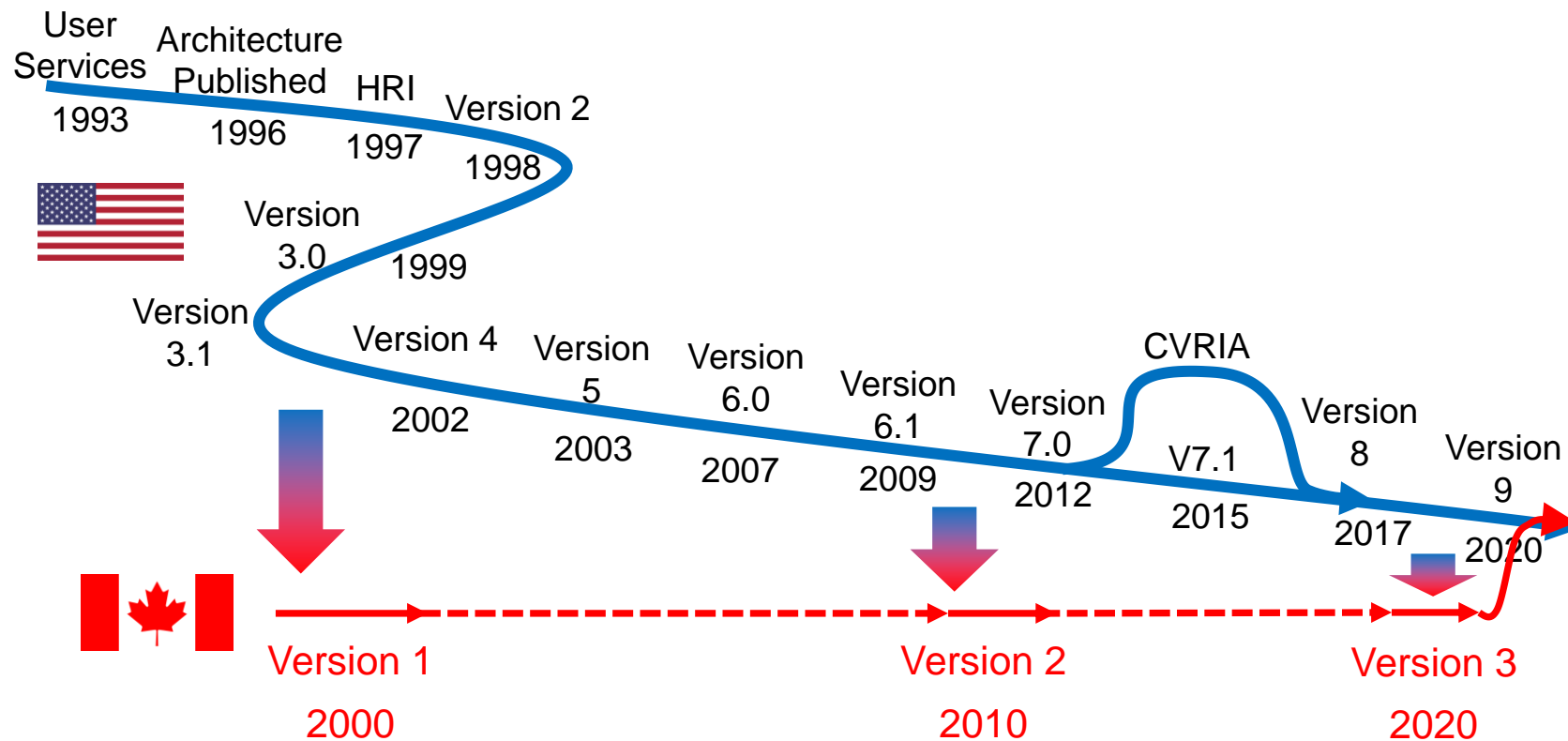


Image Source: Using Architectures in ITS Webinar (June 11, 2020)

- Completed Jurisdictional Scan
 - Several countries have developed and/or adopted reference ITS architectures
 - U.S. ARC-IT can easily be considered the gold standard
- ARC-IT is most closely aligned
 - Integrates four unique Canadian service packages
 - accessible through ARC-IT website and tools (RAD-IT / SET-IT)
 - Cross border travel
 - Common auto industry and many related standards
- Current TC approach is to encourage use of ARC-IT, and to develop new service packages if and when needed.

A long and windy road

- U.S. National ITS Architecture / ARC-IT program started in the 1990s
 - Has expanding and evolving over past 25 years
 - Rebranded in 2017
- ITS Architecture for Canada evolved along with it



★
Sept 2023 – ARC-IT 9.2 Released
Nov 2023 – new tools released
ARC-IT 9

What's new in 9.2?

ARC-IT Version 9.2 is a significant update of the US National ITS Architecture Reference focusing on improvements that support **Multimodal Accessible Travel (MAT)**, the **Management of Electronic Traffic Regulations (METR)** and other new concepts and refinements. The most significant enhancements for version 9.2 are:

- **Multimodal Accessible Travel:** Concepts supporting complete trip, integrated payment, safety for vulnerable road users, and pathway/indoor navigation use cases. Most obviously impacted service packages:
 - **SU15: Vulnerable Road User Device Transition Support**
 - TI03: En-Route Guidance
 - TI04: Trip Planning and Payment
 - TI05: Integrated Multi-Modal Electronic Payment (previously PT18)
 - TI06: Shared Use Mobility and Dynamic Ridesharing
 - **TI08: Personal Wayfinding**
 - VS12: Vulnerable Road User Safety
 - **VS18: Vulnerable Road User Clustering**
- Major enhancements to **VS17 Traffic Code Dissemination** based on developments in the Management of Electronic Traffic Regulations (METR) standards being developed in ISO/TC 204. This includes details of how METR systems are expected to operate by collecting, managing and disseminating road regulations.
- Other new or significantly enhanced Service Packages:
 - **MC12: One-Way Convoy Driving** -- all new, inspired by operations in Norway but implemented similarly in some snow-heavy US states
 - **ST05: Electric Charging Stations Management** -- modified to better accommodate information sharing and management entities
- Updates to all views to reflect **changes in technology and standards development**
- Many **new physical objects** supporting MAT, METR and other new and refined concepts, such as the **Micro-Mobility Vehicle OBE, Electric Charging Management Center and Shared Use Transportation Center**



What's new in 9.2?

RAD-IT Version 9.2.1 includes the following new-and-improved features:

- Document Settings can now be saved per architecture, allowing users to setup and save multiple documents per file; for example, a document for the regional architecture and another document(s) for the project architectures
- New output reports for service package readiness based on the flows and the available communications solutions assigned to each service package
- Improved performance on the Interfaces tab for the Build function
- Various bug fixes, including bugs related to conversion and physical object assignments

SET-IT Version 9.2.1 updated November 2023 includes the following new-and-improved features:

- Enhanced Search that now expands the fields being search to include text in the Service Packages, Service Package Instances, on Diagrams, and in Functional Objects.
- Fixes related to occasional crashes based by the Details forms
- Various bug fixes, including errors during Document generation and related to synchronizing service package names



Current Status

ARC-IT

- “Congressionally mandated “blueprint” for federally funded ITS deployments”¹
- Integrates 10 International Service Packages (4 from Canada)
- Website and tools fully support all service packages

ITS Architecture for Canada

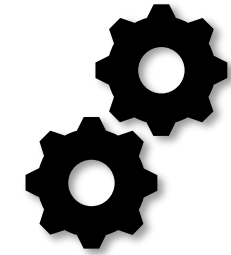
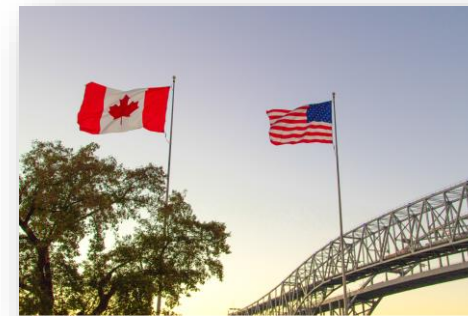
- No similar legislative or policy requirement
- Focus on supporting and encouraging use of ITS architectures (ARC-IT) rather than maintaining a parallel reference architecture
- Offline databases mirror ARC-IT: facilitates developing additional service packages if/when needed



U.S. ARC-IT 9.0



The image shows the U.S. ARC-IT 9.0 logo with the American flag. Below it are several icons: a blue cylinder, a blue document with a globe, a blue wrench and screwdriver, and the logos for RAD-IT (blue) and SET-IT (green). A screenshot of the ARC-IT 9.0 website is also visible, showing the title 'Architecture Reference for Cooperative and Intelligent Transportation'.



ITS Architectures



The image shows the ITS Architectures logo with the Canadian flag. Below it is a screenshot of the website, which includes the title 'ITS Architectures' and a search bar. The website content is partially visible, showing a list of items and a search bar.

ARC-IT Viewpoints

- The **Enterprise Viewpoint** considers the policies, funding incentives, working arrangements, and jurisdictional structure that support the technical layers of the architecture.
- The **Functional Viewpoint** provides an analysis of abstract functional elements and their logical interactions.
- The **Physical Viewpoint** represents physical elements that operate in the field and the backoffice, the functionality contained within those elements, the roles elements play in delivering user services, and the connections between those elements.
- The **Communications Viewpoint** provides a framework for identifying the protocols necessary to implement an information flow between Physical Objects (as defined in the Physical View)

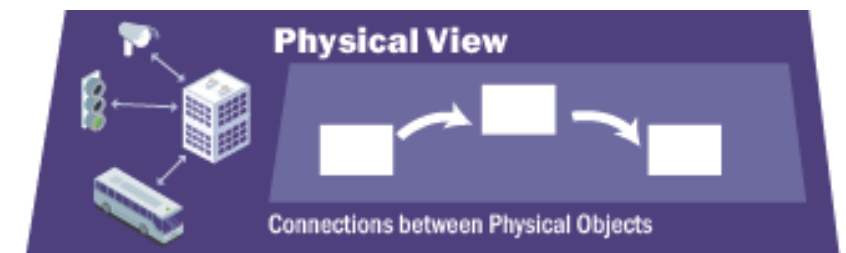
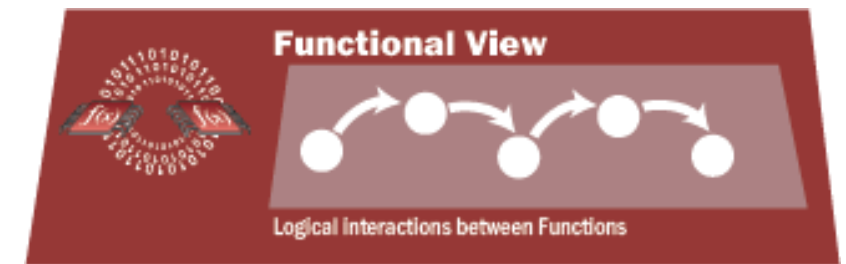


Image source: U.S. DOT

ARC-IT Viewpoints

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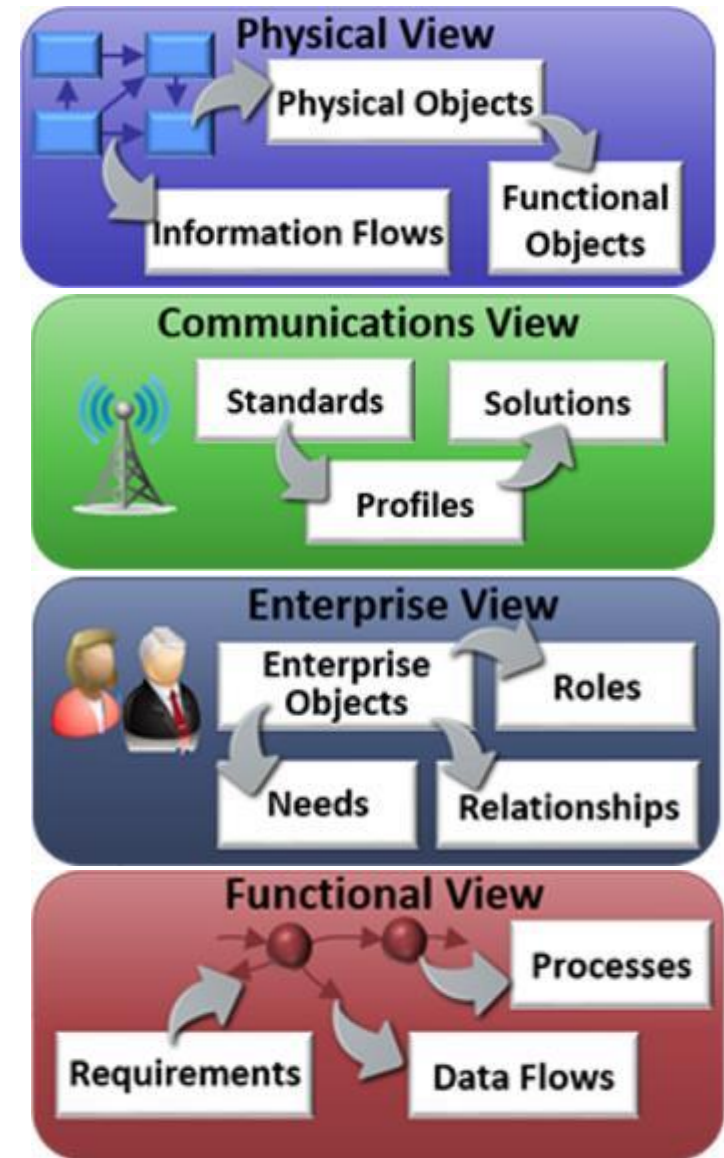


Image source: U.S. DOT

ARC-IT Physical View

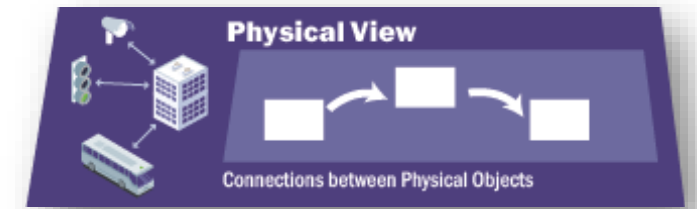


Image source: U.S. DOT

Depicts:

- Physical objects that interact to deliver services
- Interfaces and flows of information between those physical objects

Identifies options for...

- What are the interfaces to support ITS services?
- What functionality is allocated to physical objects?
- What objects require information security safeguards and what are they?

Physical View - Physical Objects

- Key “building blocks” of Physical View
- Physical systems, devices, vehicles, or people that provide ITS services
- Two Types:

- Subsystems
 - Functionality defined
- Terminators
 - No functionality

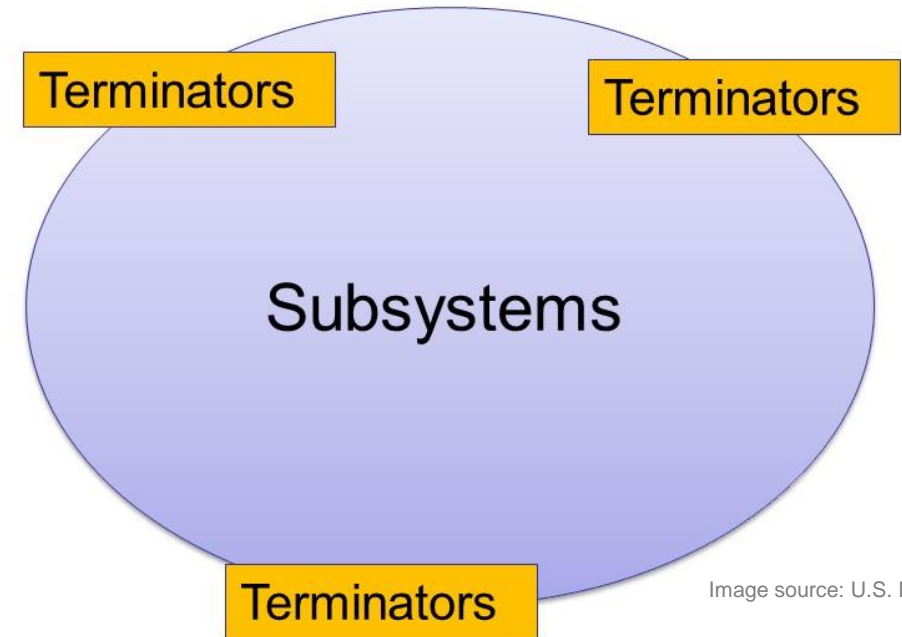
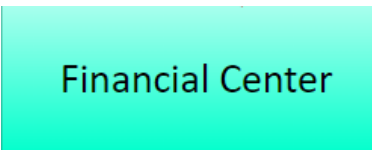
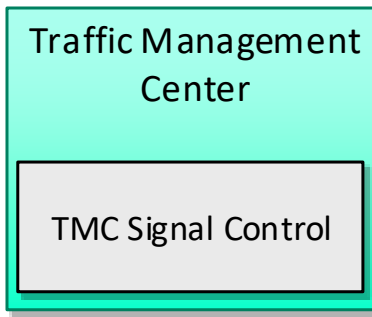
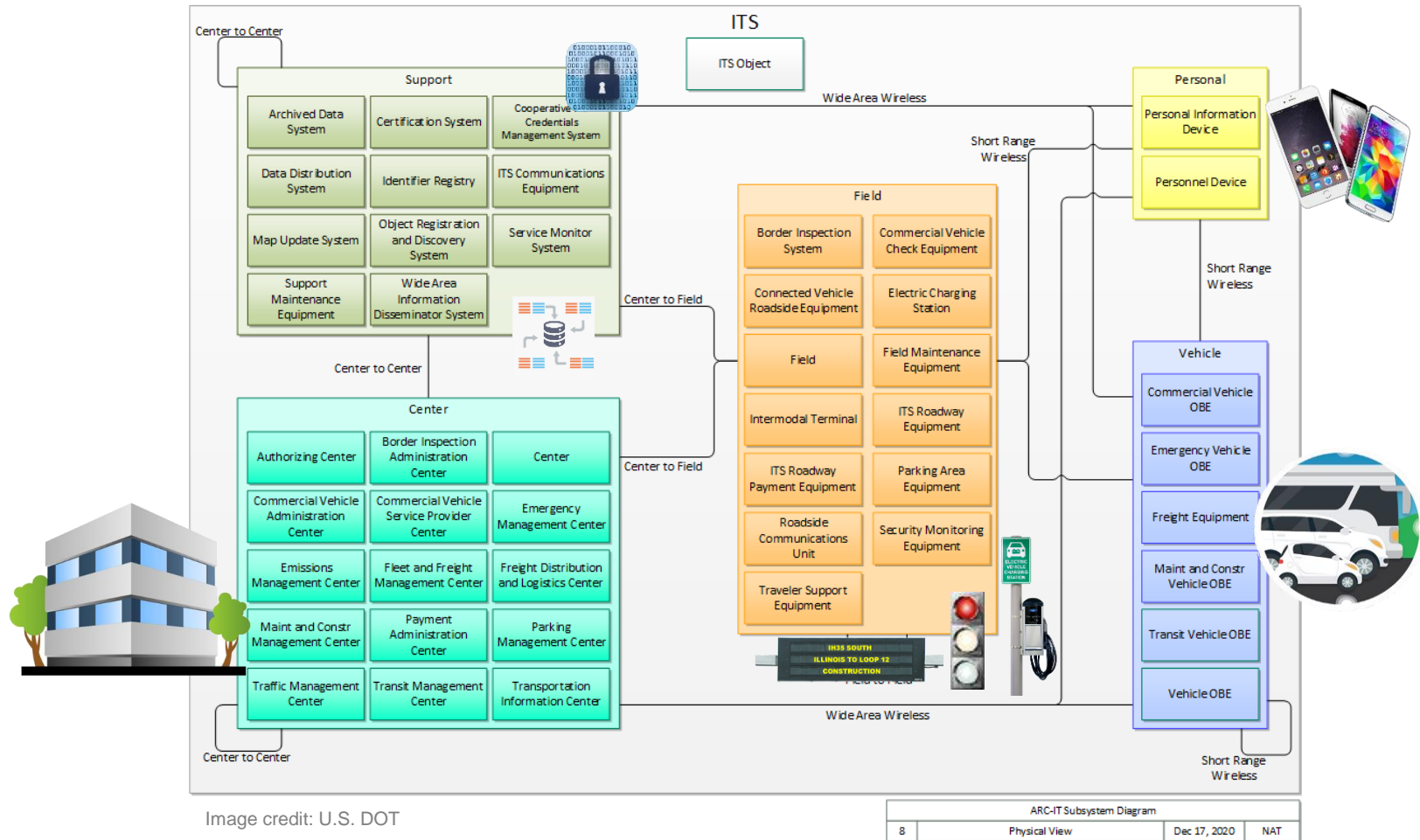


Image source: U.S. DOT

Physical View - Physical Objects

- 6 Subsystem Class Types, based on:
 - Where they reside
 - How they behave
 - How they interact



Organized into six classes (and color-coded)

Physical View - Physical Objects

- ITS Object
 - Includes the core functions and interfaces that may be included in any ITS system or device

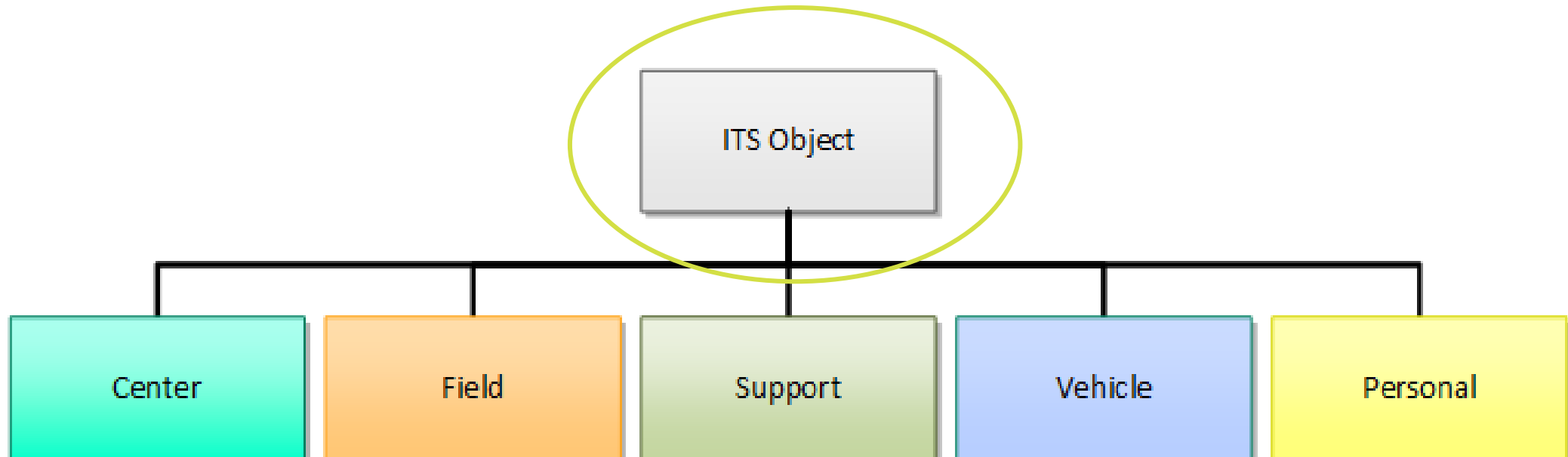
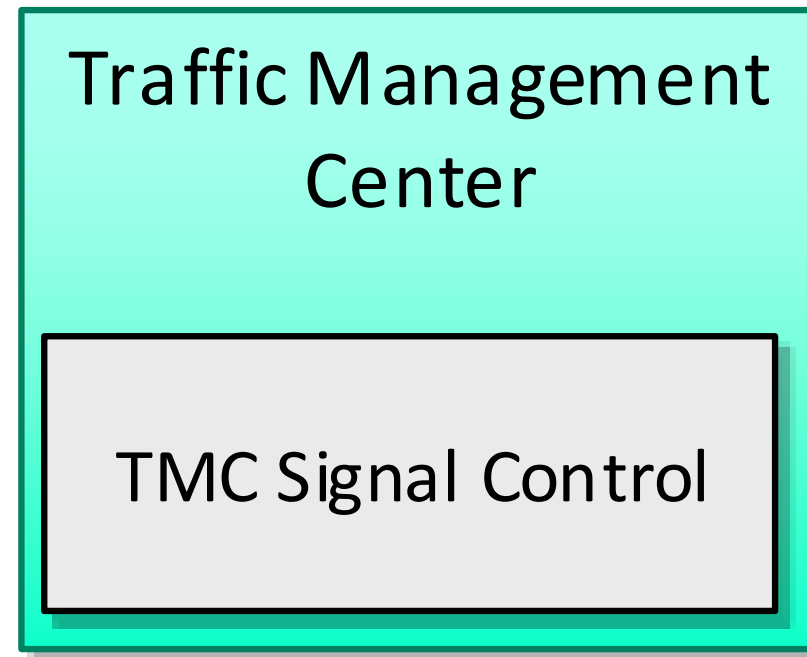


Image source: U.S. DOT

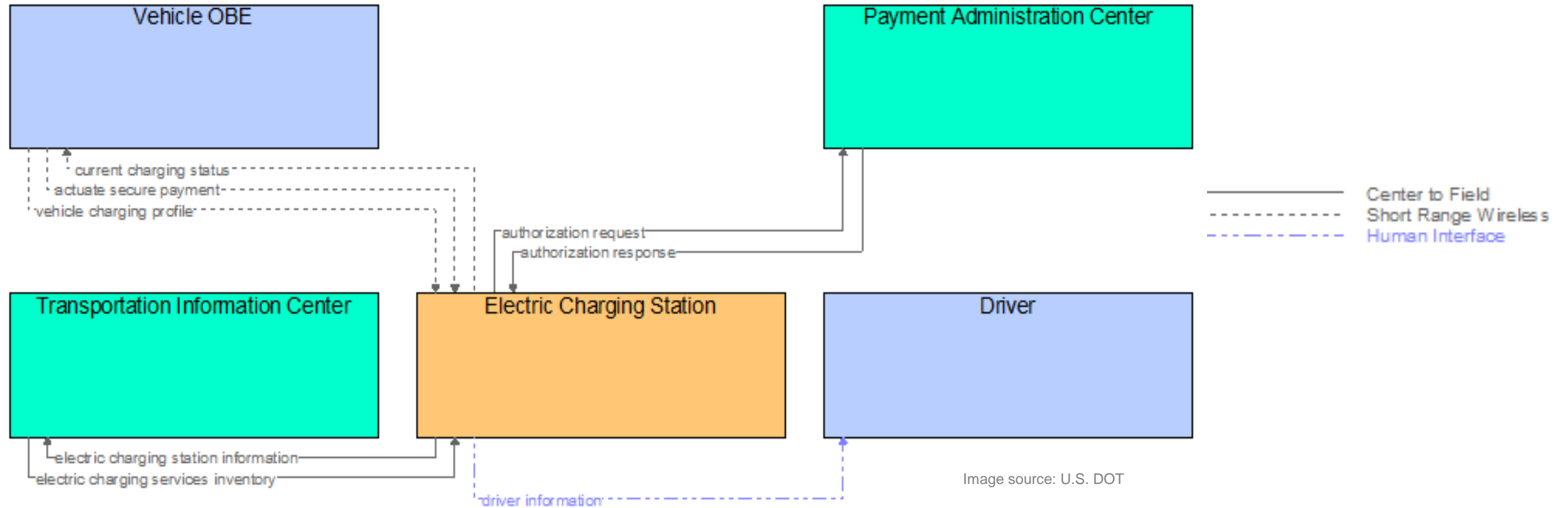
Physical View - Functional Objects

- Functional Objects are functional building blocks of Subsystems
 - Define the functions and interfaces required to support a “deployable” piece of the subsystem
 - Functional requirements are defined for each functional object



Physical View – Information Flows

- Define interfaces between physical objects



TRIPLET → 'Source Physical Object - information flow - Destination Physical Object'
e.g. Transportation Information Center – electric charging services inventory – Electric Charging Station

ARC-IT Communications View

- Depicts:
 - Layered communication solutions that support communications between physical objects
 - Solutions include groups of standards called profiles.
- Identifies options for each “triple” ...
 - Identity and appropriateness of protocols at all layers
 - How these protocols ensure or support:
 - Security
 - Privacy
 - For each option identifies gaps and overlaps for each solution

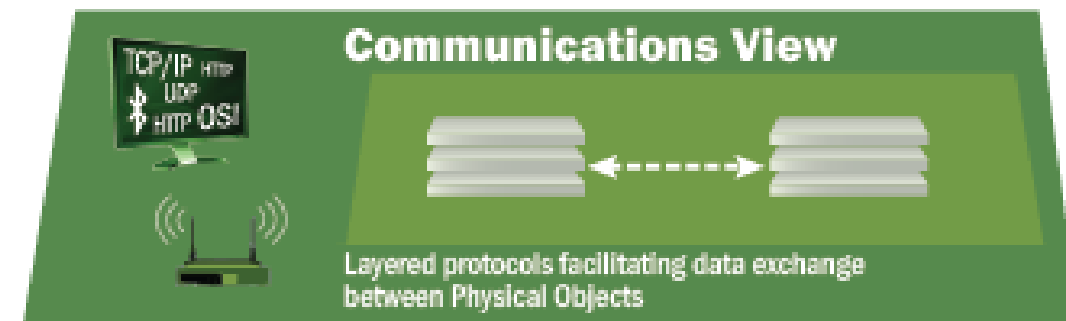
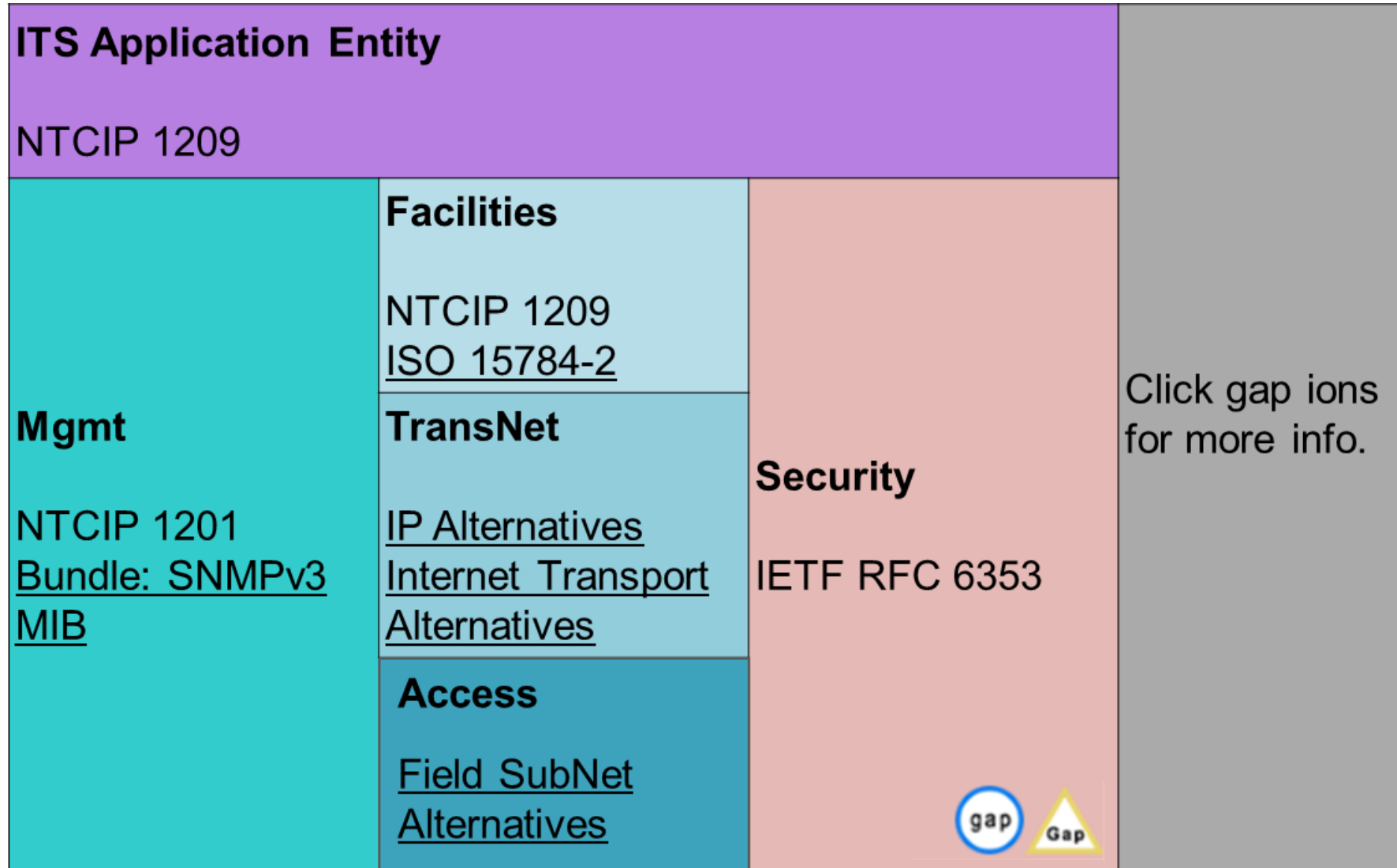


Image source: U.S. DOT

ARC-IT Communications View Example



ARC-IT Enterprise View



- Depicts:
 - Relationships between organizations
 - Roles organizations play in delivery of ITS services
- Organized around **Enterprise Objects**
 - Interact to exchange information
 - Manage or Operate Systems (Resources)



Image source: U.S. DOT

Enterprise Objects / Resources		Role/Relationship
Source	Destination	
Connected Vehicle Roadside Equipment Manager	Connected Vehicle Roadside Equipment	<u>Manages</u>
Connected Vehicle Roadside Equipment Owner	Connected Vehicle Roadside Equipment	<u>Owns</u>
Connected Vehicle Roadside Equipment Owner	Connected Vehicle Roadside Equipment Manager	<u>Operations Agreement</u>
Connected Vehicle Roadside Equipment Owner	ITS Roadway Equipment Owner	<u>Information Exchange and Action Agreement</u>
Connected Vehicle Roadside Equipment Owner	Traffic Management Center Owner	<u>Information Exchange Agreement</u>
Connected Vehicle Roadside Equipment Owner	Transit Vehicle OBE Owner	<u>Expectation of Information Provision</u>
Connected Vehicle Roadside Equipment Supplier	Connected Vehicle Roadside Equipment Owner	<u>Warranty</u>

ARC-IT Functional View

- Depicts:
 - Abstract functional objects (processes)
 - Flows of data between those processes
- Identifies options for...
 - What functionality is in physical objects?
 - What are the interfaces between logical objects?
 - What data flows between those logical objects?

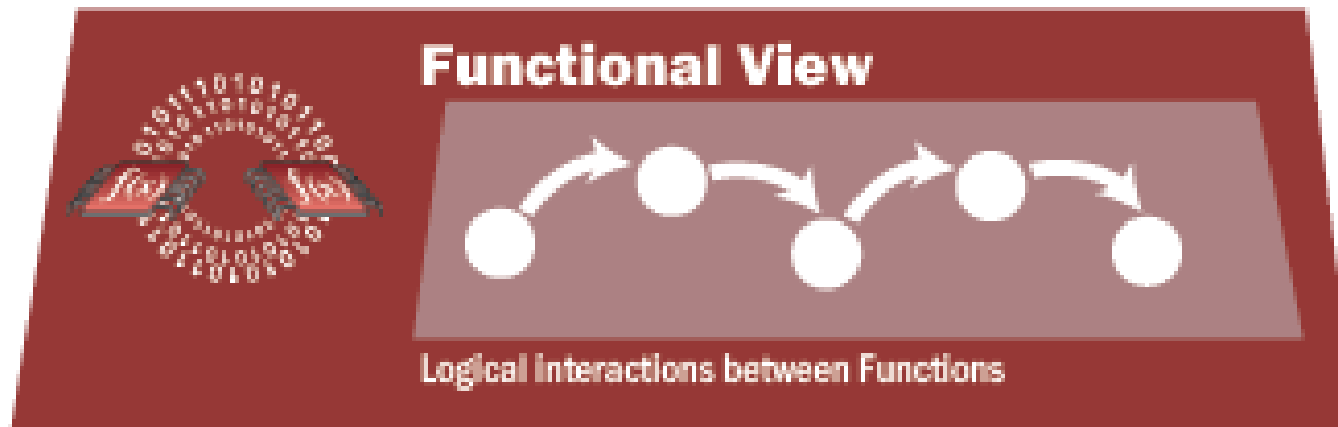


Image source: U.S. DOT

Service Packages

- Service Packages compile the elements of ARC-IT that provides a single ITS service

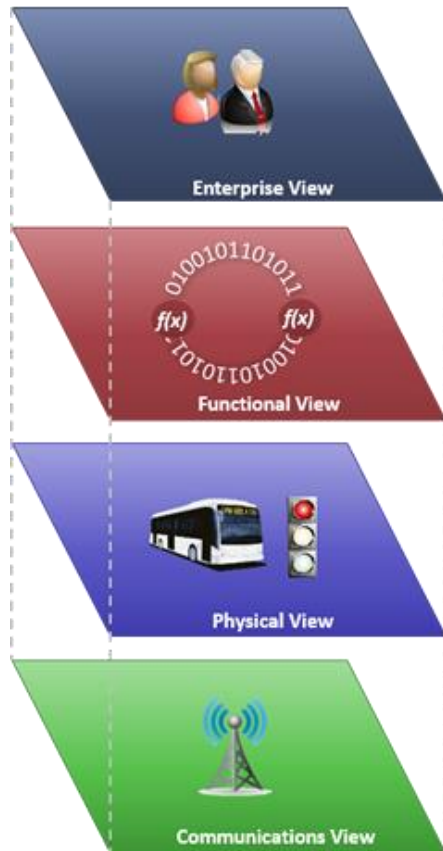
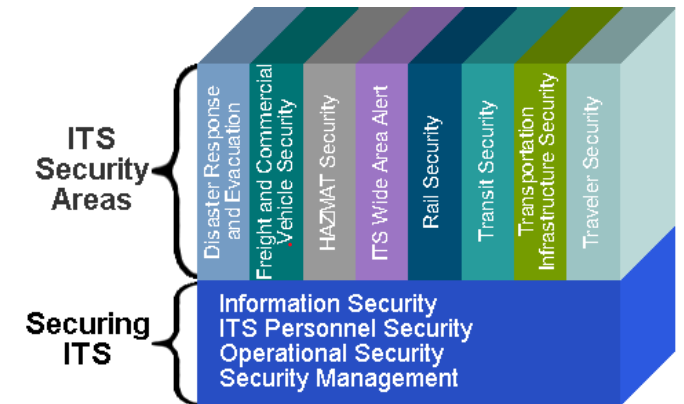
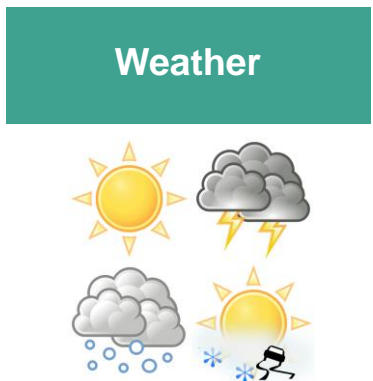
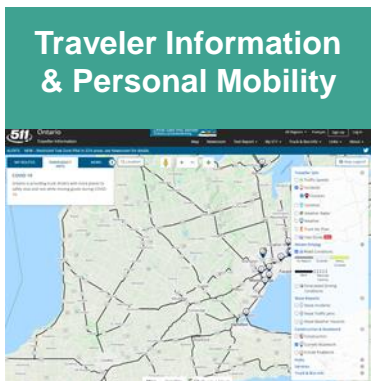


Image credit: U.S. DOT

- 156 Service Packages
- Each includes aspects of all views



Service Package Areas



SU01	Connected Vehicle System Monitoring and Management
SU02	Core Authorization
SU03	Data Distribution
SU04	Map Management
SU05	Location and Time
SU06	Object Registration and Discovery
SU07	ITS Communications
SU08	Security and Credentials Management
SU09	Device Certification and Enrollment
SU10	Center Maintenance
SU11	Field Equipment Maintenance
SU12	Vehicle Maintenance
SU13	Personnel Device Maintenance
SU14	Remote Access
SU15	Vulnerable Road User Device Transition Support Infrastructure Enhanced Cooperative Adaptive Cruise
VS15	Control
VS16	Automated Vehicle Operations
VS17	Management of Electronic Traffic Regulations (METR)
VS18	Vulnerable Road User Clustering
CV(TM21)	Speed Harmonization
CV(TM22)	Dynamic Lane Management and Shoulder Use
TM23	Border Management Systems
TM24	Tunnel Management *
TM25	Wrong Way Vehicle Detection and Warning
TM26	Signal Enforcement *

Service Package Example – Transit Signal Priority (TSP)

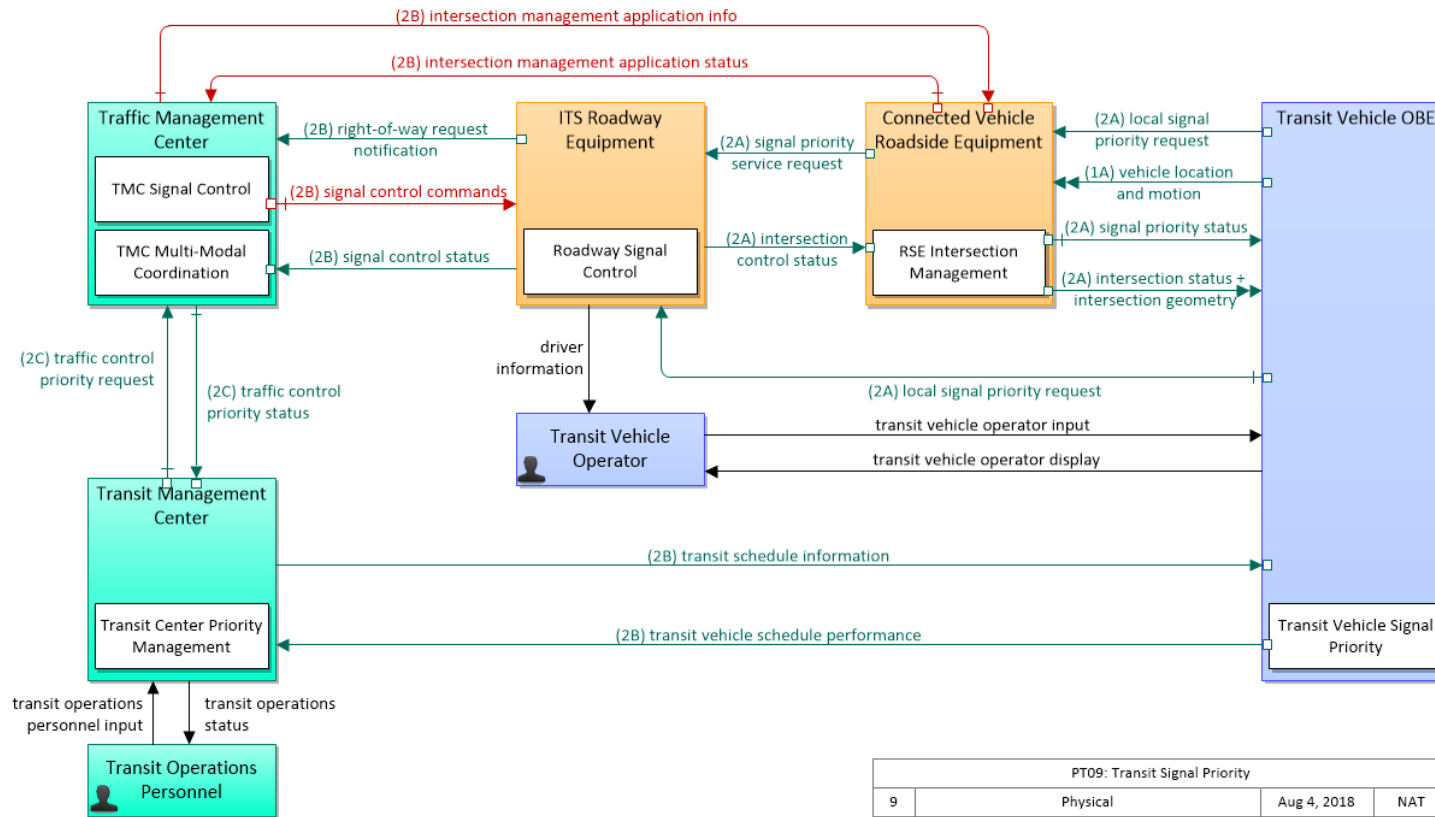
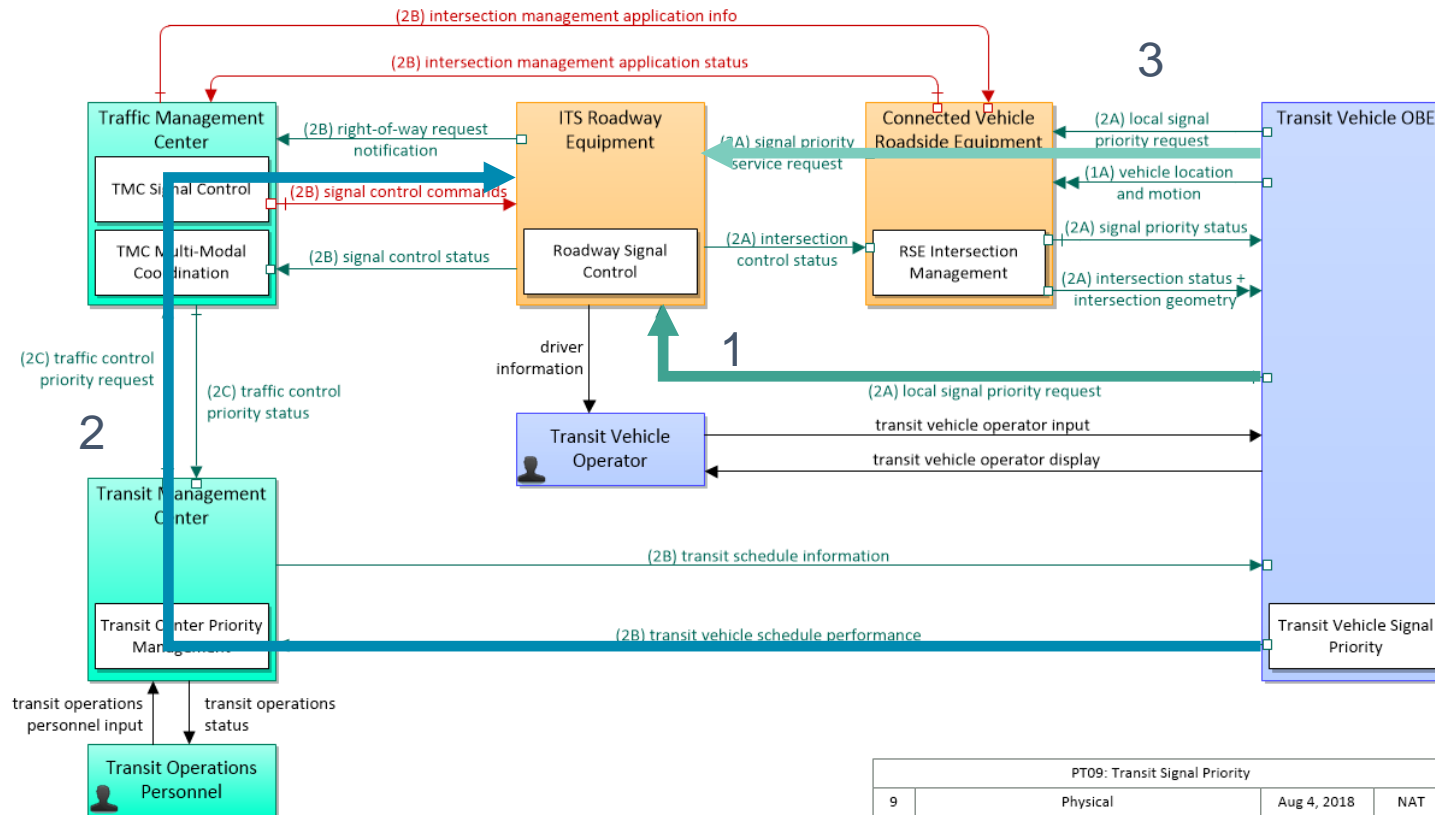


Image credit: U.S. DOT

- Service Packages represent a common entry point to ITS architectures
- Straightforward and understandable graphic presentations
- Based on deliverable ITS applications and strategies
- Use common building blocks

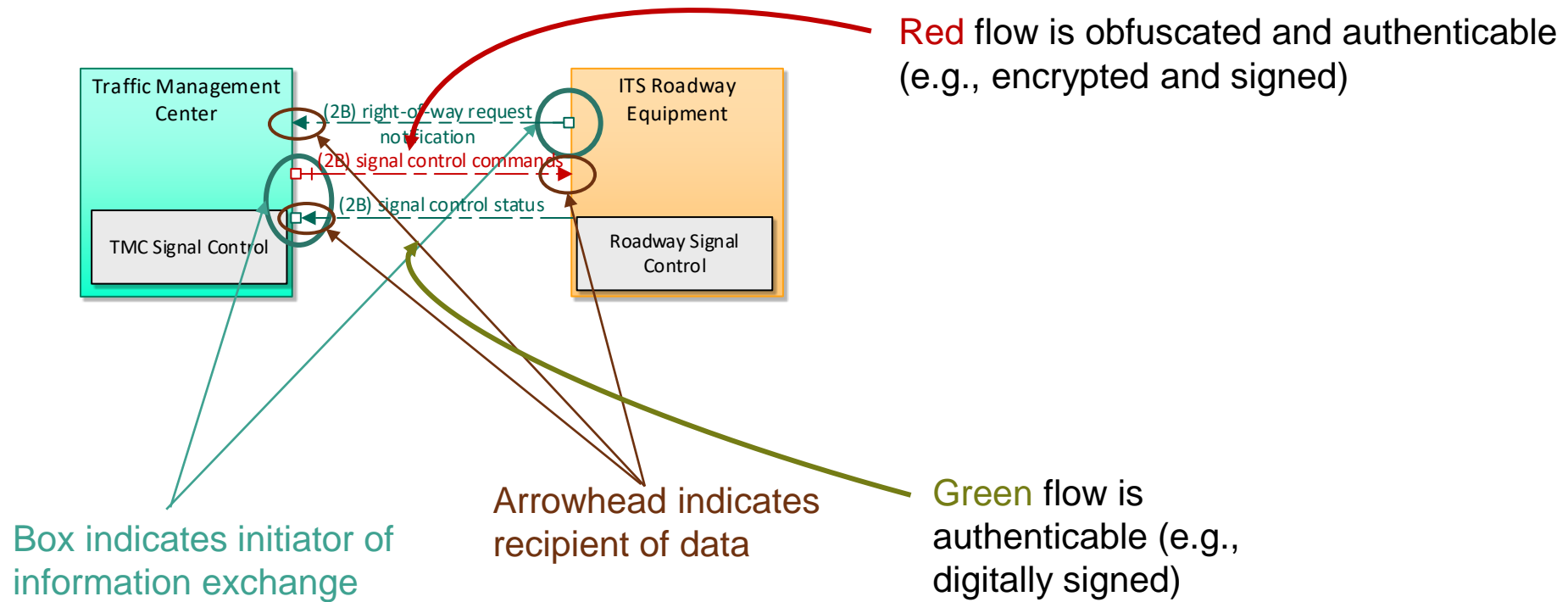
Service Package Example – Transit Signal Priority (TSP)



1. Local actuation based on a request from the transit vehicle in the field
2. Central actuation based on request from Transit Management Center
3. Local or central actuation based on Vehicle-to-Infrastructure (V2I) communication.

Image credit: U.S. DOT

Service Package Example – Transit Signal Priority (TSP)



Physical Legend										
Flow Time Context	Flow Spatial Context	Flow Routing	Flow Status	Flow Cardinality	Flow Control	Flow Security	Elements	Functional Objects		
1 - Now	A - Adjacent D - National	(c) - Routed through a comm element	Existing	Unicast	Transaction initiated By left-hand party	Clear text, No Authent.	Center	Field		
2 - Recent			Project	Multicast		Encrypted, No Authent.	Vehicle	Personal		
3 - Historical	B - Local E - Continental	(d) - Routed through a DDS	Future		Broadcast	Receipt acknowledged	Clear text, Authent.	Support	ITS	
4 - Static	C - Regional	(Abbr) - Terminal	Not Applicable				Encrypted, Authent.	People	Environment	Existing
									Future	Not Applicable

Adapted from: U.S. DOT

A large teal circle containing the text "ARC-IT Summary" in white. The slide is decorated with various geometric shapes: a teal circle in the top left, a yellow triangle in the top right, an orange circle in the middle left, a yellow square in the bottom left, and several orange and teal shapes in the bottom center.

ARC-IT Summary

- ITS Architectures provide Frameworks for Developing Integrated Transportation Systems
- There are 4 complimentary viewpoints to ARC-IT
- Service Packages include aspects of all viewpoints, and are easily accessible



Canadian Elements

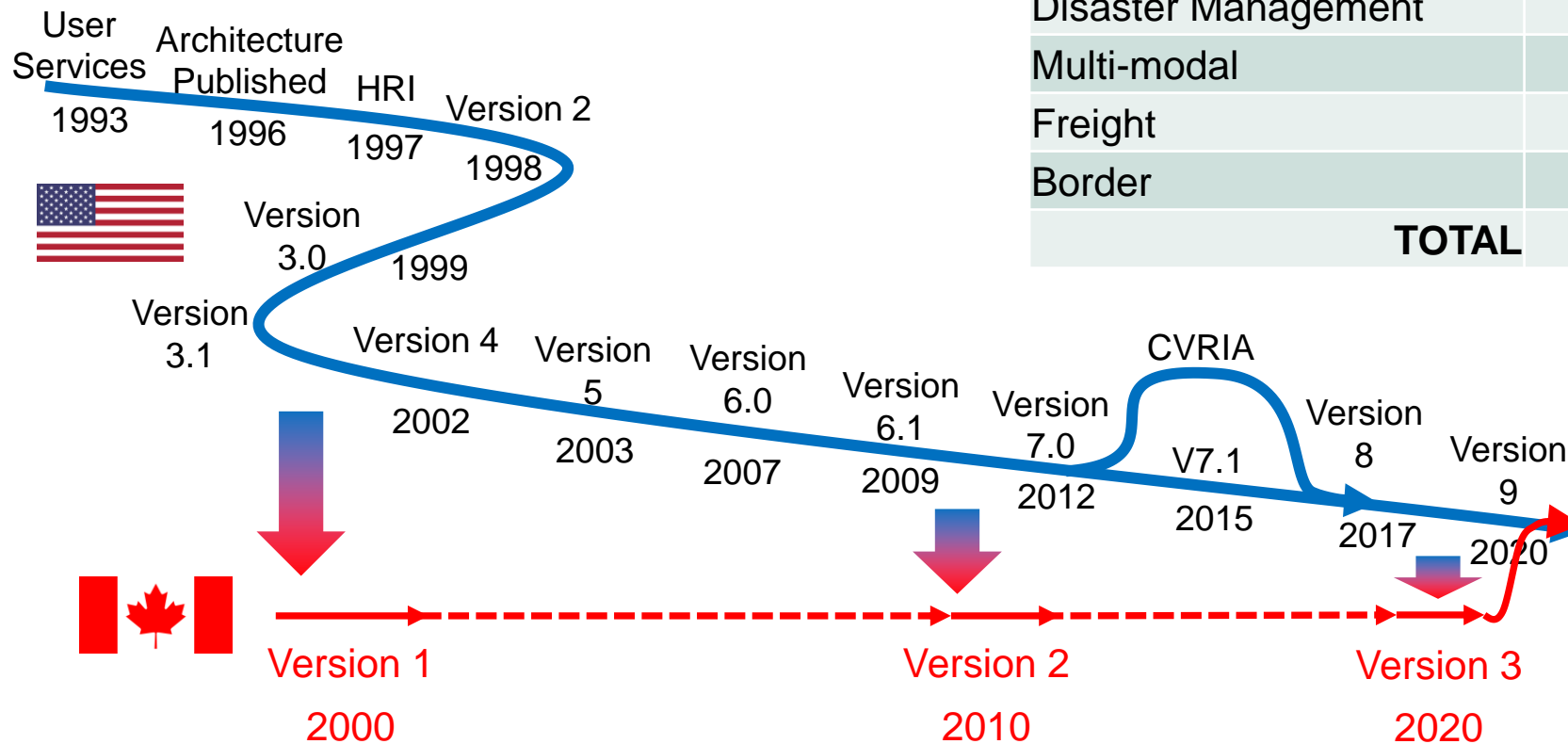


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The Evolution of Canadian Elements

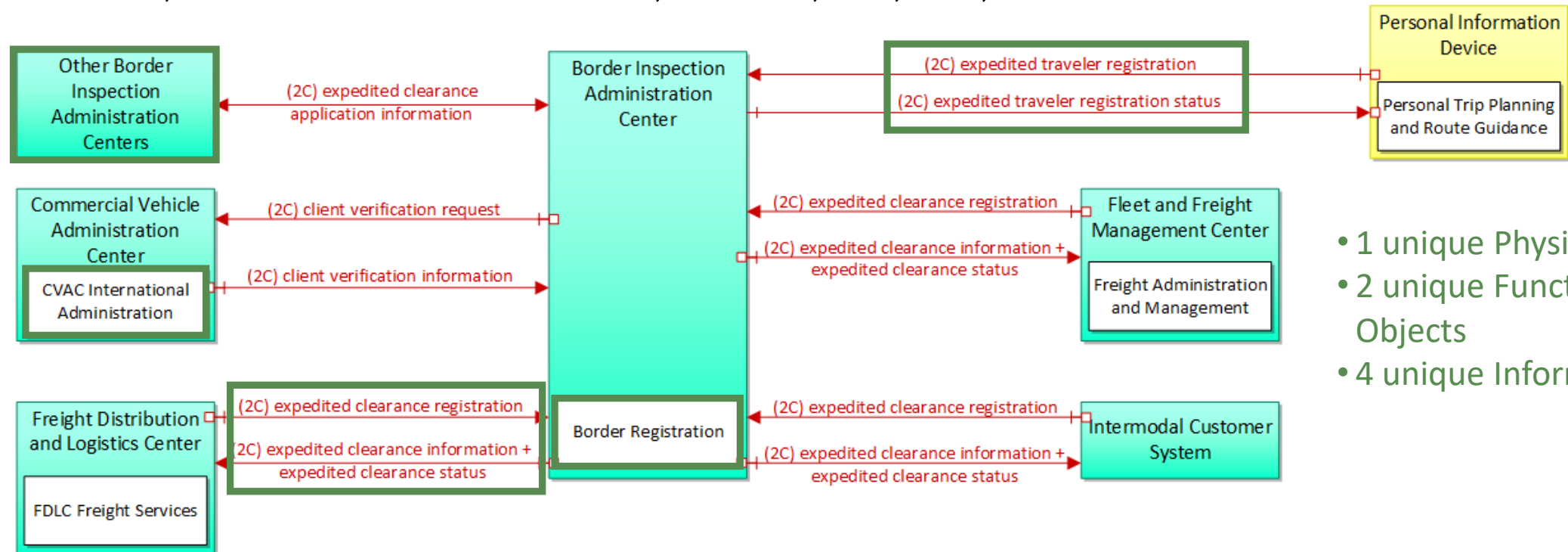


Service Area Focus	Version 1	Version 2	Version 3
Non-Vehicular	2	2	0
Maintenance	2	0	0
Weather	5	2	1
Automated Enforcement	2	1	1
Disaster Management	2	0	0
Multi-modal	1	1	0
Freight	2	1	0
Border	0	3	2
TOTAL	16	10	4

- Includes the 4 Canadian Service Packages
 - Databases
 - Website
 - RAD-IT
 - SET-IT

CVO20: International Border Registration

This service package covers registration of importers, carriers, conveyance, and drivers for expedited clearance at the border. It represents enrollment in programs such as FAST, NEXUS, Customs Self Assessment, C-TPAT, PIP, ACI, and ACE.

