Detailed ITS Architecture Training

November 29, 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.

Disclaimer

- Transport Canada does not endorse products or companies. Reference to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favouring by Transport Canada and shall not be used for advertising or service endorsement purposes.
- Transport Canada is not responsible for errors or omissions in this document and makes no representations as to the accuracy or completeness of the information. Content provided by external sources is not subject to official languages, privacy and accessibility requirements.

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

What is ITS?

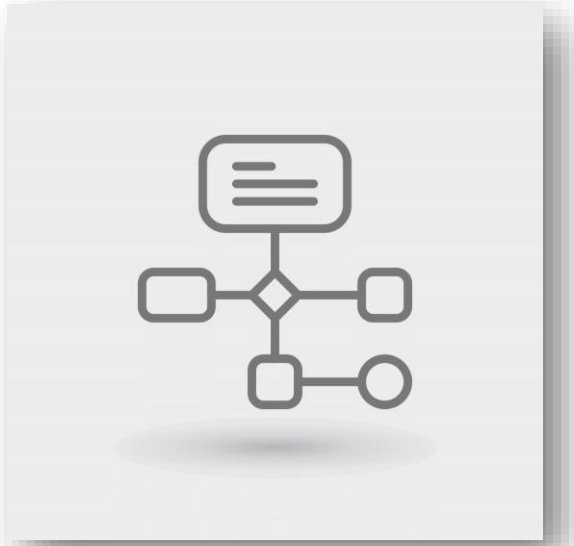
Intelligent Transportation Systems (ITS) integrate different information and communications technologies into road transportation infrastructure and vehicles, to help make the transportation system safer and more efficient.

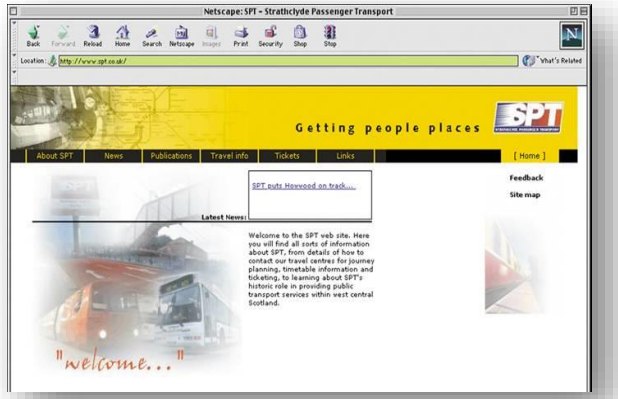
Role of Transportation Professionals

- 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

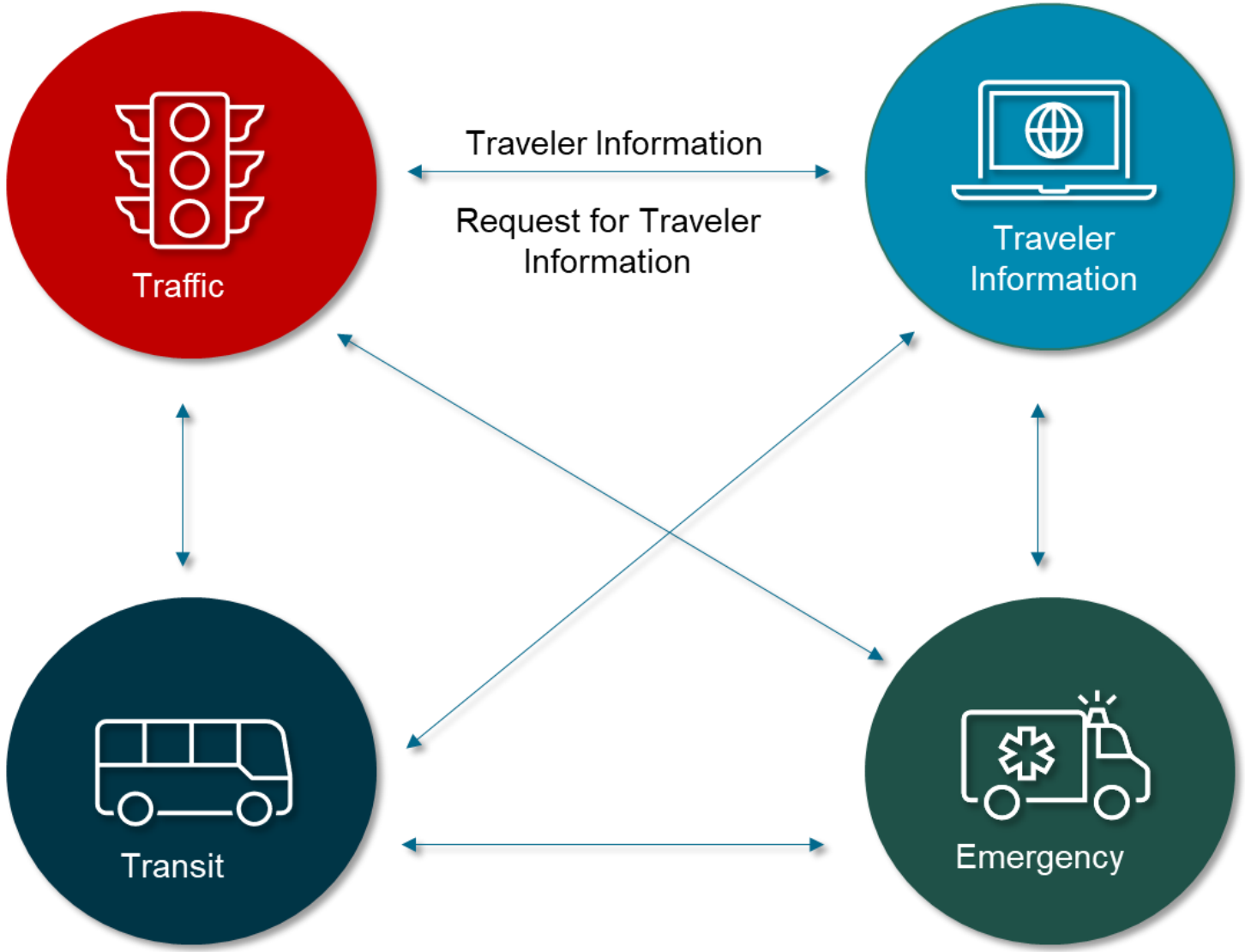




An ITS Architecture is NOT…

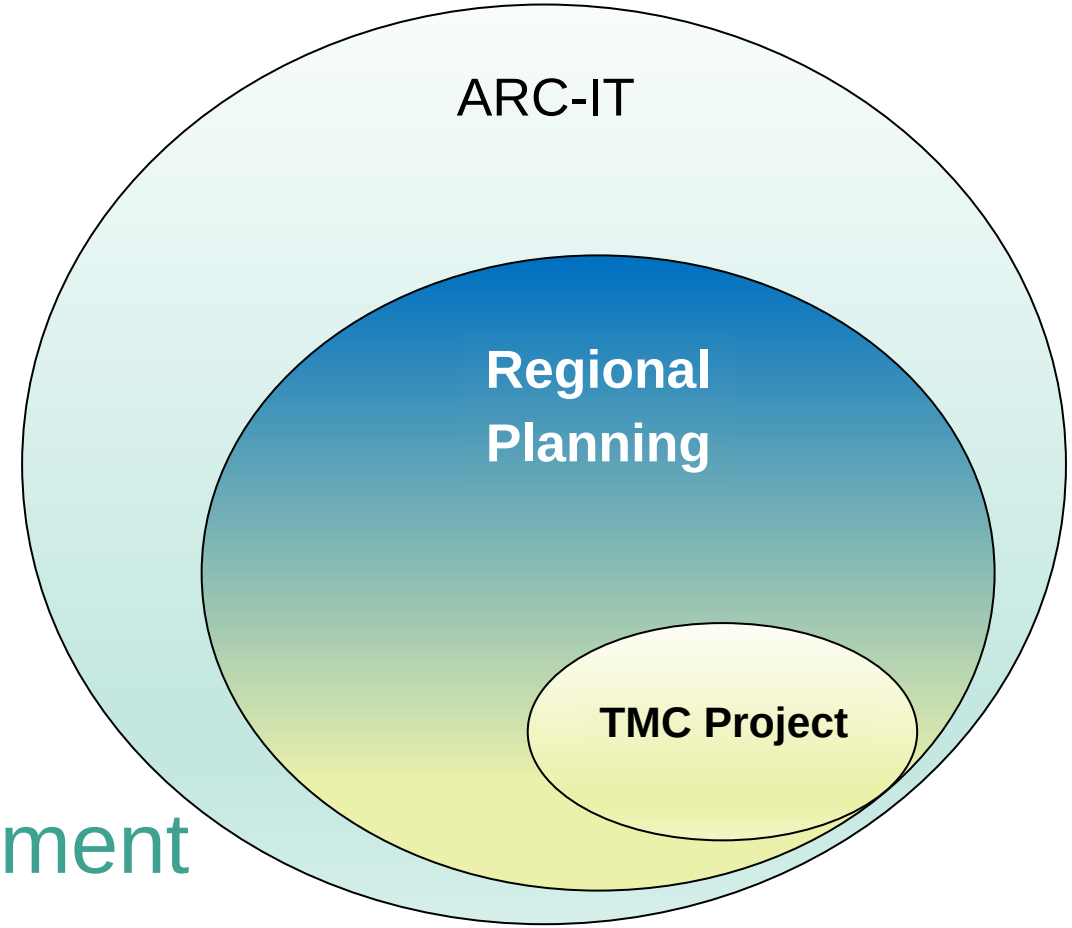
- A design document
- An institutional or development process
- Technology prescriptive . . .

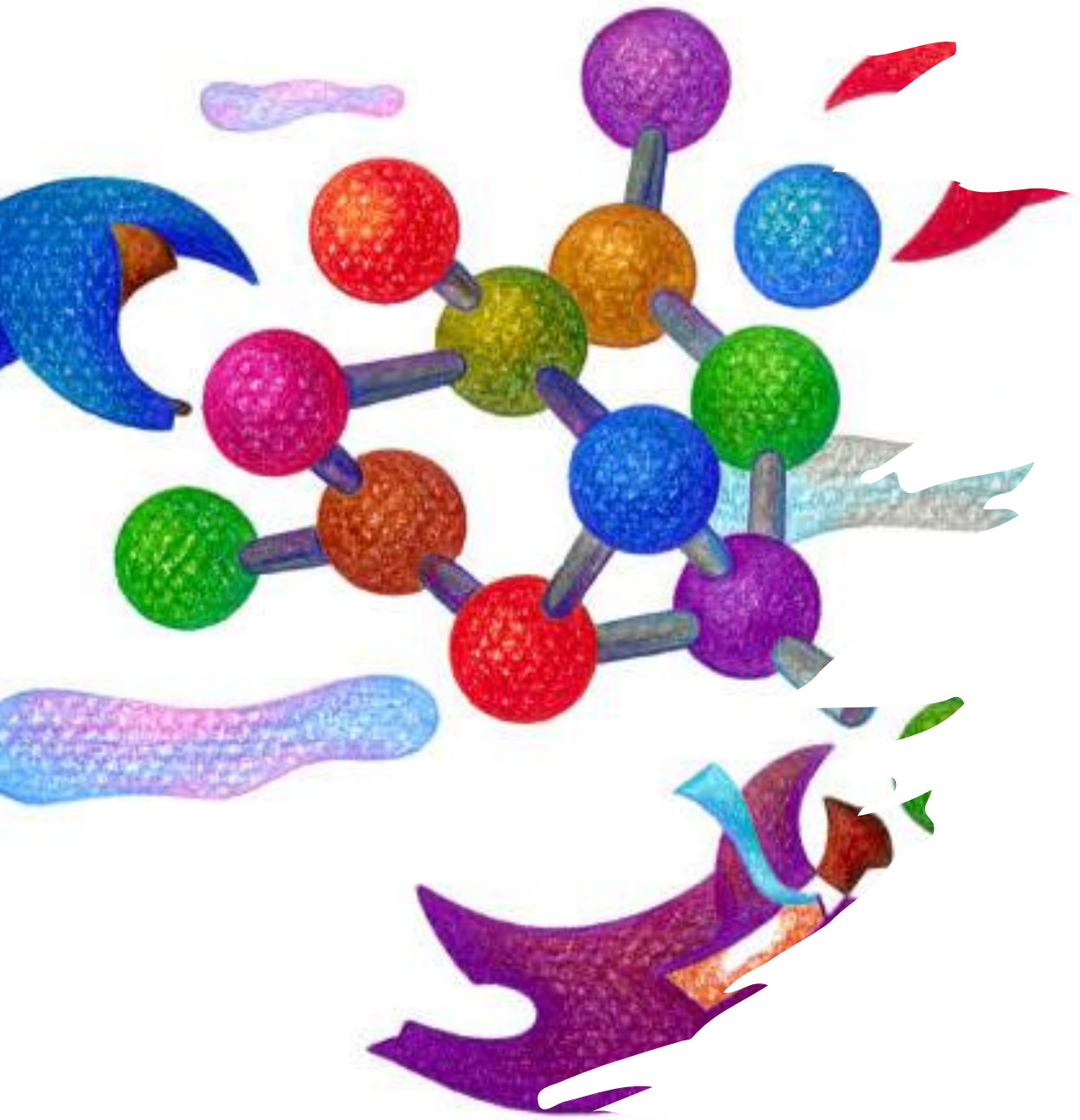
ITS Architectures Provide a Framework for Integration



Types (or levels) of ITS Architectures

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





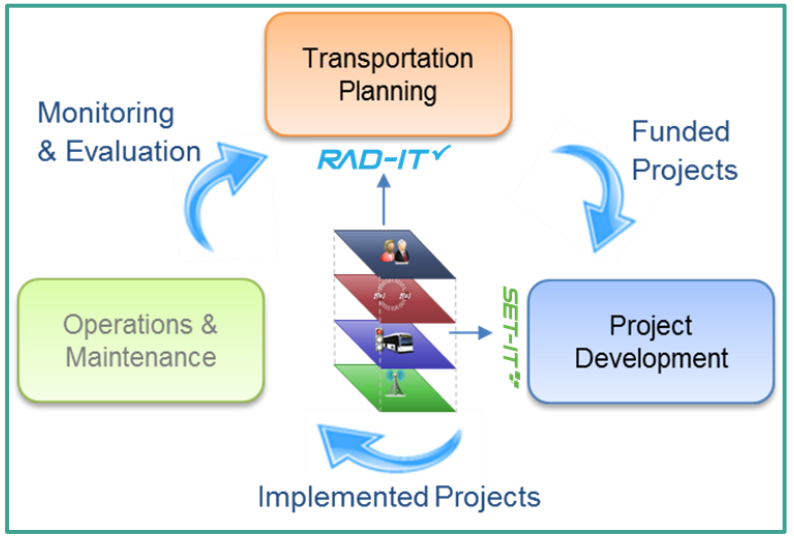
Reasons for Architecture Use in Transportation Planning and Programming

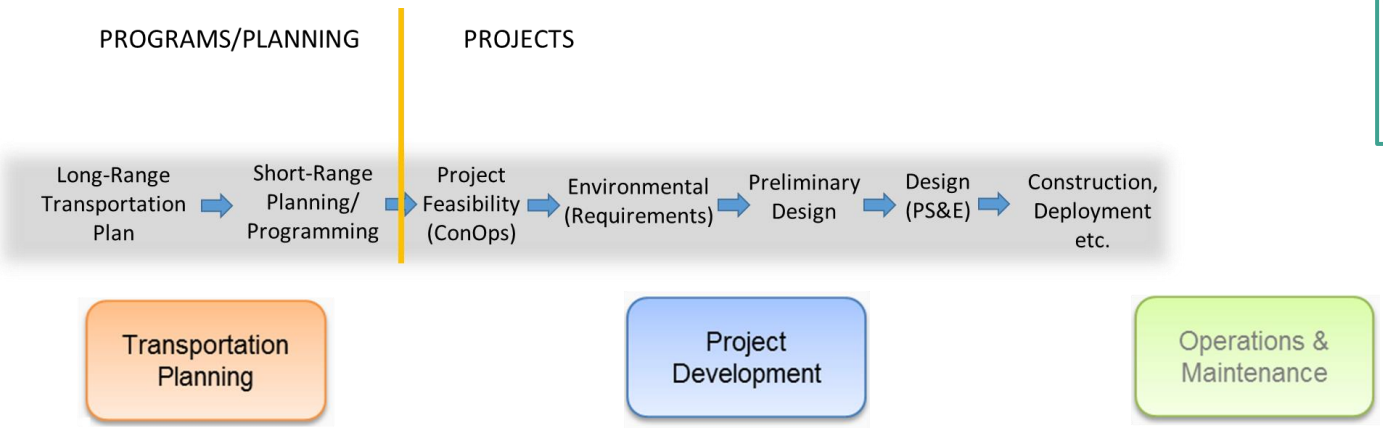
- Architecture represents a consensus vision of Operations and Planning stakeholders for deployment of ITS systems

- Addresses both short-range projects and long-range strategies

Make Architecture Useful for Programming/ Budgeting

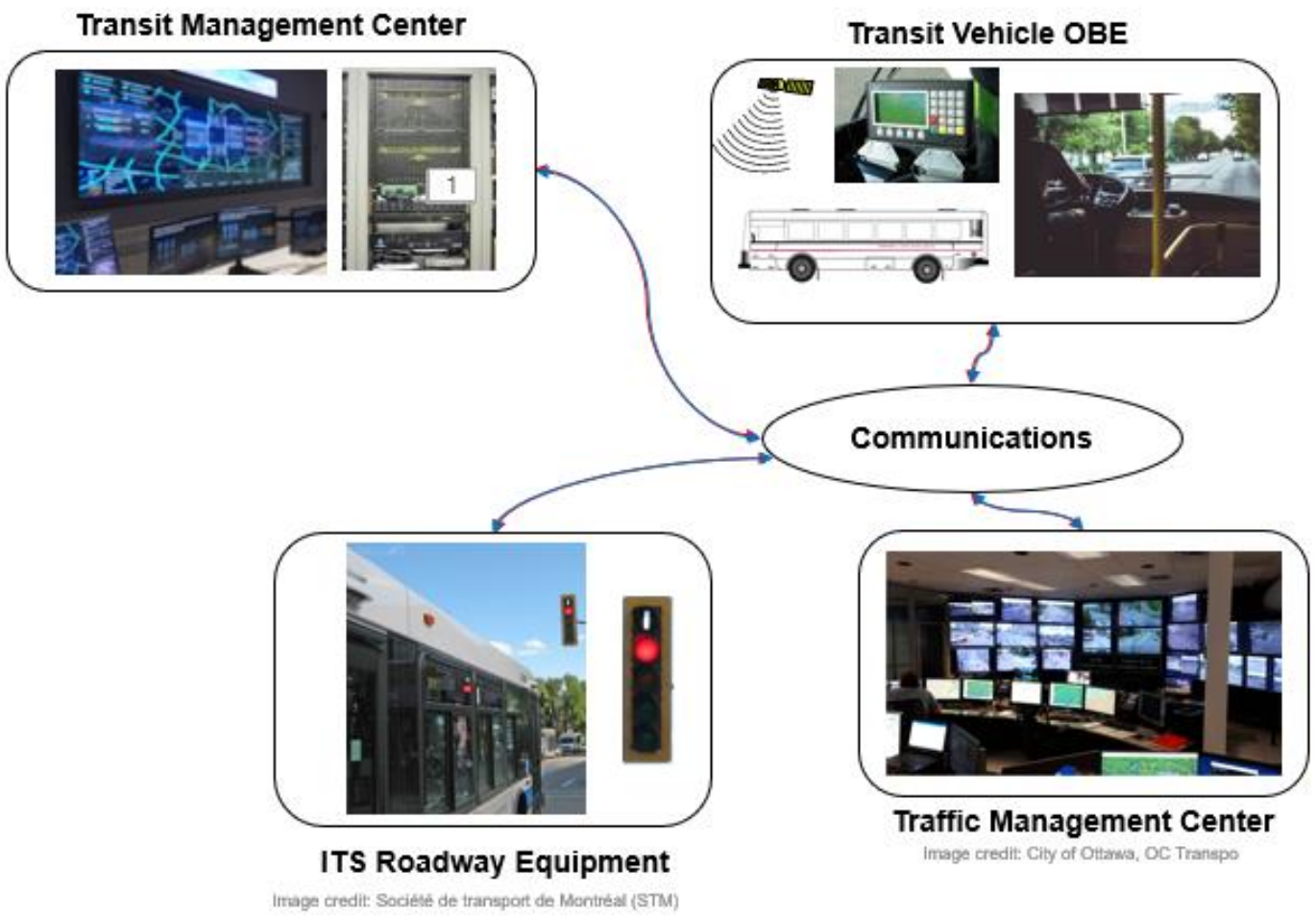
- Define near term projects in more specificity to feed into programming and budgeting processes
- Promote integration projects in region
- Establish process that uses architecture

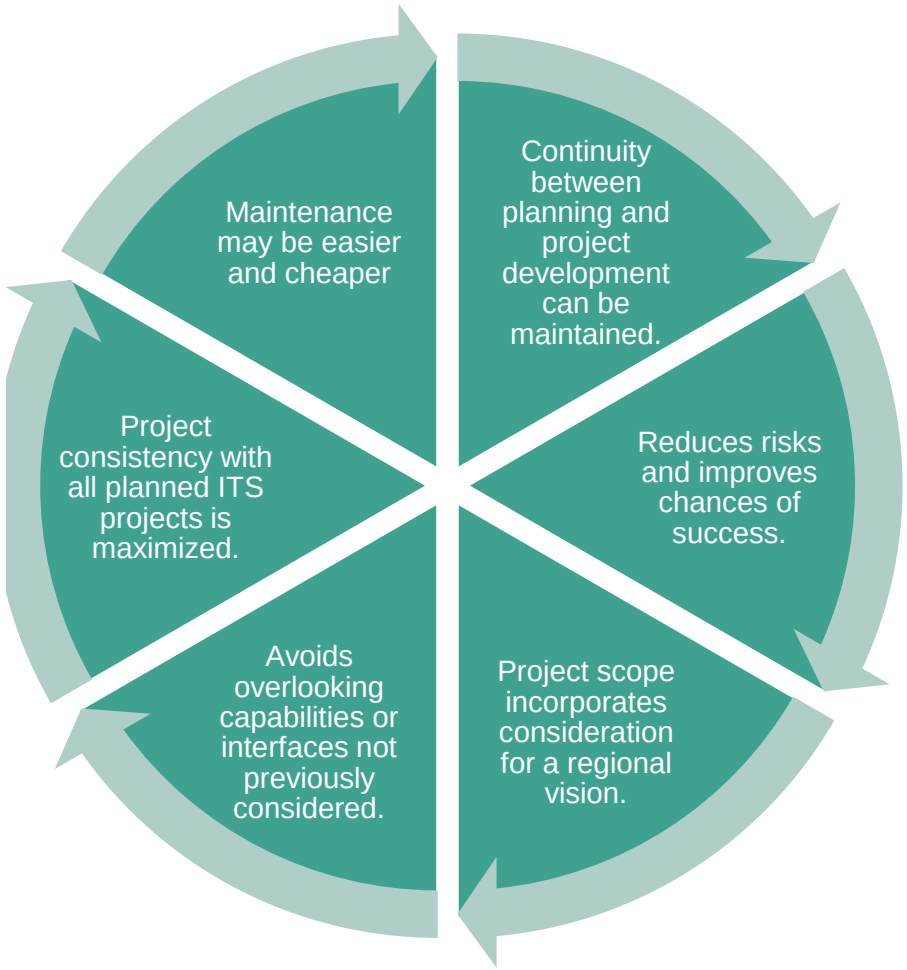




Adapted from: U.S. DOT

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

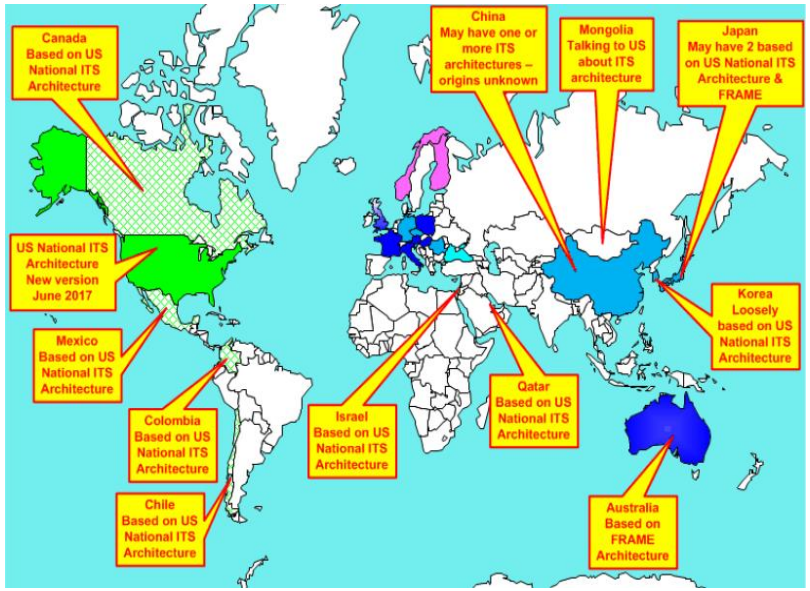
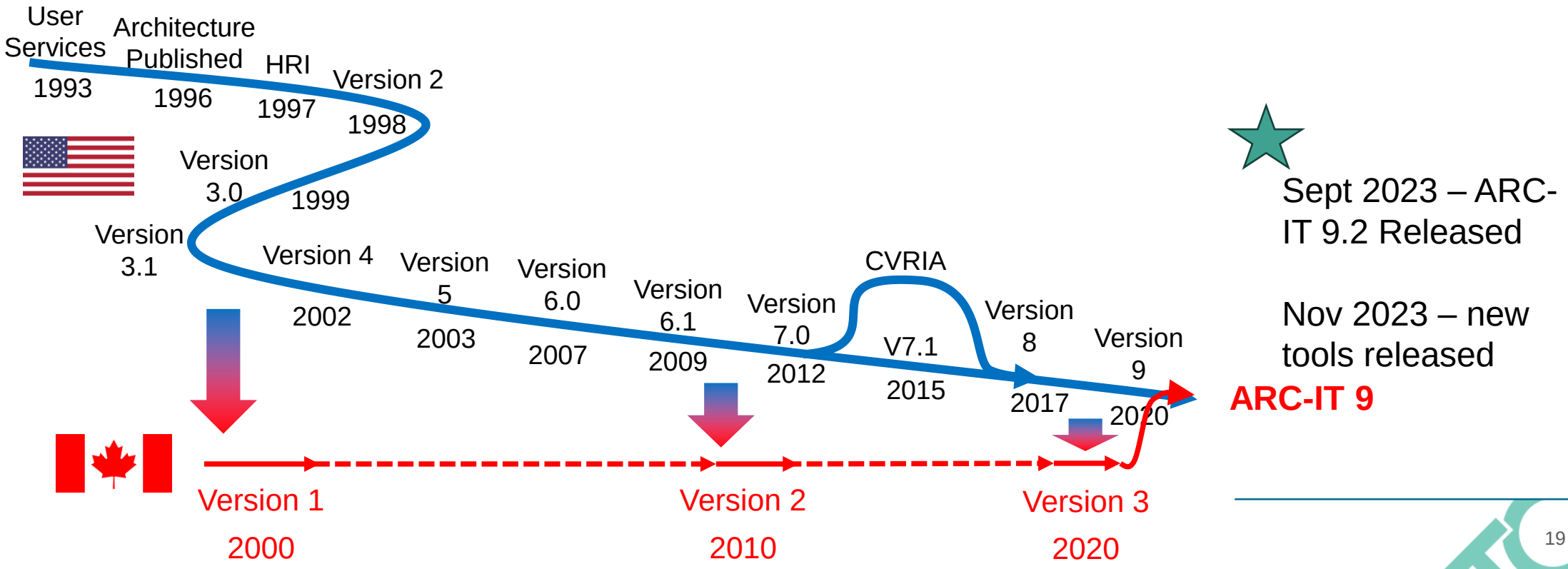


Image Source: Using Architectures in ITS Webinar (June 11, 2020)

- 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



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

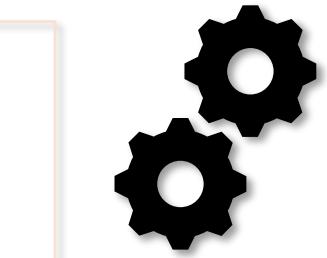
Current Status

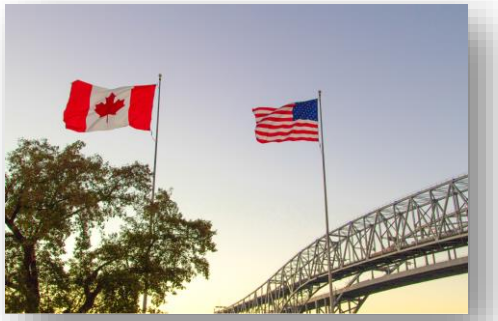
ARC-IT

- “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





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)

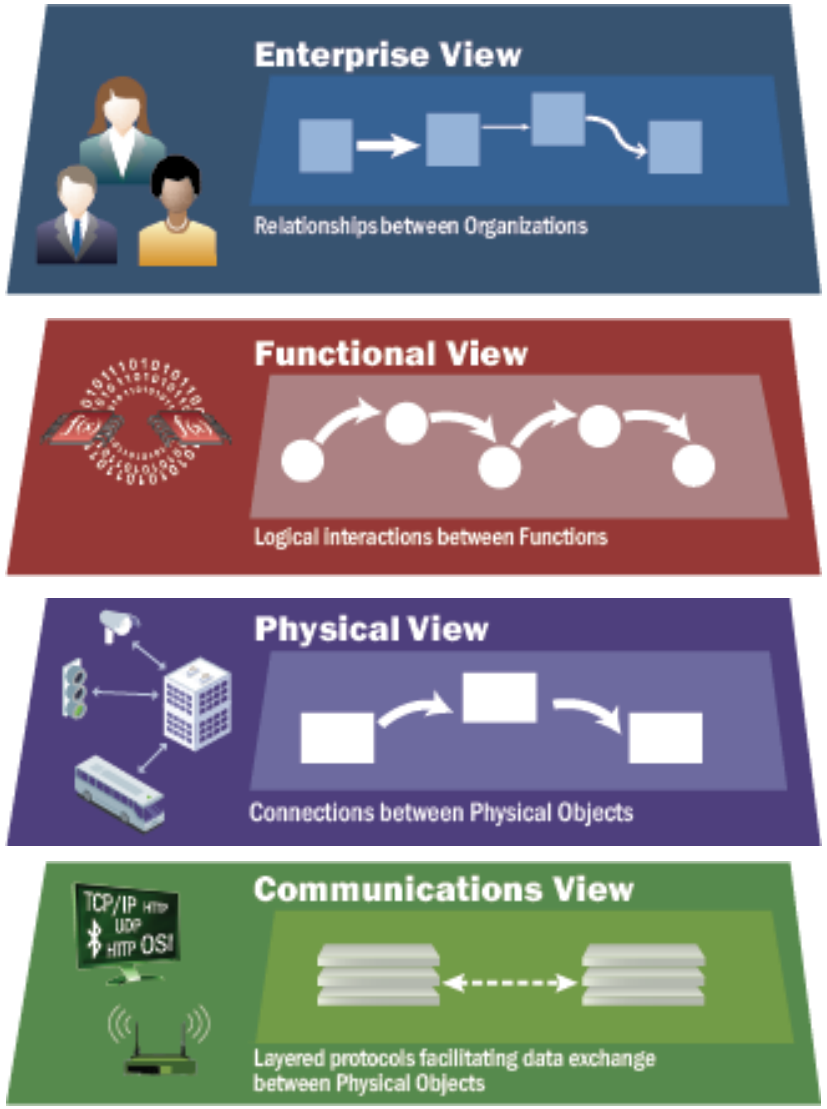


Image source: U.S. DOT

ARC-IT Viewpoints

- 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)
- 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.

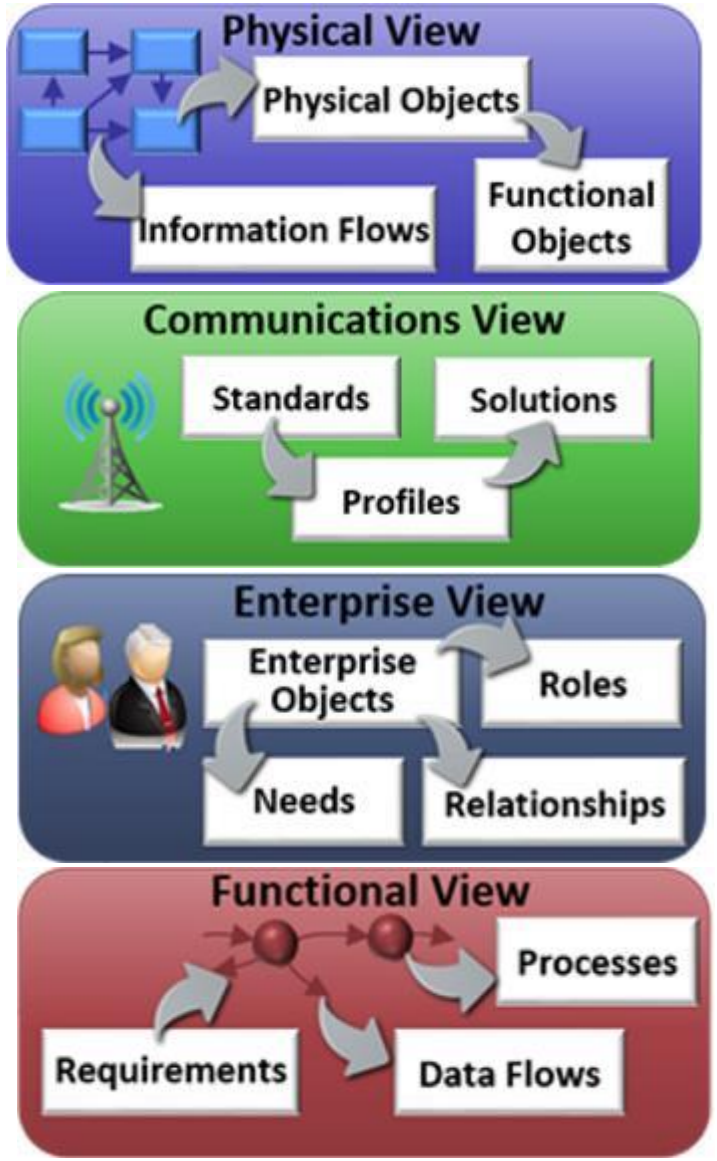


Image source: U.S. DOT

ARC-IT Physical View

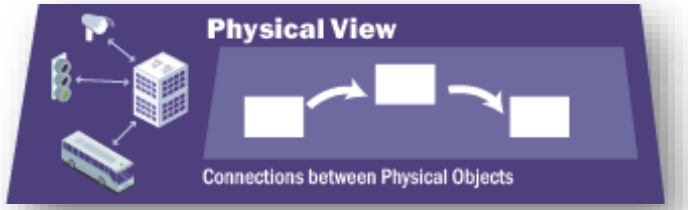


Image source: U.S. DOT

Depicts:

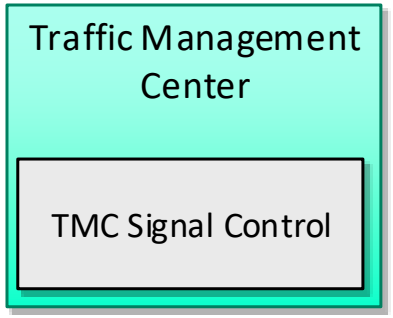
- Physical objects that interact to deliver services
- Interfaces and flows of information between those physical objects

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

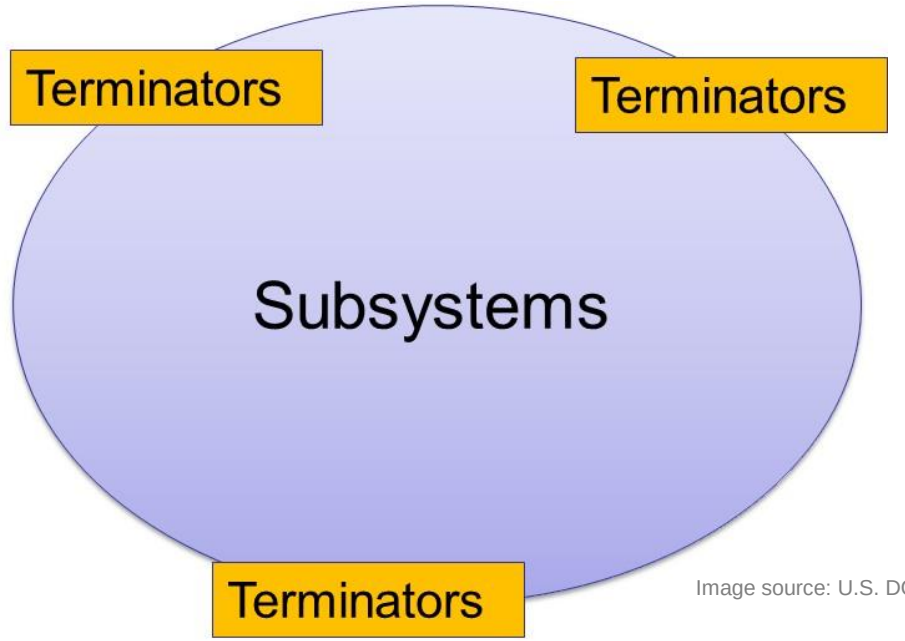


Image source: U.S. DOT

Physical View - Physical Objects

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

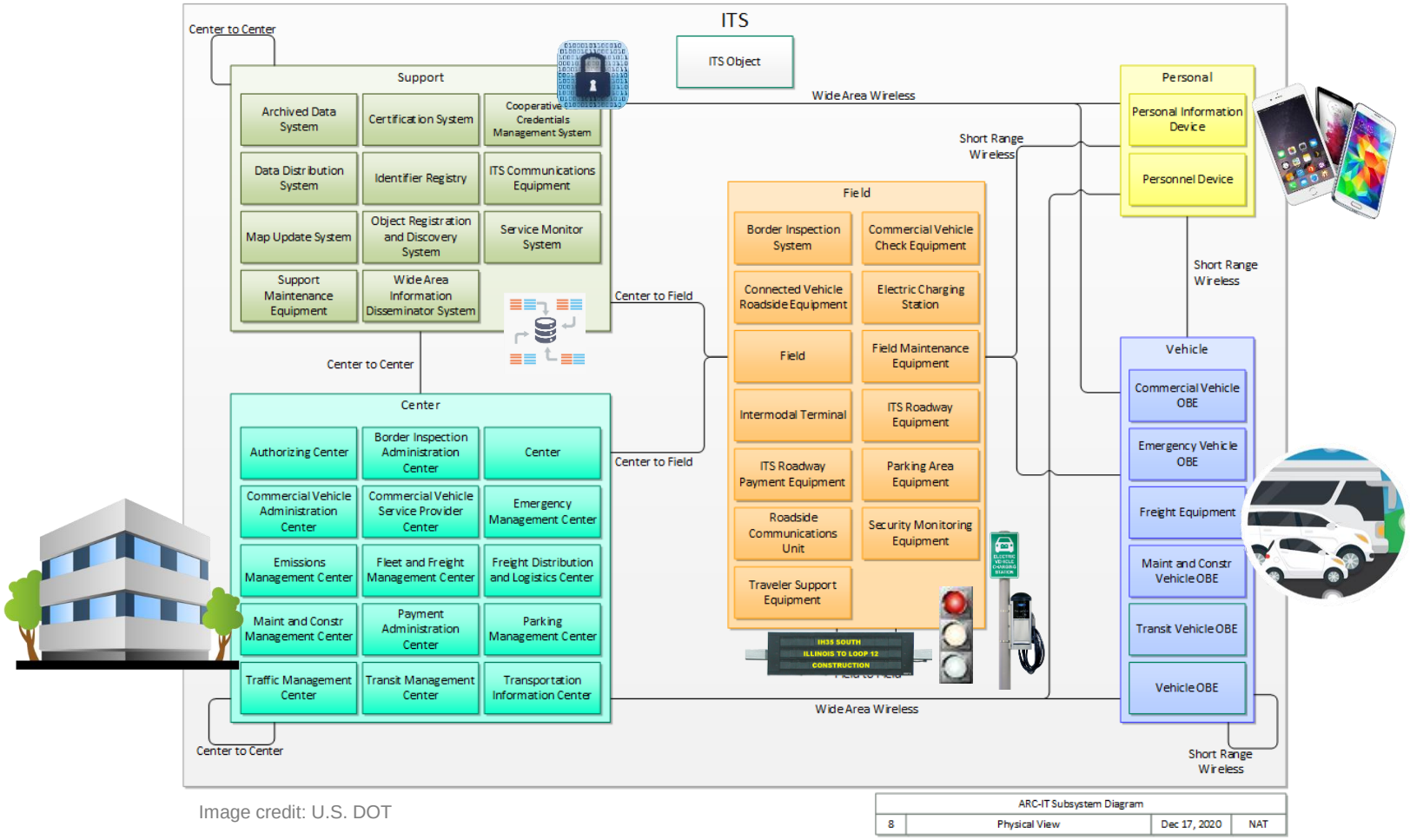


Image credit: U.S. DOT

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

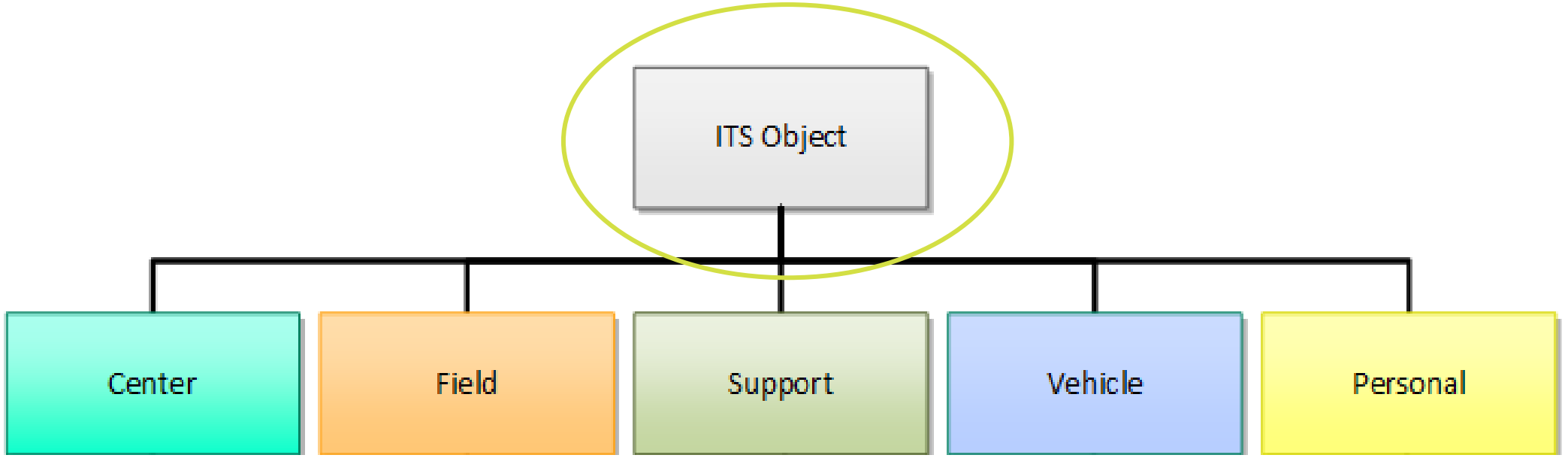
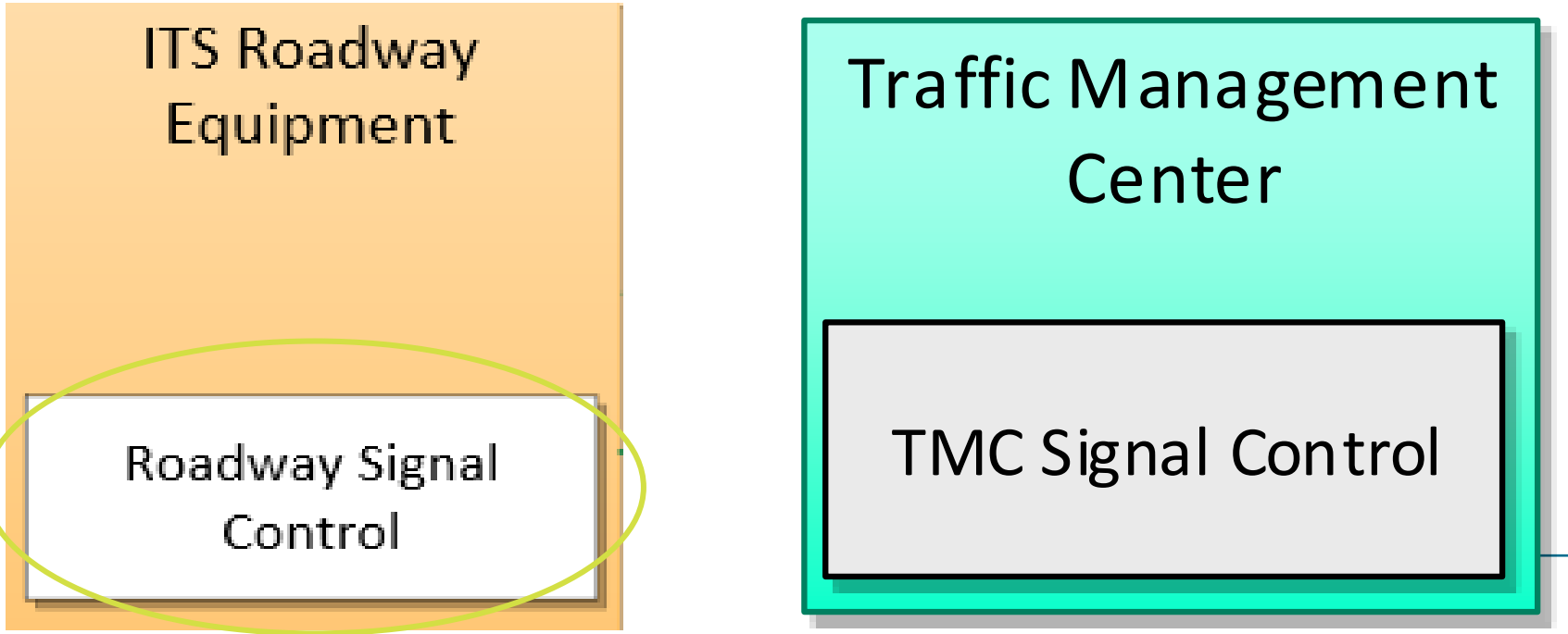