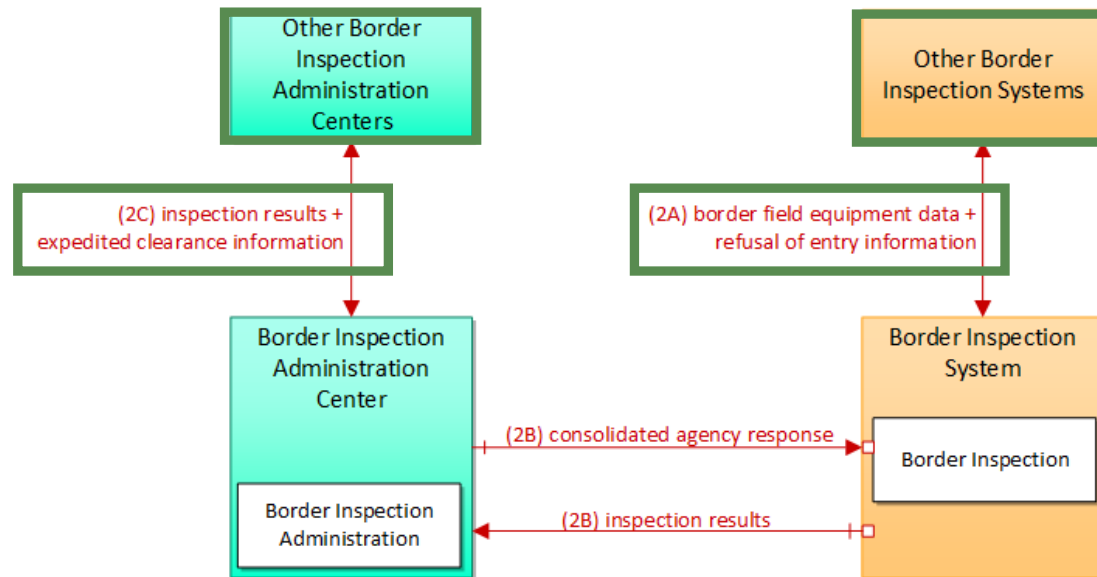


- 1 unique Physical Object
- 2 unique Functional Objects
- 4 unique Information Flows

CVO20: International Border Registration			
2	Physical	Jun 4, 2020	NAT

CVO22: International Border Coordination

This service package covers coordination and sharing of information between agencies to support expedited clearance, customs pre-processing, and border crossing inspections.

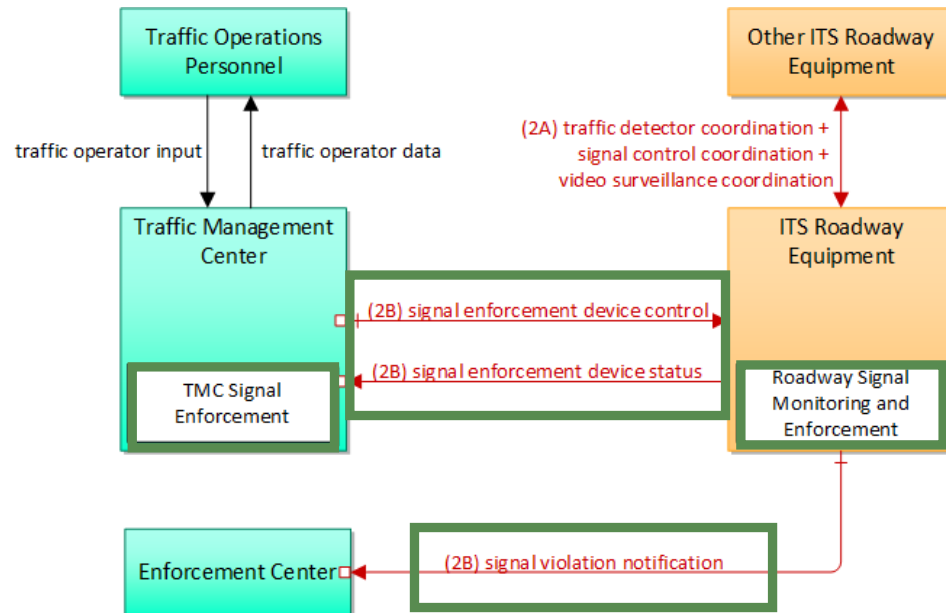


- 2 unique Physical Object
- 0 unique Functional Objects
 - But there are unique Needs and Requirements
- 4 unique Information Flows

CVO22: International Border Coordination			
1	Physical	Mar 30, 2020	NAT

TM26: Signal Enforcement

This service package supports the detection and enforcement of roadway control signals. A common implementation of this capability is "red light enforcement" for signalized intersections. Information documenting a vehicle entering the intersection when the light is red is captured and conveyed to an enforcement agency. ...

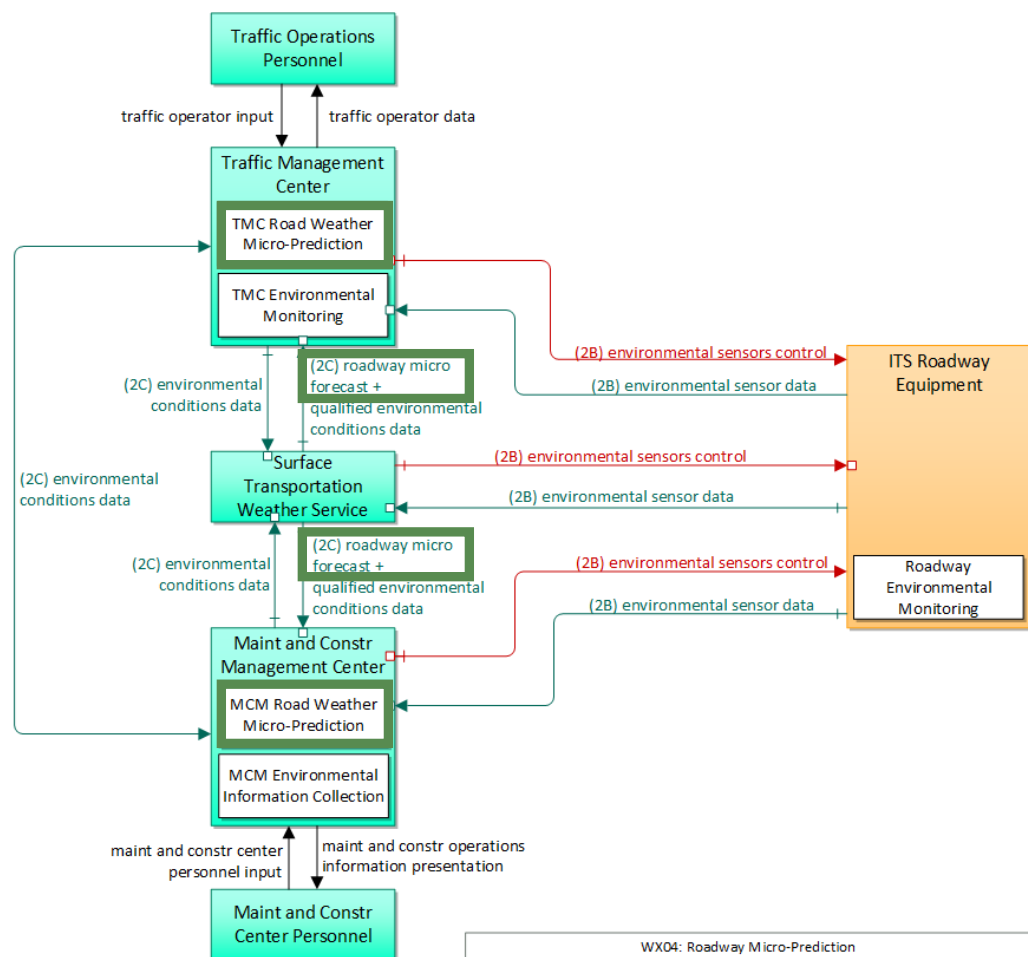


- 0 unique Physical Objects
- 2 unique Functional Objects
- 3 unique Information Flows

TM26: Signal Enforcement			
2	Physical	Apr 22, 2020	NAT

WX04: Roadway Micro-Prediction

This service package supports advanced systems which use environmental information collected from ITS roadway equipment or from the Surface Transportation Weather Service, along with advanced algorithms, to create micro-predictions of roadway conditions which can support improved safety warnings and maintenance planning and dispatch.



WX04: Roadway Micro-Prediction			
1	Physical	Mar 30, 2020	NAT

- 0 unique Physical Objects
- 2 unique Functional Objects
- 1 unique Information Flow

Canadian Elements Summary

- The 'degree of uniqueness' decreased with each Canadian version
- Version 3 included 4 Unique Service Packages
- Developed all required elements for those unique Service Packages
 - For all Views
 - To USDOT standards
 - Coordinated with U.S. ARC-IT Team
- ARC-IT Version 9 integrates the 4 as International Service Packages



Quick Break





ARC-IT Website Tour



Transport
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ARC-IT Website: <http://www.arc-it.net>

- Organizes the architecture content in a layered hypertext format
- Allows for easy and quick targeted access to topics of interest

United States Department of Transportation

ARC-IT Version 9.2
The National ITS Reference Architecture

Architecture Use Architecture Resources Architecture Terminology Contact The Architecture Team

Home

Architecture Reference for Cooperative and Intelligent Transportation

The Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) provides a common framework for planning, defining, and integrating intelligent transportation systems. It is a mature product that reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc.).

ARC-IT is a reference architecture: it provides common basis for planners and engineers with differing concerns to conceive, design and implement systems using a common language as a basis for delivering ITS, but does not mandate any particular implementation. ARC-IT includes artifacts that answer [concerns](#) relevant to a large variety of [stakeholders](#), and provides [tools](#) intended for transportation planners, regional architects and systems engineers to conceive of and develop regional architectures, and scope and develop projects.

To get started, begin with the menu bar above:

- [Architecture](#) contains links to all of the content inside the architecture, and describes the structure of the architecture. In particular:
 - [Service Packages](#) represent slices of the architecture that address a specific service like traffic signal control and provide the most straightforward entry into ARC-IT content.
 - [Views](#) and its sub-menus provide view-specific content; if for example you are looking for a particular [information flow](#), or a particular [communications profile](#), browse the relevant physical and communications sections here.
 - [Methodology](#) and its sub-menus describe the structure of the architecture: how it is built, how the artifacts within are inter-related.
 - The [Security](#) section describes how security is addressed throughout the architecture and provides links to cross-cutting security content.
- [Architecture Use](#) describes how to use ARC-IT, from the perspective of a regional architect, transportation planner or project systems engineer.
- [Architecture Resources](#) provides access to all ARC-IT content in user-downloadable forms. Notably this also includes access to our tools: RAD-IT and SET-IT, that provide you with means to manipulate the architecture according to models' rules, customizing the reference architecture to your regional or project needs.
- [Architecture Terminology](#) provides those definitions that permeate these pages.
- [Contact the Architecture Team](#) gives you a direct line to the source. We want to hear from you! If you have questions, concerns or find an error (say it isn't so!) we'd like to know about it!

Latest News

ARC-IT includes all views of the National ITS Reference Architecture - Enterprise, Functional, Physical and Communications views; as well as over 150 service packages that present slices of the architecture to show how ITS could be deployed to solve real transportation needs. Version 9.2 focuses on improvements that support Multimodal Accessible Travel (MAT), the Management of Electronic Traffic Regulations (METR) and other new concepts and refinements. [Read more...](#)

November 2023 - The ARC-IT website is updated with enhancements and bug fixes to the RAD-IT & SET-IT software. See below for details.

RAD-IT 9.2.1 includes new document output settings, a new Services Readiness output report, and corrects known performance issues while supporting conversion from previous versions. [Read more...](#)

SET-IT 9.2.1 includes enhancements to the search feature, fixes to the document generator, and fixes for occasional crashes, along with other fixes for known issues and to support conversion from previous versions. [Read more...](#)

Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)

Relationships between Organizations
Enterprise View

Logical Interactions between Functions
Functional View

Connections between Physical Objects
Physical View

Layered protocols facilitating data exchange between Physical Objects
Communications View

ARC-IT Website Title, Menu Bar, and Last Update

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Home

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Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)

- Enterprise View**
Relationships between Organizations
- Functional View**
Logical Interactions between Functions
- Physical View**
Connections between Physical Objects
- Communications View**
Layered protocols facilitating data exchange between Physical Objects

Last Updated 11/20/2023

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ARC-IT Website: Home Page

Roles

The table below lists the Roles that comprise the Enterprise View of ARC-IT.

Role Name	Description
Advises	An Enterprise that can provide information about a Resource or Document.
Certifies	An Enterprise verifies that a target Resource meets relevant performance, functional, environmental and quality requirements. This could be an independent third party or it could be the same entity that has the Develops role. For instance, an automotive OEM practicing "self certification" would have this role with respect to the Basic Vehicle, whereas an independent certification body might have this role with respect to a Vehicle OBE (though of course the OEM could also fill this role).
Develops	An Enterprise creates the target Resource or Document. The Enterprise that engineers a traffic signal controller (ITS Roadway Equipment), or designs a vehicle (Basic Vehicle) or authors a technical standard will have the Develops role.
Installs	An Enterprise performs the initial delivery, integration and configuration of the target Resource. This might be a system integrator, a state DOT Enterprise performing its own installation, or a device supplier that performs on-site installation.
Maintains	An Enterprise administers the hardware and software that comprise the target Resource. The entity that takes the 'maintains' role typically is delegated authority by the entity with the "Owns" or "Manages" roles, depending on the environment. The maintainer interacts with the target Resource so as to keep that Resource in the Operational state.
Manages	The Enterprise that is accountable for performing actions with a Resource, typically in support of one of the key operations-related roles (operates, installs, maintains). This authority is typically delegated by the Enterprise with the "Owns" role, and commonly accomplished by delegation to Human E-Objects with the "operates", "installs" or "maintains" roles, depending on the context.
Operates	A Human that is accountable for performing actions with a Resource, typically in support of one of the key operations-related roles (operates, installs, maintains). This is the person at the console or behind the wheel.
Owns	An Enterprise has financial ownership and control over the Resource. An Enterprise that Owns a resource is considered accountable for the resource and all of its contents. The Owns role includes ownership during Operations and Maintenance and also Acquisition during the Installation phase. The entity that takes the "owns" role is ultimately responsible for ensuring the resource provides its promised functionality, and for securing data the resources holds and exchanges. The owner is similarly responsible for the facilities inherent to the resource that are used to exchange data with other systems. The owner is responsible for ensuring that any data stored by the resource and any data communicated by the resource are protected to the extent necessary considering the contents of the data and the consequences of its exposure or alteration.
Provides	The Enterprise that provides the basic service of a service package.
Supplies	The Enterprise that supplies a device or software product. The Supplier delivers the target resource to the Owner.
Uses	An Enterprise or Human that interacts with a Resource or Document in a way not captured by other roles. For instance, the person that reviews a document, or the agency informed of project status would have this role.
Verifies	The Enterprise that determines whether or not a target Resource meets documented requirements. This action is typically on behalf of the Owner.

ARC-IT Website: Architecture Pull-Down

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Enterprise
Functional
Physical
Communications
Methodology
Architecture Structure
Enterprise Viewpoint
Functional Viewpoint
Physical Viewpoint
Communications Viewpoint
Security

Architecture Overview

for Cooperative and Intelligent Transportation (ARC-IT) includes a set of interconnected components that are organized into four views that focus on four different architecture perspectives. A variety of entry allow you to start with any of these components, though most people start with [Service Packages](#). Once in, you can easily navigate from component to component to find what you need. This interconnected cause of the traceability that is maintained between each of the architecture components.

The diagram illustrates the Architecture Overview. On the left, four perspective views are shown: Enterprise View (top, blue), Functional View (red), Physical View (purple), and Communications View (bottom, green). These views are interconnected and lead to a central set of components: Enterprise View (containing Enterprise Objects, Roles, Needs, Relationships), Functional View (containing Processes, Requirements, Data Flows), Physical View (containing Physical Objects, Information Flows, Functional Objects), and Communications View (containing Standards, Solutions, Profiles). These components are further linked to Service Packages and Security components on the right.

ARC-IT is comprised of four views:

1. [Enterprise View](#) considers ITS from an organizational perspective. It identifies stakeholder organizations or [enterprise objects](#) - the people and organizations that plan, develop, operate, maintain, and use ITS. It defines stakeholder [roles](#) and the [relationships](#) between [stakeholders](#). This is also the view where [needs](#) are defined since ARC-IT, and more broadly ITS, is driven by the needs of stakeholder organizations, their constituents, and customers.
2. [Functional View](#) looks at ITS from a functional perspective. Functional [requirements](#) are defined that support ITS user needs. [Processes](#) and [data flows](#) provide a structured presentation of functions and interactions that support the requirements.

ARC-IT Website: Service Packages Page

[CVO17](#)

[Intelligent Access Program](#)

CVO20: International Border Registration

This service package covers registration of importers, carriers, conveyance, and drivers for expedited clearance at the border. It represents enrollment in programs such as FAST, NEXUS, Customs Self Assessment, C-TPAT, PIP, ACI, and ACE.

Origin: Canada

Relevant Regions: Australia, Canada, European Union, and United States

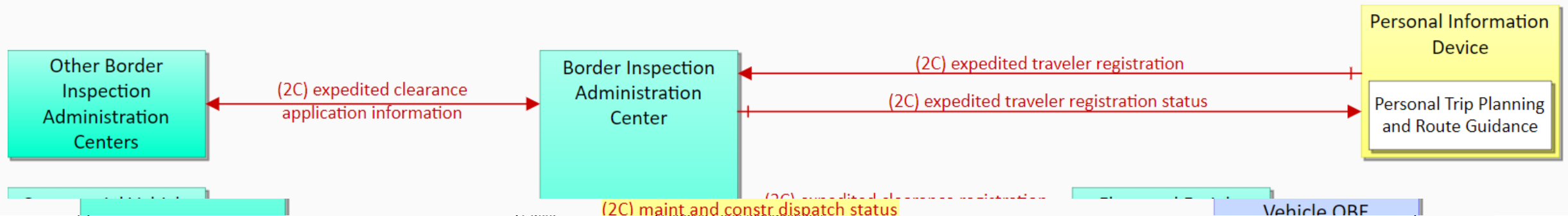
Enterprise Functional Physical Goals and Objectives Needs and Requirements Sources Security Standards System Requirements

Physical

The physical diagram can be viewed in SVG or PNG format and the current format is SVG.

[SVG Diagram](#)

[PNG Diagram](#)




PSID	Service Package Name
PS01	Emergency Call-Taking and Dispatch
PS02	Emergency Response
PS03	Emergency Vehicle Preemption (Implementations)
PS04	Mayday Notification
PS05	Vehicle Emergency Response

ARC-IT Website- Service Package Details

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[Home](#) > [Service Packages](#) > Queue Warning 

<< [VS07](#) : VS08 : [VS09](#) >>

VS08: Queue Warning


This service package utilizes connected vehicle technologies, including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications, to enable vehicles within the queue event to automatically broadcast their queued status information (e.g., rapid deceleration, disabled status, lane location) to nearby upstream vehicles and to centers (such as the TMC). The infrastructure will broadcast queue warnings to vehicles in order to minimize or prevent rear-end or other secondary collisions. This service package is not intended to operate as a crash avoidance system. In contrast to such systems, this service package will engage well in advance of any potential crash situation, providing messages and information to the driver in order to minimize the likelihood of his needing to take crash avoidance or mitigation actions later. It performs two essential tasks: queue determination (detection and/or prediction) and queue information dissemination using vehicle-based, infrastructure-based, or hybrid solutions.

Relevant Regions: Australia, Canada, European Union, and United States

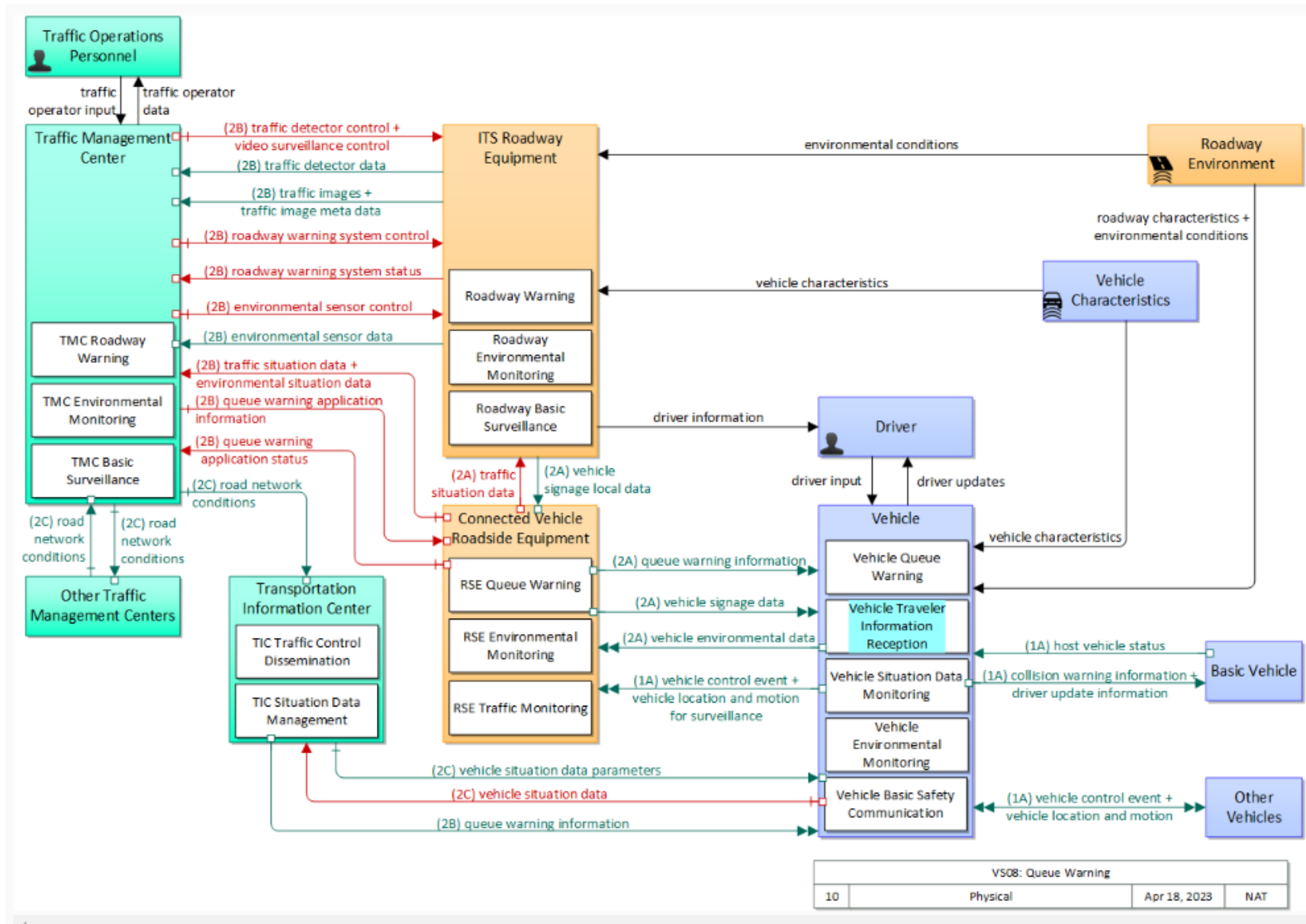
Enterprise | Functional | **Physical** | Goals and Objectives | Needs and Requirements | Sources | Security | Standards | System Requirements | Implementations

Physical

The physical diagram can be viewed in SVG or PNG format and the current format is SVG.
[SVG Diagram](#)
[PNG Diagram](#)


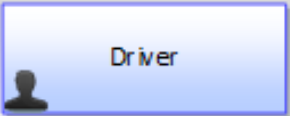
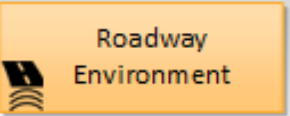
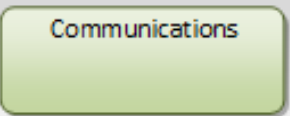


Queue Warning Service Package

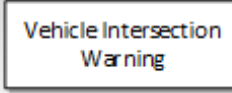
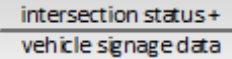
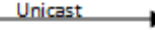
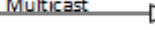
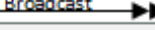
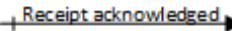
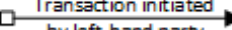
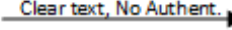

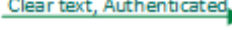
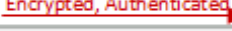


Service Packages Legend – Physical objects

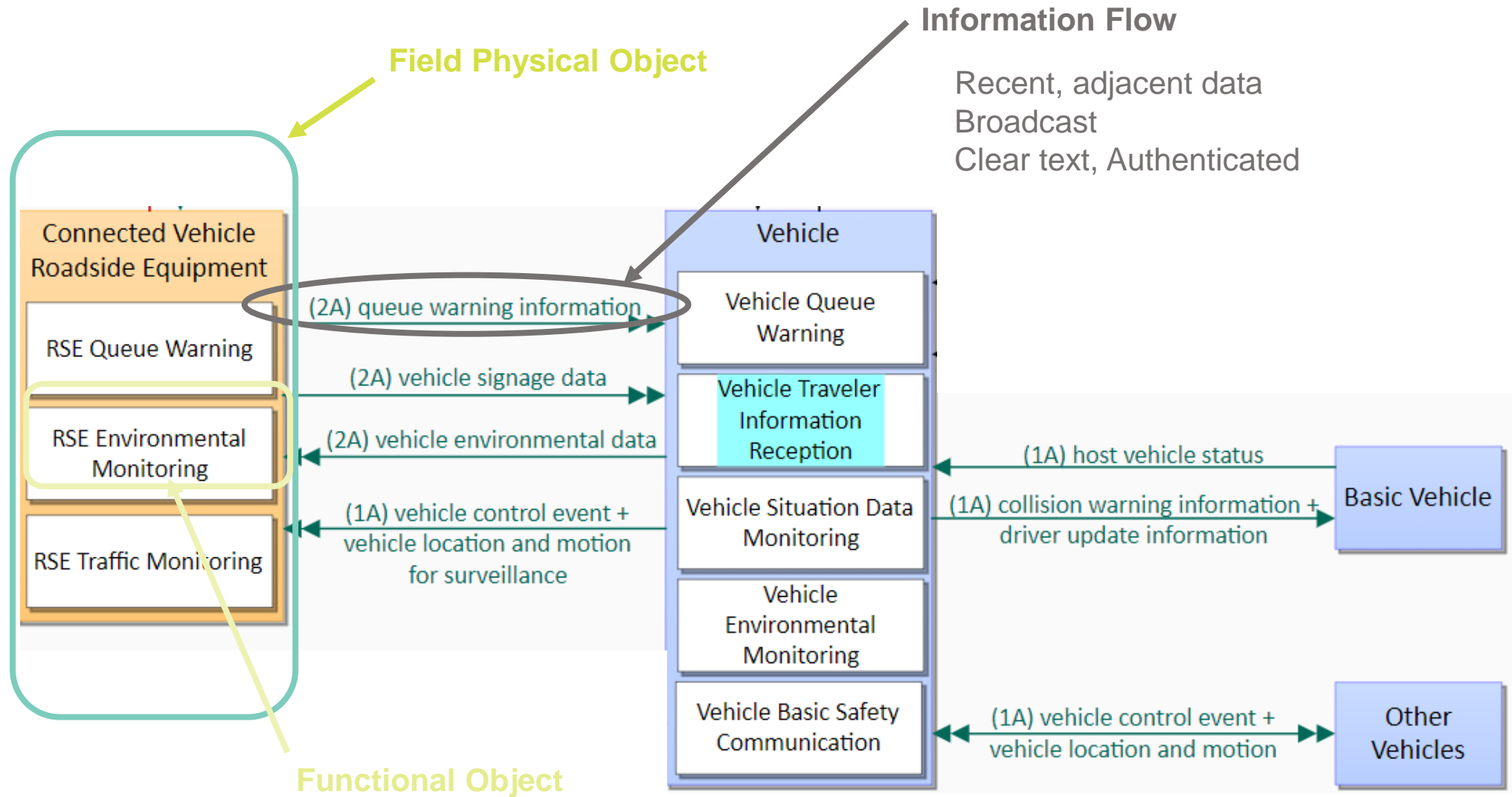
The Physical View Service Package Diagrams show the subset of the ARC-IT Physical View that supports each service package. These diagrams identify the physical objects, functional objects, and information flows that support each service package.

	<p>Physical objects are shown as colored rectangles. They represent the operational centers, field equipment, vehicle on-board equipment, personal devices, and support systems in the Intelligent Transportation Systems environment. They are color coded to identify which of these classes they belong to. Since they correspond closely with the physical transportation system, the interfaces between physical objects tend to be prime candidates for standardization.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; background-color: #00ffcc; padding: 5px; margin: 2px;">Center</div> <div style="border: 1px solid black; background-color: #ffcc00; padding: 5px; margin: 2px;">Field</div> <div style="border: 1px solid black; background-color: #ccccff; padding: 5px; margin: 2px;">Vehicle</div> <div style="border: 1px solid black; background-color: #ffff00; padding: 5px; margin: 2px;">Personal</div> <div style="border: 1px solid black; background-color: #ccffcc; padding: 5px; margin: 2px;">Support</div> <div style="border: 1px solid black; background-color: #cccccc; padding: 5px; margin: 2px;">ITS</div> </div>
	<p>People also have an operational role in ITS. People are shown in the physical view as colored rectangles that include a human silhouette that distinguishes them from the other physical objects that represent man-made parts of the Connected Vehicle environment. Like the other physical objects, they are color coded to represent the environment where they primarily operate.</p>
	<p>ITS must work within an operational environment that includes things like the road surface and striping, vulnerable road users and other objects to be detected and avoided, and unequipped vehicles that must be sensed to be avoided. This operational environment is depicted in ARC-IT with physical objects that represent the environment; these objects represent what field and vehicle-based sensors sense. All of these objects have three 'sensor' curves in the lower left corner. They may be colored as Field, Vehicle, or Personal depending on the portion of the environment they represent.</p>
	<p>Some of the physical objects defined in ARC-IT primarily provide a communications capability that enables other physical objects to share information. These communications objects are not shown on every interface where they apply to keep the service package diagrams manageable, but when they are included, they are shown as physical objects with the support class color and rounded corners to distinguish them from other physical objects.</p>

Service Packages Legend – Information Flows

	<p>Functional objects are shown as smaller white rectangles that are contained within a physical object. Functional objects define the functionality that is required for each physical object to support one or more service packages. The functional objects serve as service-oriented containers for the functionality defined in the Functional View. Not all physical objects include functional objects since functionality that is peripheral to a particular service may not be shown on the service package diagram. Physical objects that are peripheral to ITS (e.g., a Financial Center or Weather Service Center) may not include functional objects in any of the service packages. The interfaces to these physical objects are important to ITS, but ITS will not add functionality to these broader systems.</p>
	<p>Information flows between physical objects are shown as solid lines that include arrowheads to indicate the direction the information is flowing. The flow is labeled with one or more flow names that identify the information that is transferred. The source physical object, destination physical object, and information flow together identify a "triple". The relationship between functional objects and information flows are not shown on the diagram. Consult the website or the database to view the specific functional objects that are associated with each information flow.</p>
<p>Flow Time Context</p> <p>1 - Now 3 - Historical 2 - Recent 4 - Static</p>	<p>Flow Time Context is represented as a number to the left of the flow name. This indicates the time sensitivity of the data contained within the information flow. The values are "Now", "Recent", "Historical", or "Static" for data that never or rarely ever changes.</p>
<p>Flow Spatial Context</p> <p>A - Adjacent D - National B - Local E - Continental C - Regional</p>	<p>Flow Spatial Context is represented by a letter to the left of the flow name. This indicates the spatial relevance of the data contained within the information flow. The values are "Adjacent", "Local", "Regional", "National", or "Continental".</p>
<p>Flow Cardinality</p> <p>Unicast  Multicast  Broadcast </p>	<p>Flow Cardinality shows whether a flow is unicast (sent to one destination), multicast (sent to multiple addressees), or broadcast (sent to anyone with the right equipment). It is represented by the arrowhead – single, closed; single, open; or double, closed.</p>
<p>Flow Control</p> <p> Receipt acknowledged  Transaction initiated by left-hand party</p>	<p>A crossing line at the flow source indicates whether an information flow is acknowledged. Flows that are part of a transaction initiated by one side or the other are shown with a white box on the side that initiates the transaction. <i>(Note: the initiator boxes are only available in PNG format, the SVG drawings do not show the initiator boxes.)</i></p>
<p>Flow Security</p> <p>Clear text, No Authent.  Encrypted, No Authent.  Clear text, Authenticated  Encrypted, Authenticated </p>	<p>Flow Security is used to indicate what mechanisms should be in place in order for the information to get to its destination securely and in support of the overall security and privacy requirements for the system and its users. Black indicates 'clear' or no security specified; Blue indicates it should be encrypted but the sender does not have to be authenticated as the source of the message; Green indicates the information can be sent without encryption but the sender should be authenticated; Red indicates flows that require both encryption of the information and authentication of the source. These characteristics are based on a FIPS-199 analysis that evaluates confidentiality, integrity, and availability requirements for each triple.</p>

Service Packages Components



Queue Warning Example: Details of Physical View Page

Includes Physical Objects:

Physical Object	Class	Description
Connected Vehicle Roadside Equipment	Field	'Connected Vehicle Roadside Equipment' (CV RSE) represents the Connected Vehicle roadside devices that are used to send messages to, and receive messages from, nearby vehicles using Dedicated Short Range Communications (DSRC) or other alternative wireless communications technologies. Communications with adjacent field equipment and back office centers that monitor and control the RSE are also supported. This device operates from a fixed position and may be permanently deployed or a portable device that is located temporarily in the vicinity of a traffic incident, road construction, or a special event. It includes a processor, data storage, and communications capabilities that support secure communications with passing vehicles, other field equipment, and centers.

Includes Functional Objects:

Functional Object	Description	Physical Object
RSE Queue Warning	'RSE Queue Warning' provides V2I communications to support queue warning systems. It monitors connected vehicles to identify and monitor queues in real-time and provides information to vehicles about upcoming queues, including downstream queues that are reported by the Traffic Management Center.	Connected Vehicle Roadside Equipment

Includes Information Flows:

Information Flow	Description
queue warning information	Information regarding formed or impending queues (location of the end of queue, estimated duration of the queue, and other descriptions of the queue condition) and recommendations for upstream vehicles including speed reduction, lane change, or diversion recommendations.

Queue Warning Example – Functional Object

RSE Queue Warning

Physical Object:
Connected Vehicle
Roadside Equipment

Overview Requirements Information Flows Standards

Overview

'RSE Queue Warning' provides V2I communications to support queue warning systems. It monitors connected vehicles to identify and monitor queues in real-time and provides information to vehicles about upcoming queues, including downstream queues that are reported by the Traffic Management Center.

This functional object is included in the "[Connected Vehicle Roadside Equipment](#)" physical object.

This functional object is included in the following service packages:

- [VS08: Queue Warning](#)

This functional object is mapped to the following Functional View PSpecs:

- [1.1.2.6: Process Collected Vehicle Safety Data](#)
- [1.2.7.4: Process In-vehicle Signage Data](#)
- [1.2.7.7: Process Vehicle Safety and Environmental Data for Output](#)
- [6.7.3.5: Provide Short Range Traveler Information](#)


Queue Warning Example: Details of Physical View Page

Includes Physical Objects:

Physical Object	Class	Description
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Information Flow	Description
 queue warning information	Information regarding formed or impending queues (location of the end of queue, estimated duration of the queue, and other descriptions of the queue condition) and recommendations for upstream vehicles including speed reduction, lane change, or diversion recommendations.

Queue Warning Example: Information Flow

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[Home](#) > [Architecture](#) > [Views](#) > [Physical](#) > [Information Flows](#) > [queue warning information](#)

queue warning information

Information regarding formed or impending queues (location of the end of queue, estimated duration of the queue, and other descriptions of the queue condition) and recommendations for upstream vehicles including speed reduction, lane change, or diversion recommendations.

Source	Flow	Destination
Connected Vehicle Roadside Equipment	queue warning information	Vehicle

This Triple is in the following Service Packages:

- [VS08: Queue Warning](#)

This Triple is in the following Functional Objects:

- [RSE Queue Warning](#)
- [Vehicle Queue Warning](#)

This Triple is described by the following Functional View Data Flows:

- [queue warning from roadside](#)

Source	Flow	Destination
Transportation Information Center	queue warning information	Vehicle

This Triple is in the following Service Packages:

- [VS08: Queue Warning](#)

This Triple is in the following Functional Objects:

- [TIC Traffic Control Dissemination](#)
- [Vehicle Queue Warning](#)

This Triple is described by the following Functional View Data Flows:

- None




Queue Warning Example: Information Flow Triple

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[Home](#) > [Views](#) > [Physical](#) > [Triples](#) > [Connected Vehicle Roadside Equipment --> Vehicle: queue warning information](#)



[Connected Vehicle Roadside Equipment](#) --> [Vehicle: queue warning information](#)

Definition	Included In	Communication Solutions	Characteristics	Security
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Definitions

queue warning information (Information Flow): Information regarding formed or impending queues (location of the end of queue, estimated duration of the queue, and other descriptions of the queue condition) and recommendations for upstream vehicles including speed reduction, lane change, or diversion recommendations.

Connected Vehicle Roadside Equipment (Source Physical Object): 'Connected Vehicle Roadside Equipment' (CV RSE) represents the Connected Vehicle roadside devices that are used to send messages to, and receive messages from, nearby vehicles using Dedicated Short Range Communications (DSRC) or other alternative wireless communications technologies. Communications with adjacent field equipment and back office centers that monitor and control the RSE are also supported. This device operates from a fixed position and may be permanently deployed or a portable device that is located temporarily in the vicinity of a traffic incident, road construction, or a special event. It includes a processor, data storage, and communications capabilities that support secure communications with passing vehicles, other field equipment, and centers.





Vehicle (Destination Physical Object): This 'Vehicle' physical object is used to model core capabilities that are common to more than one type of Vehicle. It provides the vehicle-based general sensory, processing, storage, and communications functions that support efficient, safe, and convenient travel. Many of these capabilities (e.g., see the Vehicle Safety service packages) apply to all vehicle types including personal vehicles, commercial vehicles, emergency vehicles, transit vehicles, and maintenance vehicles. From this perspective, the Vehicle includes the common interfaces and functions that apply to all motorized vehicles. The radio(s) supporting V2V and V2I communications are a key component of the Vehicle. Both one-way and two-way communications options support a spectrum of information services from basic broadcast to advanced personalized information services. Advanced sensors, enhanced driver interfaces, and actuators complement the driver information services so that, in addition to making informed mode and route selections, the driver travels these routes in a safer and more consistent manner. This physical object supports all six levels of driving automation as defined in SAE J3016. Initial collision avoidance functions provide 'vigilant co-pilot' driver warning capabilities. More advanced functions assume limited control of the vehicle to maintain lane position and safe headways. In the most advanced implementations, this Physical Object supports full automation of all aspects of the driving task, aided by communications with other vehicles in the vicinity and in coordination with supporting infrastructure subsystems.

Communication Solutions View for Triple

Connected Vehicle Roadside Equipment --> Vehicle: queue warning information



Definition Included In **Communication Solutions** Characteristics Security

Communication Solutions

-   EU: DEN Service - BTP/GeoNetworking/G5 (10)
-  US: SAE Traveler Info - LTE-V2X WSMP (21)
-  US: SAE Traveler Info - WAVE WSMP (23)

Solutions are sorted in ascending Gap Severity order. The Gap Severity is the parenthetical number at the end of the solution.

Selected Solution

  EU: DEN Service - BTP/GeoNetworking/G5

Solution Description

This solution is used within Australia and the E.U.. It combines standards associated with EU: DEN Service with those for V-X: BTP/GeoNetworking/G5. The EU: DEN Service standards include upper-layer standards required to implement V2x decentralized environmental notification information flows. The V-X: BTP/GeoNetworking/G5 standards include lower-layer standards that support broadcast, near constant, low latency vehicle-to-vehicle and vehicle-to-infrastructure communications using the ETSI GeoNetworking Bundle over the 5.9GHz spectrum.



Communication Solution for Triple

[Connected Vehicle Roadside Equipment](#) --> [Vehicle OBE: queue warning information](#)

Link Type: Short Range
Wireless

Definition	Included In	Communication Solutions	Characteristics	Security
<p>Communication Solutions</p> <p>Name: SAE J2945/4 Road Safety Applications</p> <p>Long Name: Road Safety Applications</p> <p>Doc #: SAE J2945/4</p> <p>Version: -</p> <p>Copy URL: https://www.sae.org/standards/content/j2945/4/</p> <p>Description: This document revises and extends the existing SAE J2735 message elements in order to include additional travel and roadway information from the infrastructure to enhance safety awareness and promote the exchange and transfer of such messages types between vehicles and the infrastructure (V2I).</p>				
<p>ITS Application Gap</p> <p>SAE J2735 ⓘ</p> <p>SAE J2945/4 ⓘ</p> <p>Name: Draft not available (Critical)</p> <p>Gap Notes: SAE J2945/4 is still under development.</p> <p>Type: Standardization Gap</p> <p>Severity: High</p> <p>Description: The standards development organization has established a work item for the subject standard but a draft is not available for this critical feature to enable the interface. The draft may be missing due to the work item being new or simply a lack of activity on the work item.</p>				
<p>Mgmt</p> <p>Addressed Elsewhere ⓘ</p>	<p>Facilities</p> <p>SAE J2945 ⓘ</p> <p>TransNet</p> <p>IEEE 1609.3 ⓘ</p> <p>Access</p> <p>Bundle: WAVE - Subnet ⓘ</p>	<p>Security</p> <p>Bundle: IEEE_1609.2 ⓘ</p>		

Queue Warning Example: Needs and Requirements

Architecture ▾ Architecture Use ▾ Architecture Resources ▾ Architecture Terminology ▾ Contact The Architecture Team

ENHANCED E

Home > Service Packages > Queue Warning

<< VS07 : VS08 : VS09 >>

VS08: Queue Warning

This service package utilizes connected vehicle technologies, including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications, to enable vehicles within the queue event to automatically broadcast their queued status information (e.g., rapid deceleration, disabled status, lane location) to nearby upstream vehicles and to centers (such as the TMC). The infrastructure will broadcast queue warnings to vehicles in order to minimize or prevent rear-end or other secondary collisions. This service package is not intended to operate as a crash avoidance system.

Relevant Regions: Australia, Canada, European Union, and United States

Enterprise

Physical

The physical description is available in SVG Diagram and PNG Diagram formats.

Enterprise Functional Physical Goals and Objectives **Needs and Requirements** Sources Security Standards

Needs and Requirements

Need	Functional Object	Requirement
01 Traffic Operations needs to be able to detect a queue formation using both infrastructure and connected vehicle sources of information.	Roadway Basic Surveillance	01 The field element shall collect, process, digitize, and send traffic sensor data (speed, volume, and occupancy) to the center for further analysis and storage, under center control.
		02 The field element shall collect, process, and send traffic images to the center for further analysis and distribution.
		04 The field element shall return sensor and CCTV system operational status to the controlling center.
	Roadway Warning	01 The field element shall monitor for hazardous traffic conditions, including queues.
		05 The field element shall autonomously identify potentially hazardous conditions and activate warning signs to approaching motorists.
		07 The field element shall collect operational status of the warning system field equipment and report the operational status to the controlling center.
	RSE Environmental Monitoring	04 The field element shall provide application status to the center for monitoring.
	RSE Queue Warning	01 The field equipment shall communicate with the connected vehicles to gather real-time vehicle-collected data including vehicle speed, location and localized weather condition from the vehicle network.
	RSE Traffic Monitoring	01 The field element shall communicate with on-board equipment on passing vehicles to collect current vehicle position, speed, and heading and a record of previous events (e.g., starts and stops, link travel times) that can be used to determine current traffic conditions.
	TMC Basic Surveillance	01 The center shall monitor, analyze, and store traffic sensor data (speed, volume, occupancy) collected from field elements under remote control of the center.
		02 The center shall monitor, analyze, and distribute traffic images from CCTV systems under remote control of the center.
		04 The center shall distribute road network conditions data (raw or processed) based on collected and analyzed traffic sensor and surveillance data to other centers.
05 The center shall respond to control data from center personnel regarding sensor and surveillance data collection, analysis, storage, and distribution.		
06 The center shall maintain a database of surveillance equipment and sensors and associated data (including the roadway on which they are located, the type of data collected, and the ownership of		

Queue Warning Example – Sources

The screenshot shows a web application interface. At the top, there is a navigation bar with links for Architecture, Architecture Use, Architecture Resources, Architecture Terminology, and Contact The Architecture Team. A search bar on the right contains the text 'ENHANCED E'. Below the navigation bar, the breadcrumb trail reads 'Home > Service Packages > Queue Warning'. A navigation link '<< VS07 : VS08 : VS09 >>' is visible. The main heading is 'VS08: Queue Warning'. The description text states: 'This service package utilizes connected vehicle technologies, including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications, to enable vehicles within the queue event to automatically broadcast their queued status information (e.g., rapid deceleration, disabled status, lane location) to nearby upstream vehicles and to centers (such as the TMC). The infrastructure will broadcast queue warnings to vehicles in order to minimize or prevent rear-end or other secondary collisions. This service package is not intended to operate as a crash avoidance system. In contrast to such systems, this service package will engage well in advance of any potential crash situation, providing messages and information to the driver in order to minimize the likelihood of his needing to take crash avoidance or mitigation actions later. It performs two essential tasks: queue determination (detection and/or prediction) and queue information dissemination using vehicle-based, infrastructure-based, or hybrid solutions.' Below the description, it lists 'Relevant Regions: Australia, Canada, European Union, and United States'. A yellow arrow points down from this text to the 'Sources' tab in a tabbed interface. The 'Sources' tab is active, showing a table of related sources.

Enterprise Functional Physical Goals and Objectives Needs and Requirements Sources Security Standards

Related Sources

Document Name	Version	Publication Date
Concept Development and Needs Identification for INFLO: Functional and Performance Requirements, and High-Level Data and Communication Needs	Final	11/1/2012
Concept Development and Needs Identification for Intelligent Network Flow Optimization (INFLO), Functional and Performance Requirements, and High-Level Data and Communication Needs	Draft v5.0	11/1/2012
Report on Detailed Requirements for the INFLO Prototype	Final	12/27/2013
Report on Dynamic Speed Harmonization and Queue Warning Algorithm Design	Final	2/28/2014
System Design Document for the INFLO Prototype	Final	3/28/2014

Queue Warning Example – Security

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

Information Flow Security					
Source	Destination	Information Flow	Confidentiality	Integrity	Availability
			Basis	Basis	Basis
Basic Vehicle	Vehicle	<u>host vehicle status</u>	Low Unlikely that this includes any information that could be used against the originator.	Moderate This can be MODERATE or HIGH, depending on the application: This is used later on to determine whether a vehicle is likely going to violate a red light or infringe a work zone. This needs to be correct in order for the application to work correctly.	High Since this monitors the health and safety of the vehicle and that information is eventually reported to the driver, it should be available at all times as it directly affects vehicle and operator safety.
Connected Vehicle Roadside Equipment	ITS Roadway Equipment	<u>traffic situation data</u>	Moderate Aggregated messages may have more privacy implications than individual ones, especially if an attacker can attack more than one RSE-to-TMC connection at once.	Moderate This information is used to help with incident detection. It should be verified to ensure that it is not incorrectly influencing this. THEA: only limited adverse effect if raw/processed connected vehicle data is bad/compromised; could be LOW for ISIG	Moderate This information is used as supplemental information. It should operate correctly if not every single message is received. THEA: only limited adverse effect if info is not timely/readily available, could be LOW for ISIG
Connected Vehicle Roadside Equipment	Traffic Management Center	<u>environmental situation data</u>	Low Little to no impact if this data is observed	Moderate Only limited adverse effect if environmental data from vehicle safety and convenience systems is bad/compromised; can cope with some bad data; DISC: WYO believes this to be MODERATE HIGH. Changed from THEA's LOW inferring severity of weather data in Wyoming	Moderate Only limited adverse effect of info is not timely/readily available. DISC: WYO believes this to be MODERATE. Changed from THEA's LOW inferring severity of weather data in Wyoming
Connected Vehicle Roadside Equipment	Traffic Management Center	<u>queue warning application status</u>	Moderate This information could be of interest to a malicious individual who is attempting to determine the best way to accomplish a crime. As such it would be best to not make it easily accessible.	Moderate If this is compromised, it could send unnecessary maintenance workers, or cause the appearance of excessive traffic violations, leading to further unnecessary investigation.	Low A delay in reporting this may cause a delay in necessary maintenance, but (a) this is not time-critical and (b) there are other channels for reporting malfunctioning. Additionally, there is a message received notification, which means that RSE can ensure that all intersection safety issues are delivered.
Connected Vehicle Roadside Equipment	Traffic Management Center	<u>traffic situation data</u>	Moderate Aggregated messages may have more privacy implications than individual ones, especially if an attacker can attack more than one RSE-to-TMC connection at once.	Moderate only limited adverse effect if raw/processed connected vehicle data is bad/compromised; DISC: NYC believes this to be MODERATE: As investigation might be triggered if RF quality is reported as low, this data should be trusted. RES: Agree with NYC.	Low only limited adverse effect of info is not timely/readily available. NYC: This data is purely for statistical purposes so low availability does not harm the [RSE RF Monitoring] application.
Connected Vehicle Roadside Equipment	Vehicle	<u>queue warning information</u>	Not Applicable Broadcast and intended for public use.	Moderate Performance data that is compromised may result in incorrect actions taken by drivers, impacting their mobility and overall mobility throughout the transportation network.	Low Lack of this flow will have a slight negative impact on potential recipients, but there are other mechanisms to learn of traffic delays. Only in circumstances where queue states directly drive decisions with significant time impacts would this rise to MODERATE.
Connected Vehicle Roadside Equipment	Vehicle	<u>vehicle signage data</u>	Low This data is intentionally transmitted to everyone via a broadcast. It is meant to augment other signage data, and by definition is meant to be shared with everyone.	Moderate These signs are meant to augment other visual cues to the driver. They should be accurate, but any inaccuracies should be corrected for by other means.	Moderate These notifications are helpful to a driver, but if the driver does not receive this notification immediately, there should still be other visual cues.
			Moderate	High	High

Queue Warning Example – Standards

The screenshot shows a web application interface with a top navigation bar containing tabs for Enterprise, Functional, Physical, Goals and Objectives, Needs and Requirements, Sources, Security, and Standards. Below this is a secondary navigation bar with dropdown menus for Architecture, Architecture Use, Architecture Resources, Architecture Terminology, and Contact The Architecture Team, along with an 'ENHANCED E' button and a search icon. The breadcrumb trail reads 'Home > Service Packages > Queue Warning'. A pagination link '<< VS07 : VS08 : VS09 >>' is visible. The main heading is 'VS08: Queue Warning'. The description text states: 'This service package utilizes connected vehicle technologies, including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications, to enable vehicles within the queue event to automatically broadcast their queued status information (e.g., rapid deceleration, disabled status, lane location) to nearby upstream vehicles and to centers (such as the TMC). The infrastructure will broadcast queue warnings to vehicles in order to minimize or prevent rear-end or other secondary collisions. This service package is not intended to operate as a crash avoidance system. In contrast to such systems, this service package will engage well in advance of any potential crash situation, providing messages and information to the driver in order to minimize the likelihood of his needing to take crash avoidance or mitigation actions later. It performs two essential tasks: queue determination (detection and/or prediction) and queue information dissemination using vehicle-based, infrastructure-based, or hybrid solutions.' Below the text, it lists 'Relevant Regions: Australia, Canada, European Union, and United States'. A large yellow arrow points from this text to the 'Physical' tab in the bottom navigation bar. The 'Physical' tab is selected, and the content below it reads: 'The physical diagram can be viewed in SVG or PNG format and the current format is SVG.' followed by links for 'SVG Diagram' and 'PNG Diagram'.

Enterprise Functional Physical Goals and Objectives Needs and Requirements Sources Security Standards

Architecture Architecture Use Architecture Resources Architecture Terminology Contact The Architecture Team ENHANCED E

Home > Service Packages > Queue Warning

<< VS07 : VS08 : VS09 >>

VS08: Queue Warning

This service package utilizes connected vehicle technologies, including vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications, to enable vehicles within the queue event to automatically broadcast their queued status information (e.g., rapid deceleration, disabled status, lane location) to nearby upstream vehicles and to centers (such as the TMC). The infrastructure will broadcast queue warnings to vehicles in order to minimize or prevent rear-end or other secondary collisions. This service package is not intended to operate as a crash avoidance system. In contrast to such systems, this service package will engage well in advance of any potential crash situation, providing messages and information to the driver in order to minimize the likelihood of his needing to take crash avoidance or mitigation actions later. It performs two essential tasks: queue determination (detection and/or prediction) and queue information dissemination using vehicle-based, infrastructure-based, or hybrid solutions.

Relevant Regions: Australia, Canada, European Union, and United States

Enterprise Functional Physical Goals and Objectives Needs and Requirements Sources Security Standards

Physical

The physical diagram can be viewed in SVG or PNG format and the current format is SVG.

[SVG Diagram](#)

[PNG Diagram](#)

ARC-IT Website: Views



Architecture Use Architecture Resources Architecture Terminology Contact The Architecture Team

ENHANCED B

Service Packages

Views

- Enterprise
- Functional
- Physical
- Communications

Methodology

- Architecture Structure
- Enterprise Viewpoint
- Functional Viewpoint
- Physical Viewpoint
- Communications Viewpoint

Security

Architecture Reference for Cooperative and Intelligent Transportation

Cooperative and Intelligent Transportation (ARC-IT) provides a common framework for designing intelligent transportation systems. It is a mature product that reflects the consensus of the ITS community (transportation practitioners, systems engineers, system architects, consultants, etc.).

Architecture Structure: it provides common basis for planners and engineers with differing concerns to design intelligent transportation systems using a common language as a basis for delivering ITS, but does not replace existing standards. ARC-IT includes artifacts that answer **concerns** relevant to a large variety of users intended for transportation planners, regional architects and systems engineers to design, develop, and scope and develop projects.

Architecture Use: menu bar above:

- Architecture Use: links to all of the content inside the architecture, and describes the structure of the architecture.
- Service Packages** represent slices of the architecture that address a specific service like traffic signal control and provide the most straightforward entry into ARC-IT content.
- Views** and its sub-menus provide view-specific content; if for example you are looking for a particular **information flow**, or a particular **communications profile**, browse the relevant physical and communications sections here.
- Methodology** and its sub-menus describe the structure of the architecture: how it is built, how the artifacts within are inter-related.
- The **Security** section describes how security is addressed throughout the architecture and provides links to cross-cutting security content.
- Architecture Use** describes how to use ARC-IT, from the perspective of a regional architect, transportation planner or project systems engineer.
- Architecture Resources** provides access to all ARC-IT content in user-downloadable forms. Notably this also includes access to our tools: RAD-IT and SET-IT, that provide you with means to manipulate the architecture.

Latest News

ARC-IT 9.0 includes changes to all views of the National ITS Reference Architecture to incorporate a remodeled Communications view, new services, more detailed information exchanges, additional physical objects, and a revamped Architecture Use section. [Read more...](#)

November 2020 – Both **RAD-IT** and **SET-IT** have been updated with new communications view tools, auto-backup, bug fixes and performance improvements. See below for details.

RAD-IT 9.0 replaces the Standards tab with a more complete Communications tab. RAD-IT has been updated to correct known issues and to support conversion from previous versions. [Read more...](#)

SET-IT 9.0 includes a redesigned Communications view with tools to create and customize comm solutions as well as an improved Shape Properties tool. SET-IT has been updated to correct known issues and to support conversion from previous versions. [Read more...](#)

Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)

- Enterprise View**: Relationships between Organizations
- Functional View**: Logical Interactions between Functions
- Physical View**: Connections between Physical Objects
- Communications View**: Layered protocols facilitating data exchange between Physical Objects

ARC-IT Website: Views Page

Architecture ▾ Architecture Use ▾ Architecture Resources ▾ Architecture Terminology ▾ Contact The Architecture Team

Home > Architecture > Views

Views

The Architecture Reference for Cooperative & Intelligent Transportation (ARC-IT) provides a framework for planning, programming, and implementing intelligent transportation systems. As shown in the figure, ARC-IT is comprised of 4 Views:

- [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 functional 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

Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)

Relationships between Organizations
Enterprise View

Logical interactions between Functions
Functional View

Connections between Physical Objects
Physical View

Layered protocols facilitating data exchange between Physical Objects
Communications View

ARC-IT Website: Enterprise View Page

Architecture ▼ Architecture Use ▼ Architecture Resources ▼ Architecture Terminology ▼ Contact The Architecture Team

ENHANCED E

[Home](#) > [Architecture](#) > [Views](#) > Enterprise

Enterprise


The Enterprise View addresses the relationships between organizations and users, and the roles those entities play in the delivery and consumption of ITS services. Relationships between entities are dependent on the roles those entities take in the delivery of user services.

The building blocks of ARC-IT's Enterprise View are [Enterprise Objects](#) that interact to exchange information, manage and operate systems beyond the scope of one organization. The Enterprise View focuses on the relationships between those Enterprise Objects, but also defines how Enterprise Objects interact with Physical Objects, which appear in the Enterprise View as [Resources](#).

The [relationships](#) between Enterprise Objects are organized as various types of Coordination: an agreement or contract intended to achieve the common purposes necessary to implement and deliver an ITS service. The relationship between an Enterprise Object and a Resource is a [Role](#): owns, operates, develops, installs, maintains, etc.

[Stakeholders](#) take the position of Enterprise Objects when they participate in ITS. Stakeholders have [needs](#) – capabilities they require from ITS in order to accomplish a goal or solve a problem.

With ARC-IT version 8.1 and later, the Enterprise View defines the various roles and relationships that support aspects of the development, installation, operations and maintenance phases of the [system life cycle](#). The [enterprise viewpoint](#) specification provides the background for enterprise relationships in the United States, and defines the graphical language used within SET-IT to illustrate project-level enterprise relationships.



The diagram, titled "Enterprise View", illustrates the relationships between organizations. It features three stylized human icons (two men and one woman) on the left. To their right is a flowchart with four blue square boxes connected by arrows, representing a process flow. Below the flowchart, the text "Relationships between Organizations" is displayed.

ARC-IT Website: Functional View Page

Architecture ▼ Architecture Use ▼ Architecture Resources ▼ Architecture Terminology ▼ Contact The Architecture Team

ENHANCED E

[Home](#) > [Architecture](#) > [Views](#) > Functional

Functional

The Functional View addresses the analysis of abstract functional elements and their logical interactions. Here ARC-IT is depicted as a set of [Processes](#) organized hierarchically. These Processes (activities and functions) trace to a set of [Requirements](#) derived from source documents. The [data flows](#) that move between processes and the data stores where data may reside for longer periods are all defined in a Data Dictionary.

The behavior of a Function (aka Process) is the set of actions performed by this element to achieve an objective. A Process performs actions to achieve an application objective or to support actions of another Process. This may involve data collection, data transformation, data generation, data generation or processing in performing those actions. The Functional View defines Processes to control and manage system behavior, such as monitoring, and other active control elements that are part of describing the functional behavior of the system. It also describes data processing functions, data stores and the logical flows of information among these elements.

The Functional View is modeled using a Structure Analysis methodology. This uses the National ITS Architecture's Logical Architecture as the starting point that was based on the work of Hatley/Pirbhai and included Yourdon-Demarco Data Flow Diagrams (DFDs) to illustrate the flow of data between functional elements. For expedience in ARC-IT the diagrams are not included – just the collections of processes and their data flows. The reader should use the Physical view diagrams for graphical representations of system behavior.

For details on how the functional view is structured, see the [functional viewpoint](#) specification.

Functional View

Logical Interactions between Functions

ARC-IT Website: Physical View Page

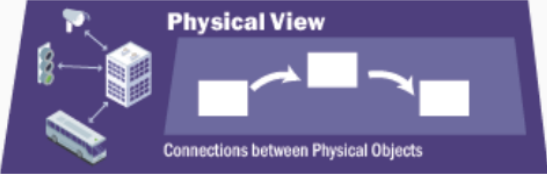
Architecture ▼ Architecture Use ▼ Architecture Resources ▼ Architecture Terminology ▼ Contact The Architecture Team

ENHANCED E

Home > Architecture > Views > Physical

Physical

The physical view describes the transportation systems and the information exchanges that support ITS. In this view, the Architecture is depicted as a set of integrated [Physical Objects](#) (Subsystems and Terminators) that interact and exchange information to support the Architecture service packages. Physical Objects are defined to represent the major physical components of the ITS Architecture. Physical Objects include subsystems, and terminators that together provide a set of capabilities that are more than would be implemented at any one place or time. Subsystems are Physical Objects that are part of the overall Intelligent Transportation System and provide the functionality that is 'inside-the-boundary' of ITS. Terminators are Physical Objects that lie at the boundary of ITS and supply information needed by ITS' functions or receive information from ITS. [Functional Objects](#) break up the subsystems into deployment-sized pieces and define more specifically the functionality and interfaces that are required to support a particular Service Package. [Information Flows](#) depict the exchange of information that occurs between Physical Objects (Subsystems and Terminators). The information exchanges in the Physical View are identified by [Triples](#) that include the source and destination Physical Objects and the Information Flow that is exchanged.



The Physical view is related to the other Architecture views. Each Functional Object is linked to the Functional View, which describes more precisely the functions that are performed and the details of the data that is exchanged by the object. Physical Objects and Functional Objects are also depicted as Resources in the Enterprise view, which describes the organizations that are involved and the roles they play in installing, operating, maintaining, and certifying all of the components of the Architecture.

At the heart of the physical view, the physical objects are organized into six different Classes that define ITS at the highest level of abstraction. A general "ITS" Class covers all of ITS while five more specific classes (Center, Support, Field, Vehicle, and Personal) are used to group physical objects based on where they reside and fundamentally how they behave and interact with other physical objects. Each of the classes is shown in the figure below.

ITS

ARC-IT Website Communications View Page


Architecture ▼ Architecture Use ▼ Architecture Resources ▼ Architecture Terminology ▼ Contact The Architecture Team

ENHANCED E

Home > Architecture > Views > Communications

Communications

The Communications View identifies the protocol stacks needed to implement an information flow between a source and destination (e.g., information flow triple) in the Physical View. ARC-IT terms these protocol stacks as "solutions". [Solutions](#) are composed of a collection of industry [standards](#); usually formally developed standards produced by a standards development organization, but often a published specification such as an IETF RFC. Each triple from the Physical View is associated with one or more solutions. These solutions, their components and attributes can be examined from several different perspectives and from different places within ARC-IT.



A typical triple solution is assembled according to the ARC-IT communications model, as defined by the [communications viewpoint](#). All solutions are built according to this model, and the components of the solution assigned to the various parts of the model depending on their role in the solution. Sometimes a standard satisfies multiple aspects of a solution, and so might appear more than once in an illustration of the solution. Triple solutions are accessible from several places, but are most commonly from the context of a [service package](#) by clicking on the flow or from the overall list of ARC-IT [triples](#).

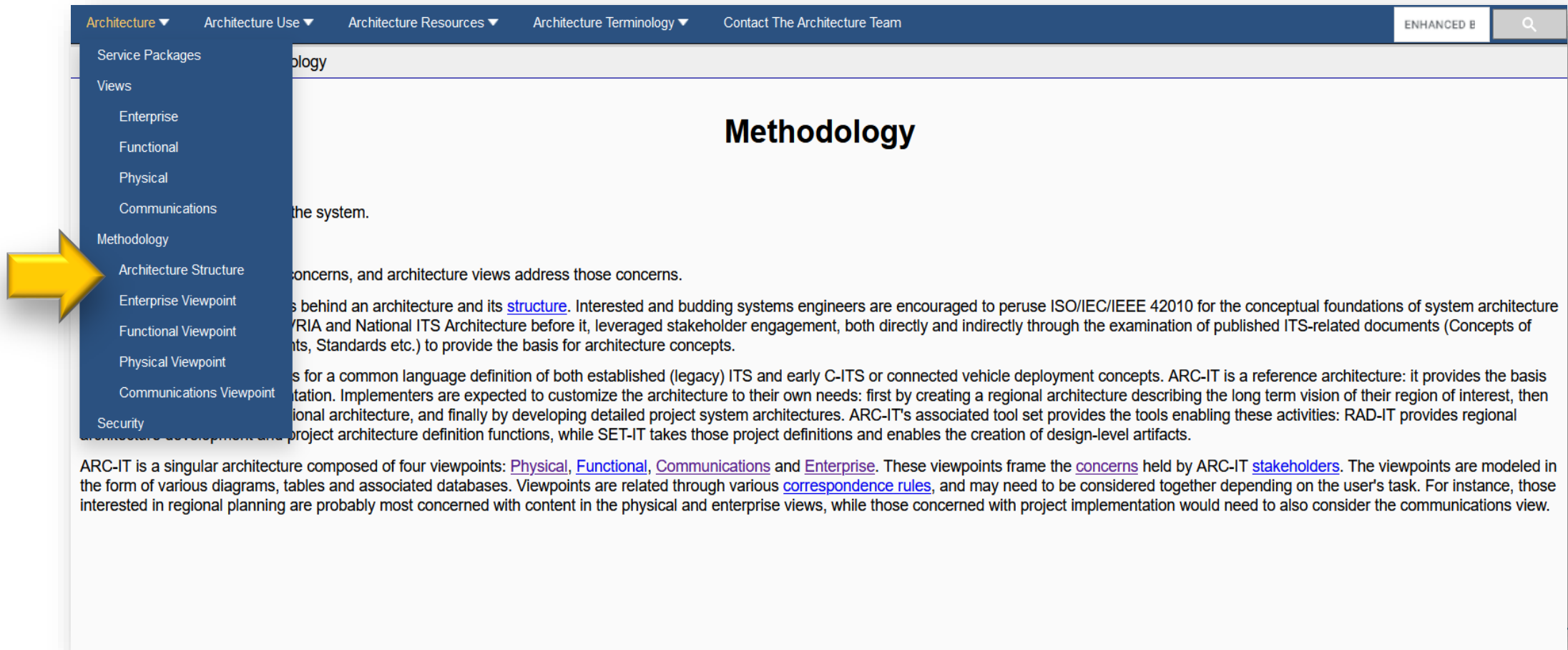
A sample triple solution is shown at right. Standards names are sometimes hyperlinked: this indicates the standard is actually part of a group of standards or one of several alternatives; clicking on the link will expand the bundle or explain the alternatives. 'Info' buttons next to standards generate pop-ups that provide some detail about the standard in question.

ITS Info

ITE TMDD Vol 2 ⓘ

gap Click gap icons for more info.

ARC-IT Website: Methodology



The screenshot shows the ARC-IT website's navigation menu on the left, with a yellow arrow pointing to the 'Methodology' item. The main content area displays the title 'Methodology' and the beginning of a paragraph: '...ology' followed by 'the system.' Below this, there are several paragraphs of text discussing architecture concerns, viewpoints, and the ARC-IT methodology. The text includes phrases like 'concerns, and architecture views address those concerns.', 'behind an architecture and its [structure](#). Interested and budding systems engineers are encouraged to peruse ISO/IEC/IEEE 42010 for the conceptual foundations of system architecture', 'YRIA and National ITS Architecture before it, leveraged stakeholder engagement, both directly and indirectly through the examination of published ITS-related documents (Concepts of', 'nts, Standards etc.) to provide the basis for architecture concepts.', 's for a common language definition of both established (legacy) ITS and early C-ITS or connected vehicle deployment concepts. ARC-IT is a reference architecture: it provides the basis', 'tation. Implementers are expected to customize the architecture to their own needs: first by creating a regional architecture describing the long term vision of their region of interest, then', 'ional architecture, and finally by developing detailed project system architectures. ARC-IT's associated tool set provides the tools enabling these activities: RAD-IT provides regional', 'project architecture definition functions, while SET-IT takes those project definitions and enables the creation of design-level artifacts.'

ARC-IT is a singular architecture composed of four viewpoints: [Physical](#), [Functional](#), [Communications](#) and [Enterprise](#). These viewpoints frame the [concerns](#) held by ARC-IT [stakeholders](#). The viewpoints are modeled in the form of various diagrams, tables and associated databases. Viewpoints are related through various [correspondence rules](#), and may need to be considered together depending on the user's task. For instance, those interested in regional planning are probably most concerned with content in the physical and enterprise views, while those concerned with project implementation would need to also consider the communications view.

ARC-IT Website: Architecture Structure

Architecture ▼ Architecture Use ▼ Architecture Resources ▼ Architecture Terminology ▼ Contact The Architecture Team

ENHANCED B

[Home](#) > [Architecture](#) > [Methodology](#) > Architecture Structure

Architecture Structure

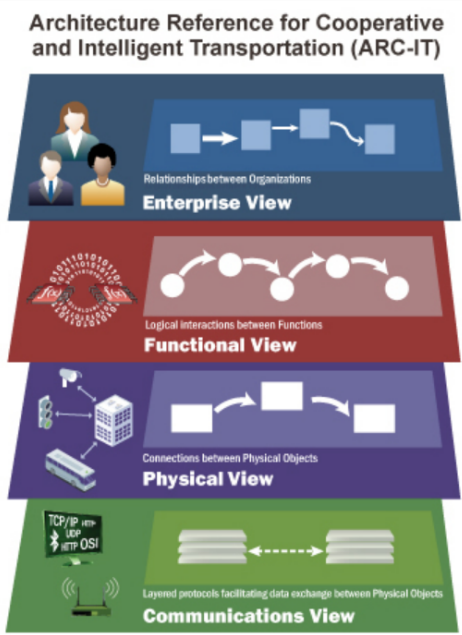
The diagram depicts ARC-IT as a set of layered viewpoints - each providing a different perspective to understand the architecture.

The approach to develop a System Architecture in this way is based on ISO/IEC/IEEE 42010:2011, a standard for "Systems and software engineering — Architecture description." This includes steps to define, not just data and messages, but the full environment in which the stakeholder concerns are satisfied. The figure to the right identifies the four Viewpoints used to describe ARC-IT: [Enterprise](#), [Functional](#), [Physical](#), and [Communication](#). While there is only one model per View, the models used result in a large number of diagrams per View. Only by considering all aspects of the model can one understand the scope of each Viewpoint and thus gain a complete picture the architecture.

Each Viewpoint includes a specification that describes the concerns addressed by that particular viewpoint. The accompanying viewpoint specifications also define the relevant model constructs, serving as a legend for the diagrams.

In addition to the four viewpoints, ARC-IT provides a fifth perspective: the ITS service package (formerly ITS application) perspective. This is not a viewpoint per se, but rather a way of looking at subsets of each view focused on a specific service or group of services. Service packages are derived from documentation like ConOps, System Requirements, standards, and other documents that have been written to describe parts of the Cooperative ITS environment. It should be noted that this is not an exhaustive list - new services will be developed over time and the architecture modified appropriately.

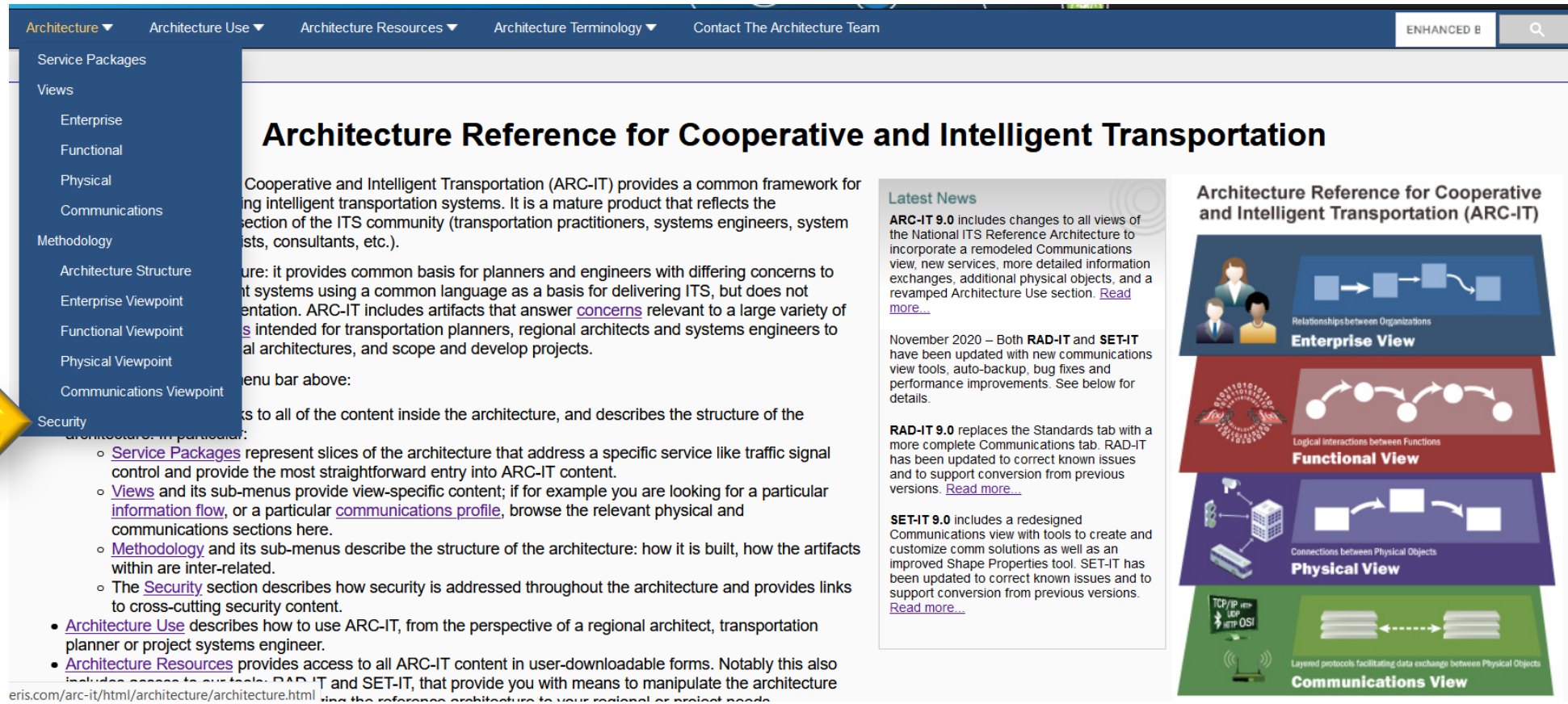
The Architecture Viewpoints are related through various [correspondence rules](#).



Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)

- Enterprise View**: Relationships between Organizations
- Functional View**: Logical interactions between Functions
- Physical View**: Connections between Physical Objects
- Communications View**: Layered protocols facilitating data exchange between Physical Objects

ARC-IT Website: Security



The screenshot shows the ARC-IT website's navigation menu. A yellow arrow points to the 'Security' option in the 'Views' sub-menu. The main content area displays the title 'Architecture Reference for Cooperative and Intelligent Transportation' and a list of articles. A sidebar on the right contains 'Latest News' and a diagram of the four views: Enterprise View, Functional View, Physical View, and Communications View.

Architecture Use Architecture Resources Architecture Terminology Contact The Architecture Team ENHANCED B

Service Packages

Views

- Enterprise
- Functional
- Physical
- Communications
- Methodology
- Architecture Structure
- Enterprise Viewpoint
- Functional Viewpoint
- Physical Viewpoint
- Communications Viewpoint
- Security

Architecture Reference for Cooperative and Intelligent Transportation

Cooperative and Intelligent Transportation (ARC-IT) provides a common framework for designing intelligent transportation systems. It is a mature product that reflects the consensus of the ITS community (transportation practitioners, systems engineers, system architects, consultants, etc.).

ARC-IT provides a common basis for planners and engineers with differing concerns to deliver intelligent transportation systems using a common language as a basis for delivering ITS, but does not limit the scope of the architecture. ARC-IT includes artifacts that answer **concerns** relevant to a large variety of transportation systems. It is intended for transportation planners, regional architects and systems engineers to develop regional architectures, and scope and develop projects.

Menu bar above:

- Architecture Use describes how to use ARC-IT, from the perspective of a regional architect, transportation planner or project systems engineer.
- Architecture Resources provides access to all ARC-IT content in user-downloadable forms. Notably this also includes access to our tools: RAD-IT and SET-IT, that provide you with means to manipulate the architecture using the reference architecture to your regional or project needs.

Service Packages represent slices of the architecture that address a specific service like traffic signal control and provide the most straightforward entry into ARC-IT content.

Views and its sub-menus provide view-specific content; if for example you are looking for a particular **information flow**, or a particular **communications profile**, browse the relevant physical and communications sections here.

Methodology and its sub-menus describe the structure of the architecture: how it is built, how the artifacts within are inter-related.

The **Security** section describes how security is addressed throughout the architecture and provides links to cross-cutting security content.

Latest News

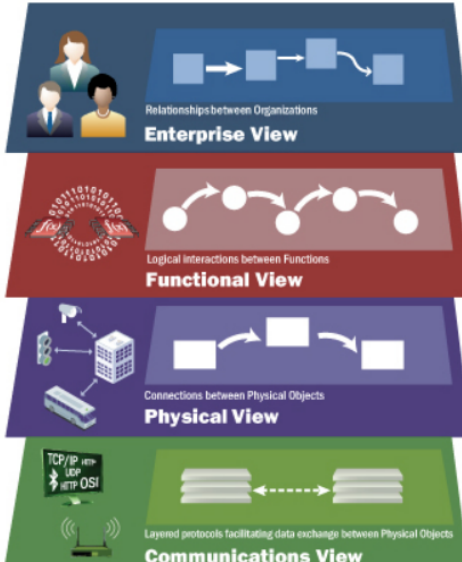
ARC-IT 9.0 includes changes to all views of the National ITS Reference Architecture to incorporate a remodeled Communications view, new services, more detailed information exchanges, additional physical objects, and a revamped Architecture Use section. [Read more...](#)

November 2020 – Both **RAD-IT** and **SET-IT** have been updated with new communications view tools, auto-backup, bug fixes and performance improvements. See below for details.

RAD-IT 9.0 replaces the Standards tab with a more complete Communications tab. RAD-IT has been updated to correct known issues and to support conversion from previous versions. [Read more...](#)

SET-IT 9.0 includes a redesigned Communications view with tools to create and customize comm solutions as well as an improved Shape Properties tool. SET-IT has been updated to correct known issues and to support conversion from previous versions. [Read more...](#)

Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)



- Enterprise View**: Relationships between Organizations
- Functional View**: Logical interactions between Functions
- Physical View**: Connections between Physical Objects
- Communications View**: Layered protocols facilitating data exchange between Physical Objects

ARC-IT Website: Security

Architecture ▼ Architecture Use ▼ Architecture Resources ▼ Architecture Terminology ▼ Contact The Architecture Team

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[Home](#) > Security

Security

Security [concerns](#) related to ITS are focused on protection of surface transportation information and infrastructure. Surface transportation is now, more than ever, relying on information technologies to sense, collect, process and disseminate information to improve the efficiency of moving goods and people, improve the safety of our transportation system and provide travel alternatives.

Security concerns are addressed in the ITS Architecture in two ways:

1. [Securing ITS](#): ITS as an information system must be protected so that ITS applications are trusted, reliable and available when they are needed. This aspect of security applies to all the physical objects and information flows, impacts all enterprise objects, and affects the structure and content of communications profiles. "Securing ITS" provides the foundation for ITS and especially C-ITS, since ITS systems must be secure before they can reliably be used to improve the efficacy of the surface transportation system.
2. [ITS Security Areas](#): ITS can be used to enhance the security of the surface transportation system. Eight security areas define the ways that ITS can be used to detect, respond to, and recover from [threats](#) against the surface transportation system. These eight ITS security areas are shown at the top of the figure below, supported by the "Securing ITS" security services that make ITS secure. Specific subsystems, information flows, service packages, and supporting physical and logical architecture definitions have been defined for each ITS security area.



ITS Security Areas

- Disaster Response and Evacuation
- Freight and Commercial Vehicle Security
- ZMAT Security
- Wide Area Alert
- Rail Security
- Transit Security
- Transportation Infrastructure Security
- Traveler Security

ARC-IT Website: Architecture Use

Architecture ▾ Architecture Resources ▾ Architecture Terminology ▾ Contact The Architecture Team

Home > Architect

- ARC-IT & Planning
- Regional Architecture Definition
- Regional Architecture Use
- Project Development

Architecture Use

ARC-IT is a reference architecture that provides a common basis for planners and engineers with differing concerns to conceive, design and implement systems using a common language as a basis for delivering ITS, but does not mandate any particular implementation. The National ITS Architecture was developed over 25 years ago in order to:

- Provide a National "Vision" for ITS
- Guide Sound ITS Planning and Investments at the State and Local Level
- Identify and Scope Need for ITS Standards

In order to provide a connection between transportation planning and ARC-IT, the website provides a connection between planning attributes defined by the USDOT and the views of ARC-IT. This connection is described on the ARC-IT Connection to Planning pages. The planning attributes for which this connection is defined are:

- **Planning Factors:** There are seven planning factors defined by the most recent Transportation authorization bill, Fixing America's Surface Transportation (FAST), that metropolitan planning organizations (MPOs) and states should consider when developing their transportation plans.
- **Goals:** Transportation planning begins with a set of broad goals that reflect the desired outcomes and the transportation vision for the region. The representative goals included in the ARC-IT mapping to planning are closely tied to the planning factors.
- **Objectives:** Each of the goals in a metropolitan or statewide transportation plan is supported by one or more 'objectives' that define what needs to occur to accomplish the goals. A range of objectives are included in the ARC-IT mapping to planning, gathered from a variety of references and recent transportation plans, that reflect the spectrum of objectives that are used in current practice.

In order to guide the investments in ITS at the state and local level, 23 CFR 940 requires the creation of a Regional ITS Architecture, which is defined by the regulation as "a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects". The definition of the components of a Regional ITS Architecture and an approach for the update or development of these architectures is provided [Regional ITS Architecture Definition and Development](#).

A regional ITS architecture can effectively bridge the gap between strategic planning for an integrated surface transportation system and the ITS projects that support that strategic vision. The principal value of a regional ITS architecture is that it provides a context for projects that include ITS so that each project can build a piece of a larger system. The regional ITS architecture can be used to visualize and articulate the overall ITS system for the region so that all the stakeholders in a region spend their money compatibly instead of competitively. A discussion of the ways to use a Regional ITS Architecture are found at [Regional ITS Architecture Use](#).

Additional information on how the components of ARC-IT support architecture use can be found at: [More on ARC-IT Use](#)

ARC-IT Website: Regional ITS Architecture Definition

Architecture ▾ Architecture Use ▾ Architecture Resources ▾ Architecture Terminology ▾ Contact The Architecture Team ENHANCED B 🔍

[Home](#) > [Architecture Use](#) > Regional ITS Architecture Definition

Regional ITS Architecture Definition

Intelligent Transportation Systems (ITS) have been defined as: "the application of advanced sensor, computer, electronics, and communication technologies and management strategies—in an integrated manner—to improve the safety and efficiency of the surface transportation system". This definition encompasses a broad array of systems and information processing and communications technologies. In order to fully incorporate ITS into the surface transportation network, ITS must be "mainstreamed" into the overall transportation planning and project development processes that exist in each state and metropolitan region of the country.

To support that effort a Regional ITS Architecture is developed as "a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects". Regional ITS Architectures can be and have been developed and maintained by state departments of Transportation (DOTs) or by Metropolitan Planning Organizations (MPOs) or Council of Governments (COGs) for a region, district, or state. The concept of a regional ITS architecture was first defined in 23 CFR 940 on *Intelligent Transportation System Architecture and Standards*. See "[US DOT Policy on Regional ITS Architecture](#)" below for more about the federal regulations dealing with ITS.

To support that effort a Regional ITS Architecture is developed as "a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects". Regional ITS Architectures can be and have been developed and maintained by state departments of Transportation (DOTs) or by Metropolitan Planning Organizations (MPOs) or Council of Governments (COGs) for a region, district, or state.

Click one of the links below to learn more about Regional ITS Architectures:

- [Purpose](#) – describes the purpose of a regional ITS architecture
- [US DOT Policy](#) – describes the regulations behind the establishment of architectures in the US and how they are used
- [Components](#) – contains all the components of a regional ITS architecture and how they are developed
- [Approach](#) – describes different approaches to developing a regional ITS architecture either as an update to an existing architecture or as a new development effort

[Architecture Maintenance](#) will describe the effort to maintain an architecture and how

ARC-IT Website: Regional ITS Architecture Use

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[Home](#) > [Architecture Use](#) > [Regional ITS Architecture Definition](#) > Regional ITS Architecture Use

Regional ITS Architecture Use

The implementation of transportation projects can be seen as a lifecycle as shown below and the regional ITS architecture can be used to support the planning, programming, and implementation of those projects, as described in this section.

```
graph TD; LRP[Long Range Planning] -- "Identified Project" --> PB[Programming/Budgeting]; PB -- "Funded Project" --> IM[Implementation]; IM -- "Implemented Project" --> OM[Operations & Maintenance]; OM -- "Monitoring & Evaluation" --> LRP;
```

= Regional Architecture Use

ARC-IT Website: Use in Project Development



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Home > Architecture Use > Use in Project Development

Use in Project Development

The [regional ITS architecture](#) provides context for ITS projects. By using the regional ITS architecture as a starting point, the steps taken by each project will be on the path to the larger objectives set forth in the long range transportation plan. The ARC-IT tools, RAD-IT and SET-IT, allow the transportation planner and project developer to use ARC-IT to create their own regional ITS architecture and project architectures, respectively. These tailored architectures are not just references: they are structured descriptions of services provided, relationships required, and items to be deployed, operated, maintained and managed. As responsibility shifts from the planner to the project developer, ARC-IT tool use shifts from RAD-IT to SET-IT.

Architecture Use

A well-maintained regional architecture can provide a tool for making a strong initial start in doing the systems engineering for a project. Regional ITS architecture content such as the stakeholders, their roles and responsibilities (included in the operational concept), elements, service packages, and the list of agreements supports the project concept of operations. The functional requirements are high-level requirements that can support system requirements development, and the interfaces and ITS standards support project design. In addition to assisting project implementers in the preliminary engineering stage, planners may also benefit from participating in the conceptual development of projects and strategies prior to the start of the formal project development. These components can inform creation of project documents, including Requests for Proposals (RFPs), and architectural details can inform the project's scope of work.

The items from the regional ITS architecture that are used to jumpstart the systems engineering process are derived from ARC-IT using the Regional Architecture Development tool for Intelligent Transportation (RAD-IT), formerly known as Turbo Architecture. The subsystems and terminators used to define the inventory elements, functional objects and functional requirements, information flows used to define the interfaces, and related ITS standards are all derived from the ARC-IT definition. More information on how the regional ITS architecture can be used to start to support systems engineering is included in the [Systems Engineering for ITS Handbook](#), and the [Systems Engineering Guidebook for ITS](#).

Regional Architecture

Feasibility Study / Concept Exploration

Concept of Operations

System Requirements

High-Level Design

Detailed Design

RAD-IT Scope

SET-IT Scope

ARC-IT Website: Architecture Resources



Architecture ▾ Architecture Use ▾ Architecture Resources ▾ Architecture Terminology ▾ Contact The Architecture Team

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[Home](#) > Resources

Resources

This page provides links to various resources that will complement your understanding of ARC-IT.

- [ARC-IT Website Download](#) - provides the ARC-IT website to be viewed (VIEW-IT) offline.
- [Databases](#) - provides the Microsoft Access compatible databases that contain the source material for ARC-IT content
- [Documents](#) - provides a set of links to documents related to ARC-IT
- [Tools](#) - provides the links to download a copy of ARC-IT software tools: Regional Architecture Development for Intelligent Transportation (RAD-IT) and the Systems Engineering Tool for Intelligent Transportation (SET-IT)
- [Training](#) - provides on-line training material on ARC-IT, RAD-IT, and SET-IT
- [Presentations](#) - provides copies of presentation material from public workshops and webinars that have been conducted regarding the architecture

ARC-IT Website: Architecture Terminology



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[Home](#) > [Architecture Terminology](#) > Acronyms

Acronyms

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

AAA: American Automobile Association

AACN: Advanced Automatic Crash Notification

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[Home](#) > [Architecture Terminology](#) > Glossary

Glossary

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0-9

Access Control

Refers to mechanisms and policies that restrict access to computer resources. An access control list (ACL), for example, specifies what operations different users can perform on specific files and directories.

ARC-IT Website: Contact Us Page

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[Home](#) > Contact The Architecture Team

Contact The Architecture Team

The ARC-IT Team is very interested in input that will help us improve the architecture. We encourage you to provide us with your suggestions or additions to ARC-IT, by filling out the form below with your suggestions or comments.

***Required fields**

*Name:

Organization:

*E-mail:

*Comment:

A large teal circle containing the text 'ARC-IT Website Tour Summary' in white. The slide is decorated with various geometric shapes: a teal circle in the top left, a yellow triangle in the top right, an orange circle in the middle left, a yellow square in the bottom left, and several orange and teal shapes in the bottom center.

ARC-IT Website Tour Summary

- Provides access to all key components of the reference architecture
 - Service Packages provide easy access
 - Viewpoints provide alternative access
- Guidance for Architecture Use
- Additional Resources
 - Guides
 - Recorded training
 - RAD-IT / SET-IT downloads
 - Downloadable Website
 - Databases

Training Schedule

Session Topic	Description	Date / Time
Detailed ITS Architecture Training	Provides more detailed and comprehensive training on key architecture components and how to access them through the ARC-IT website.	Today
Regional ITS Architecture Development	Provides a high-level overview of the regional ITS Architecture development process, incorporating examples from the ARC-IT RAD-IT tool.	Wednesday December 6, 2023 1:30PM–4:00PM EST
Systems Engineering Training	Provides an introduction to the concept of Systems Engineering, its importance to the lifecycle of delivering ITS, and how the Architecture helps support to the process.	Wednesday December 13, 2023 1:30PM–4:00PM EST

- French stream: January 30, February 6, and February 13, 2024.
- English stream #2: February 14, February 21, and February 28, 2024.

Questions or
Comments?

Email contacts:

- Support: ITSArchitecture-ArchitectureSTI@tc.gc.ca
- Jonathan Parent Jonathan.Parent@tc.gc.ca
- Mara Bullock mara.bullock@wsp.com



Thank You for Joining!



Regional ITS Architecture Training

December 6, 2023



Transport
Canada

Transports
Canada

Canada 



Webinar Tips and Protocols


- You can ask questions at any time using the question and answer box. We will answer as many questions as possible.
- You can also raise your hand to ask questions verbally if you wish.
- **Please keep your line muted.**
- You may also send your questions via email at ITSArchitecture-ArchitectureSTI@tc.gc.ca to be answered later.

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Acknowledgements



This presentation is based on training materials prepared by the United States Department of Transportation (USDOT).

Transport Canada would like to thank the ITS Architecture for Canada Stakeholder Advisory Committee and others that have graciously reviewed the training material and provided pictures, graphics and other material.

Goals and Objectives

1

Understand the purpose of
Regional ITS Architectures

2

Understand fundamentals
of developing a Regional
ITS Architecture

3

Understand the basics of
the RAD-IT tool

Agenda

- ITS Architecture review
- Introduction to Regional ITS Architectures
- Review of the Regional ITS Architecture development process

A note on spelling: U.S. spelling has been used in this presentation for consistency with ARC-IT



ITS Architecture Review



Transport
Canada

Transports
Canada

Canada



What is ITS?

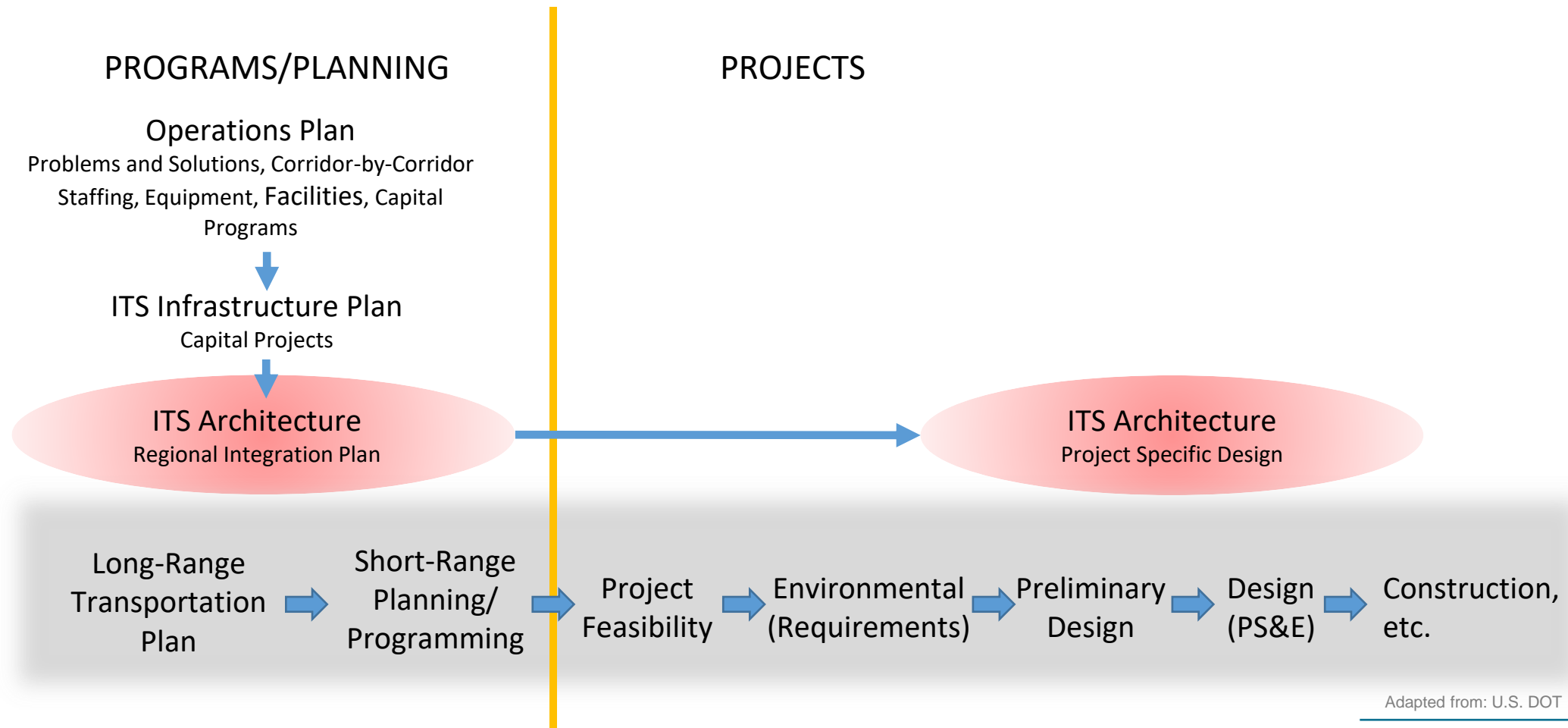
Intelligent Transportation Systems (ITS) integrate different information and communications technologies into road transportation infrastructure and vehicles, to help make the transportation system safer and more efficient.

What is an ITS Architecture?

- Framework for Developing Integrated Transportation Systems
- Identifies:
 - Organizations
 - Systems operated
 - Functions performed
 - Information exchanged
 - Communications
- **WITHOUT** getting into specific technologies
 - Technology Neutrality is key

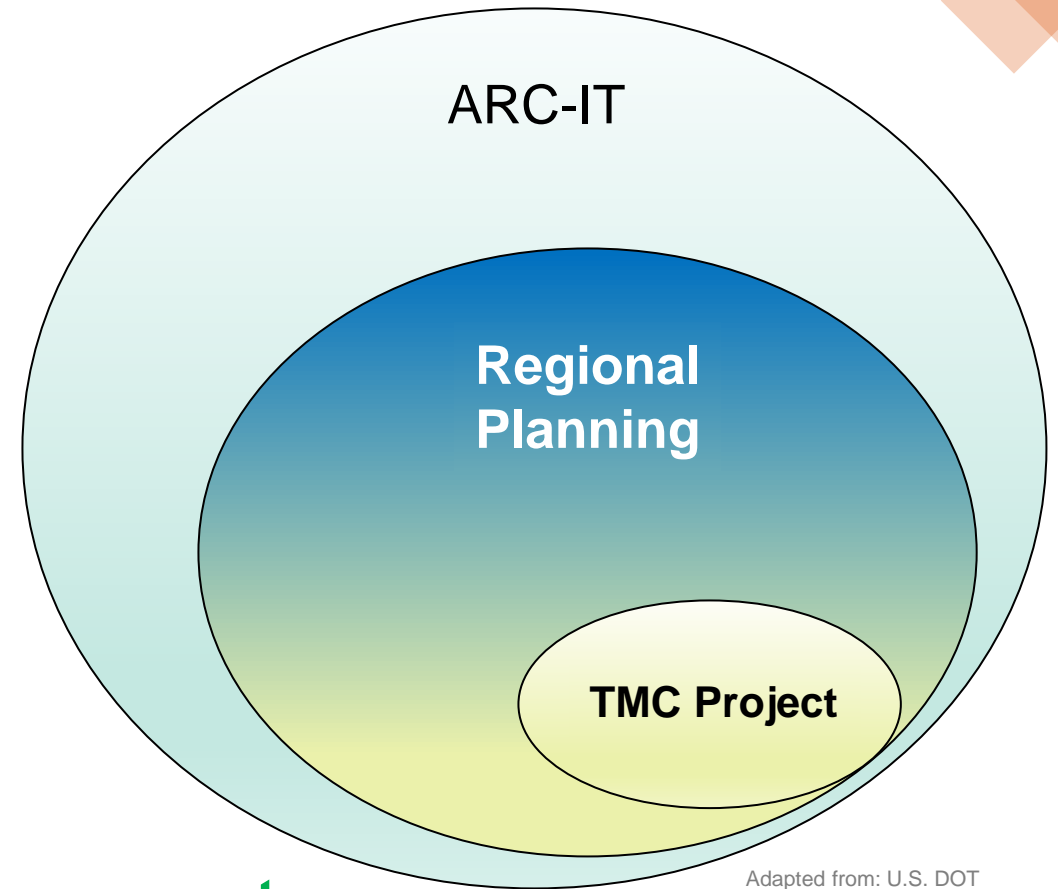


Where does an ITS Architecture fit into Traditional Project Development Lifecycles?



Types of ITS Architectures

- Reference
 - National/Resource
- Regional
 - Used for planning
- Project
 - Used for design/deployment



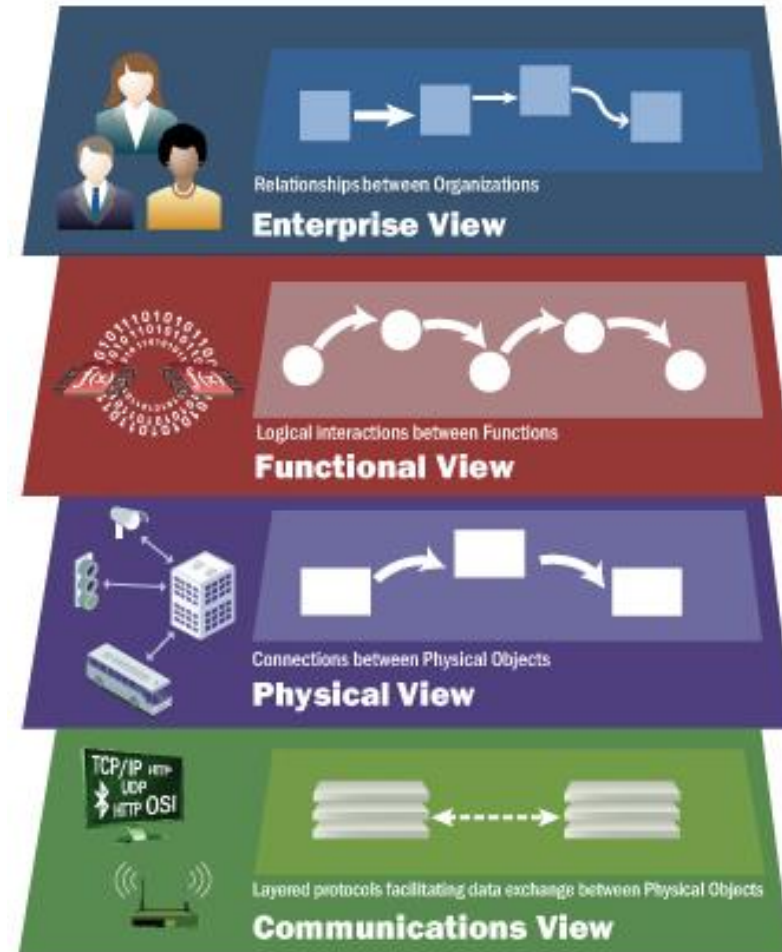
Adapted from: U.S. DOT



ARC-IT Structure (Reference)

- Defined around 4 views:
 - **Enterprises** to carry out services
 - **Functions** to implement services
 - **Physical** objects to implement that functionality
 - **Communications** solutions necessary

Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)



Physical

- Identify systems and devices
- Identify interfaces

Transit Management Center



Transit Vehicle OBE



Communications



ITS Roadway Equipment

Image credit: Société de transport de Montréal (STM)



Traffic Management Center

Image credit: City of Ottawa, OC Transpo

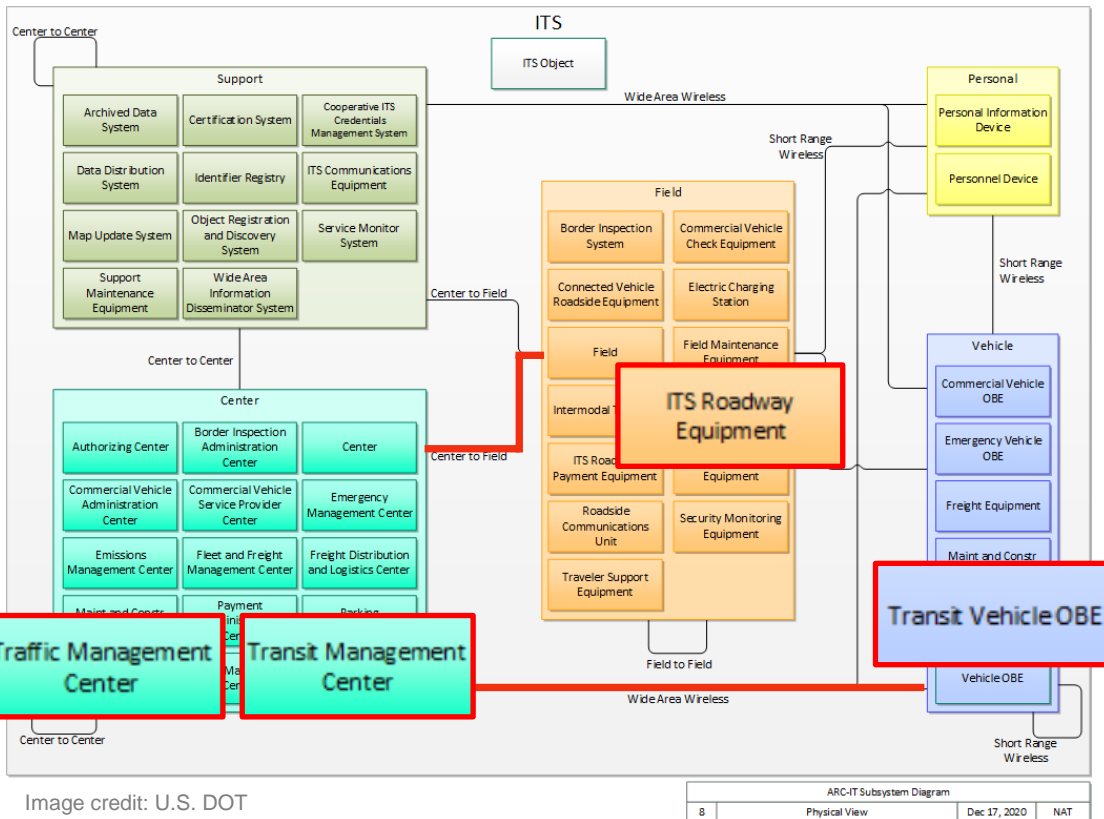
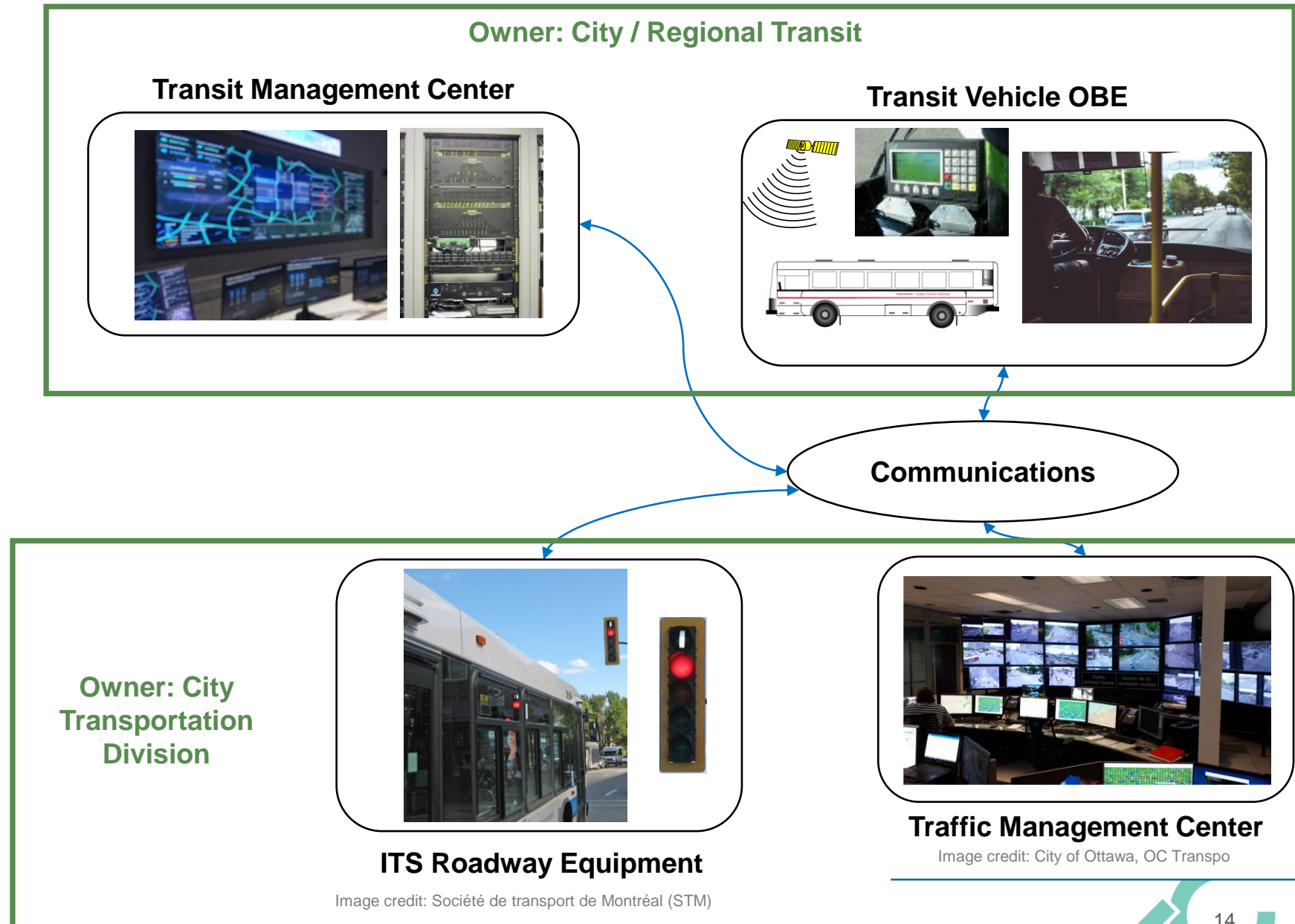


Image credit: U.S. DOT

Enterprise

- Identify who is involved
- What are their roles and responsibilities
 - Owner
 - Development
 - Installation
 - Operations
 - Maintenance



Functional

- Identify the functions for each physical device
- Identify functional requirements

Transit Management Center



Transit Vehicle OBE



Communications

Roadway Field Management Station Operation



ITS Roadway Equipment



Traffic Management Center

Image credit: City of Ottawa, OC Transpo

Image credit: Société de transport de Montréal (STM)

#	Requirement
01	The field element shall control traffic signals under center control.
02	The field element shall respond to pedestrian crossing requests by accommodating the pedestrian crossing.
03	The field element shall provide the capability to notify the traffic management center of pedestrian calls and pedestrian accommodations.
04	The field element shall report the current signal control information to the center.
05	The field element shall report current preemption status to the center.
06	The field element shall return traffic signal controller operational status to the center.
07	The field element shall return traffic signal controller fault data to the center.
08	The field element shall report current transit priority status to the center.
09	The field element shall report current intersection signal timing information to roadside equipment for transmission to connected vehicles.
10	The field element shall receive request for transit vehicle signal priority.
12	The field element shall report current commercial vehicle priority status to the center.
13	The field element shall provide to roadside equipment the intersection geometry and signal phase movement information including phase and timing information, alarm status, and priority/preempt status.
14	The field element shall provide data to the Connected Vehicle Roadside Equipment.
15	The field element shall receive requests for emergency vehicle signal preemption.
16	The field element shall receive request for signal change from an emissions/environmental field device.
17	The field element shall report current emissions/environmental priority status to the center.

Communications

- Select communications standards / protocols
- Address Security

Transit Management Center



Transit Vehicle OBE

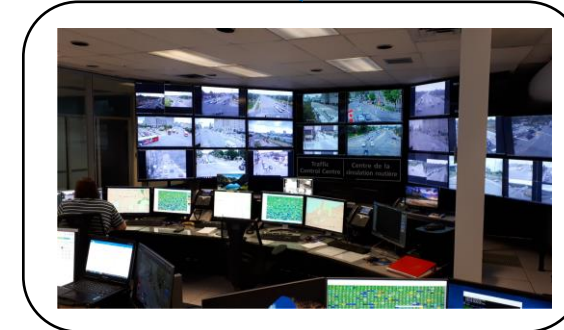


Communications



ITS Roadway Equipment

Image credit: Société de transport de Montréal (STM)



Traffic Management Center

Image credit: City of Ottawa, OC Transpo

ITS Application Entity		
NTCIP 1202 ⓘ NTCIP 1210 ⓘ		
Mgmt	Facilities	Security
	NTCIP 1202 ⓘ NTCIP 1210 ⓘ NTCIP 2301 ⓘ	
	TransNet	
NTCIP 1201 ⓘ Bundle: SNMPv1_MIB ⓘ	IETF RFC 793 ⓘ IP Alternatives ⓘ	IETF RFC 8446 ⓘ
	Access	
	Field SubNet Alternatives ⓘ	

Image credit: U.S. DOT





ITS Architecture Review Summary

- ITS Architectures provide frameworks for developing integrated transportation systems
- ITS Architectures support ITS Planning and Project Development



Introduction to Regional ITS Architectures

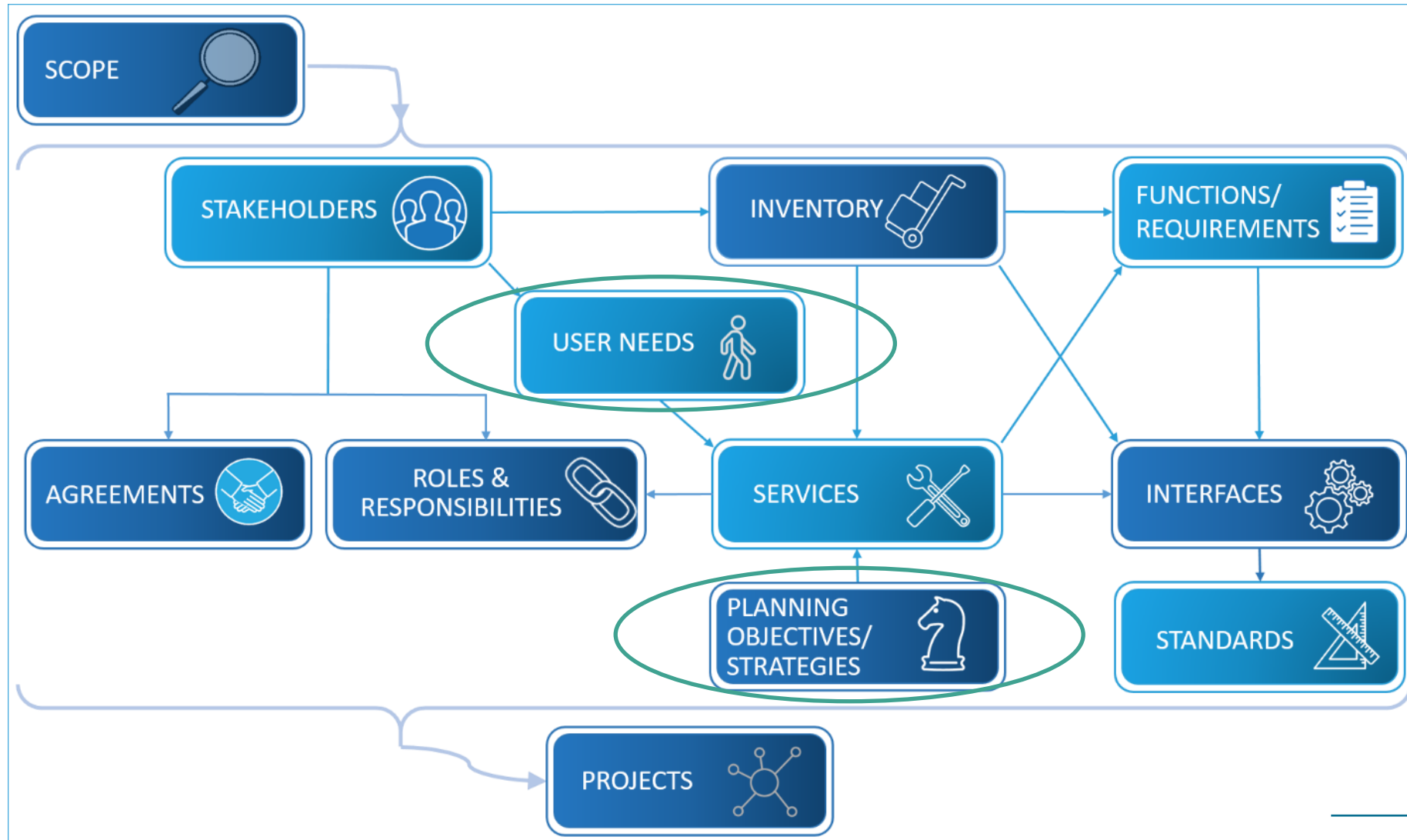


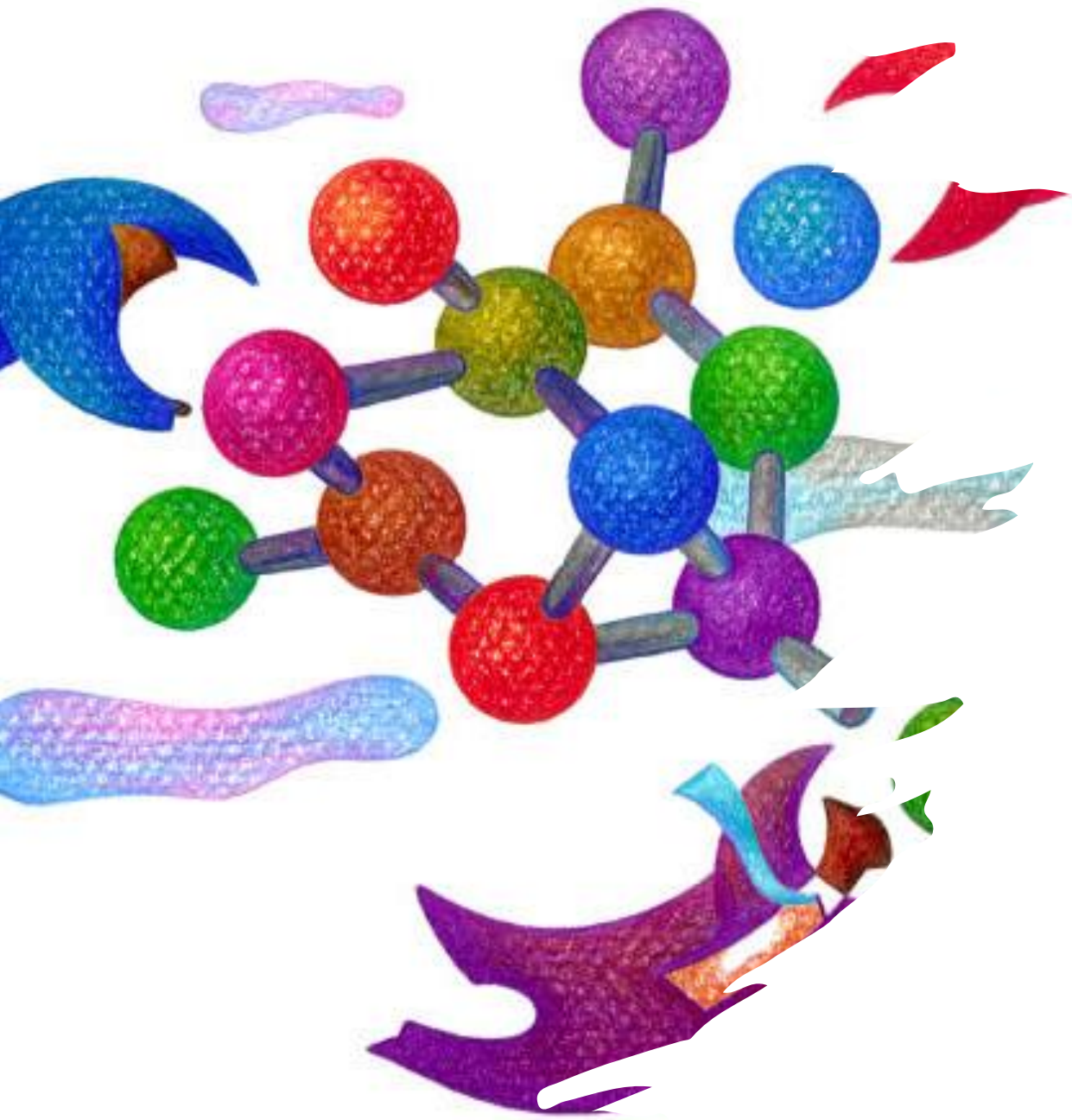
Regional ITS Architecture

A framework for ensuring institutional agreement and technical integration for the implementation of ITS projects in a particular region



Regional ITS Architecture Components





Reasons for Architecture Use in Transportation Planning and Programming

- Architecture represents a consensus vision of Operations and Planning stakeholders for deployment of ITS systems
- Addresses both short-range projects and long-range strategies



Stakeholder Involvement is Key

- ITS Architecture development provides an excellent opportunity for linking operations and planning stakeholders, during development and later during maintenance or update activities
- Committee that supported architecture development should also take a leading role in overseeing architecture use and maintenance

Connecting Stakeholder Visions

- Regional architecture development and update can expand the interaction of planning and operations

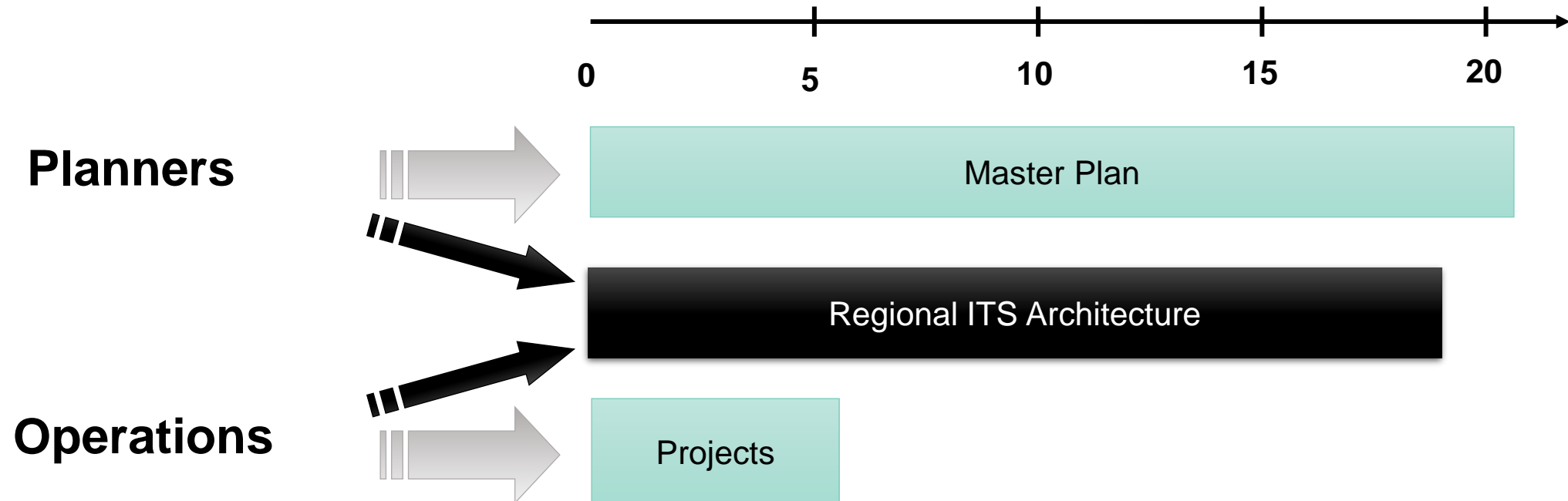


Image credit: U.S. DOT

Transportation Goals and Objectives

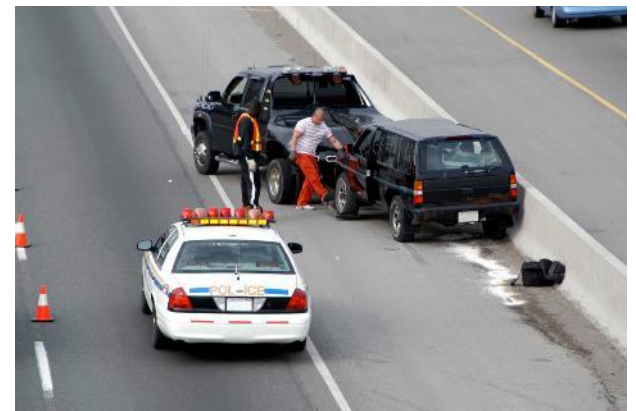
Regional Goals and Objectives

Goals

- An example goal is “Improve Safety for All System Users”

Objectives

- An example objective is “Reduce collision-related fatalities and serious injuries for all modes through data-driven, innovative, and proactive processes.”