Image source: U.S. DOT

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

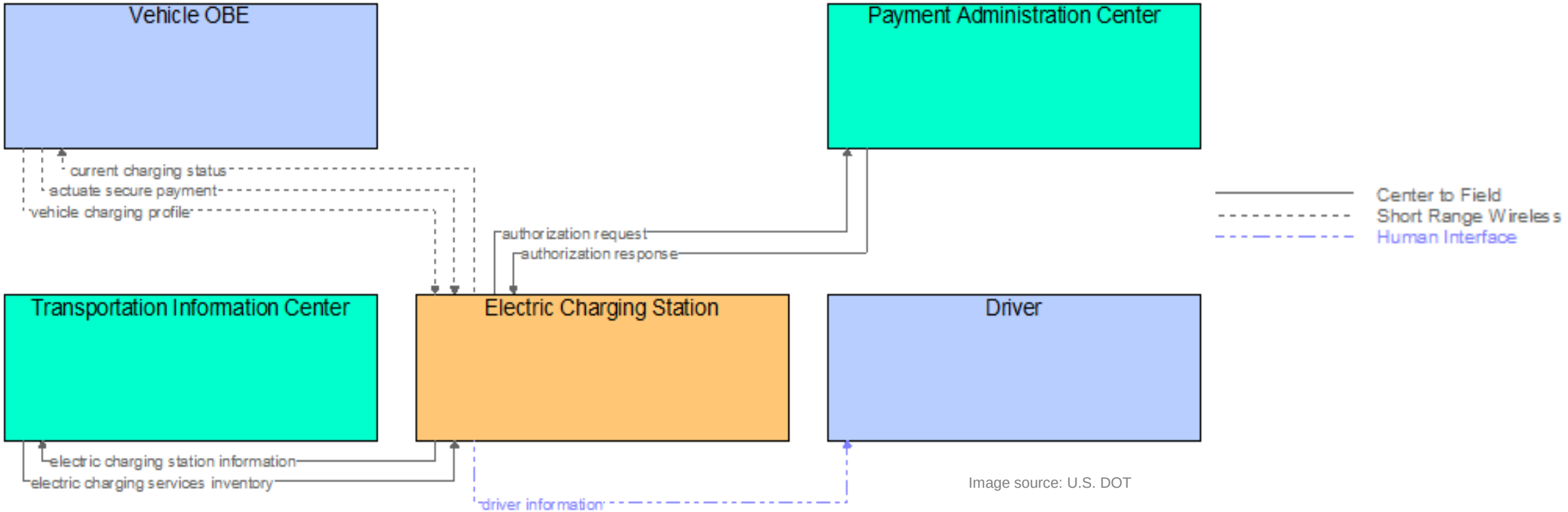


Image source: U.S. DOT

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

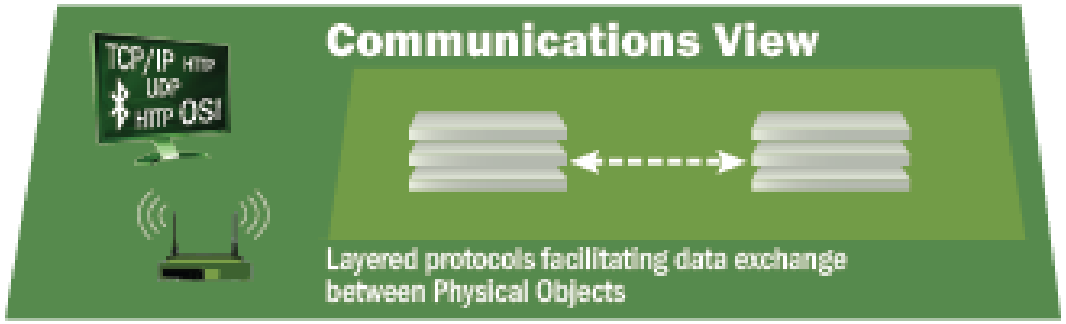


Image source: U.S. DOT

ARC-IT Communications View Example

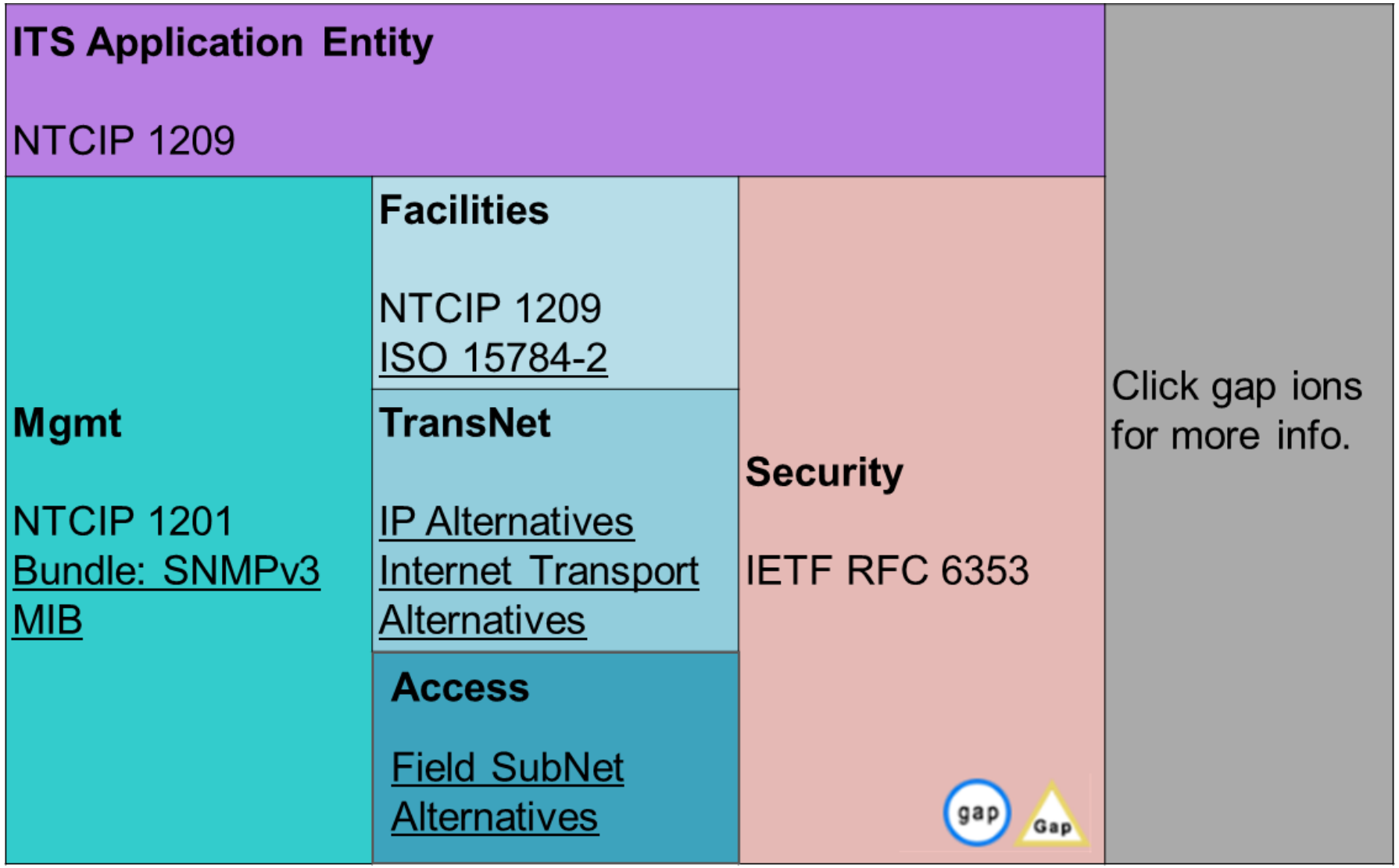


Image source: U.S. DOT

ARC-IT Enterprise View

Development | Installation | Operations | Maintenance

- Depicts:
  - Relationships between organizations
  - Roles organizations play in delivery of ITS services

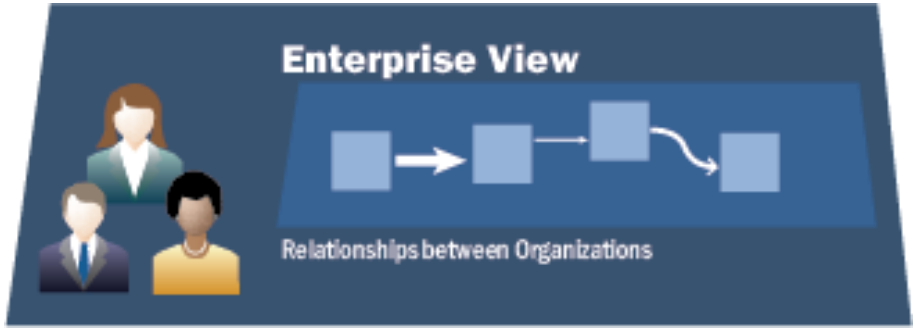


Image source: U.S. DOT

- Organized around **Enterprise Objects**
  - Interact to exchange information
  - Manage or Operate Systems (Resources)

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

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?

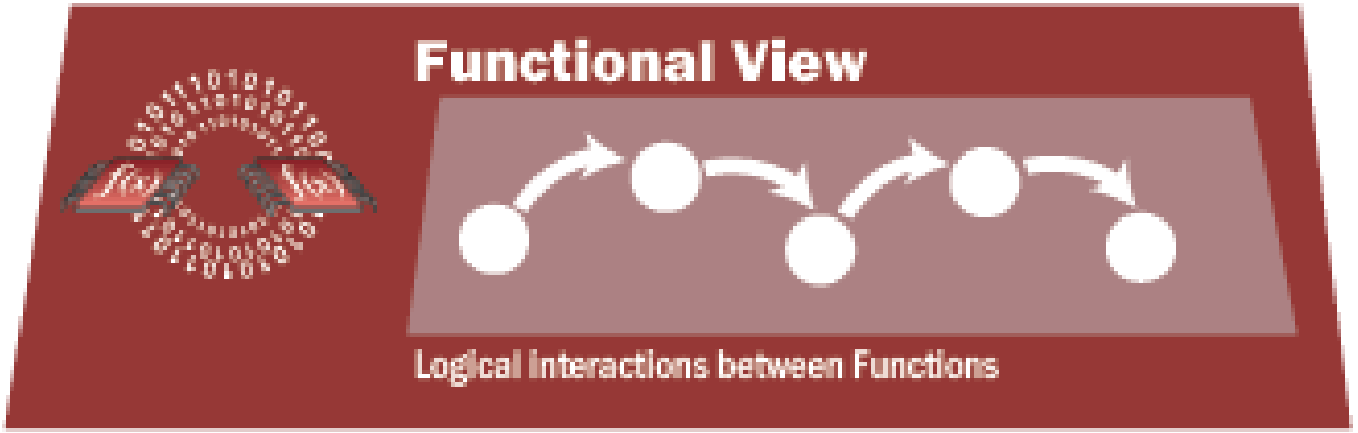


Image source: U.S. DOT

Service Packages

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

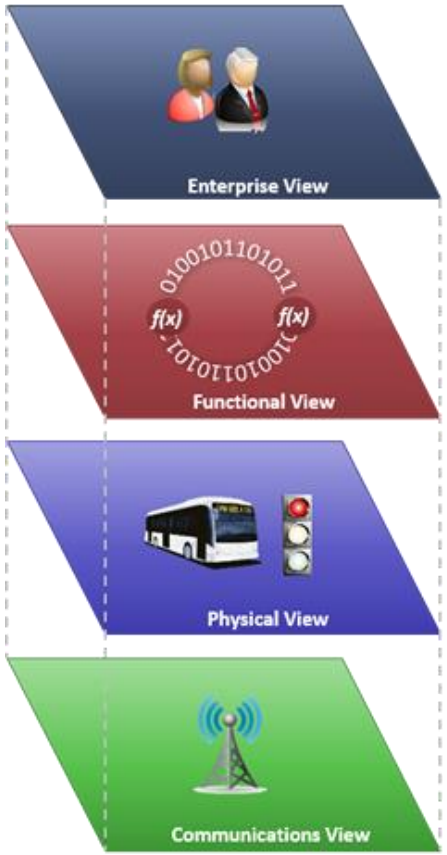
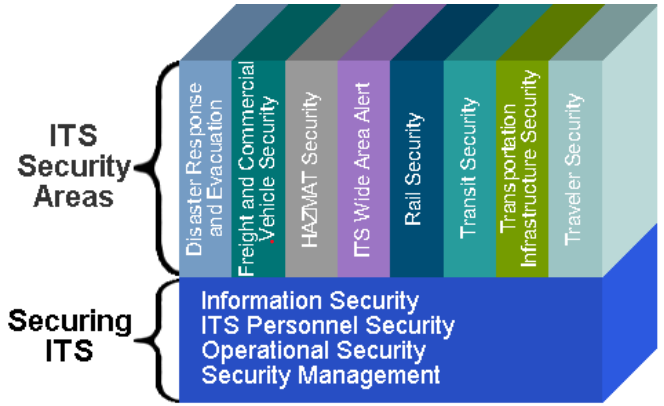


Image credit: U.S. DOT

- 156 Service Packages
- Each includes aspects of all views



Service Package Areas

Commercial Vehicle Operations

Data Management

Maintenance & Construction

Parking Management

Public Safety

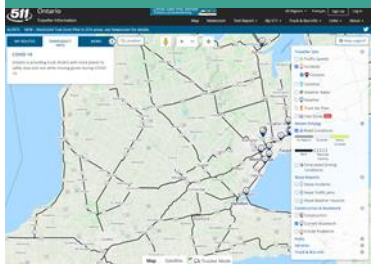
Public Transportation

Support

Sustainable Travel

Traffic Management

Traveler Information & Personal Mobility



Vehicle Safety

Weather

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
VS15	Infrastructure Enhanced Cooperative Adaptive Cruise 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)

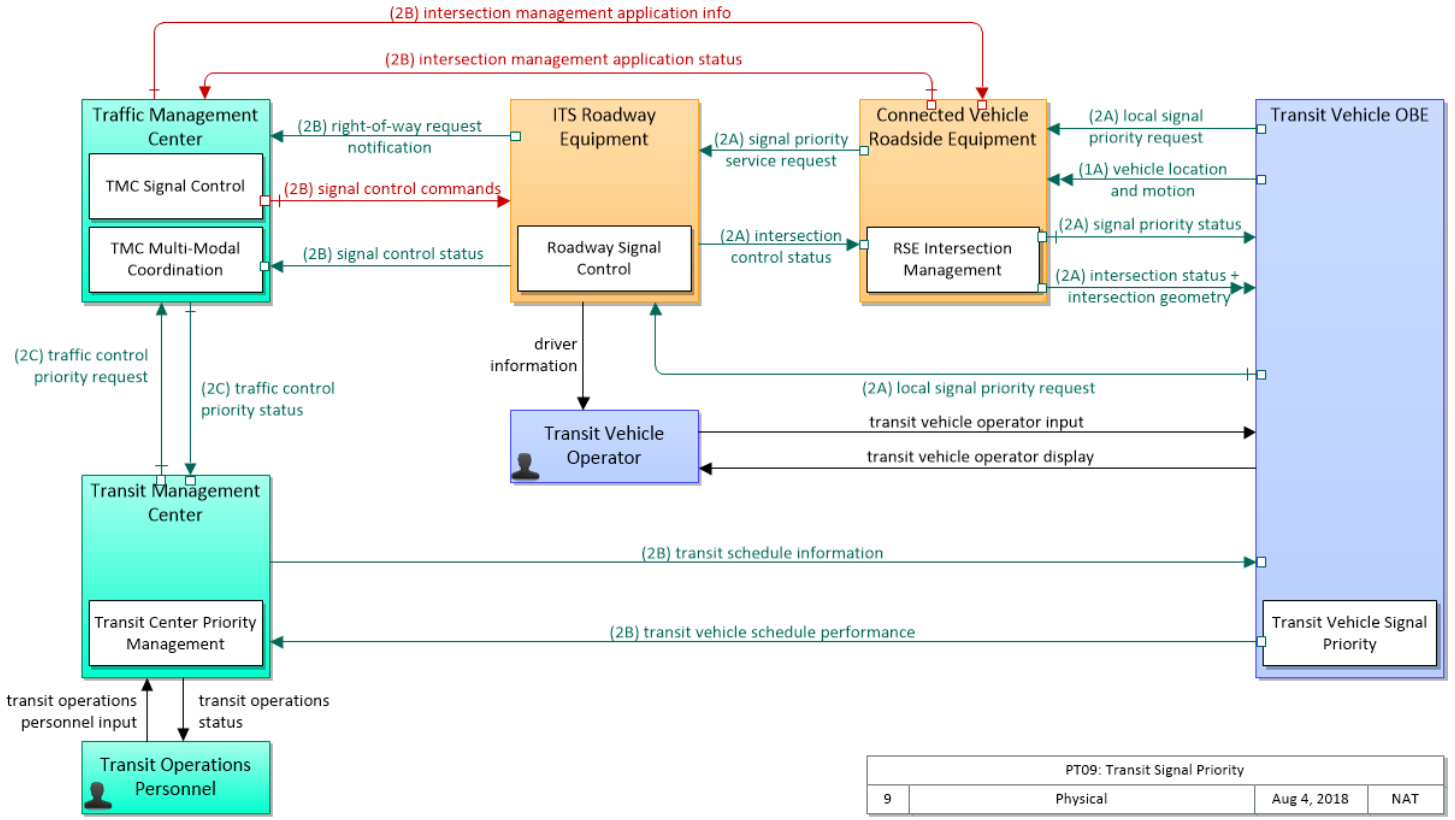


Image credit: U.S. DOT

- 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)

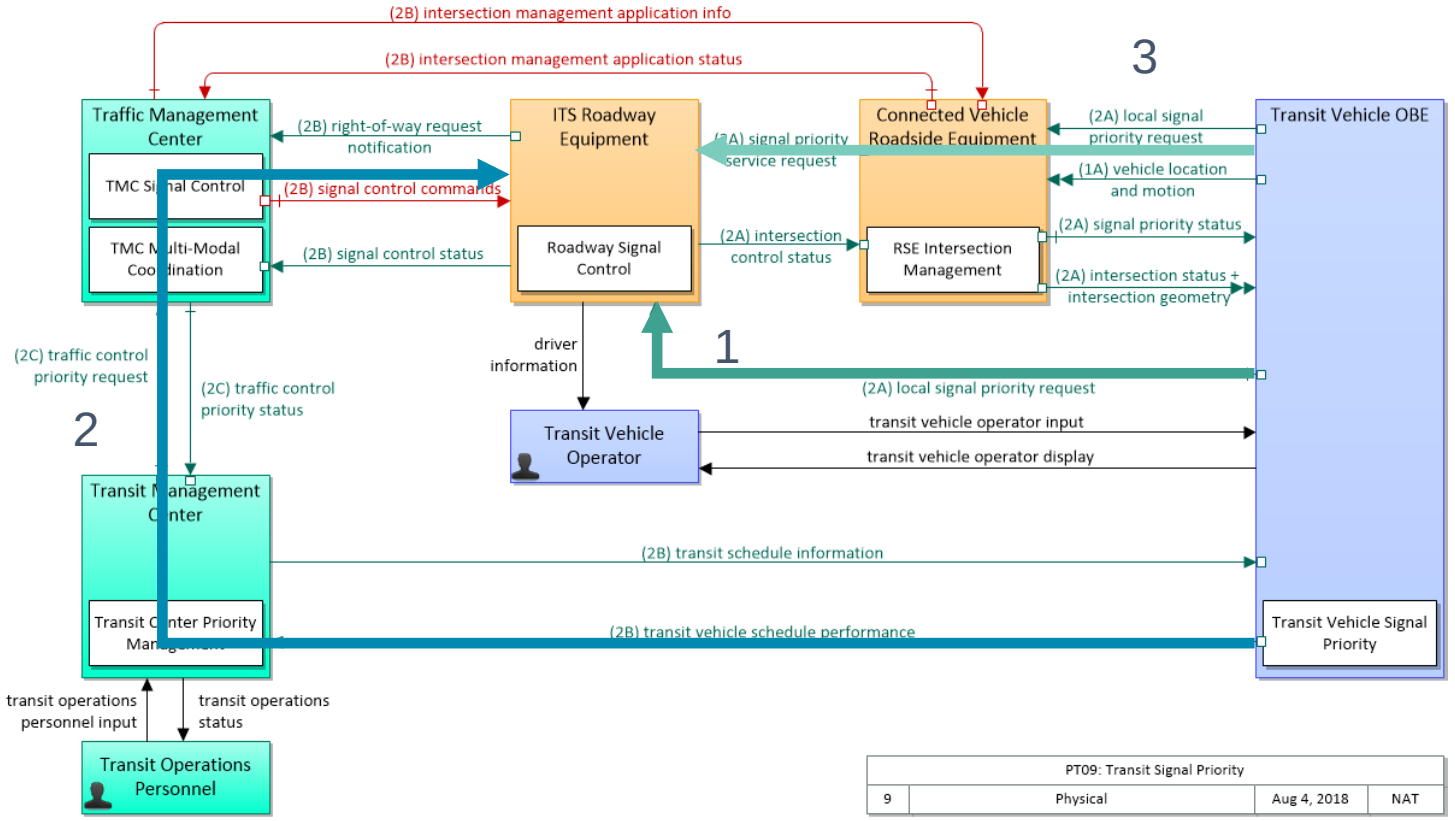
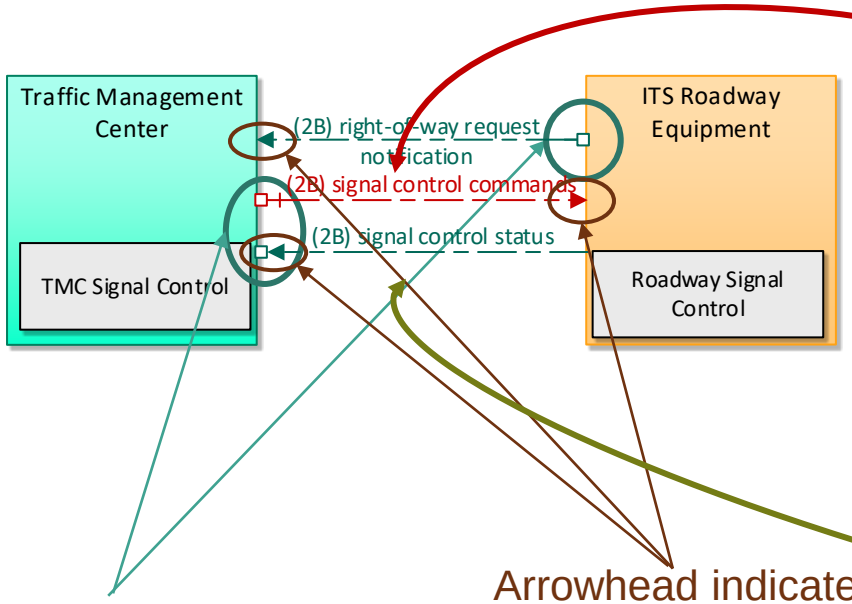


Image credit: U.S. DOT

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.

Service Package Example – Transit Signal Priority (TSP)



Red flow is obfuscated and authenticable (e.g., encrypted and signed)

Box indicates initiator of information exchange

Arrowhead indicates recipient of data

Green flow is authenticable (e.g., digitally signed)

Physical Legend

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

Adapted from: U.S. DOT

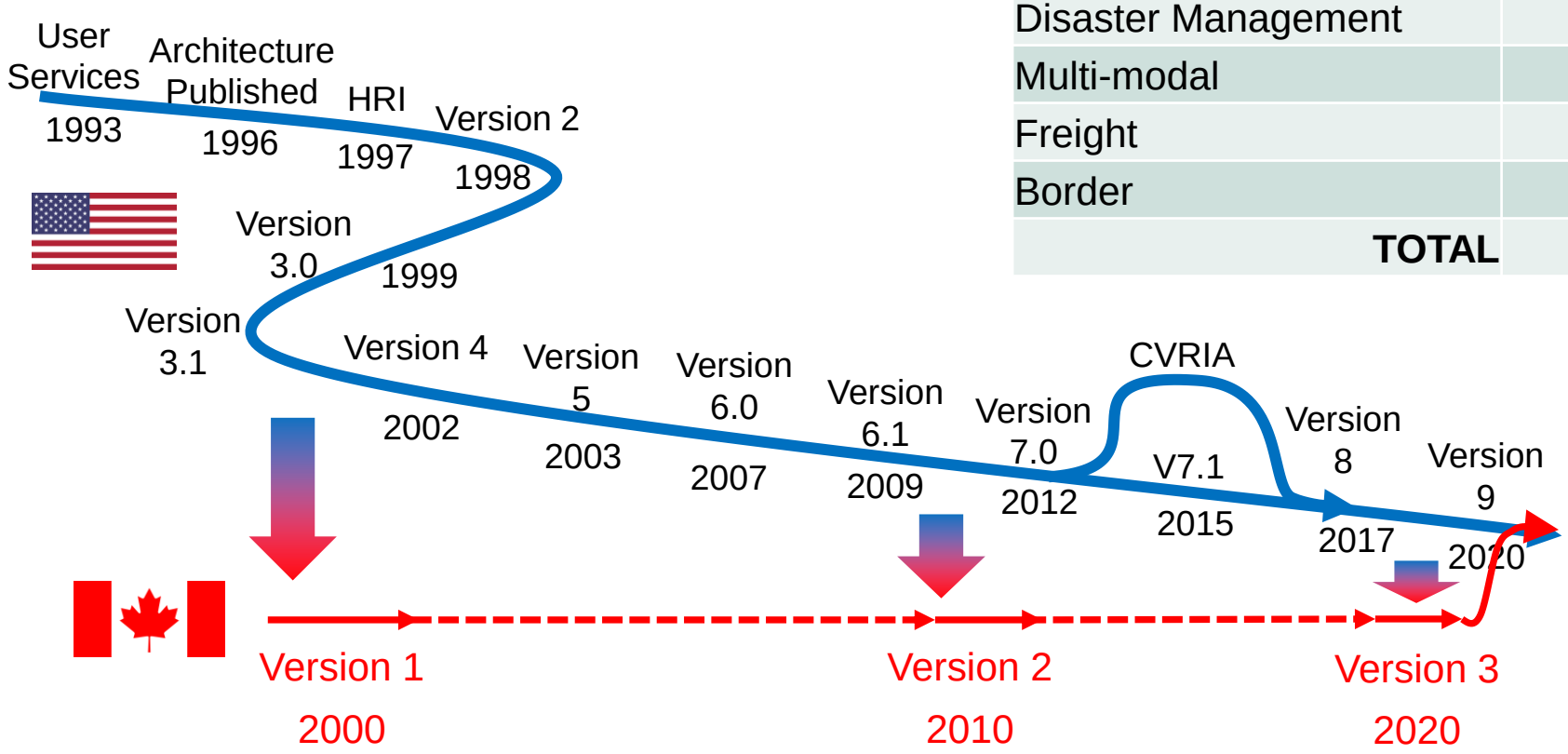
ARC-IT Summary

- 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

The Evolution of Canadian Elements

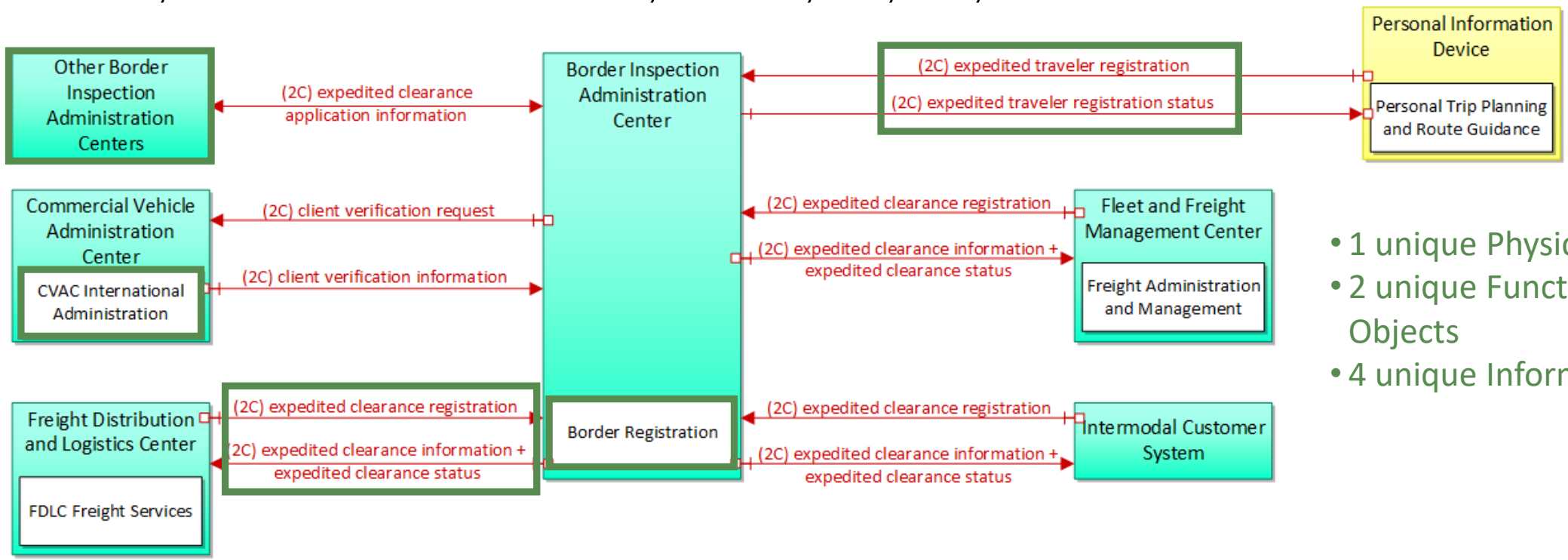
Service Area Focus	Version 1	Version 2	Version 3
Non-Vehicular	2	2	0
Maintenance	2	0	0
Weather	5	2	1
Automated Enforcement	2	1	1
Disaster Management	2	0	0
Multi-modal	1	1	0
Freight	2	1	0
Border	0	3	2
TOTAL	**16**	**10**	**4**



- 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.

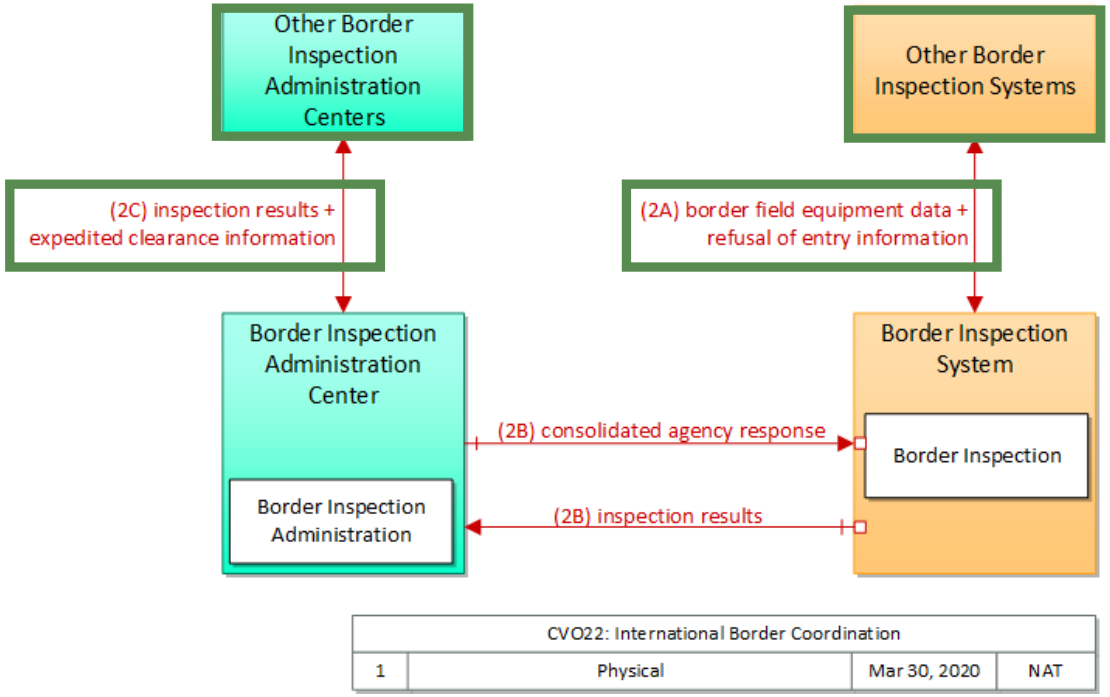


- 1 unique Physical Object
- 2 unique Functional Objects
- 4 unique Information Flows

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

CVO22: International Border Coordination

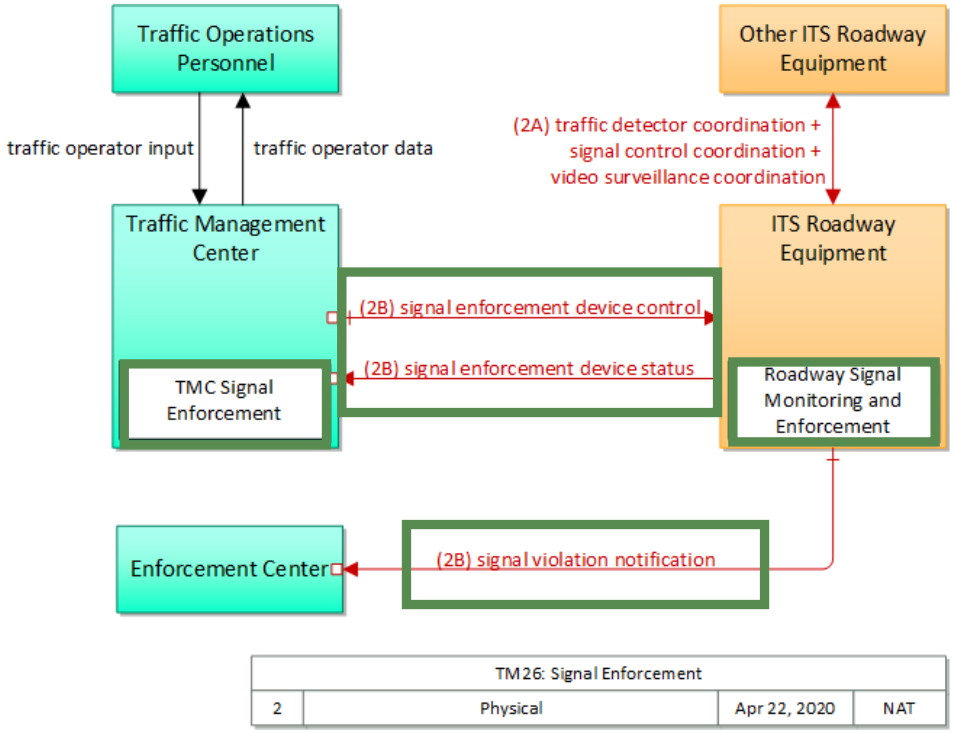
This service package covers coordination and sharing of information between agencies to support expedited clearance, customs pre-processing, and border crossing inspections.



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

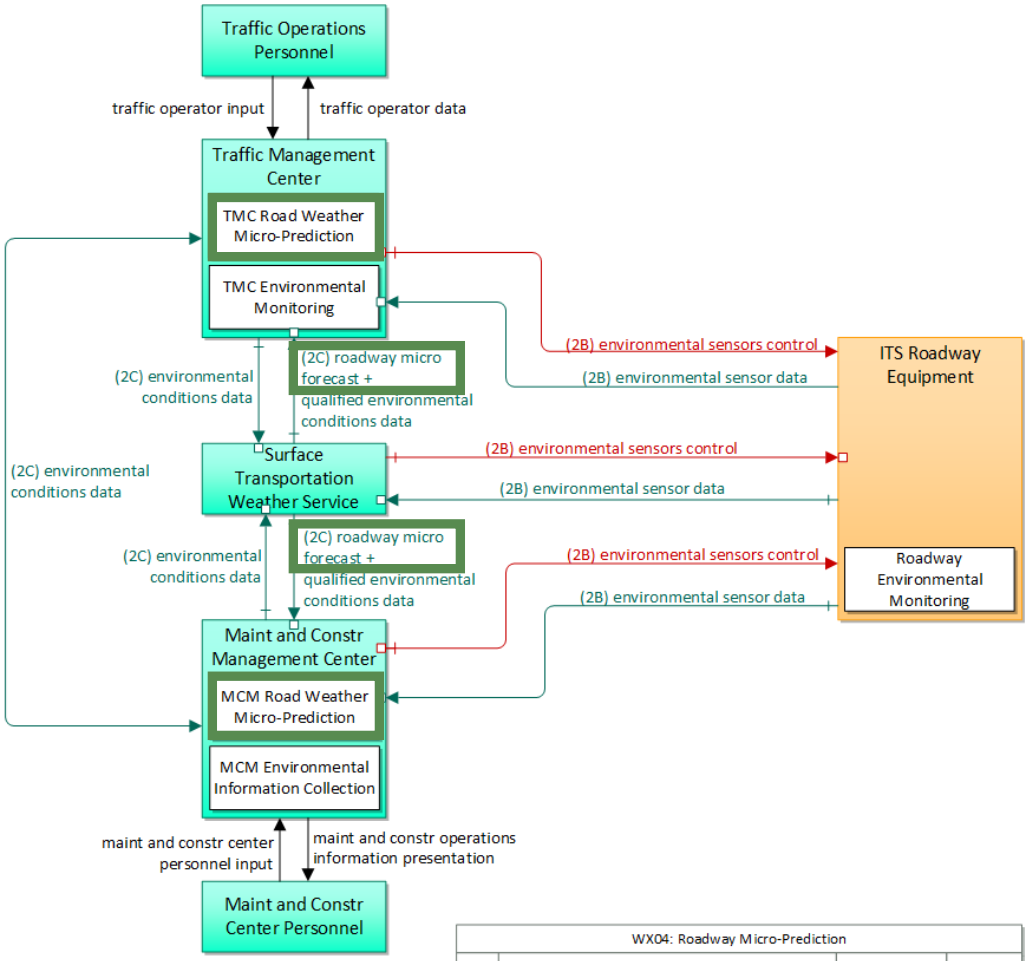
TM26: Signal Enforcement

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

WX04: Roadway Micro-Prediction



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

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.

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

Canadian Elements Summary

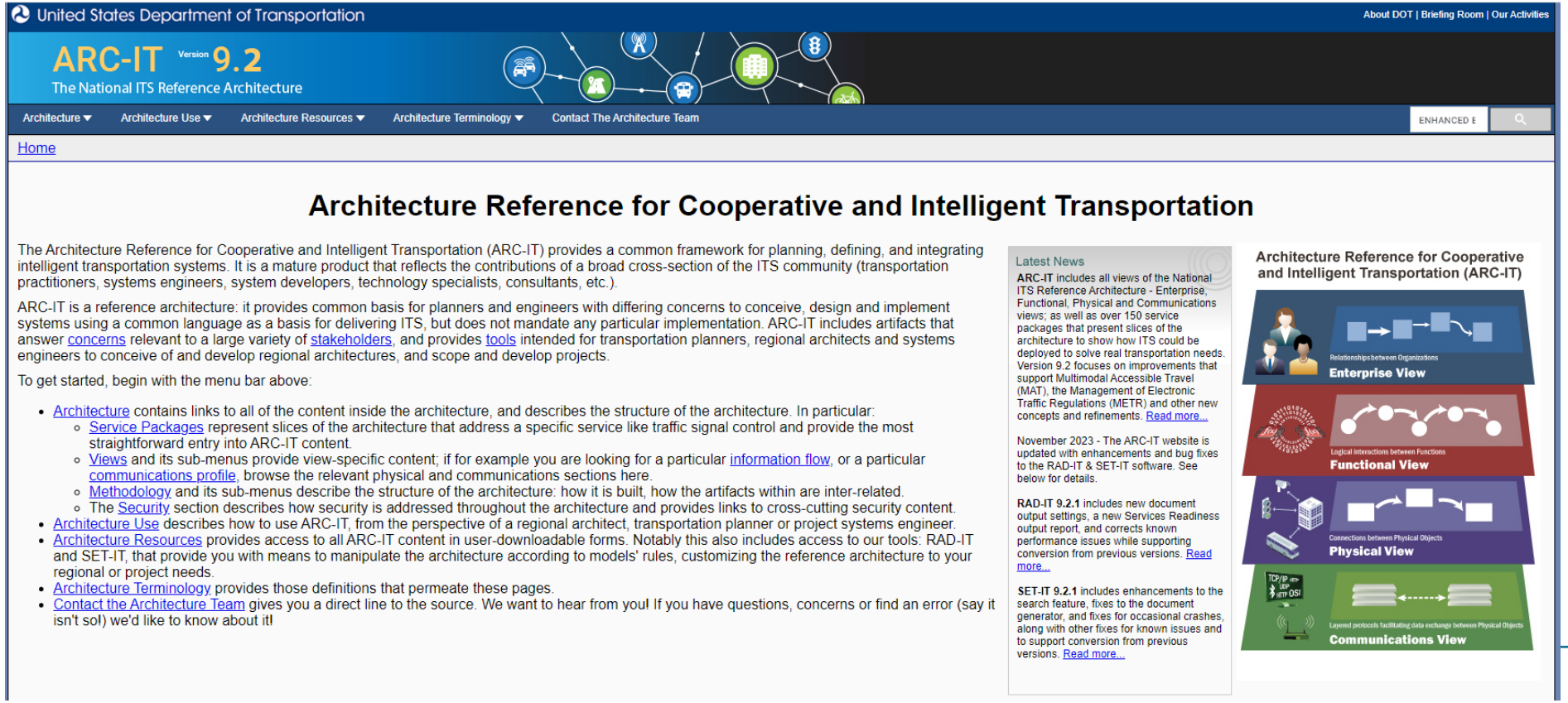
- The ‘degree of uniqueness’ decreased with each Canadian version
- Version 3 included 4 Unique Service Packages
- Developed all required elements for those unique Service Packages
  - For all Views
  - To USDOT standards
  - Coordinated with U.S. ARC-IT Team
- ARC-IT Version 9 integrates the 4 as International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

Quick Break

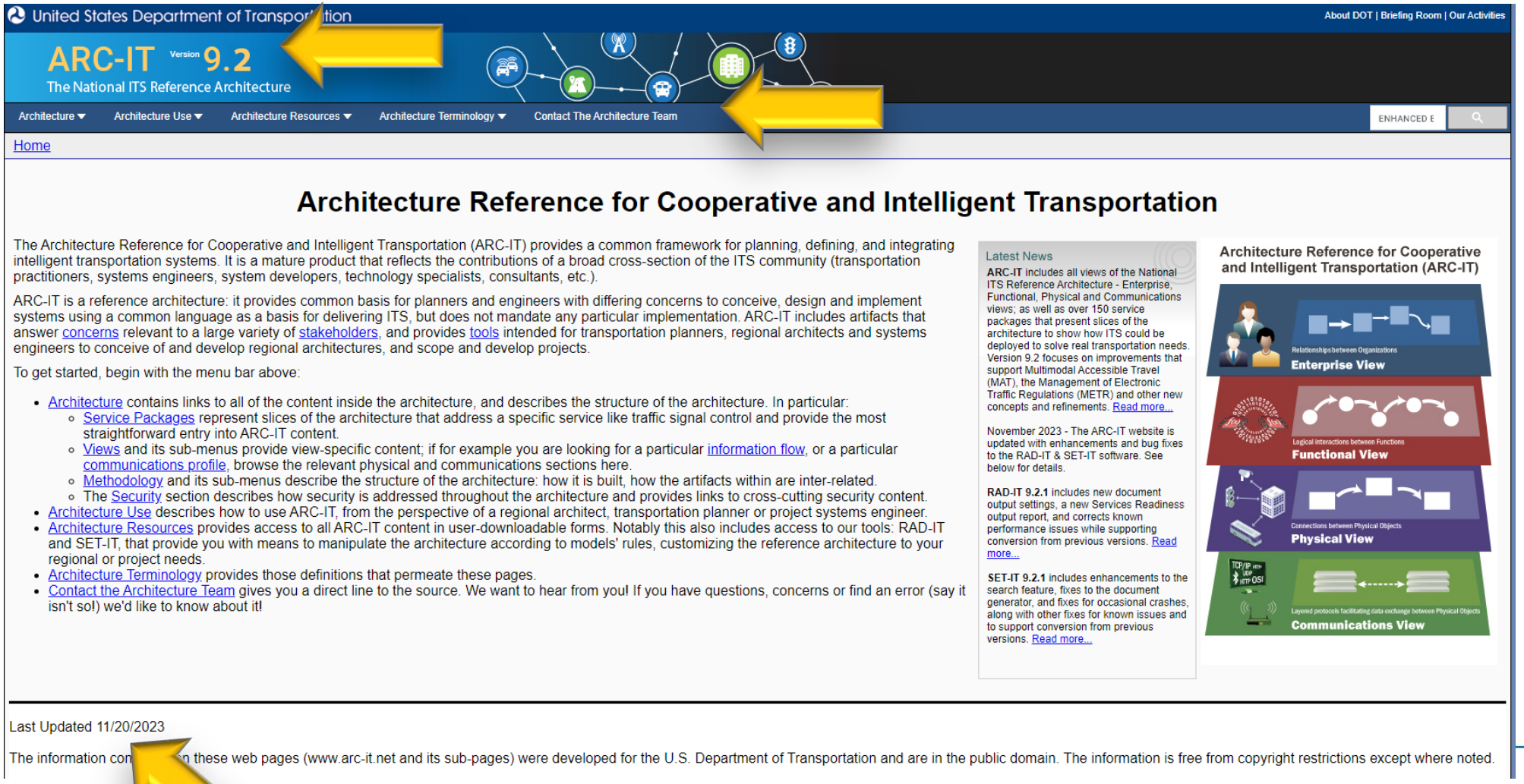
ARC-IT Website Tour

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



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



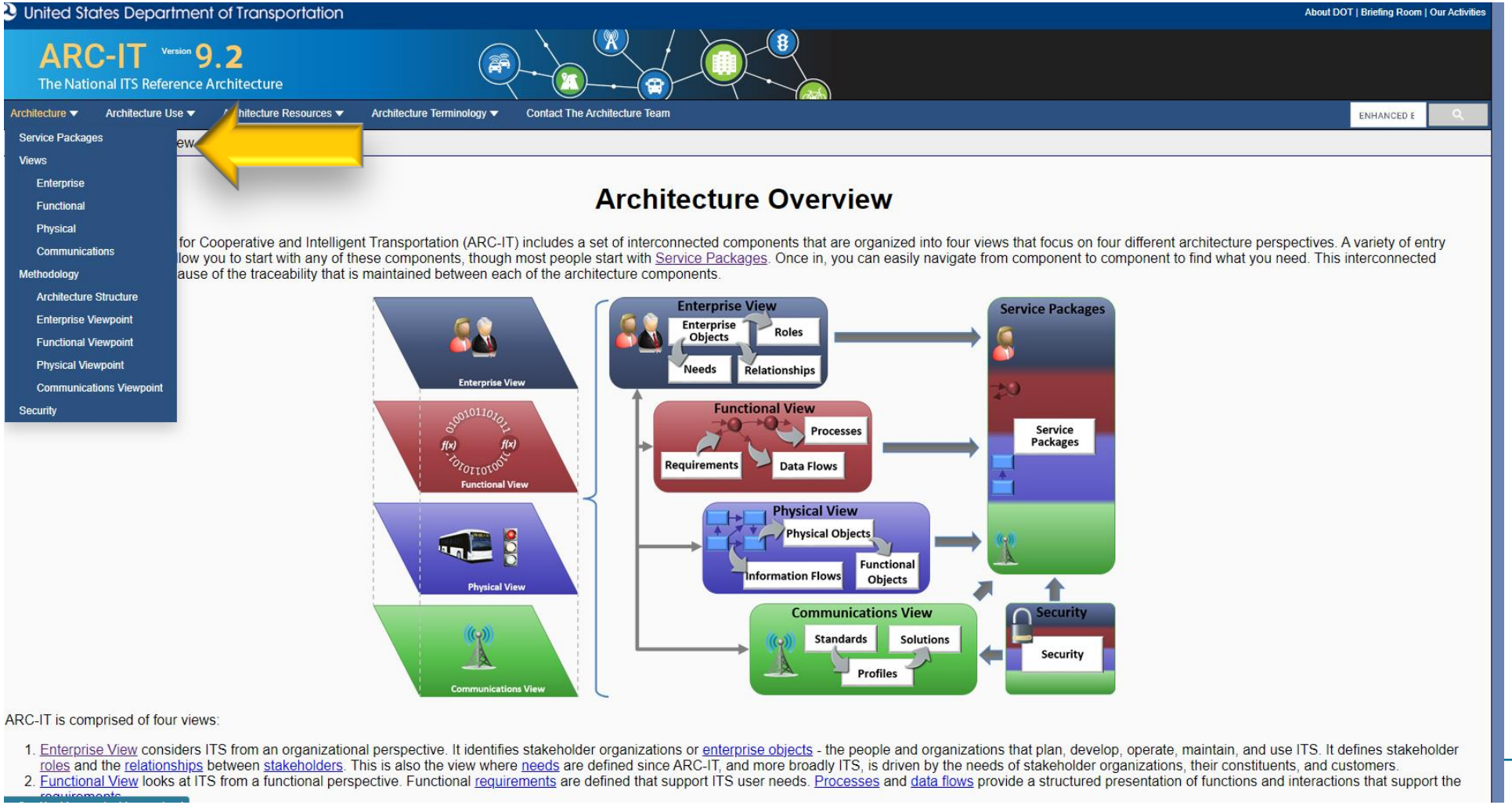
ARC-IT Website: Home Page

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



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.