Goals and Objectives and the Architecture



- Architecture should be based on operations-related goals and objectives
 - Include objectives in regional ITS architecture and map to service packages or projects



- Services and projects in architecture can support development of operations-related objectives
 - Architecture contains long range plan for ITS through definition of services and projects

Master Plan and Architecture

Master Plan	Regional Architecture
Goals, objectives, strategies, and projects to achieve it	ITS Services and projects
Covers at least the next 20 years	Long term timeframe
Leads to an intermodal system	Covers multiple modes
Fiscally constrained	Not fiscally constrained
Must be updated every 4-5 years	Updated per maintenance plan

ITS Strategic Plan (cont.)

- May contains elements that go beyond the regional architecture requirements
 - Vision, goals, and objectives
 - Strategies for ITS deployment
 - Funding considerations
 - Detailed project definitions
 - Gaps in planned projects
 - Benefits analysis
 - Communications Plan

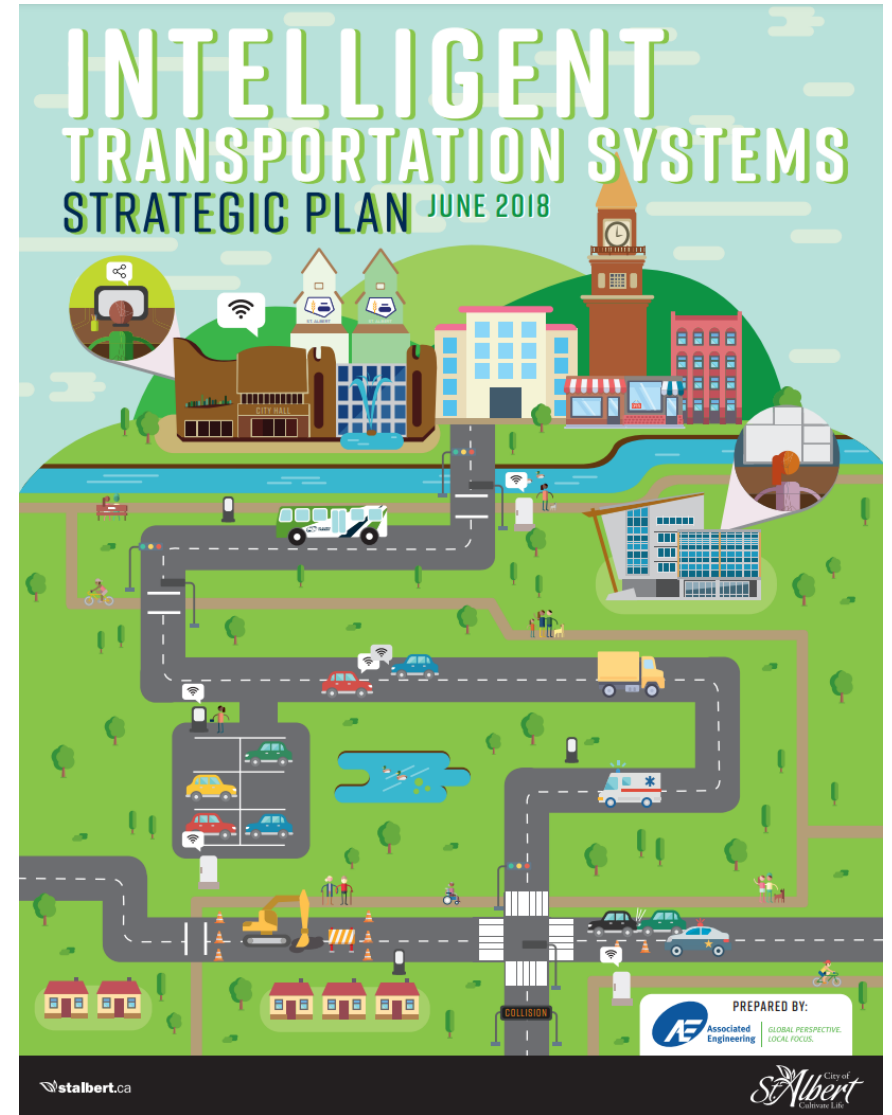


Image credit: City of St. Albert

Making Architecture Useful for Long Range Planning

- Explicitly connect architecture services and projects to objectives and strategies
- Describe mid-long-term projects in language suitable for the plan (e.g., as “strategies”)
- Create executive summary material/ graphics as part of architecture that would be appropriate for a Master Plan
- Formally approve architecture

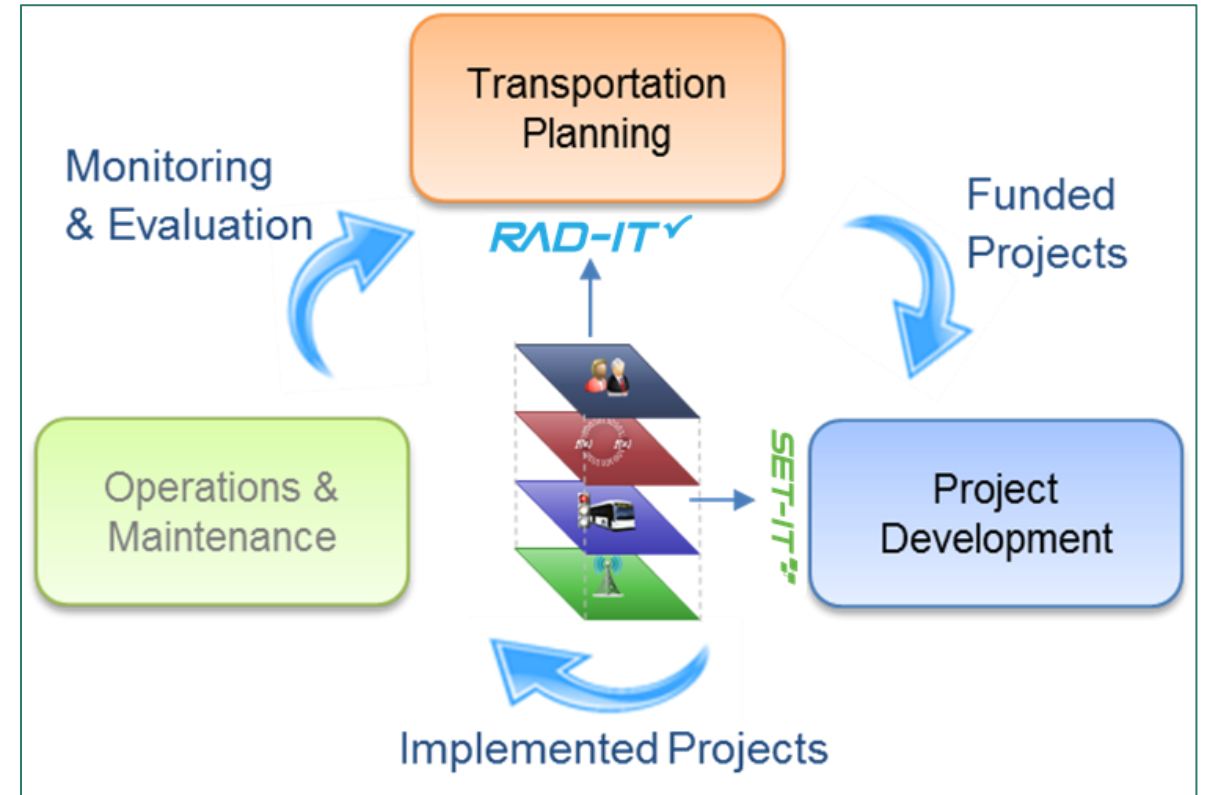
Make Architecture Useful for Programming / Budgeting

- Define near term projects in more specificity to feed into programming and budgeting processes
- Promote integration projects in region
- Establish process that uses architecture



ARC-IT Tool Suite

- Two free downloadable software tools available to apply ARC-IT to regions and projects
 - Regional Architecture Development for Intelligent Transportation (RAD-IT)
 - Systems Engineering Tool for Intelligent Transportation (SET-IT)



Adapted from: U.S. DOT

<https://www.arc-it.net/html/resources/tools.html>

ARC-IT Tools Integration

- SET-IT's Import Function: connecting regional planning to project definition
 - Take the Regional Architecture content as an input for a project in SET-IT
 - Drive more system engineering analysis using tools → requirements, interface control documents (ICDs), security, communications standards



Image credit: U.S. DOT

- RAD-IT's Import Function: supports feedback from a SET-IT project back into the Regional Architecture

<https://www.arc-it.net/html/resources/tools.html>

RAD-IT

United States Department of Transportation

ARC-IT Version 9.2
The National ITS Reference Architecture

Architecture ▾ Architecture Use ▾ Architecture Resources ▾ Architecture Terminology ▾ Contact The Architecture Team

[Home](#) > [Resources](#) > [Tools](#) > RAD-IT

This sample architecture originated as an exercise in the National ITS Architecture Public Sector Training Course. It illustrates many of the Regional Architecture Development for Intelligent Transportation (RAD-IT) software features as well as parts of the Architecture Reference for Cooperative & Intelligent Transportation (ARC-IT) that merge traditional ITS concepts with connected vehicle technologies and supporting services. To this end, several minor extensions have been made to the basic Marinara County scenario so that features like user defined Physical Objects, Flows, and connected vehicle service packages can also be illustrated.

- Project Sequencing Support
- Operational Concept (i.e. Agency Roles and Responsibilities)
- Functional Requirements Support
- Support for List of Agreements, selected based on interfaces between stakeholders' elements

The Marinara County transportation region encompasses rural and urban areas, including the rapidly expanding city of Saucelito. The regional boundary coincides with the metropolitan planning area. The total regional population of 675,000 is demographically diverse: 5% continue the traditional regional farming activities, 62% are Saucelito residents, and over 50% of the region's workers are in technology industries. Marinara's largest employer is Parma-John, a pharmaceuticals firm with a payroll of over 11,000 workers.

That dependence has been removed with the March 2021 release but there are some one-time steps that need to be done in [ADE Steps page](#) for instructions.

Contact the Helpdesk if you have any questions.

Known Issues:

- Generating outputs, such as the web pages or batch diagrams, using a network file share may cause an error - set Sync
- Following installation some users have reported an error that "Access is denied" when they try to launch the tool. This is installation and your anti-virus software. Try temporarily disabling your anti-virus software and reinstalling RAD-IT.

RAD-IT includes a Conversion facility that supports quick and easy conversion of existing Turbo and RAD-IT databases, providing existing Turbo or RAD-IT users.

Support Services: Our customer support team is standing by to offer friendly, responsive technical support to RAD-IT users.

If you can't find what you need in the knowledge base, you can contact customer support via phone or email. To receive the best information ready before contacting us:

- The version of RAD-IT that you are using.
- The version and name of your operating system and Office products.
- A brief description of your problem or issue.

RAD-IT - New - Marinara County

File Home Output

Filters Elements Selection Diagrams Tables Document Web Pages

Filtering Output

Start Planning Stakeholders Inventory Services Needs R & R Functions Interfaces Standards Agreements

Current Region: Marinara County

Architectures

Regional

Marinara County

Region to Project New Delete

Project

MCDOT Saucelito Traffic Coordination
MCDOT Traffic Monitoring Expansion Project
MCDOT V2I Safety Initiative
TOMATO

Project to Region New Delete

Related

Alfredo County

New Delete

Regional Architecture Attributes

Name

Marinara County

Description

This sample architecture originated as an exercise in the National ITS Architecture Public Sector Training Course. It illustrates many of the Regional Architecture Development for Intelligent Transportation (RAD-IT) software features as well as parts of the Architecture Reference for Cooperative & Intelligent Transportation (ARC-IT) that merge traditional ITS concepts with connected vehicle technologies and supporting services. To this end, several minor extensions have been made to the basic Marinara County scenario so that features like user defined Physical Objects, Flows, and connected vehicle service packages can also be illustrated.

Timeframe

Through 2030 (Next 10 to 15 years)

Geographic Scope

The Marinara County transportation region encompasses rural and urban areas, including the rapidly expanding city of Saucelito. The regional boundary coincides with the metropolitan planning area. The total regional population of 675,000 is demographically diverse: 5% continue the traditional regional farming activities, 62% are Saucelito residents, and over 50% of the region's workers are in technology industries. Marinara's largest employer is Parma-John, a

Service Scope

The intelligent transportation system for the Marinara region consists of freeway management, surface street systems, and transit services that are managed by the county and local agencies. There is now a growing interest in traveler information systems that use new technologies to collect traffic data and develop traveler information concerning traffic as well as parking and event data for the region.

Developer

Bob Olley (MCDOT)

Maintainer

Will N Able (MCTPB)

Version

v2018-b

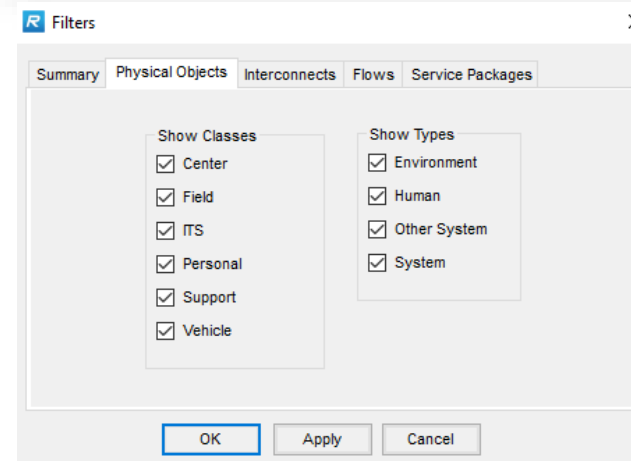
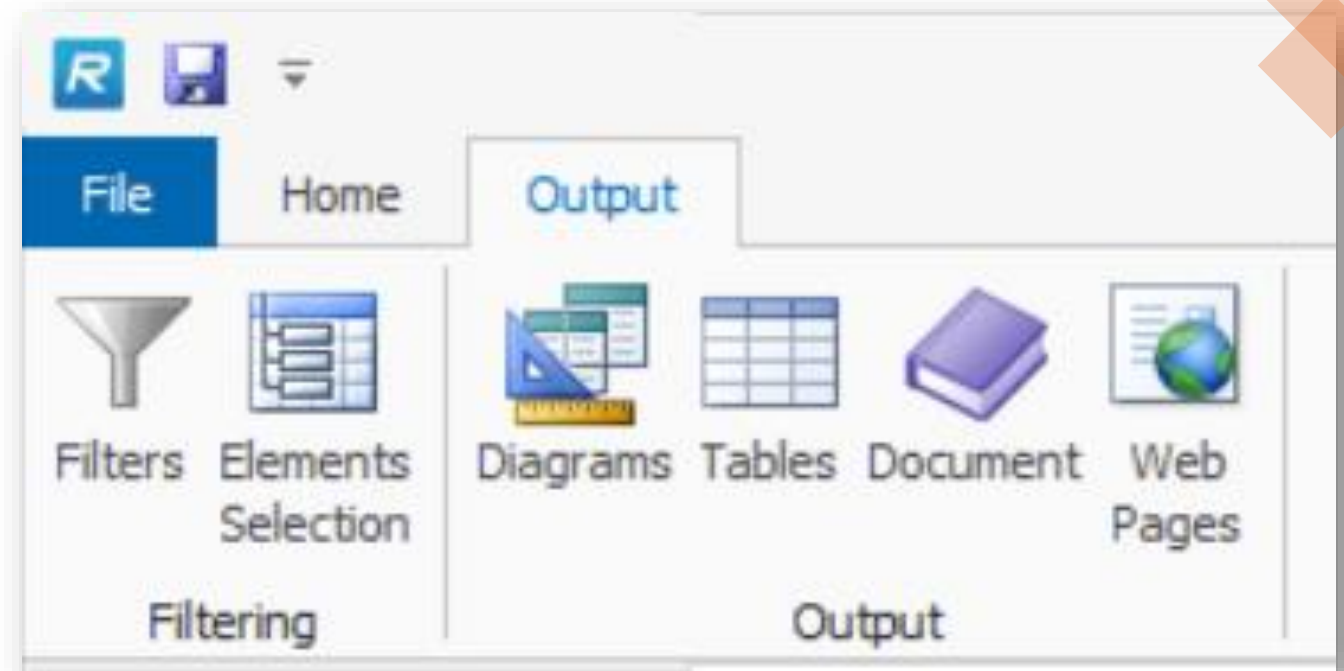
Date/Time

6/13/2018 12:00:00 AM

Change Log Apply Cancel

RAD-IT Outputs

- Diagrams
 - Subsystem Summary
 - Interconnect
 - Flow
 - Plus - Batch capability
- Tables
- Documents – regional and project
- Customized website



RAD-IT Outputs: Subsystem Diagram

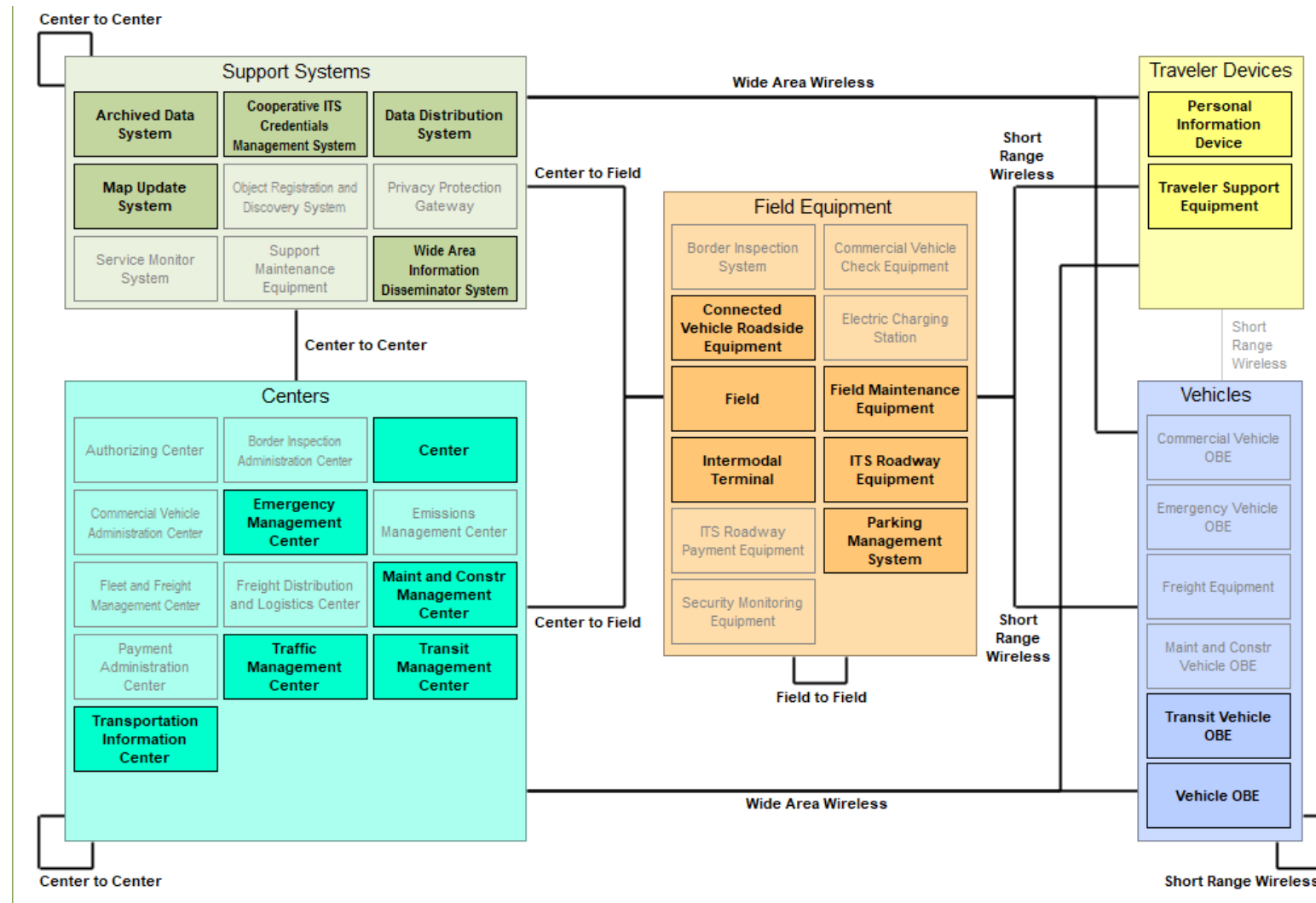
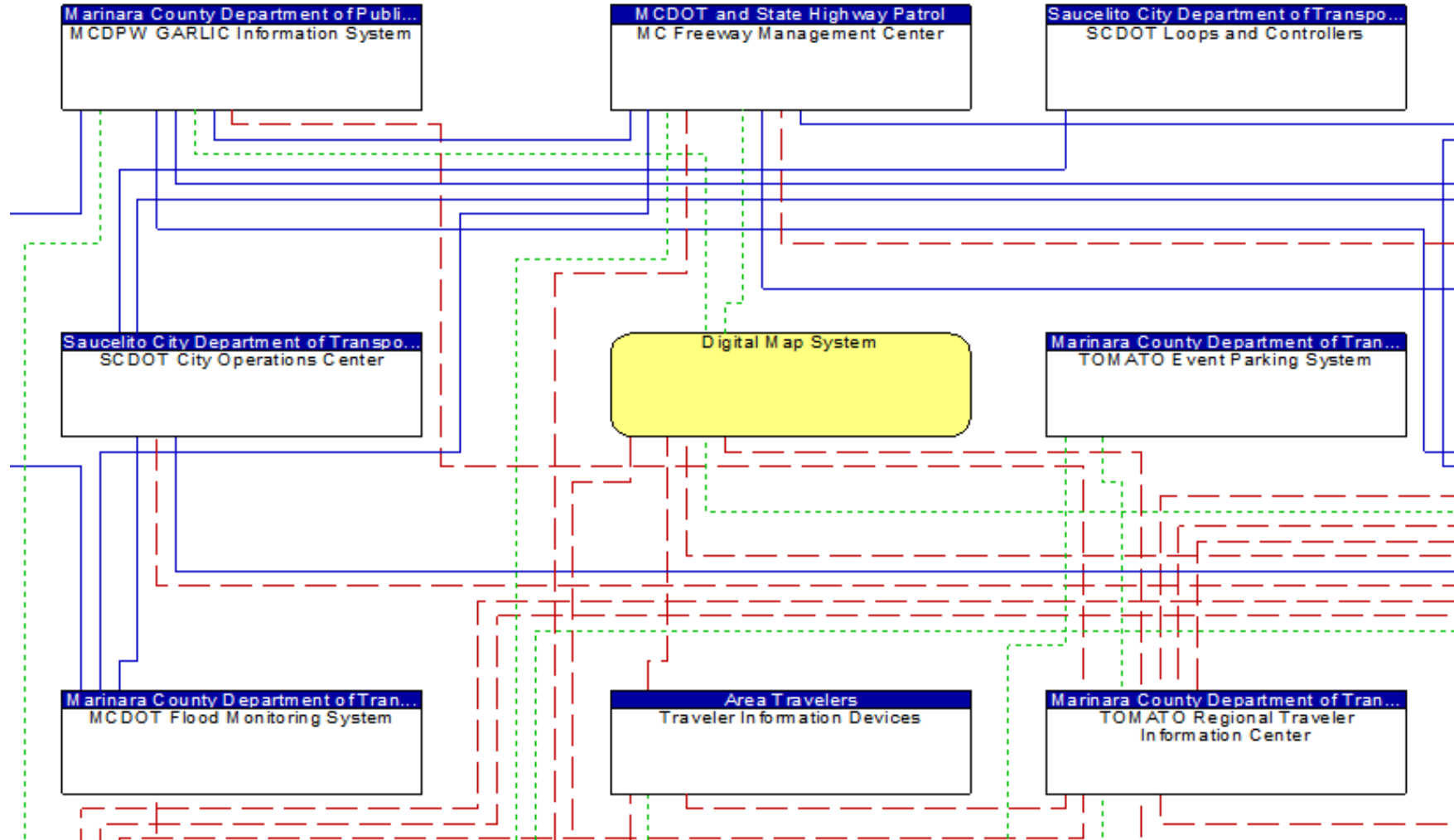
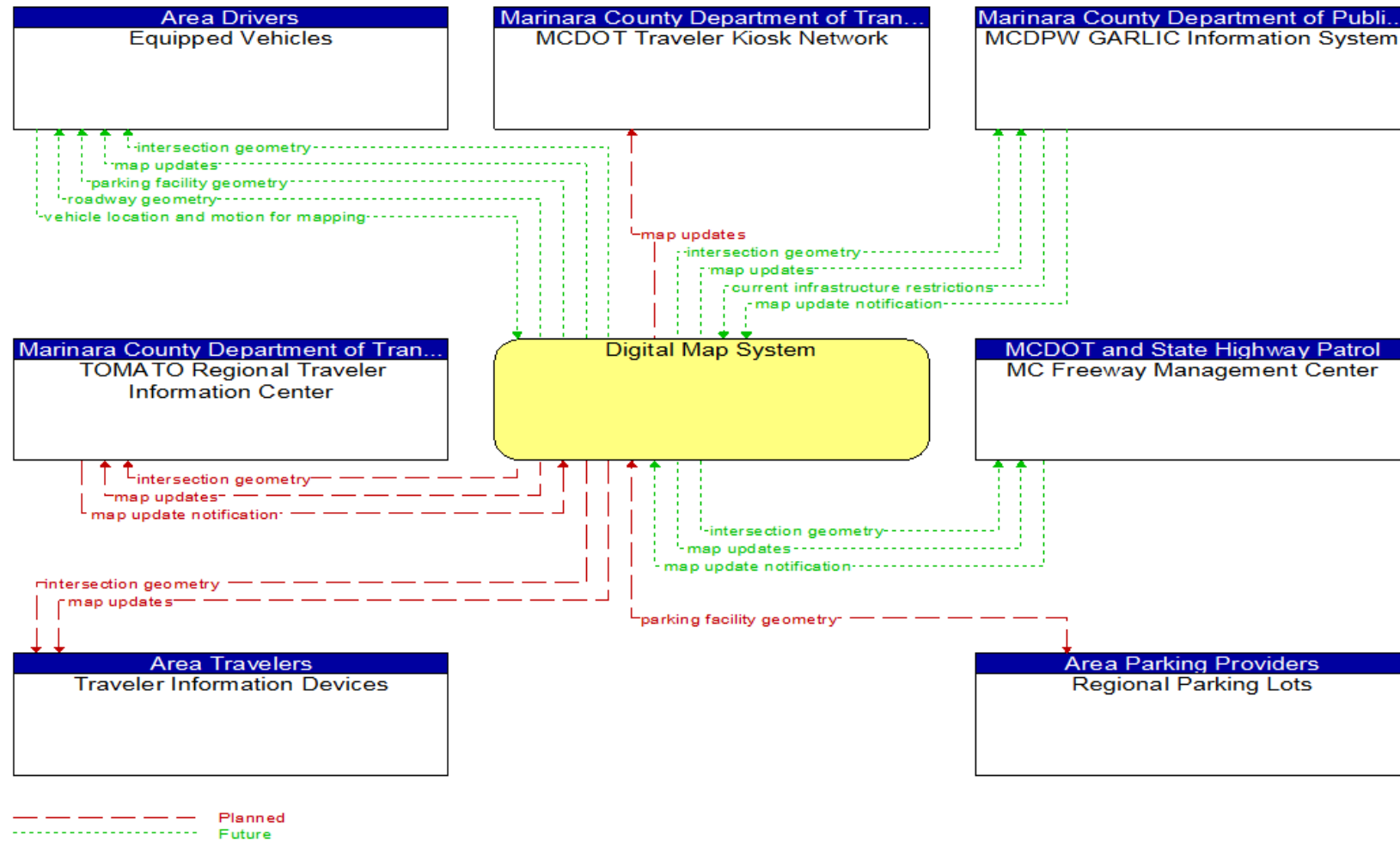


Image credit: U.S. DOT

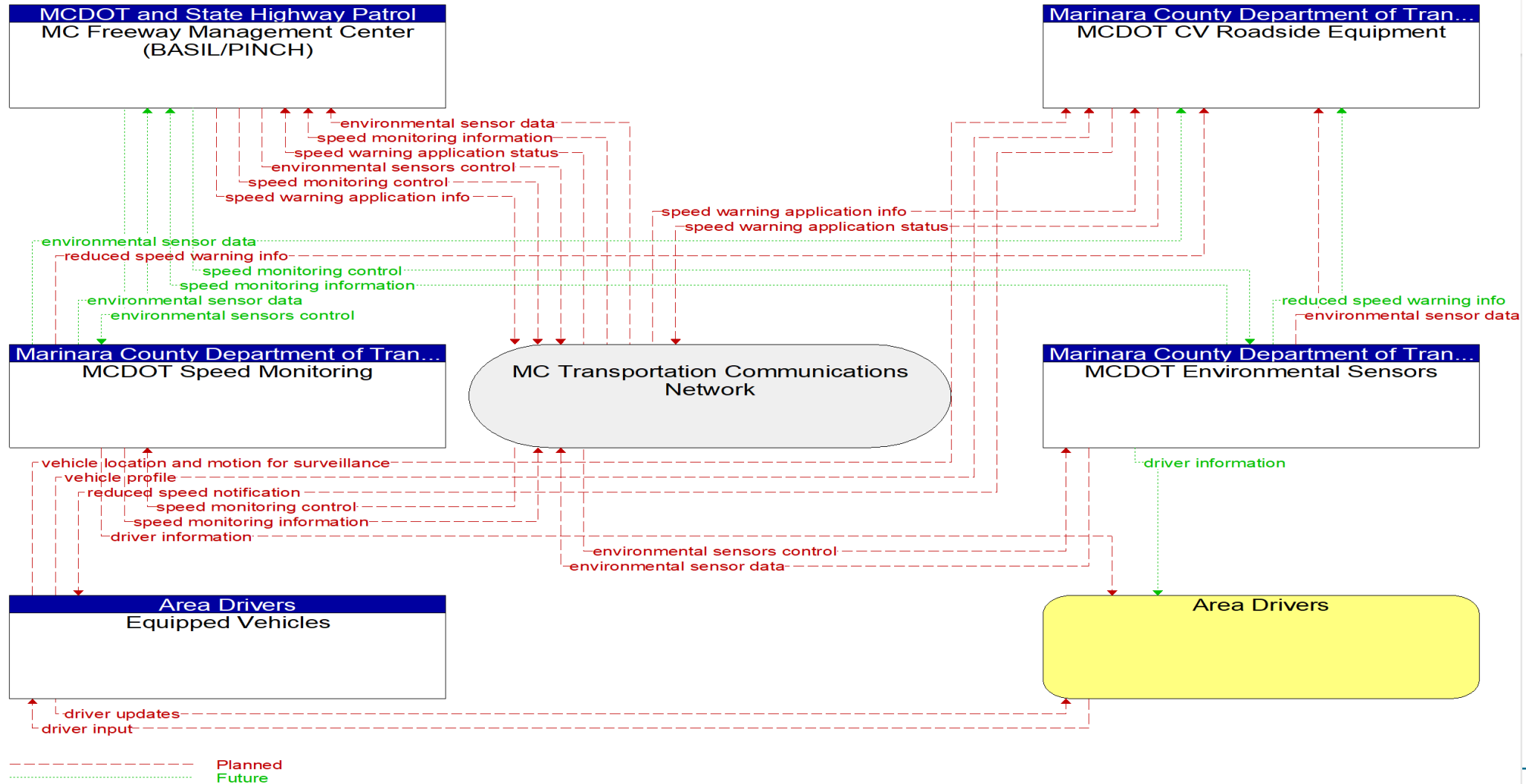
RAD-IT Outputs: Interconnect Diagram



RAD-IT Outputs: Context Diagrams



RAD-IT Outputs: Service Diagrams



RAD-IT Outputs: Tables

Services

Output Tables

1. Select Table

- Summary / File Info
- Stakeholder Topics
- Physical Components & Services
 - Inventory
 - Services
 - Needs
 - Requirements
 - Functional Objects
 - Physical Objects
 - Inventory to Service Package Comparison
 - Needs to Requirements

2. Select Columns

Available Columns

- Service Package
- Service Package Name
- Service Package Description
- Service Package Status
- Service Package Instance
- Included Elements
- Comment

Selected Columns

3. Select Action

Save to File Open Application

4. Create Output

Roll up multiple rows into a single row

Word Excel Text

Service Package	Service Package Name	Service Package Description	Service Package Status	Service Package Instance	Included Elements	Comment
DM01	ITS Data Warehouse	This service package provides the same broad access to multimodal, multidimensional data from varied data sources as in the ITS Data Warehouse service package, but provides this access using enhanced interoperability between physically distributed ITS archives that are each locally managed. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse service package are parsed by the local archive and dynamically translated to requests to remote archives which relay the data necessary to satisfy the request.	Planned	No	MC Planning Data Warehouse	
PM04	Regional Parking Management	This service package supports communication and coordination between equipped parking facilities and also supports regional coordination between parking facilities and traffic and transit management systems. This service package also shares information with transit management systems and information service providers to support multimodal travel planning, including parking reservation capabilities. Information including current parking availability, system status, and operating strategies are shared to enable local parking facility management that supports regional transportation strategies.	Future	No	Regional Parking Lots	
PM04	Regional Parking Management	This service package supports communication and coordination between equipped parking facilities and also supports regional coordination between parking facilities and traffic and transit management systems. This service package also shares information with transit management systems and information service providers to support multimodal travel planning, including parking reservation capabilities. Information including current parking availability, system status, and operating strategies are shared to enable local parking facility management that supports regional transportation strategies.	Future	No	TOMATO Event Parking System	
PM04	Regional Parking Management	This service package supports communication and coordination between equipped parking facilities and also supports regional coordination between parking facilities and traffic and transit management systems. This service package also shares information with transit management systems and information service providers to support multimodal travel planning, including parking reservation capabilities. Information including current parking availability, system status, and operating strategies are shared to enable local parking facility management that supports regional transportation strategies.	Future	No	TOMATO Regional Traveler Information Center	

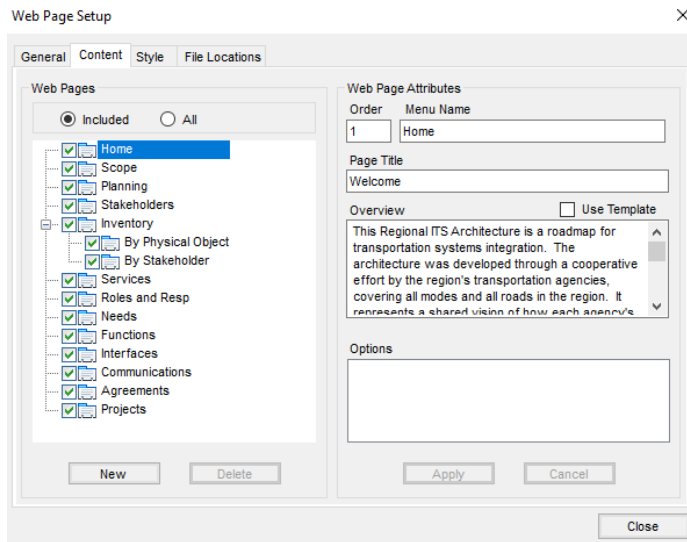
RAD-IT Outputs: Documents

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|

RAD-IT Outputs: Website



RAD-IT

Marinara

- Home**
- Scope
- Planning
- Stakeholders
- Inventory
 - By Physical Object
 - By Stakeholder
- Services
- Roles and Resp
- Needs
- Interfaces
- Standards
- Agreements
- Projects

Welcome

This Regional ITS Architecture is a roadmap for transportation systems integration. The architecture was developed through a cooperative effort by the region's transportation agencies, covering all modes and all roads in the region. It represents a shared vision of how each agency's systems will work together in the future, sharing information and resources to provide a safer, more efficient, and more effective transportation system for travelers in the region. The architecture provides an overarching framework that spans all of the region's transportation organizations and individual transportation projects. Using the architecture, each transportation project can be viewed as an element of the overall transportation system, providing visibility into the relationship between individual transportation projects and ways to cost-effectively build an integrated transportation system over time. The purpose of this regional ITS architecture web site is to encourage use of the regional ITS architecture and gather feedback so that the architecture is used and continues to reflect the intelligent transportation system vision for the region. The menu bar at left provides access to the stakeholders, the transportation systems in the region (the Inventory), the transportation-related functions that are envisioned, and the existing and planned integration opportunities in the region.

Regional ITS Architecture Summary

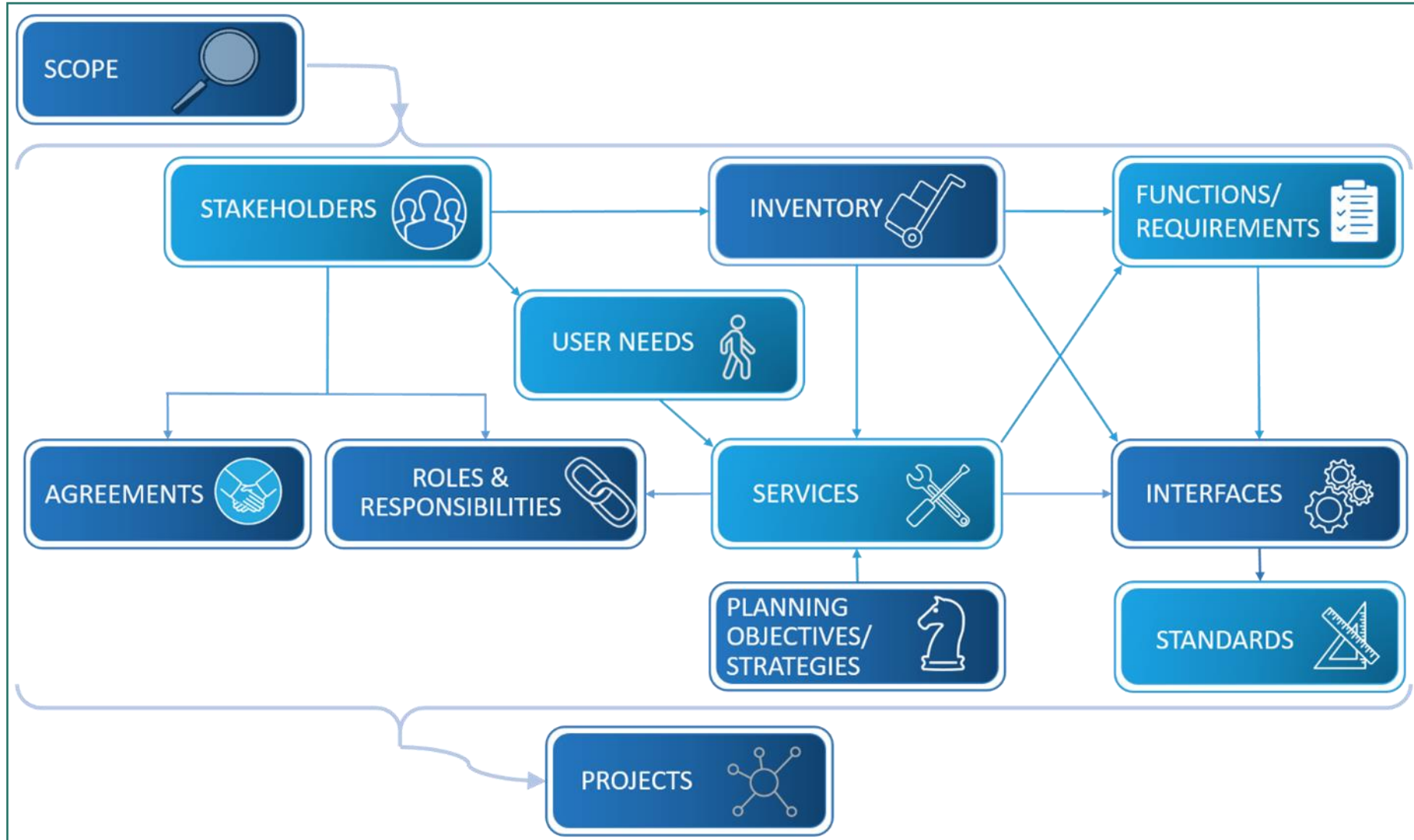
- A Regional ITS Architecture provides a framework for ensuring institutional agreement and technical integration for the implementation of ITS projects in a particular region
- Can support planning
 - Long-Range Transportation Plans
 - Master Plans
 - Short-Range or Strategic Plans
 - Capital Plans or Programs



Regional ITS Architecture Development Process



So how is a Regional ITS Architecture Developed?



Development Process Guide

REGIONAL ITS ARCHITECTURE GUIDE

Prepared by the
National ITS Architecture Team

Prepared for:
Intelligent Transportation Systems Joint Program Office (ITS JPO)
US Department of Transportation
Washington, DC 20590

November 5, 2020

<https://www.arc-it.net/documents/raguide/raguide.pdf>

So how is a Regional ITS Architecture Developed?

RAD-IT guides you through the development process

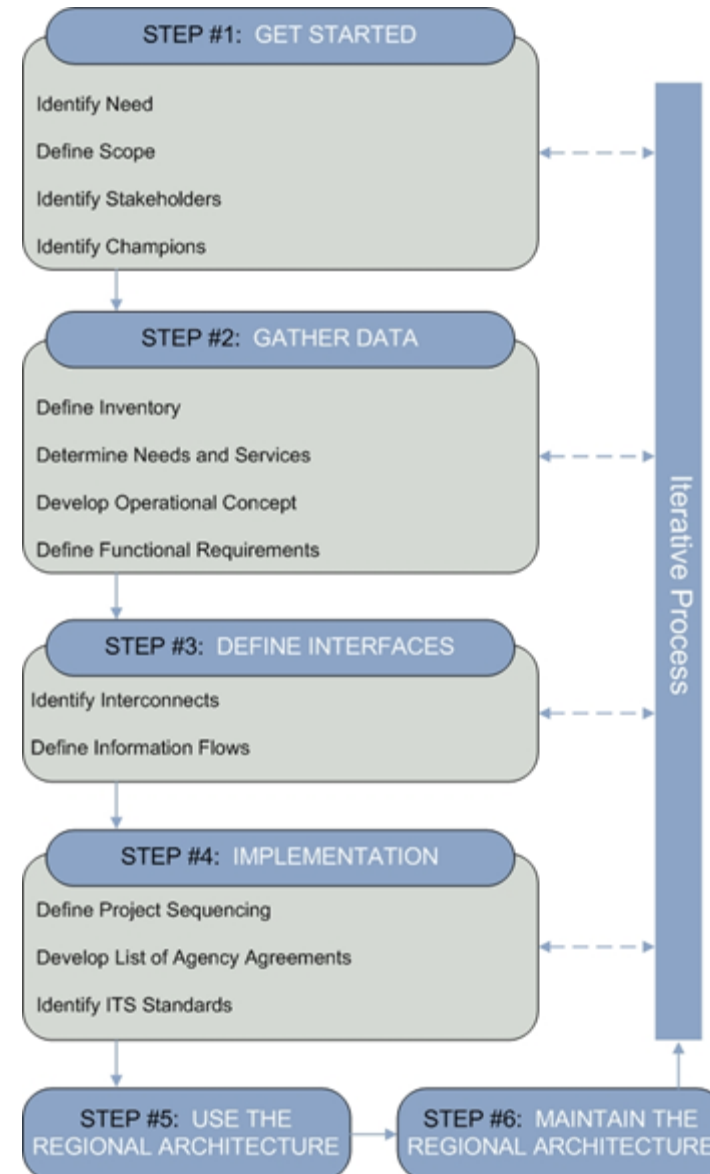
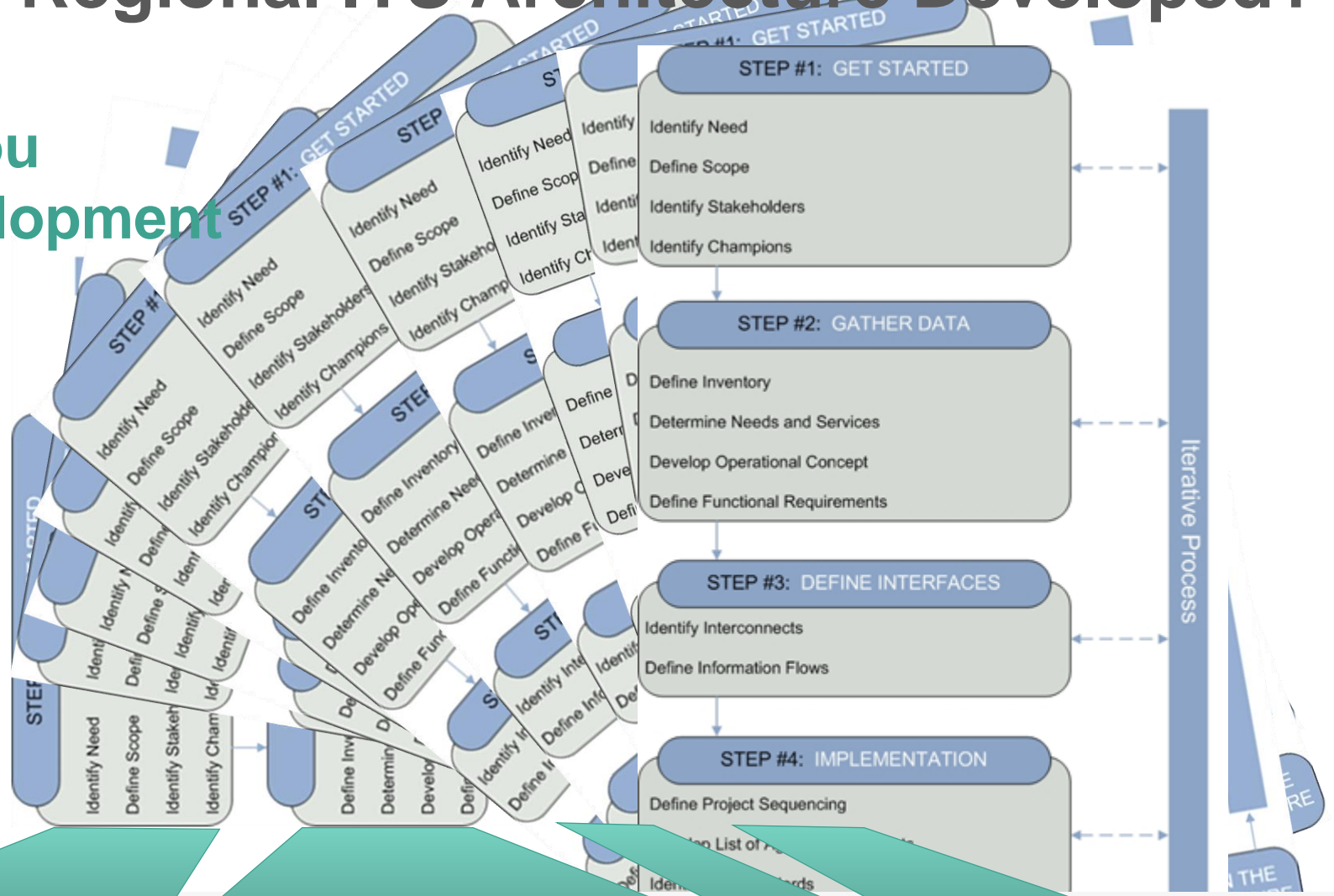


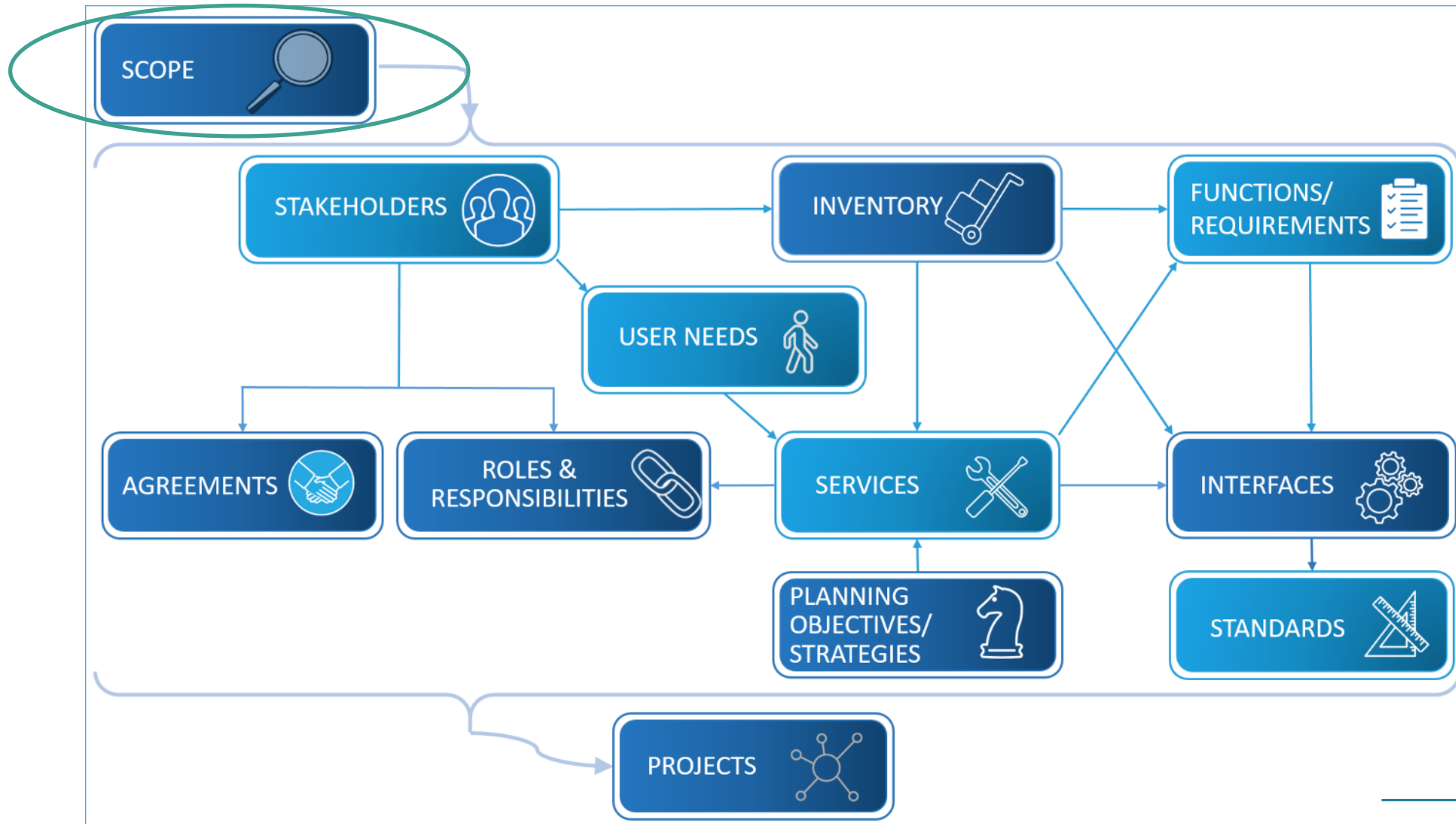
Image credit: Regional ITS Architecture Guide (2010 – previous version)

So how is a Regional ITS Architecture Developed?

RAD-IT guides you through the development process



Regional ITS Architecture Process



Architecture Region - Scope

SCOPE



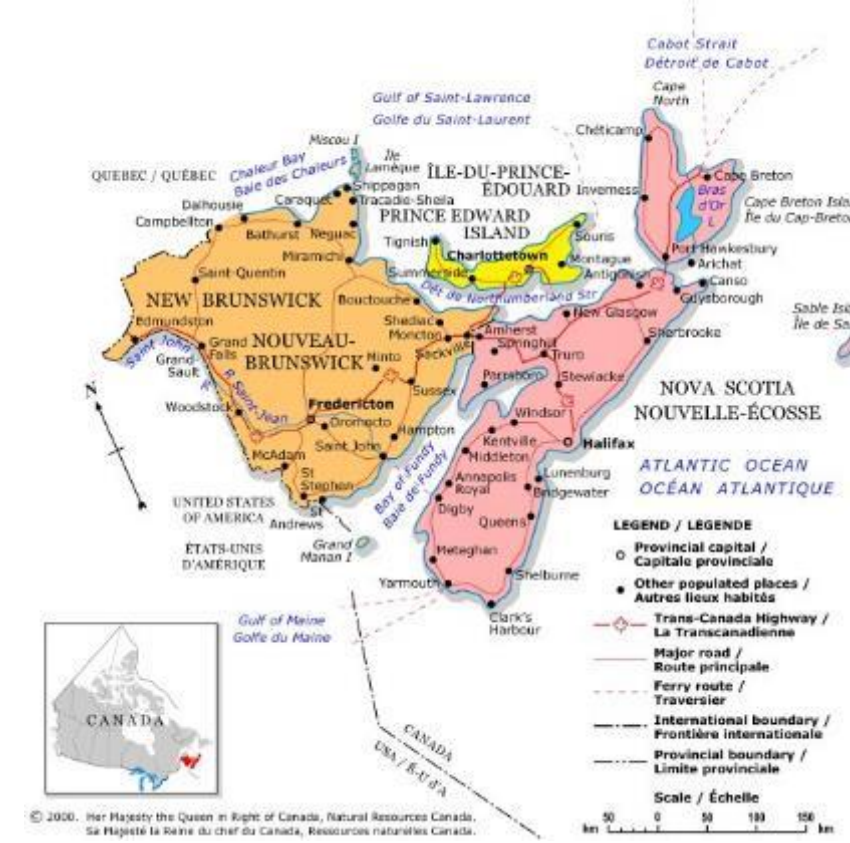
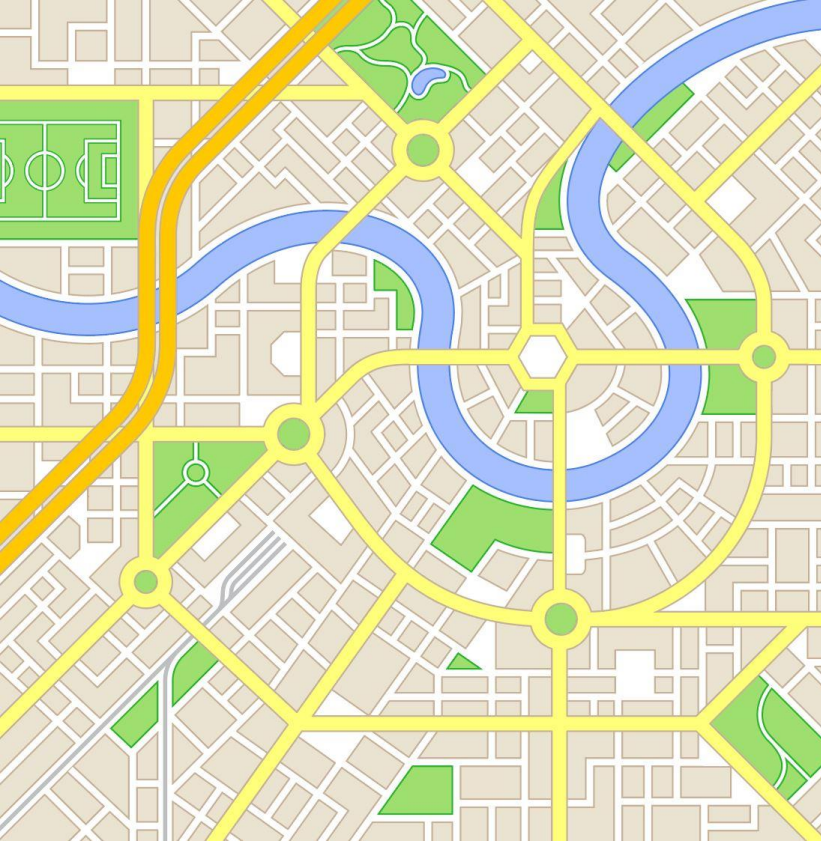
Geographic area



Time horizon



Breadth of ITS services



Architecture Geographic Area Options

- Municipality (e.g., City or Region)
- Multiple-municipality (e.g., GTHA)
- Provincial & multi-province
- ITS corridor
- ITS project funding boundary
- Service area

Architecture Time Horizon



- How far into the future to consider?

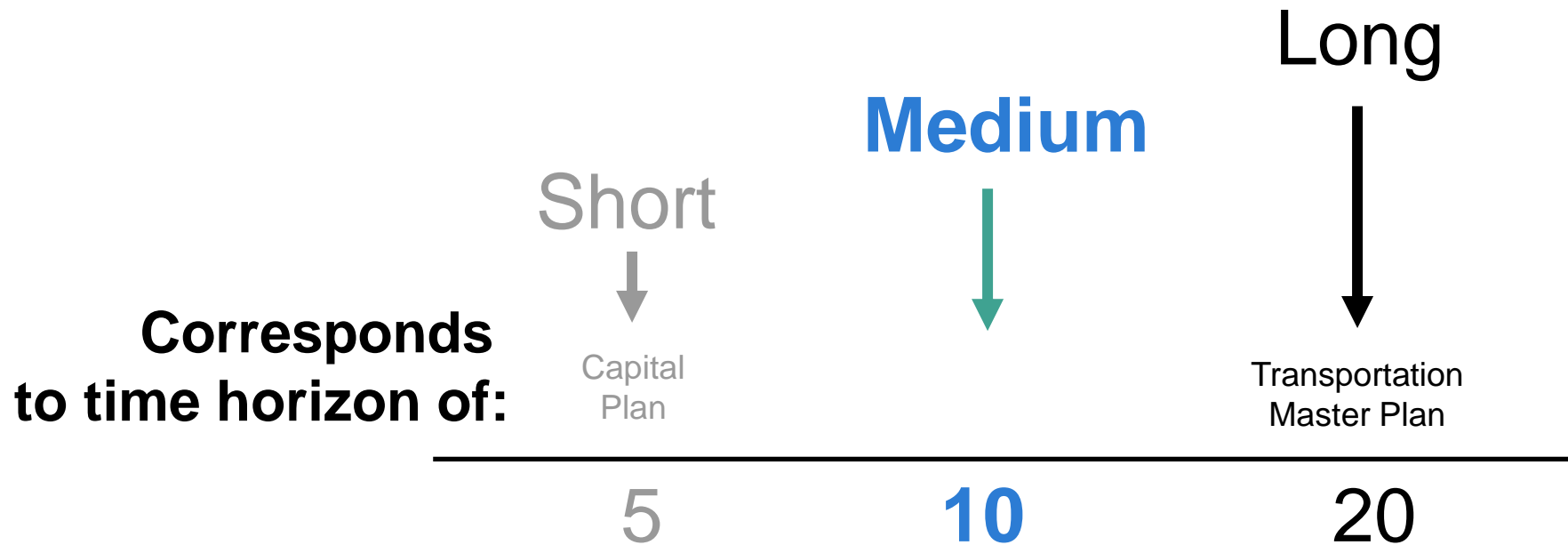


Image credit: U.S. DOT

Architecture Breadth of Services



- Include province-wide services?
 - 511 traveler information
 - Commercial vehicle operations
- Include only publicly funded services?
- Consider other architectures

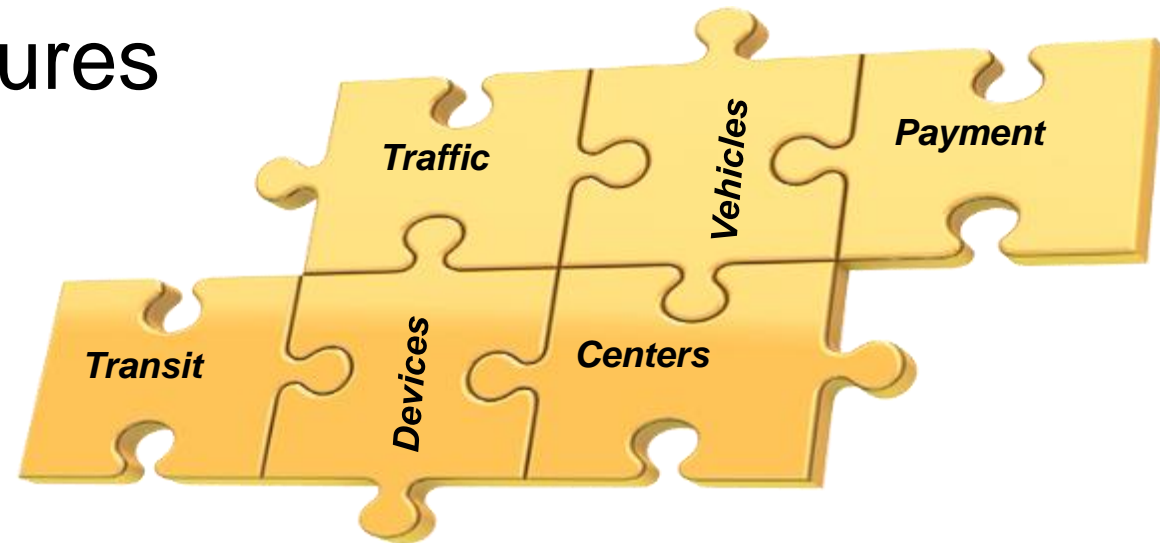
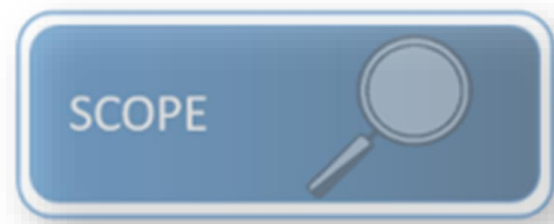


Image credit: U.S. DOT

RAD-IT – Scope (Start)



RAD-IT - New - Marinara County

File Home Output

Filters Elements Selection Diagrams Tables Document Web Pages

Filtering Output

Start Planning Stakeholders Inventory Services User Needs R & R Functions Interfaces Communications Agreements

Current Region: Marinara County

Architectures

Regional

Marinara County

Region to Project New Delete

Project

MCDOT Saucelito Traffic Coordination
MCDOT Traffic Monitoring Expansion Project
MCDOT V2I Safety Initiative
TOMATO

Project to Region New Delete

Related

Alfredo County

New Delete

Regional Architecture Attributes

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Developer
Bob Olley (MCDOT)

Maintainer
Will N Able (MCTPB)

Version
v2020-b

Date/Time
11/16/2020 12:23:00 PM

Change Log Apply Cancel

Web Output – Scope

SCOPE



RAD-IT ✓

Marinara Regional ITS Architecture

Home

Scope

Planning

Stakeholders

Inventory

By Physical Object

By Stakeholder

Services

Roles and Resp

Needs

Functions

Interfaces

Communications

Agreements

Projects

Architecture | **Scope**

The scope of the Regional ITS Architecture can be described in terms of: 1) the size of the region and jurisdictions covered (geographic scope), 2) the planning or time horizon, and 3) the variety of transportation services that are covered. This scope is defined in the context of adjacent and overlapping Regional ITS Architectures.

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Region for Peel Regional ITS Architecture (~2011)



DRAFT - Peel Regional ITS Architecture

- [Home](#)
- [Project Background](#)
- [Downloads](#)
- [Scope](#)**
- [Stakeholders](#)
- [Inventory](#)
- [Services](#)
- [Projects](#)

Architecture Scope

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Description

Regional ITS Architecture to facilitate the planning for the Public Works - Transportation Division of Peel Region. The Architecture focuses on ITS Services that the Public Works - Roads Division manages and/or interfaces with.

Time Frame 2006-2026

Geographic Scope

The Regional Municipality of Peel is a regional municipality in Southern Ontario, Canada. It consists of three municipalities to the west and northwest of Toronto: the cities of Brampton and Mississauga, and the town of Caledon.

Service Scope

ITS Services that the Public Works Division manages and/or interfaces with.

Regional Goals, Objectives, and Strategies



- Connecting a region's transportation planning processes to the ITS architecture
- Connect to planning attributes defined in:
 - Long Range Plans
 - Strategic Plan
 - Transportation Systems Management and Operations (TSMO) Plan

RAD-IT – Planning

Start Planning Stakeholders Inventory Services User Needs R & R Functions Interfaces Communications Agreements

Current Region: Marinara County

Objectives and Strategies

Objectives: Regional All Customize

- 1.1. Improve average on-time performance for primary designated PASTA routes by 15 percent.
- 1.1.1. Implement PASTA automated vehicle location system.
- 1.1.2. Upgrade PASTA fleet management system.
- 1.2. At least 95 percent of trips on PASTA can be made with no more than 1 transfer.
- 2.1. Develop 20,000 visitors annually to TOMATO traveler information website and kiosks in
- 2.2. Develop 8,000 annual uses of the TOMATO multimodal trip planning tool by year 2020.
- 3.1. Implement flexible payment mechanisms on 50 percent of publicly operated parking spa
- 4.1. Increase percentage of incident management agencies in the region that use the Marin
- 4.2. Decrease road departure crashes along MC highways
- 4.3. Decrease amount of time to warn travelers of dangerous conditions or emergency
- 5.1. Increase the percent of the primary highway system in which travel conditions can be
- 5.2. Maintain a program of evaluating 100 percent of signals for retiming every 5 years.
- 5.3. Reduce the daily hours of recurring congestion on major freeways by 7 percent by ye
- 5.4. Reduce time between incident verification and posting of traveler alert to dynamic mess
- 5.5. Increase the percent of transportation facilities whose owners share their traveler info
- 6.1. Enhance transportation planning with data from all modes.
- 7.1. Improve the efficiency of the surface transportation system

Objective/Strategy Attributes

Type: Objective Supports

Number: 1.1 Name: Improve average on-time performance for primary designated PASTA routes by 15

Description:

Source: Marinara County Long Range Transportation Plan (MC LRTP)

Performance Measures: Selected All Edit

- On-time performance of public transit routes.

Service Packages: Selected All Search

- PT02: Transit Fixed-Route Operations
- PT06: Transit Fleet Management

Projects: Selected All

New Delete Apply Cancel

Web Output – Planning

RAD-IT ✓
Marinara Regional ITS Architecture

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Objective 1.1

Statement

Improve average on-time performance for primary designated PASTA routes by 15 percent within 5 years.

Source: Marinara County Long Range Transportation Plan (MC LRTP)

Supported by

[Implement PASTA automated vehicle location system.](#)

[Upgrade PASTA fleet management system.](#)

Associated Performance Measures

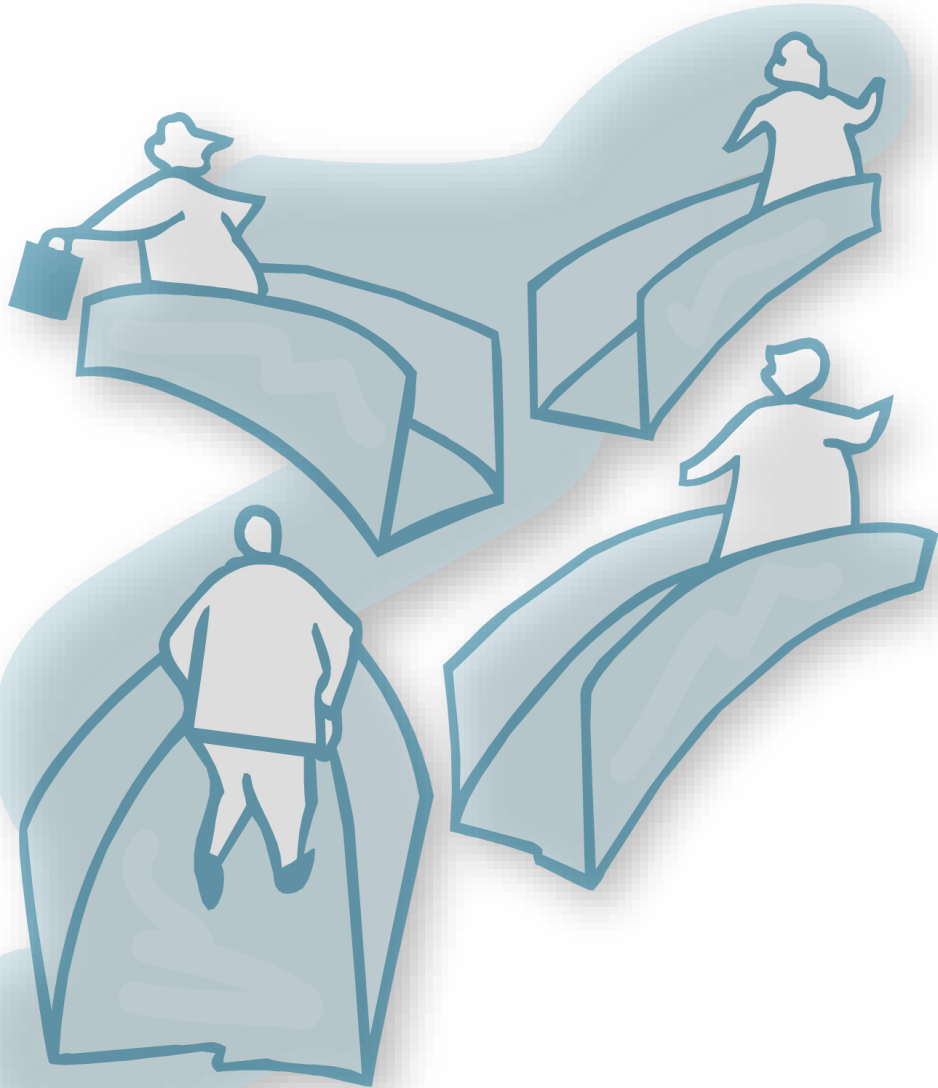
Category	Number	Performance Measure
Transit	1	On-time performance of public transit routes.

Associated Service Packages

PT02: Transit Fixed-Route Operations

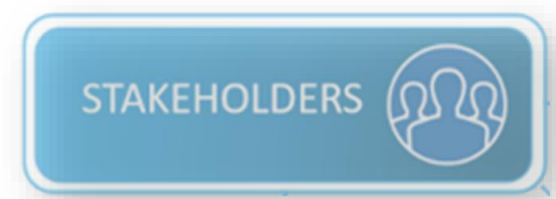
PT06: Transit Fleet Management

Stakeholders



Someone who deploys, owns, operates, maintains, or is impacted by an ITS system.

RAD-IT – Stakeholders



Start | Planning | Stakeholders | Inventory | Services | User Needs | R & R | Functions | Interfaces | Communications | Agreements

Current Region: Marinara County

Stakeholders

Stakeholders: Regional All

- Alfredo County Department of Transportation
- Area Drivers
- Area Parking Providers
- Area Travelers
- Business Advertisers
- IndyCert
- Marinara County Department of Public Works
- Marinara County Department of Transportation
- Marinara County Fairly Entertainment
- Marinara County Government Offices
- Marinara County IT Department
- Marinara County Law Enforcement
- Marinara County Sheriff's Department
- Marinara County Transportation Planning Board
- Marinara Port Authority
- MC Freeway Operators

Stakeholder Attributes

Name
Alfredo County Department of Transportation

Description
Alfredo County Department of Transportation (MCDOT) operates its own set of freeway and state roads within their county. Activities are coordinated through its Freeway Management Center.

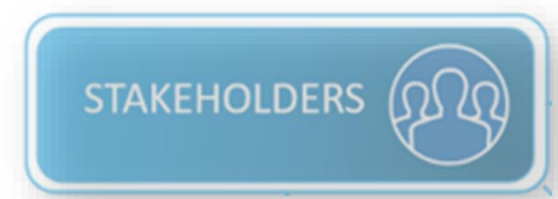
Stakeholder Group

Web Output – Stakeholders



RAD-IT [✓] Marinara Regional ITS Architecture													
Home	<h2>Stakeholders</h2> <p>The Regional ITS Architecture resulted from the consensus input of a diverse set of stakeholders, encompassing traffic, transit, public safety, and many other operating agencies at local, state, and national levels. It includes both public and private sectors and spans the organizations that manage, support, or are impacted by the surface transportation system, with particular focus on agencies that operate transportation systems in the region.</p> <table border="1"><thead><tr><th>Stakeholder</th><th>Description</th></tr></thead><tbody><tr><td>Alfredo County Department of Transportation</td><td>Alfredo County Department of Transportation (MCDOT) operates its own set of freeway and state roads within their county. Activities are coordinated through its Freeway Management Center.</td></tr><tr><td>Area Drivers</td><td>The 'Driver' represents the person that operates a vehicle on the roadway. Included are operators of private, transit, commercial, and emergency vehicles where the interactions are not particular to the type of vehicle (e.g., interactions supporting vehicle safety applications). The Driver originates driver requests and receives driver information that reflects the interactions which might be useful to all drivers, regardless of vehicle classification. Information and interactions which are unique to drivers of a specific vehicle type (e.g., fleet interactions with transit, commercial, or emergency vehicle drivers) are covered by separate objects.</td></tr><tr><td>Area Parking Providers</td><td>A group can also be used to identify multiple stakeholders that are associated with the same inventory element. The County Government Building in downtown Saucelito has a 1000 space lot and parking garage facility, dividing between monthly reserved spots and metered parking. The Fairground, located 10 miles northwest of downtown Saucelito, has the capacity to park 1200 vehicles for normal events. Under special conditions, the Fairgrounds staff have converted some of the Fairground field area into parking; this has the potential to provide an additional 800 spots. Sun-Dried Mall Partners (SDMP) operates the Sun-Dried Mall on the southeast edge of Saucelito. The Mall is a 200,000 sq. ft. enclosed pedestrian mall with parking for 2000 vehicles, plus PASTA bus service. The SDMP have indicated a willingness to offer some of their parking area for city events and are also interested in any traveler information services that could be offered in the Mall.</td></tr><tr><td>Area Travelers</td><td>TOMATO will provide internet access to regional travel information. This service will synthesize map and route descriptions, real-time traffic data, static and dynamic transit information, parking availability, event schedules, and other relevant items into travel information products that will be displayed via the World Wide Web (WWW) or through connected vehicle's onboard equipment.</td></tr><tr><td>Business Advertisers</td><td>We have not identified the specific advertisers at this time. This will be a mix of local merchants and national companies that provide products and services to the citizens of Marinara County and the typically affluent traveler who vacations here.</td></tr></tbody></table>	Stakeholder	Description	Alfredo County Department of Transportation	Alfredo County Department of Transportation (MCDOT) operates its own set of freeway and state roads within their county. Activities are coordinated through its Freeway Management Center.	Area Drivers	The 'Driver' represents the person that operates a vehicle on the roadway. 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Stakeholder		Description											
Alfredo County Department of Transportation		Alfredo County Department of Transportation (MCDOT) operates its own set of freeway and state roads within their county. Activities are coordinated through its Freeway Management Center.											
Area Drivers		The 'Driver' represents the person that operates a vehicle on the roadway. Included are operators of private, transit, commercial, and emergency vehicles where the interactions are not particular to the type of vehicle (e.g., interactions supporting vehicle safety applications). The Driver originates driver requests and receives driver information that reflects the interactions which might be useful to all drivers, regardless of vehicle classification. Information and interactions which are unique to drivers of a specific vehicle type (e.g., fleet interactions with transit, commercial, or emergency vehicle drivers) are covered by separate objects.											
Area Parking Providers		A group can also be used to identify multiple stakeholders that are associated with the same inventory element. The County Government Building in downtown Saucelito has a 1000 space lot and parking garage facility, dividing between monthly reserved spots and metered parking. The Fairground, located 10 miles northwest of downtown Saucelito, has the capacity to park 1200 vehicles for normal events. Under special conditions, the Fairgrounds staff have converted some of the Fairground field area into parking; this has the potential to provide an additional 800 spots. Sun-Dried Mall Partners (SDMP) operates the Sun-Dried Mall on the southeast edge of Saucelito. The Mall is a 200,000 sq. ft. enclosed pedestrian mall with parking for 2000 vehicles, plus PASTA bus service. The SDMP have indicated a willingness to offer some of their parking area for city events and are also interested in any traveler information services that could be offered in the Mall.											
Area Travelers		TOMATO will provide internet access to regional travel information. This service will synthesize map and route descriptions, real-time traffic data, static and dynamic transit information, parking availability, event schedules, and other relevant items into travel information products that will be displayed via the World Wide Web (WWW) or through connected vehicle's onboard equipment.											
Business Advertisers		We have not identified the specific advertisers at this time. This will be a mix of local merchants and national companies that provide products and services to the citizens of Marinara County and the typically affluent traveler who vacations here.											
Scope													
Planning													
Stakeholders													
Inventory													
By Physical Object													
By Stakeholder													
Services													
Roles and Resp													
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Region for Peel Regional ITS Architecture (~2011)



DRAFT - Peel Regional ITS Architecture

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- Inventory
- Services
- Projects

Stakeholders

The Regional ITS Architecture resulted from the consensus input of a diverse set of stakeholders, encompassing traffic, transit, public safety, and many other operating agencies at local, state, and national levels. It includes both public and private sectors and spans the organizations that manage, support, or are impacted by the surface transportation system, with particular focus on agencies that operate transportation systems in the region.

Stakeholder	Description
Brampton Fire Department	Brampton Fire and Emergency Services provide fire protection, prevention, public fire education and emergency services to the residents of Brampton.
Brampton Transit	Brampton Transit (BT) is public transport bus operator for the City of Brampton in the Regional Municipality of Peel, and within the Greater Toronto Area. Brampton Transit began operations in 1974. In May 2005, a major upgrade occurred that put more routes into a grid pattern. In 2006 Brampton Transit became Canada's fastest-growing transit system in terms of ridership. Over 10 million riders used Brampton Transit in 2006, marking a 12.4 percent increase over 2005 levels and shattering all previous ridership records for the city. In 2010, Brampton Transit introduced Züm, a bus rapid transit route running along Queen Street and Highway 7 from downtown Brampton to York University
Brampton Works and Transportation	The department's responsibility ranges from managing the City's 10-Year Roads Capital Program and road operations to provision, repair and maintenance of all City-owned fleet vehicles and equipment used within the City of Brampton.
City of Brampton	Brampton is the third-largest city in the Greater Toronto Area and the seat of Peel Region. As of the 2006 census, Brampton's population stood at 433,806, making it the 11th largest city in Canada. It is also one of Canada's fastest growing municipalities, with an average annual growth rate (2001 2006) of 6.6%.
	Mississauga is a city located in Peel Region in the western part of the

Other Municipalities	Neighbouring municipalities to Peel, including Toronto, Halton, York and Durham.
--------------------------------------	--

Inventory of ITS Elements

- A list of ITS elements and the elements that interface with them
- And an element is:
 - “An ITS system or piece of a system”

An architecture is built around an inventory of existing and future ITS systems

- *Know what you have today*
- *Plan for future systems*

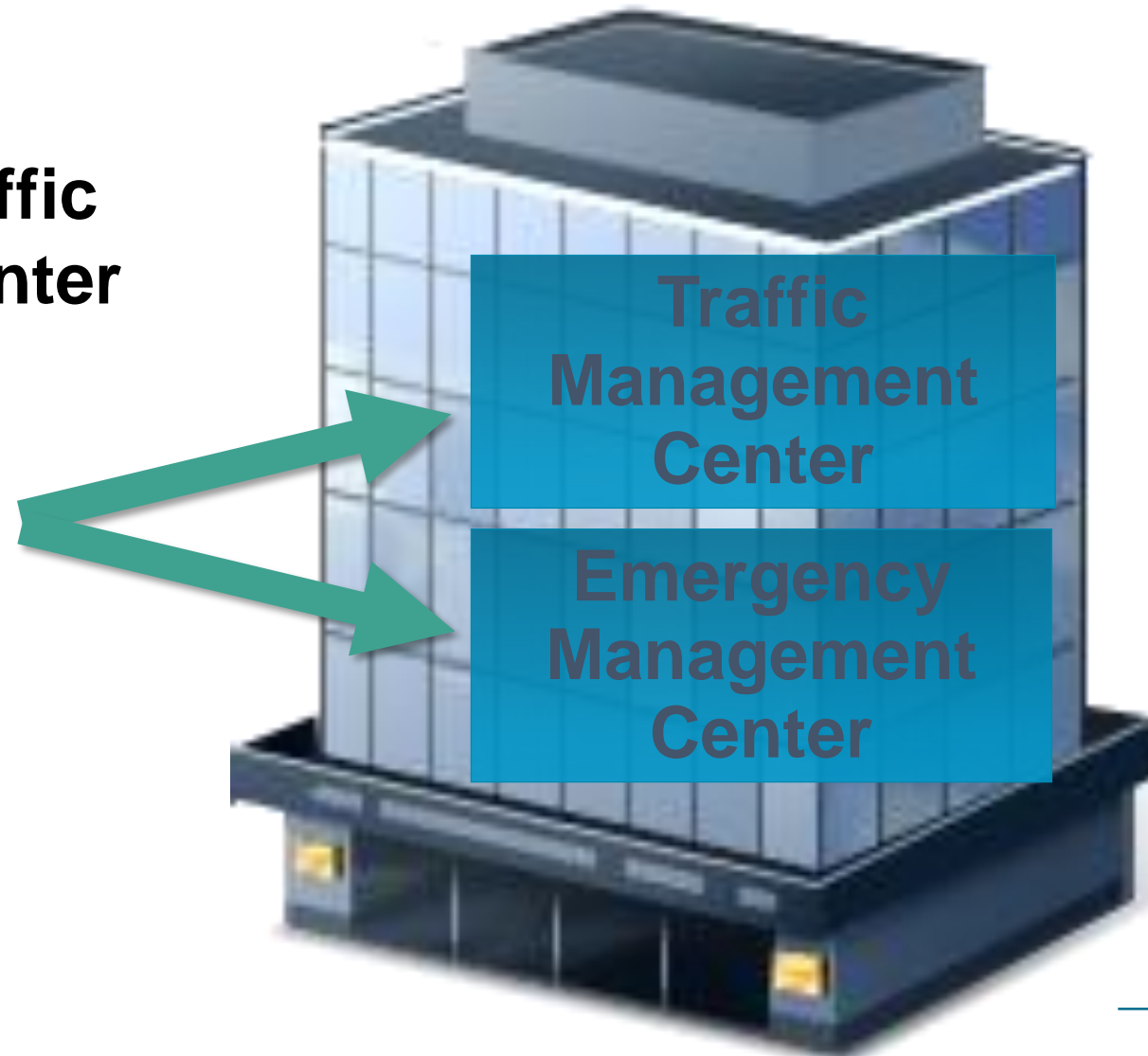
Mapping Elements to Physical Objects



Element:

Provincial Traffic
Operations Center

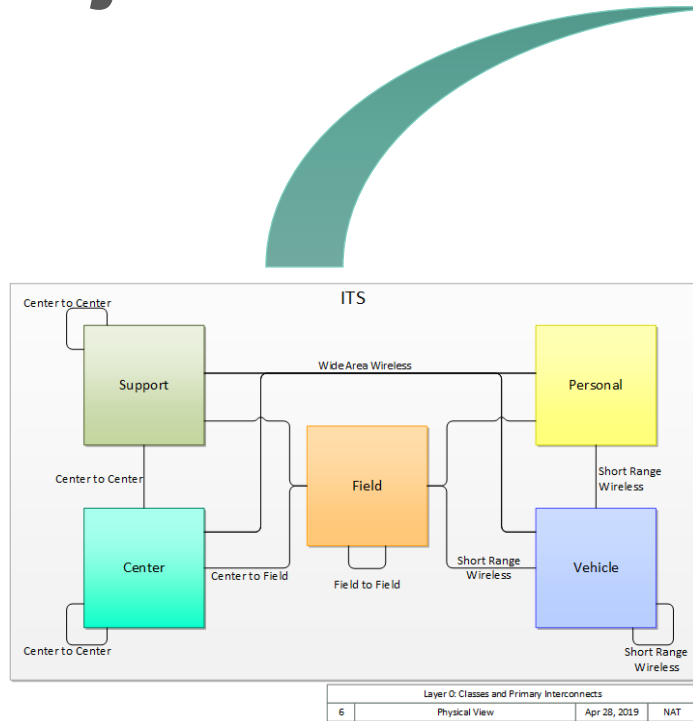
Physical Objects



Traffic
Management
Center

Emergency
Management
Center

Importance of Mapping to Physical Objects



- Requirements
- Interfaces
- Standards



RAD-IT – Inventory



Start | Planning | Stakeholders | **Inventory** | Services | User Needs | R & R | Functions | Interfaces | Communications | Agreements

Current Region:

Elements

Elements: Regional All

- Alfredo County Freeway Management Center
- Area Drivers
- Center Location and Time Source (LTS)
- Communications for Alfredo Networking and Operations Local Infrastructure
- Device and Application Certification Systems
- Digital Map System
- Equipped Vehicles
- Field Location and Time Source (LTS)
- Marinara County Data Sharing System
- Marinara Port Management System
- MC Field Maintenance Equipment
- MC Freeway Management Center (BASIL/PINCH)
- MC Freeway Operators
- MC IT Field Personnel
- MC Planning Data Warehouse
- MC Public Safety Communications and Dispatch Centers
- MC Transportation Communications Network
- MCDOT CV Roadside Equipment
- MCDOT Detectors
- MCDOT Dynamic Message Signs
- MCDOT Environmental Sensors
- MCDOT Field Equipment
- MCDOT Flood Monitoring System
- MCDOT Speed Monitoring

Element Attributes

Name: Alfredo County Freeway Management Center

Type: Transportation (Shared) | Class: Center

Status (Region): Existing | Related: Alfredo County

Stakeholder (Owner): Alfredo County Department of Transportati... | Details | Physical Standards

Description: This element is actually defined in the Alfredo County Regional ITS Architecture. It is included here to show interfaces between the Marinara County and Alfredo County centers.

Physical Objects: Selected Related All

- Traffic Management Center (Subsystem)
- Archived Data System <Support> (Subsystem)
- Authorizing Center (Subsystem)
- Border Inspection Administration Center (Subsystem)

Web Output – Inventory



RAD-IT **Marinara Regional ITS Architecture**

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Inventory

Each stakeholder agency, company, or group owns, operates, maintains or plans ITS systems in the region. The Regional ITS Architecture inventory is a list of "elements" that represent all existing and planned ITS systems in a region as well as non-ITS systems that provide information to or get information from the ITS systems.

Element	Description
Alfredo County Freeway Management Center	This element is actually defined in the Alfredo County Regional ITS Architecture. It is included here to show interfaces between the Marinara County and Alfredo County centers.
Area Drivers	The 'Driver' represents the person that operates a vehicle on the roadway. Included are operators of private, transit, commercial, and emergency vehicles where the interactions are not particular to the type of vehicle (e.g., interactions supporting vehicle safety applications). The Driver originates driver requests and receives driver information that reflects the interactions which might be useful to all drivers, regardless of vehicle classification. Information and interactions which are unique to drivers of a specific vehicle type (e.g., fleet interactions with transit, commercial, or emergency vehicle drivers) are covered by separate objects.

Inventory – List Alphabetical

Web Output – Inventory

INVENTORY



RAD-IT[✓]

Marinara Regional ITS Architecture

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Inventory by Physical Object

The inventory is made up of the transportation and communications centers, the field equipment, the vehicles, and other systems in the regional transportation system. In ARC-IT, "Physical Objects" (PObjects) are the subsystems and terminators that generally represent the systems in ITS. The following table sorts the inventory by ARC-IT Pobject. This sorts elements that perform similar functions together, so elements of a particular type can be easily identified.

PObject	Element
Archived Data System	MC Planning Data Warehouse
Center	Center Location and Time Source (LTS)
Center Personnel	MC Freeway Operators
	MCDPW Center Personnel
Certification System	Device and Application Certification Systems
Connected Vehicle Roadside Equipment	MCDOT CV Roadside Equipment
Cooperative ITS Credentials Management System	Security Credentials Management System
Data Distribution System	Marinara County Data Sharing System

By Physical Object – Organized by ARC-IT Physical Object type

Web Output – Inventory



RAD-IT[✓] Marinara Regional ITS Architecture

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 - By Stakeholder**
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Inventory by Stakeholder

Each stakeholder is associated with one or more systems or "elements" that make up the regional transportation system. This table sorts the inventory by stakeholder, so each stakeholder can easily identify and review the information for all elements that they own and operate.

Stakeholder	Role	Element
(No Stakeholder)		Vehicles
Alfredo County Department of Transportation	Manages	Alfredo County Freeway Management Center
	Owns	Alfredo County Freeway Management Center
	Owns	Communications for Alfredo Networking and Operations Local Infrastructure
	Manages	Communications for Alfredo Networking and Operations Local Infrastructure
Area Drivers		Area Drivers
	Owns	Equipped Vehicles
	Operates	Equipped Vehicles
Area Parking Providers	Owns	Regional Parking Lots
	Manages	Regional Parking Lots
Area Travelers	Owns	Traveler Information Devices
	Operates	Traveler Information Devices

By Stakeholder – Organized by RAD-IT Stakeholder



Web Output – Inventory (Detail)



RAD-IT^Y
Marinara Regional ITS Architecture

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MC Freeway Management Center (BASIL/PINCH)

Status: Existing

Description
MCDOT has deployed two computer systems which monitor and record data from the sensors and operators. One is Bay Area Safety Information Logging (BASIL) system which provides detailed electronic records of incident histories and impacts. The other system is the Prediction of INCident Hazards (PINCH) system which uses BASIL data to provide warnings to the operators at times of high risk of incidents. MCDOT hopes eventually to use these systems to reduce incident severity and frequency.

Stakeholders

Stakeholder	Role	Role Status
MCDOT and State Highway Patrol	Owns	Existing
MC Freeway Operators	Operates	Existing

Physical Objects
[Traffic Management Center](#)

Functional Objects

Functional Object	Description	User Defined
Center Connected Vehicle Infrastructure Management	'Center Connected Vehicle Infrastructure Management' is the back office application that supports monitoring and maintenance of the Connected Vehicle infrastructure (RSEs, support systems, and associated communications links). It monitors the performance and configuration of the infrastructure portion of the Connected Vehicle Environment. This includes tracking and management of the infrastructure configuration as well as detection, isolation, and correction of infrastructure service problems. The application also includes monitoring of performance of the infrastructure equipment, including RSEs and communications links.	False
Center Data Collection	'Center Data Collection' collects and stores information that is created in the course of center operations. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.	False

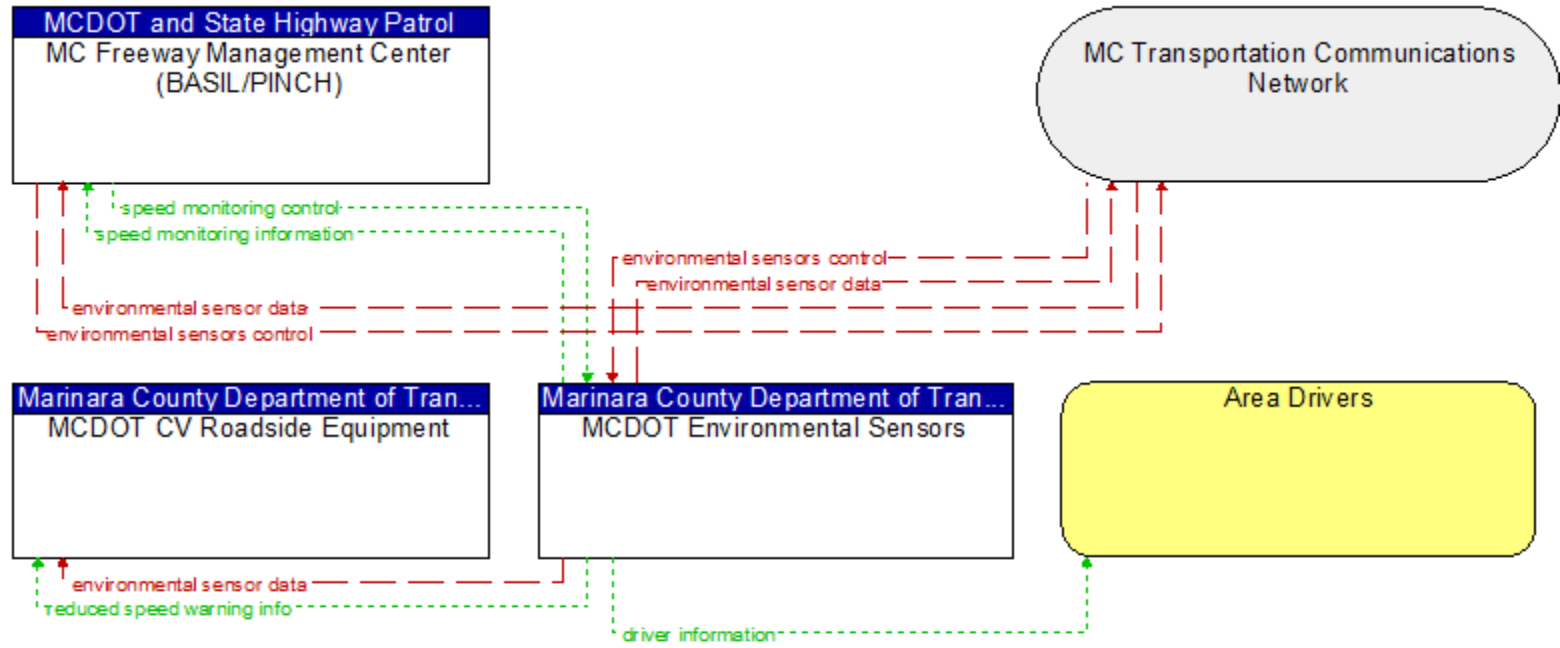
...

TMC Variable Speed Limits	'TMC Variable Speed Limits' provides center monitoring and control of variable speed limits systems. It monitors data on traffic and environmental conditions collected from sensors along the roadway. Based on the measured data, it calculates and sets suitable speed limits usually by lane. It controls equipment that posts the current speed limits and displays additional information such as basic safety rules and current traffic information to drivers.	False
----------------------------------	--	-------

Physical Standards

Document Number	Title	Description
CEN ISO 24014-2	Public transport — Interoperable fare management system — Part 2: Business practices	ISO/TR 24014-2:2013 introduces a generic conceptual framework that can be applied to all Interoperable Fare Management Systems (IFMS) compliant with ISO 24014-1, as the basis for business practices relating to the conceptual framework for an IFMS, which is described in ISO 24014-1. This generic conceptual framework comprises three parts: 1) structure of the set of rules; 2) collaboration of functional models; and 3) integration of the set of rules.
ISO 21212	Intelligent transport systems — Communications access for land mobiles (CALM) — 2G Cellular systems	ISO 21212 determines the air interface for second generation (2G) cellular networks and 2G systems (e.g. using WAP and I-Mode type protocols) to be compliant to CALM, i.e., requirements that must be met before a 2G system can be incorporated into a CALM system. It specifies protocols and parameters that 2G systems shall include to support prolonged, long-range, high data rate wireless communication links in ITS environments where heterogeneous handovers or media independent handovers (MIH) are either necessary to maintain the link, or desirable as determined by media selection policies.
ISO 22179	Intelligent transport systems — Full speed range adaptive cruise control (FSRA) systems — Performance requirements and test procedures	THIS STANDARD HAS BEEN REVISED BY ISO 15622

Web Output – Inventory (Context)



--- Planned
--- Future

ITS Services

- ITS capabilities used to meet operational goals and objectives
- Examples:
 - Emergency Vehicle Preemption
 - Electronic Toll Collection
 - Transit Signal Priority
 - Traffic Incident Management





Service Package Areas

- ITS services in the ARC-IT



Service Packages and a Regional ITS Architecture

- Service Packages provide a menu of ITS services
 - Select Service Packages of interest
 - Map to your inventory and tailor



Parking Space Management	✓
Smart Park and Ride System	✓
Parking Electronic Payment	✓
Regional Parking Management	
Parking Reservations	
Loading Zone Management	✓

•
•
•

RAD-IT – Services



Start | Planning | Stakeholders | Inventory | **Services** | User Needs | R & R | Functions | Interfaces | Communications | Agreements

Current Region: Marinara County

Service Packages

Service Packages: Region All

- DM01: ITS Data Warehouse
- PM01: Parking Space Management
- PM03: Parking Electronic Payment
- PM04: Regional Parking Management
- PM05: Parking Reservations
- PS10: Wide-Area Alert
- PT02: Transit Fixed-Route Operations
- PT06: Transit Fleet Management
- SU01: Connected Vehicle System Monitoring and Management
 - SP SU01: Connected Vehicle System Monitor
- SU03: Data Distribution
- SU04: Map Management
- SU05: Location and Time
- SU08: Security and Credentials Management
- SU09: Device Certification and Enrollment
- SU11: Field Equipment Maintenance
- TI01: Broadcast Traveler Information
- TI02: Personalized Traveler Information
- TI04: Infrastructure-Provided Trip Planning and Route Guidance
- TI05: Travel Services Information and Reservation
- TI07: In-Vehicle Signage
- TM01: Infrastructure-Based Traffic Surveillance
- TM03: Traffic Signal Control
- TM05: Traffic Metering
- TM06: Traffic Information Dissemination
- TM07: Regional Traffic Management
- TM08: Traffic Incident Management System
- TM12: Dynamic Roadway Warning

Service Package Attributes

ID: Status (Region):

Name:

Description:

Elements: Selected Regional All

- Marinara Port Management System
- MC Freeway Management Center (BASIL/PINCH)
- MC Planning Data Warehouse
- MC Public Safety Communications and Dispatch Centers
- MCDPW GARI IC Information System

Projects: Selected All

- MCDOT Saucelito Traffic Coordination
- MCDOT Traffic Monitoring Expansion Project
- MCDOT V2I Safety Initiative
- TOMATO

Comment:

Web Output – Services



Service Packages

One of the first steps in developing an architecture is to identify the transportation services that are important to the Region. The following table lists each service package and its applicability to the Region. More information about each service package can be obtained by selecting the service package in the table below.

Service Package	Service Package Name	Status
DM01	ITS Data Warehouse	Planned
PM01	Parking Space Management	Planned
PM03	Parking Electronic Payment	Planned
PM04	Regional Parking Management	Planned
PM05	Parking Reservations	Future
PS10	Wide-Area Alert	Planned
PT02	Transit Fixed-Route Operations	Existing

User Needs



- User Needs provide a starting point to determine system requirements
- User needs defined in ARC-IT for each service package and can be customized in a regional architecture

RAD-IT – User Needs



Start | Planning | Stakeholders | Inventory | Services | **User Needs** | R & R | Functions | Interfaces | Communications | Agreements

Current Region: Marinara County

Needs: Regional All Autoselect

- DM01: ITS Data Warehouse
 - N 01. System operators need to be able to store data for long term access by themselves and other operators.
 - N 02. System operators need to be able to query for and receive archive data products containing freeway data, arterial data, parking data, transit and ridesharing data, incident management data, safety-related data, environmental and weather data, vehicle and passenger data.
 - N 02. System operators need to be able to query for and receive archive data products containing freeway data, arterial data, parking data, transit and ridesharing data, incident management data, safety-related data, environmental and weather data, vehicle and passenger data.
 - N 03. System operators need to be able to manage data processing with regard to data archive functions, including data aggregation, data tagging (processed, edited, raw, transformed, etc.), data storage timing and longevity, data quality analysis, data formatting and metadata assignments.
- PM04: Regional Parking Management
- PS10: Wide-Area Alert
- PT02: Transit Fixed-Route Operations
- PT06: Transit Fleet Management
- SU01: Connected Vehicle System Monitor
- SU04: Map Management with Connected Vehicles
- SU08: Security and Credentials Management

Need Attributes

Associated Need Area: DM01: ITS Data Warehouse

Number: 02 | Applicability: Applicable | **User Defined**

Need

System operators need to be able to query for and receive archive data products containing freeway data, arterial data, parking data, transit and ridesharing data, incident management data, safety-related data, environmental and weather data, vehicle and passenger data.

RAD-IT [™] Marinara Regional ITS Architecture																	
<ul style="list-style-type: none"> Home Scope Planning Stakeholders Inventory By Physical Object By Stakeholder Services Roles and Resp Needs Functions Interfaces Communications Agreements Projects 	<p>Needs</p> <p>The Stakeholders' Needs listed below are designed to answer two basic questions: – What does the System(s) need to do? – What do users need from the System(s)?</p> <p>They are written from the perspective of a system user or stakeholder in that system and are categorized by the Intelligent Transportation System (ITS) Service Packages that comprise the regional architecture. Service Packages provide an accessible, service-oriented perspective to the overall system architecture used to describe the region or project. They identify the pieces of the physical view that are required to implement a particular ITS service. Each of these service packages has a set of Needs associated with it that can be used as the basis for stakeholder validation, setting proper expectations, and eliciting requirements for the systems and devices to be implemented.</p>	<table border="1"> <thead> <tr> <th>Need Area</th> <th>Need Number</th> <th>Need</th> </tr> </thead> <tbody> <tr> <td rowspan="3">DM01: ITS Data Warehouse</td> <td>01</td> <td>System operators need to be able to store data for long term access by themselves and other operators.</td> </tr> <tr> <td>02</td> <td>System operators need to be able to query for and receive archive data products containing freeway data, arterial data, parking data, transit and ridesharing data, incident management data, safety-related data, environmental and weather data, vehicle and passenger data.</td> </tr> <tr> <td>03</td> <td>System operators need to be able to manage data processing with regard to data archive functions, including data aggregation, data tagging (processed, edited, raw, transformed, etc.), data storage timing and longevity, data quality analysis, data formatting and metadata assignments.</td> </tr> <tr> <td rowspan="2">PM04: Regional Parking Management</td> <td>01</td> <td>Regional parking management needs to be able to share information with various transportation operations agencies in order to support multimodal travel planning, including parking reservation capabilities.</td> </tr> <tr> <td>02</td> <td>Regional parking management needs to coordinate activities with other parking operations, including sharing of availability, hours, and other information to facilitate efficient regional transportation strategies.</td> </tr> </tbody> </table>	Need Area	Need Number	Need	DM01: ITS Data Warehouse	01	System operators need to be able to store data for long term access by themselves and other operators.	02	System operators need to be able to query for and receive archive data products containing freeway data, arterial data, parking data, transit and ridesharing data, incident management data, safety-related data, environmental and weather data, vehicle and passenger data.	03	System operators need to be able to manage data processing with regard to data archive functions, including data aggregation, data tagging (processed, edited, raw, transformed, etc.), data storage timing and longevity, data quality analysis, data formatting and metadata assignments.	PM04: Regional Parking Management	01	Regional parking management needs to be able to share information with various transportation operations agencies in order to support multimodal travel planning, including parking reservation capabilities.	02	Regional parking management needs to coordinate activities with other parking operations, including sharing of availability, hours, and other information to facilitate efficient regional transportation strategies.
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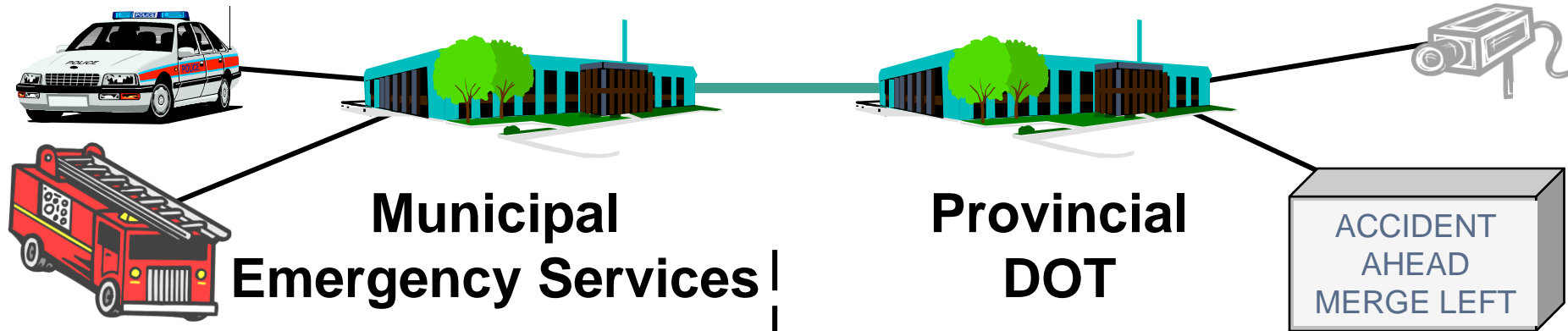
Roles and Responsibilities

Identifies the roles and responsibilities of stakeholders in the operation, implementation and maintenance of the ITS systems

- Roles – ITS functions of a stakeholder
- Responsibilities – Duties or obligations of a stakeholder in delivering one or more ITS services in a region



R & R examples for Incident Management



Adapted from: U.S. DOT

- Provide incident information to Provincial DOT TMC
- Dispatch emergency vehicles to incident

- Monitor roadways and provide incident information to Emergency Services
- Share CCTV images with Emergency Services

RAD-IT – Roles & Responsibilities

Start | Planning | Stakeholders | Inventory | Services | User Needs | **R & R** | Functions | Interfaces | Communications | Agreements

Current Region: Marinara County

Role and Responsibility Areas

Regional Areas: Included All Autoselect

- Amber Alert for Marinara County
- Data Management for Marinara County
- Freeway Management for Marinara County
- Incident Management for Marinara County
 - Marinara County Department of Public Works
 - Marinara County Department of Transportation**
 - Marinara County Sheriff's Department
 - Saucelito City Department of Transportation
 - Saucelito Fire Department
 - Saucelito Police Department
- MCDOT V2I Safety Initiative Roles and Responsibilities
- Parking Management for Marinara County
- Security for Marinara County
- Support Services for Marinara County
- Surface Street Management for Marinara County
- Transit Services for Marinara County
- Traveler Information for Marinara County
- Vehicle Safety for Marinara County

Stakeholder Roles and Responsibilities

RR

Area: Incident Management for Marinara County

Stakeholder: Marinara County Department of Transportation

R&Rs: Selected All Editable

	Role and Responsibility	In Project	Status	Include
▶	Assess and address collateral damage to freeway facilities.	<input checked="" type="checkbox"/>	Planned	<input checked="" type="checkbox"/>
	Detect freeway incidents and coordinate with Highway Patrol	<input checked="" type="checkbox"/>	Planned	<input checked="" type="checkbox"/>
	Operate Pasta Helpers Freeway Service Patrol	<input type="checkbox"/>	Planned	<input checked="" type="checkbox"/>
	Provide CCTV image feeds to responding agencies.	<input type="checkbox"/>	Planned	<input checked="" type="checkbox"/>
	Provide resources to support closures, detours, and cleanup	<input type="checkbox"/>	Planned	<input checked="" type="checkbox"/>
*		<input type="checkbox"/>		<input type="checkbox"/>

Web Output – Roles & Responsibilities



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Incident Management for Marinara County Roles and Responsibilities

Stakeholder	Role and Responsibility
Marinara County Department of Public Works	Adapt traffic signal control to accommodate detours around the incident scene.
	Provide signal preemption for Saucelito and County fire.
	Provide traffic control resources including portable VMS, cones, sand, front loaders, etc.
Marinara County Department of Transportation	Provide resources to support closures, detours, and cleanup
	Assess and address collateral damage to freeway facilities.
	Detect freeway incidents and coordinate with Highway Patrol
	Operate Pasta Helpers Freeway Service Patrol
	Provide CCTV image feeds to responding agencies.

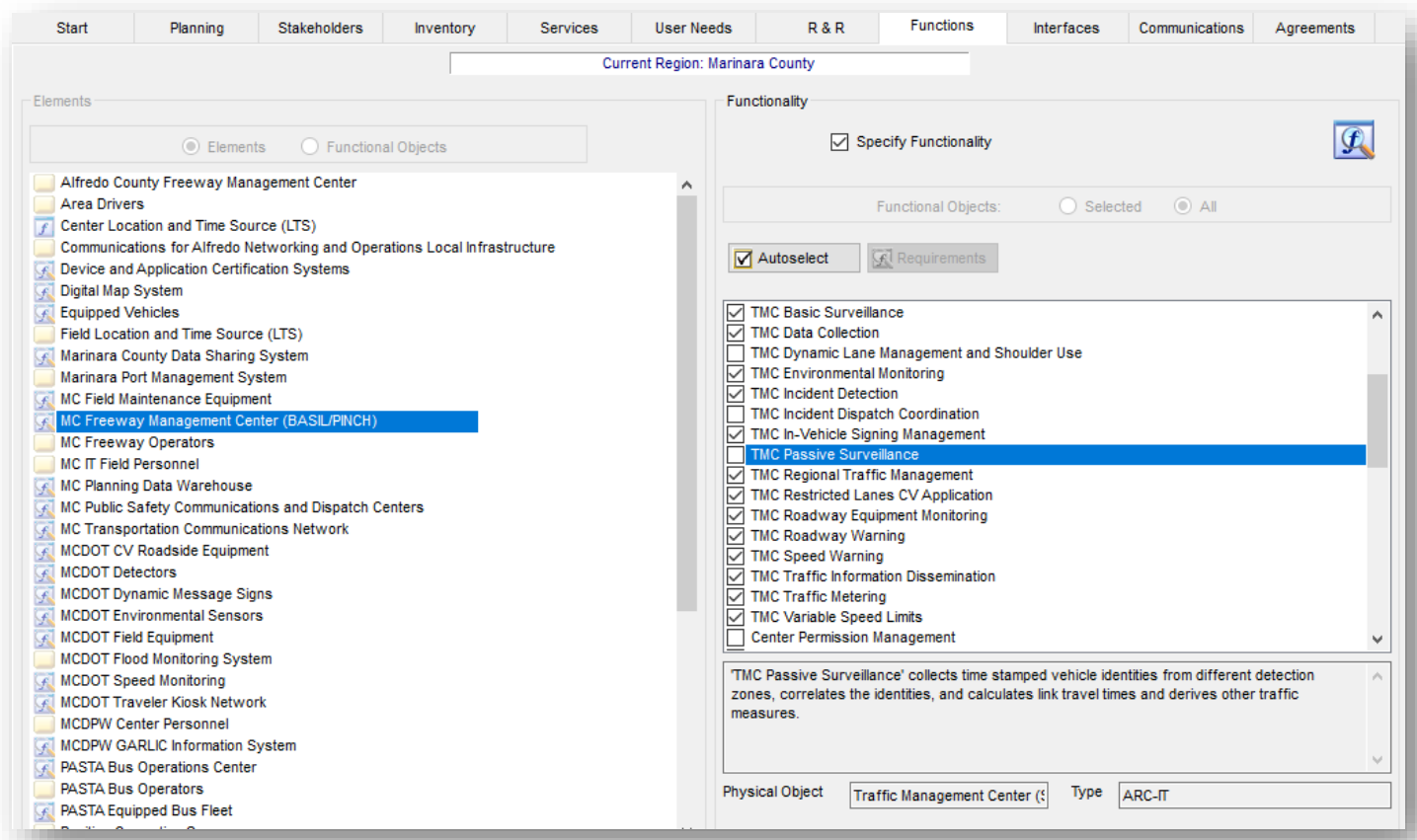
Functional Requirements

- High-level descriptions of what ITS elements will do in the region
 - NOT detailed design requirements
- Functional Objects provide that high level view.