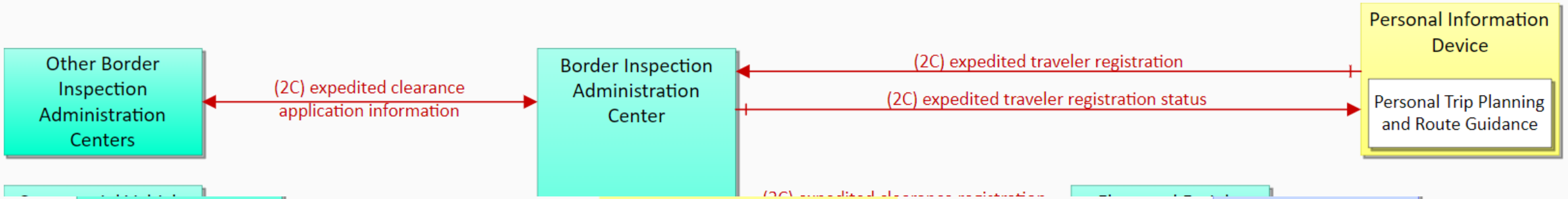
Origin: Canada

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

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

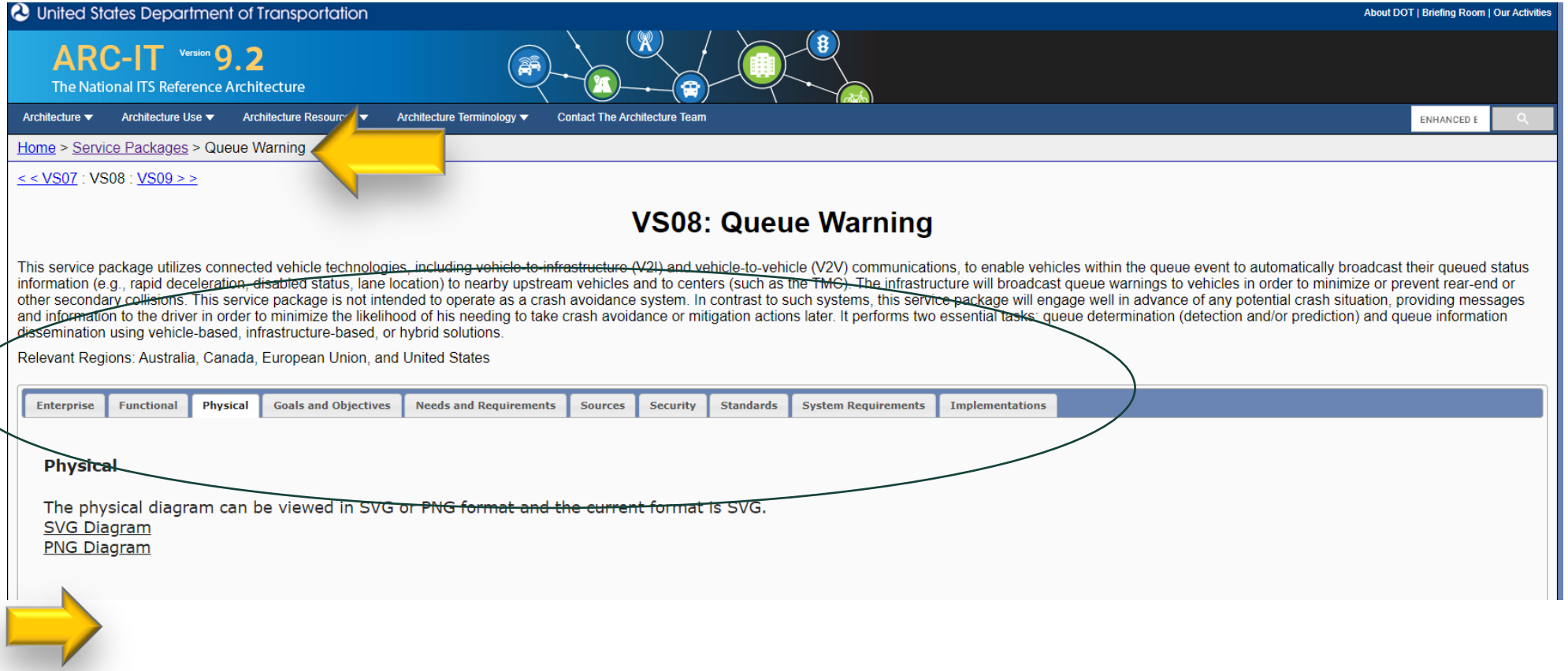
Physical

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

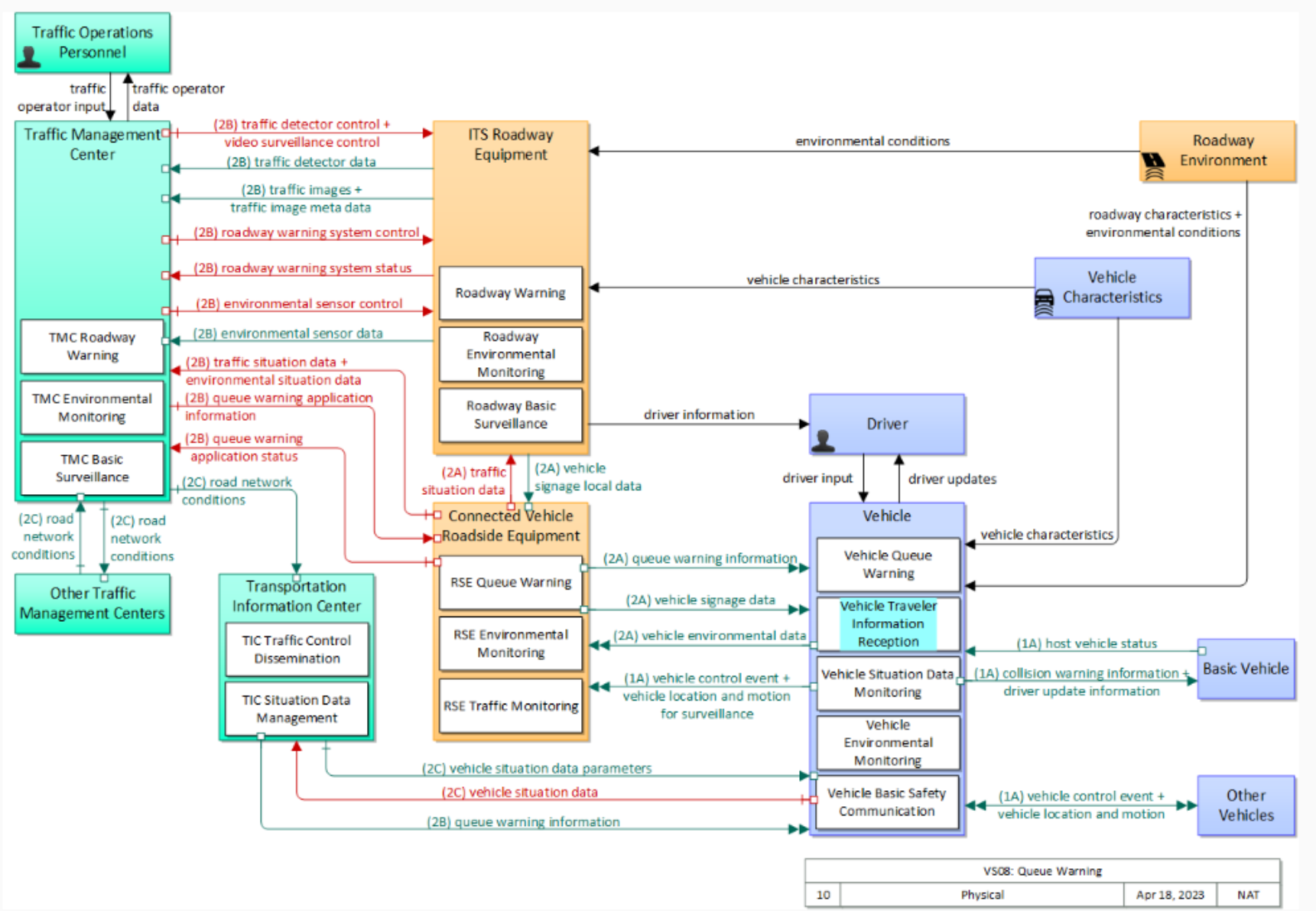


	PS01	Emergency Call-Taking and Dispatch
	PS02	Emergency Response
	PS03	Emergency Vehicle Preemption **(Implementations)**
	PS04	Mayday Notification
	PS05	Vehicle Emergency Response

ARC-IT Website- Service Package Details



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.

Vehicle On-Board Equipment

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.

Center | Field | Vehicle | Personal | Support | ITS

Driver

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.

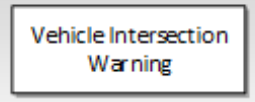
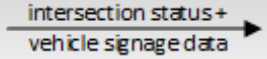
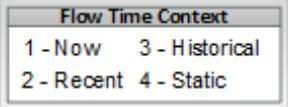
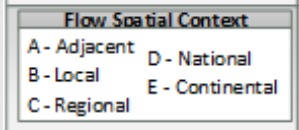
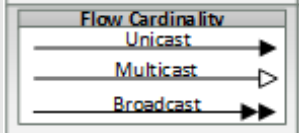
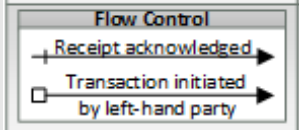
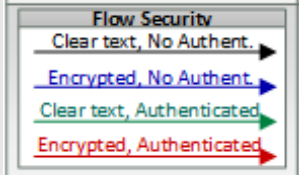
Roadway Environment

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.

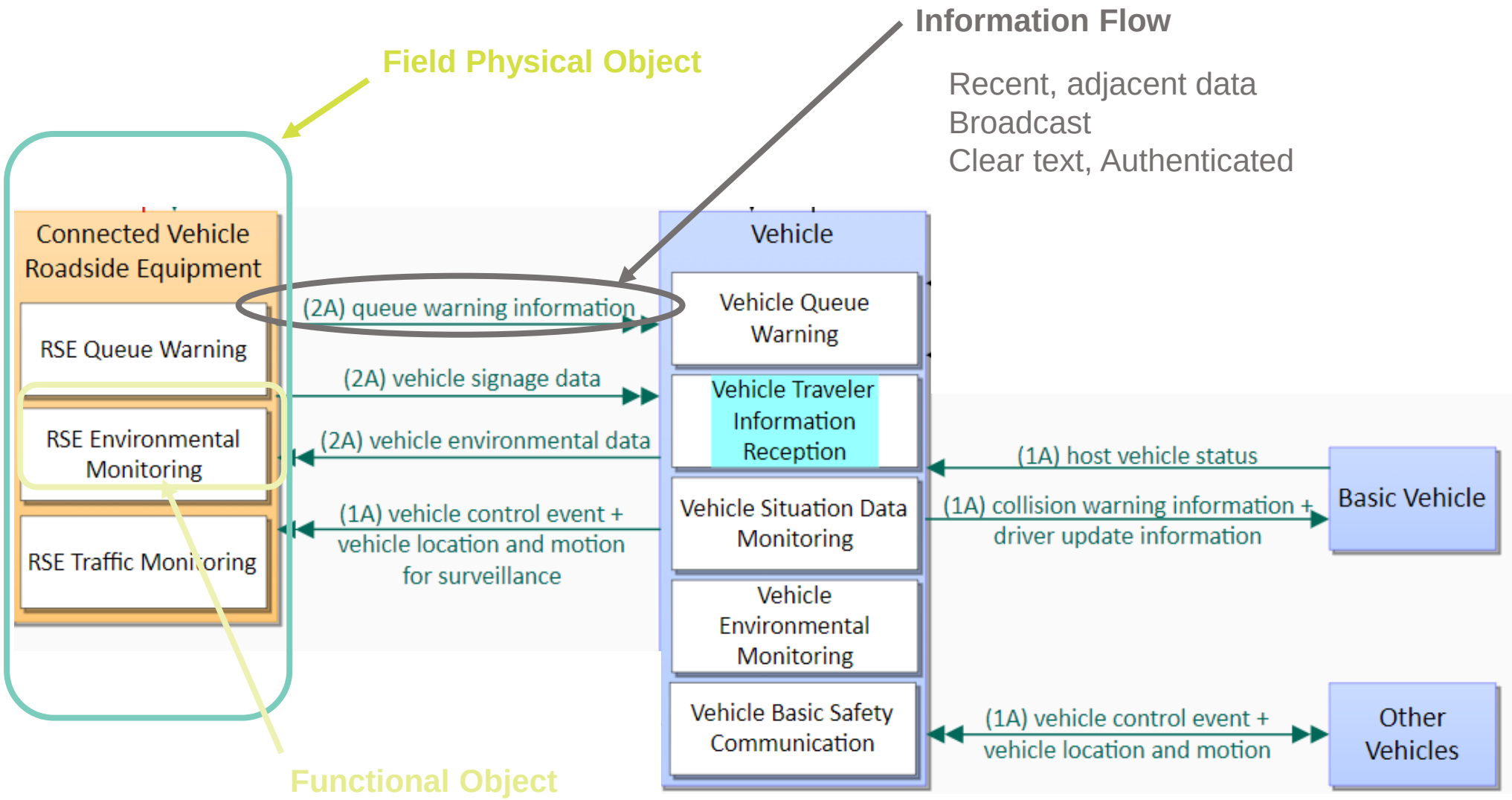
Communications

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.

Service Packages Legend – Information Flows

	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.
	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.
	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.
	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".
	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.
	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. *(Note: the initiator boxes are only available in PNG format, the SVG drawings do not show the initiator boxes.)*
	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.

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.

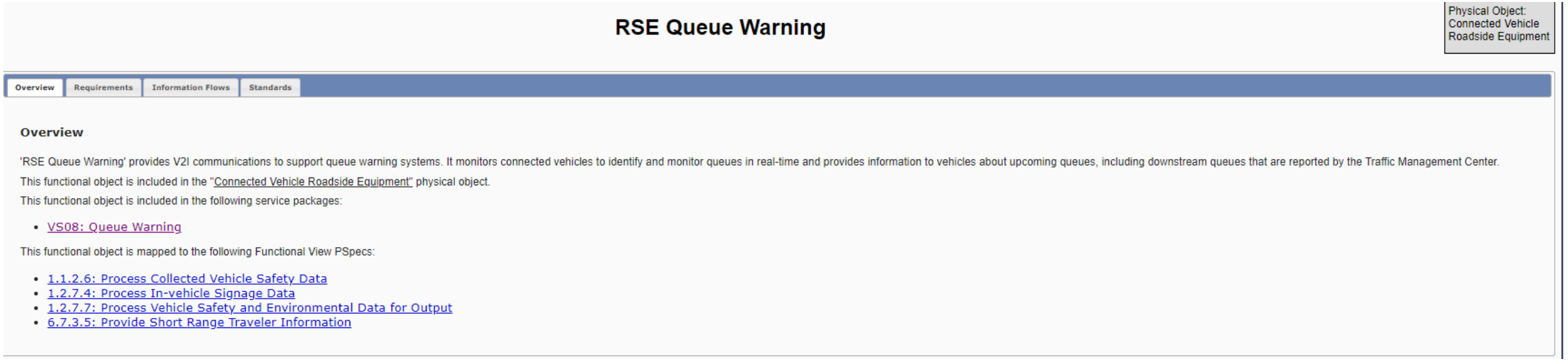
Includes Functional Objects:

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:

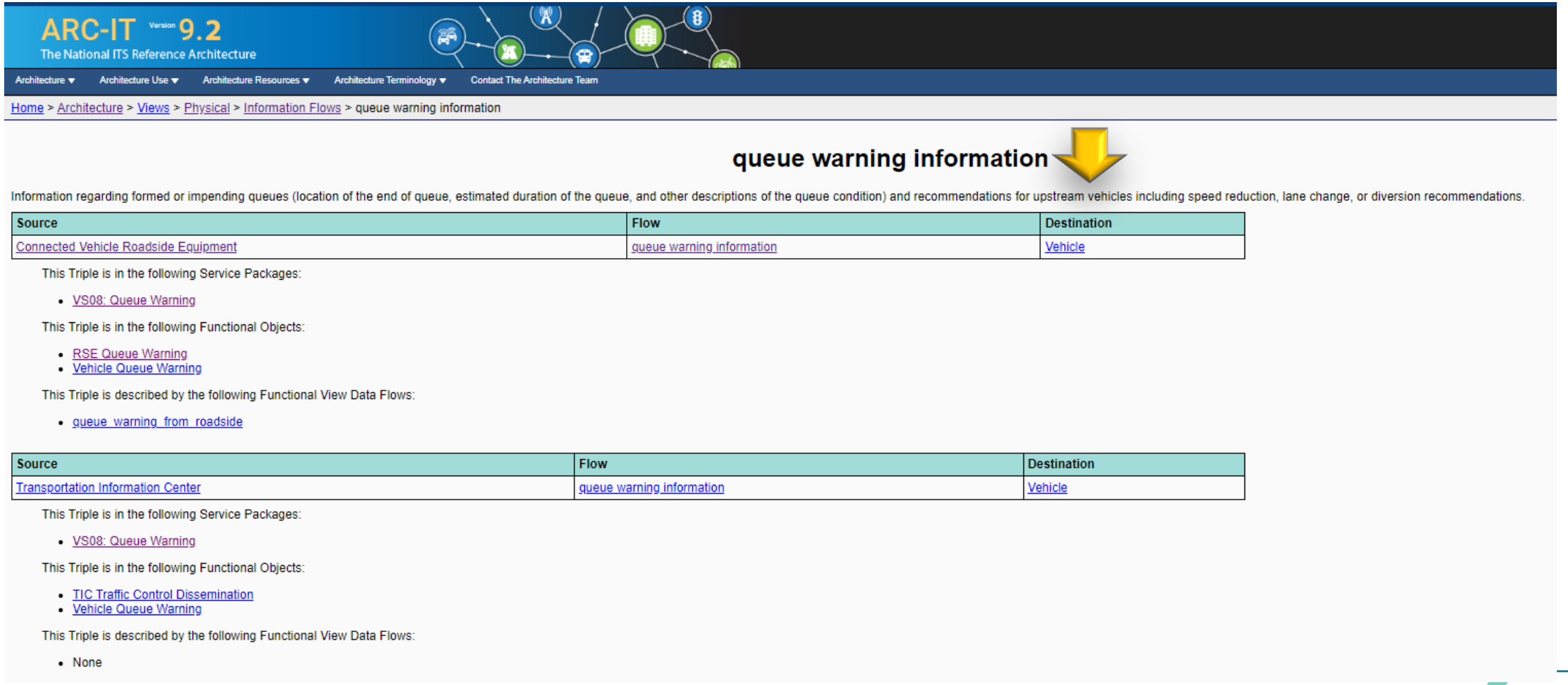
Physical Object	Class	Description
Connected Vehicle Roadside Equipment	Field	'Connected Vehicle Roadside Equipment' (CV RSE) represents the Connected Vehicle roadside devices that are used to send messages to, and receive messages from, nearby vehicles using Dedicated Short Range Communications (DSRC) 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.

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

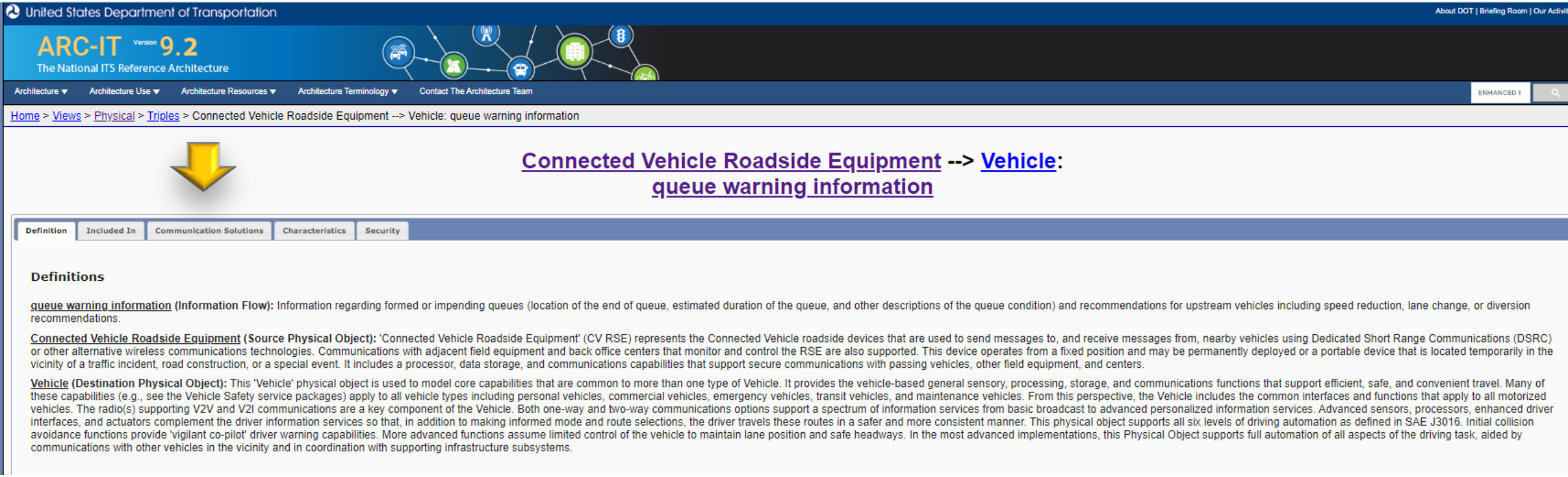
Includes Information Flows:

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.

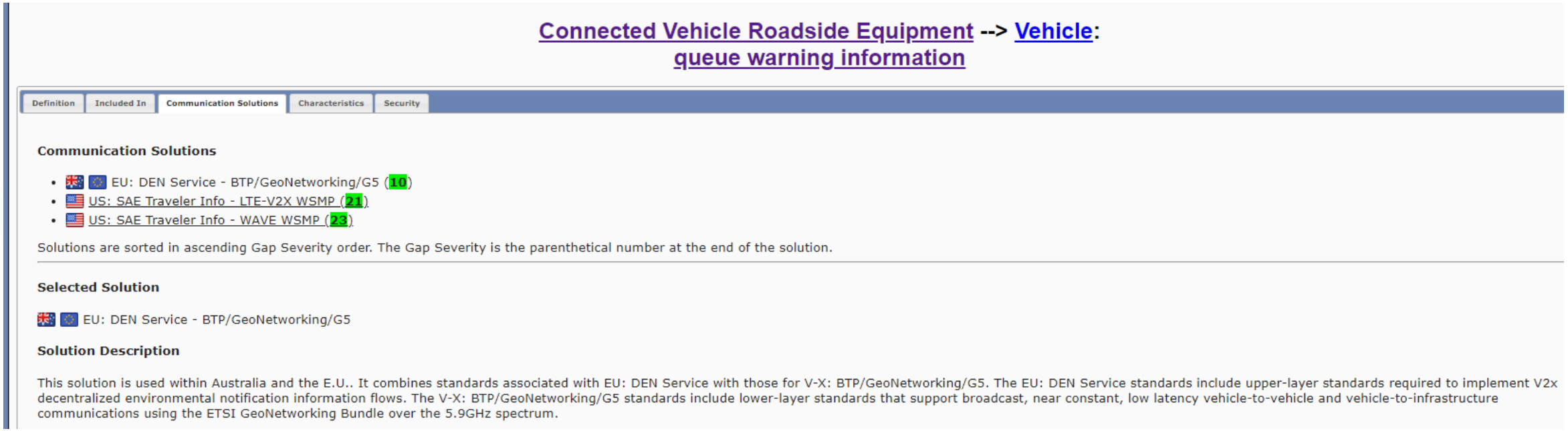
Queue Warning Example: Information Flow



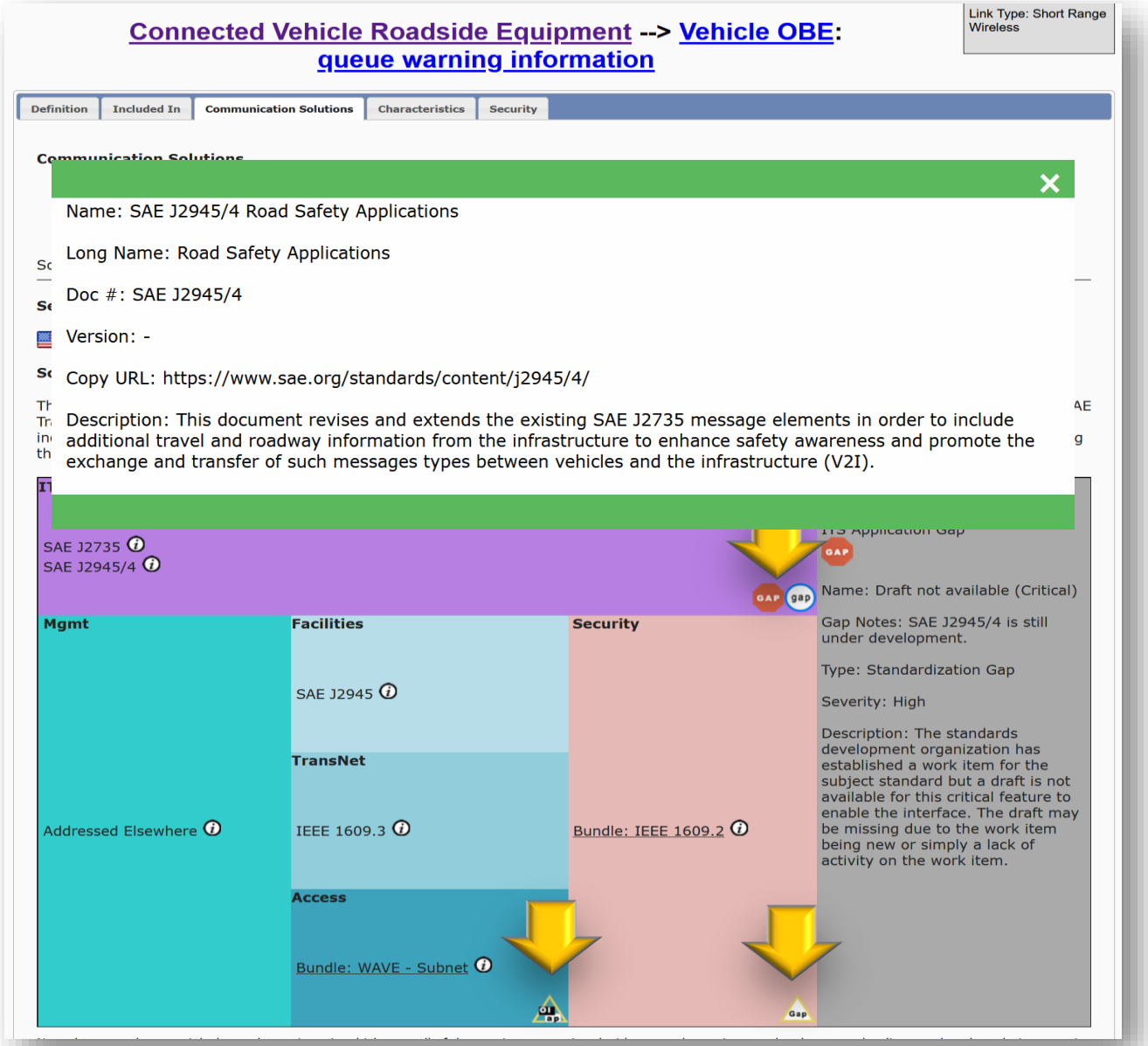
Queue Warning Example: Information Flow Triple



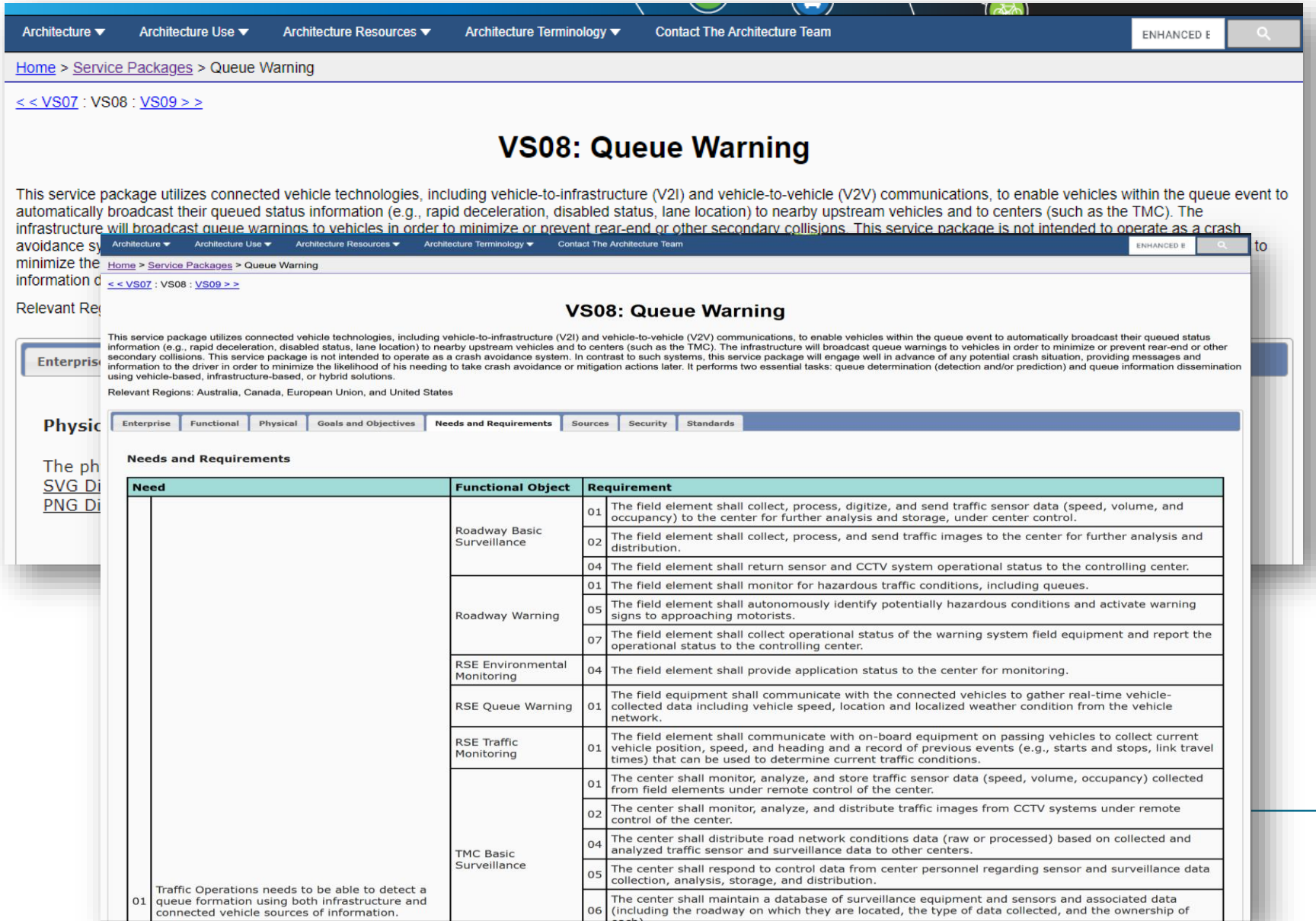
Communication Solutions View for Triple



Communication Solution for Triple



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 sy to minimize the information d

Relevant Re

Enterpris

Physic

The ph
SVG Di
PNG Di

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.

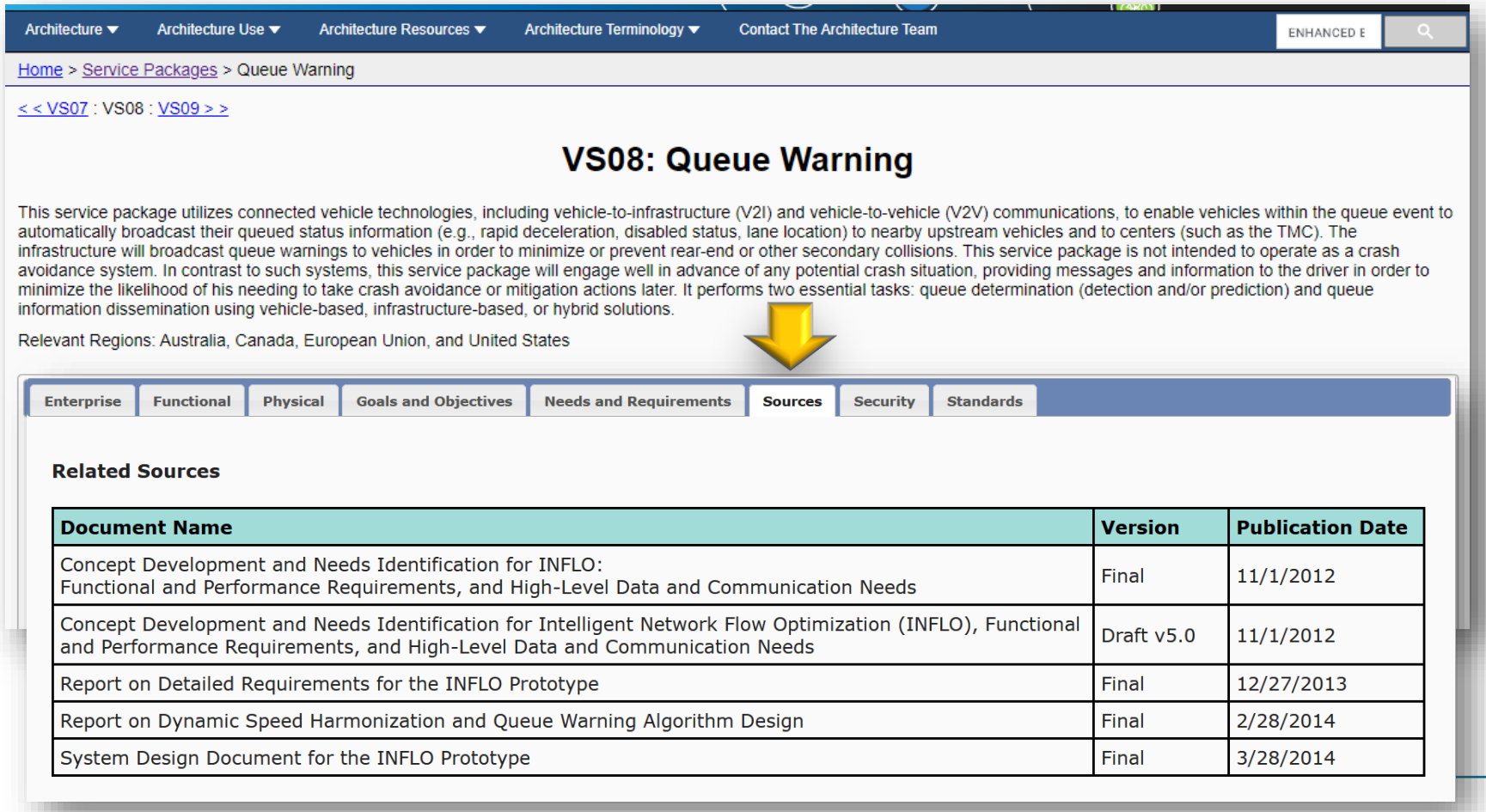
Relevant Regions: Australia, Canada, European Union, and United States

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

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



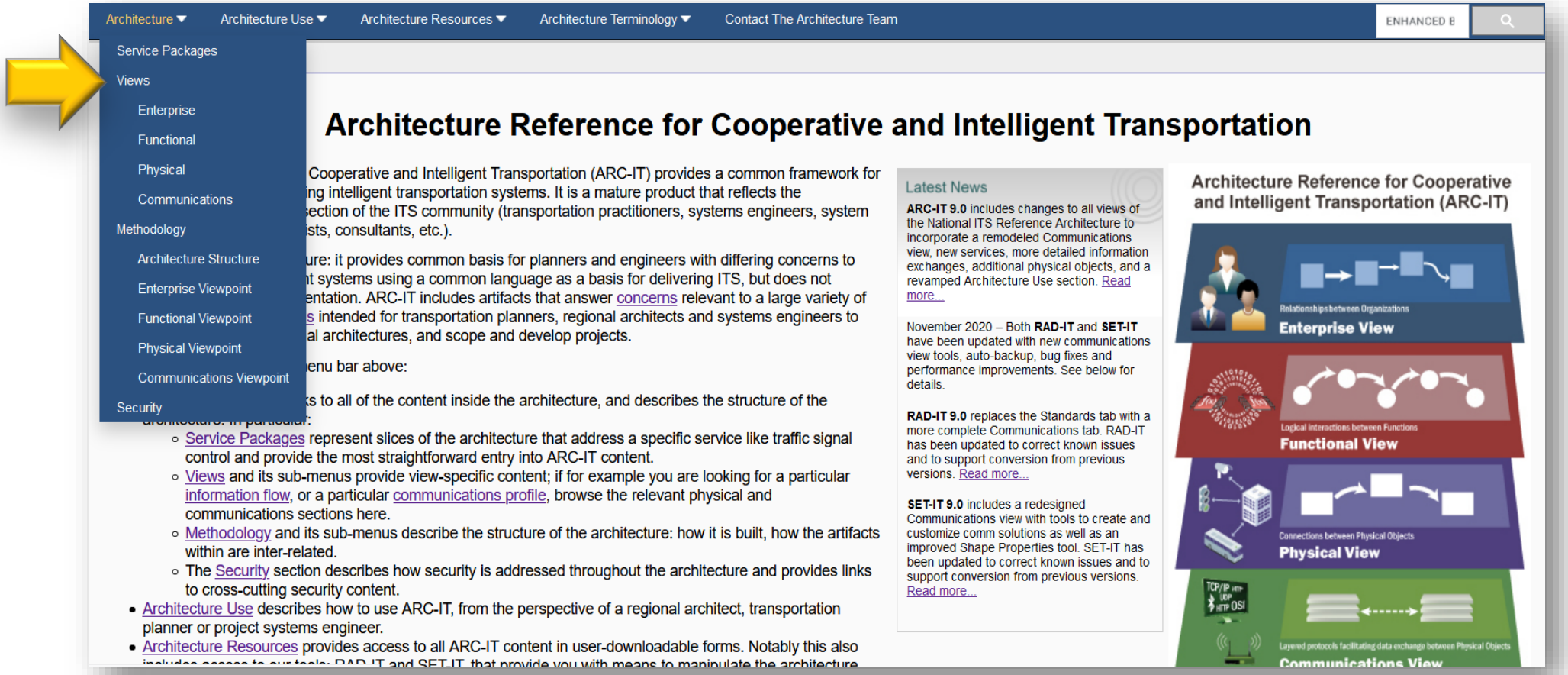
Queue Warning Example – Security

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

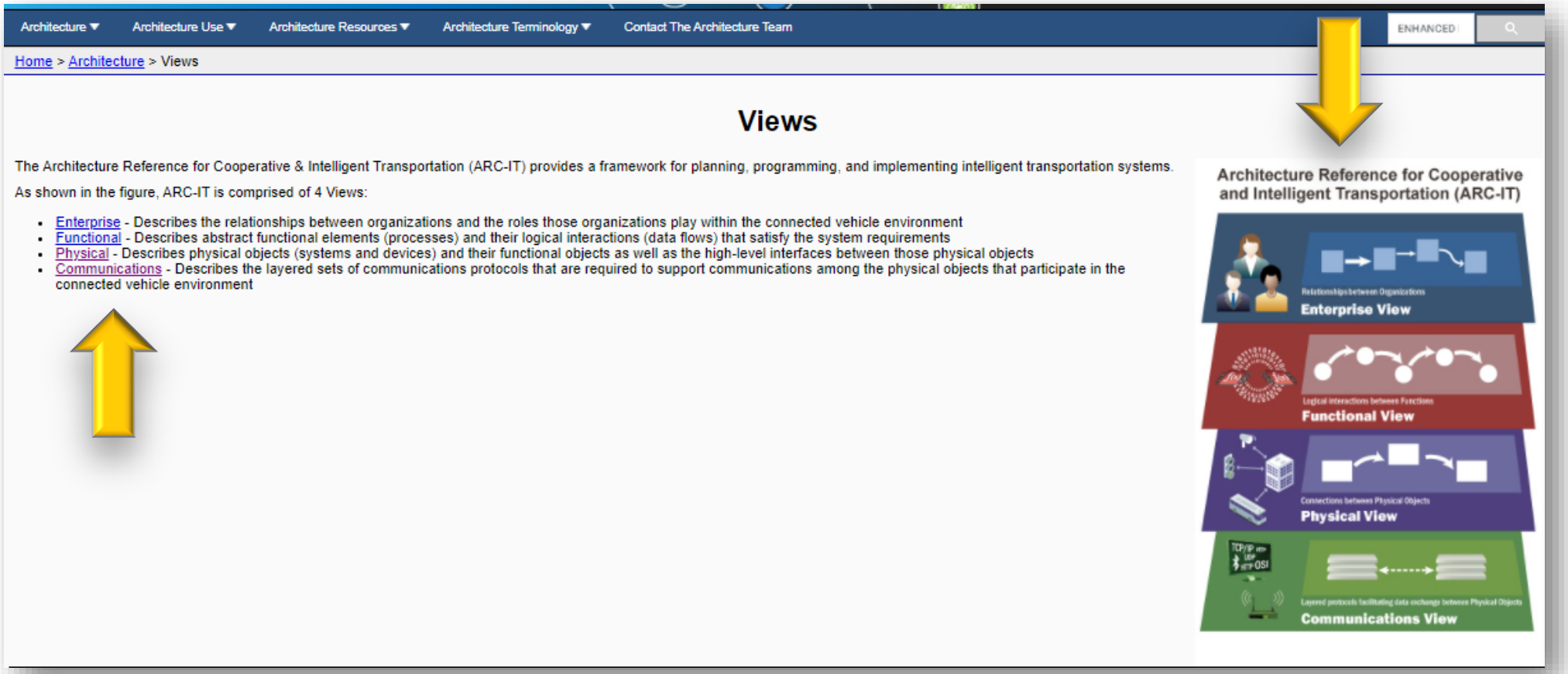
Information Flow Security					
Source	**Destination**	**Information Flow**	**Confidentiality**	**Integrity**	**Availability**
			Basis	**Basis**	**Basis**
Basic Vehicle	Vehicle	host vehicle status	Low	Moderate	High
			Unlikely that this includes any information that could be used against the originator.	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.	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	traffic situation data	Moderate	Moderate	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.	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	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	environmental situation data	Low	Moderate	Moderate
			Little to no impact if this data is observed	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	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	queue warning application status	Moderate	Moderate	Low
			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.	If this is compromised, it could send unnecessary maintenance workers, or cause the appearance of excessive traffic violations, leading to further unnecessary investigation.	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	traffic situation data	Moderate	Moderate	Low
			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.	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 wih NYC.	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	queue warning information	Not Applicable	Moderate	Low
			Broadcast and intended for public use.	Performance data that is compromised may result in incorrect actions taken by drivers, impacting their mobility and overall mobility throughout the transportation network.	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 signficant time impacts would this rise to MODERATE.
Connected Vehicle Roadside Equipment	Vehicle	vehicle signage data	Low	Moderate	Moderate
			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.	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.	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

ARC-IT Website: Views



ARC-IT Website: Views Page



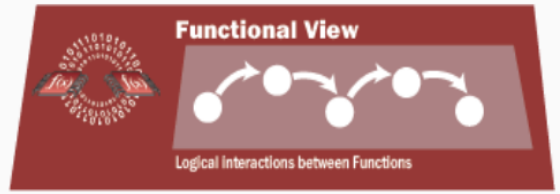
ARC-IT Website: Enterprise View Page

ARC-IT Website: Functional View Page

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

Home > Architecture > Views > Functional

Functional



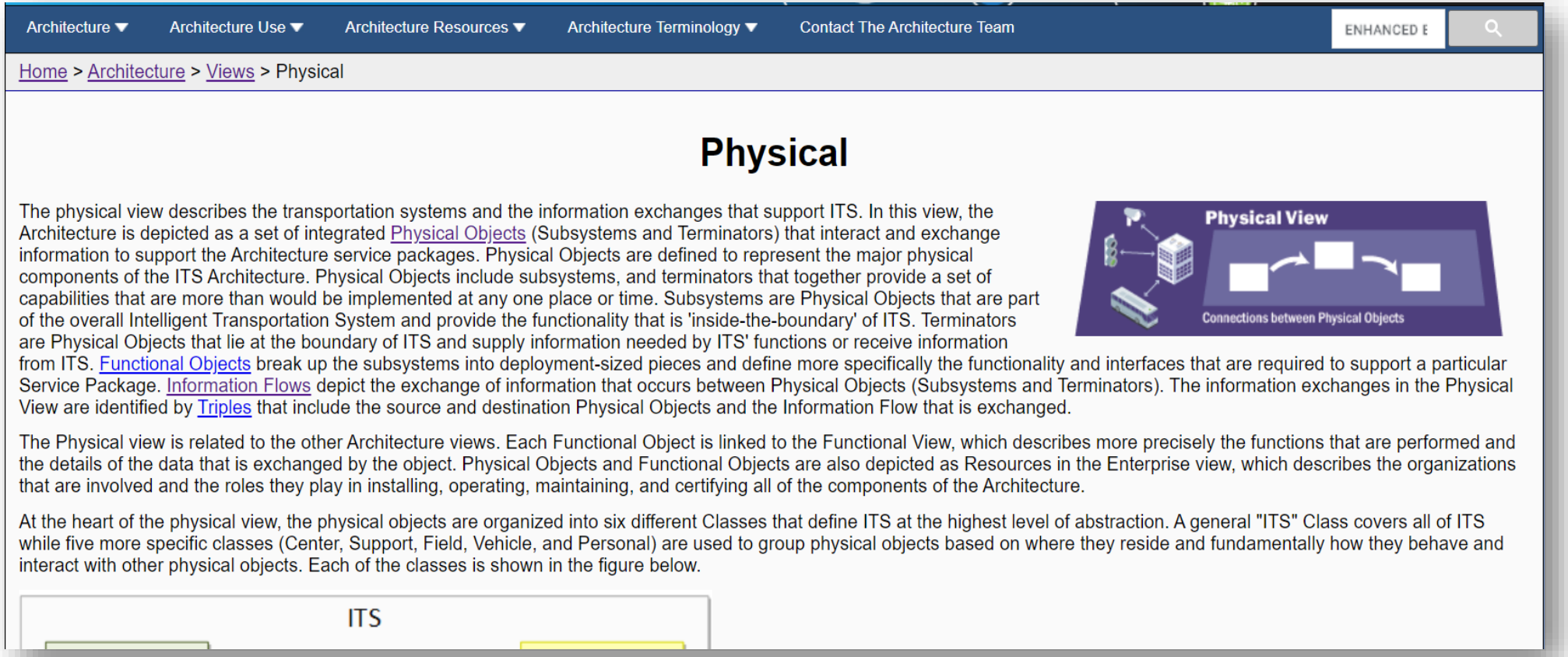
The Functional View addresses the analysis of abstract functional elements and their logical interactions. Here ARC-IT is depicted as a set of Processes organized hierarchically. These Processes (activities and functions) trace to a set of Requirements derived from source documents. The data flows that 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.