RAD-IT – Functions (Step 1)

- In ARC-IT Functional requirements are defined for every Functional Object
- RAD-IT allows selections of the Functional Objects for each element



RAD-IT – Functional Requirements (Step 2)

MC Freeway Management Center (BASIL/PINCH) | TMC Environmental Monitoring

Limit Details Needs Sort Present

MC Freeway Management Center (BASIL/PINCH) - TMC Environmental Monitoring Requirements (7 Entries)

Number	Requirement	Status	Include	User Defined
01	The traffic center shall remotely control environmental sensors that measure road surface conditions including temperature, moisture, icing, salinity, and other measures.	Planned	<input checked="" type="checkbox"/>	<input type="checkbox"/>
02	The traffic center shall remotely control environmental sensors that measure weather conditions including temperature, wind, humidity, precipitation, and visibility.	Planned	<input checked="" type="checkbox"/>	<input type="checkbox"/>
03	The traffic center shall assimilate current and forecast road conditions and surface weather information using a combination of weather service provider information (such as the National Weather Service and value-added sector specific meteorological services), data from roadway maintenance operations, and environmental data collected from sensors deployed on and about the roadway.	Planned	<input checked="" type="checkbox"/>	<input type="checkbox"/>
04	The traffic center shall be able to receive road condition information from weather service providers.	Not Applicable	<input type="checkbox"/>	<input type="checkbox"/>
05	The traffic center shall receive aggregated and processed vehicle environmental data collected from vehicle safety and convenience systems through the connected vehicle roadside equipment.	Planned	<input checked="" type="checkbox"/>	<input type="checkbox"/>
06	The traffic center shall be able to share the collected environmental data with Maintenance and construction operations.	Not Applicable	<input type="checkbox"/>	<input type="checkbox"/>
07	The traffic center shall provide drivers road weather advisories.	Not Applicable	<input type="checkbox"/>	<input type="checkbox"/>

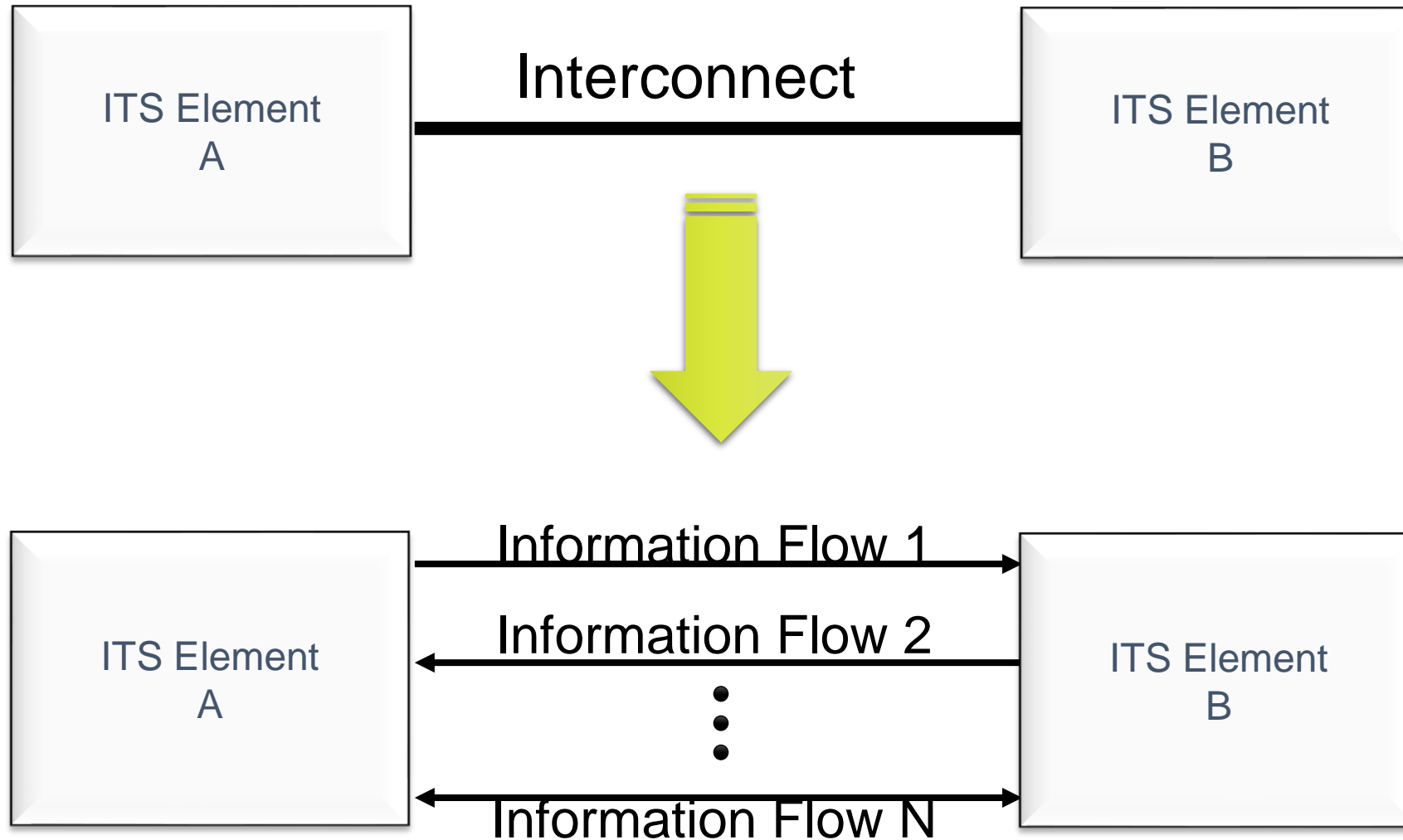
Interfaces

- **Identify Interconnects**
Which systems will share info?
- **Define Information Flows**
What information will they share?





Interconnects are made up of Information Flows



RAD-IT – Interfaces



Element:

Build | Connect | **Flows** | Group | Sort | Present | Filter | Elements | Limit | New Flows | Info

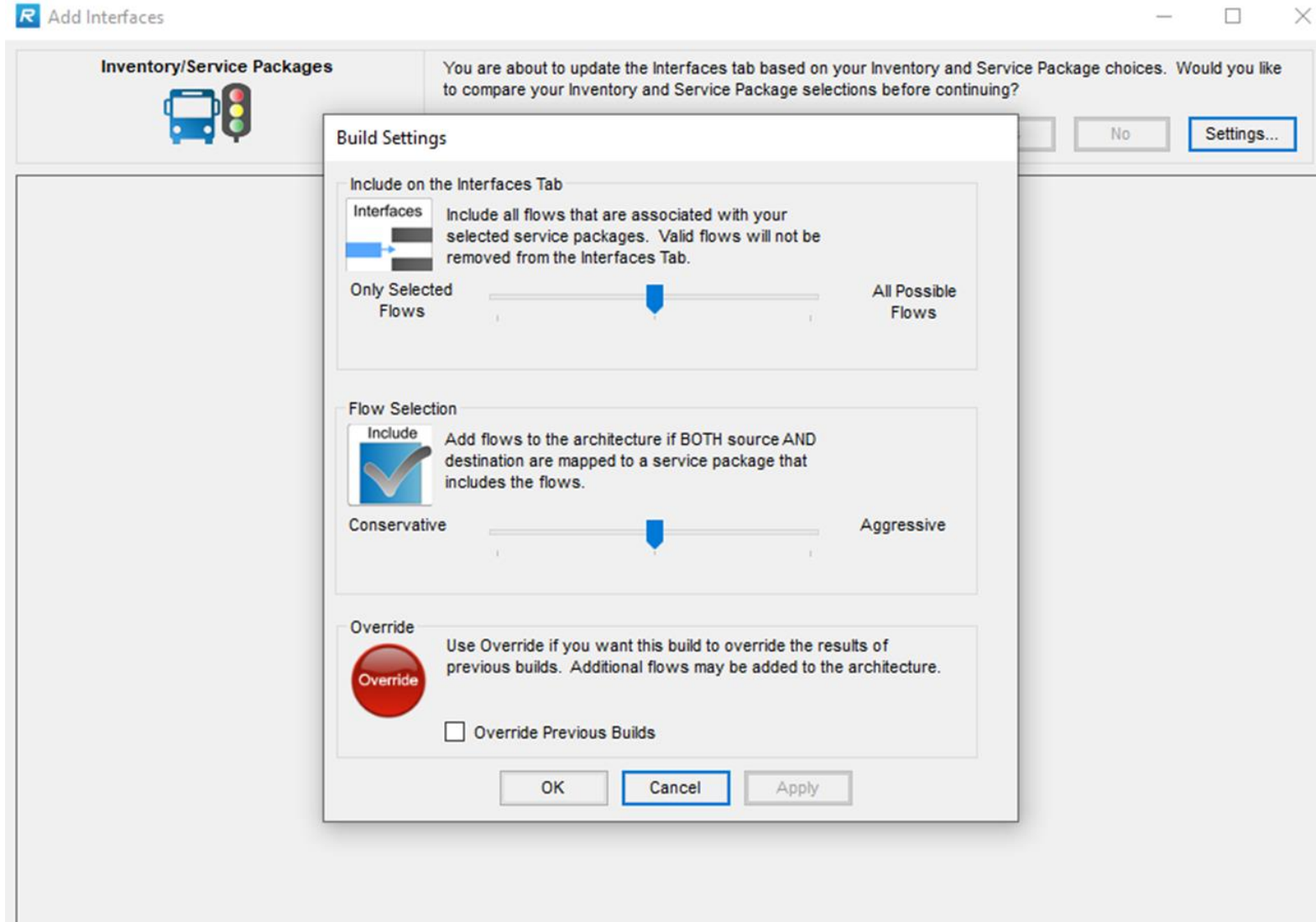
Element Selection | Build | Display | Style | Filters | Details

Start | Planning | Stakeholders | Inventory | Services | User Needs | R & R | Functions | **Interfaces** | Communications | Agreements

Marinara County: All Information Flows (553 Entries)

	Source Element	Flow Name	Destination Element	Status	Communications	DDS	Include
▶	Alfredo County Freeway Manag...	device control request	MC Freeway Management Cent...	Planned	Communications for Alfredo ...	Not Identified	<input checked="" type="checkbox"/>
	Alfredo County Freeway Manag...	traffic images	MC Freeway Management Cent...	Planned	Communications for Alfredo ...	Not Identified	<input checked="" type="checkbox"/>
	Alfredo County Freeway Manag...	road network conditions	MC Freeway Management Cent...	Planned	Communications for Alfredo ...	Not Identified	<input checked="" type="checkbox"/>
	Alfredo County Freeway Manag...	device data	MC Freeway Management Cent...	Planned	Communications for Alfredo ...	Not Identified	<input checked="" type="checkbox"/>
	Alfredo County Freeway Manag...	device status	MC Freeway Management Cent...	Planned	Communications for Alfredo ...	Not Identified	<input checked="" type="checkbox"/>
	Alfredo County Freeway Manag...	incident information	MC Freeway Management Cent...	Planned	Communications for Alfredo ...	Not Identified	<input checked="" type="checkbox"/>

RAD-IT – Interfaces



- Include
 - Only selected
 - Only from Service Packages
 - All
- Select
 - Add but don't select as in architecture
 - Add/select if both Source AND Destination
 - Add/select if either Source OR Destination

Web Output – Interfaces



- Home
- Scope
- Planning
- Stakeholders
- Inventory
 - By Physical Object
 - By Stakeholder
- Services
- Roles and Resp
- Needs
- Functions
- Interfaces**
- Communications
- Agreements
- Projects

Interfaces

A primary purpose of the Regional ITS Architecture is to identify the integration opportunities among transportation systems (the "ITS elements") in the region. The following table identifies every interface defined for the Region. Each entry in the "Interfacing Element" column is a link to more detailed information about the particular interface.

Element	Interfacing Element	Status
Alfredo County Freeway Management Center	MC Freeway Management Center (BASIL/PINCH)	Planned
Area Drivers	Equipped Vehicles	Planned
	MCDOT Detectors	Future
	MCDOT Dynamic Message Signs	Existing
	MCDOT Environmental Sensors	Future
	MCDOT Field Equipment	Existing
	MCDOT Speed Monitoring	Planned
Center Location and Time Source (LTS)	Equipped Vehicles	Planned
	Field Location and Time Source (LTS)	Planned
	MC Freeway Management Center (BASIL/PINCH)	Planned
	MCDOT CV Roadside Equipment	Planned
	MCDOT Field Equipment	Planned

ITS Standards

- Over 100 ITS Standards
- Cover Transit, Traffic, CVO, Toll, Traveler Information, Connected Vehicle...



RAD-IT – Communication Solutions

- Identified as Communications Solutions by Interface

Start	Planning	Stakeholders	Inventory	Services	User Needs	R & R	Functions	Interfaces	Communications	Agreements
Marinara County Solutions by Interface (401 Entries)										
Source Element	Flow Name	Destination Element	Solution	Readiness	Override					
Alfredo County Freeway Management Center	device control request	MC Freeway Management Center (BASL/PNCH)	US: TMDD - NTCP Messaging(Moderate)	✓ Moderate	<input type="checkbox"/>					
Alfredo County Freeway Management Center	device data	MC Freeway Management Center (BASL/PNCH)	US: TMDD - NTCP Messaging (Moderate)	✓ Moderate	<input type="checkbox"/>					
Alfredo County Freeway Management Center	device status	MC Freeway Management Center (BASL/PNCH)	US: TMDD - NTCP Messaging (Moderate)	✓ Moderate	<input type="checkbox"/>					
Alfredo County Freeway Management Center	incident information	MC Freeway Management Center (BASL/PNCH)	US: TMDD - NTCP Messaging (Moderate)	✓ Moderate...	<input type="checkbox"/>					
Alfredo County Freeway Management Center	road network conditions	MC Freeway Management Center (BASL/PNCH)	US: TMDD - NTCP Messaging(Moderate)	✓ Moderate	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	Equipped Vehicles	GNSS Data - GNSS serial interface(High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	MC Freeway Management Center (BASL/PNCH)	GNSS Data - GNSS serial interface(High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	MCDOT CV Roadside Equipment	GNSS Data - GNSS serial interface (High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	MCDOT Field Equipment	GNSS Data - GNSS serial interface (High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	MCDPW GARLIC Information System	GNSS Data - GNSS serial interface (High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	PASTA Bus Operations Center	GNSS Data - GNSS serial interface (High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	SCDDT City Operations Center	GNSS Data - GNSS serial interface (High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	TOMATO Regional Traveler Information Center	GNSS Data - GNSS serial interface (High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Center Location and Time Source (LTS)	location and time	Traveler Information Devices	GNSS Data - GNSS serial interface (High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
Device and Application Certification Systems	device enrollment information	Security Credentials Management System	US: Device enrollment - Secure Internet (ITS)(High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					
▶ Digital Map System	intersection geometry	Equipped Vehicles	US: SAE Other J2735 - Secure Wireless Internet (ITS)(Moderate)	✓ Moderate	<input checked="" type="checkbox"/>					
Digital Map System	map updates	Equipped Vehicles	US: SAE Other J2735 - Secure Wireless Internet (ITS)(Moderate)	✓ Lowest	<input type="checkbox"/>					
Digital Map System	parking facility geometry	Equipped Vehicles	Data for Distribution (BD) - OVC DCS over Wireless(Lowest)	✓ Lowest	<input type="checkbox"/>					
Digital Map System	roadway geometry	Equipped Vehicles	(None Data) - Secure Wireless Internet (ITS)(Lowest)	✓ Lowest	<input type="checkbox"/>					
Digital Map System	roadway geometry	Equipped Vehicles	US: SAE Lane-Level Mapping - Secure Wireless Internet (ITS)(High-Moderate)	✓ High-Mod...	<input type="checkbox"/>					

Standards from Marinara

STANDARDS



RAD-IT[✓]

Marinara Regional ITS Architecture

Home
Scope
Planning
Stakeholders
Inventory
 By Physical Object
 By Stakeholder
Services
Roles and Resp
Needs
Functions
Interfaces
Communications
Agreements
Projects

US: SAE Other J2735 - Secure Wireless Internet (ITS)

Description

This solution is used within the U.S.. It combines standards associated with US: SAE Other J2735 with those for I-M: Secure Wireless Internet (ITS). The US: SAE Other J2735 standards include upper-layer standards required to implement V2X information flows that do not yet have fully specified functionality and performance characteristics. The I-M: Secure Wireless Internet (ITS) standards include lower-layer standards that support secure communications between two entities, either or both of which may be mobile devices, but they must be stationary or only moving within wireless range of a single wireless access point (e.g., a parked car). Security is based on X.509 or IEEE 1609.2 certificates. A non-mobile (if any) endpoint may connect to the service provider using any Internet connection method.

Includes Standards

Level	DocNum	FullName	Description
Mgmt	IETF RFC 3411	An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks	This standard (RFC) defines the basic architecture for SNMPv3 and includes the definition of information objects for managing the SNMP entity's architecture.
Mgmt	IETF RFC 3412	Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)	This standard (RFC) contains a MIB that assists in managing the message processing and dispatching subsystem of an SNMP entity.
Mgmt	IETF RFC 3413	Simple Network Management Protocol (SNMP) Applications	This standard (RFC) includes MIBs that allow for the configuration and management of remote Targets, Notifications, and Proxys.

...

Supports Interfaces

Source	Destination	Flow
Digital Map System	Equipped Vehicles	intersection geometry
Digital Map System	Traveler Information Devices	intersection geometry
Equipped Vehicles	Digital Map System	vehicle location and motion for mapping

Agreements

- Document institutional integration in region
- May be required for interjurisdictional interfaces
- Define:
 - Integration plans
 - Maintenance & operations plans
 - Funding responsibilities



Agreements from Marinara Regional ITS Architecture

RAD-IT[✓] Marinara Regional ITS Architecture

- Home
- Scope
- Planning
- Stakeholders
- Inventory
 - By Physical Object
 - By Stakeholder
- Services
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- Functions
- Interfaces
- Communications
- Agreements**
- Projects

Agreements

Agreements provide the institutional underpinnings for the technical integration identified in the Regional ITS Architecture. This page lists the agreements that support Intelligent Transportation Systems in the region.

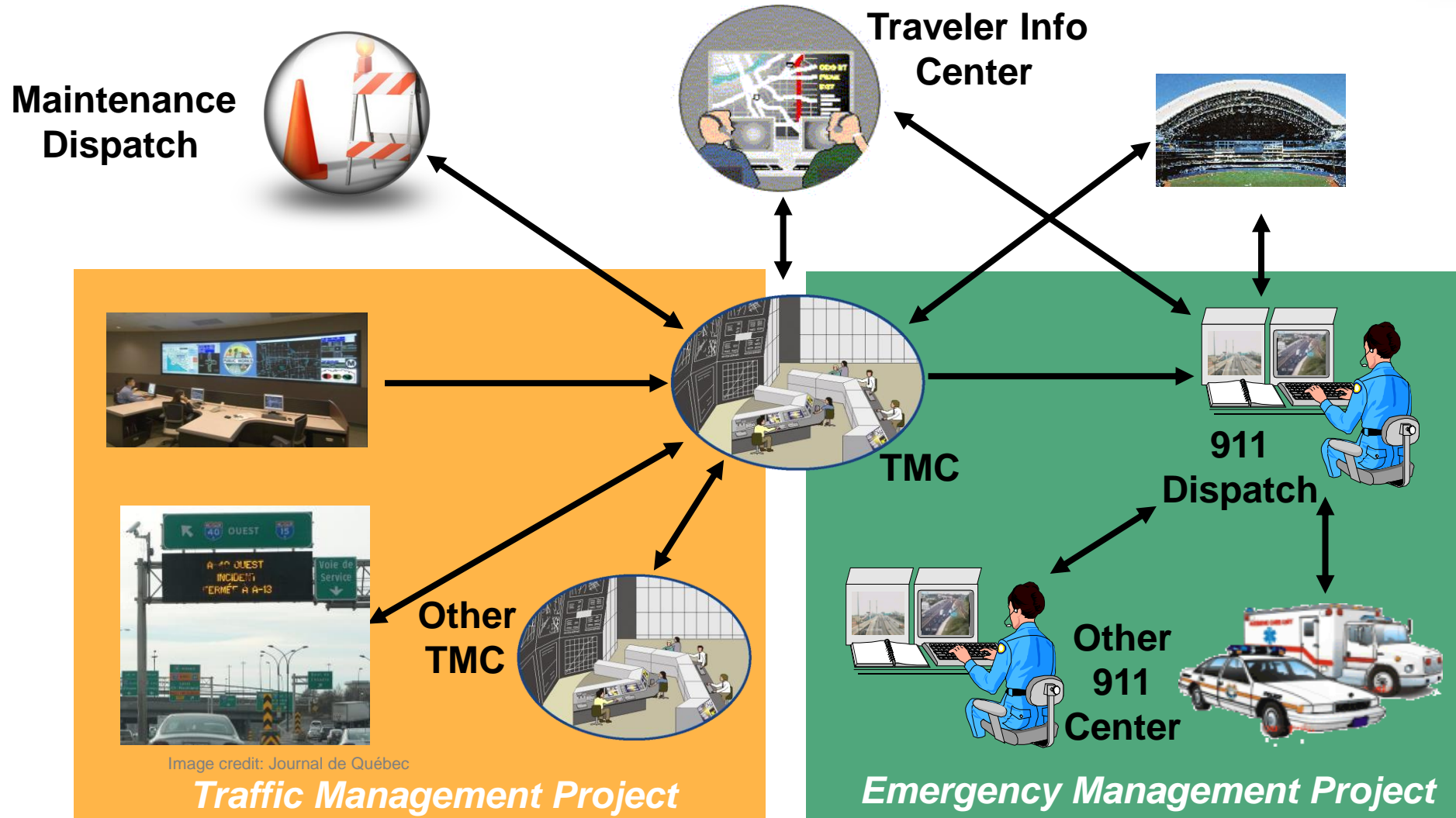
Number	Title	Status
11	Marinara County Department of Public Works Marinara County Department of Transportation Information Exchange and Action Agreement	Planned
12	Marinara County Department of Public Works MCDOT and State Highway Patrol Information Exchange Agreement	Planned
04	Marinara County Department of Public Works National Digital Traveler Information Exchange Agreement	Planned
05	Marinara County Department of Public Works The Security Authority Information Exchange Agreement	Planned
13	Marinara County Department of Transportation Area Drivers Information Provision Agreement	Planned
14	Marinara County Department of Transportation Area Travelers Information Provision Agreement	Planned
15	Marinara County Department of Transportation Marinara County IT Department Information Exchange and Action Agreement	Planned
10001-04-15191	Marinara County FMC Joint Operations Agreement	Planned
16	Marinara County IT Department Marinara County Department of Public Works Information Provision Agreement	Planned
17	Marinara County IT Department MCDOT and State Highway Patrol Information Provision Agreement	Planned
MCTPB-96-00321	Marinara County Regional Architecture Memorandum of Understanding	Planned
06	MCDOT and State Highway Patrol Marinara County Department of Transportation Information Exchange and Action Agreement	Planned

Projects



- Projects are defined within the regional architecture
- An implementation sequence is also defined

Project Identification



Adapted from: U.S. DOT

Project Excerpt from Marinara Regional ITS Architecture



RAD-IT ✓ Marinara Regional ITS Architecture

- Home
- Scope
- Planning
- Stakeholders
- Inventory
 - By Physical Object
 - By Stakeholder
- Services
- Roles and Resp
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- Projects**

Projects

The Regional ITS Architecture provides a starting point for project definition. It provides an overall framework that shows how anticipated projects will integrate with each other and with existing systems. This page lists all the ITS projects that have been mapped to the regional ITS architecture.

Project	Status	Timeframe	Description
MCDOT Saucelito Traffic Coordination	Planned	FY2020	Information about the MCDOT–Saucelito Traffic Coordination
MCDOT Traffic Monitoring Expansion Project	Planned	FY 2021	This is a new project created to demonstrate a single agency (MCDOT) using RAD–IT to select the inventory and services from the region that are part a small ITS project. An instance of the region's parent ITS Roadway Equipment is used and an instance of the region's parent Traffic Monitoring service package. Just pass through each of the tabs and select the items that are part of the project by clicking on the checkboxes in the left hand lists.
MCDOT V2I Safety Initiative	Planned	FY 2025	Marinara County is contemplating a new Vehicle to Infrastructure (V2I) project as part of the state's new push for Connected and Automated Vehicles (C/AV) technology. This project will demonstrate the use of connected vehicle roadside equipment to collect traffic conditions from passing equipped vehicles and, in turn, provide information to those equipped vehicles to inform them of traffic conditions ahead such as queues backing up or warning of dangerous curves or lane closures. The project was defined in RAD–IT to include the service packages necessary to meet the needs described above. Once the details of the project architecture were fleshed out using SET–IT, two additional service packages (SU01 and SU10) were added to address management and maintenance needs. The entire project was then re–imported to RAD–IT and the regional architecture updated to include those services.
TOMATO	Planned	FY2022	TOMATO will provide regional traveler information of a general nature to tourists and personalized information to residents and businesses. This service will synthesize map and route descriptions, real–time traffic data, static and dynamic transit information, parking availability, event schedules, and other relevant items into traveler information products that will be provided to travelers through multiple mechanisms. The project will be built using city, county, state, and federal funds, but will be transferred to a public–private arrangement still under definition for long–term operation.

Regional ITS Architecture Development Summary

- This session provided a quick walk through of what can be documented for a Regional ITS Architecture
- Don't worry, there are additional resources
 - Recorded RAD-IT Training (including hands-on):
<https://www.arc-it.net/html/resources/training.html>
 - ARC-IT Website:
<https://www.arc-it.net/index.html>
 - Regional ITS Architecture Guide:
<https://www.arc-it.net/documents/raguide/raguide.pdf>
 - RAD-IT Download:
<https://www.arc-it.net/html/forms/raditform.php>

Topic Area	Web-Based Training
ITS Architecture	ARC-IT Web Training Use & Maintenance Web
Software Tools	RAD-IT Web Training SET-IT Web Training

Training Schedule

Session Topic	Description	Date / Time
Detailed ITS Architecture Training	Provides more detailed and comprehensive training on key architecture components and how to access them through the ARC-IT website.	Complete
Regional ITS Architecture Development	Provides a high-level overview of the regional ITS Architecture development process, incorporating examples from the ARC-IT RAD-IT tool.	Today
Systems Engineering Training	Provides an introduction to the concept of Systems Engineering, its importance to the lifecycle of delivering ITS, and how the Architecture helps support to the process.	Wednesday December 13, 2023 1:30PM–4:00PM EST

- French stream: January 30, February 6, and February 13, 2024.
- English stream #2: February 14, February 21, and February 28, 2024.

Questions or
Comments?

Email contacts:

- Support: ITSArchitecture-ArchitectureSTI@tc.gc.ca
- Jonathan Parent Jonathan.Parent@tc.gc.ca
- Mara Bullock mara.bullock@wsp.com



Thank You for Joining!



Systems Engineering Training

December 13, 2023





Webinar Tips and Protocols

- You can ask questions at any time using the question and answer box. We will answer as many questions as possible.
- You can also raise your hand to ask questions verbally if you wish.
- **Please keep your line muted.**
- You may also send your questions via email at ITSArchitecture-ArchitectureSTI@tc.gc.ca to be answered later.

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Acknowledgements

This presentation is based on training materials prepared by the United States Department of Transportation (USDOT).

Transport Canada would like to thank the ITS Architecture for Canada Stakeholder Advisory Committee and others that have graciously reviewed the training material and provided pictures, graphics and other material.

Goals and Objectives

1

Understand the purposes and uses of Architecture & Systems Engineering for ITS

2

Understand fundamentals of Systems Engineering

3

Find opportunities where Systems Engineering will benefit your process

4

See SET-IT in Action

Agenda

- ITS Architecture Review
- Introduction to Systems Engineering
- Review of Systems Engineering Process
- Establishing Systems Engineering in Your Organization
- Seeing SET-IT in action

A note on spelling: U.S. spelling has been used in this presentation for consistency with ARC-IT



ITS Architecture Review



Transport
Canada

Transports
Canada

Canada 



What is ITS?

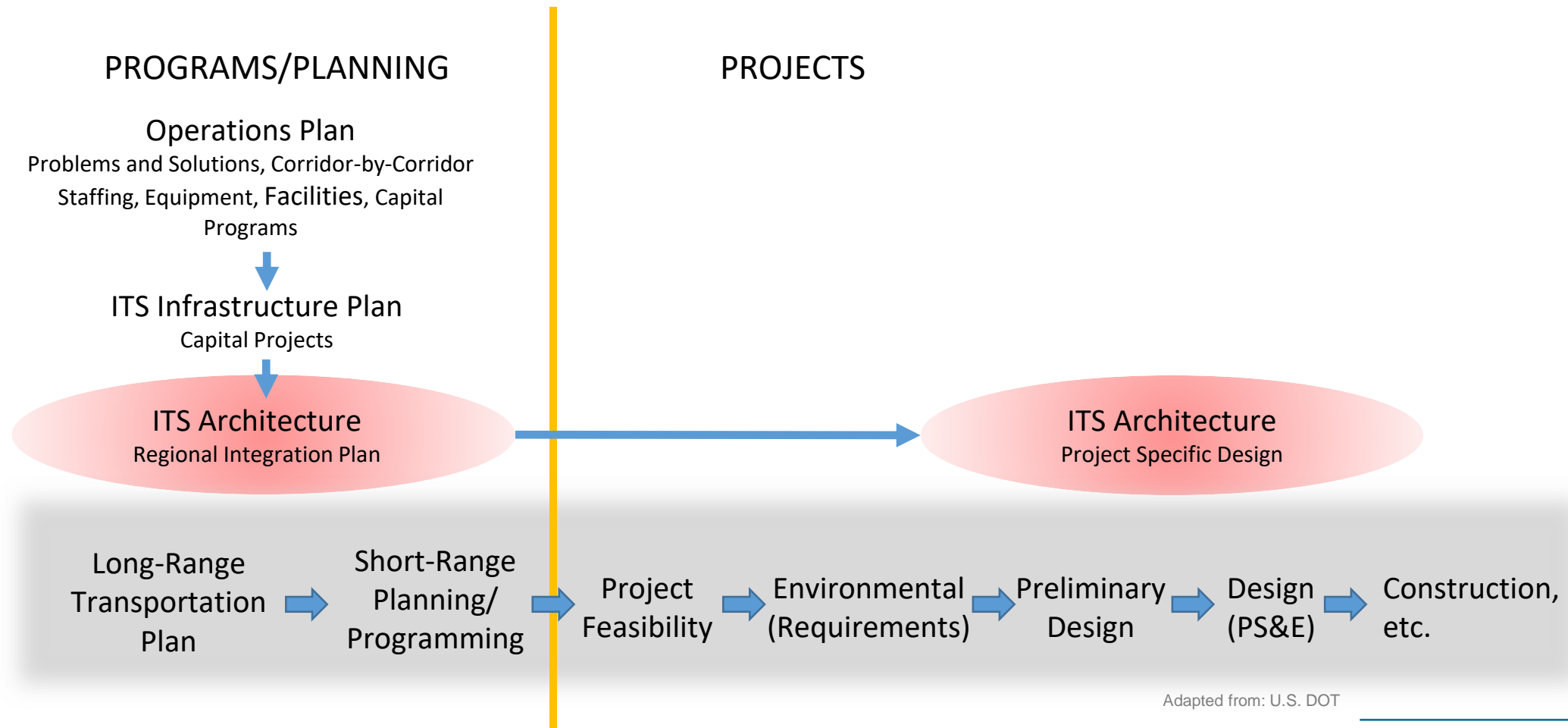
Intelligent Transportation Systems (ITS) integrate different information and communications technologies into road transportation infrastructure and vehicles, to help make the transportation system safer and more efficient.

What is an ITS Architecture?

- Framework for Developing Integrated Transportation Systems
- Identifies:
 - Organizations
 - Systems operated
 - Functions performed
 - Information exchanged
 - Communications
- WITHOUT getting into specific technologies
 - Technology Neutrality is key



Where does an ITS Architecture fit into Traditional Project Development Lifecycles?





ITS Architecture Review Summary

- ITS Architectures provide Frameworks for Developing Integrated Transportation Systems
- ITS Architectures support ITS Planning and Project Development



Introduction to Systems Engineering





Transportation Projects - What Has Worked?

- Road authorities have been building road infrastructure for many years
- They have developed processes for design and construction of roads and bridges where:
 - Past performance is well understood
 - Requirements are well defined and understood
 - Technology is proven and well understood
 - Documented designs are proven and well known
- Projects are not undertaken without following “approved” processes, documents, and standards

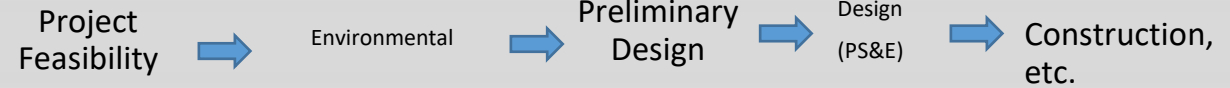
Traditional Project Development Process Has Led to This Success



Low Risk of Unsuccessful Implementation!

- ✓ Performance of products and materials well understood
- ✓ Requirements well defined and understood
- ✓ Proven, well-known technology
- ✓ Documented, proven designs

Traditional Project Development ALSO Works for ITS Infrastructure Expansion



ITS Infrastructure Expansion: Low Risk of Unsuccessful Implementation Projects

Processes and approved manuals ALSO in place for field installation of many ITS technologies

BUT This Traditional Process Does NOT Work for Complex ITS Projects



Project Feasibility



Environmental



Preliminary Design



Design (PS&E)



Construction, etc.

What is Different about Designing Complex Systems?

Software and computer technology are involved!
= Higher Risk

So, just how *do* you manage systems development when software or integration to other systems is involved?

Use Systems Engineering!

What is Systems Engineering?

An **inter-disciplinary approach** and means to enable the realization of successful systems.¹

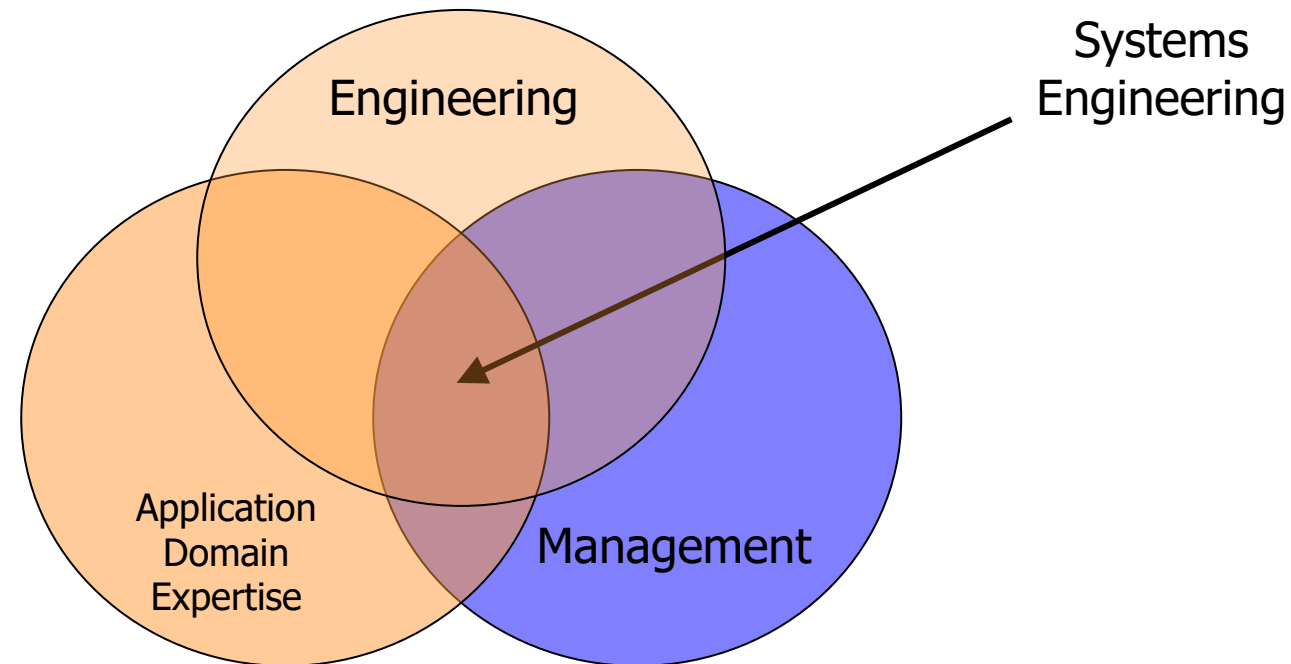
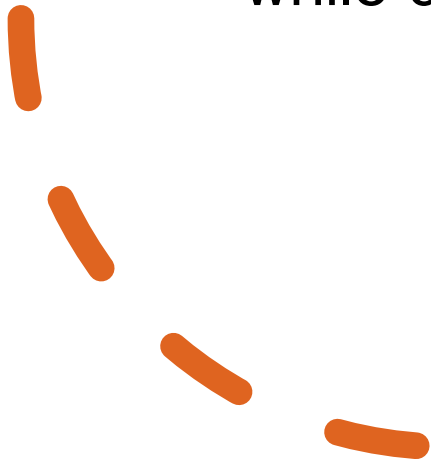


Image credit: 1-EIA-731 Annex B (Glossary)

Systems Engineering (cont.)

- Focuses on:
 - Defining customer needs and required functionality early in the development cycle
 - Documenting requirements
 - Then proceeding with design, implementation, and system validation while considering the complete problem



Systems Engineering Principles

- Start with Your Eye on the Finish Line
- Stakeholder Involvement is Key
- Define the Problem before Implementing the Solution
- Delay Technology Choices



Multiple Approaches, One Purpose

- Systems Engineering allows for multiple approaches
 - Sequential / Waterfall / “V”
 - Spiral
 - Evolutionary / Agile
 - (similar but different than Agile development)
- All have one purpose
 - Develop & Deliver a system that
 - Meets requirements
 - Satisfies needs
 - *Is used* (operated/maintained meeting mission objectives)

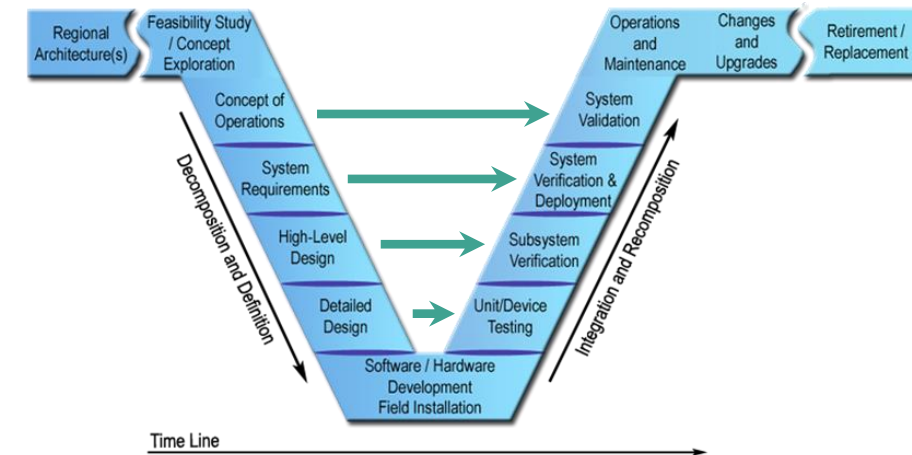


Image credit: U.S. DOT

Simplified Systems Engineering Process

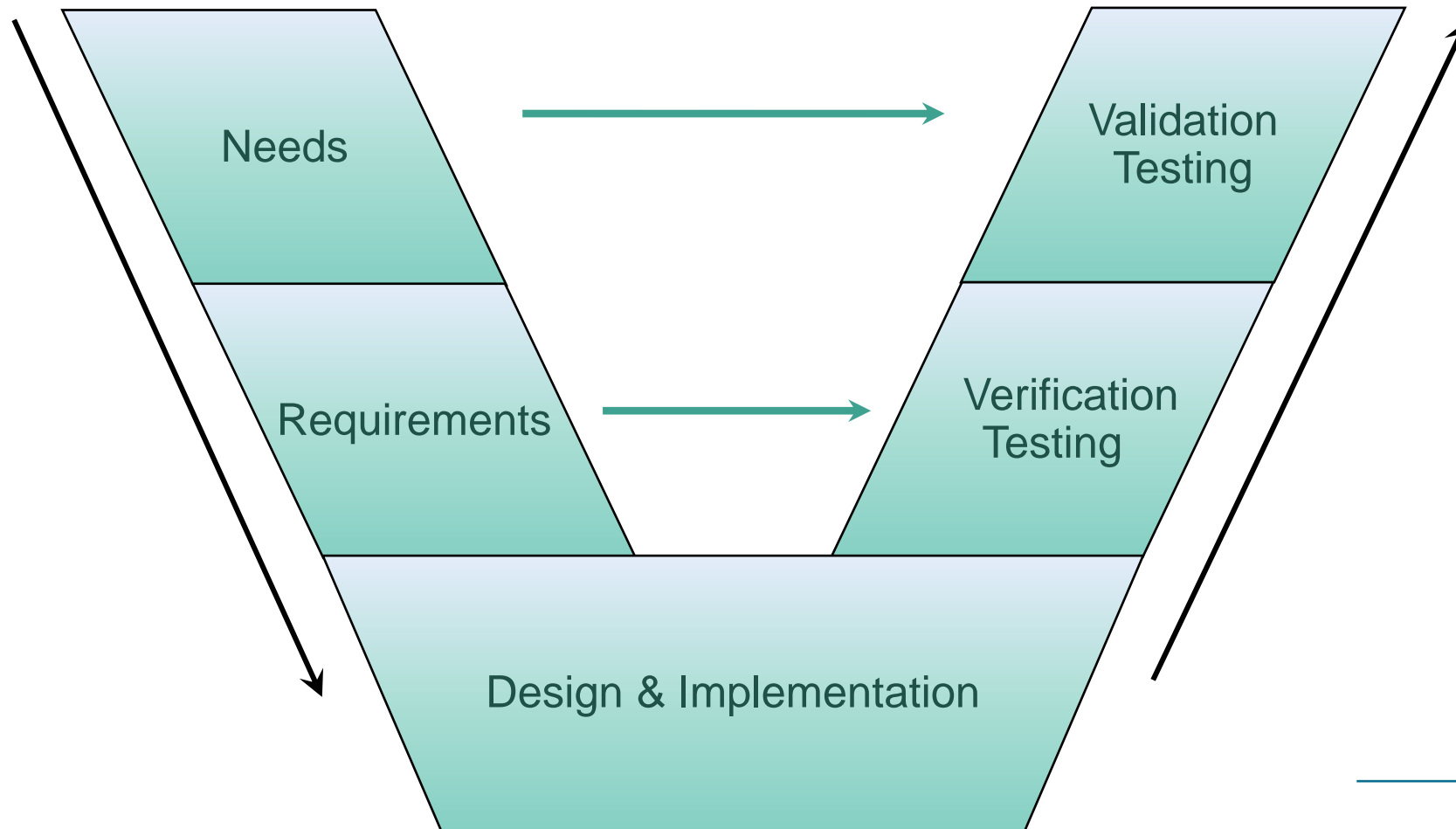
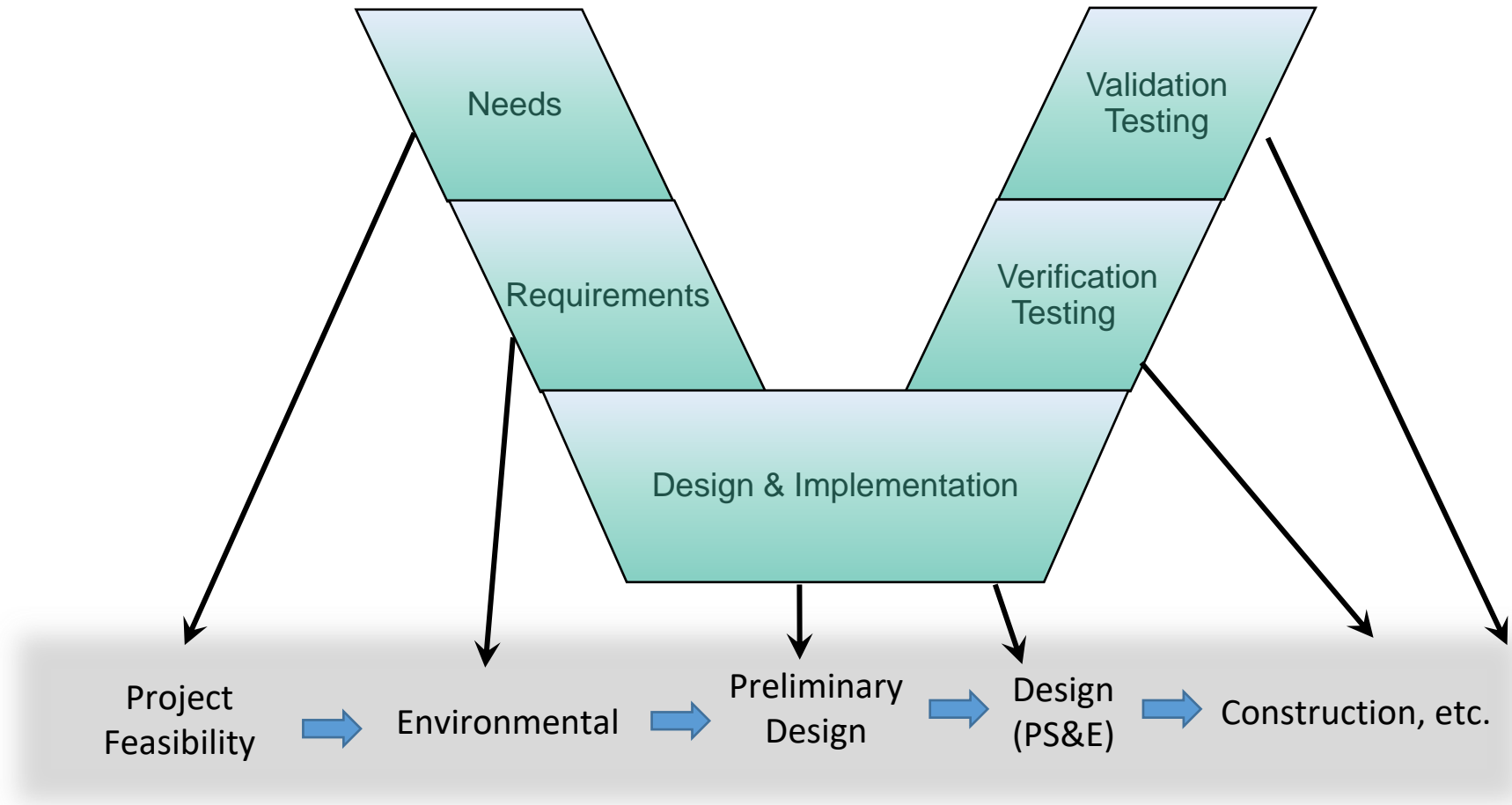


Image credit: U.S. DOT

Mapping to Transportation Process



Adapted from: U.S. DOT

What Do System Engineering Documents Look Like?

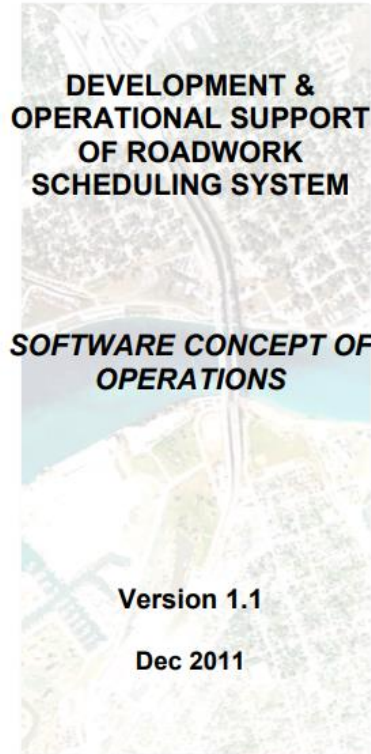
Focus on these documents:

- Concept of Operation
- Requirements
- Verification
- Validation

What documents should include

- Properly documented needs
- High-Level Requirements based on needs
- Traceability between needs and requirements

Example: Roadwork Scheduling System for MTO



Example: Roadwork Scheduling System for MTO

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5 CONCEPTS FOR THE PROPOSED SYSTEM

5.1 Background, Objectives, and Scope

Refer to Sections 3.1, 4.1 and 4.2 for background of the proposed system.

There are two major objectives of the project:

1. Develop and deploy a Roadwork Scheduling System (RSS) that allows multiple contractors / consultants to apply for roadway closures and Right-of-Way (ROW) usage; and for MTO RWSCU staff to review and either approve or deny the requests.
2. Prepare the RSS users for the transition to the new RSS system, including operational and technical support with a live Help Desk for 3 years.

5.2 Operational Policies and Constraints

From the Technical Workshop and review of existing documentation, the following operational policies and constraints shall be observed during system design:

1. **Notification:** the scope of each Notification should be limited to the same highway, closure start and end dates. If the closure involves multiple highways, multiple Notifications should be raised. Same consideration applies for the closure date range.
2. **Submission Time:** RWSCU requires certain time (2 business days) to process each Notification. The Contractors should observe the required lead time (configurable) for submission of Notifications. To maintain flexibility, the system should allow Contractors to submit a Notification even if not meeting the lead time requirements (but may provide warning). The RSS can sort the Notifications based on start time of the first closure to help RWSCU staff to set work priority.
3. **Revision:** From the existing MTO RWSCU protocol, only 1 revision is allowed per Notification (the limit will be configurable).
4. **Control of Creation of RSS Users and Contracts:** must be controlled by RWSCU staff, not by Contractor.
5. **Daily Occurrence:** maximum of 7 occurrences is allowed per Notification (the limit will be configurable).

Example: Roadwork Scheduling System for MTO

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3 SPECIFIC REQUIREMENTS

3.1 General

General

Req. Number	Description	Traceability
SR1.1	RSS shall be a stand-alone browser based application so that multiple contractors may concurrently enter roadwork closure applications directly.	RFP1.1
SR1.2	RSS shall be hosted from an external hosting service provider.	RFP1.2
SR1.3	RSS shall be running in an external host server (e.g. cloud computing) using running Linux Operating System. The choice of Linux shall be agreed during the design stage.	RFP1.6
SR1.4	Users shall access RSS from a website address that is visible from the Internet using https protocol.	RFP 2.1 RFP1.3
SR1.5	<i>Remarks:</i> The rules and mechanisms regarding access to the RSS system shall be presented to MTO for approval before committing the code.	RFP2.12
SR1.6	As users may not have Administrator rights to install software on their desktops, the usage of plug-in software shall be avoided.	RFP1.8
SR1.7	All data entry in the Notification form shall be stored in the RSS database that is hosted externally.	Operations Review
SR1.8	The database schema of RSS shall be presented to MTO (by allocating one full day workshop) for approval, highlighting the parent-child relationships of the various tables. The database schema shall include a dictionary describing all tables, the elements within the table and the allowable values for each element. (Note. This is a project requirement but not a software requirement but is included for reference)	RFP3.6

Modes of Operations

Req. Number	Description	Traceability
RS2.1	RSS shall have two operation modes which are Normal mode and Maintenance mode.	Operations Review

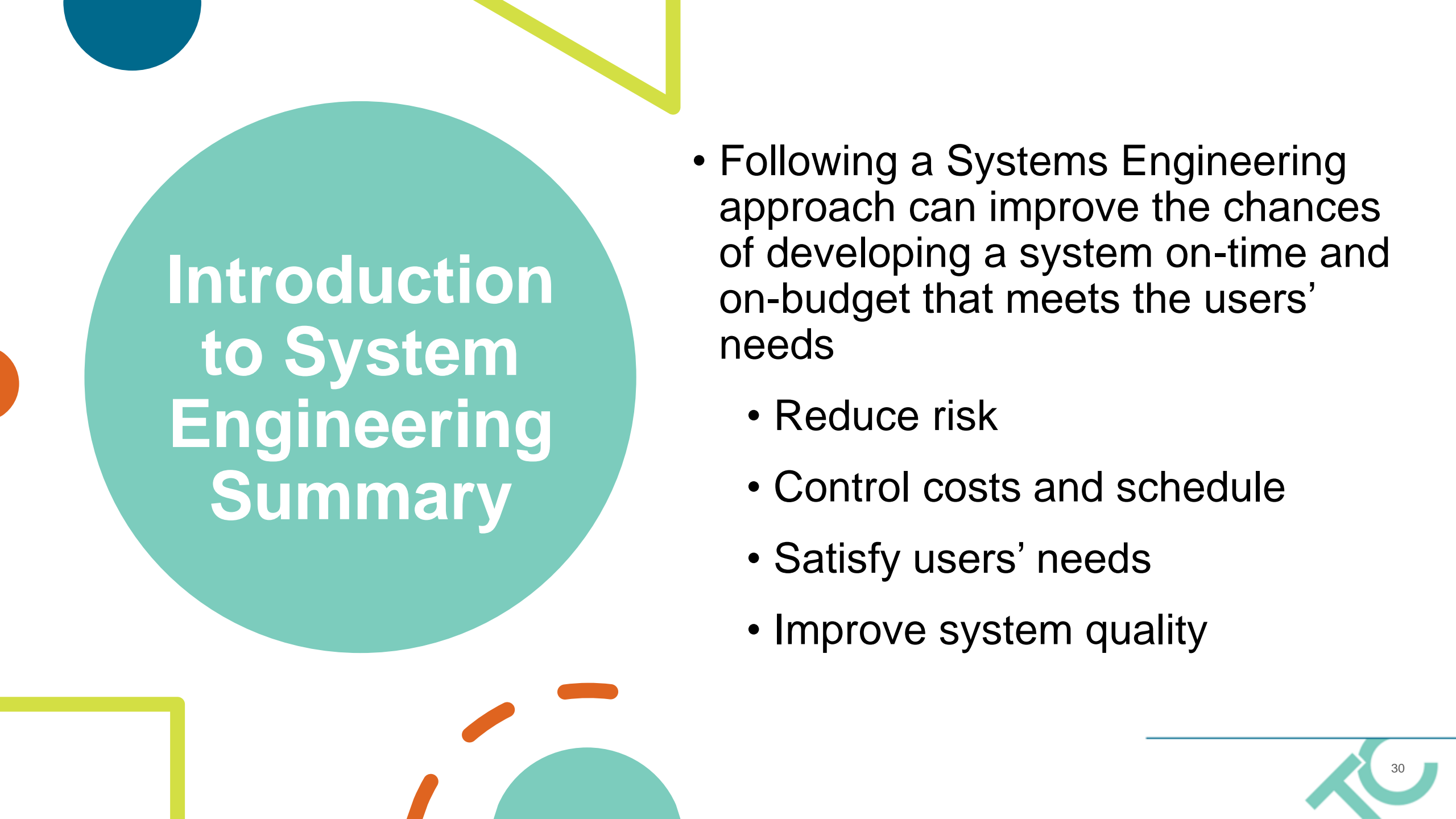
Example: Traceability and Integration into Test Documents

ACCEPTANCE TESTING (versus ConOps v1.6)					
Note that each Acceptance Test use case is tested in the following manner:					
1) All SRS Requirements related to the use case must have been tested during System Testing and found to PASS.					
2) The use case described works as expected in 'free-play' testing of the NGCS-Lite system.					
All use cases PASS, so the Acceptance Test is considered to be a PASS also.					
ConOps Section#	Use-Case Name	SRS Requirements	Package	ConOps Use Case Scenario	Use Case Pass / Fail?
6.1	Map Overview	R4.2.1-x	A (for static map elements only)	<p>This use case covers the embedded Google Maps functionality of the Map View. If it is not already displayed, choose Map View from the menu bar and verify that Google Maps is used to display a map of Ontario. Test enabling / disabling the icon overlays for DMS and CCTV devices, MTO crossings data, active events, and subsystem devices (DMS and ATC devices belonging to BAS, LMS and QWS subsystems.) Test the DMS Message overlay that shows the currently displayed DMS messages as a map layer. Test the Google traffic layer and the overlay for Central Region flow data. Test the Google Streetview function and the searching facility.</p> <p>Try Satellite View and Map View. Use the mouse, mousewheel and the embedded controls to pan around and to zoom in / out. Check that event declaration may be initiated by clicking on a crossing and choosing to declare one of the various types of event in the Crossing information dialog. Check that it is possible to access a Crossing Editor function from the Crossing information dialog. Click on each of the different types of device icons and check that suitable information dialogs are shown, with short-cuts to common functions. Click on the embedded Device Tree on the left hand side of the map pane to expand the nodes to show all field devices, and try out the functions to zoom the map to any given device.</p>	PASS
6.2	Communications Log	R4.2.2-x	A	<p>This use case relates to the CommLog database functions. Using the menu bar, select the CommLog function. Click the button to create a new CommLog and create a dummy entry and save it. Choose to append an additional entry to this existing commlog and check that it is not possible to modify entries that have already been saved. Test the sorting, filtering and searching functionality for finding existing CommLogs in the database. Test the functions for automatically copying information from an active event into a new CommLog and for linking Events and other CommLogs to CommLog entries.</p>	PASS
6.3	Event View	R4.2.3-x		<p>This use case focuses on the different types of events and their attributes. Verify that menu entries exist for creating each of the different types of event: Incident, Roadwork, Congestion, Amber Alert, Red Alert, Adverse Weather, Road Maintenance, Border Crossing Delay and Border Closure. Choose to declare each type of event in turn and inspect the Event Declaration window. Make sure all of the fields specified in the ConOps description of the events are present, and have the documented properties. Cancel event declaration without proceeding to Manage DMS Response.</p>	PASS
6.3.4	Amber Alert	R4.2.3.4-x		<p>This use case focuses on the special functionality provided for Amber Alert events. When an Amber alert is declared by</p>	PASS



Purpose of Systems Engineering

- Improve the chances of developing a system on-time and on-budget that meets the users' needs
 - Reduce risks to successful delivery
 - Control costs and schedule
 - Satisfy users' needs
 - Improve system quality



Introduction to System Engineering Summary

- Following a Systems Engineering approach can improve the chances of developing a system on-time and on-budget that meets the users' needs
 - Reduce risk
 - Control costs and schedule
 - Satisfy users' needs
 - Improve system quality



Systems Engineering Process (V-Model)



Transport
Canada

Transports
Canada

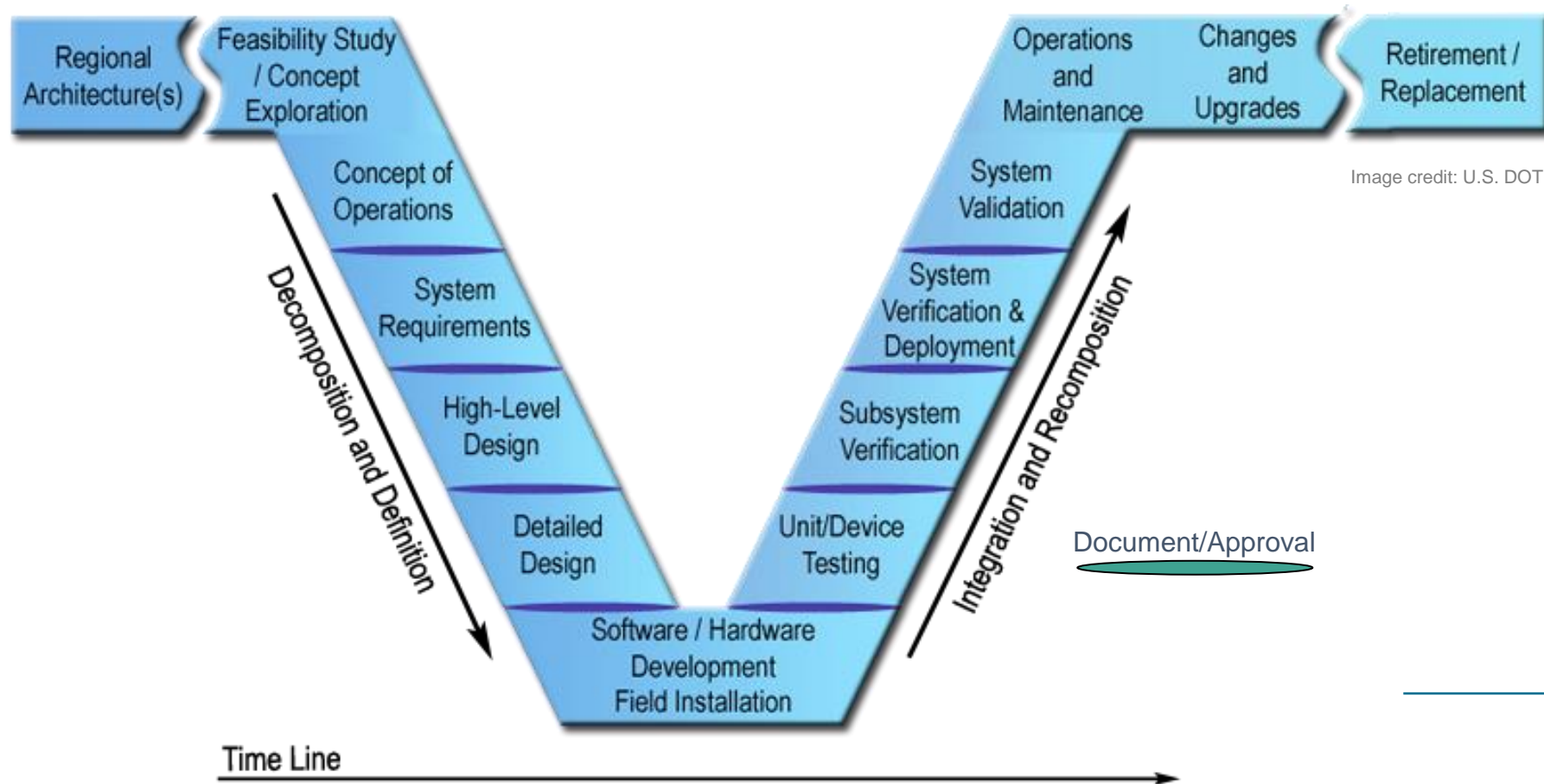
Canada

Multiple Approaches, One Purpose

- Systems Engineering allows for multiple approaches
 - Sequential / Waterfall / “V”
 - Spiral
 - Evolutionary / Agile
 - (similar but different than Agile development)
- All have one purpose
 - Develop & Deliver a system that
 - Meets requirements
 - Satisfies needs
 - *Is used* (operated/maintained meeting mission objectives)

V-Model

- Example of Sequential Systems Engineering



Regional Architecture Use in Project Development



- Before a project starts, use the Arch to help define key aspects

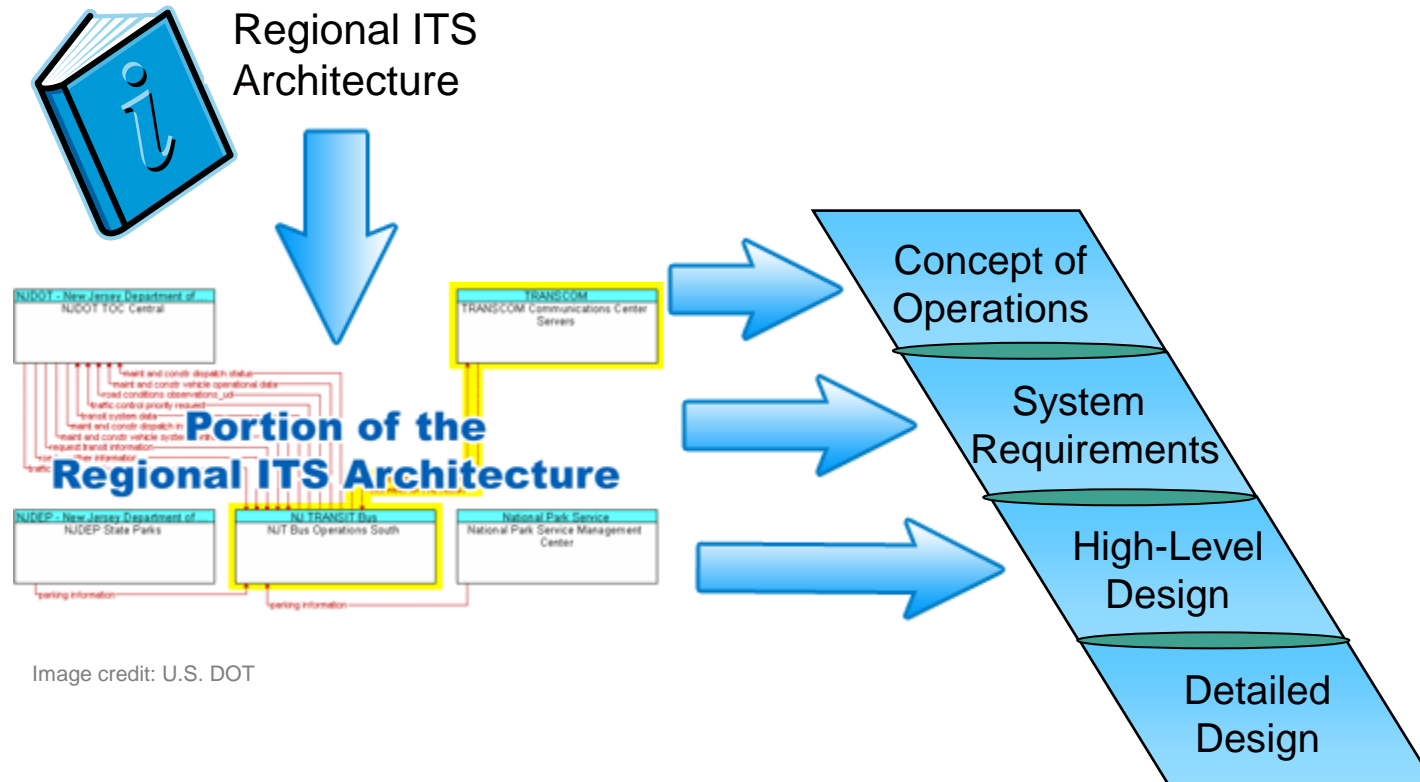


Image credit: U.S. DOT

Benefits of Having a Regional ITS Architecture

- Project scope considers regional vision
- Helps avoid overlooking capabilities or interfaces not previously considered
- Project consistency with other ITS projects is maximized
- Continuity between planning and project development is maintained
- If there is a Regional ITS Architecture, it will make life easier

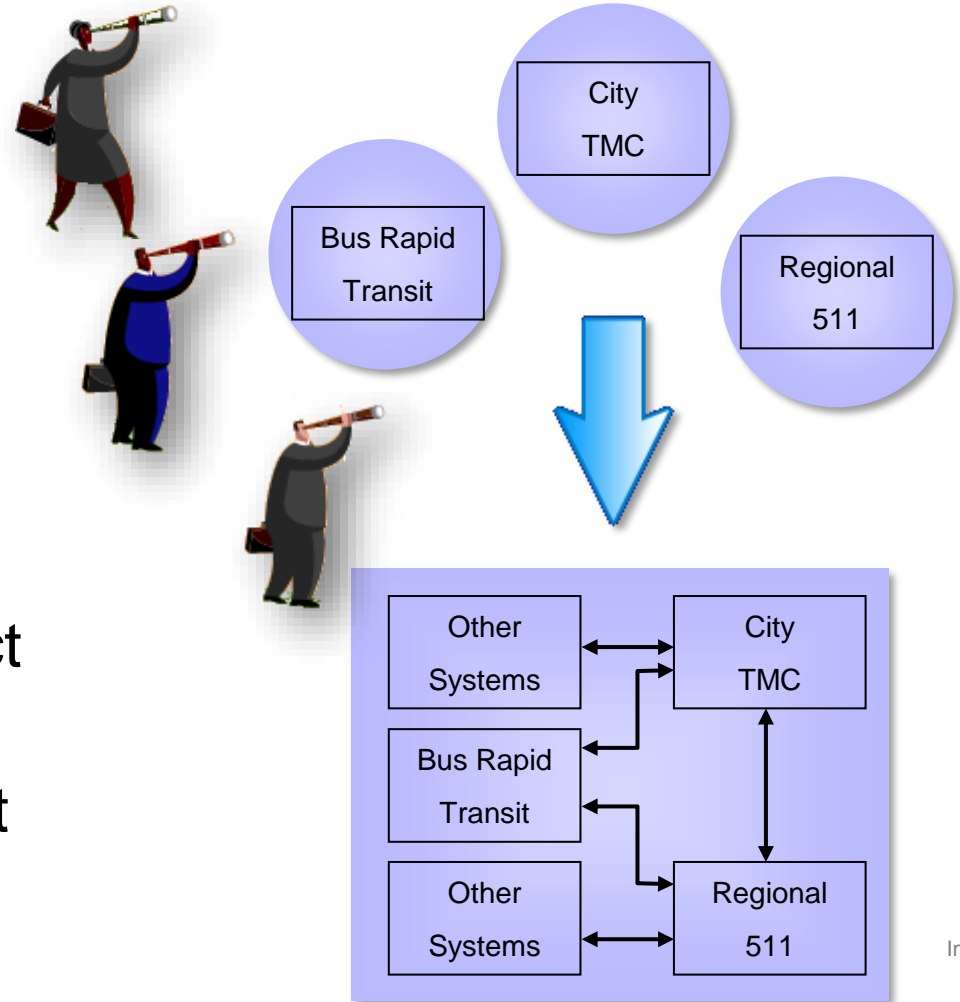
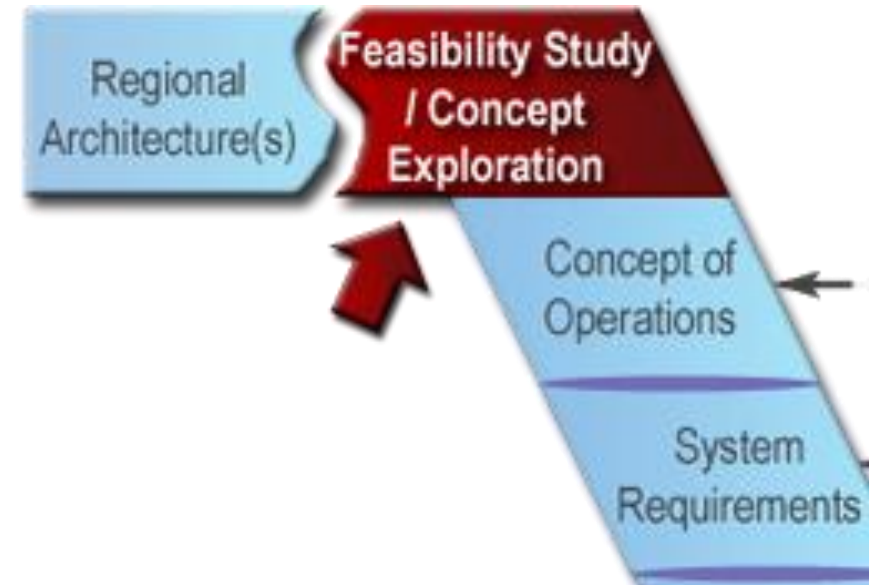


Image credit: U.S. DOT

Feasibility Study/ Concept Exploration

- Assess economic, political, and technical feasibility
- Evaluate alternative concepts
- Makes the business case
- Key activities:
 - Define evaluation criteria
 - Perform initial risk analysis
 - Identify alternative concepts
 - Evaluate alternatives
 - Document results





Feasibility Study/ Concept Exploration Benefits

- Considers alternatives prior to significant investment
- Reduces risk of cost and schedule overruns
 - Project feasibility is verified
 - Project risks are identified
- Use where
 - Feasibility is in question
 - Fundamentally different alternatives exist

Concept of Operations



- Defines:
 - **Who:** Stakeholder roles and responsibilities
 - **What:** Stakeholder needs, system elements and high-level capabilities
 - **Where:** Geographic and physical extent
 - **When:** Sequence of activities performed
 - **How:** Development, operation, and maintenance of system

Concept of Operations (cont'd)

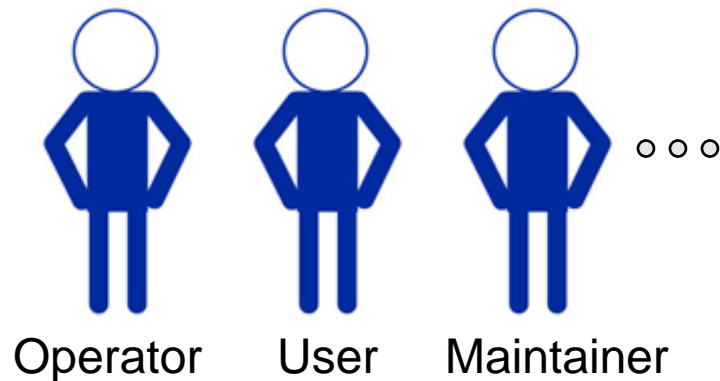


Image Credit: U.S. DOT

- Written in the stakeholders' language
- Shows agreement on:
 - Goals, objectives, and expectations
 - Project scope
 - Stakeholder responsibilities
 - Operational Needs
 - How the system will operate
 - Operational and support environment

Concept of Operations Standards

- Suggested industry standards for ConOps outlines

ANSI/AIAA-G-043 Outline
1. Scope
2. Reference Documents
3. User-Oriented Operational Description
4. Operational Needs
5. System Overview
6. Operational Environment
7. Support Environment
8. Operational Scenarios

Supports New Systems
Developments

IEEE 1362 Outline
1. Scope
2. Reference Documents
3. The Current System or Situation
4. Justification for and Nature of Changes
5. Concepts for the Proposed System
6. Operational Scenarios
7. Summary of Impacts
8. Analysis of the Proposed System

Supports System Upgrades

Image Credit: U.S. DOT

Benefits of Developing a Concept of Operations

- Early stakeholder agreement on:
 - System capabilities
 - Users' Needs
 - Roles and responsibilities
 - Key performance measures and a basic plan for system validation
- Manage stakeholder expectations

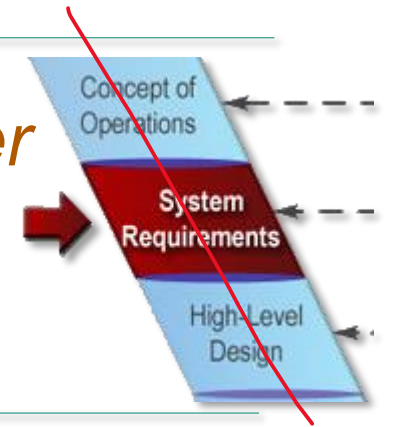


Start with Your Eye on the Finish Line

A ConOps helps the project team visualize the final system at the beginning of the project.

System Requirements

“Something that governs *what*, *how well*, and *under what conditions* a product will achieve a given purpose”



-- EIA-632, Electronics Industry Association Standard “Processes for Engineering a System”

System Requirements

- Key activities
 - Elicit Requirements
 - Analyze Requirements
 - Document Requirements
 - Validate Requirements
 - Manage Requirements

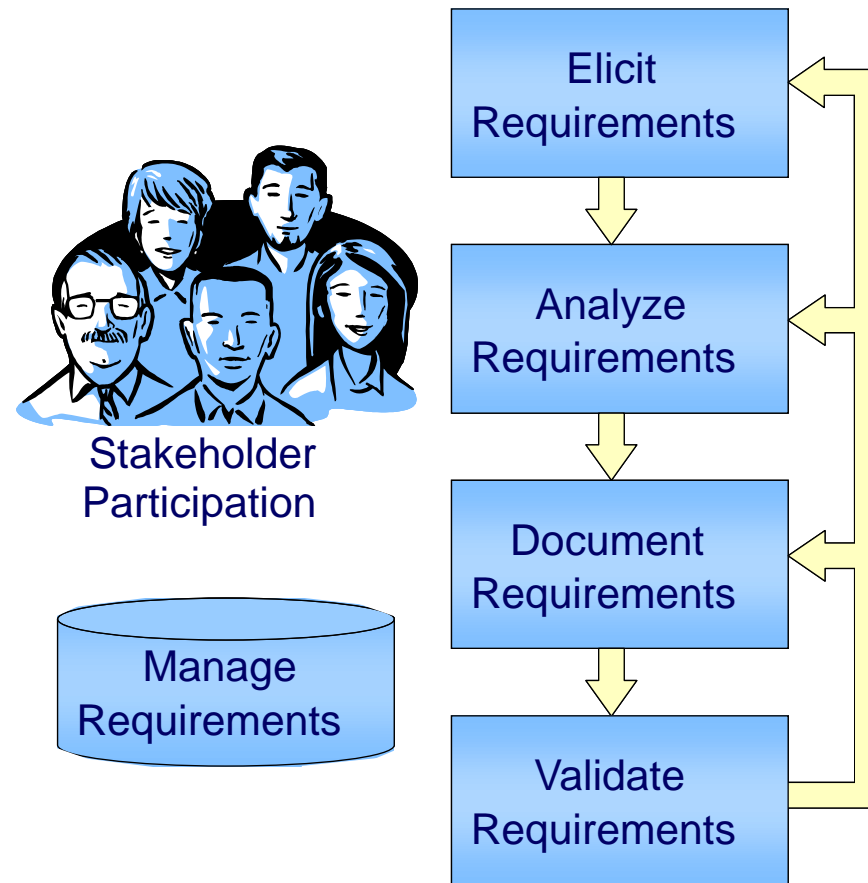
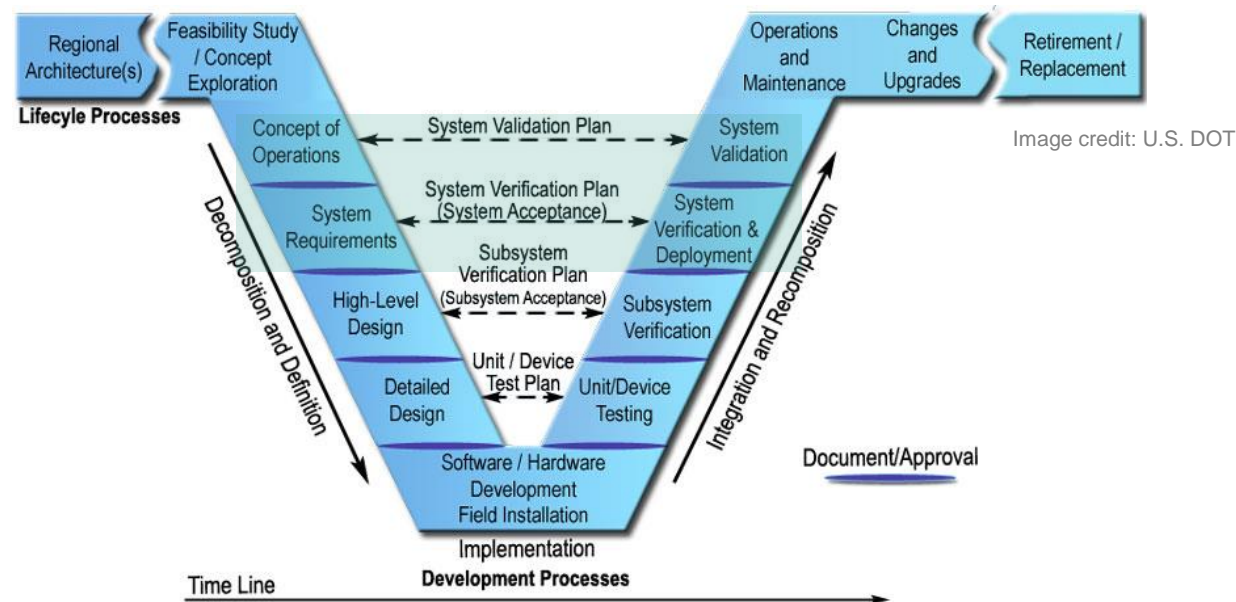


Image Credit: U.S. DOT

System Requirements

- More key activities
 - Create a System Verification Plan/System Acceptance Plan that assures testing, demonstration, inspection, and analysis in relation to each requirement
 - Create a System Validation Plan that describes the functionality the system must display prior to customer acceptance



Writing Style for Requirements

- Use “shall” rather than “will” or “should”
- One requirement per sentence
- Avoid use of pronouns
- Avoid vague references such as “good workmanship” and “proven technology”

Quality Requirements

Quality Requirements Are

- ★ Necessary
- ★ Unambiguous
- ★ Complete
- ★ Measurable
- ★ Consistent
- ★ Achievable
- ★ Testable
- ★ Technology-independent



Examples of Poor Requirements

- “The system shall use radar detectors for traffic monitoring.”
- “State-of-the-art computers shall be used.”
- “The system shall manage incidents.”
- “All work shall be performed to the satisfaction of the Engineer.”
- “Industry standard designs and components shall be used.”

Requirements Examples (good or bad?):

1. “The retrieval of any single status from any field device shall not exceed 2 seconds from the initiation of the request.”
2. “Congestion shall be reduced.”
3. “The system user shall be able to verify reversible lane gate status of up, down, locked, and 15° status.”
4. “People shall feel safer about riding the bus.”

System Requirements

- Usually defined in a hierarchy – for example:

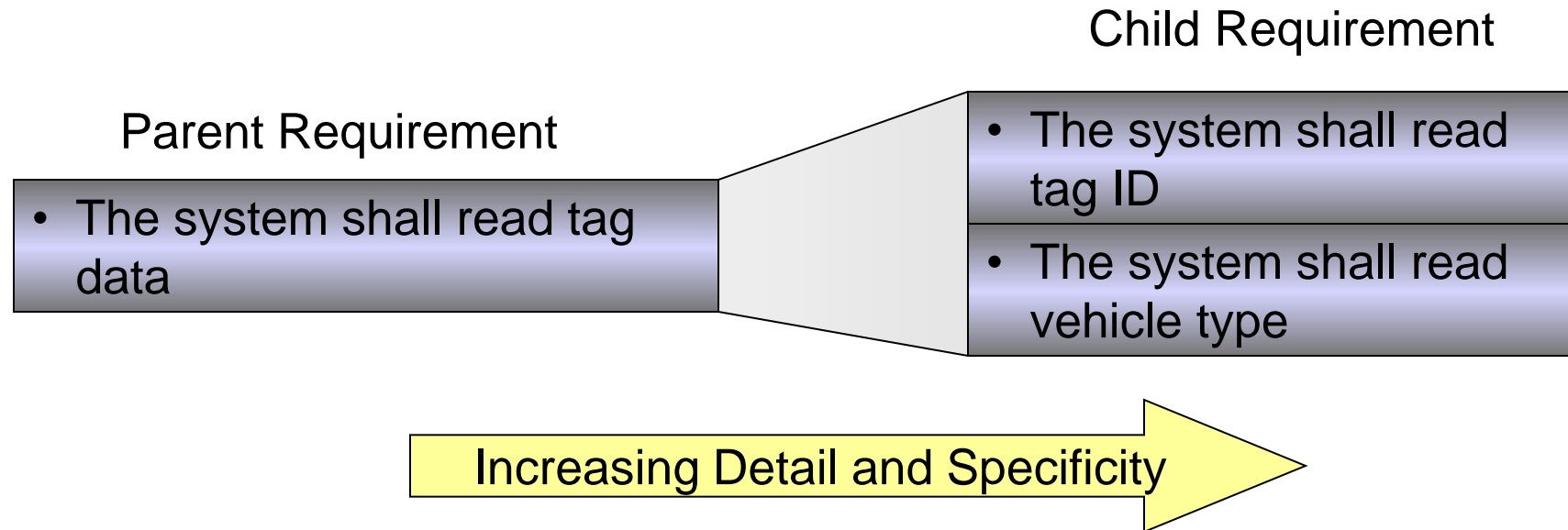


Image Credit: U.S. DOT

Regional Architecture Use in System Requirements (Example)

- DMS Regional Architecture Requirements

Element	Functional Area	ID	Requirement
Municipal Traffic Management Center (TMC)	TMC Traffic Information Dissemination	1	The center shall remotely control dynamic messages signs for dissemination of traffic and other information to drivers.

- DMS Project Requirements

- Parent requirement: The center shall remotely control dynamic message signs...
- Add detailed **child** requirements to:
 - Activate and display a message
 - Prioritize messages
 - Define a message (pick list, spell check)
 - Blank the sign
 - Schedule messages for display



Benefits of System Requirements

- A clear statement of requirements provides:
 - A shared understanding of the problem to be solved by customer and developer
 - A firm basis for managing project scope
 - The connection between user needs and system design
 - The foundation for system verification/testing

Problem

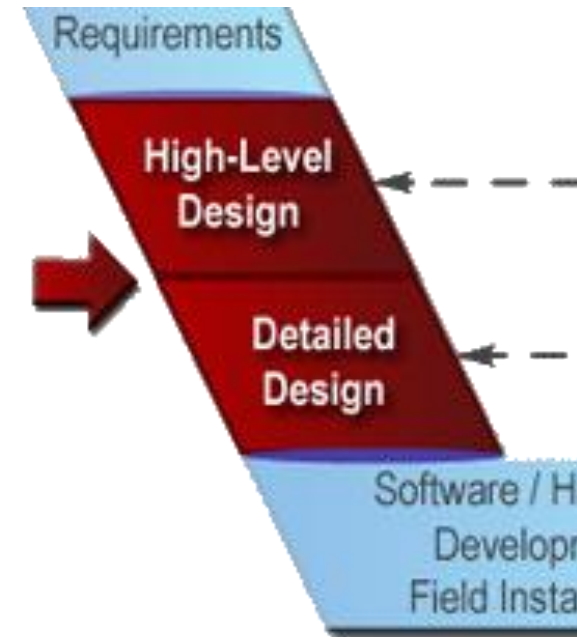


Solution

A clear statement of requirements is frequently identified as a key factor in successful IT projects.

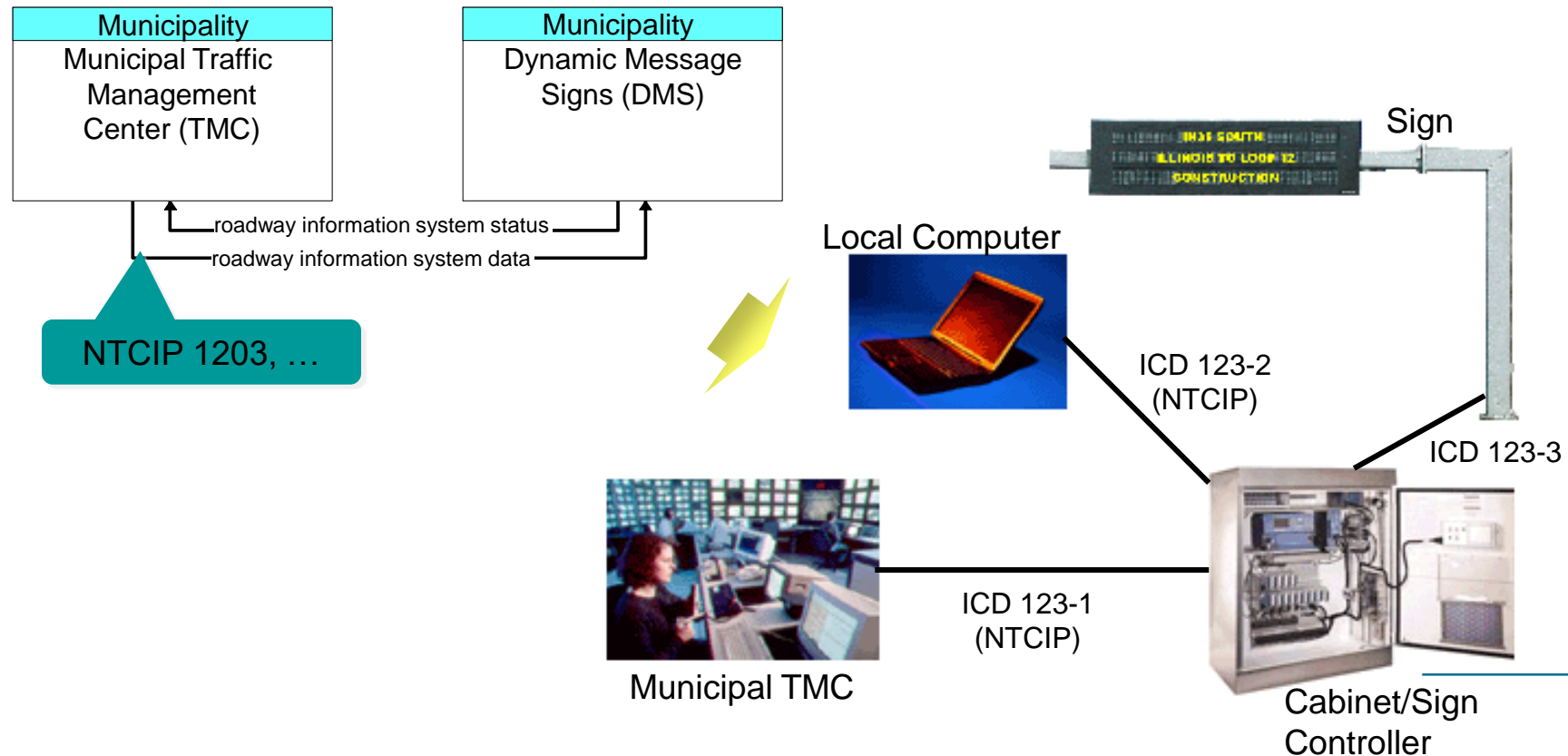
System Design

- The bridge between requirements and implementation
- Two distinct levels
 - High-Level Design: Overall structure of the system
 - subsystems, components, and interfaces
 - Detailed Design: Complete specification of hardware, software, and communications components



Regional Architecture Use in System Design

- Architecture interfaces are starting point for project interface design



Interface Standards in Project Design

• DMS Project Communication Solutions

Communication Solutions

- AU: DMS and RWIS data - DMS and RWIS Comms (1)
- EU: UTMCI Data - UTMCI (1)
- US: NTCIP Message Sign - SNMPv3/TLS (1)
- US: NTCIP Message Sign - SNMPv1/TLS (1)
- US: NTCIP Message Sign - SNMPv1 (32)
- Data for Distribution (TBD) - Apache Kafka (36)
- Data for Distribution (TBD) - OMG DDS (36)
- Data for Distribution (TBD) - OASIS MQTT (42)
- Data for Distribution (TBD) - OASIS AMQP (45)

} Select and tailor for project

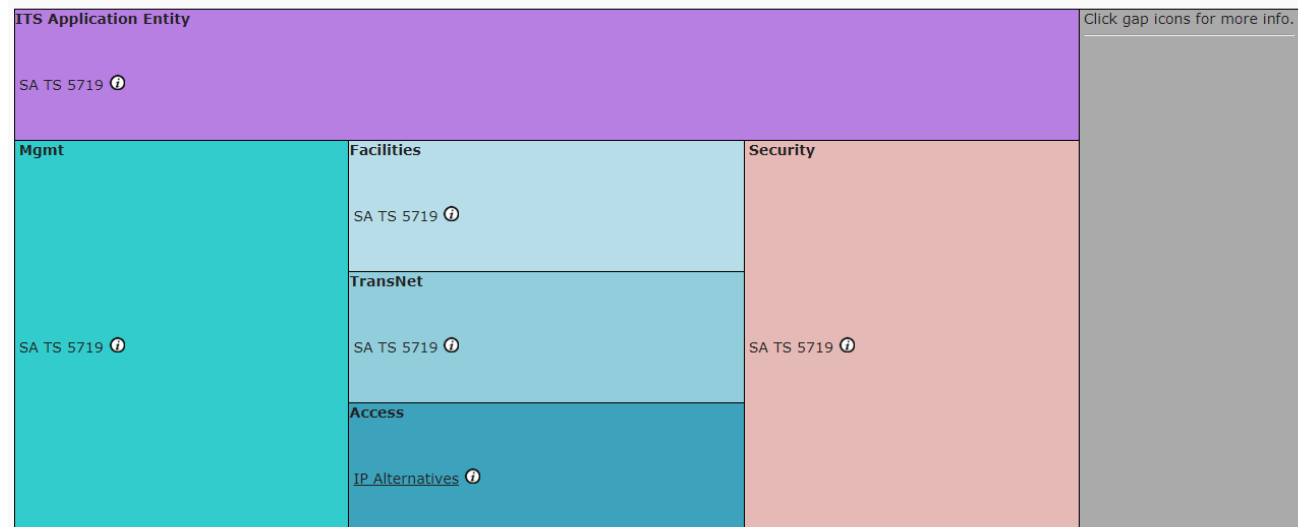
Solutions are sorted in ascending Gap Severity order. The Gap Severity is the parenthetical number at the end of the solution.

Selected Solution

AU: DMS and RWIS data - DMS and RWIS Comms

Solution Description

This solution is used within Australia. It combines standards associated with AU: DMS and RWIS data with those for I-F: DMS and RWIS Comms. The AU: DMS and RWIS data standards include lower-layer standards that define messages, monitoring and control of DMS and RWIS using SA TS 5719. The I-F: DMS and RWIS Comms standards include lower-layer standards that support communications for DMS and RWIS using SA TS 7519 via IP.



Note that some layers might have alternatives, in which case all of the gap icons associated with every alternative may be shown on the diagram, but the solution severity calculations (and resulting ordering of solutions) includes only the issues associated with the default (i.e., best, least severe) alternative.

Benefits of System Design

- A good system design:
 - Relates requirements to the system specifications
 - Defines open interfaces that supports different vendor solutions and off-the-shelf products
 - Supports efficient hardware and software development
 - Provides a roadmap for system integration and testing
 - Facilitates maintenance and future expansion and upgrade of the system

A superior system design allows new technologies to be cost-effectively incorporated.

Measures of Success



THE RIGHT NEEDS AND
REQUIREMENTS ARE
CAPTURED



SYSTEM SATISFIES ALL OF
THE NEEDS AND
REQUIREMENTS



BUT HOW DO WE MAKE
SURE IT DOES?

Software/Hardware Development and Testing

- Key activities
 - Plan software/hardware development
 - Establish development environment
 - Procure off-the-shelf products
 - Develop software and hardware
 - Perform unit/device testing
- Performed by technical specialists
 - Developers & Testers should be independent for higher risk efforts
- Systems engineering plays a monitoring role

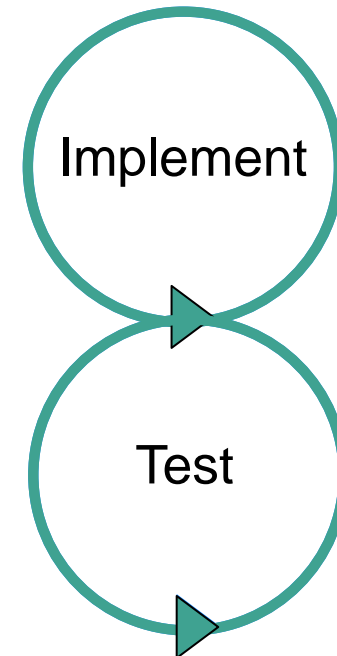
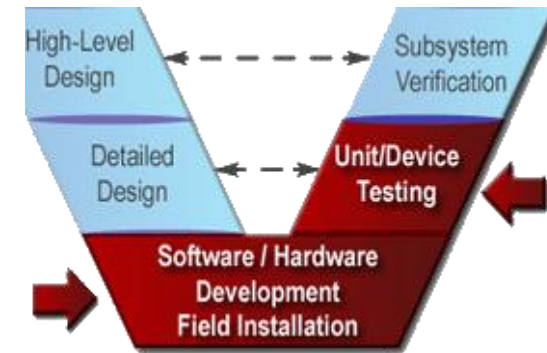
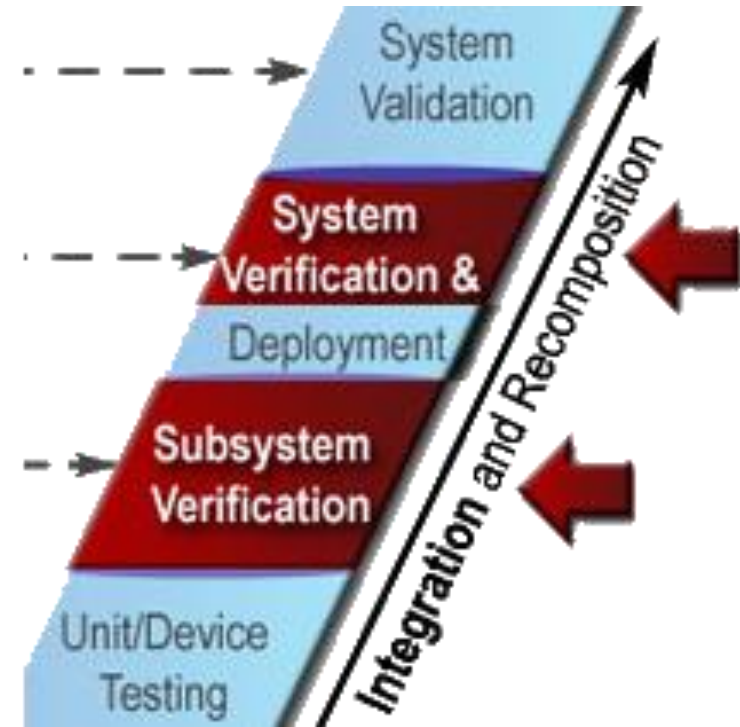


Image credit: U.S. DOT

Integration and Verification

- Key activities
 - Add detail to integration and verification plans
 - Establish integration and verification environment
 - Perform integration
 - Perform verification
 - Confirm system meets requirements
- Verification – was system built right?



Initial Deployment / Implementation

- Key activities
 - Plan for system installation and transition
 - Prepare the facility
 - Deliver the system
 - Install the system
 - Perform acceptance tests
 - Review/accept documentation
 - Conduct training
 - Transition to operation
- Facilitates smooth transition to operations

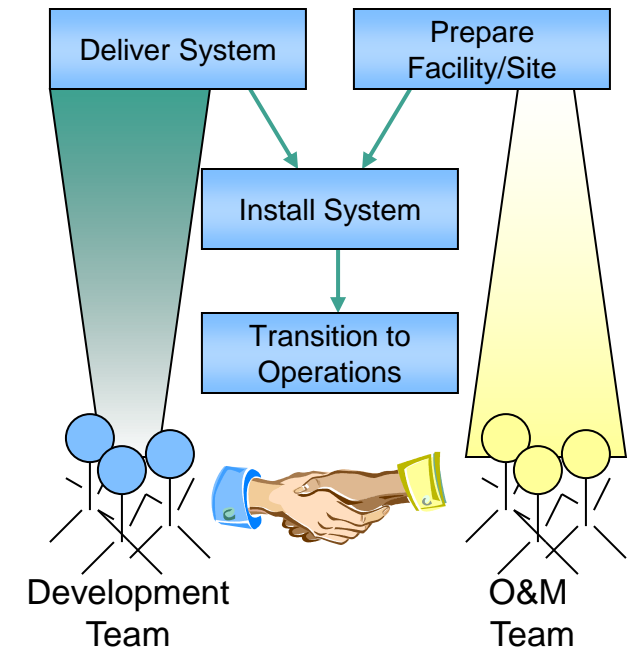


Image credit: U.S. DOT

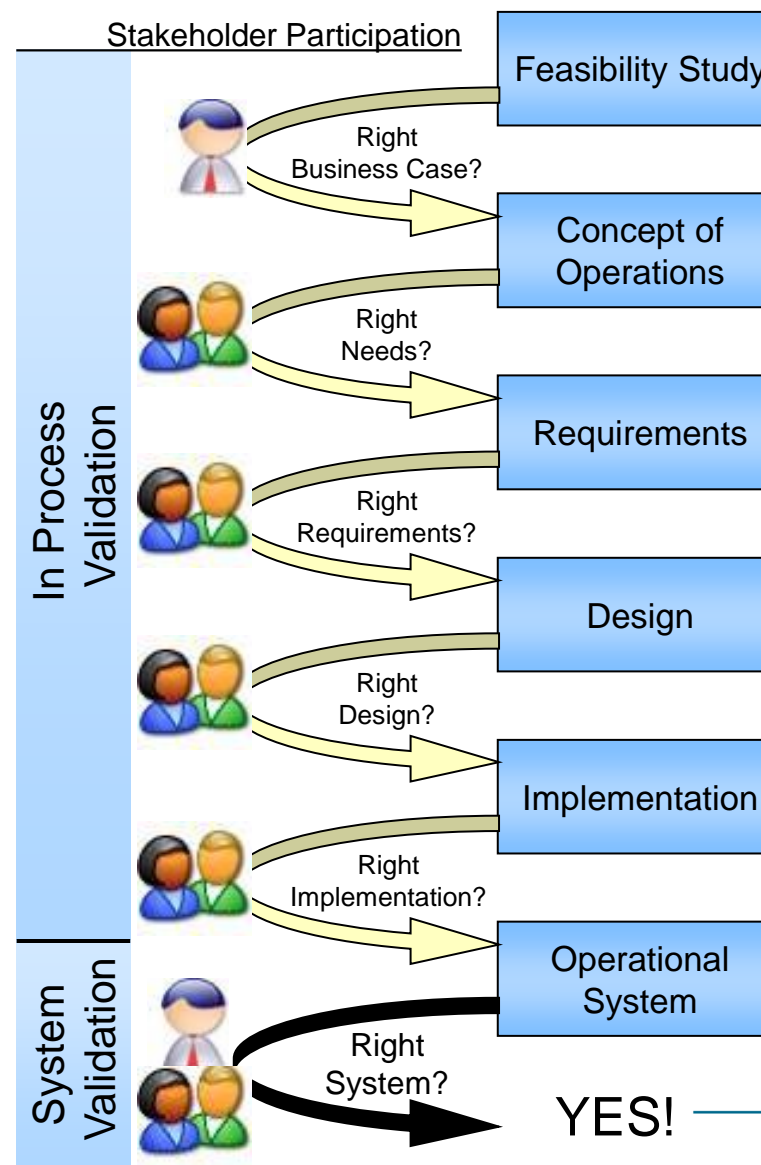
System Validation

- Validation – was the right system built?
- Confirm that user needs are met by the installed system
- Key activities
 - Update Validation Plan as necessary and develop procedures
 - Validate system
 - Document validation results including any recommendations or corrective actions



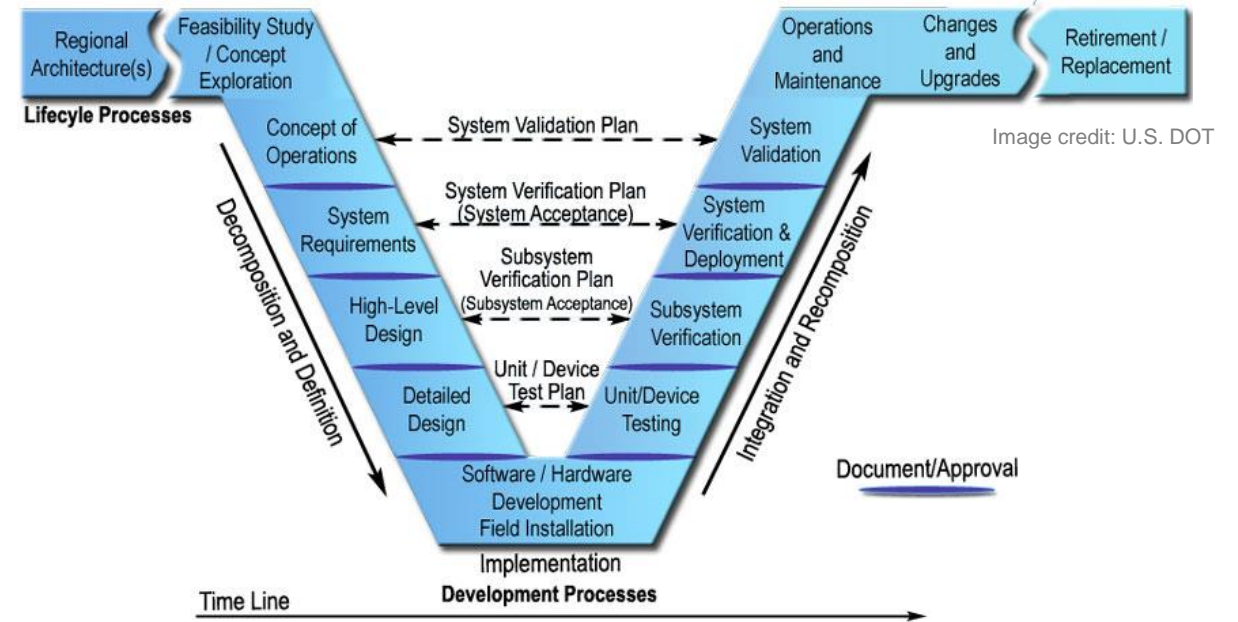
System Validation

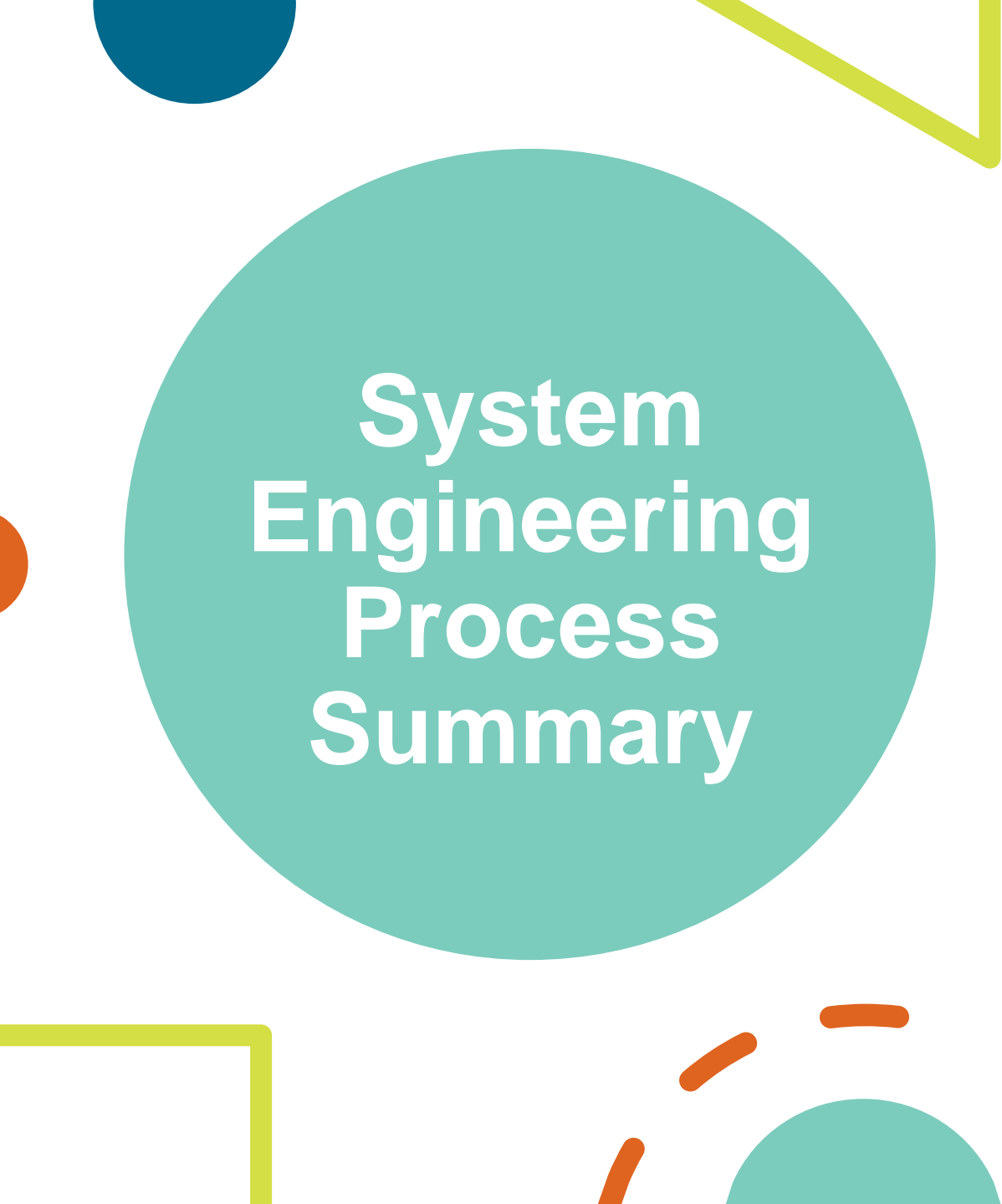
- Validation takes place throughout the Systems Engineering process



Summary

- V-Model for Systems Engineering is a well thought out and clear process
 - Considers full lifecycle
 - Builds off needs
 - Clearly defined requirements
 - Provides traceability
 - Integrates validation





System Engineering Process Summary

- V-Model for Systems Engineering is a well thought out and clear process
 - Considers full lifecycle
 - Builds off needs
 - Clearly defined requirements
 - Provides traceability
 - Integrates validation



Establishing Systems Engineering in Your Organization



Transport
Canada

Transports
Canada

Canada 

Improving Systems Engineering Capability

- Three aspects should be addressed:
 - People: Build systems engineering knowledge
 - Process: Establish systems engineering processes for your organization
 - Technology: Use System Engineering Tools to make the processes more efficient and effective

Building Systems Engineering Knowledge



Identify systems engineering specialists in your organization

Don't overlook the Information Technology Group



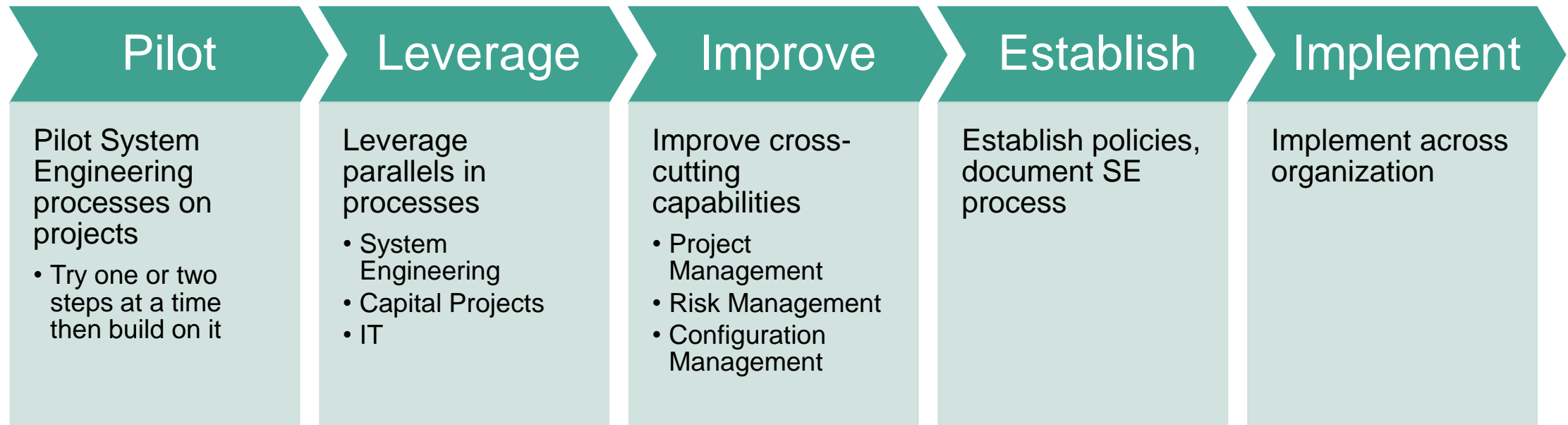
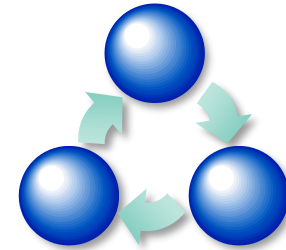
Provide staff training opportunities



Consider Systems Engineering experience when hiring consultants

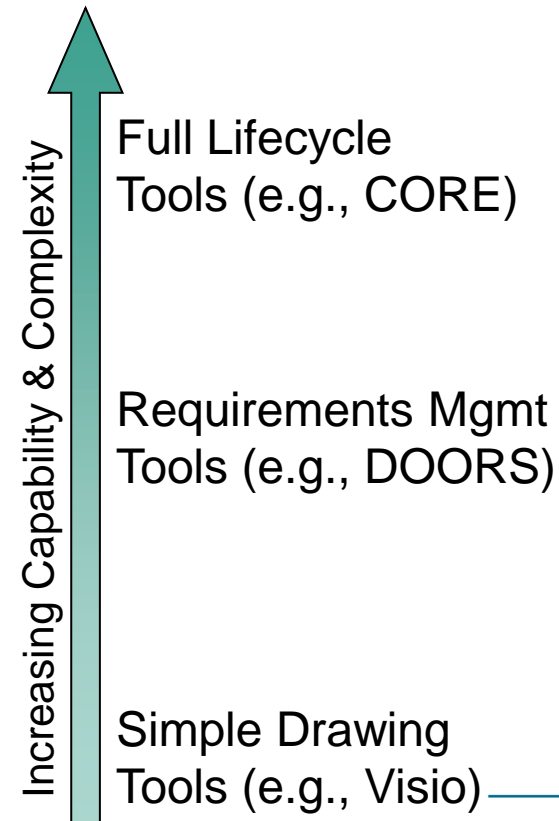
Still need System Engineering skills within your organization

Process Improvement Recommendations



Systems Engineering Tools

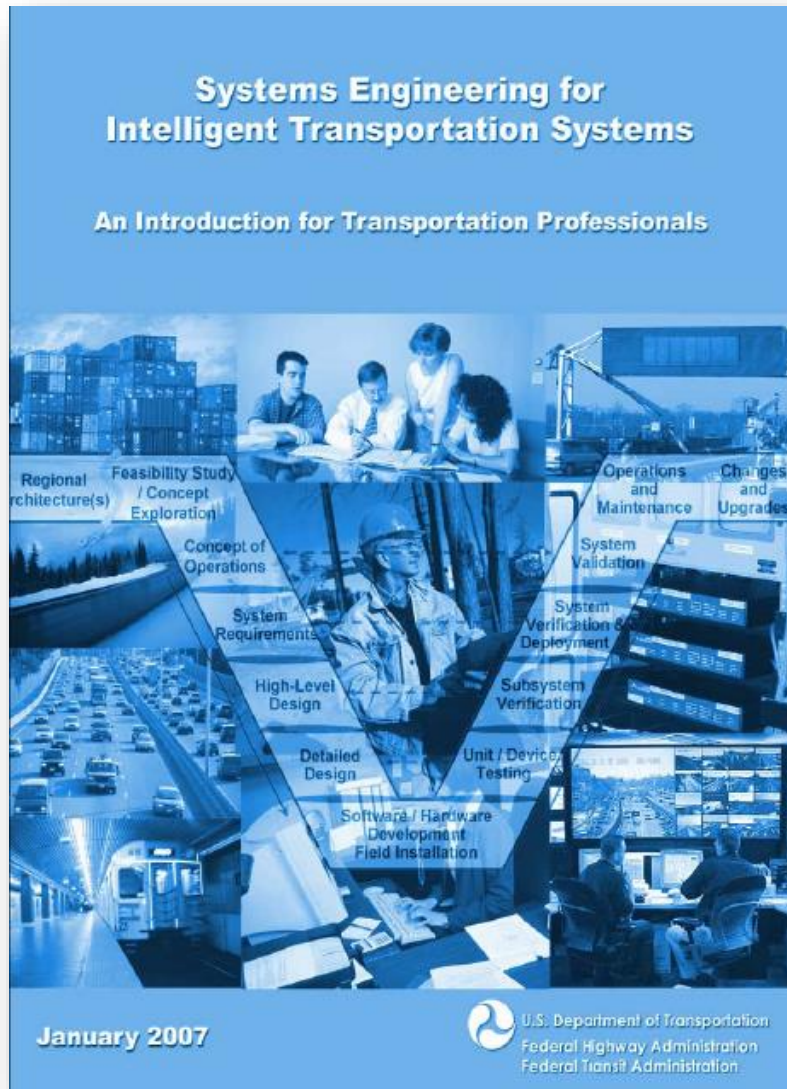
- Establish SE library (e.g., templates, best practices, decision support tools)
- Consider range of SE tools as organization gains experience
 - Project Management
 - Requirements Management
 - Systems Architecture
 - Testing/Problem Tracking
- Use complex tools based on project need



Systems Engineering Resources

- Systems Engineering Handbook
- Systems Engineering Guidebook
- Guide to Contracting ITS
- Lessons Learned Database

Systems Engineering Handbook



<http://ops.fhwa.dot.gov/publications/seitsguide/index.htm>

Systems Engineering Guidebook

U.S. Department of Transportation
Federal Highway Administration

FHWA Home | Feedback

HOME WHAT'S NEW VIEWS SEARCH GLOSSARY RESOURCES FEEDBACK SITE MAP

Welcome to the Systems Engineering Guidebook for ITS

Challenges Lifecycle Tasks Version 3.0 Solutions

Regional Autoleveling Connected Exploration System Engineering Management Operations & Maintenance Change II Integration Performance Measurement


FWHA
CA Division
Caltrans

Welcome

Welcome to [Version 3.0](#) of the Systems Engineering Guidebook for ITS Web Site. Co-sponsored by the Federal Highway Administration and the California Department of Transportation, this web site provides quick and easy access to information that will help you intelligently apply systems engineering to your Intelligent Transportation Systems projects. This resource is the culmination of decades of experience in applying these processes and capabilities in ITS and other industries. We are eager to add your lessons learned and experience in a continuing effort to provide a quality, relevant resource for ITS practitioners. Please send us your [feedback](#).

- [What is Systems Engineering?](#)
- [Why Use Systems Engineering on Your Project?](#)
- [Key Systems Engineering Principles](#)







Testimonials



SE Guidebook Views

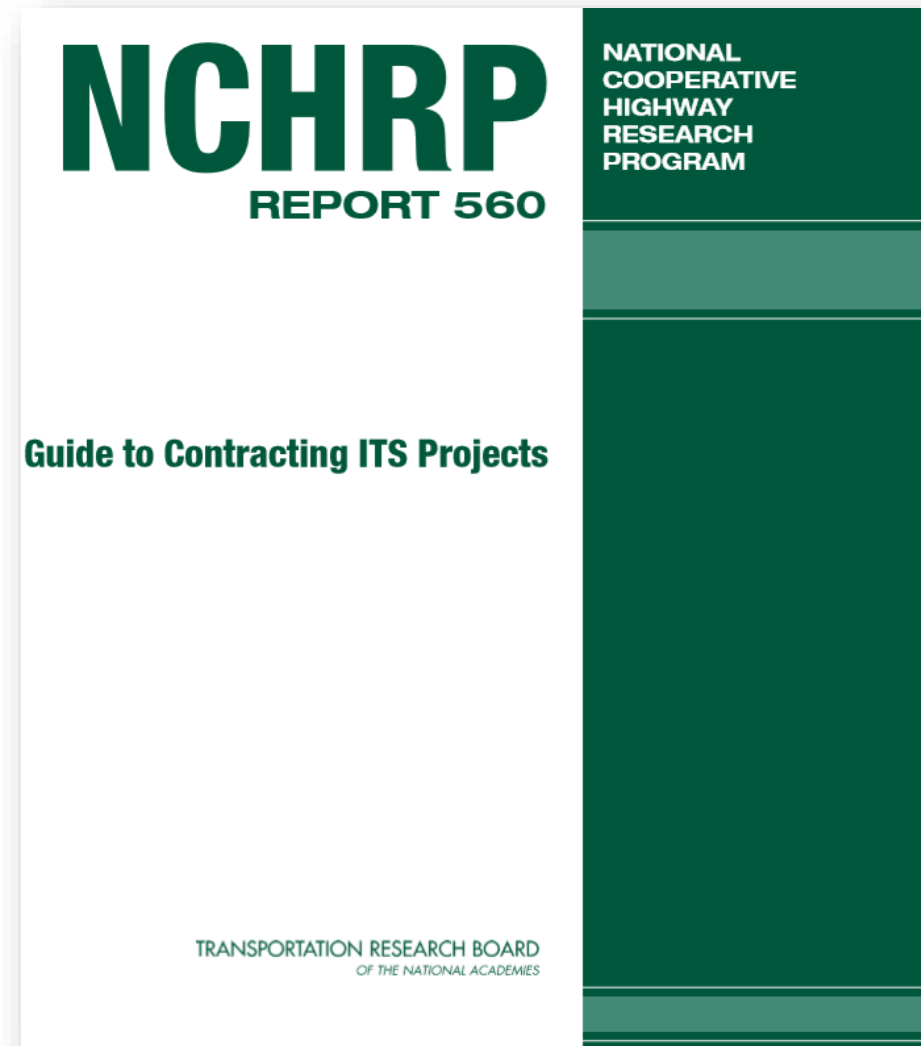
The Systems Engineering Guidebook content can be accessed through seven different views. Select the view on the right that best suits your needs.