ARC-IT Website: Physical View Page



ARC-IT Website Communications View Page

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

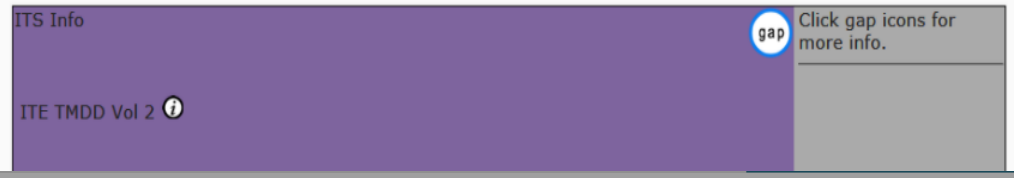
Home > Architecture > Views > Communications

Communications

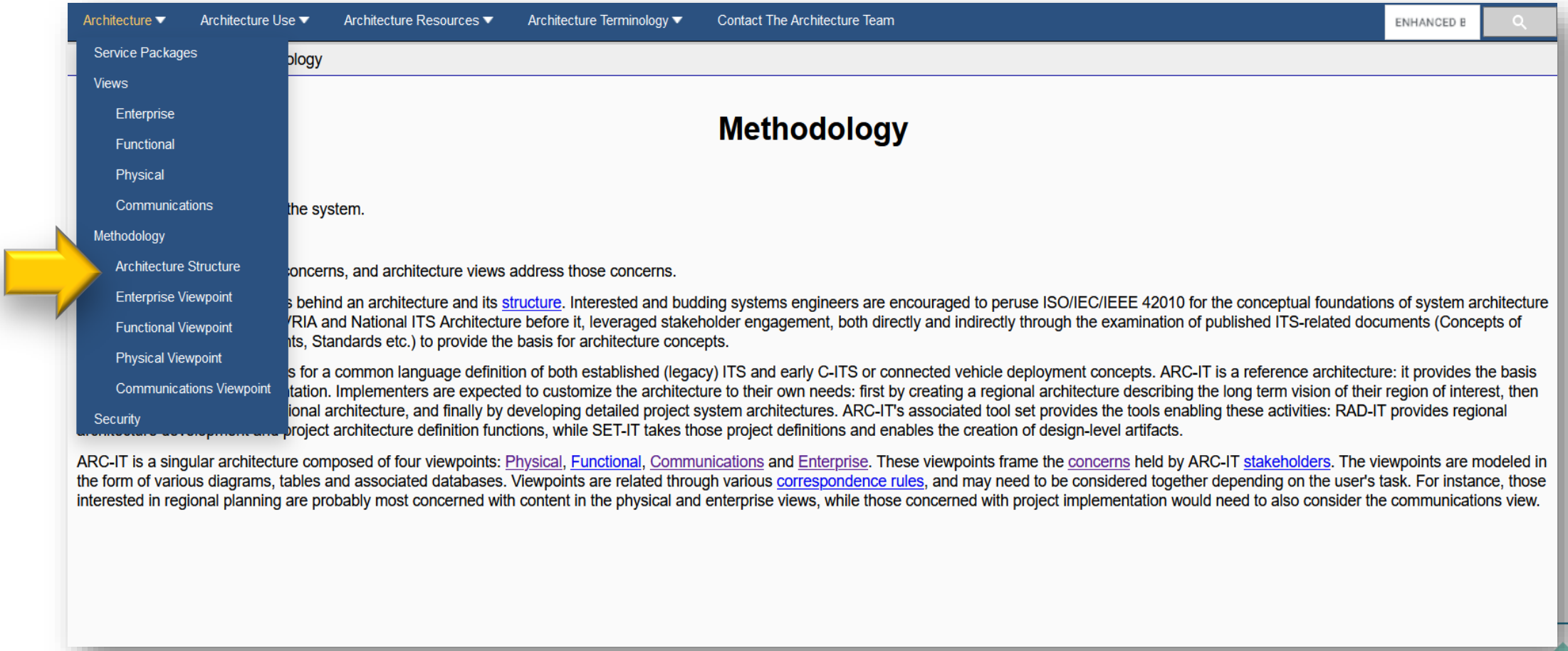
The Communications View identifies the protocol stacks needed to implement an information flow between a source and destination (e.g., information flow triple) in the Physical View. ARC-IT terms these protocol stacks as "solutions". Solutions are composed of a collection of industry standards; usually 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.



ARC-IT Website: Methodology



ARC-IT Website: Architecture Structure

Architecture ▾ | Architecture Use ▾ | Architecture Resources ▾ | Architecture Terminology ▾ | Contact The Architecture Team | ENHANCED S

Home > Architecture > Methodology > Architecture Structure

Architecture Structure

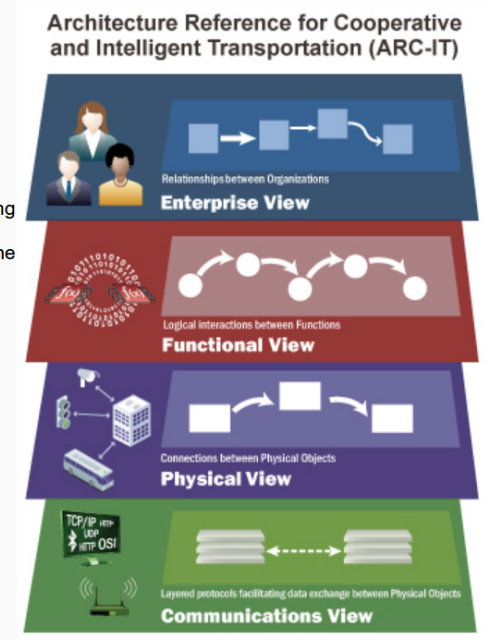
The diagram depicts ARC-IT as a set of layered viewpoints - each providing a different perspective to understand the architecture.

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.

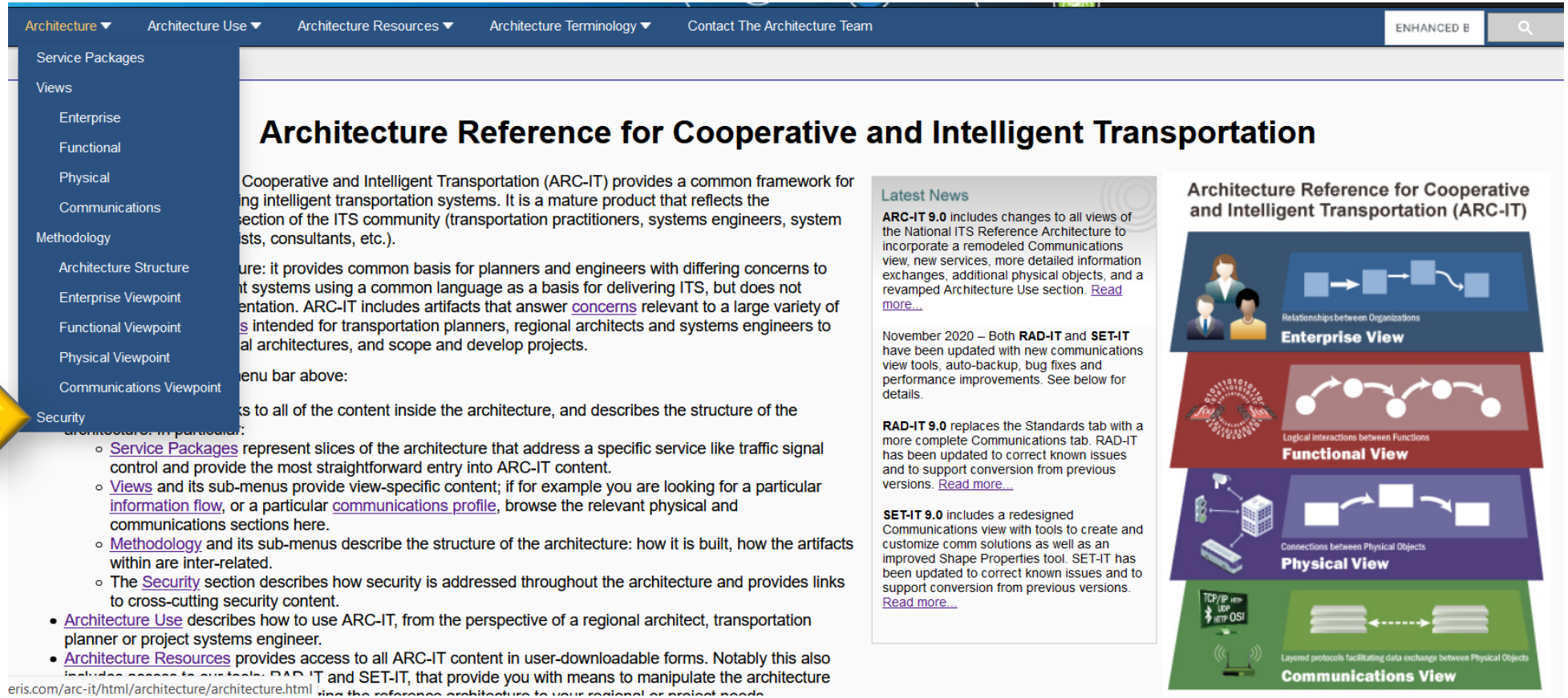
Each Viewpoint includes a specification that describes the concerns addressed by that particular viewpoint. The accompanying viewpoint specifications also define the relevant model constructs, serving as a legend for the diagrams.

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.



ARC-IT Website: Security



ARC-IT Website: Security

Architecture ▼ | Architecture Use ▼ | Architecture Resources ▼ | Architecture Terminology ▼ | Contact The Architecture Team | ENHANCED S

Home > Security

Security

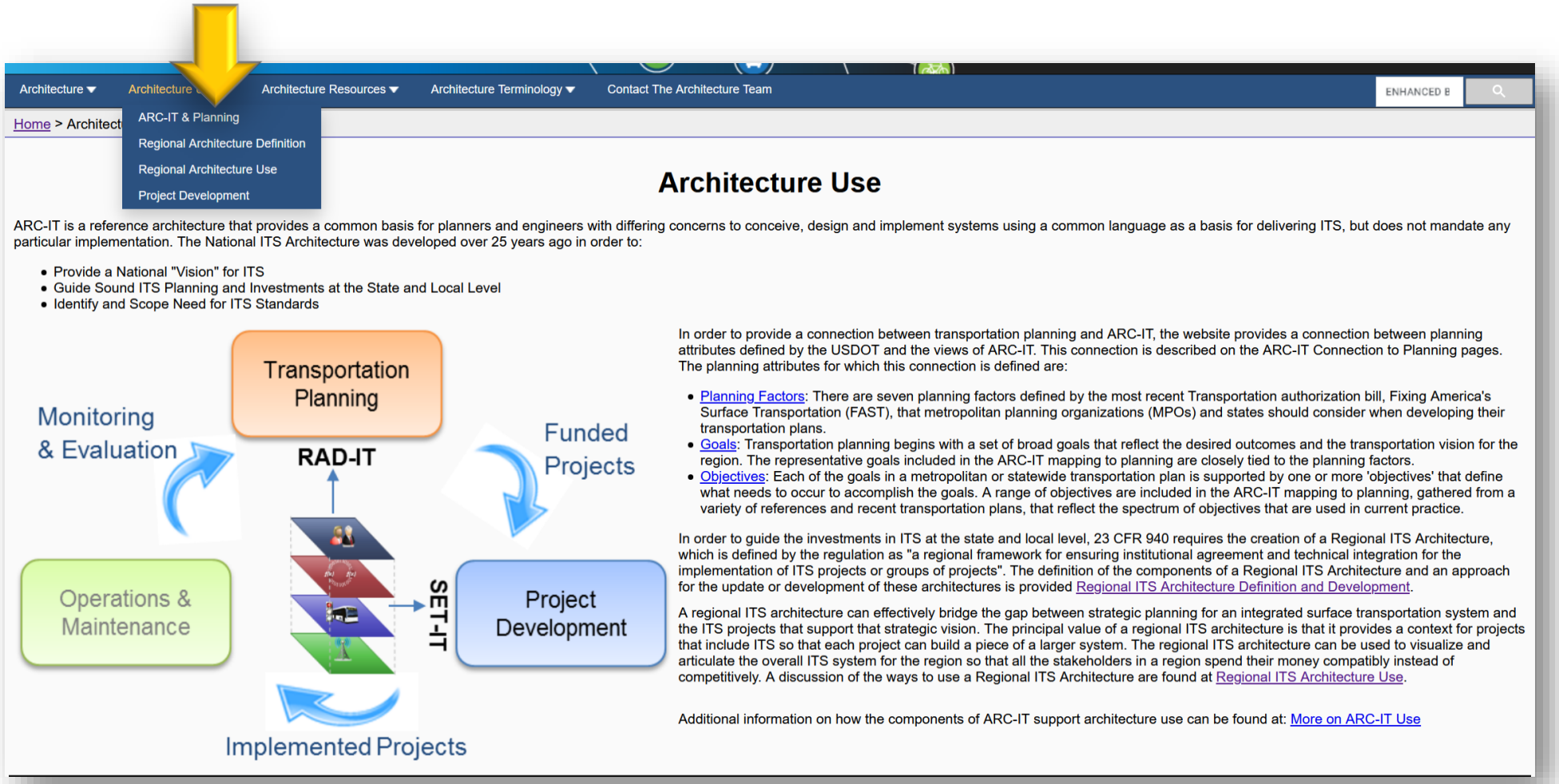
Security concerns related to ITS are focused on protection of surface transportation information and infrastructure. Surface transportation is now, more than ever, relying on information technologies to sense, collect, process and disseminate information to improve the efficiency of moving goods and 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.

ARC-IT Website: Architecture Use



ARC-IT Website: Regional ITS Architecture Definition

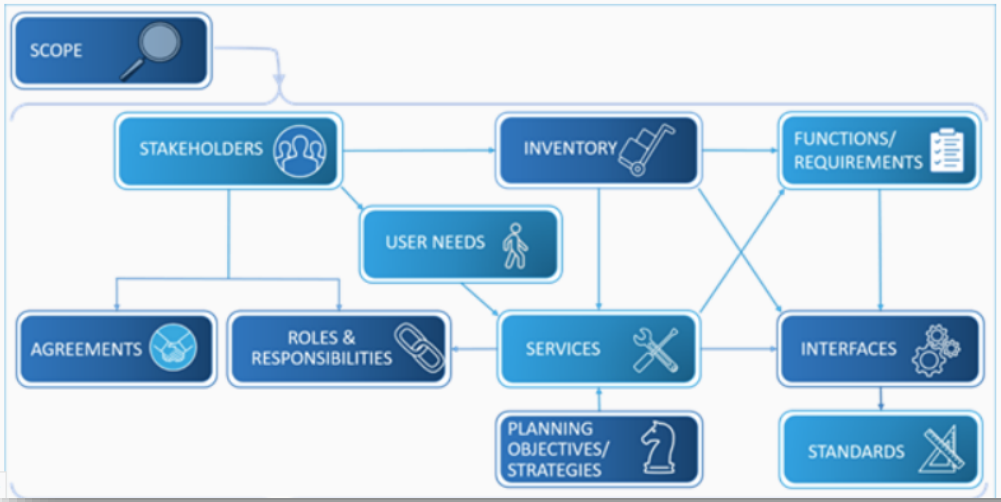
Architecture ▾ Architecture Use ▾ Architecture Resources ▾ Architecture Terminology ▾ Contact The Architecture Team ENHANCED B

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.



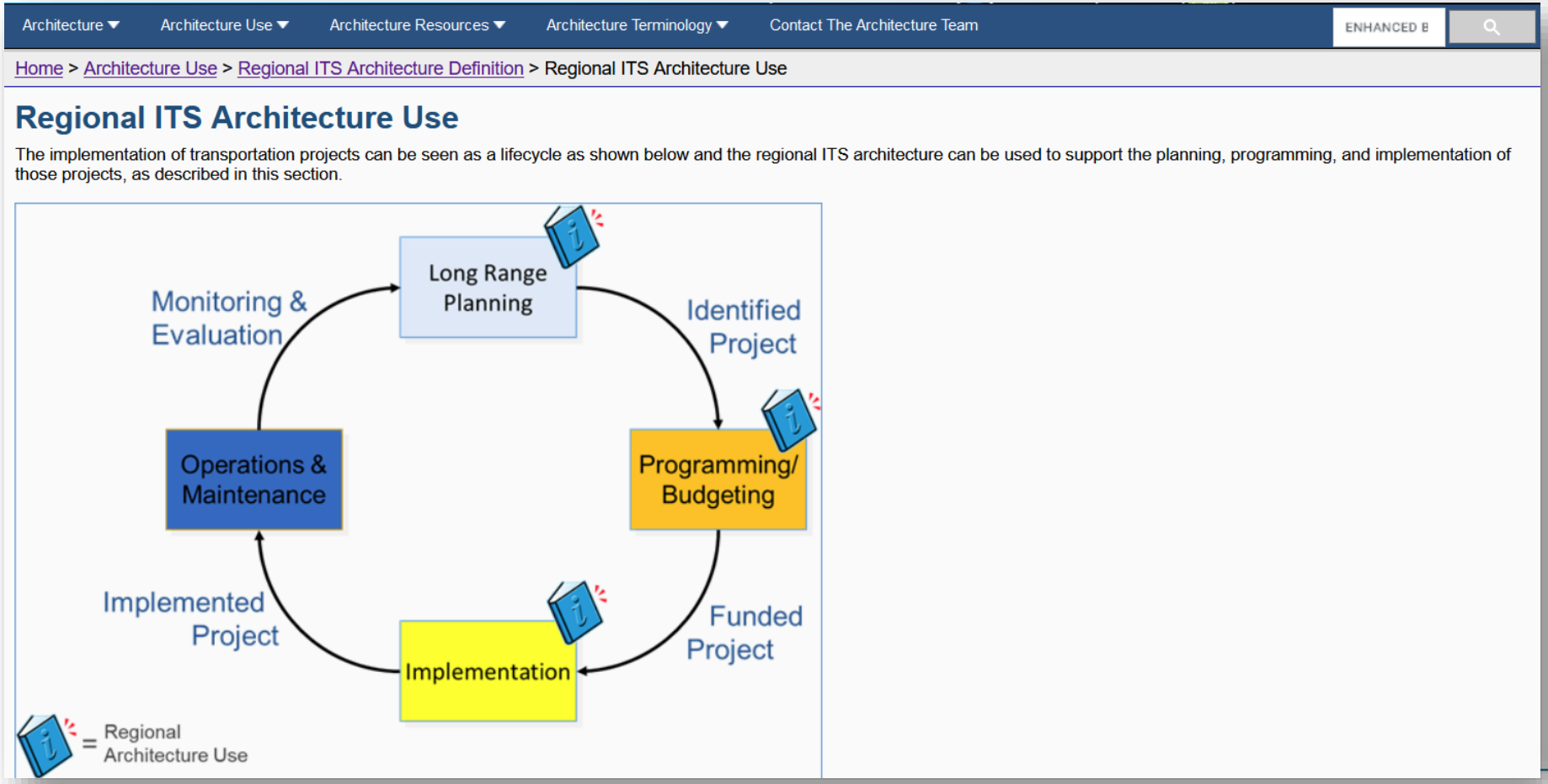
To support that effort a Regional ITS Architecture is developed as "a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects". Regional ITS Architectures can be and have been developed and maintained by state departments 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



ARC-IT Website: Use in Project Development

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

Home > Architecture Use > Use in Project Development

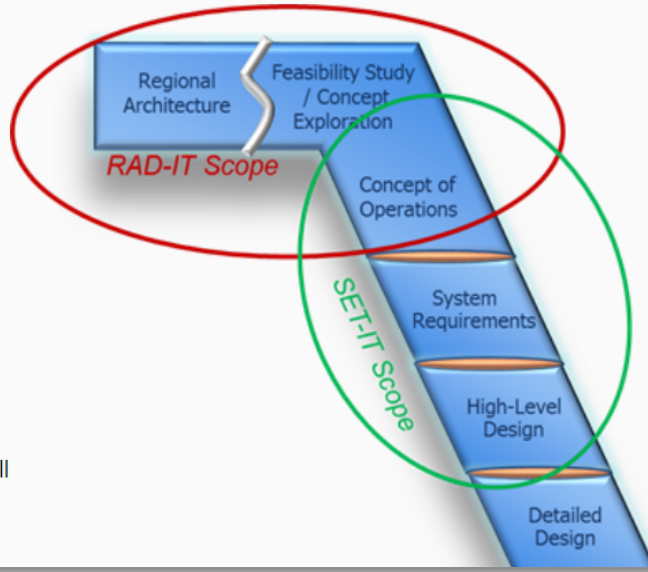
Use in Project Development

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.

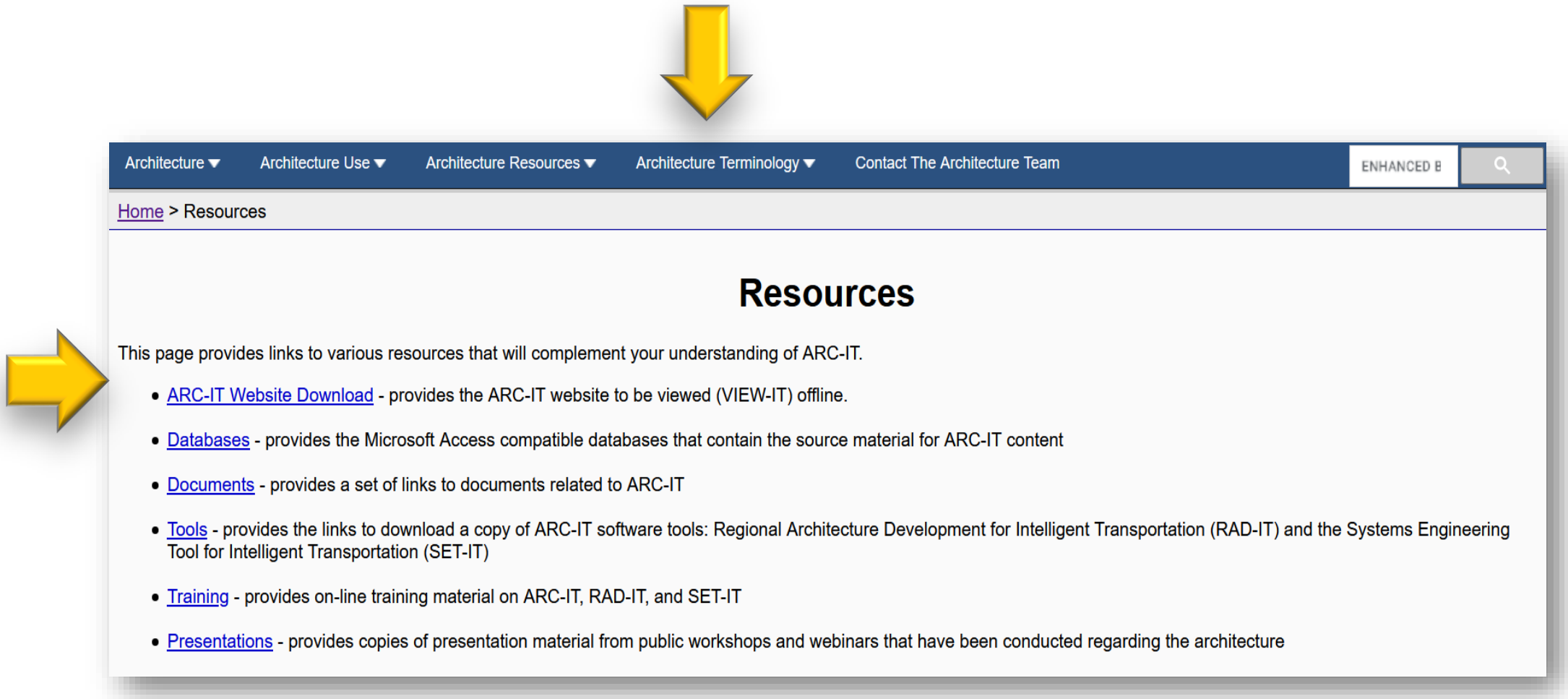
Architecture Use

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.

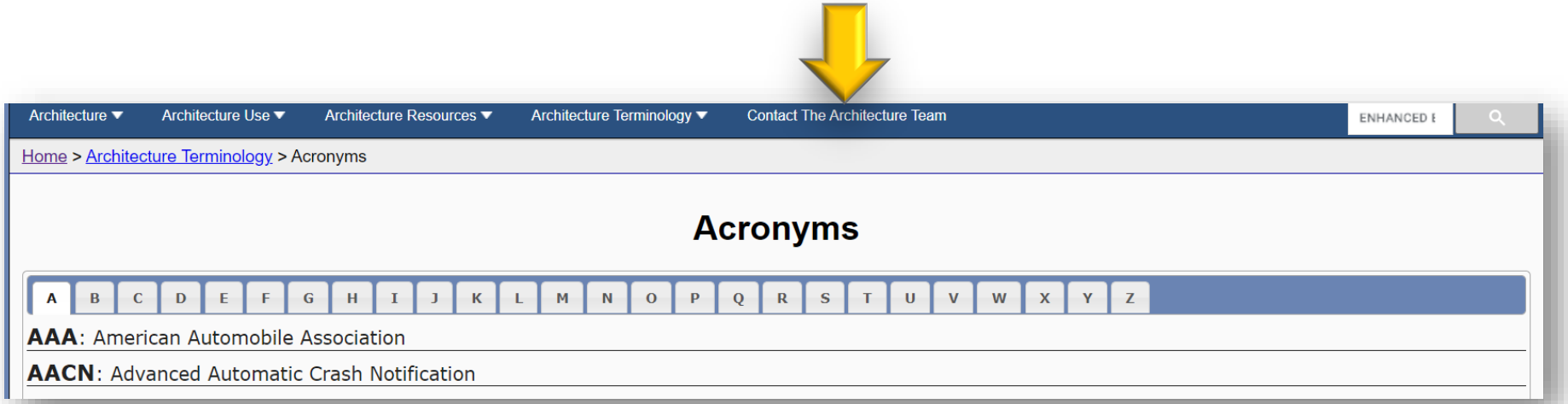
The items from the regional ITS architecture that are used to jumpstart the systems engineering process are derived from ARC-IT using the Regional Architecture Development tool for Intelligent Transportation (RAD-IT), formerly known as Turbo Architecture. The subsystems and terminators used to define 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.

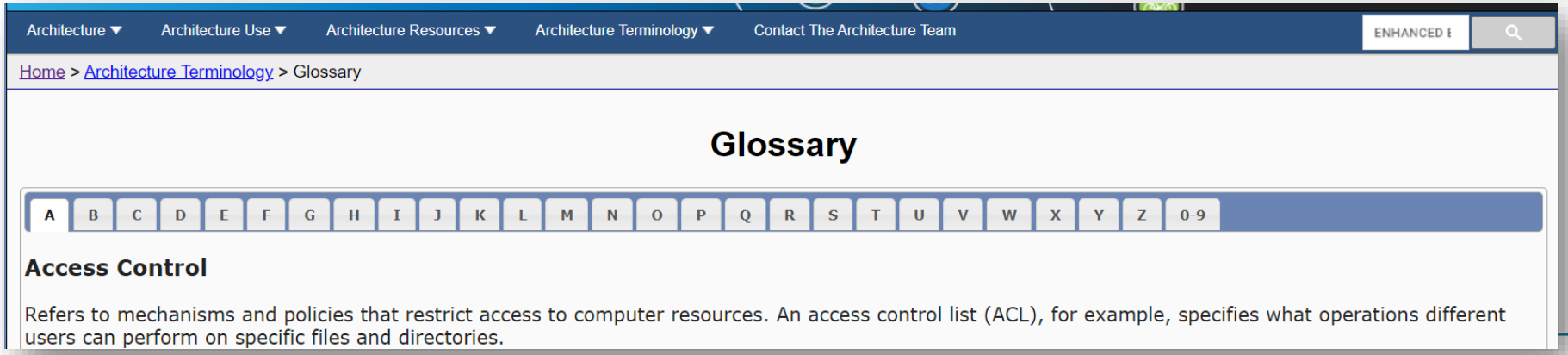


ARC-IT Website: Architecture Resources

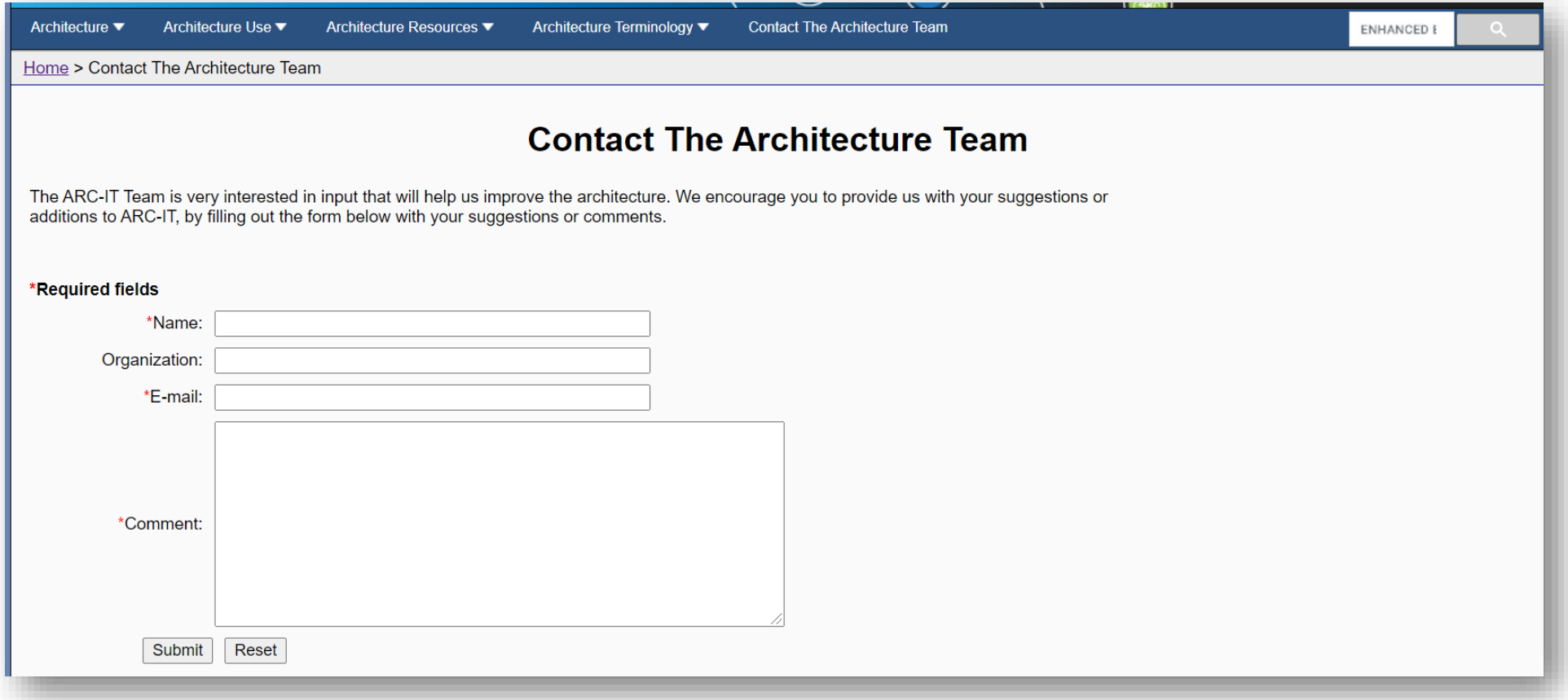


ARC-IT Website: Architecture Terminology





ARC-IT Website: Contact Us Page



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

Transport Canada Transports Canada

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.

Disclaimer

- Transport Canada does not endorse products or companies. Reference to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favouring by Transport Canada and shall not be used for advertising or service endorsement purposes.
- Transport Canada is not responsible for errors or omissions in this document and makes no representations as to the accuracy or completeness of the information. Content provided by external sources is not subject to official languages, privacy and accessibility requirements.

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

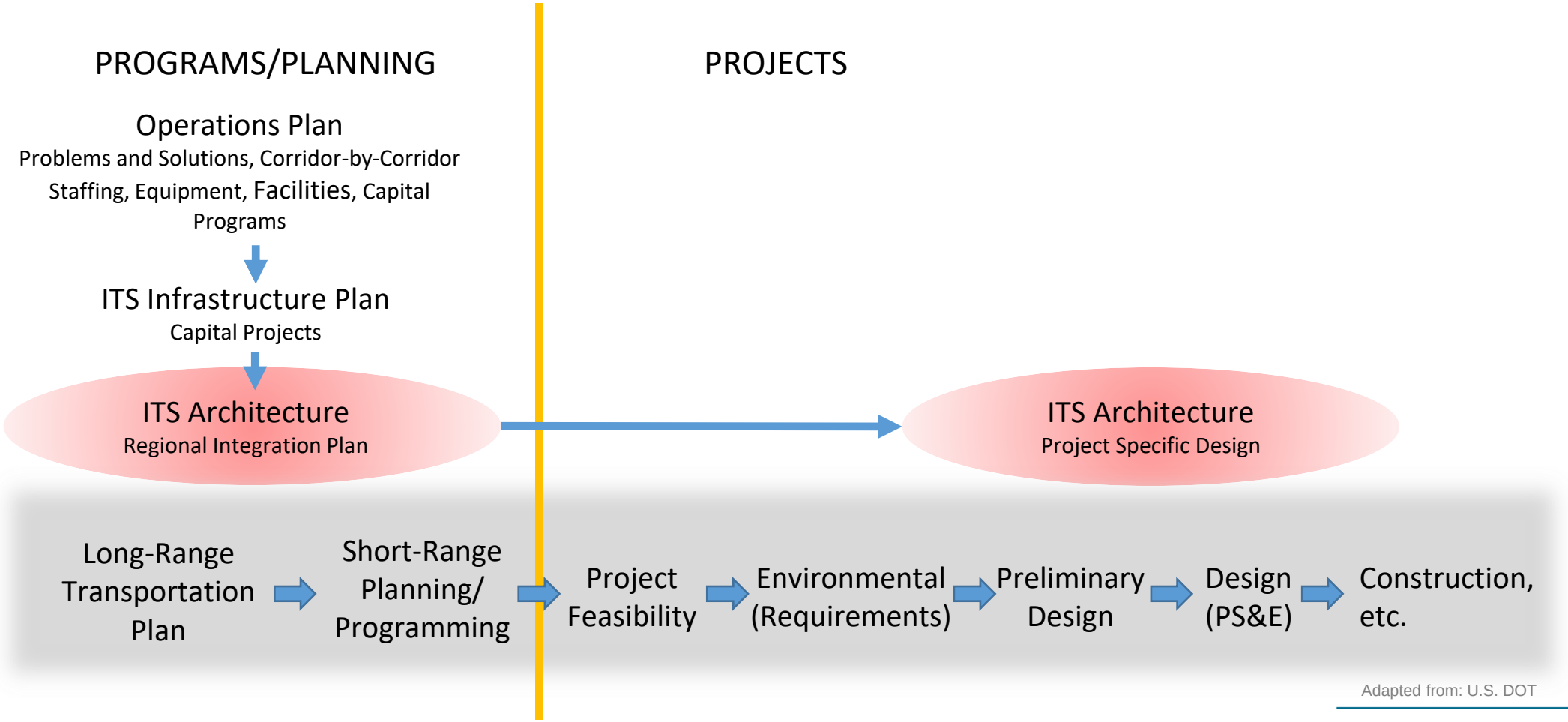
What is ITS?

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

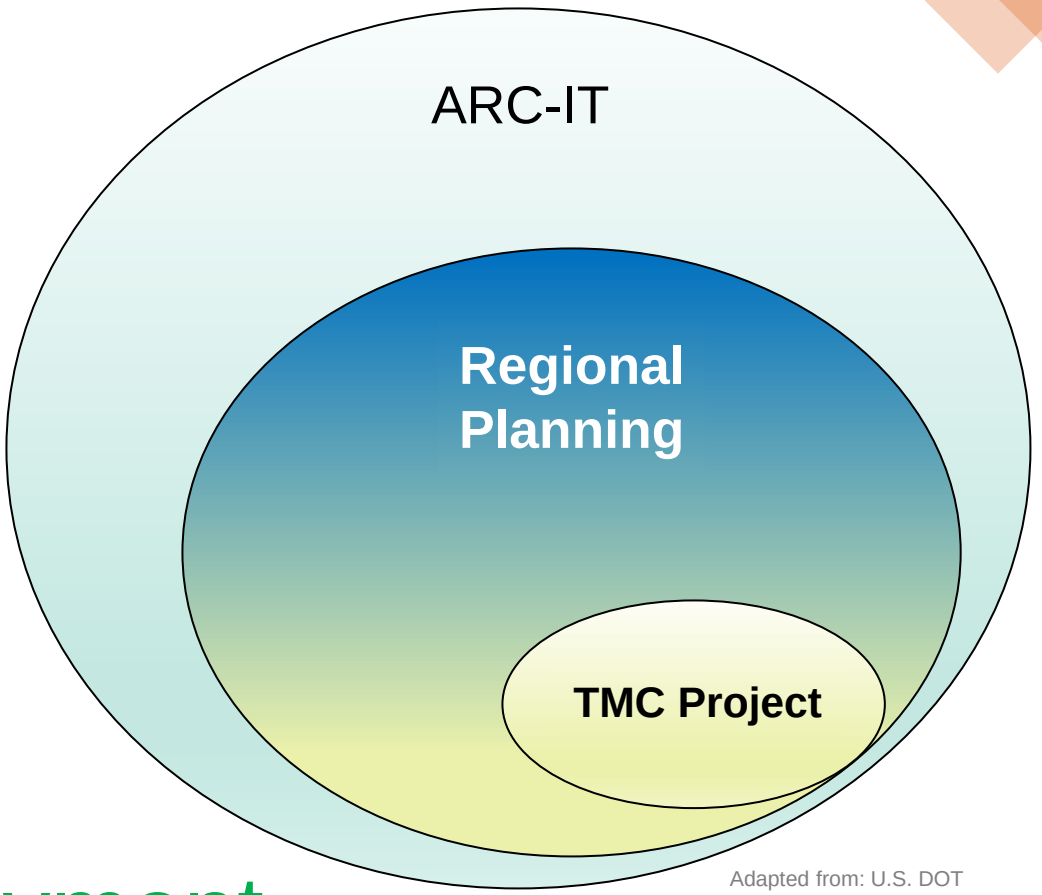
Where does an ITS Architecture fit into Traditional Project Development Lifecycles?



Adapted from: U.S. DOT

Types of ITS Architectures

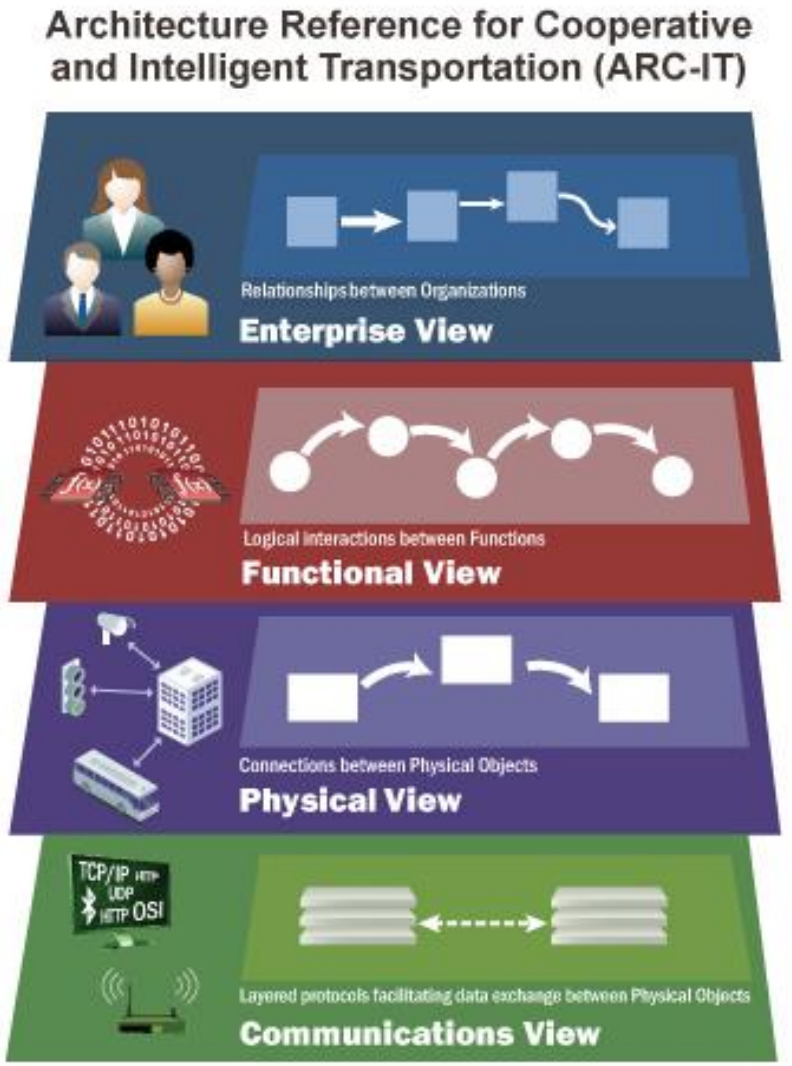
- Reference
  - National/Resource
- Regional
  - Used for planning
- Project
  - Used for design/deployment



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



Physical

- Identify systems and devices
- Identify interfaces

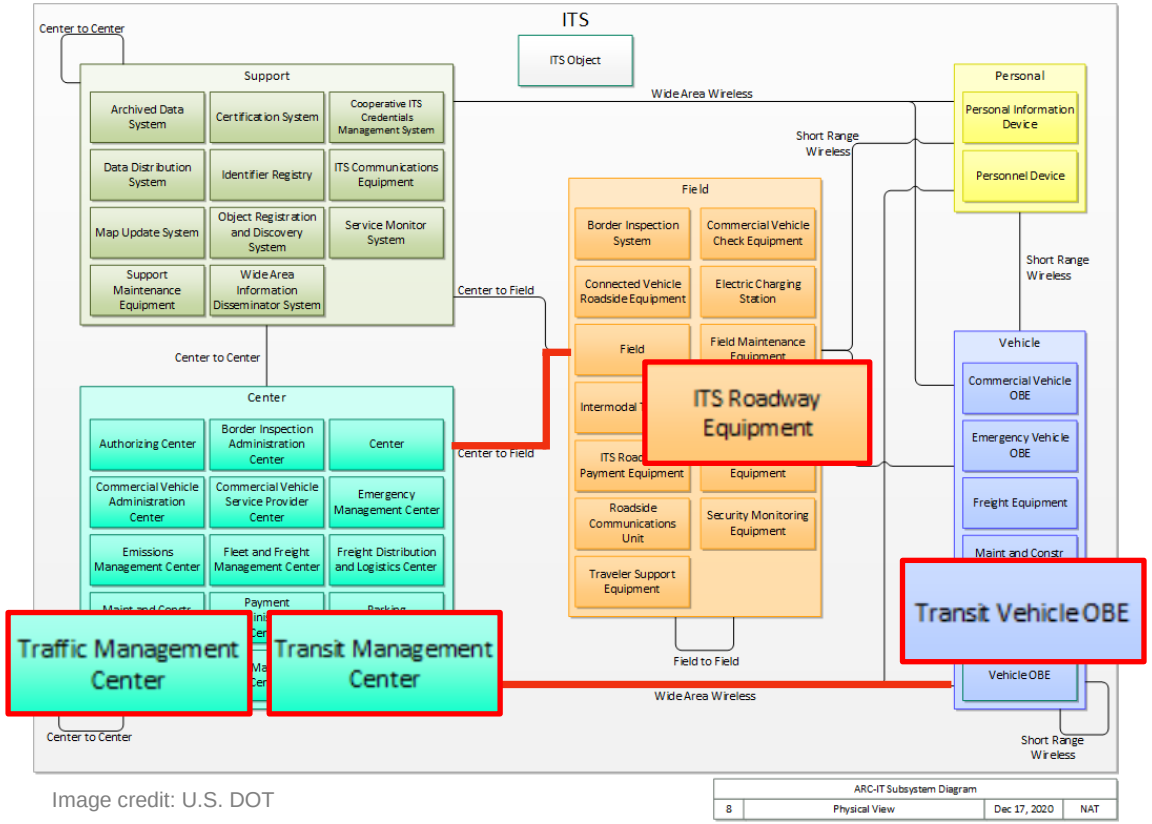


Image credit: U.S. DOT

Transit Management Center

Transit Vehicle OBE

Communications

ITS Roadway Equipment

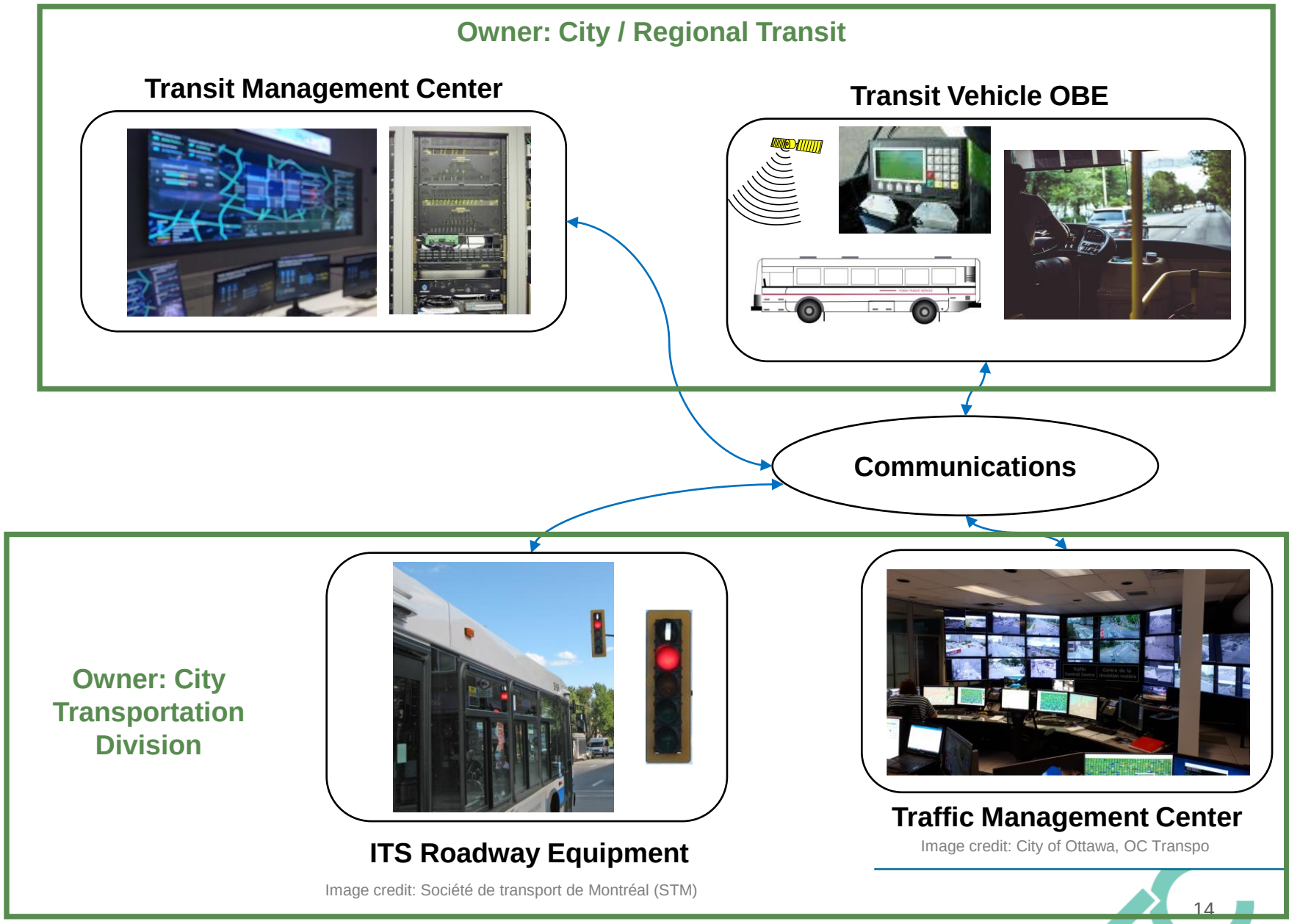
Image credit: Société de transport de Montréal (STM)

Traffic Management Center

Image credit: City of Ottawa, OC Transpo

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

#	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.

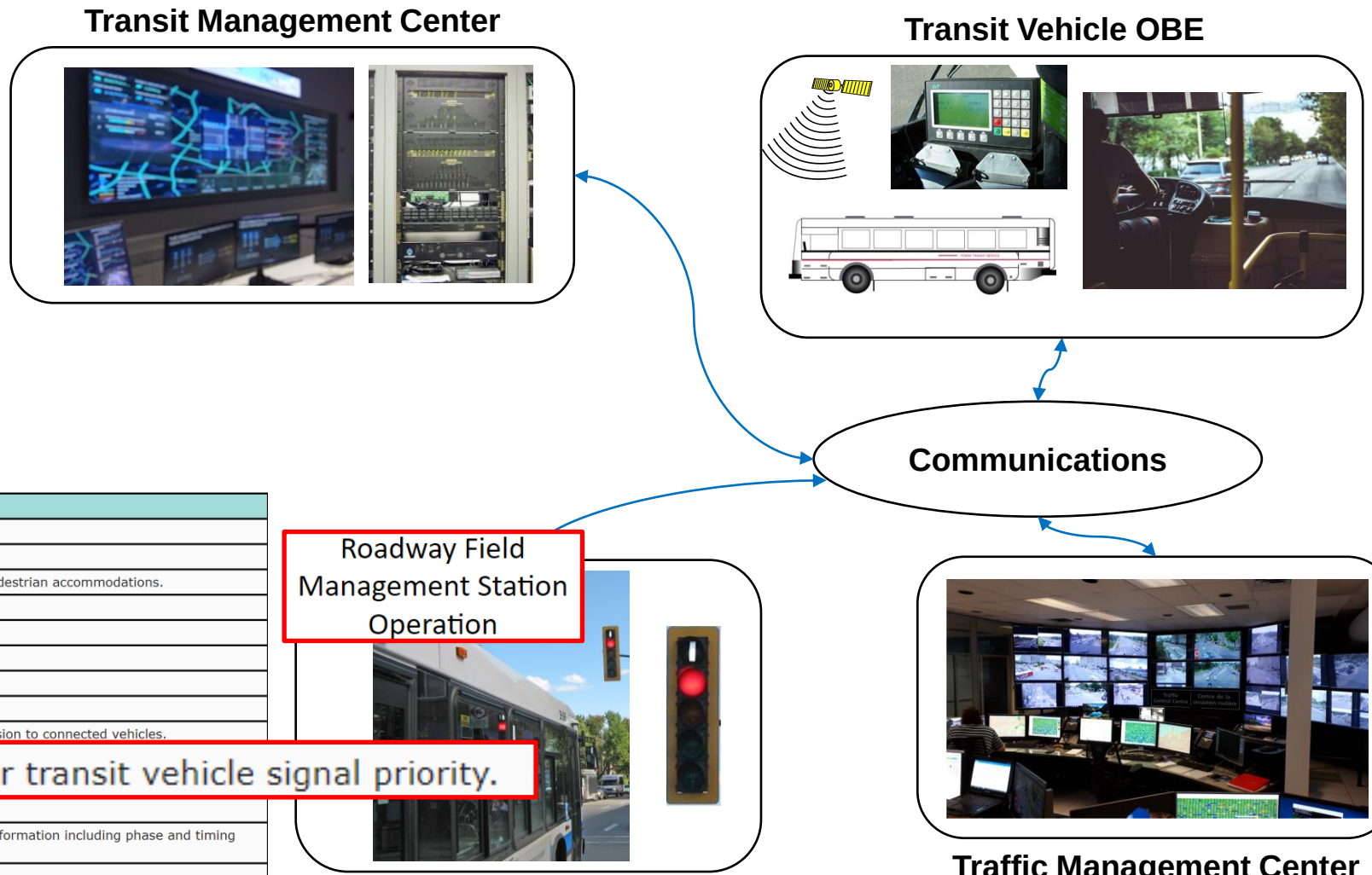


Image credit: Société de transport de Montréal (STM)

Image credit: City of Ottawa, OC Transpo

Communications

- Select communications standards / protocols
- Address Security

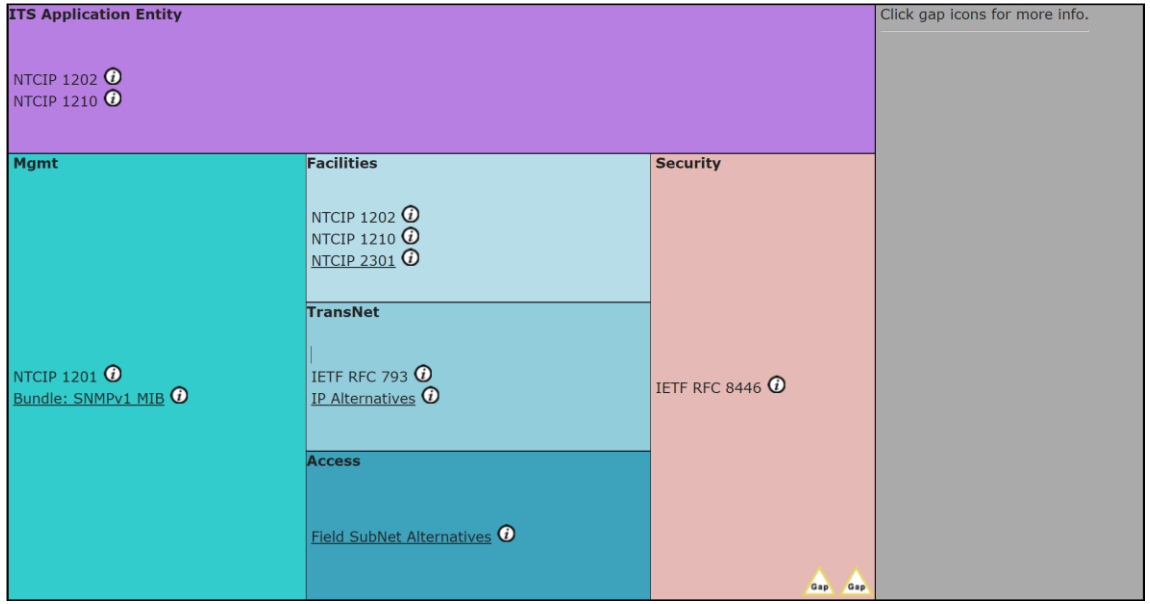


Image credit: U.S. DOT

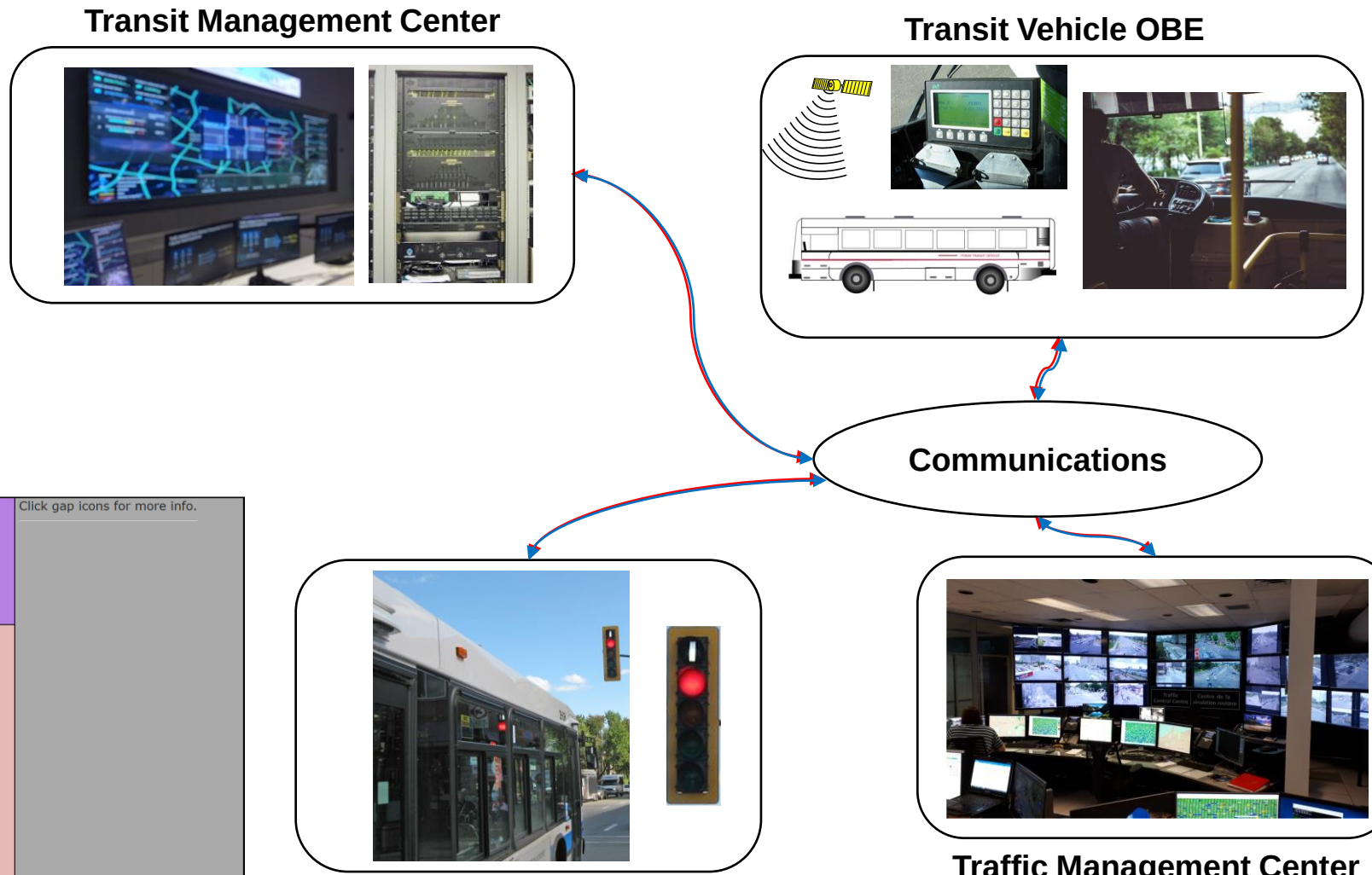


Image credit: Société de transport de Montréal (STM)

Image credit: City of Ottawa, OC Transpo

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

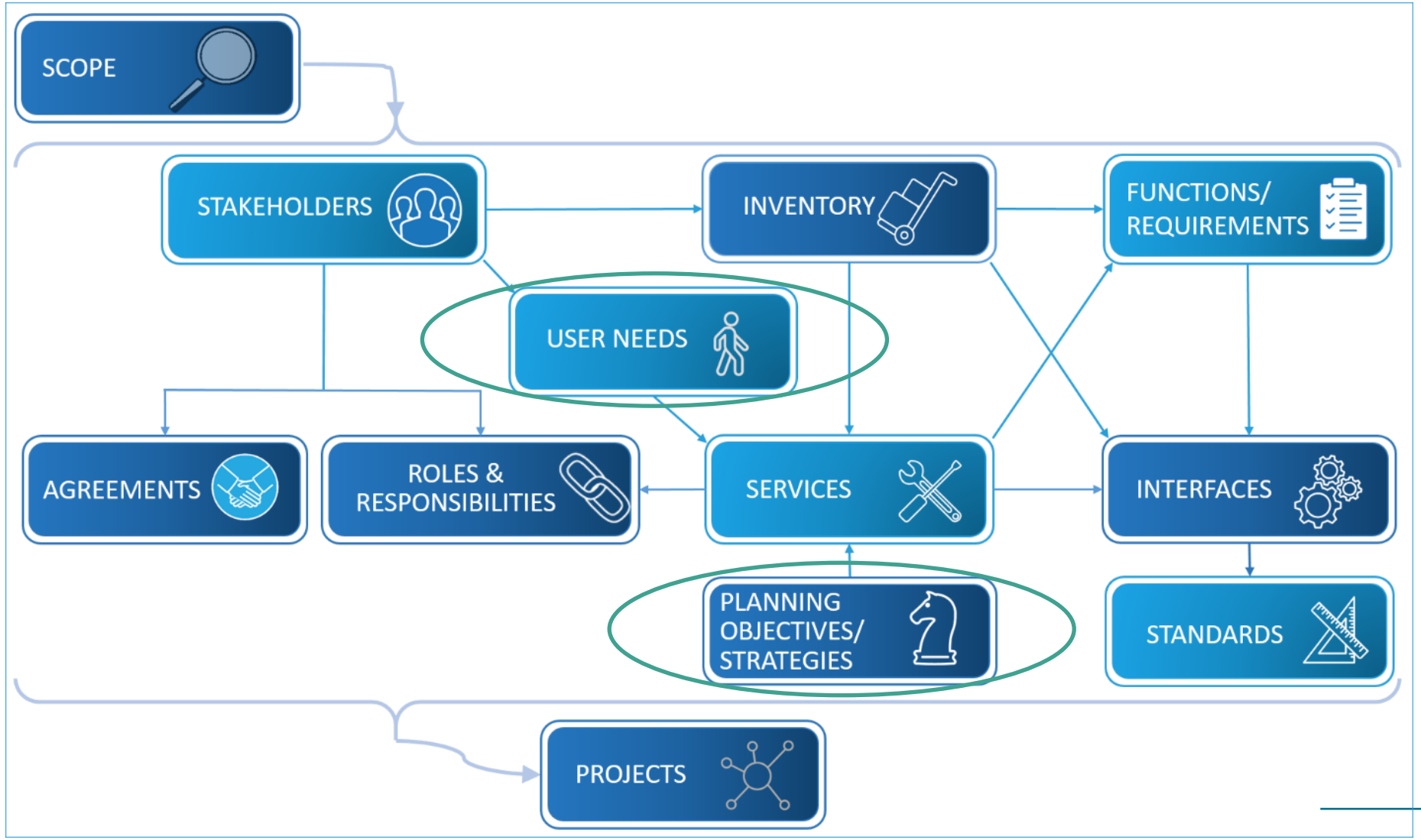
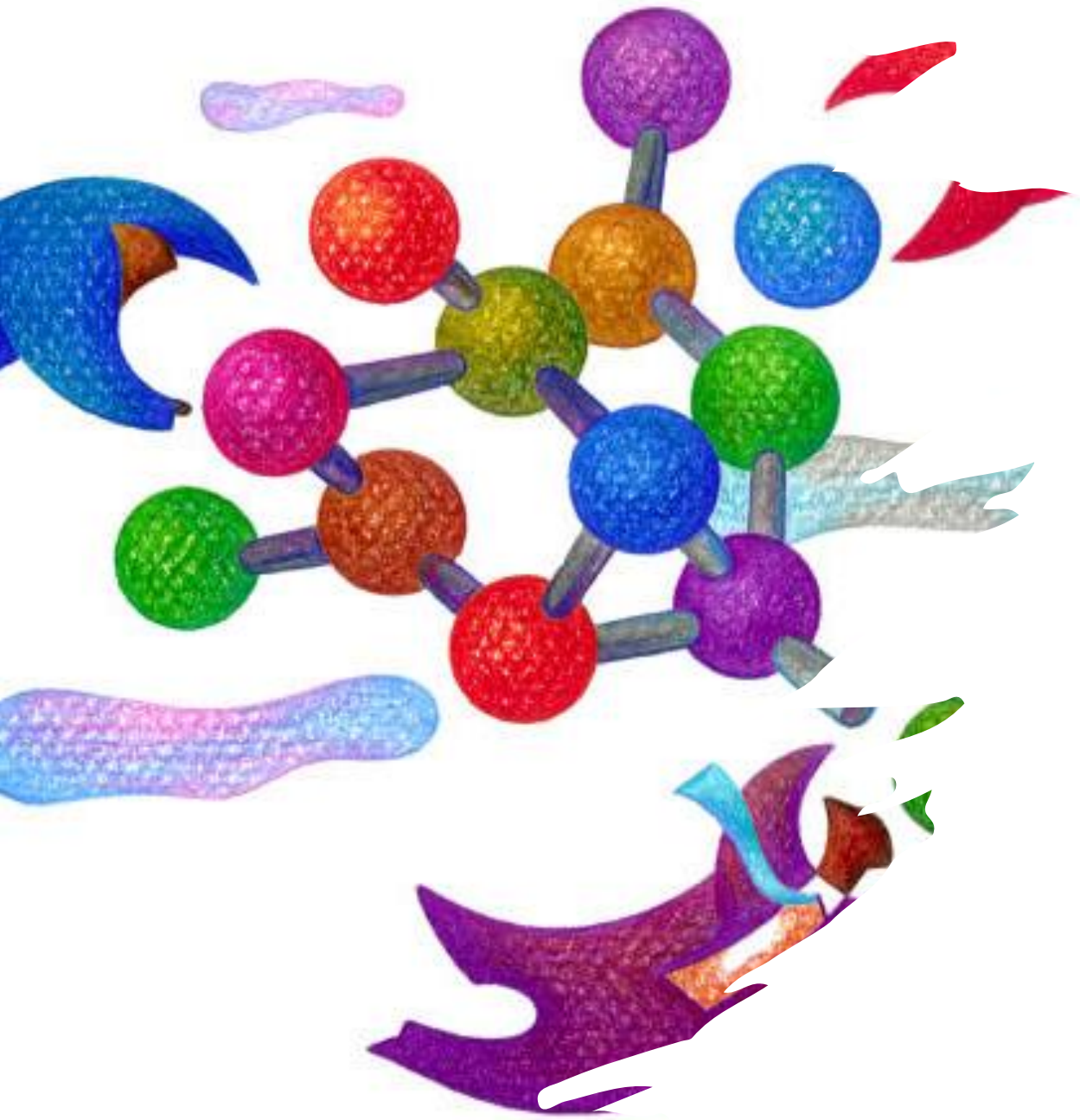


Image credit: U.S. DOT



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

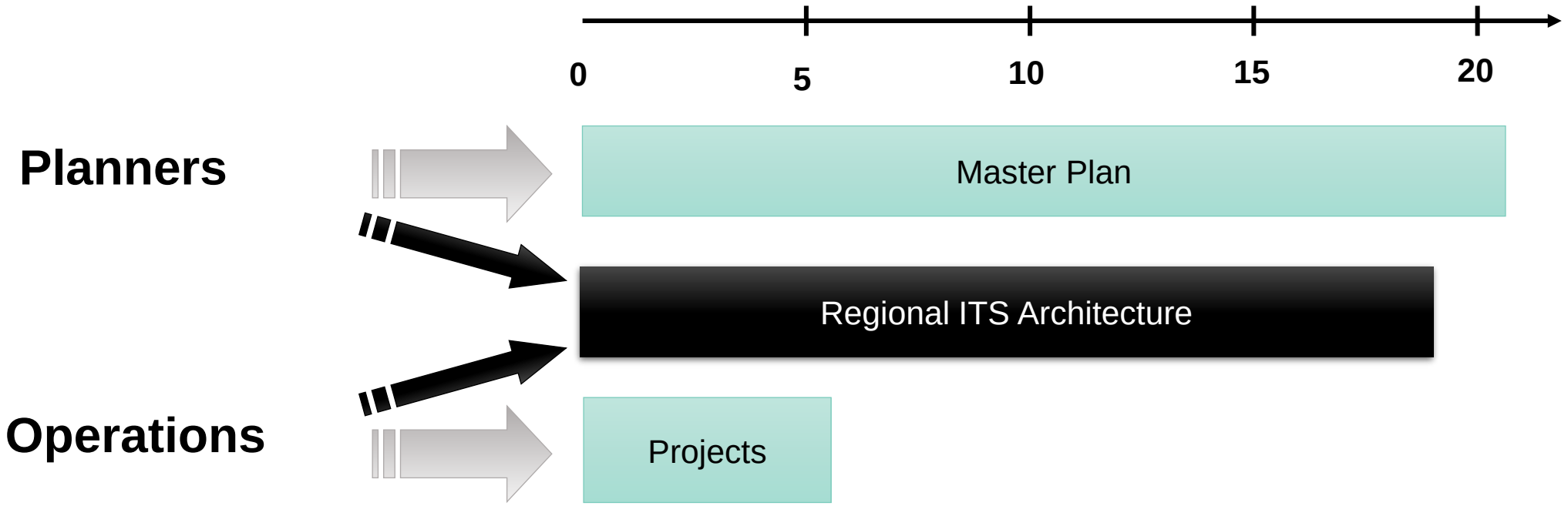


Image credit: U.S. DOT

Transportation Goals and Objectives

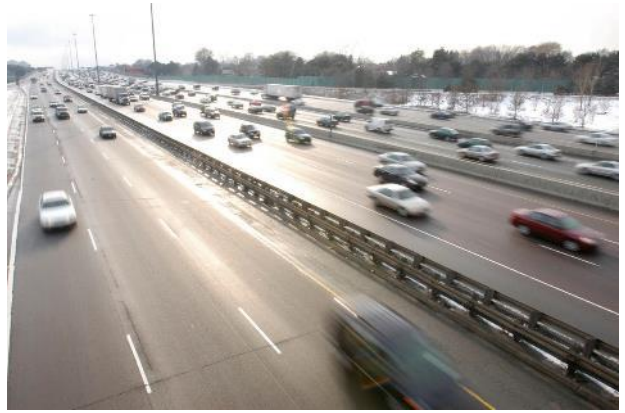
Regional Goals and Objectives

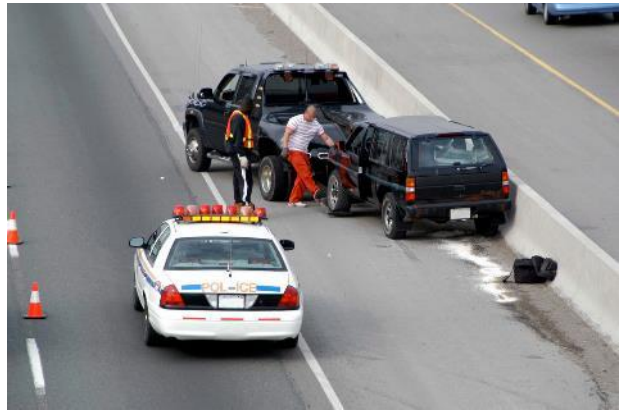
Goals

- 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

Image credit: U.S. DOT

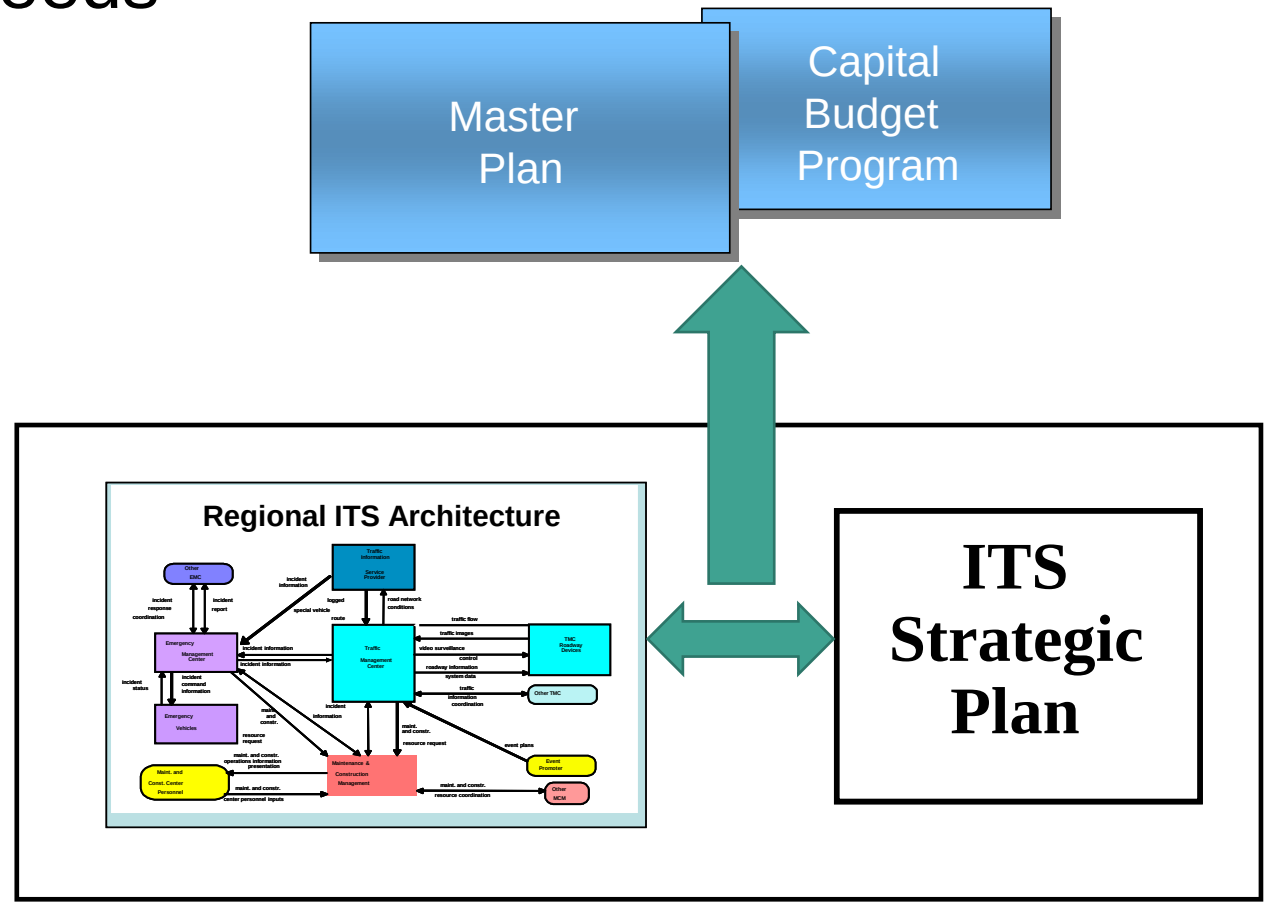
- Architecture should be based on operations-related goals and objectives
  - Include objectives in regional ITS architecture and map to service packages or projects
- Services and projects in architecture can support development of operations-related objectives
  - Architecture contains long range plan 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

- Defines a region's ITS needs and identifies a set of capabilities meet the needs



Adapted from: U.S. DOT

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

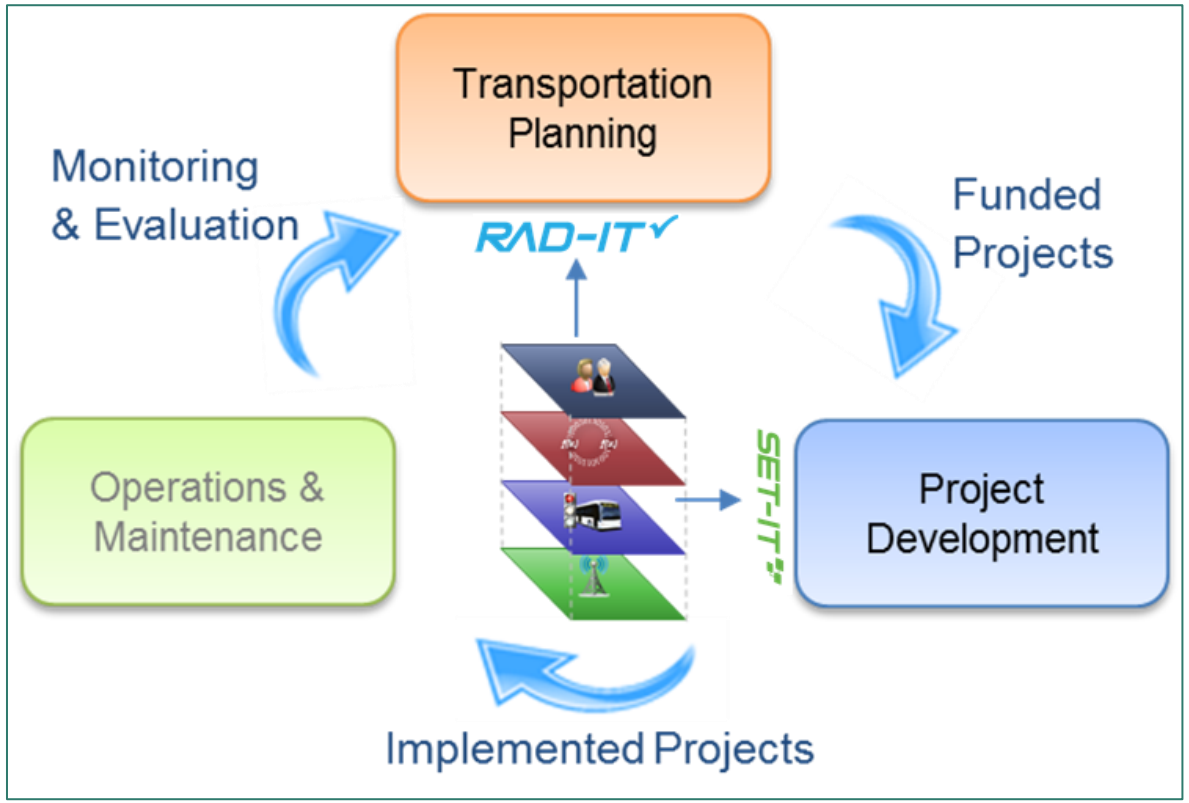
- Explicitly connect architecture services and projects to objectives and strategies
- Describe mid-long-term projects in language suitable for the plan (e.g., as “strategies”)
- Create executive summary material/ graphics as part of architecture that would be appropriate for a Master Plan
- Formally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

- 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:

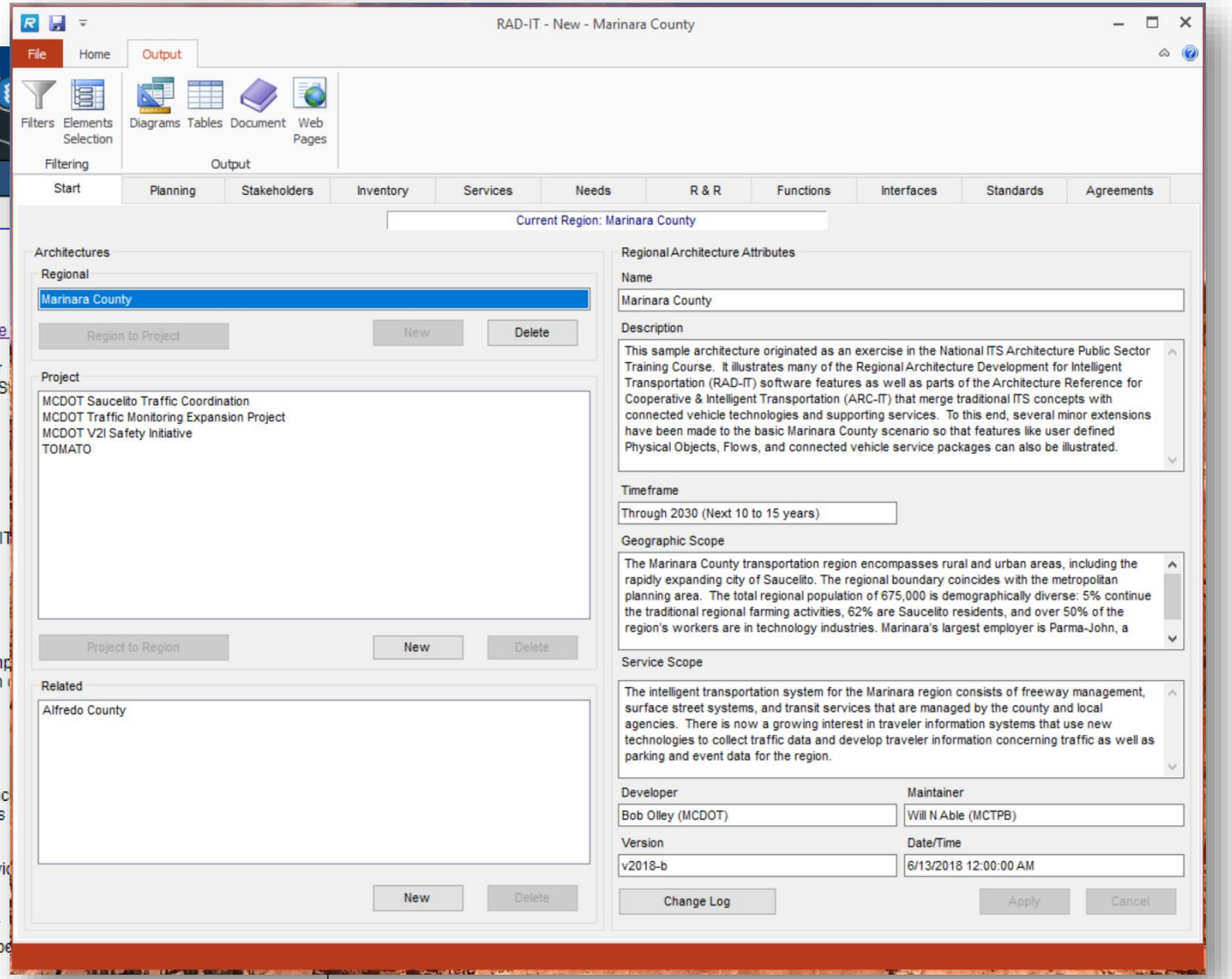
- Generating outputs, such as the web pages or batch diagrams, using a network file share may cause an error - set Sync
- Following installation some users have reported an error that "Access is denied" when they try to launch the tool. This is installation and your anti-virus software. Try temporarily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

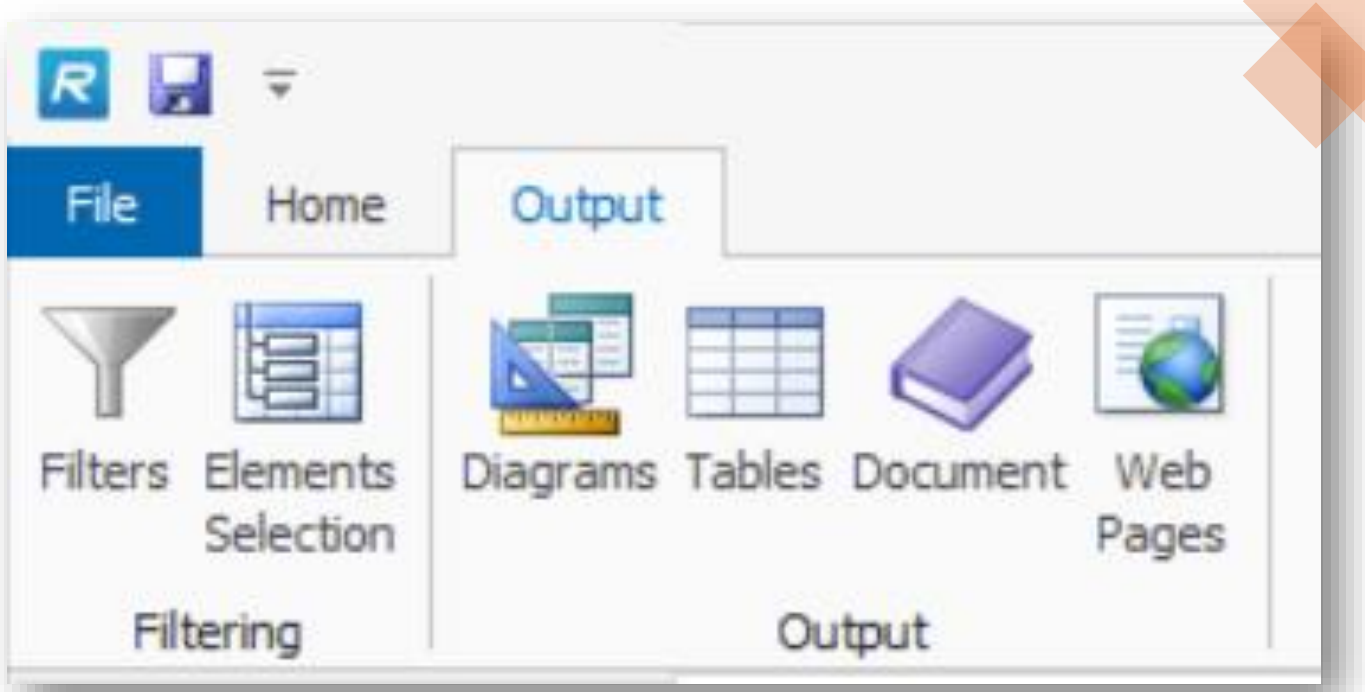
- The version of RAD-IT that you are using.
- The version and name of your operating system and Office products.
- A brief description of your problem or issue.

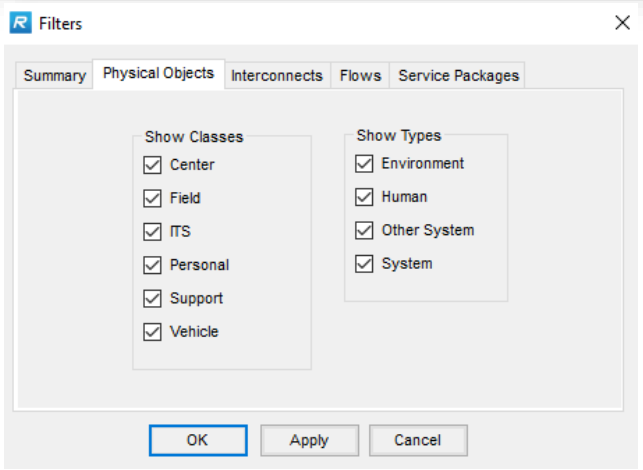


https://www.arc-it.net/html/resources/radit.html

RAD-IT Outputs

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





RAD-IT Outputs: Subsystem Diagram

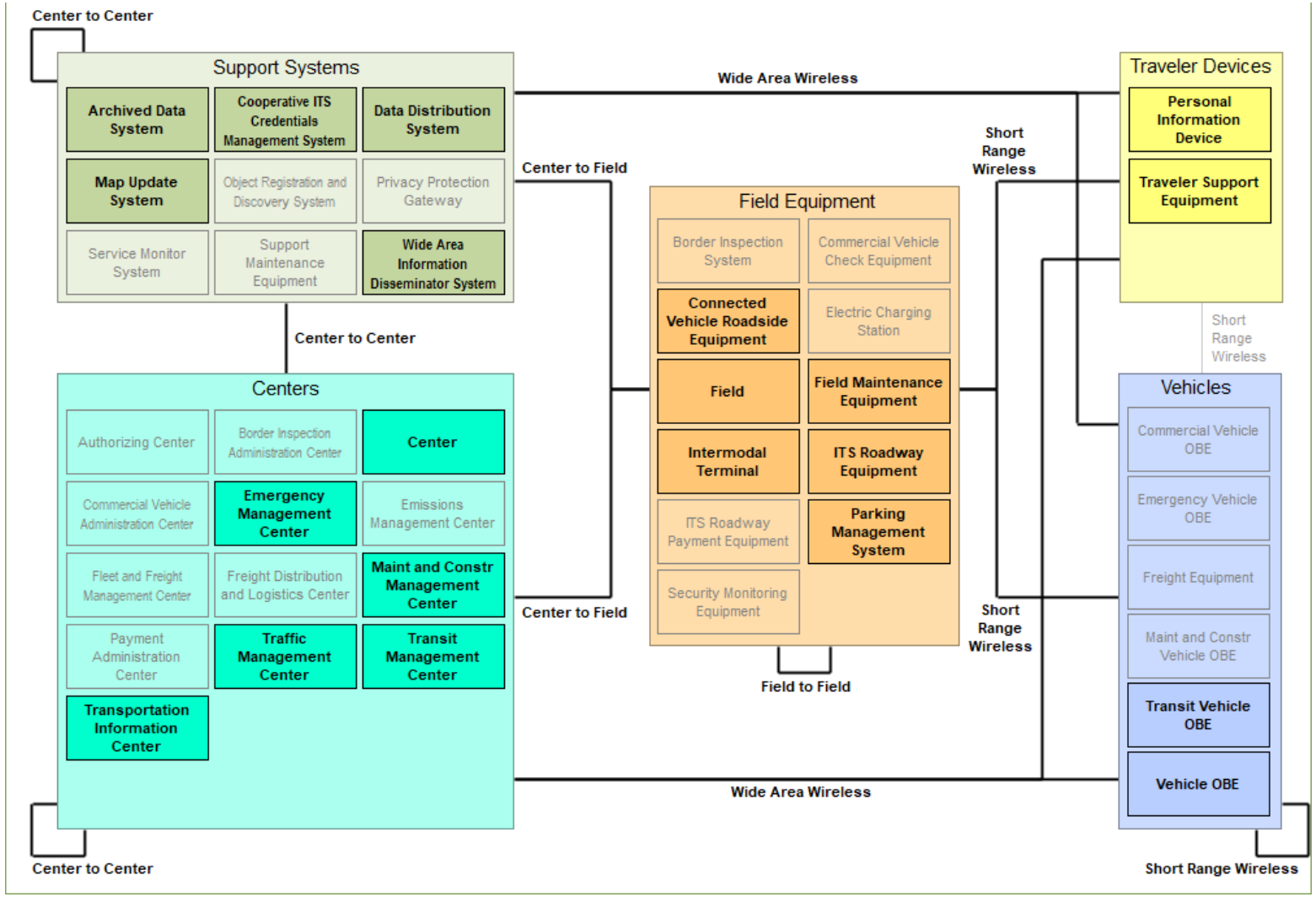
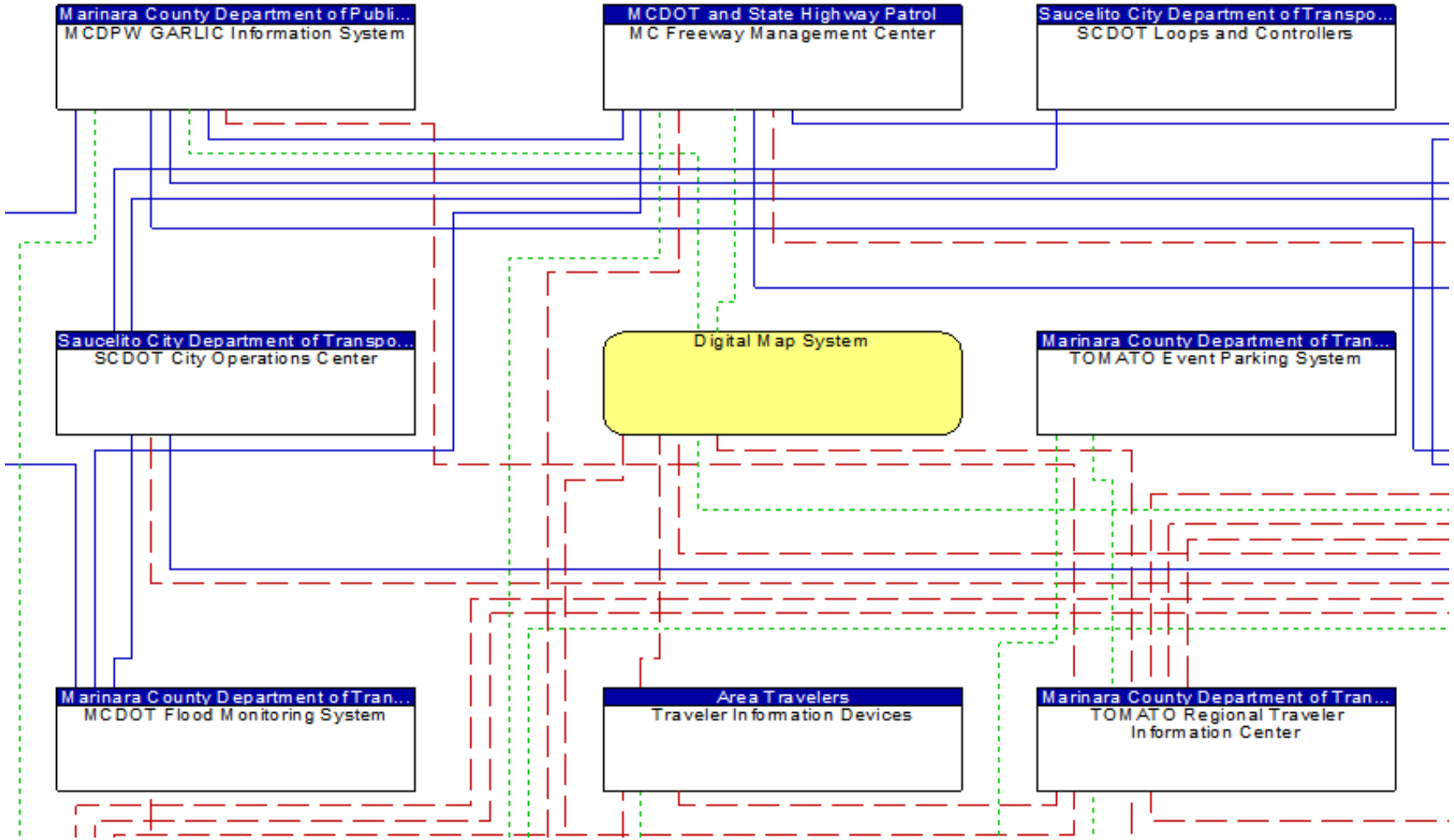
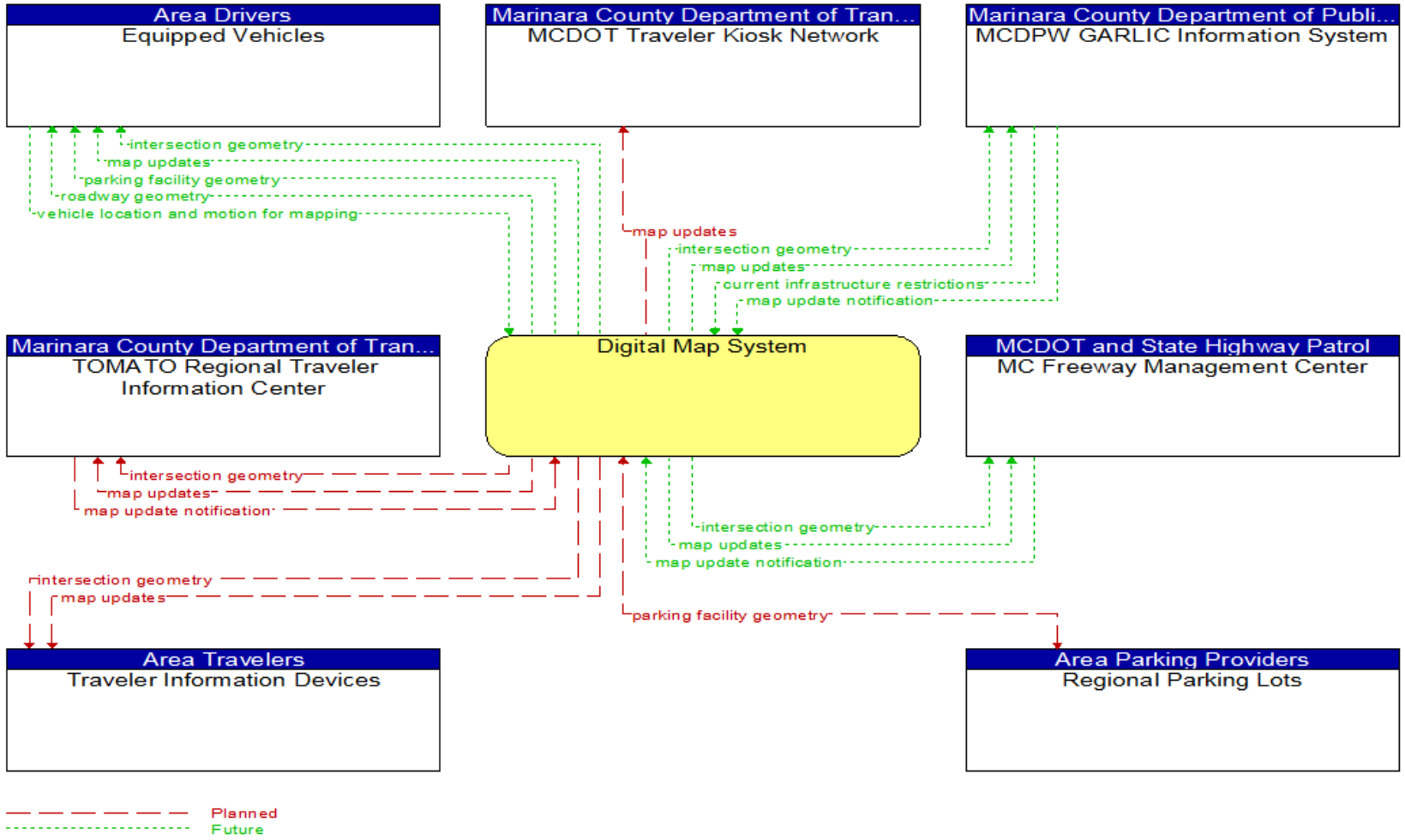