Views

- [Process](#) 
- [Deliverable](#) 
- [Example](#) 
- [Checklist](#) 
- [Capability](#) 
- [Role](#) 

<http://www.fhwa.dot.gov/cadiv/segb/>

Choosing the Right Contracting Approach

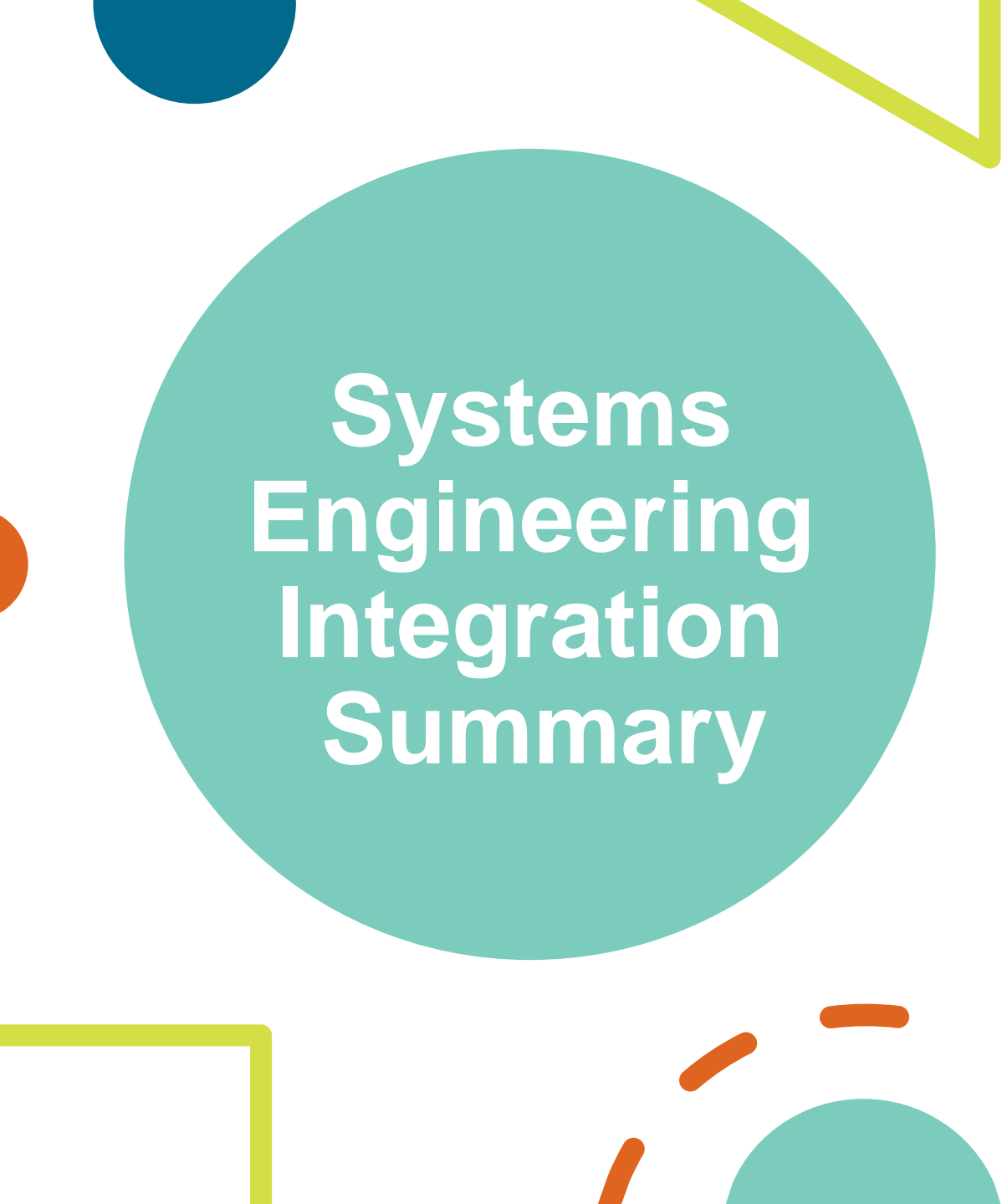


http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_560.pdf

Lessons Learned Database

The screenshot shows the homepage of the Lessons Learned Database. At the top, there is a navigation bar with the ITS Deployment Evaluation logo and menu items: Benefits, Costs, Deployment Statistics, Executive Briefings, Lessons Learned (highlighted), and Decision Support Resources. Below the navigation bar is a large banner with the title "Lessons Learned" and a sub-header "Lessons Learned capture the real life experience of practitioners in their planning, deployment, operation, maintenance, and evaluation of ITS. It is a reflection on what was done right, what one would do differently, and how one could be more effective in the future." A search bar is located below the banner. Below the search bar is a section titled "Browse Lessons Learned Topics" with a grid of 16 topic icons and labels: Arterial Management, Freeway Management, Roadway Operations & Maintenance, Crash Prevention & Safety, Road Weather Management, Transportation Management Center, Alternative Fuels, Traffic Incident Management, Transit Management, Emergency Management, Traveler Information, Driver Assistance, Information Management, Commercial Vehicle Operations, Intermodal Freight, and Electronic Payments & Pricing.

<https://www.itskrs.its.dot.gov/lessons>



Systems Engineering Integration Summary

- Systems engineering and improved processes should make your job easier, not harder
 - Needs to be part of standard operating principles
 - Integration into SOPs does take time
 - It's a long-term investment
- Real process improvement requires real commitment
 - From the organization
 - Individual engineers/managers can't do it alone
- There is a wealth of training and guidance resources



Seeing SET-IT in Action



Transport
Canada

Transports
Canada

Canada 

Yukon ITS



ALERTS

Search Map

Legend

- Road Conditions
 - Bare
 - Partly Covered
 - Covered - Packed
 - Covered - Loose
- Difficult
- Travel Advisory
- Closed
- No Report

Reduced Visibility

- Traffic Speeds
- Incidents
- Construction
- Closures
- Special Events
- Cameras
- Weather Alerts
- Weather Forecasts
- Weather Stations
- Message Signs
- Roadway Markers
- Ferries
- Border Crossings

Truck Restrictions

- Weight Restrictions
- Bridge Restrictions

Marker Clustering

Map Satellite

Keyboard shortcuts | Map data ©2023 Google | 20 km | Terms of Use | Report a map error | 9:59 AM

ARC-IT Support Tools: RAD-IT / SET-IT



- Regional Architecture Development for Intelligent Transportation (RAD-IT)
 - Formerly known as Turbo Architecture software
 - Software tool to create and maintain regional ITS architectures
 - Uses ARC-IT physical view information as basis for architecture development
- Systems Engineering Tool for Intelligent Transportation (SET-IT)
 - Allows creation of diagram-based project architectures
 - Covers the physical, enterprise, and communications viewpoints
- To download tools:
 - <https://www.arc-it.net/html/resources/tools.html>
- Access recorded training
 - <https://www.arc-it.net/html/resources/training.html>

Starting Off

SET-IT - C:\Projects\Transport Canada\TC ITS Arch\Architecture\Yukon ITS\Yukon ITS.setit

Project Home Review Output

Diagram Enterprise Physical Comm Synchronize

Overview

Show Implementations Combine Type(s) Combine Group(s)

Add	SP	SP #	Imp #	Imp	Service Package	Readiness	Management
<input type="checkbox"/>	SU10	0	0	SU10	Center Maintenance		Management
<input type="checkbox"/>	SU11	0	0	SU11	Field Equipment Maintenance		Management
<input type="checkbox"/>	SU12	0	0	SU12	Vehicle Maintenance		Safety
<input type="checkbox"/>	SU13	0	0	SU13	Personnel Device Maintenance		Management
<input type="checkbox"/>	SU14	0	0	SU14	Remote Access		Convenience, Su
<input type="checkbox"/>	TI01	0	0	TI01	Broadcast Traveler Information		Informational, M
<input type="checkbox"/>				TI01.1	Wide Area Broadcast	Impractical	Informational, M
<input type="checkbox"/>				TI01.2	C-ITS Local Broadcast	Impractical	Informational, M
<input type="checkbox"/>	TI02	0	0	TI02	Personalized Traveler Information		Informational, M
<input type="checkbox"/>	TI03	0	0	TI03	Dynamic Route Guidance		Informational, M
<input type="checkbox"/>	TI04	0	0	TI04	Infrastructure-Provided Trip Planning and Route Guidance		Informational, M
<input type="checkbox"/>	TI05	0	0	TI05	Travel Services Information and Reservation		Convenience, Inf
<input type="checkbox"/>	TI06	0	0	TI06	Dynamic Ridesharing and Shared Use Transportation		Mobility
<input type="checkbox"/>				TI06.1	Shared Use Mobility	Impractical	Mobility
<input type="checkbox"/>				TI06.2	Dynamic Ridesharing	Impractical	Mobility
<input type="checkbox"/>	TI07	0	0	TI07	In-Vehicle Signage		Safety
<input type="checkbox"/>	TM01	0	0	TM01	Infrastructure-Based Traffic Surveillance		Informational, M
<input type="checkbox"/>				TM01.1	Detector-Based Surveillance	Moderate	Informational, M
<input type="checkbox"/>				TM01.2	Video Monitoring	Moderate	Informational, M
<input type="checkbox"/>				TM01.3	Bluetooth Signature Monitoring	Impractical	Informational, M
<input checked="" type="checkbox"/>	TM02	0	0	TM02	Vehicle-Based Traffic Surveillance		Informational, M
<input type="checkbox"/>				TM02.1	Wide-Area Wireless Communications	Moderate	Informational, M
<input type="checkbox"/>				TM02.2	C-ITS Communications	Impractical	Informational, M
<input type="checkbox"/>	TM03	0	0	TM03	Traffic Signal Control		Management, M
<input type="checkbox"/>				TM03.1	Pre-Timed (Fixed Time) Control	Impractical	Management, M
<input type="checkbox"/>				TM03.2	Fully Traffic Responsive	Impractical	Management, M
<input type="checkbox"/>				TM03.3	Field Master Controlled	Impractical	Management, M
<input type="checkbox"/>	TM04	0	0	TM04	Connected Vehicle Traffic Signal System		Management, M
<input type="checkbox"/>				TM04.1	Pre-Timed (Fixed Time) Control	Impractical	Management, M
<input type="checkbox"/>				TM04.2	Fully Traffic Responsive	Impractical	Management, M
<input type="checkbox"/>				TM04.3	Field Master Controlled	Impractical	Management, M
<input type="checkbox"/>	TM05	0	0	TM05	Traffic Metering		Management, M
<input type="checkbox"/>	TM06	0	0	TM06	Traffic Information Dissemination		Informational
<input type="checkbox"/>				TM06.1	Dynamic Message Signs	Low	Informational
<input type="checkbox"/>				TM06.2	Advisory Radio	Impractical	Informational
<input type="checkbox"/>	TM07	0	0	TM07	Regional Traffic Management		Management
<input type="checkbox"/>	TM08	0	0	TM08	Traffic Incident Management System		Management, M
<input type="checkbox"/>	TM09	0	0	TM09	Integrated Decision Support and Demand Management		Environmental, M
<input type="checkbox"/>	TM10	0	0	TM10	Electronic Toll Collection		Management, M
<input type="checkbox"/>	TM11	0	0	TM11	Road Use Charging		Management, M

Cameras in the field are used to collect and share traffic images that are used by operating agencies to manage traffic and shared with the traveling public to convey traffic flow and congestion information.

This service package includes 1 physical diagram.

TM02 Video Monitoring

7 TM02 Infrastructure-Based Traffic Surveillance 1 Mar 17, 2012

Project Home Review Output

Diagram Enterprise Physical Comm Synchronize

New Views Tools

Overview

Project

Service Packages

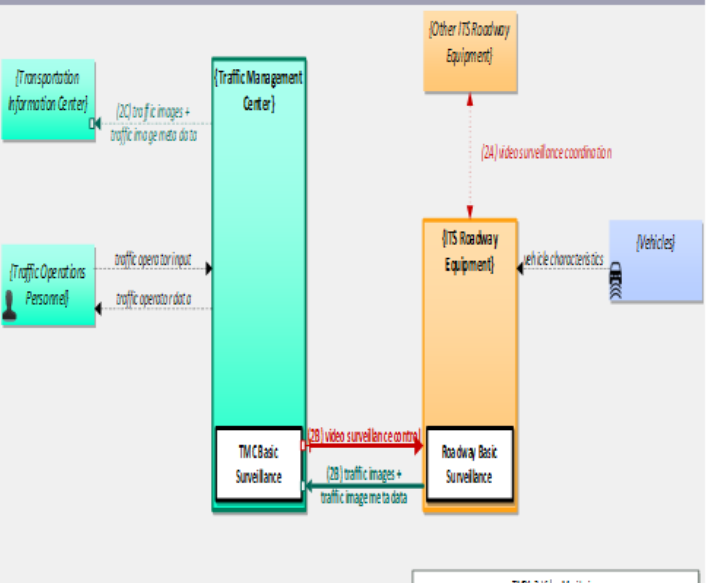
Change Log

Show Implementations Combine Type(s) Combine Group(s)

Add	SP	SF	#	Imp #	Imp	Service Package	Readiness	Informational
<input checked="" type="checkbox"/>	TM06	0	0	0	TM06.1	Dynamic Message Signs	Low	Informational
<input type="checkbox"/>					TM06.2	Advisory Radio	Impractical	Informational
<input type="checkbox"/>	TM07	0	0	0	TM07	Regional Traffic Management		Management
<input type="checkbox"/>	TM08	0	0	0	TM08	Traffic Incident Management System		Management, Mc
<input type="checkbox"/>	TM09	0	0	0	TM09	Integrated Decision Support and Demand Management		Environmental, M
<input type="checkbox"/>	TM10	0	0	0	TM10	Electronic Toll Collection		Management, Mc
<input type="checkbox"/>	TM11	0	0	0	TM11	Road Use Charging		Management, Mc
<input type="checkbox"/>	TM12	0	0	0	TM12	Dynamic Roadway Warning		Safety
<input type="checkbox"/>	TM13	0	0	0	TM13	Standard Railroad Grade Crossing		Mobility, Safety
<input type="checkbox"/>	TM14	0	0	0	TM14	Advanced Railroad Grade Crossing		Mobility, Safety
<input type="checkbox"/>	TM15	0	0	0	TM15	Railroad Operations Coordination		Management
<input type="checkbox"/>	TM16	0	0	0	TM16	Reversible Lane Management		Management, Re
<input type="checkbox"/>	TM17	0	0	0	TM17	Speed Warning and Enforcement		Management, Re
<input type="checkbox"/>	TM18	0	0	0	TM18	Drawbridge Management		Management
<input type="checkbox"/>	TM19	0	0	0	TM19	Roadway Closure Management		Management, Sa
<input type="checkbox"/>	TM20	0	0	0	TM20	Variable Speed Limits		Management, Mc
<input type="checkbox"/>	TM21	0	0	0	TM21	Speed Harmonization		Management, Mc
<input type="checkbox"/>	TM22	0	0	0	TM22	Dynamic Lane Management and Shoulder Use		Management, Mc
<input type="checkbox"/>	TM23	0	0	0	TM23	Border Management Systems		Mobility, Regulat
<input type="checkbox"/>	TM24	0	0	0	TM24	Tunnel Management		Management, Sa
<input type="checkbox"/>	TM25	0	0	0	TM25	Wrong Way Vehicle Detection and Warning		Safety
<input type="checkbox"/>	TM26	0	0	0	TM26	Signal Enforcement		Management, Re
<input type="checkbox"/>	VS01	0	0	0	VS01	Autonomous Vehicle Safety Systems		Safety
<input type="checkbox"/>	VS02	0	0	0	VS02	V2V Basic Safety		Safety
<input type="checkbox"/>	VS03	0	0	0	VS03	Situational Awareness		Safety
<input type="checkbox"/>	VS04	0	0	0	VS04	V2V Special Vehicle Alert		Safety
<input type="checkbox"/>	VS05	0	0	0	VS05	Curve Speed Warning		Safety
<input type="checkbox"/>	VS06	0	0	0	VS06	Stop Sign Gap Assist		Safety
<input type="checkbox"/>	VS07	0	0	0	VS07	Road Weather Motorist Alert and Warning		Environmental, Ir
<input type="checkbox"/>	VS08	0	0	0	VS08	Queue Warning		Mobility, Safety
<input type="checkbox"/>					VS08.1	Traditional ITS Queue Warning	Low	Mobility, Safety
<input type="checkbox"/>					VS08.2	WAW Queue Warning	Moderate	Mobility, Safety
<input type="checkbox"/>					VS08.3	C-ITS Queue Warning	Impractical	Mobility, Safety
<input type="checkbox"/>	VS09	0	0	0	VS09	Reduced Speed Zone Warning / Lane Closure		Safety
<input type="checkbox"/>					VS09.1	Traditional Reduced Speed Warning	Low	Safety
<input type="checkbox"/>					VS09.2	WAW Reduced Speed Warning	Impractical	Safety
<input type="checkbox"/>					VS09.3	C-ITS Reduced Speed Warning	Impractical	Safety
<input type="checkbox"/>	VS10	0	0	0	VS10	Restricted Lane Warnings		Management, Mc
<input type="checkbox"/>	VS11	0	0	0	VS11	Oversize Vehicle Warning		Safety
<input type="checkbox"/>	VS12	0	0	0	VS12	Pedestrian and Cyclist Safety		Mobility, Safety
<input type="checkbox"/>	VS13	0	0	0	VS13	Intersection Safety Warning and Collision Avoidance		Safety
<input type="checkbox"/>	VS14	0	0	0	VS14	Cooperative Adaptive Cruise Control		Mobility
<input type="checkbox"/>	VS15	0	0	0	VS15	Infrastructure Enhanced Cooperative Adaptive Cruise Control		Safety
<input type="checkbox"/>	VS16	0	0	0	VS16	Automated Vehicle Operations		Mobility
<input type="checkbox"/>	VS17	0	0	0	VS17	Traffic Code Dissemination		Informational, Re
<input checked="" type="checkbox"/>	WX01	0	0	0	WX01	Weather Data Collection		Environmental, Ir
<input type="checkbox"/>					WX01.1	Environmental Sensor Stations	Moderate	Environmental, Ir

Cameras in the field are used to collect and share traffic images that are used by operating agencies to manage traffic and shared with the traveling public to convey traffic flow and congestion information.

This service package includes 1 physical diagram.



Physical Legend

Flow Time Context

1 - Now 3 - Historical
2 - Recent 4 - Static

Flow Spatial Context

A - Adjacent D - National
B - Local E - Continental
C - Regional

Flow Routing

(c) - Routed through a common element
(d) - Routed through a DDS

Abbr - Terminal

Flow Status

Existing
Project
Future
Not Applicable

Flow Cardinality

Unicast
Multicast
Broadcast

Flow Control

Transaction initiated
By left-hand party
Receipt acknowledged

Flow Security

Clear text, No Authent.
Encrypted, No Authent.
Clear text, Authenticated
Encrypted, Authenticated

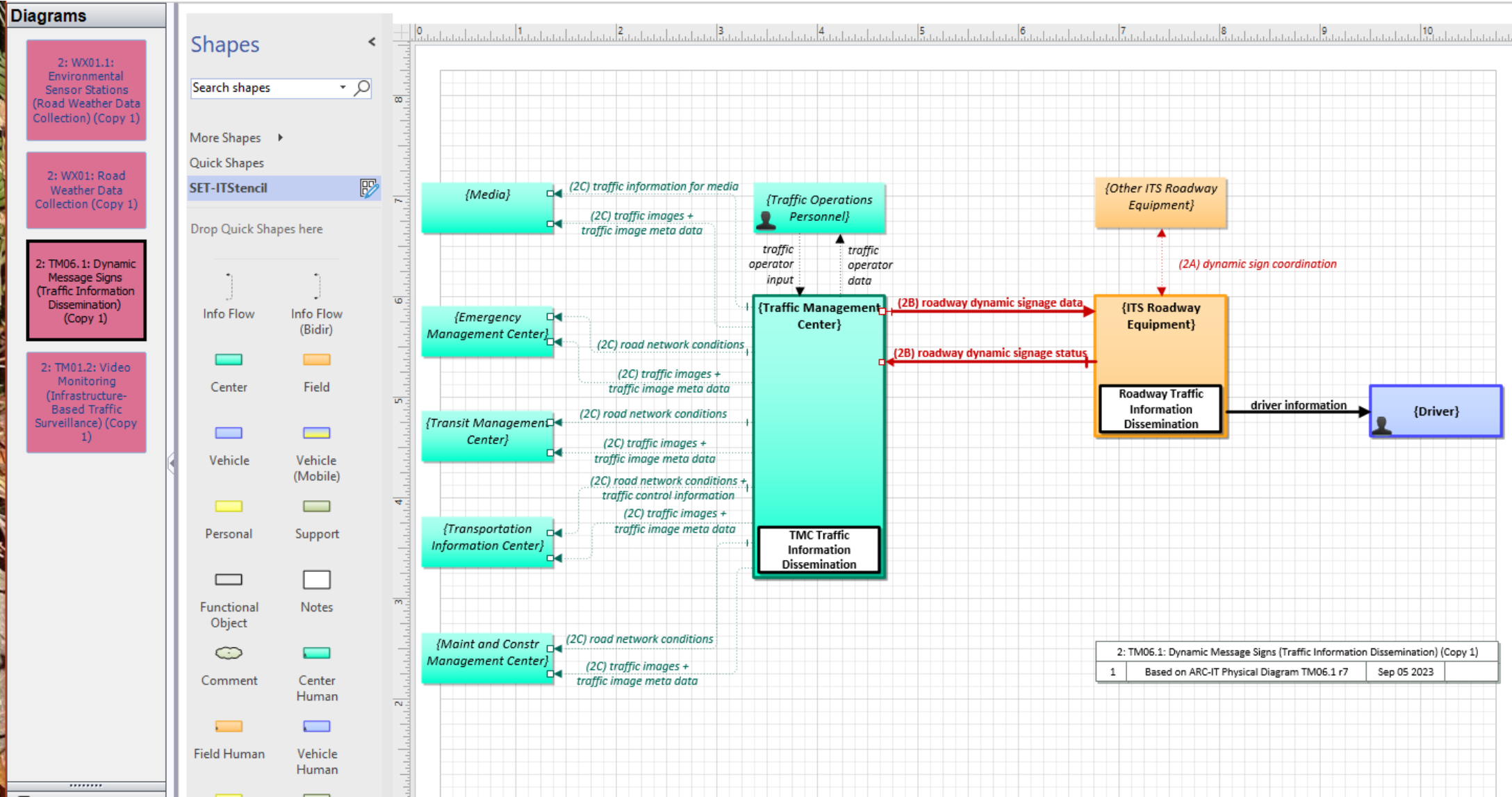
Elements

Center Field
Vehicle Personal
Support ITS
People Environment

Functional Objects

Existing Project
Future Not Applicable

Editing a diagram



Physical Legend

Flow Time Context

1 - Now 3 - Historical
2 - Recent 4 - Static

Flow Spatial Context

A - Adjacent D - National
B - Local E - Continental
C - Regional

Flow Routing

(c) - Route d through a comm element
(d) - Route d through a DDS

Abbr - Terminal

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Clear text, No Authent.
Encrypted, No Authent.
Clear text, Authenticated
Encrypted, Authenticated

Elements

Center	Field
Vehicle	Personal
Support	ITS

People Environment

Functional Objects

Existing	Project
Future	Not Applicable

Project Home Diagram Review Output

Diagram Item Enterprise Physical Comm Inclusion

Started

Line Text AV Synchronize Shape Properties

FIPS Clean up Update Diagram Verification

Calibri

B I U abc

Paste Copy Size Painter

Align&Space Size&Position Connection Points

Cut Copy Size Painter

Zoom To Page

Diagrams

2: WX01.1: Environmental

Shapes

Shape Properties

{Traffic Management Center} Physical Object Center - System

Element Details

Name: Jam Logic VMS Control

Description: Auto-Populate

Status: Project Abbreviation: JLVC

Type: System Parent Element:

Class: Center Domain: Transportation

Physical Object (A) Related All

- Traffic Management Center
- Alerting and Advisory System
- Alternate Mode Transportation Center
- Archived Data System <Support>
- Archived Data User System
- Asset Management System
- Authorizing Center
- Border Inspection Administration Center

Stakeholder	Role	Status
	Manages	Project
	Owns	Project

OK Cancel

Diagram

{Traffic Operations Personnel}

traffic operator input

{Traffic Management Center}

traffic operator data

Motorists

information

Element(s)

Inclusion

Fundamental

Physical Object(s)

- Traffic Management Center
- Alerting and Advisory System
- Alternate Mode Transportation Center
- Archived Data User System
- Asset Management System
- Authorizing Center
- Border Inspection Administration Center
- Care Facility
- Commercial Vehicle Administration Center
- Commercial Vehicle Service Provider Center
- CVO Information Requestor Center
- DMV
- Emergency Management Center
- Emergency Telecommunications System
- Emissions Management Center

Shape Properties

Form Source: Shape Properties - New

Overview

Diagrams

Definitions

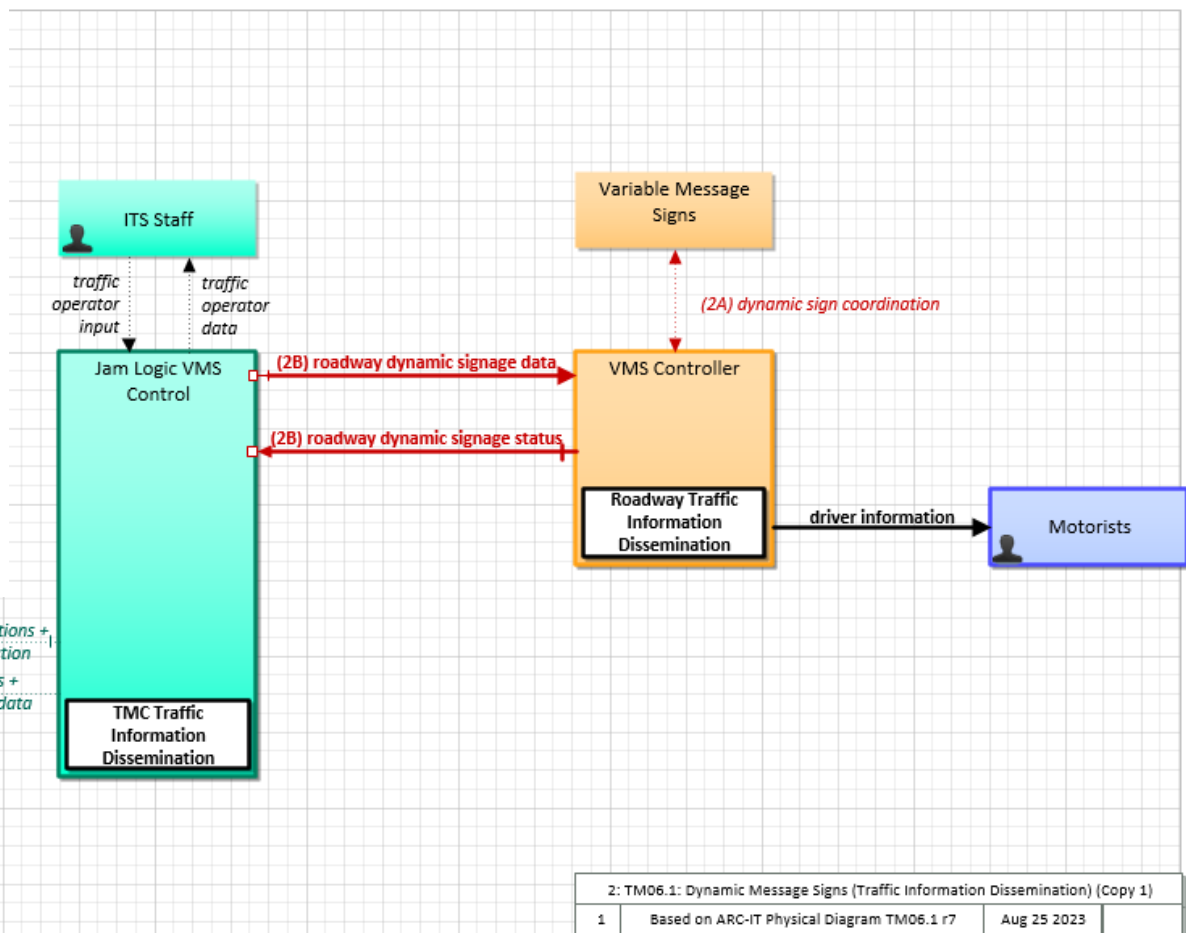
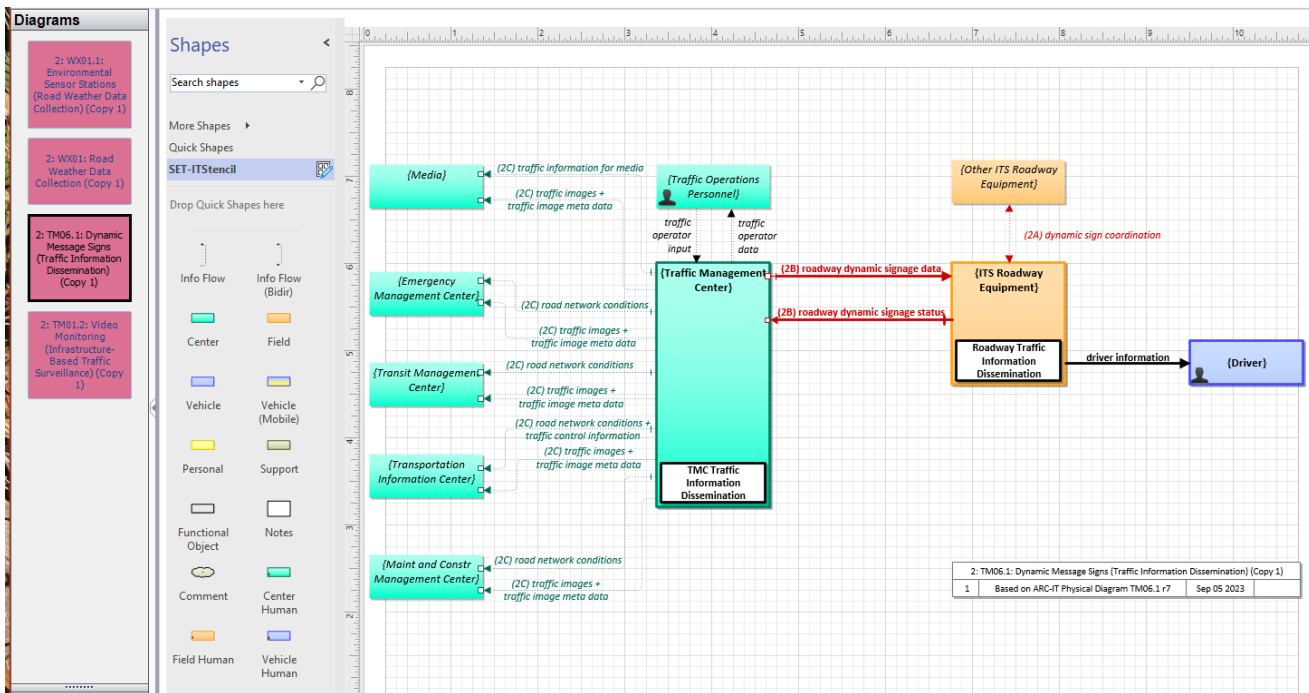
Personal Human

Support Human

Traffic Information Dissemination) (Copy 1)

am TM06.1 r7	Sep 05 2023
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Editing a diagram



Diagrams

2: WX01.1: Environmental Sensor Stations (Road Weather Data Collection) (Copy 1)

2: WX01: Road Weather Data Collection (Copy 1)

2: TM06.1: Dynamic Message Signs (Traffic Information Dissemination) (Copy 1)

2: TM01.2: Video Monitoring (Infrastructure-Based Traffic Surveillance) (Copy 1)

- Overview
- Diagrams**
- Definitions

Shapes

Search shapes

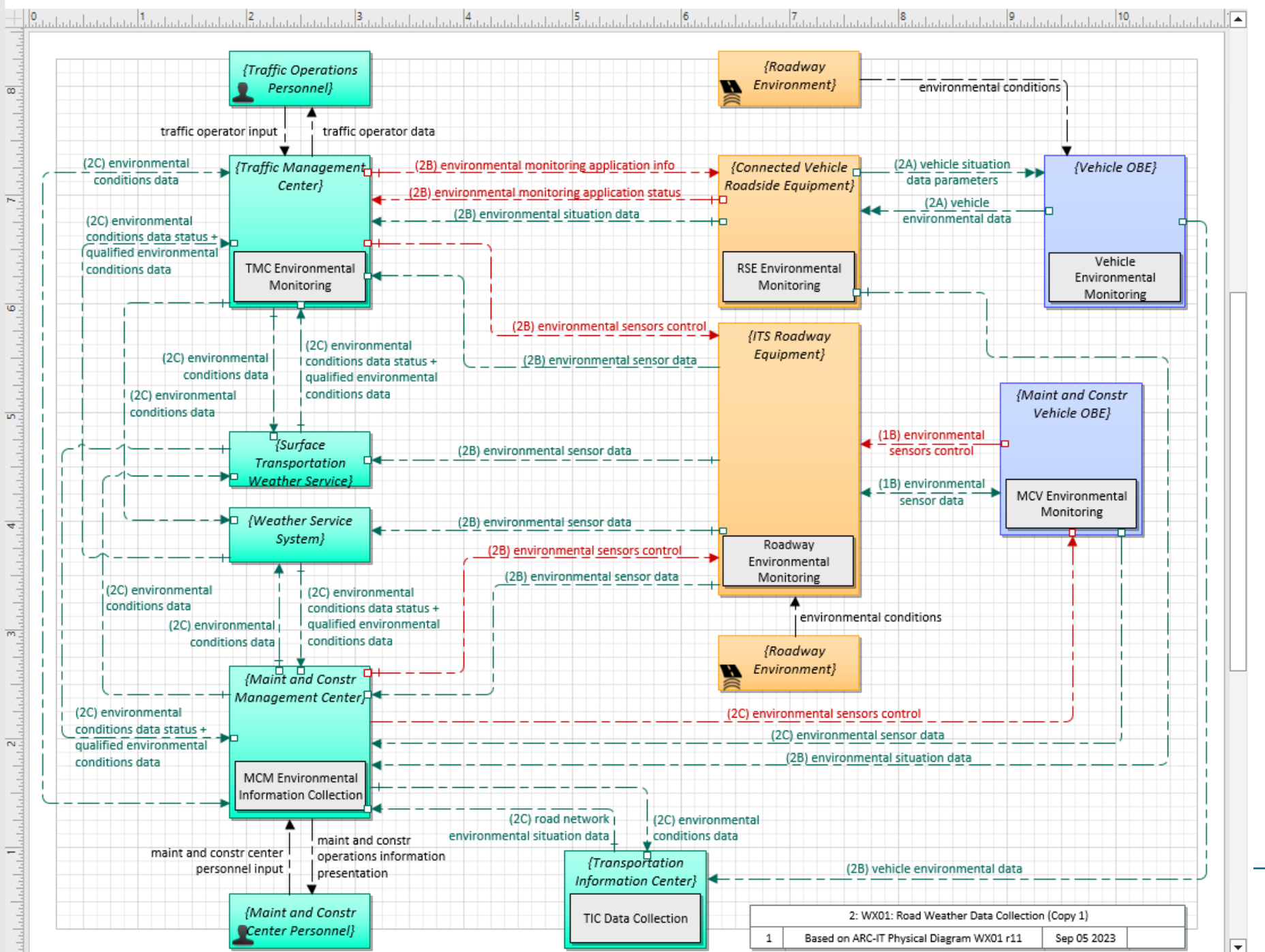
More Shapes

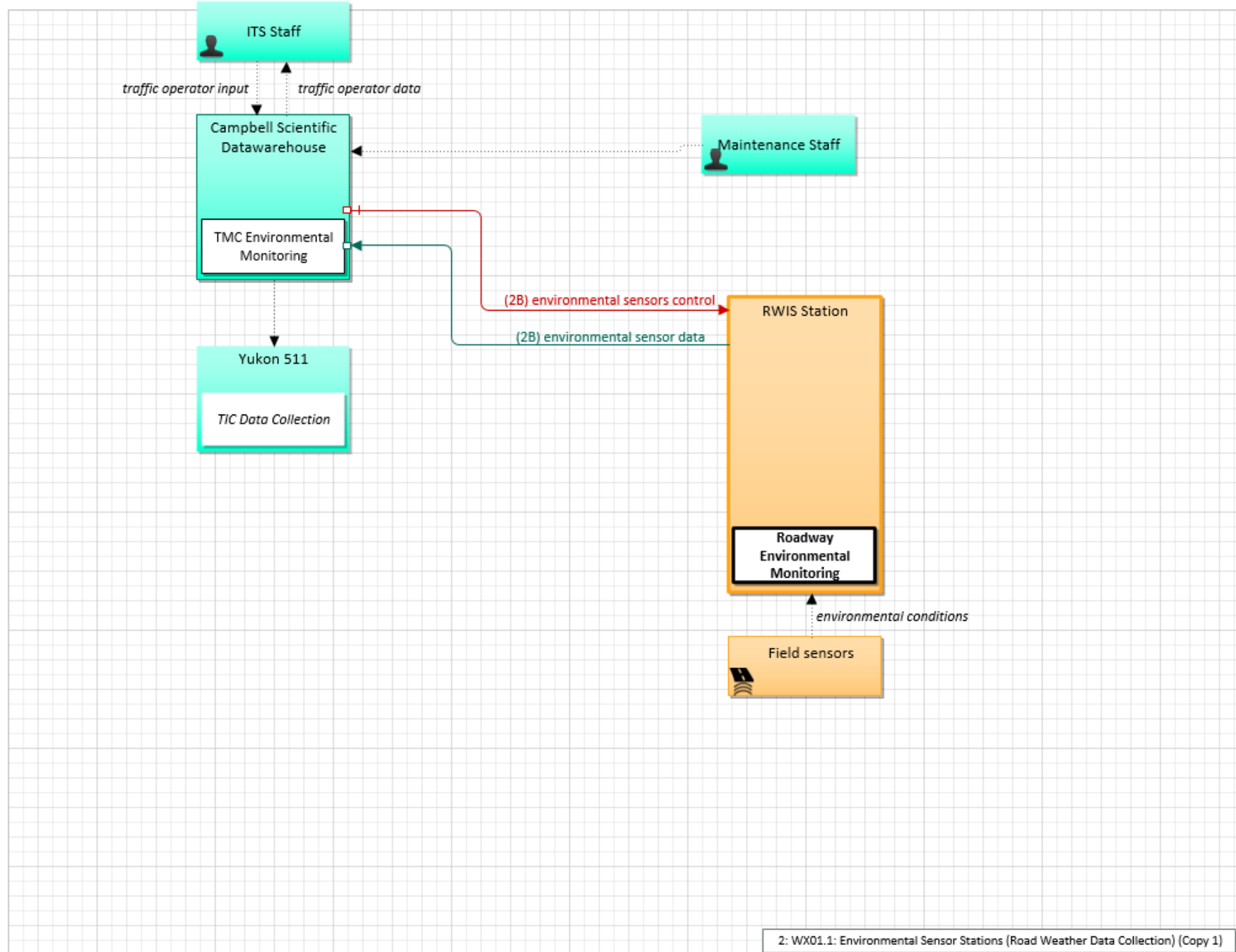
Quick Shapes

SET-ITSStencil

Drop Quick Shapes here

- Info Flow
- Center
- Vehicle
- Personal
- Functional Object
- Comment
- Field Human
- Personal Human
- Field
- Info Flow (Bidir)
- Field
- Vehicle (Mobile)
- Support
- Notes
- Center Human
- Vehicle Human
- Support Human
- Support





Shape Properties

{ITS Roadway Equipment} Physical Object Field - System

Element(s)

- RWIS Station
- VMS Controller

New... Edit...

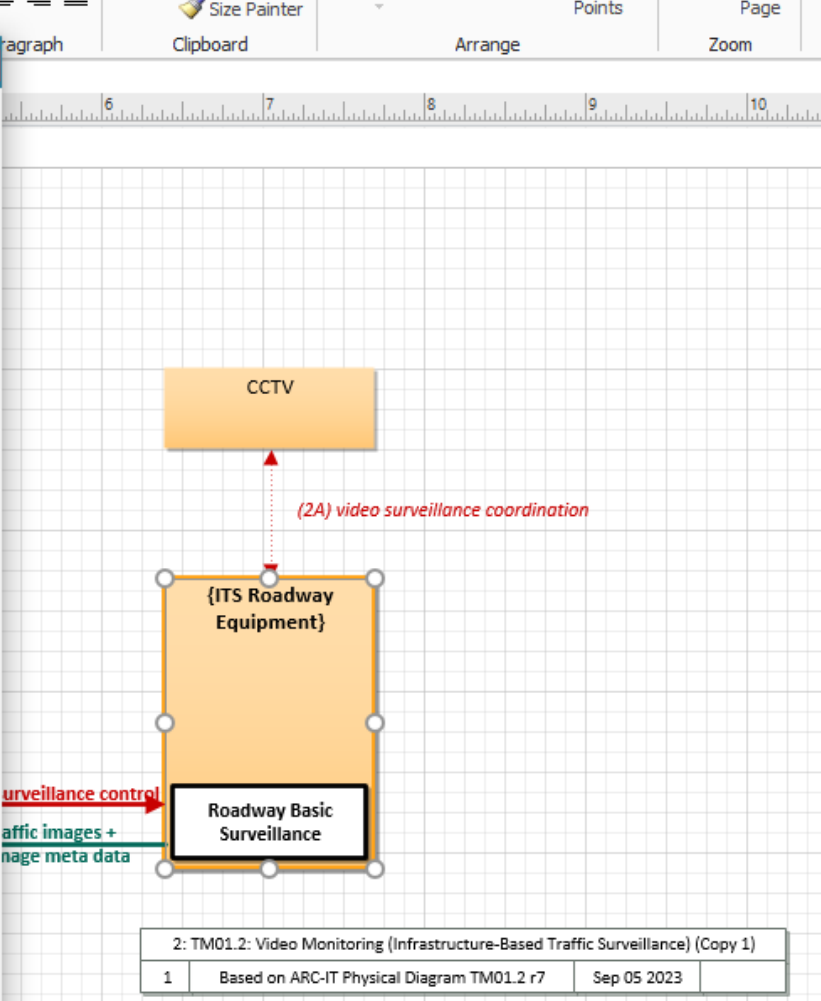
Inclusion

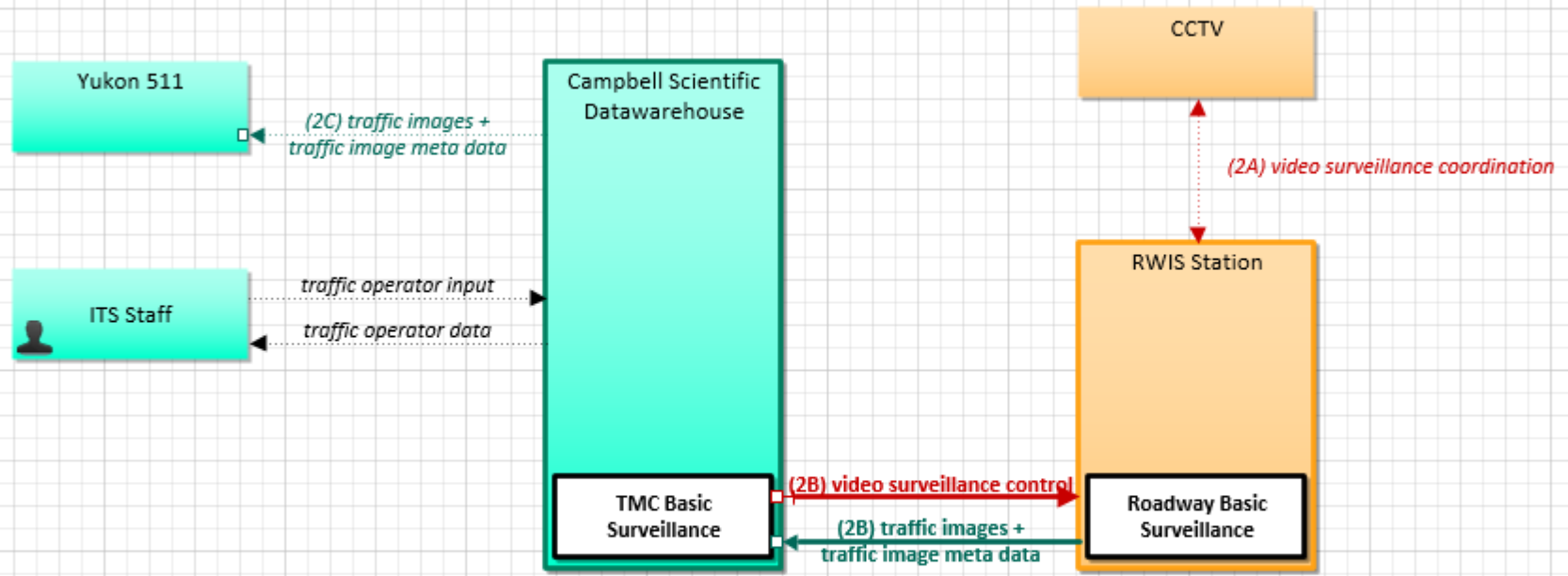
Fundamental

Physical Object(s)

- ITS Roadway Equipment
- Border Inspection System
- Commercial Vehicle Check Equipment
- Connected Vehicle Roadside Equipment
- Electric Charging Station
- Field Maintenance Equipment
- Freight Consolidation Station
- Intermodal Terminal
- ITS Roadway Payment Equipment
- Multimodal Crossing Equipment
- Other Border Inspection Systems
- Other Connected Vehicle Roadside Equipment
- Other ITS Roadway Equipment
- Parking Area Equipment
- Security Monitoring Equipment

Shape Properties





2: TM01.2: Video Monitoring (Infrastructure-Based Traffic Surveillance) (Copy 1)

1	Based on ARC-IT Physical Diagram TM01.2 r7	Aug 25 2023
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- 0: Yukon ITS Overview
 - 2: WX01.1: Environmental Sensor Stations (Road Weather Data Collection) (Copy 1)
 - 2: TM06.1: Dynamic Message Signs (Traffic Information Dissemination) (Copy 1)
 - 2: TM01.2: Video Monitoring (Infrastructure-Based Traffic Surveillance) (Copy 1)
- Overview
- Diagrams
- Definitions

Shapes

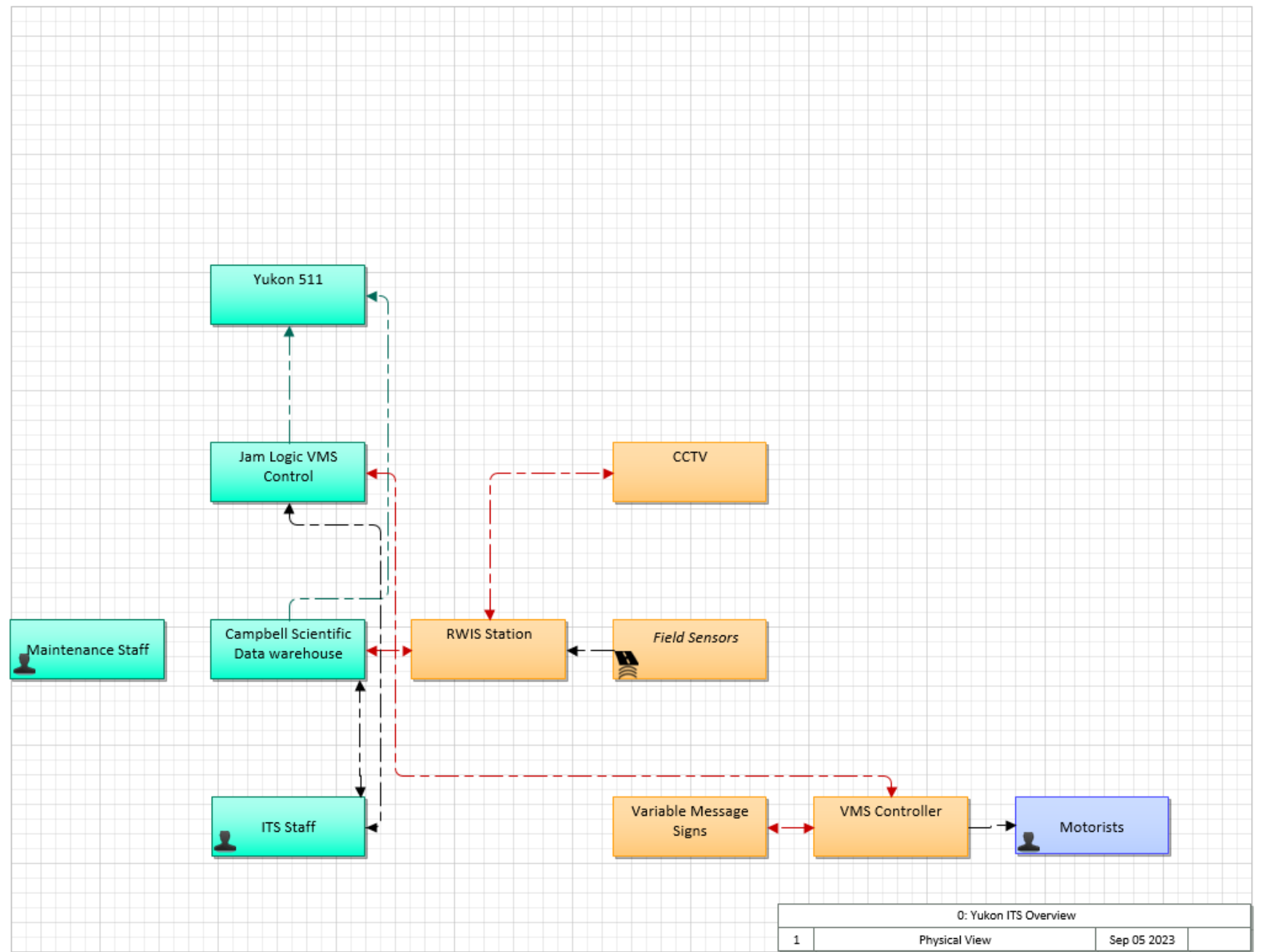
Search shapes

More Shapes

SET-ITStencil

Drop Quick Shapes here

- Notes
- Comment
- Abbrev
- Terminal
- Legend Physical Lay...
- Legend Physical ...



Definitions

Service Packages

Service Package Instances

Service Package Issues

Diagram Information

Need Areas

Needs

Scenarios

Sequences

Stakeholders

Elements

Physical Objects

Functional Objects

Elements to Functional Objects

Information Flows

Information Flow Triples

Name	Source	Destination	Type	Information Flow Triples			Status
				User Defined	DDS	Communications	
driver information	VMS Controller	Motorists	Human	<input type="checkbox"/>			Project
dynamic sign coordination	Variable Message Signs	VMS Controller	System	<input type="checkbox"/>			Project
dynamic sign coordination	VMS Controller	Variable Message Signs	System	<input type="checkbox"/>			Project
environmental conditions	Field Sensors	RWIS Station	Environment	<input type="checkbox"/>			Project
environmental sensor data	RWIS Station	Campbell Scientific Data warehouse	System	<input type="checkbox"/>			Project
environmental sensors control	Campbell Scientific Data warehouse	RWIS Station	System	<input type="checkbox"/>			Project
road network conditions	Jam Logic VMS Control	Yukon 511	System	<input type="checkbox"/>			Project
roadway dynamic signage data	Jam Logic VMS Control	VMS Controller	System	<input type="checkbox"/>			Project
roadway dynamic signage status	VMS Controller	Jam Logic VMS Control	System	<input type="checkbox"/>			Project
traffic control information	Jam Logic VMS Control	Yukon 511	System	<input type="checkbox"/>			Project
traffic image meta data	Campbell Scientific Data warehouse	Yukon 511	System	<input type="checkbox"/>			Project
traffic image meta data	Jam Logic VMS Control	Yukon 511	System	<input type="checkbox"/>			Project
traffic image meta data	RWIS Station	Campbell Scientific Data warehouse	System	<input type="checkbox"/>			Project
traffic images	Campbell Scientific Data warehouse	Yukon 511	System	<input type="checkbox"/>			Project
traffic images	Jam Logic VMS Control	Yukon 511	System	<input type="checkbox"/>			Project
traffic images	RWIS Station	Campbell Scientific Data warehouse	System	<input type="checkbox"/>			Project
traffic operator data	Campbell Scientific Data warehouse	ITS Staff	Human	<input type="checkbox"/>			Project
traffic operator data	Jam Logic VMS Control	ITS Staff	Human	<input type="checkbox"/>			Project
traffic operator input	ITS Staff	Campbell Scientific Data warehouse	Human	<input type="checkbox"/>			Project
traffic operator input	ITS Staff	Jam Logic VMS Control	Human	<input type="checkbox"/>			Project
video surveillance control	Campbell Scientific Data warehouse	RWIS Station	System	<input type="checkbox"/>			Project
video surveillance coordination	CCTV	RWIS Station	System	<input type="checkbox"/>			Project
video surveillance coordination	RWIS Station	CCTV	System	<input type="checkbox"/>			Project

Communications View

SET-IT - C:\Projects\Transport Canada\TC_ITS Arch\Architecture\Yukon ITS\Yukon ITS.setit

Project Home Review Output Search

Diagram Enterprise Physical Comm Synchronize Calculate Solution Assignments

New Views Tools

Definitions

- Flow Triples to Solutions
- Solutions
- Issues
- Service Package Issues
- Profiles
- P-Interconnects
- Standards**
- Standard Bundles
- Assumptions and Constraints

In My Project	Name	SDO	Doc #	Title	Standards	Description	User Defined	More...
<input checked="" type="checkbox"/>	Bundle: ISO 15784-2	ISO	ISO 15784-2	Intelligent	ISO 15784-2	ISO 15784-2 specifies the standards that provide a mechanism to exchange data and messages in the following cases: a)	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	Bundle: SNMPv3 MIB	N/A		SNMPv3 &		A bundle of standards (RFCs) that groups the common management information bases (MIBs) used to manage IP	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	Field SubNet Alternatives	N/A		Field SubNet		A set of alternative standards that defines various SubNet Layer alternatives for use in center-to-field and field-to-field	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	IETF RFC 6353 TLS for SNMP	IETF	IETF RFC 6353	Transport Layer		This standard (RFC) defines how to use the TLS authentication service to provide authentication within the access control	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	IETF RFC 793 TCP	IETF	IETF RFC 793	Transmission		This standard (RFC) defines the main connection-oriented Transport Layer protocol used on Internet-based networks.	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	Internet Subnet Alternatives	N/A		Internet Subnet		A set of alternative standards that includes any Subnet Layer method of connecting to the Internet.	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	Internet Transport Alternatives	N/A		Internet Transport		A set of alternative standards that identifies the two major options for the transport layer for mainstream IP-based	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	IP Alternatives	N/A		Internet Protocol		A set of alternative standards that allows for the selection of IPv4 or IPv6.	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	ITE TMDD Vol 2	ITE	ITE TMDD Vol 2	Traffic		This standard defines the messages and data elements for the external center to traffic management center interface.	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	NTCIP C2C Alternatives	NTCIP	NTCIP 2306	Application Profile		This standard defines alternatives for deploying center-to-center communications using XML directly over HTTPS. This	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	NTCIP CCTV Objects	NTCIP	NTCIP 1205	NTCIP Objects for		This standard defines SNMP objects (data elements) for control and monitoring of closed-circuit television (CCTV) camera	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	NTCIP Global Objects	NTCIP	NTCIP 1201	NTCIP Global		This standard defines SNMP objects (data elements) used by a wide range of field devices like time and versioning	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	NTCIP Message Sign Objects	NTCIP	NTCIP 1203	NTCIP Object		This standard defines SNMP objects (data elements) for monitoring and controlling dynamic message signs (such as	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	NTCIP Video Switch Objects	NTCIP	NTCIP 1208	NTCIP Object		This standard defines SNMP objects (data elements) for the control and monitoring of video switches.	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	NTCIP Weather Station Objects	NTCIP	NTCIP 1204	NTCIP		This standard defines SNMP objects (data elements) for monitoring and controlling environmental sensor stations	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	Secure Session Alternatives	N/A		Secure Session		A set of alternative standards that identifies standards that are used to establish and maintain secure Internet sessions.	<input type="checkbox"/>	Details
<input checked="" type="checkbox"/>	W3C WSDL	W3C	W3C WSDL 1.1	Web Services		This standard defines the mechanism for a system to describe the web services that it supports.	<input type="checkbox"/>	Details



Why would you want to use it?

- Supports big picture thinking
- Saves time
- Performs consistency checks and validation
- Uses common terminology with ITS projects across North America
- Supports development of interoperable systems

Benefits

- Have I missed anything?
- Are there other users that I should be thinking of?
- How might my system look in 10 years?
- Diagrams that are easily understood by other agencies, consultants, system providers.
- Free tool



SET-IT In Action Summary

- SET-IT can be used at the beginning phases of a project or after systems are in place
- Supports creation of material in a consistent format
- Provides numerous benefits including completeness tests
- Tool is free to use

Training Schedule

Session Topic	Description	Date / Time
Detailed ITS Architecture Training	Provides more detailed and comprehensive training on key architecture components and how to access them through the ARC-IT website.	Complete
Regional ITS Architecture Development	Provides a high-level overview of the regional ITS Architecture development process, incorporating examples from the ARC-IT RAD-IT tool.	Complete
Systems Engineering Training	Provides an introduction to the concept of Systems Engineering, its importance to the lifecycle of delivering ITS, and how the Architecture helps support to the process.	Today

- French stream: January 30, February 6, and February 13, 2024.
- English stream #2: February 14, February 21, and February 28, 2024.

Questions or Comments?

Email contacts:

- Support: ITSArchitecture-ArchitectureSTI@tc.gc.ca
- Jonathan Parent jonathan.parent@tc.gc.ca  Transport Canada 
- Mara Bullock mara.bullock@wsp.com 

Thank You for Joining!