Image credit: U.S. DOT

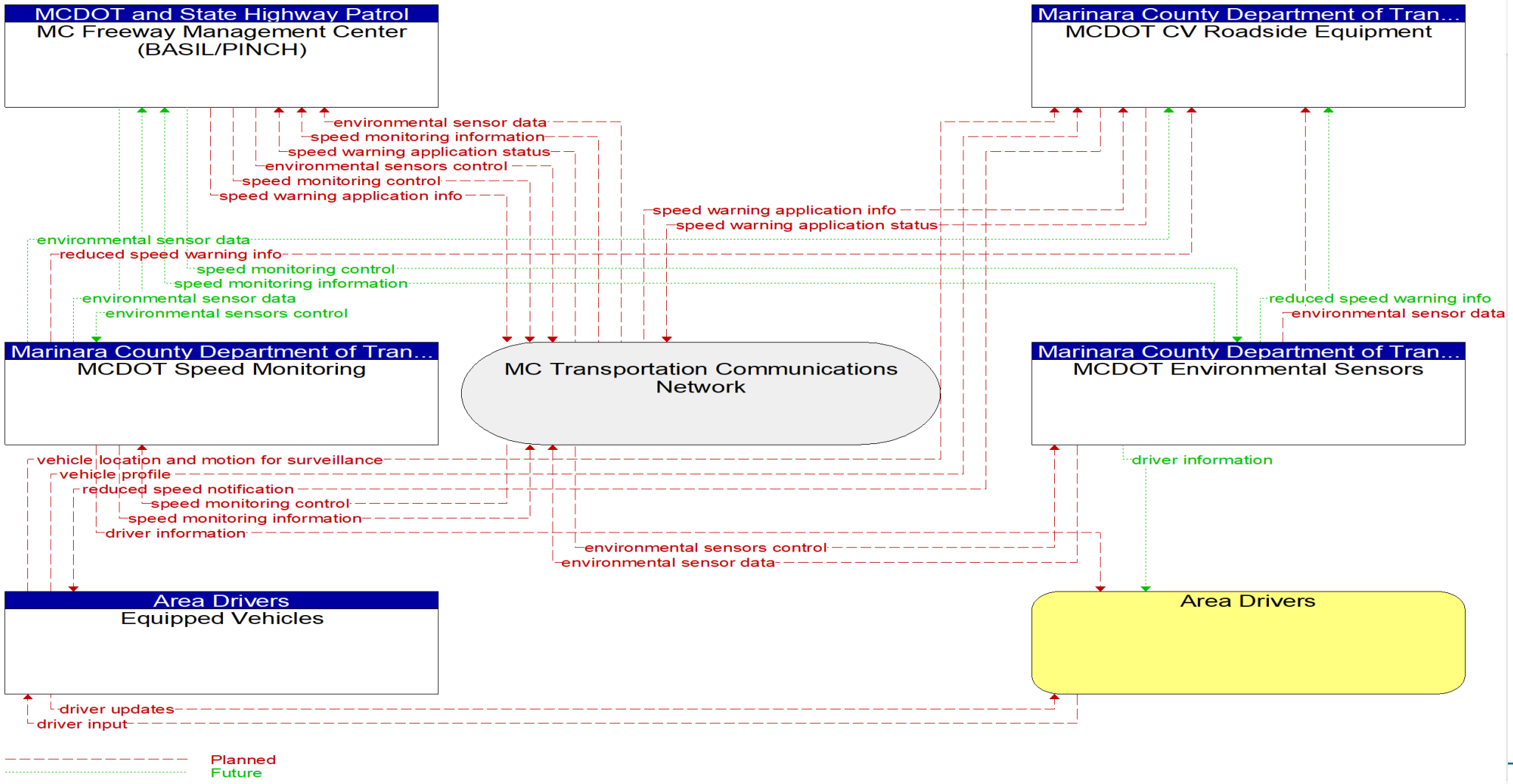
RAD-IT Outputs: Interconnect Diagram



RAD-IT Outputs: Context Diagrams

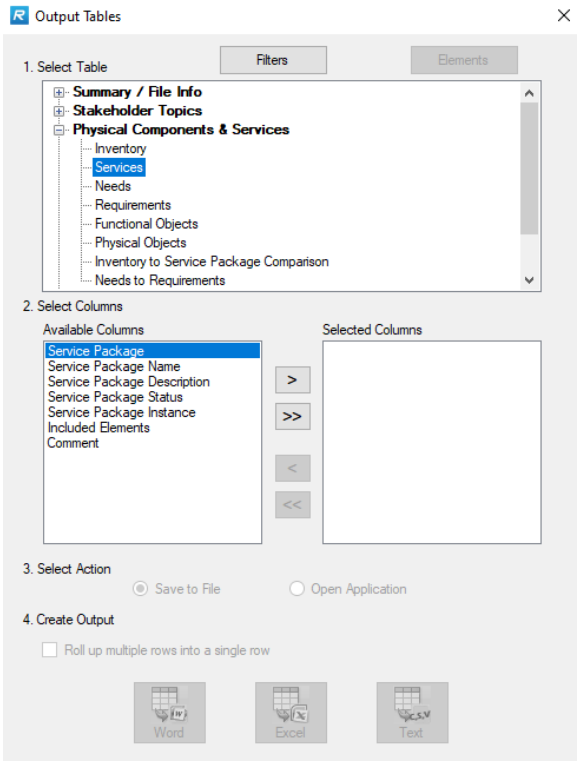


RAD-IT Outputs: Service Diagrams



VS09: Reduced Speed Zone Warning / Lane Closure

RAD-IT Outputs: Tables



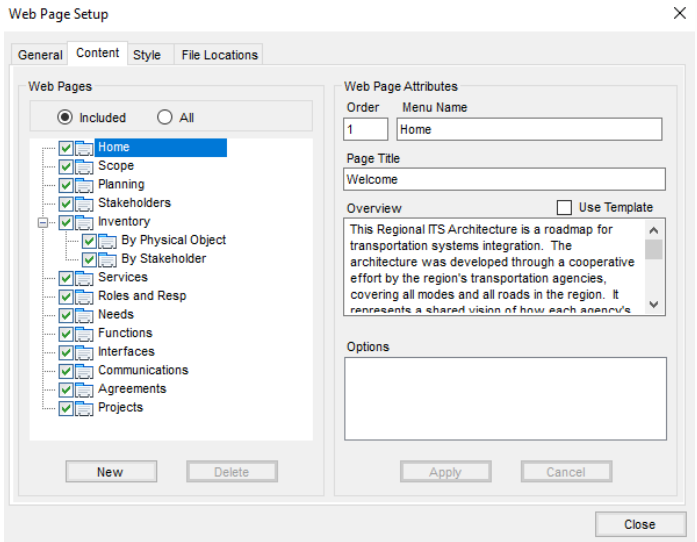
Services

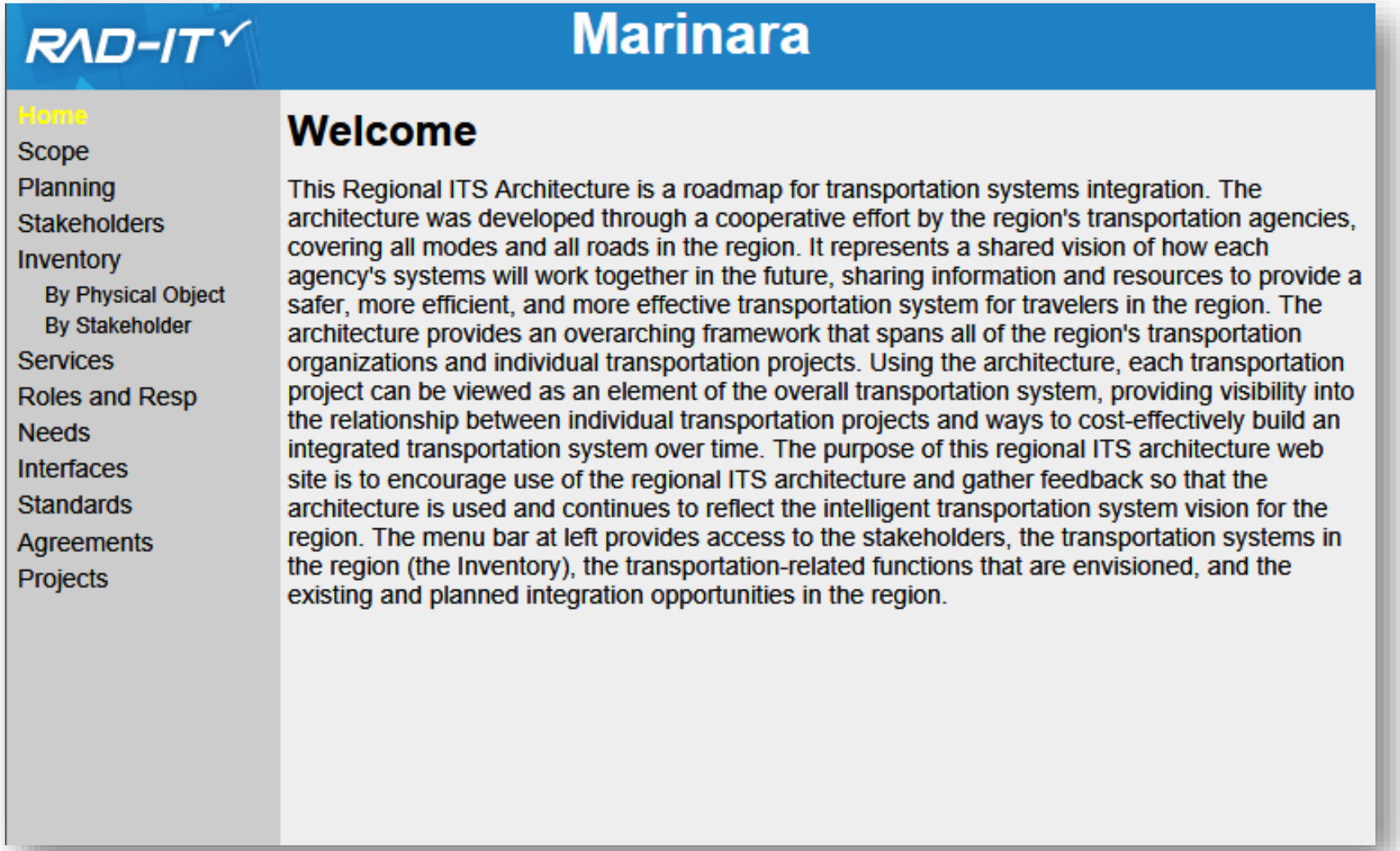
Service Package	Service Package Name	Service Package Description	Service Package Status	Service Package Instance	Included Elements	Comment
DM01	ITS Data Warehouse	This service package provides the same broad access to multimodal, multidimensional data from varied data sources as in the ITS Data Warehouse 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

Table of Contents

RAD-IT Outputs: Website





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

Transport Canada Transports Canada

Canada

So how is a Regional ITS Architecture Developed?

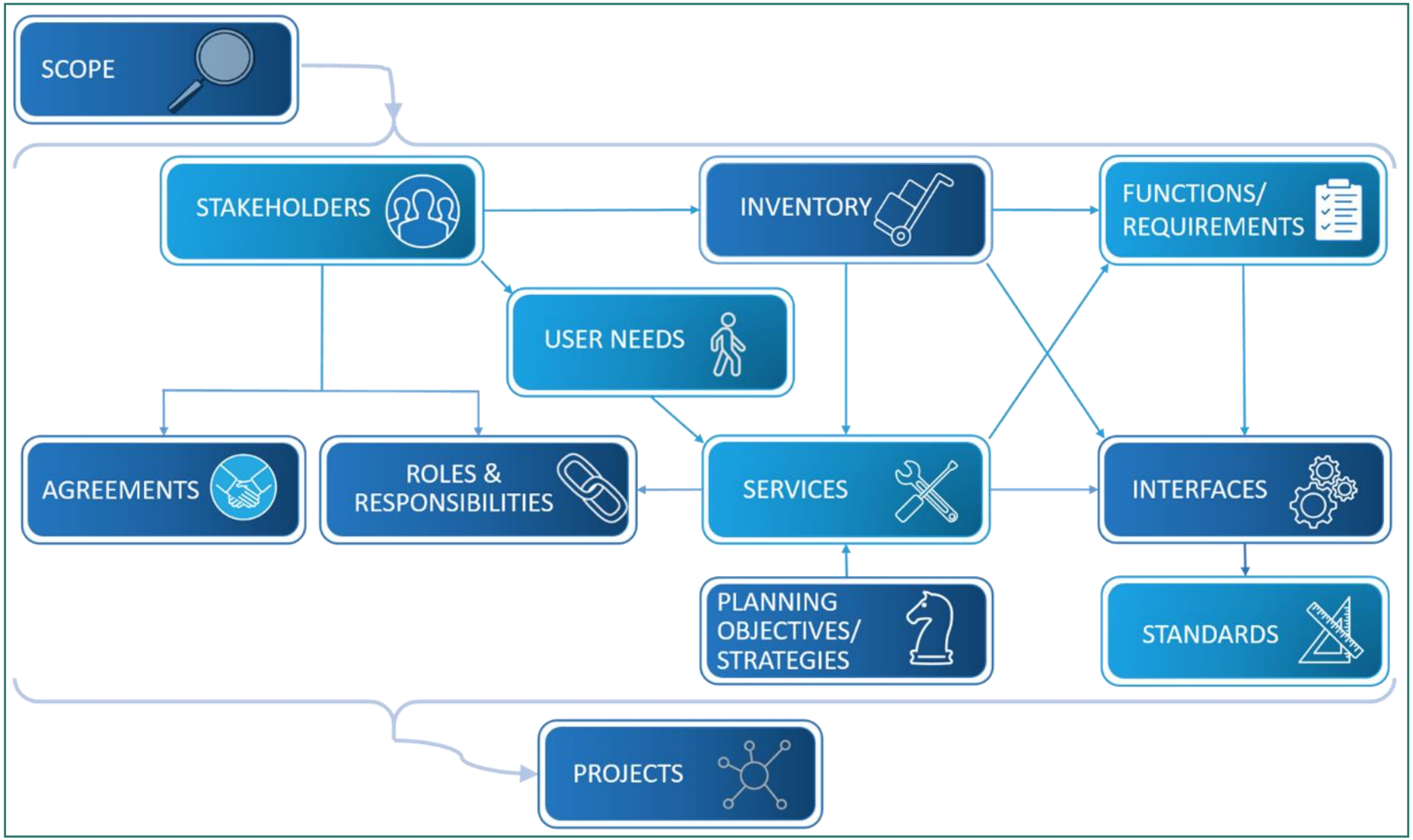
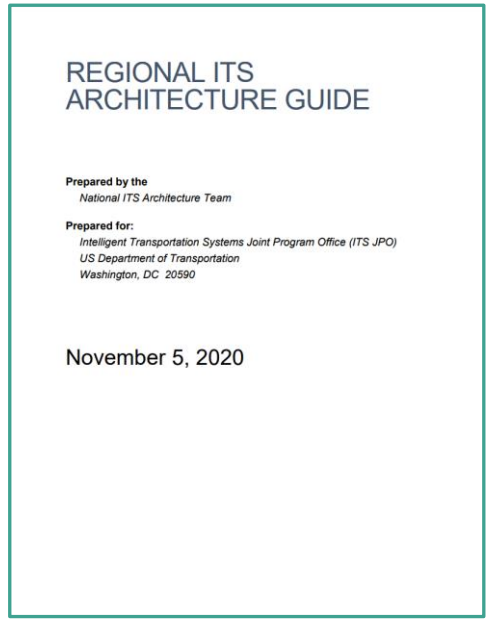


Image credit: U.S. DOT

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

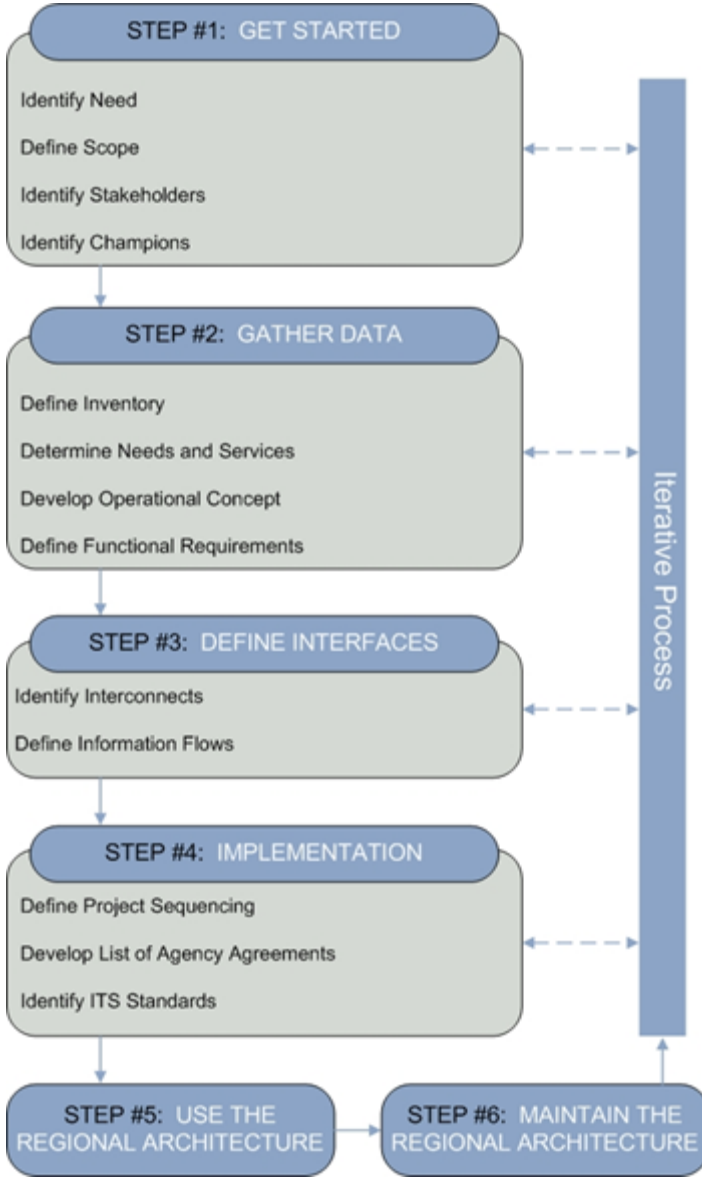
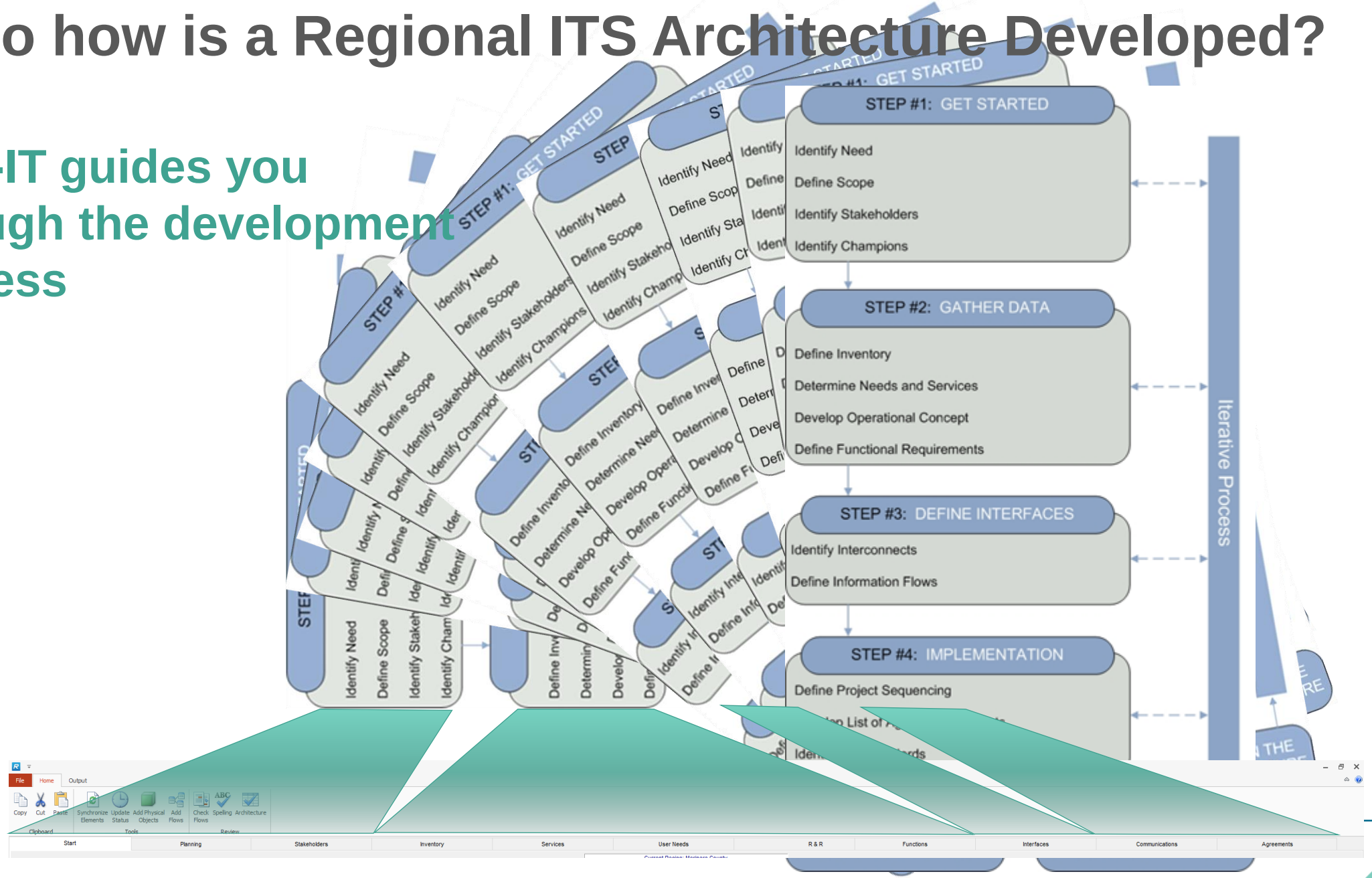


Image credit: Regional ITS Architecture Guide (2010 – previous version)

So how is a Regional ITS Architecture Developed?

RAD-IT guides you through the development process



Regional ITS Architecture Process

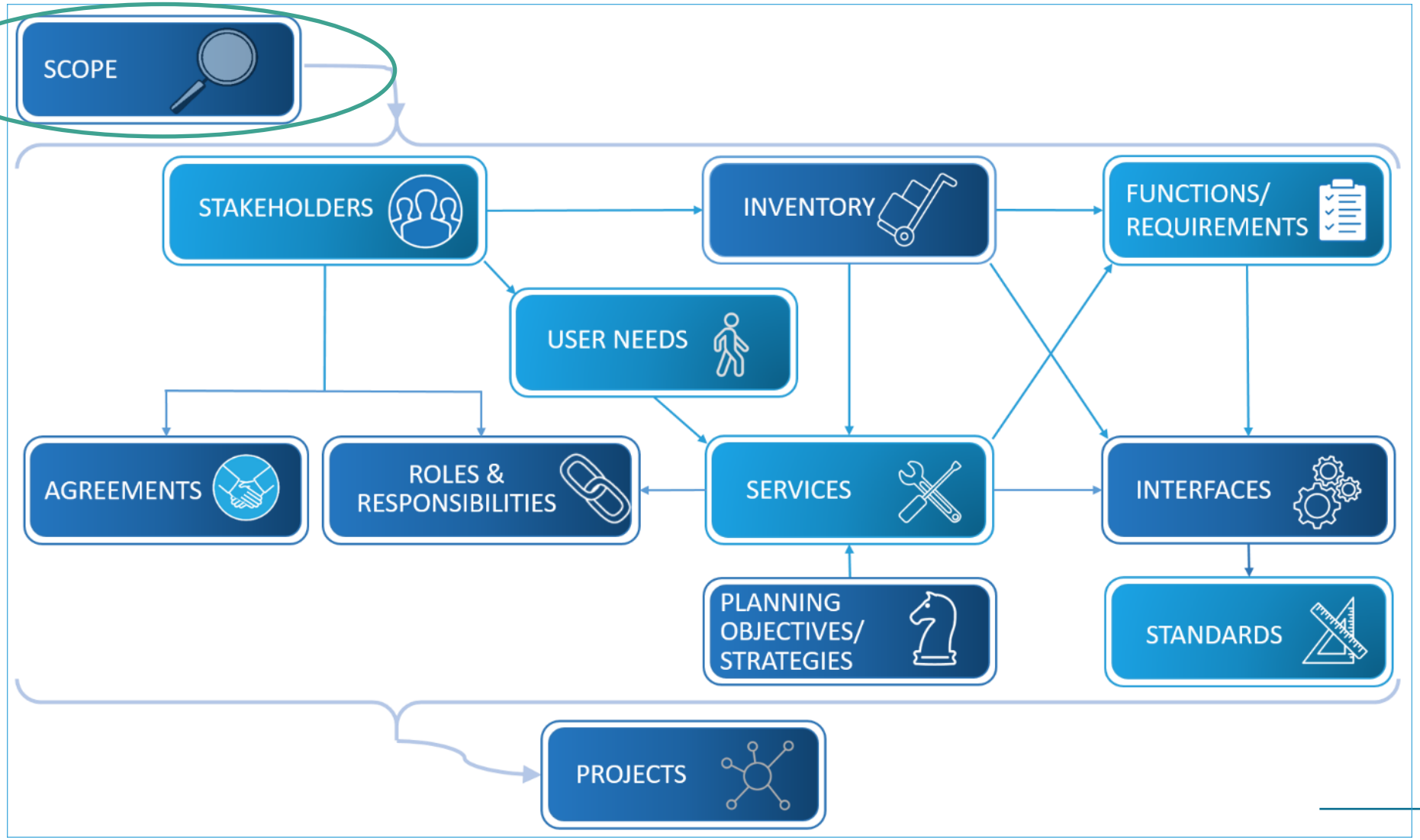
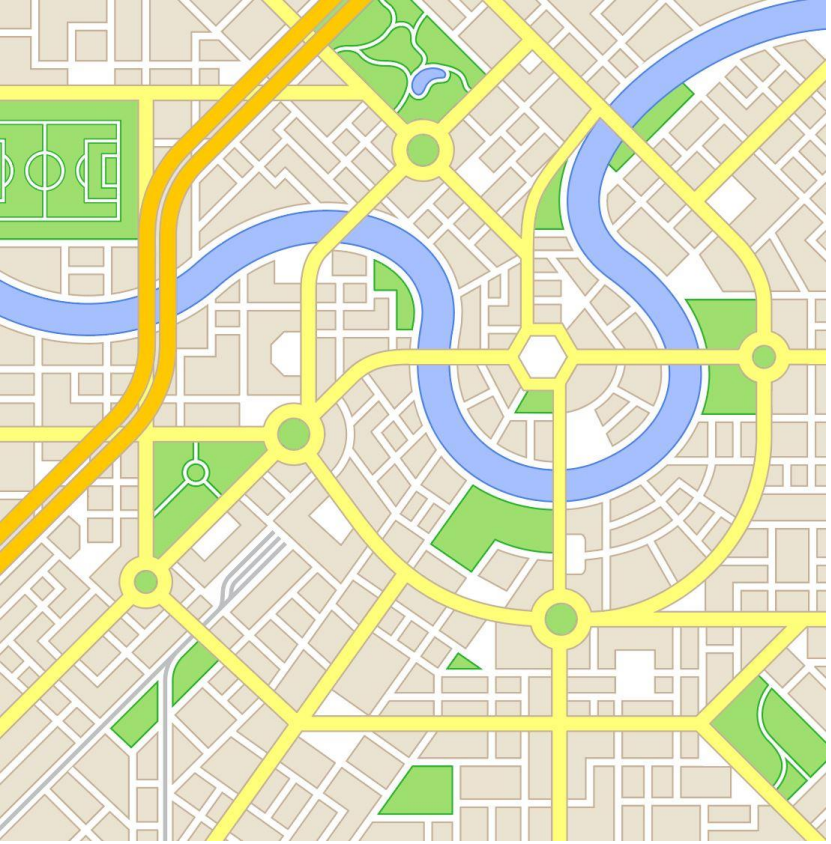


Image credit: U.S. DOT

Architecture Region - 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?

Corresponds to time horizon of:

Short

Capital Plan

5

Medium

10

Long

Transportation Master Plan

20

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

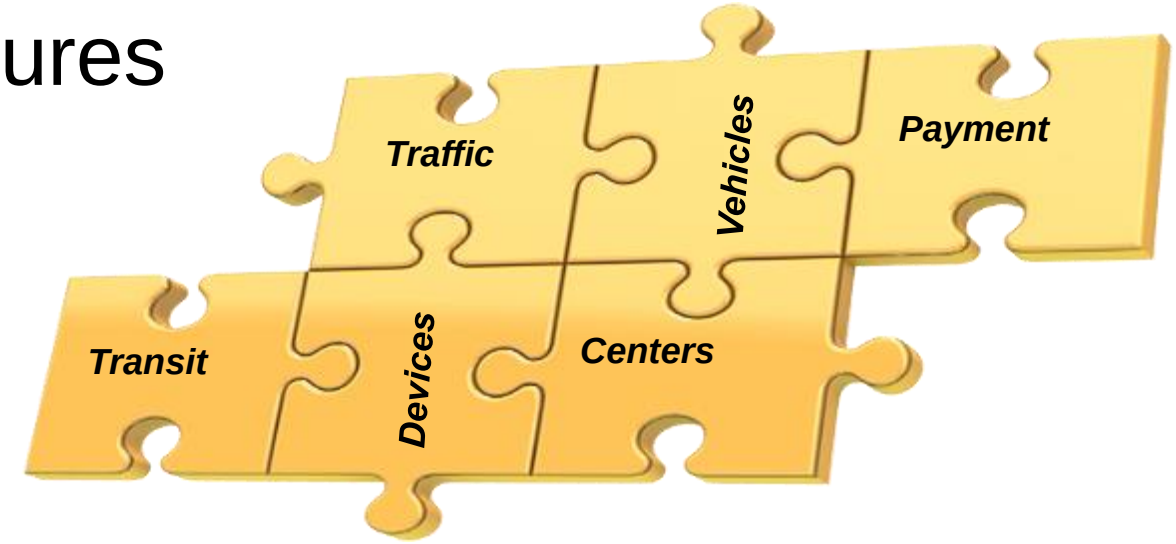
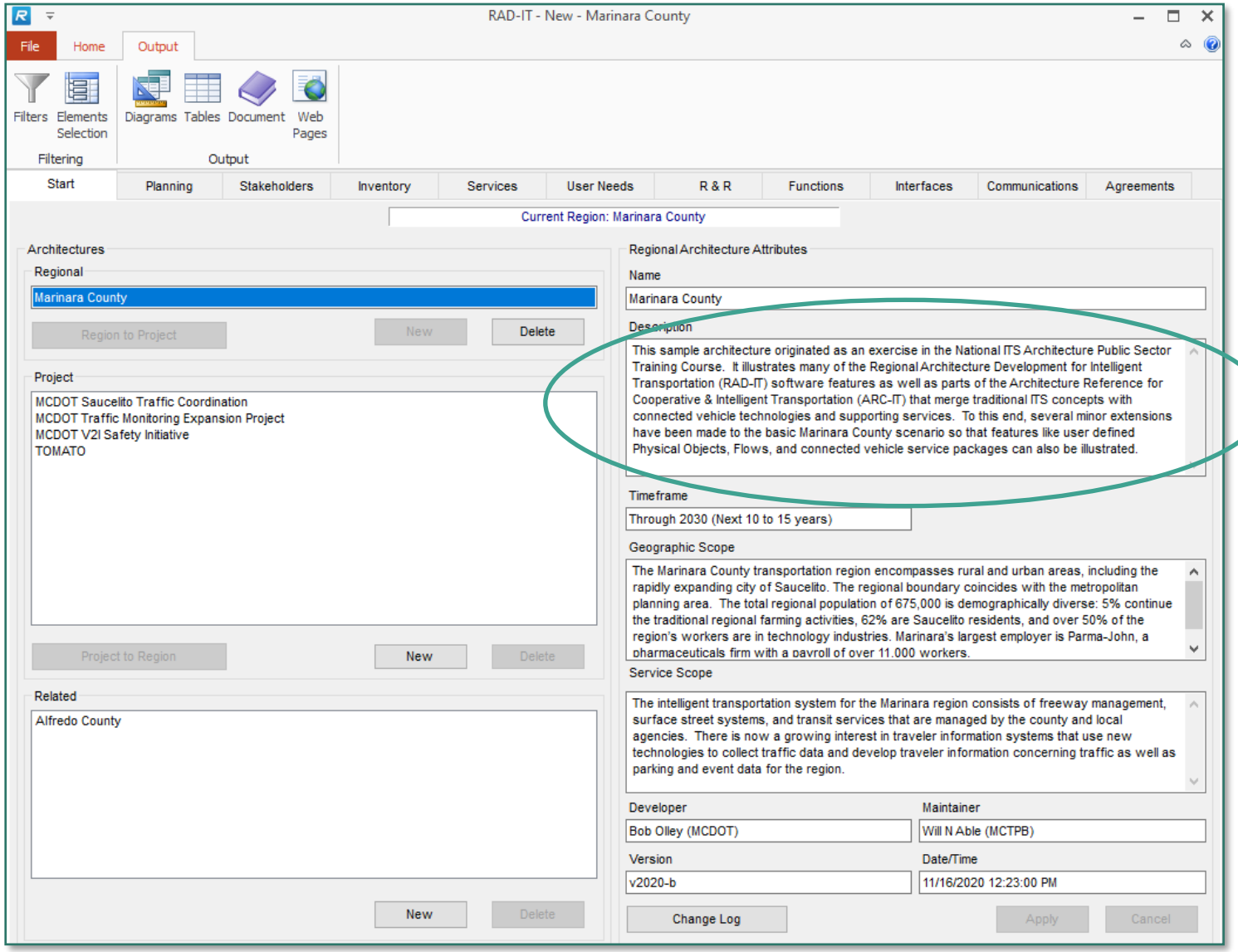


Image credit: U.S. DOT

RAD-IT – Scope (Start)



Web Output – Scope

RAD-IT

Marinara Regional ITS Architecture

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.

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.

Time Frame: 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 pharmaceuticals firm with a payroll of over 11,000 workers.

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.

Region for Peel Regional ITS Architecture (~2011)

Region of Peel
Working for you

DRAFT - Peel Regional ITS Architecture

Home
Project Background
Downloads
Scope
Stakeholders
Inventory
Services
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.

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.

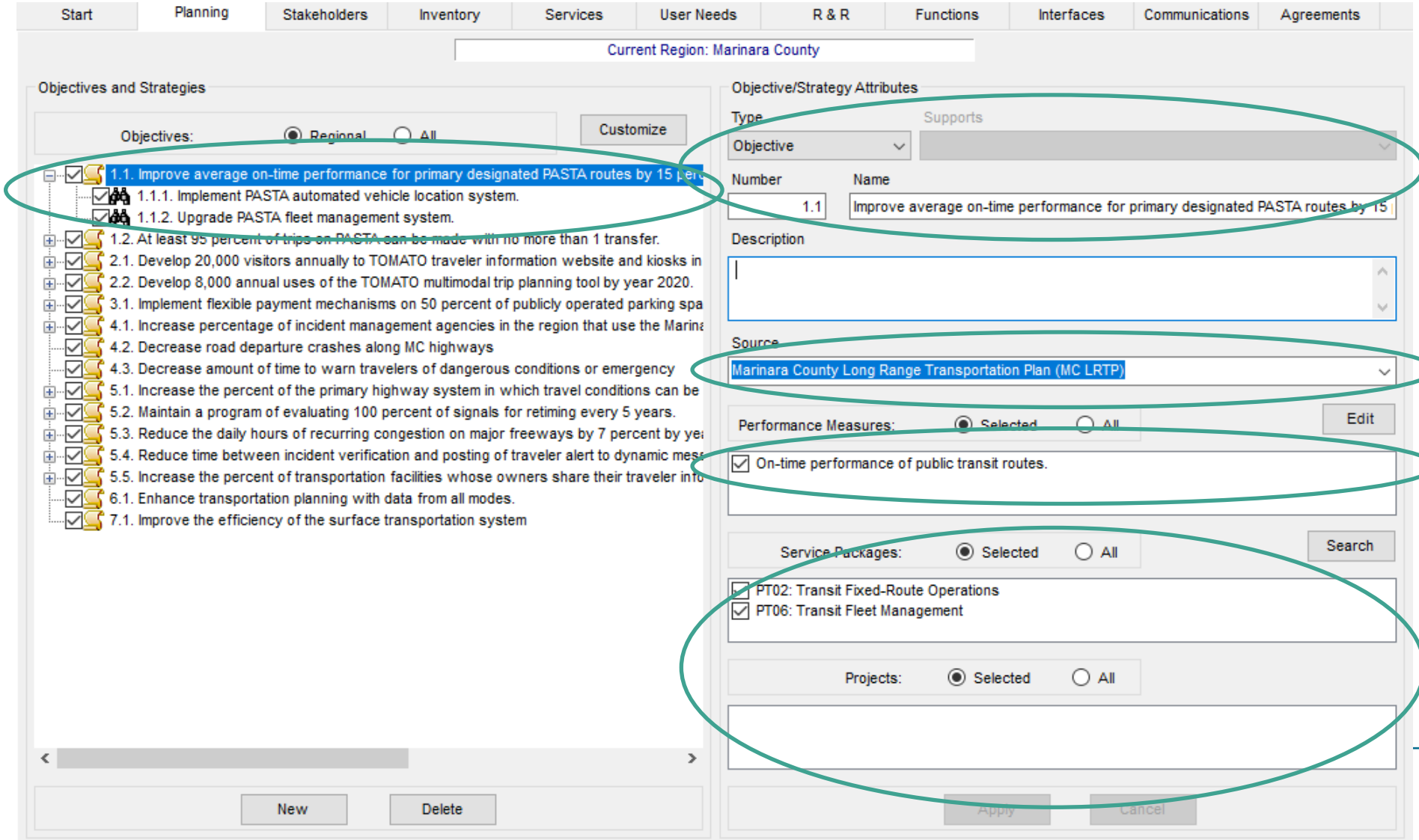
Service Scope

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



Web Output – Planning

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

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.

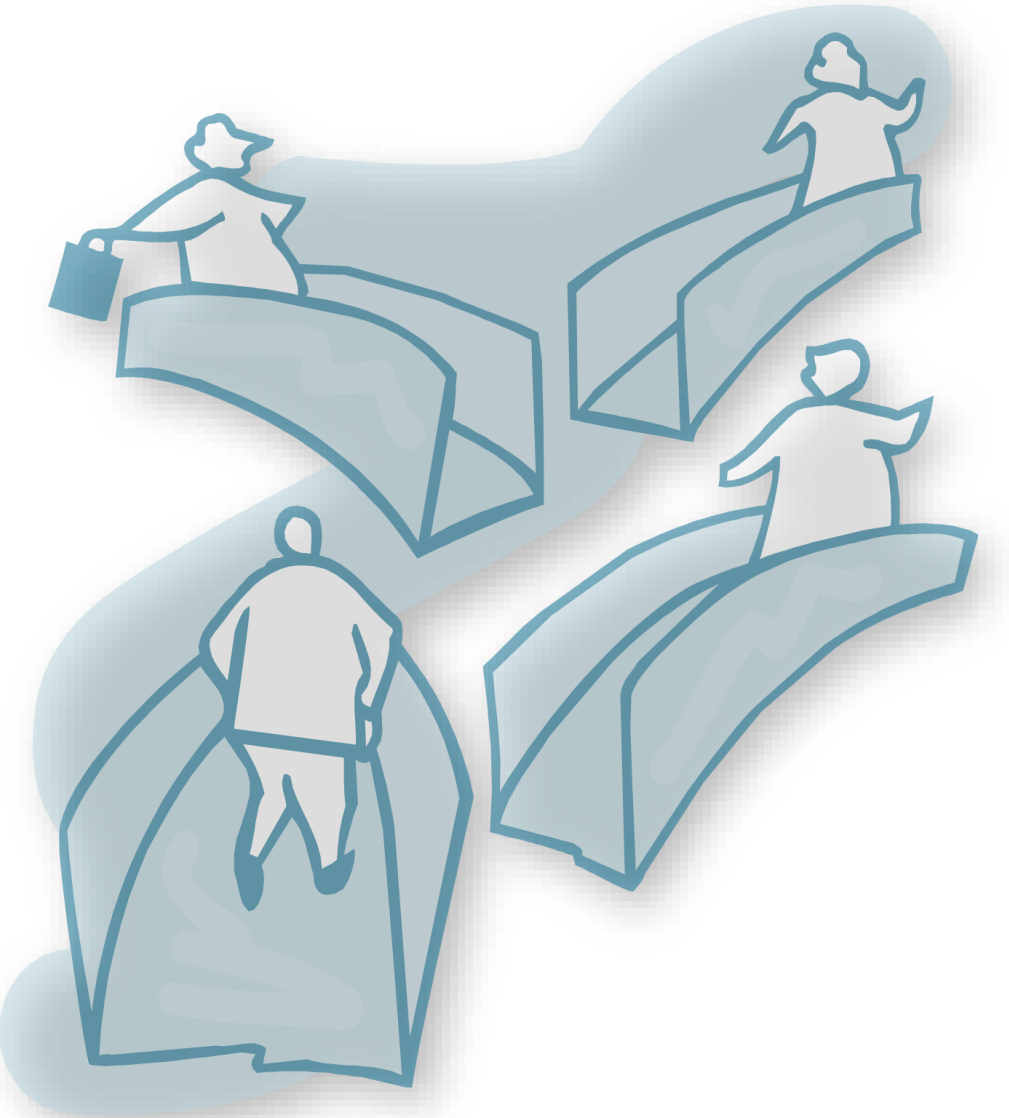
Associated Performance Measures

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

Associated Service Packages

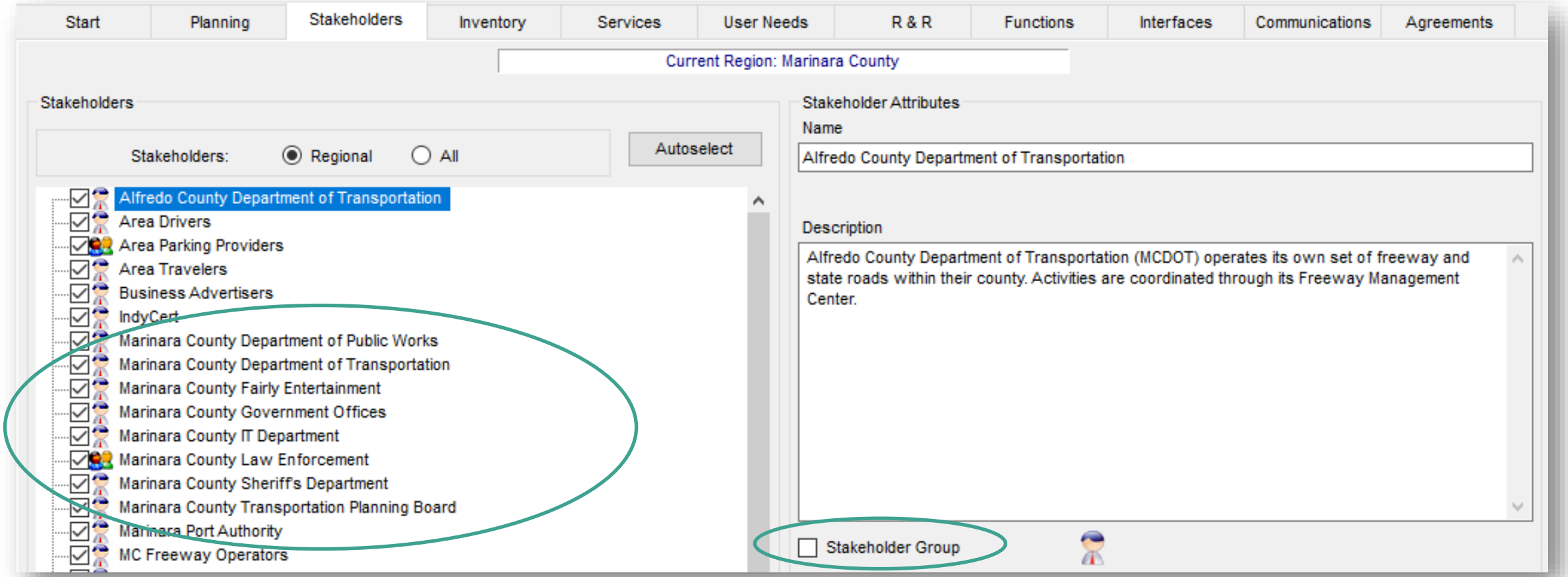
PT02: Transit Fixed–Route Operations
PT06: Transit Fleet Management

Stakeholders

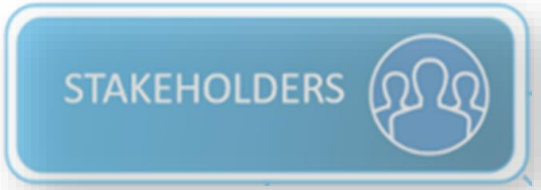


Someone who deploys, owns, operates, maintains, or is impacted by an ITS system.

RAD-IT – Stakeholders



Web Output – Stakeholders



RAD-IT

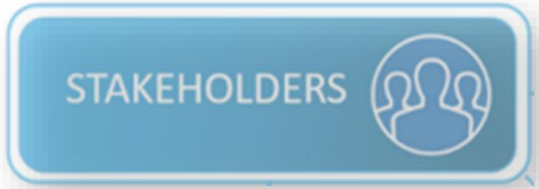
Marinara Regional ITS Architecture

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
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.

Region for Peel Regional ITS Architecture (~2011)



Region of Peel
Working for you

DRAFT - Peel Regional ITS Architecture

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*

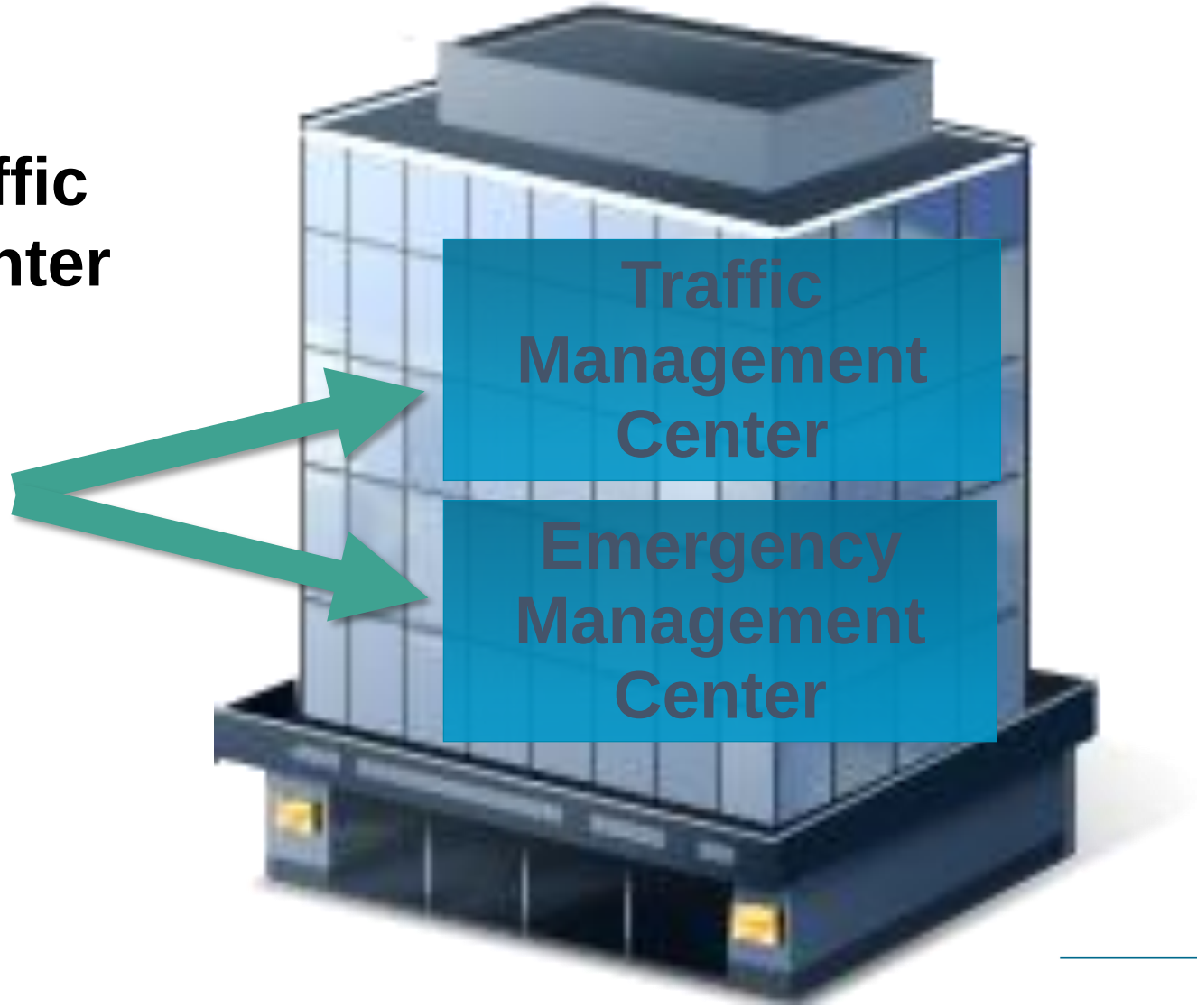
Mapping Elements to Physical Objects

INVENTORY

Element:

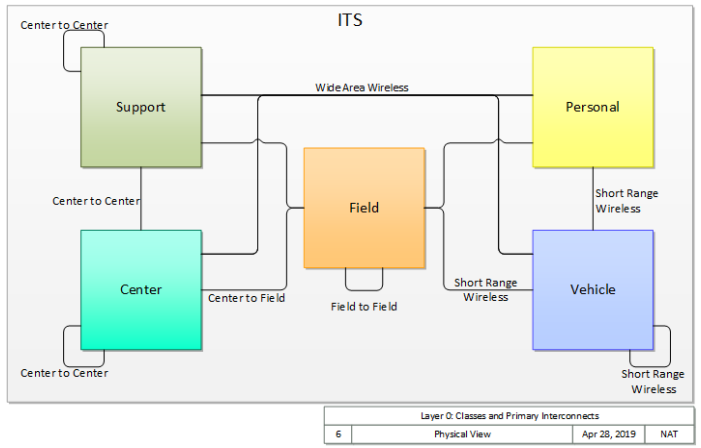
Provincial Traffic Operations Center

Physical Objects

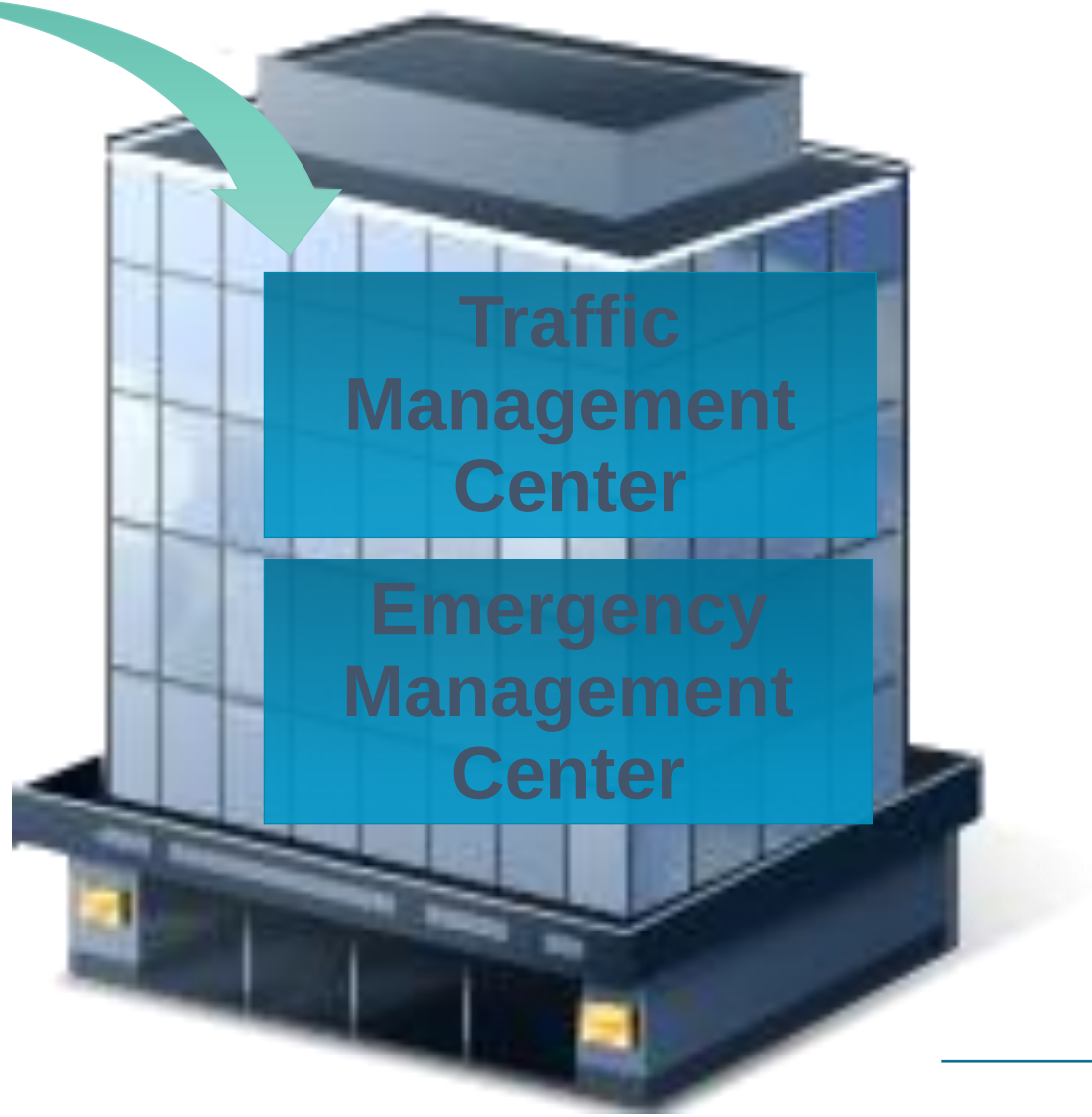


Adapted from: U.S. DOT

Importance of Mapping to Physical Objects

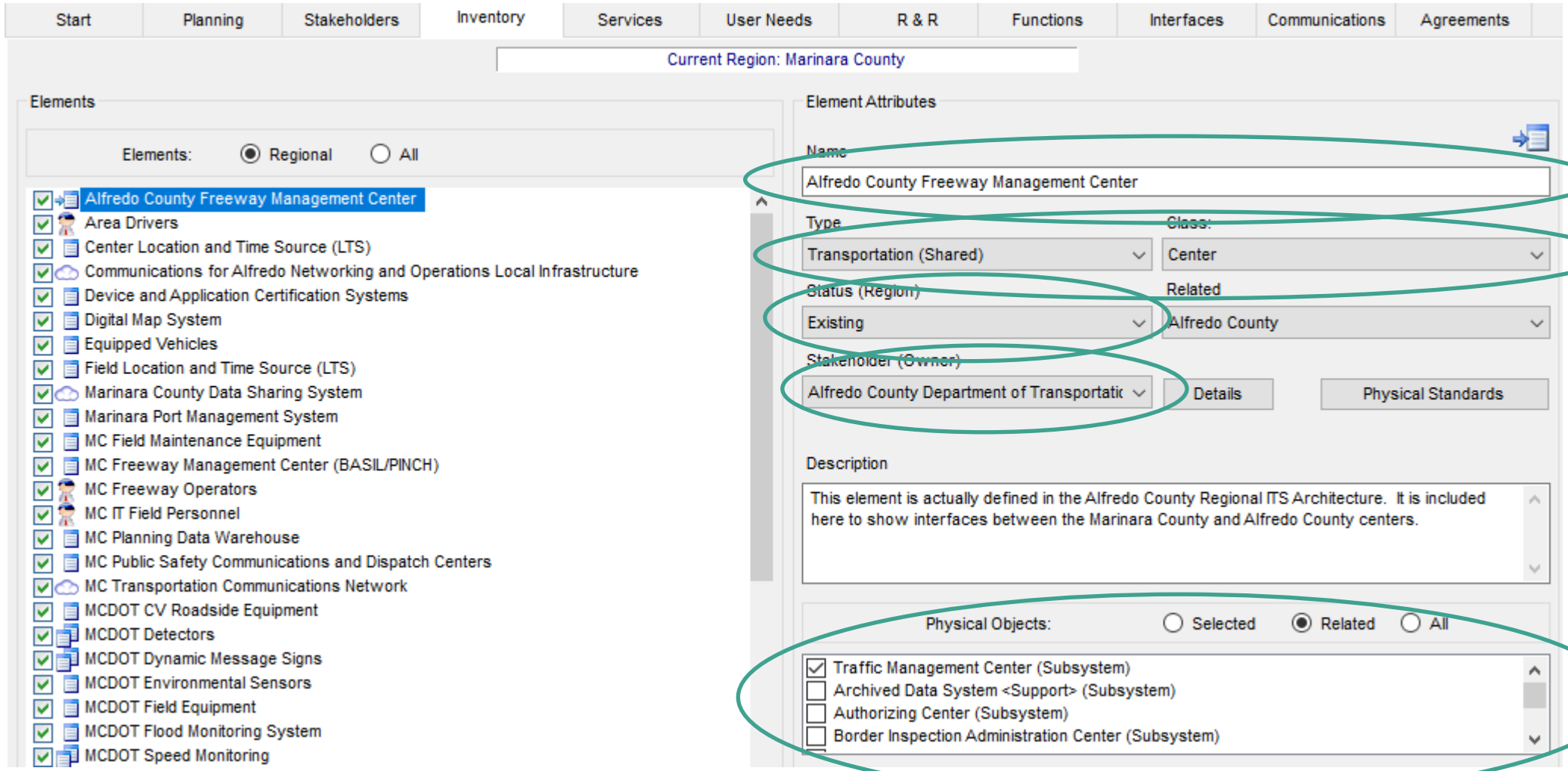


- **Requirements**
- **Interfaces**
- **Standards**



Adapted from: U.S. DOT

RAD-IT – Inventory



Web Output – Inventory

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

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

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

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

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

Marinara Regional ITS Architecture

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

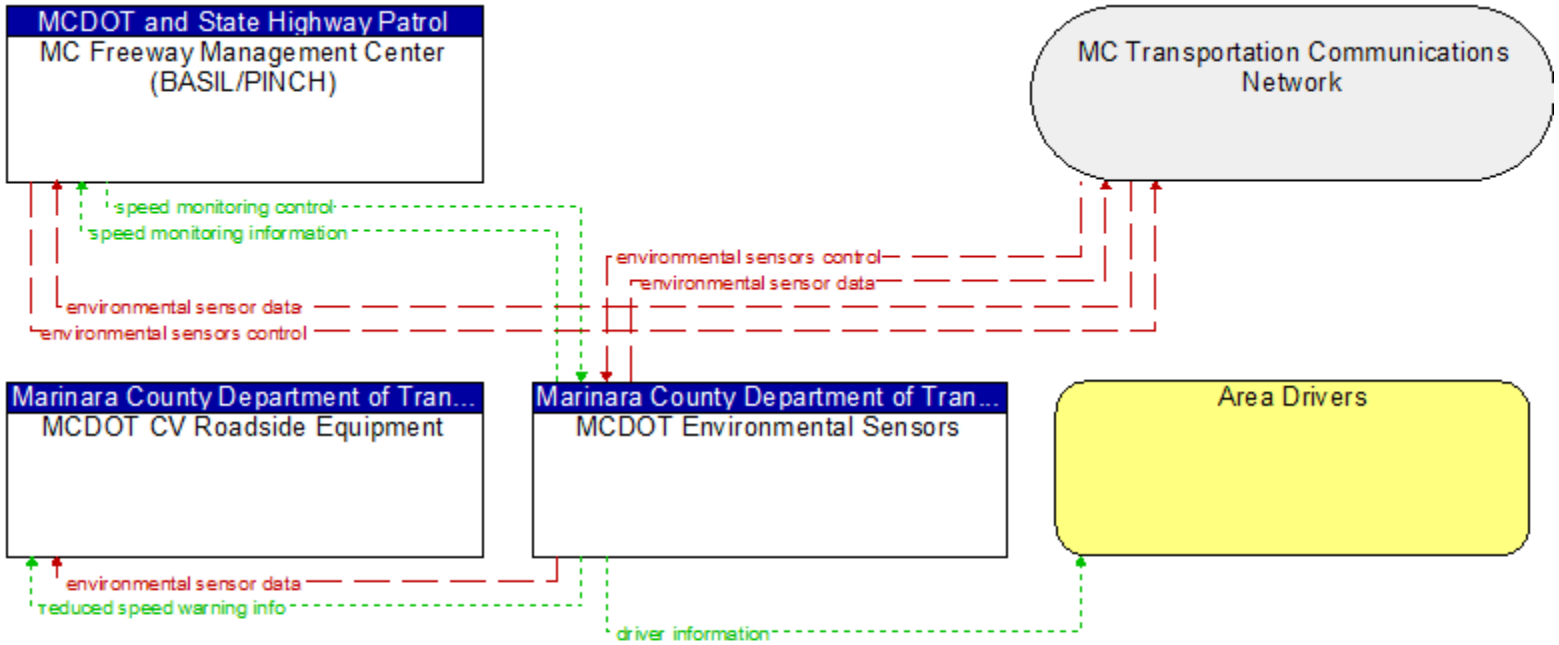
Functional Objects

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)



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

SERVICES

- ITS services in the ARC-IT

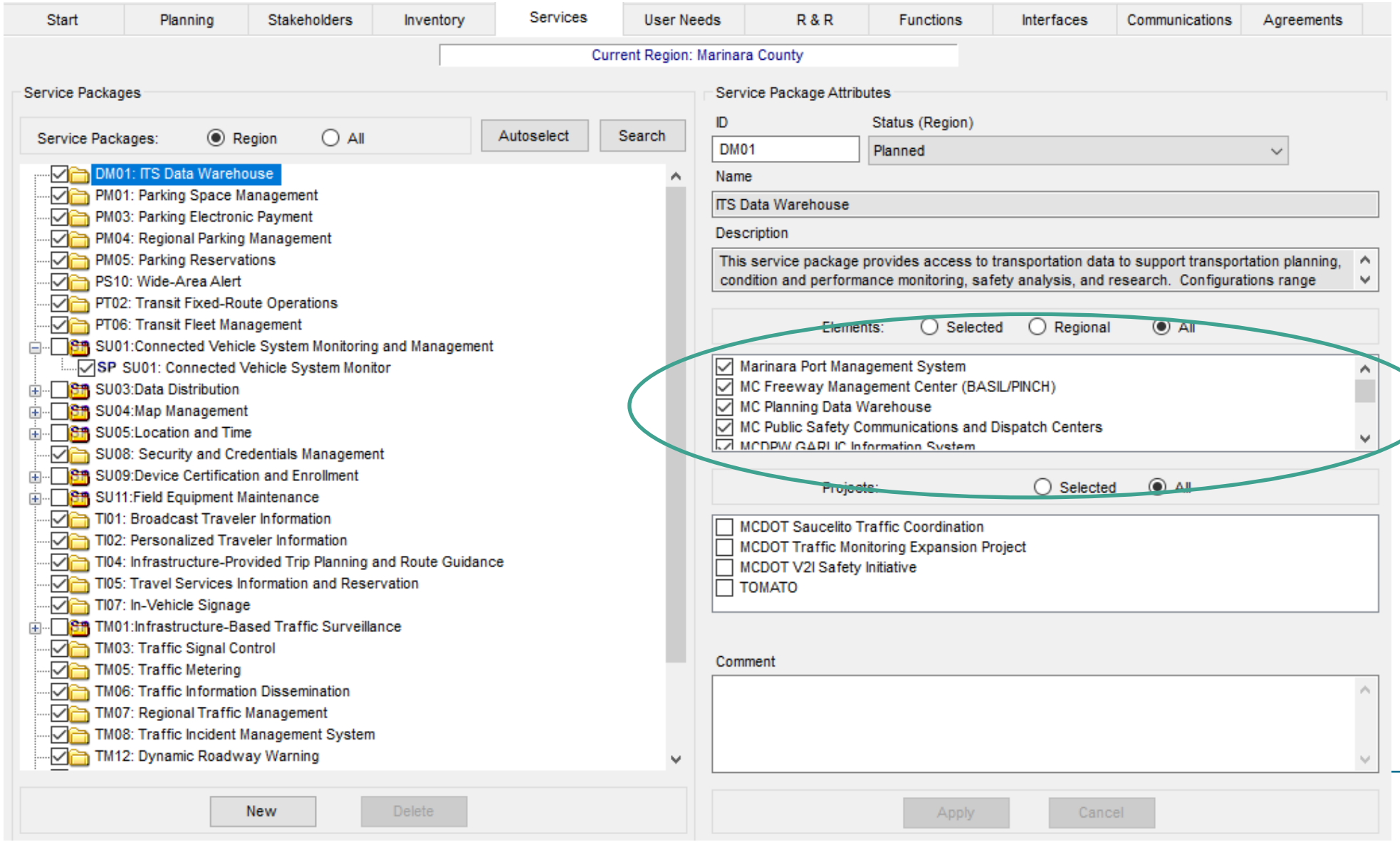
Service Packages and a Regional ITS Architecture

SERVICES

- 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



Web Output – Services

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

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.

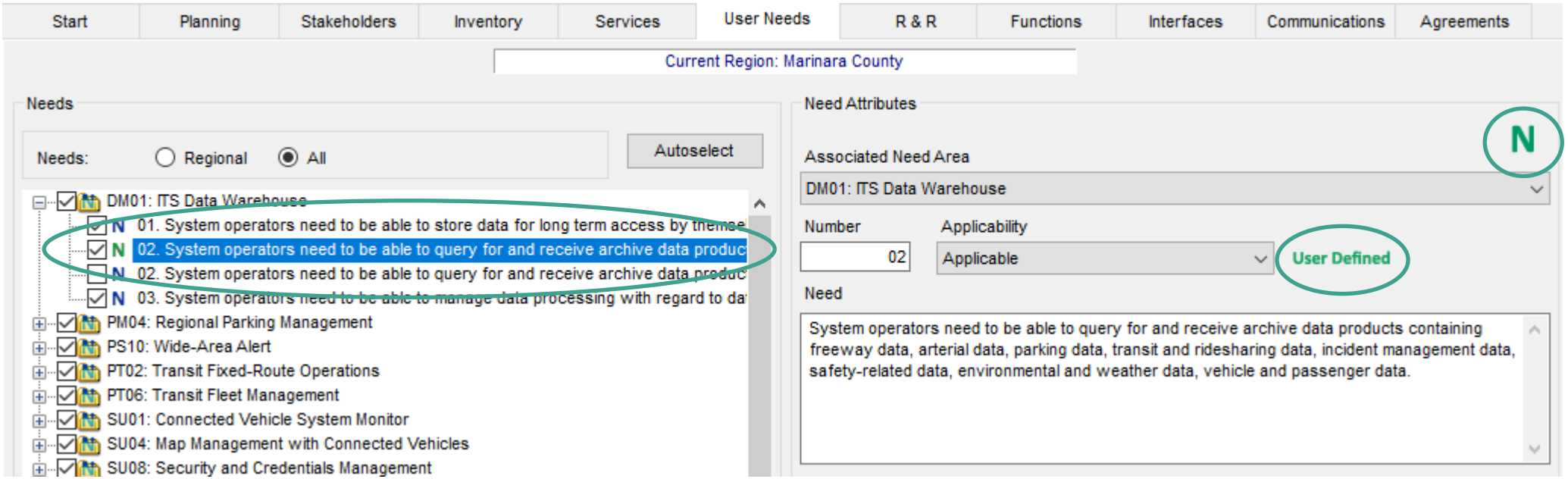
Service Package	Service Package Name	Status
DM01	ITS Data Warehouse	Planned
PM01	Parking Space Management	Planned
PM03	Parking Electronic Payment	Planned
PM04	Regional Parking Management	Planned
PM05	Parking Reservations	Future
PS10	Wide–Area Alert	Planned
PT02	Transit Fixed–Route Operations	Existing

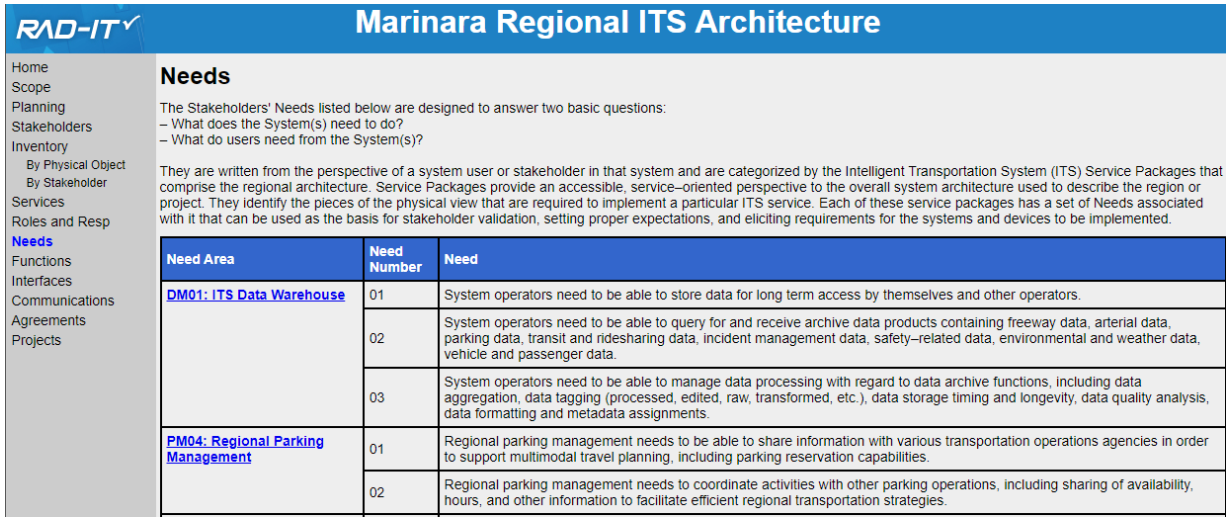
User Needs

- 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



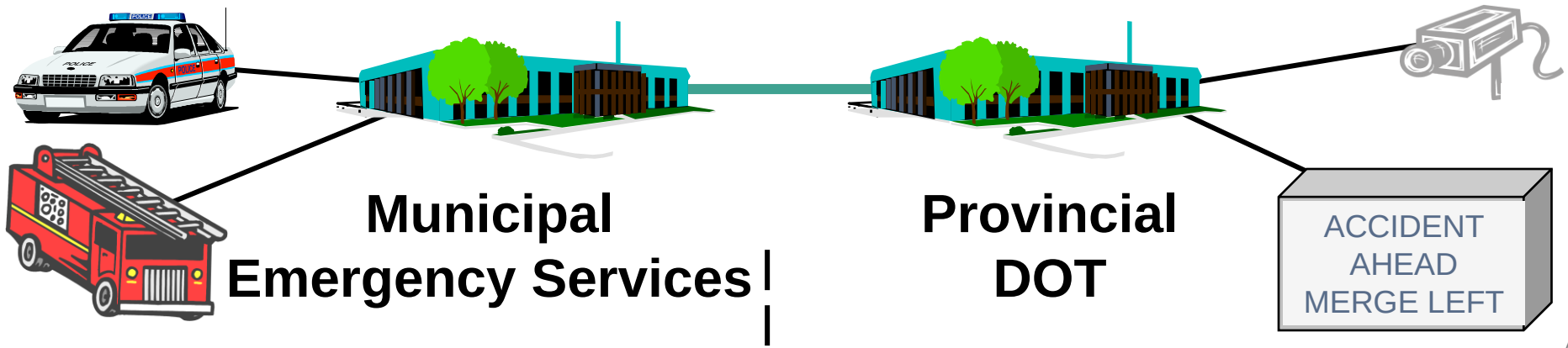


Roles and Responsibilities

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

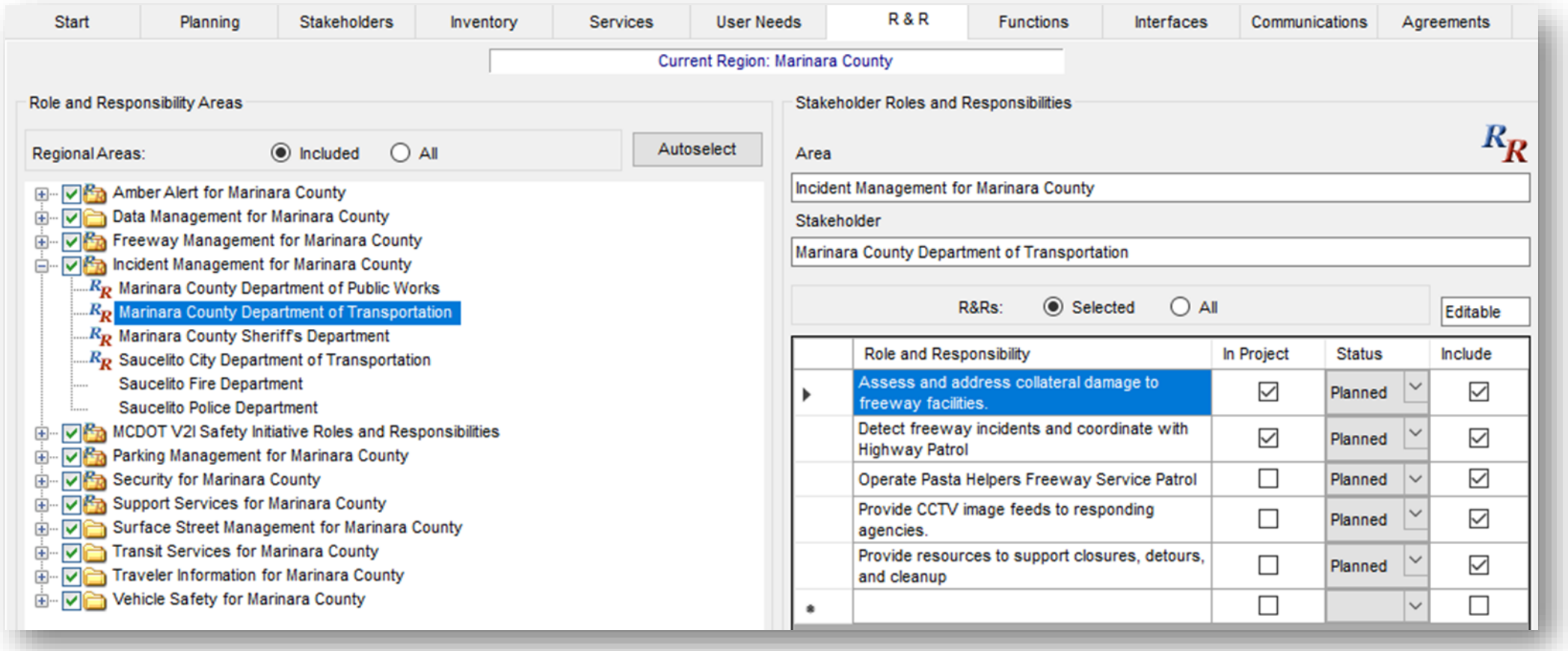
Municipal Emergency Services

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

Provincial DOT

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

RAD-IT – Roles & Responsibilities



Web Output – Roles & Responsibilities

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

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.

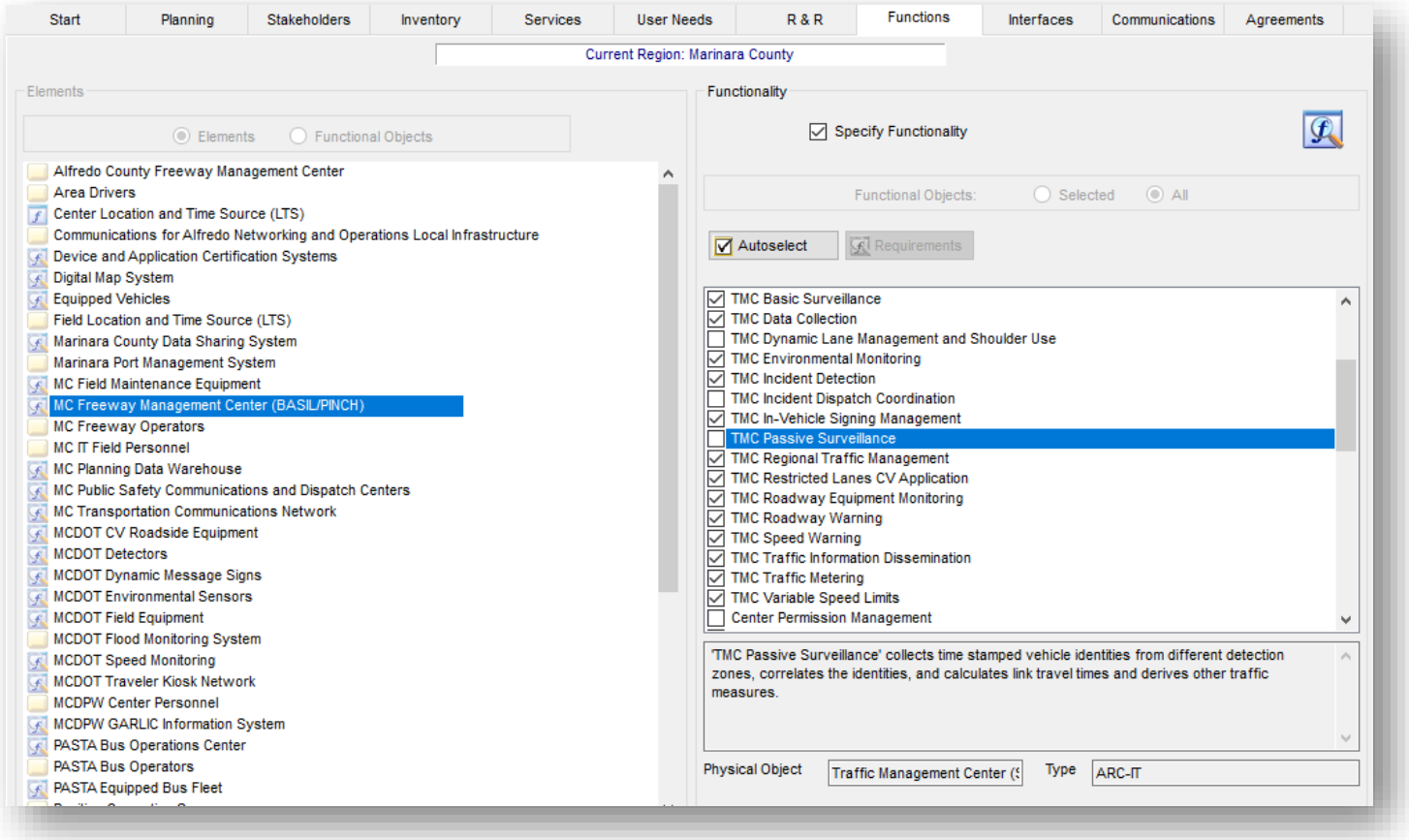
Functional Requirements

- 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)

FUNCTIONS/ REQUIREMENTS

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)

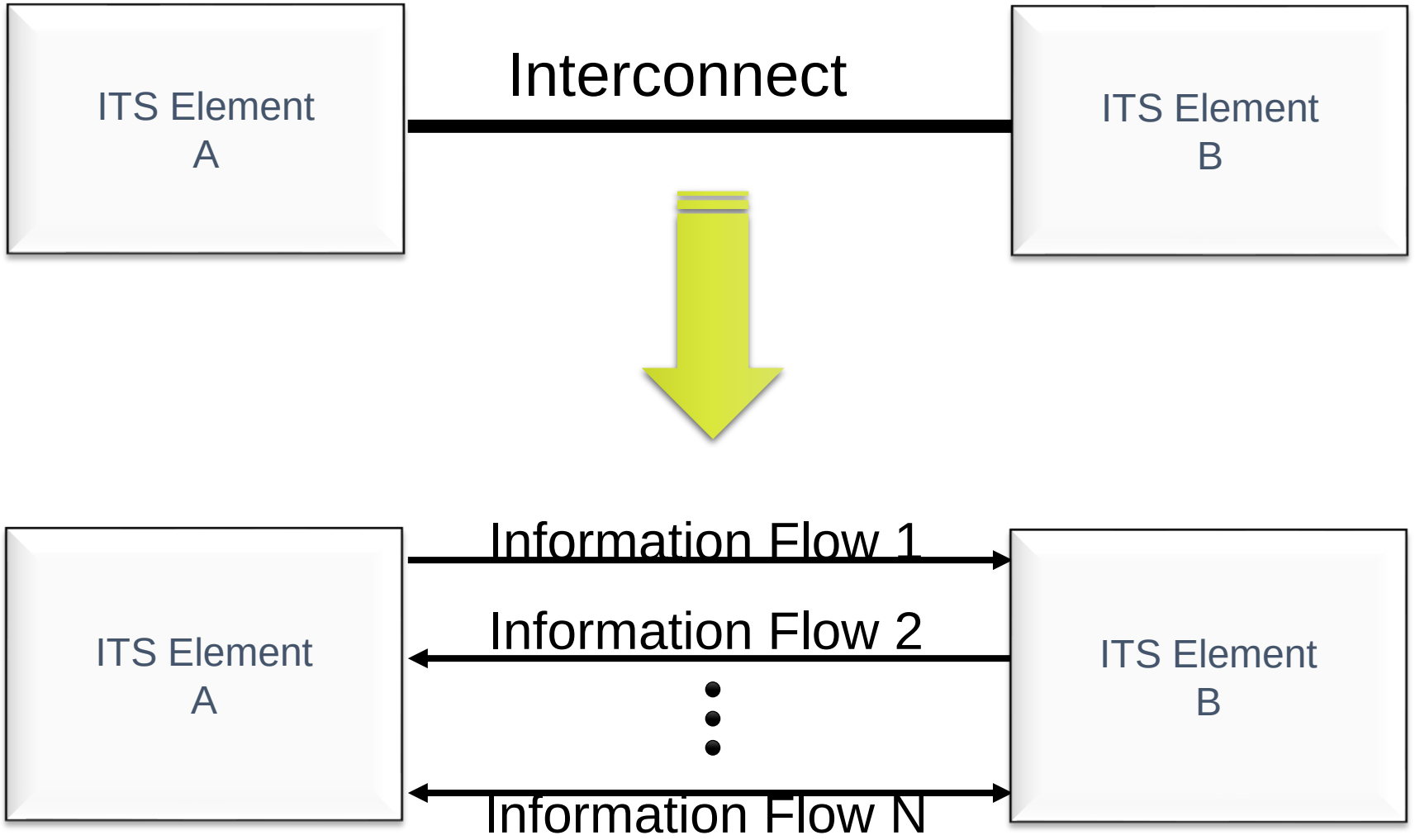
Number	Requirement	Status	Include	User Defined
01	The traffic center shall remotely control environmental sensors that measure road surface conditions including temperature, moisture, icing, salinity, and other measures.	Planned	☑	☐
02	The traffic center shall remotely control environmental sensors that measure weather conditions including temperature, wind, humidity, precipitation, and visibility.	Planned	☑	☐
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	☑	☐
04	The traffic center shall be able to receive road condition information from weather service providers.	Not Applicable	☐	☐
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	☑	☐
06	The traffic center shall be able to share the collected environmental data with Maintenance and construction operations.	Not Applicable	☐	☐
07	The traffic center shall provide drivers road weather advisories.	Not Applicable	☐	☐

Interfaces

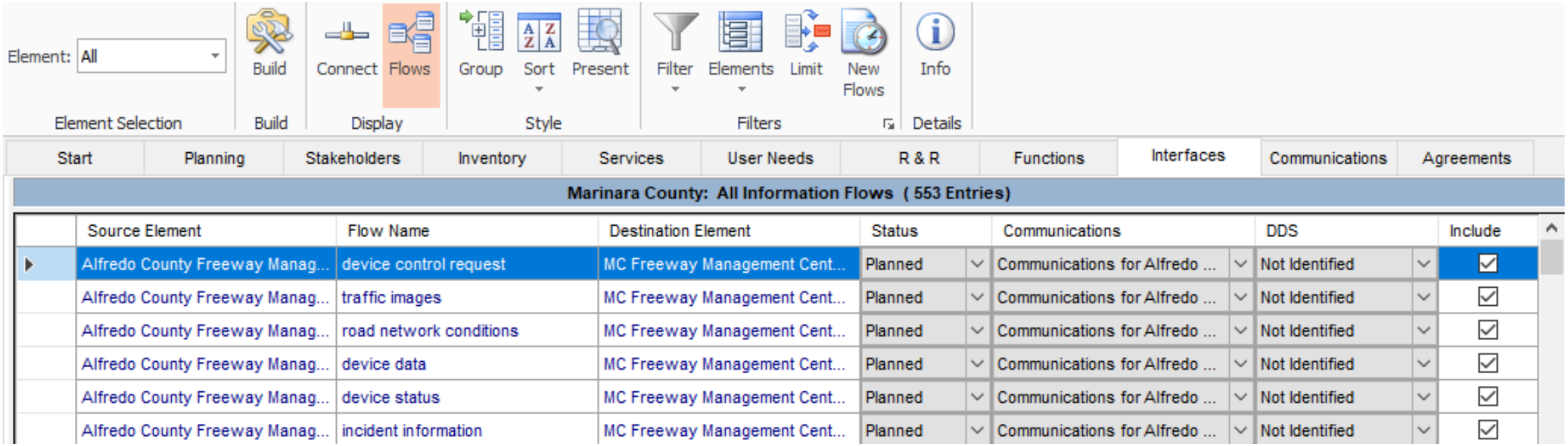
- Identify Interconnects
  Which systems will share info?

- Define Information Flows
  What information will they share?

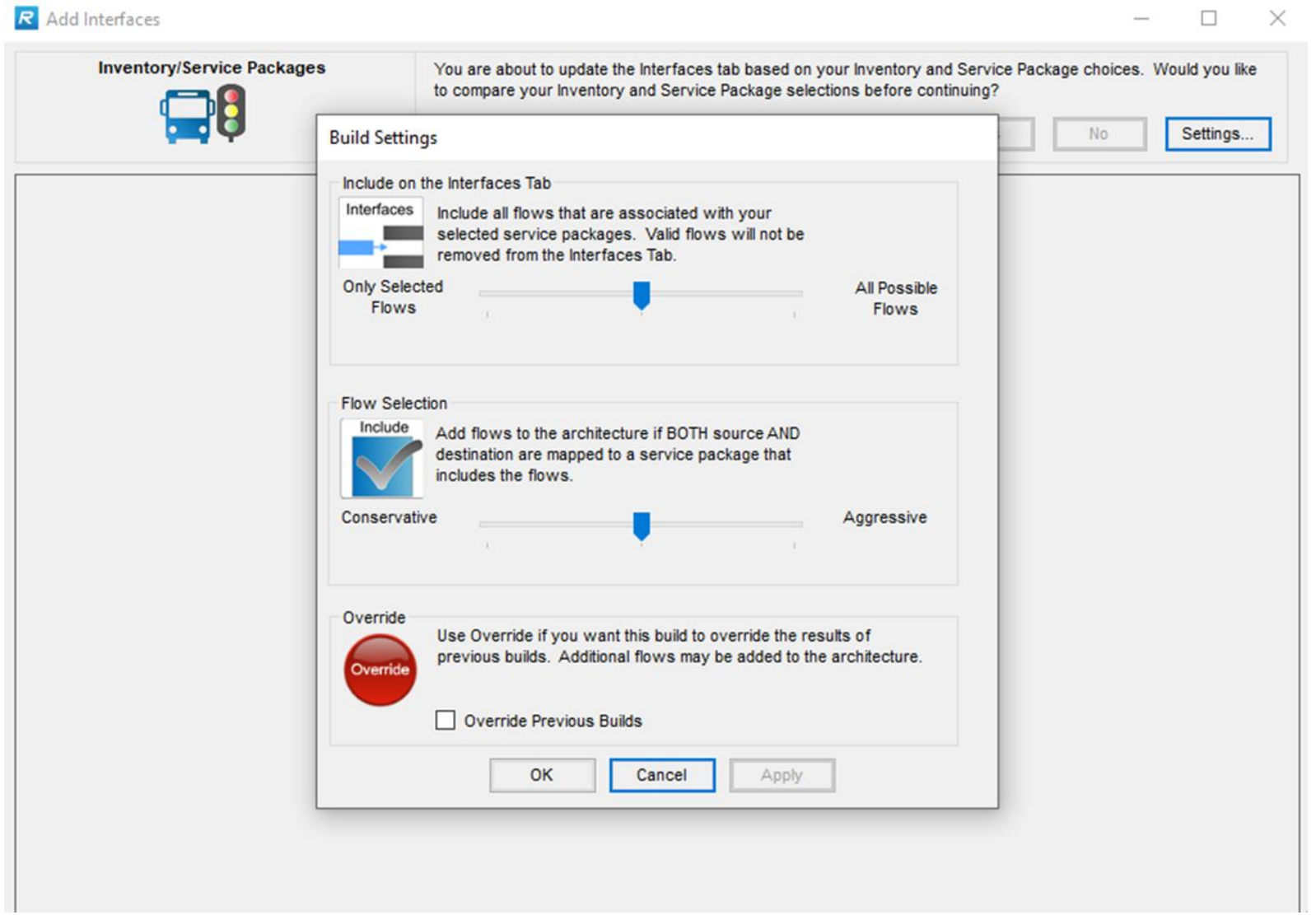
Interconnects are made up of Information Flows



RAD-IT – Interfaces

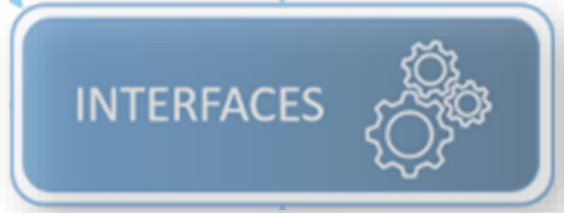


RAD-IT – Interfaces



- 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



RAD-IT

Marinara Regional ITS Architecture

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.

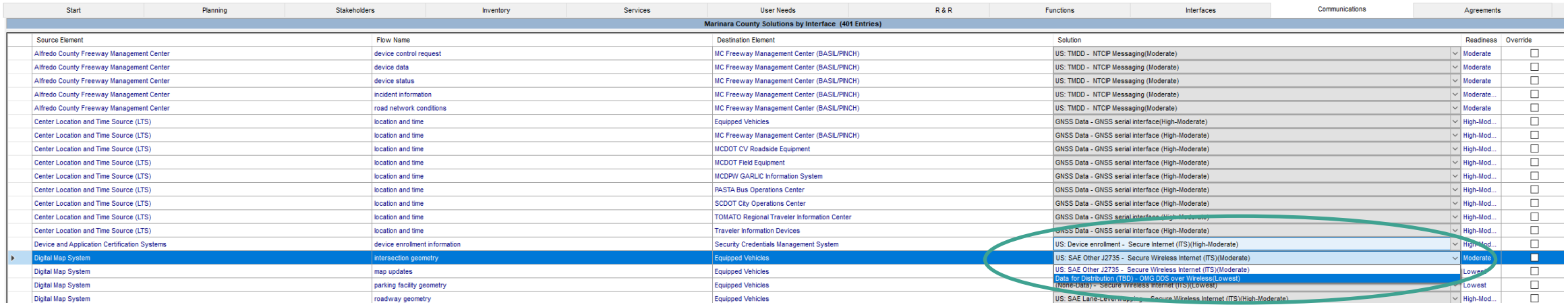
Element	Interfacing Element	Status
Alfredo County Freeway Management Center	MC Freeway Management Center (BASIL/PINCH)	Planned
Area Drivers	Equipped Vehicles	Planned
	MCDOT Detectors	Future
	MCDOT Dynamic Message Signs	Existing
	MCDOT Environmental Sensors	Future
	MCDOT Field Equipment	Existing
	MCDOT 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

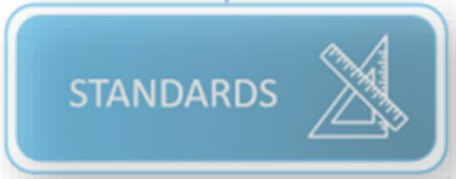


Start | Planning | Stakeholders | Inventory | Services | User Needs | R & R | Functions | Interfaces | Communications | Agreements

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 (BASIL/PINCH)	US: TMDD - NTCIP Messaging(Moderate)	Moderate	
Alfredo County Freeway Management Center	device data	MC Freeway Management Center (BASIL/PINCH)	US: TMDD - NTCIP Messaging (Moderate)	Moderate	
Alfredo County Freeway Management Center	device status	MC Freeway Management Center (BASIL/PINCH)	US: TMDD - NTCIP Messaging (Moderate)	Moderate	
Alfredo County Freeway Management Center	incident information	MC Freeway Management Center (BASIL/PINCH)	US: TMDD - NTCIP Messaging (Moderate)	Moderate...	
Alfredo County Freeway Management Center	road network conditions	MC Freeway Management Center (BASIL/PINCH)	US: TMDD - NTCIP Messaging(Moderate)	Moderate	
Center Location and Time Source (LTS)	location and time	Equipped Vehicles	GNSS Data - GNSS serial interface(High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	MC Freeway Management Center (BASIL/PINCH)	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	MCDOT CV Roadside Equipment	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	MCDOT Field Equipment	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	MCDPW GARLIC Information System	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	PASTA Bus Operations Center	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	SCDOT City Operations Center	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	TOMATO Regional Traveler Information Center	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Center Location and Time Source (LTS)	location and time	Traveler Information Devices	GNSS Data - GNSS serial interface (High-Moderate)	High-Mod...	
Device and Application Certification Systems	device enrollment information	Security Credentials Management System	US: Device enrollment - Secure Internet (ITS)(High-Moderate)	High-Mod...	
Digital Map System	intersection geometry	Equipped Vehicles	US: SAE Other J2735 - Secure Wireless Internet (ITS)(Moderate)	Moderate	
Digital Map System	map updates	Equipped Vehicles	US: SAE Other J2735 - Secure Wireless Internet (ITS)(Moderate)	Lowest	
Digital Map System	parking facility geometry	Equipped Vehicles	Data for Distribution (TBD) - OMG DDS over Wireless(Lowest)	Lowest	
Digital Map System	roadway geometry	Equipped Vehicles	(None-Data) - Secure Wireless Internet (ITS)(Lowest)	High-Mod...	

Standards from Marinara



RAD-IT

Marinara Regional ITS Architecture

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 charcateristics. 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.

...

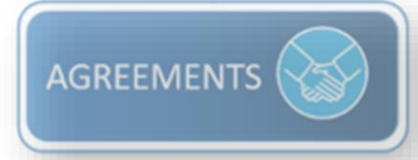
Supports Interfaces

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

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

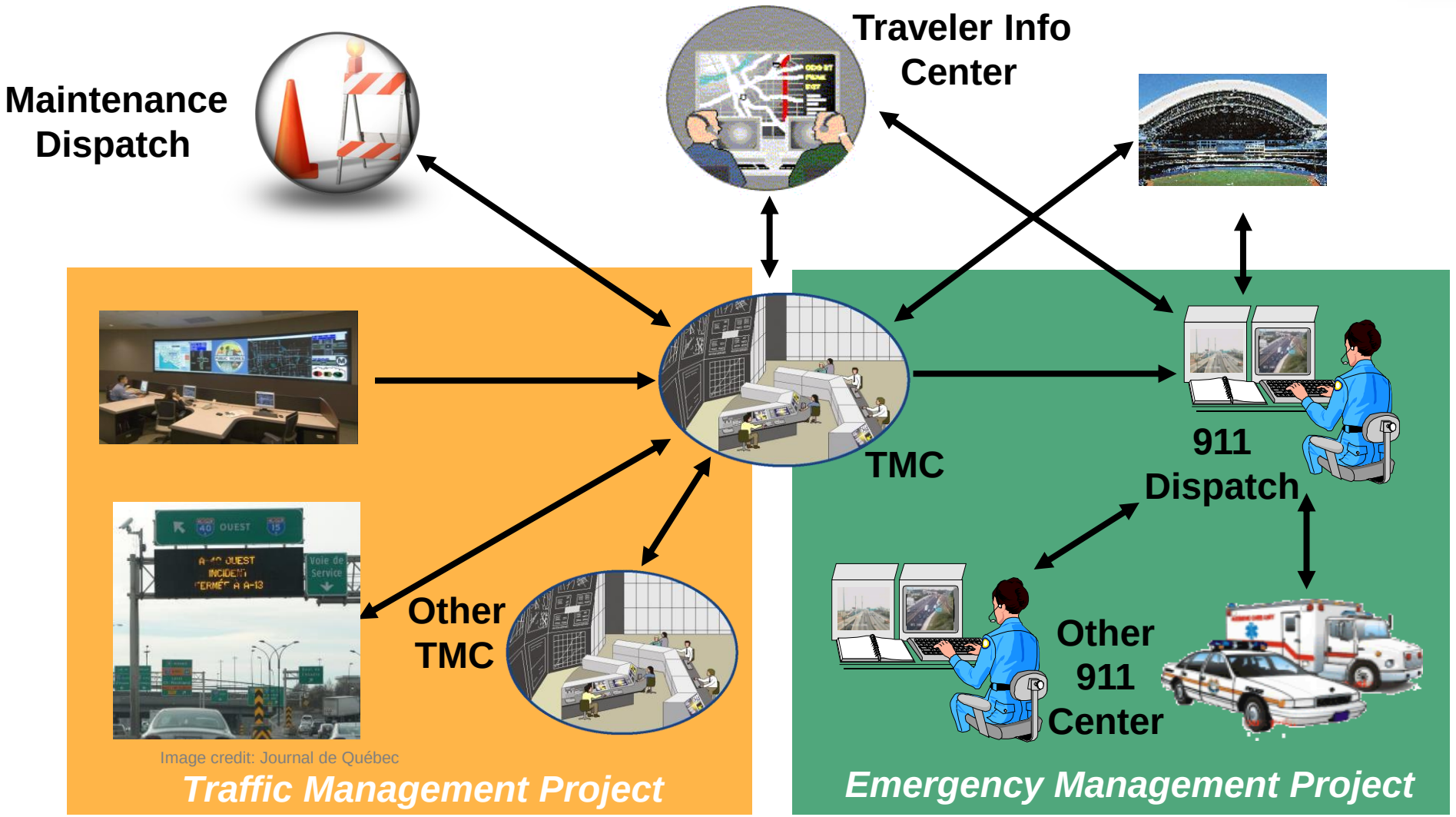


Image credit: Journal de Québec

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
Needs
Functions
Interfaces
Communications
Agreements
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

Transport Canada Transports Canada

Thank You for Joining!

Systems Engineering Training

December 13, 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.

Disclaimer

- Transport Canada does not endorse products or companies. Reference to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favouring by Transport Canada and shall not be used for advertising or service endorsement purposes.
- Transport Canada is not responsible for errors or omissions in this document and makes no representations as to the accuracy or completeness of the information. Content provided by external sources is not subject to official languages, privacy and accessibility requirements.

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

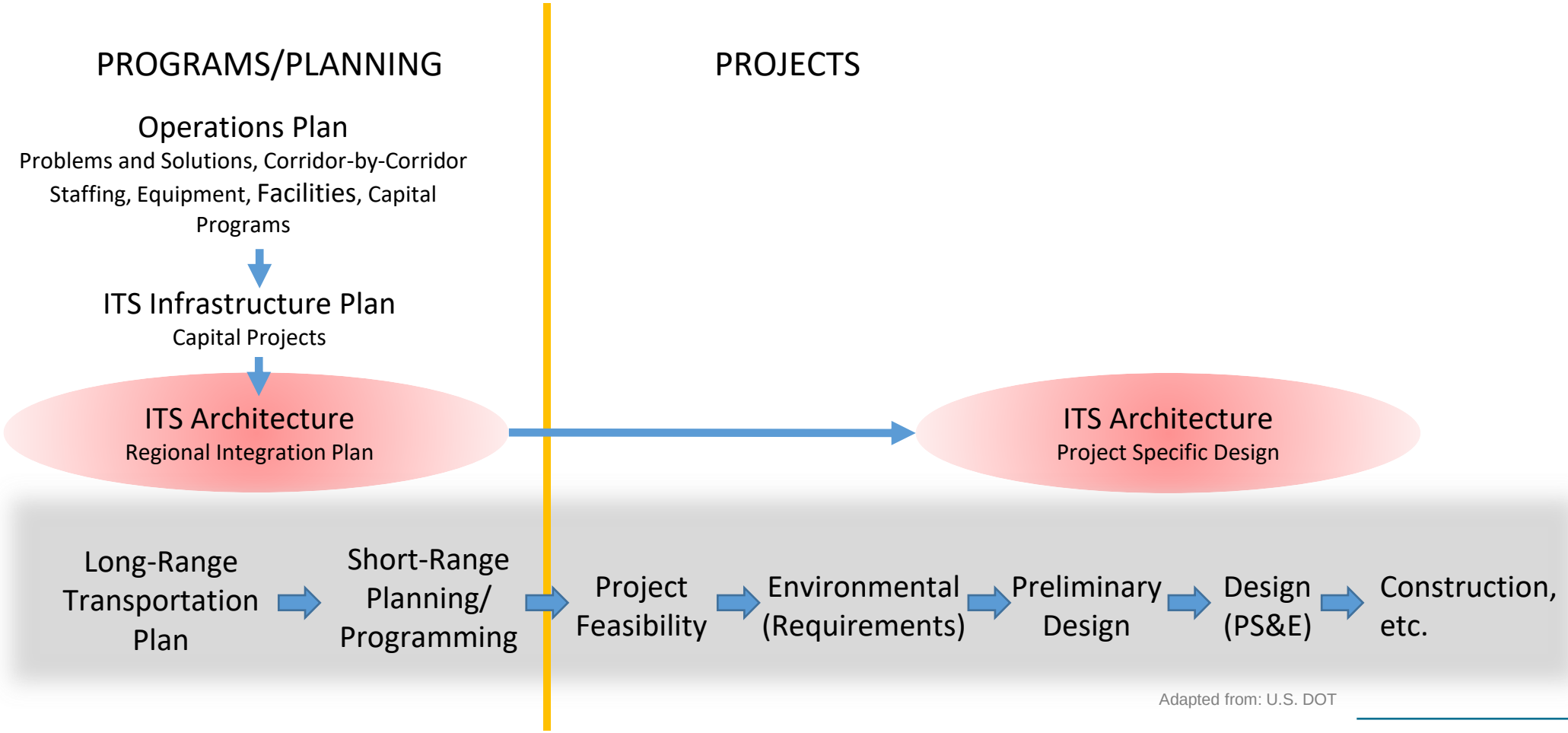
What is ITS?

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?

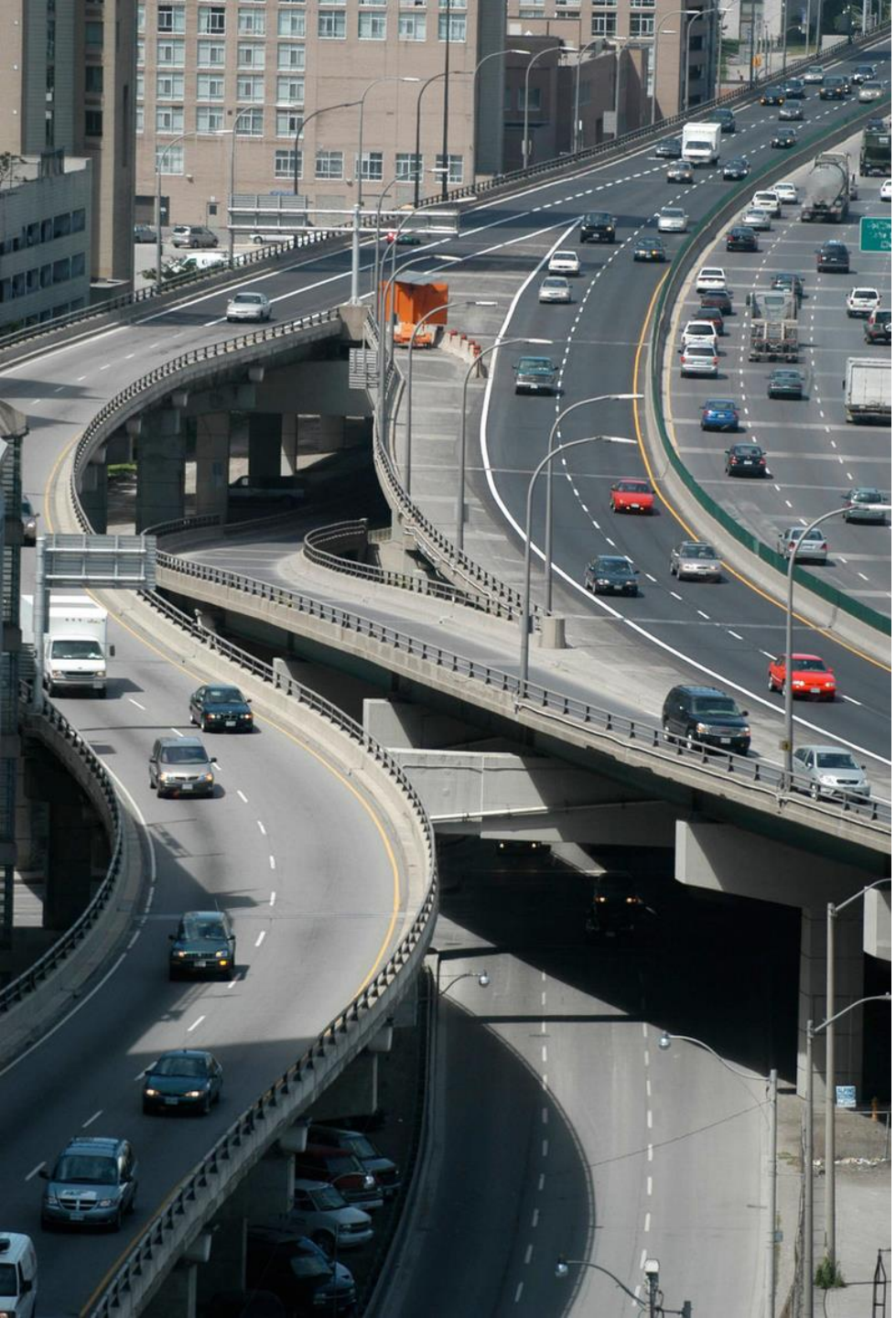


Adapted from: U.S. DOT

ITS Architecture Review Summary

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

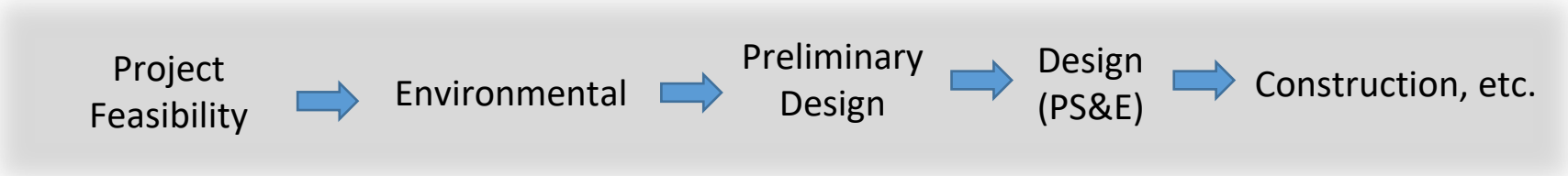
Introduction to Systems Engineering



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

Project Feasibility → Environmental → Preliminary Design → Design (PS&E) → Construction, etc.

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 → Prelimi ry esig → 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]

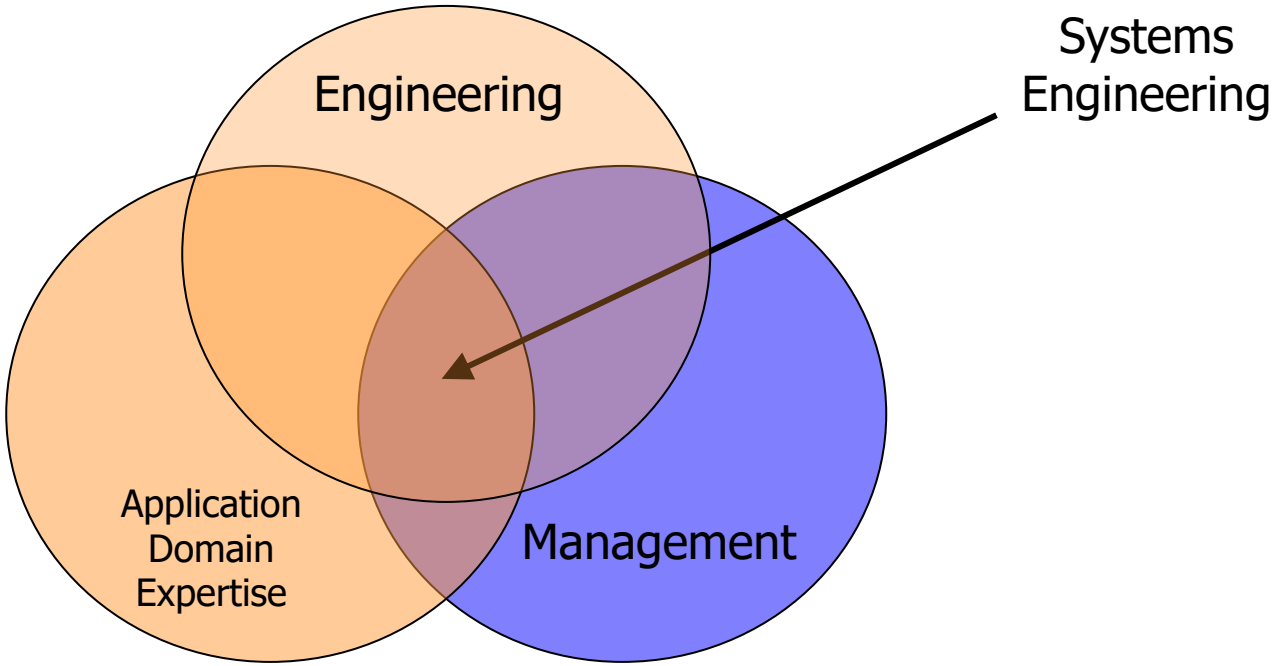


Image credit: 1-EIA-731 Annex B (Glossary)

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)

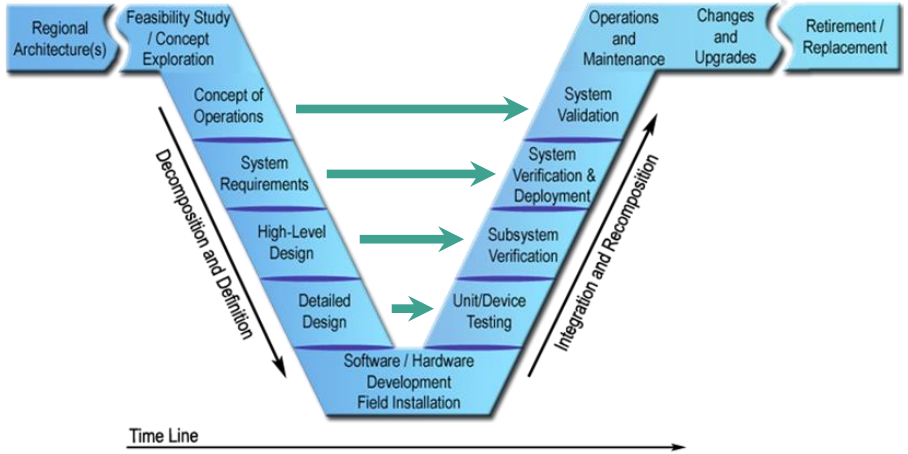


Image credit: U.S. DOT

Simplified Systems Engineering Process

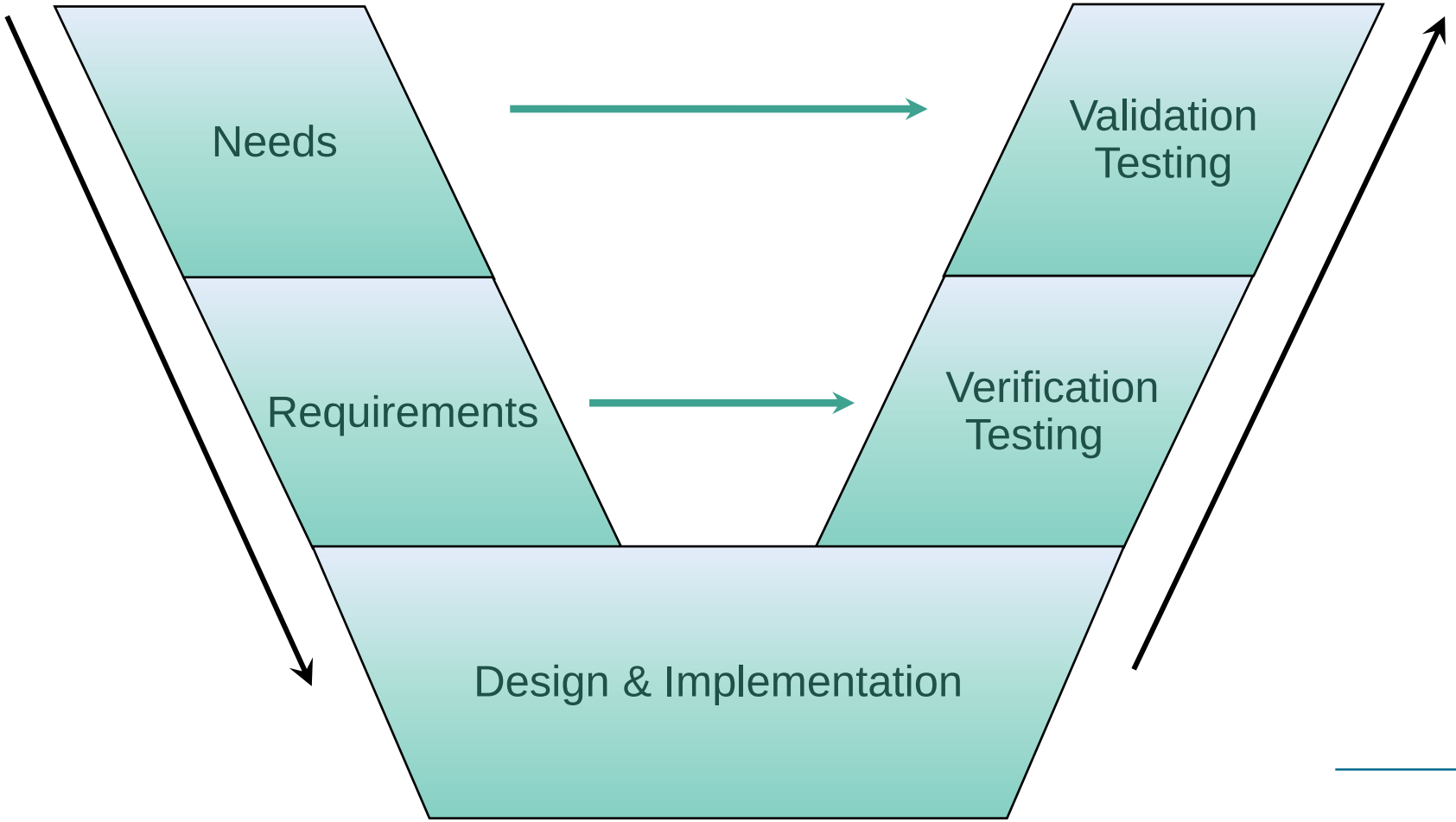
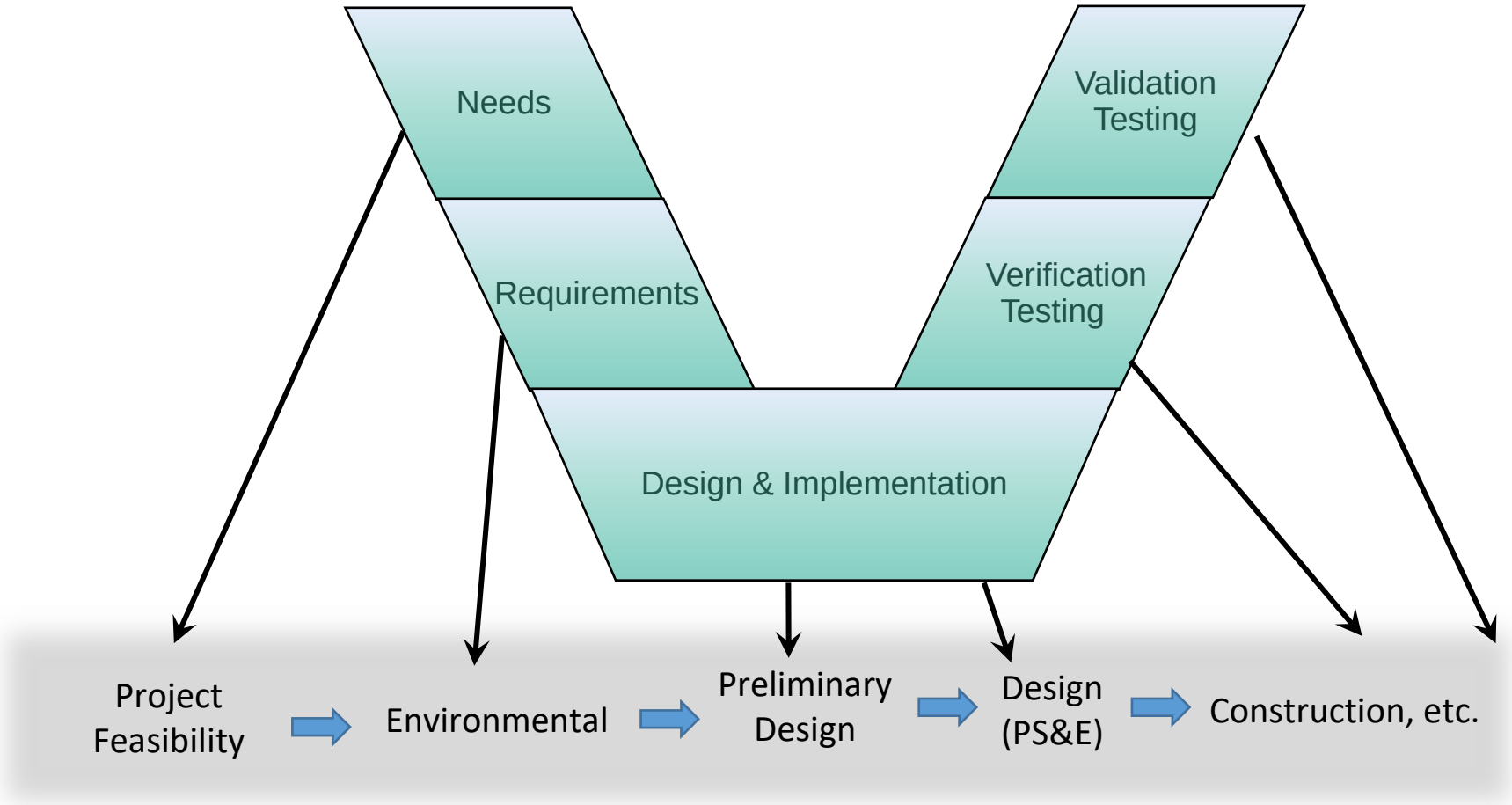


Image credit: U.S. DOT

Mapping to Transportation Process



Adapted from: U.S. DOT

What Do System Engineering Documents Look Like?

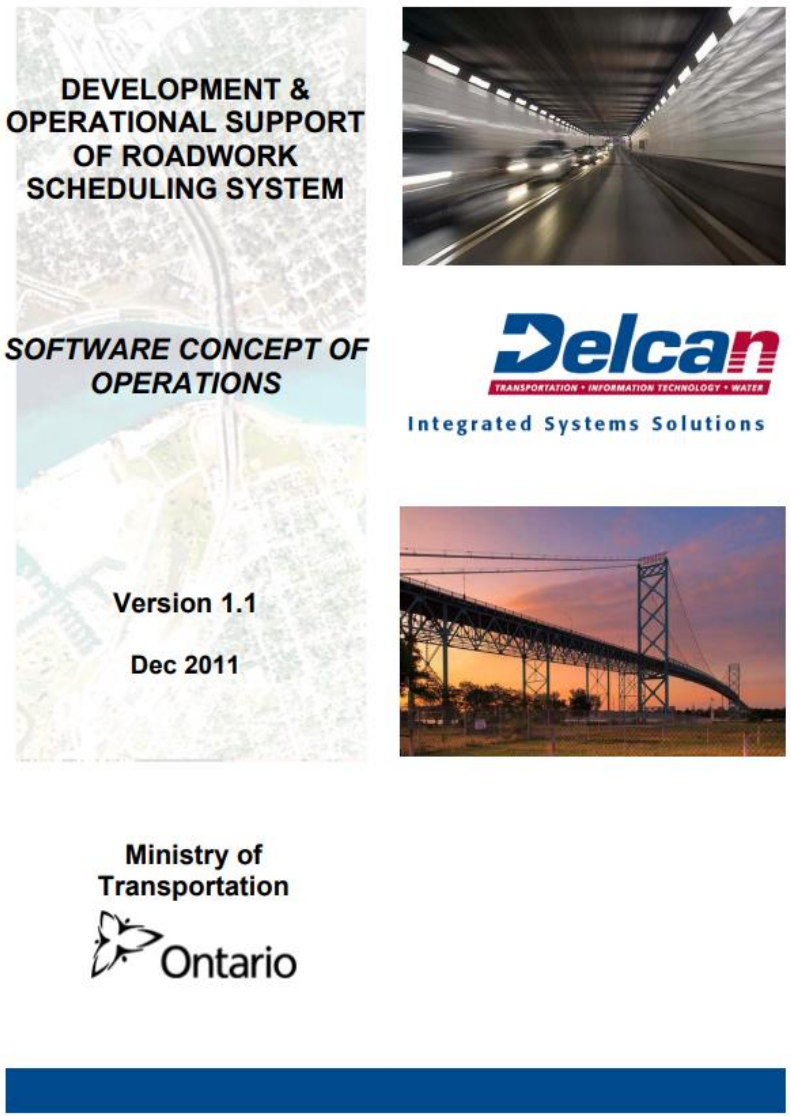
Focus on these documents:

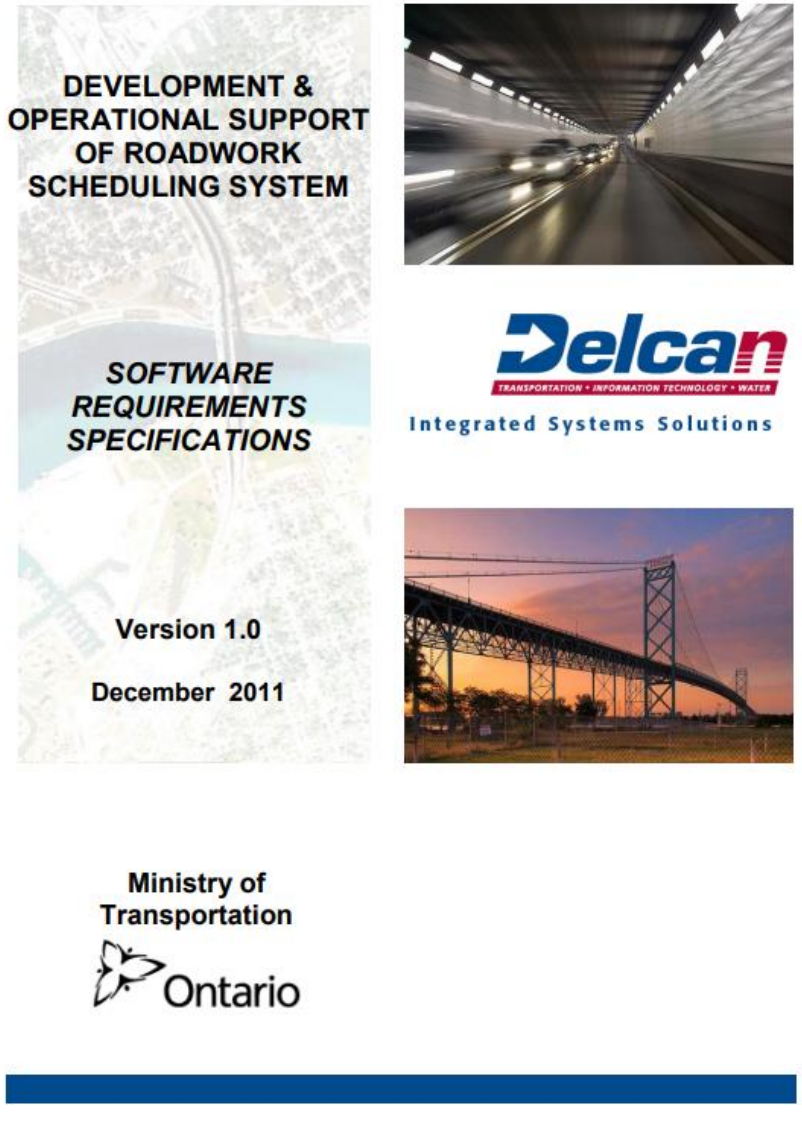
- Concept of Operation
- Requirements
- Verification
- Validation

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

TABLE OF CONTENTS

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

TABLE OF CONTENTS

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	*Remarks:* 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)	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.	PASS
				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.	
6.2	Communications Log	R4.2.2-x	A	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.	PASS
6.3	Event View	R4.2.3-x		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.	PASS
6.3.2.4	Amber Alert	R4.2.3.1.5-x		This use case focuses on the special functionality provided for Amber Alert events. When an Amber alert is declared by	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)

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

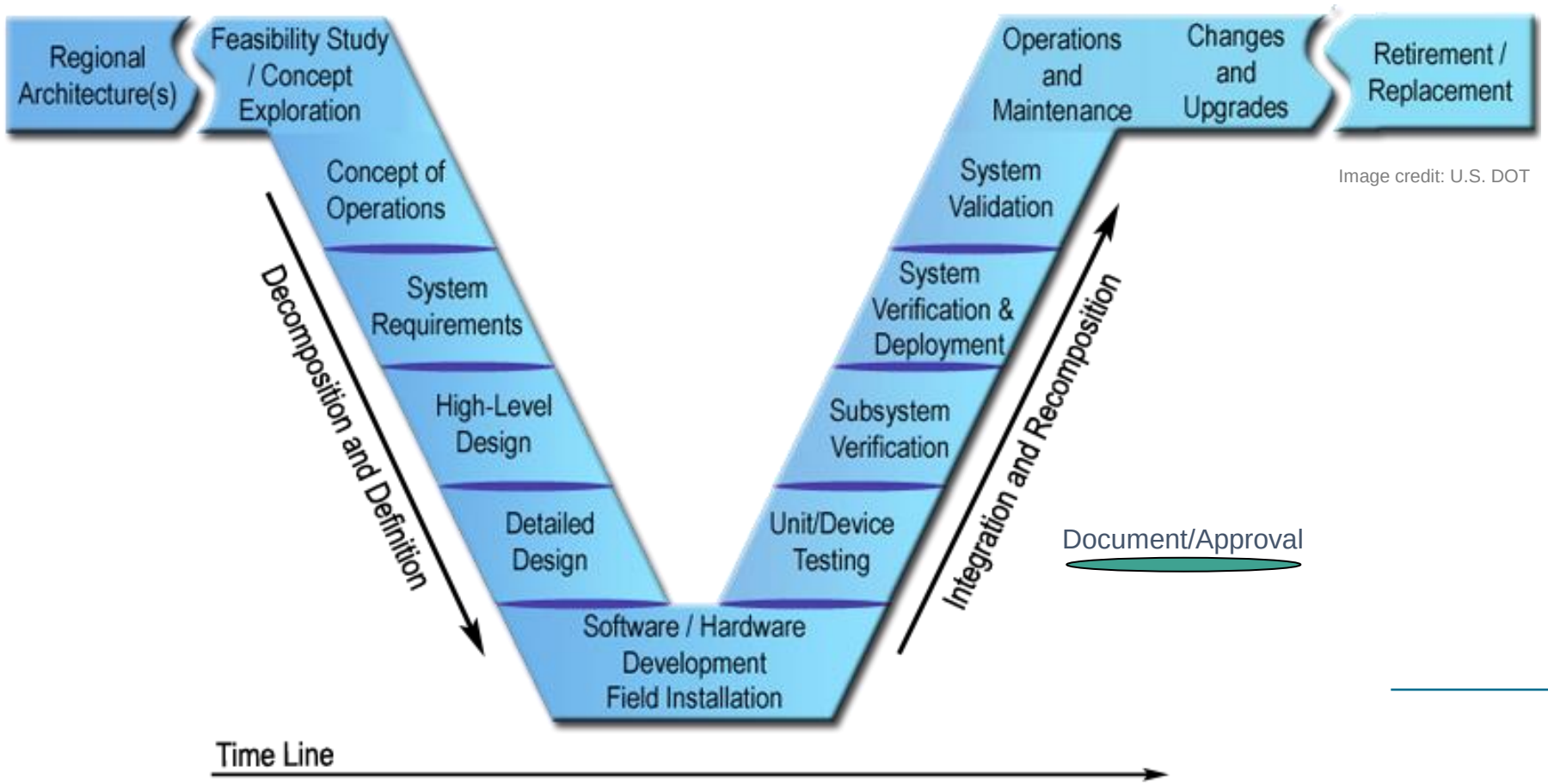


Image credit: U.S. DOT

Regional Architecture Use in Project Development

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

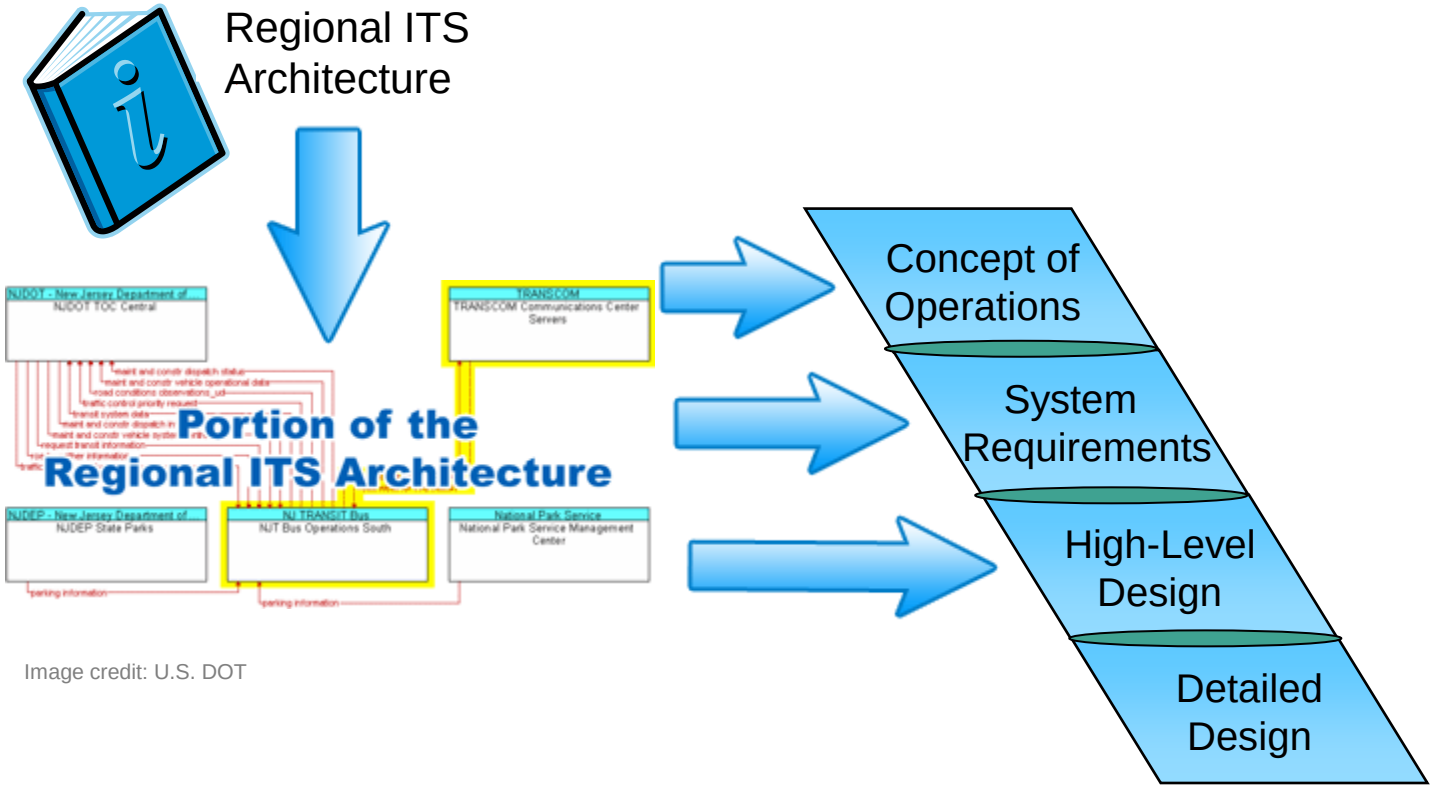


Image credit: U.S. DOT

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

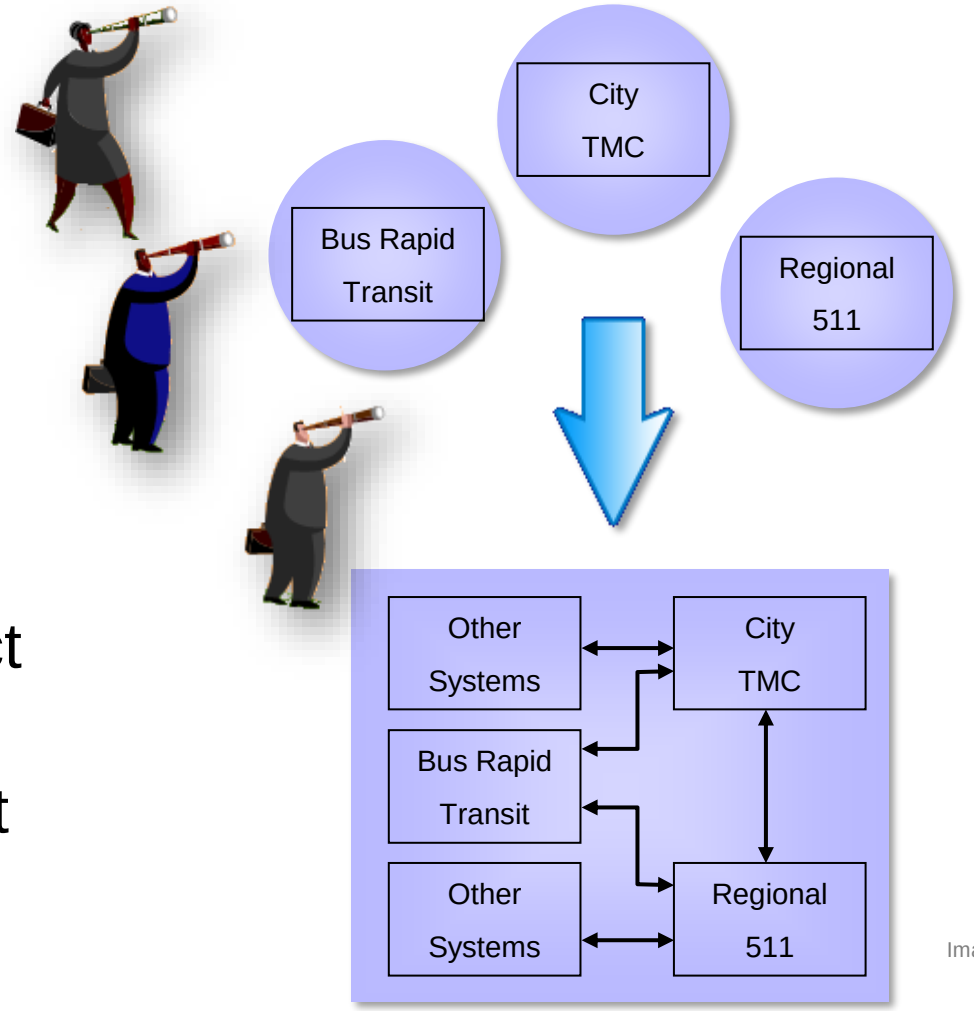
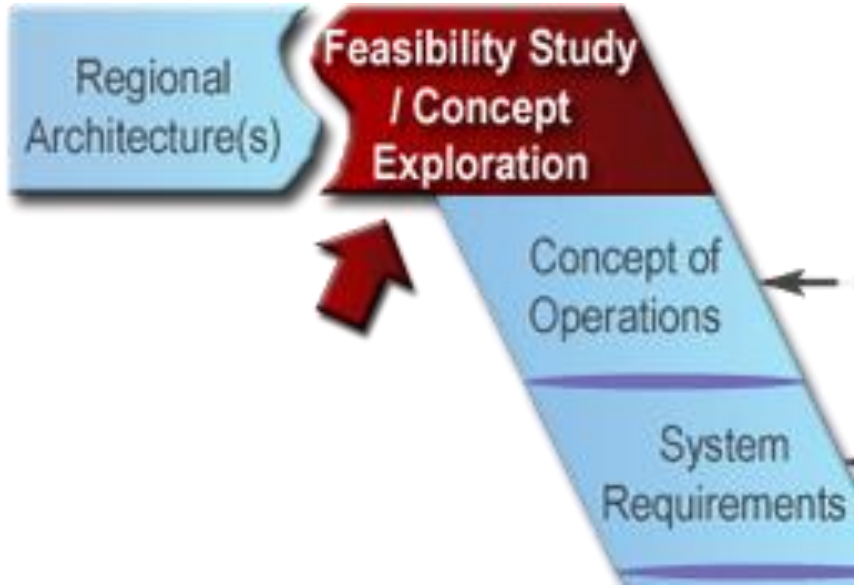


Image credit: U.S. DOT

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)

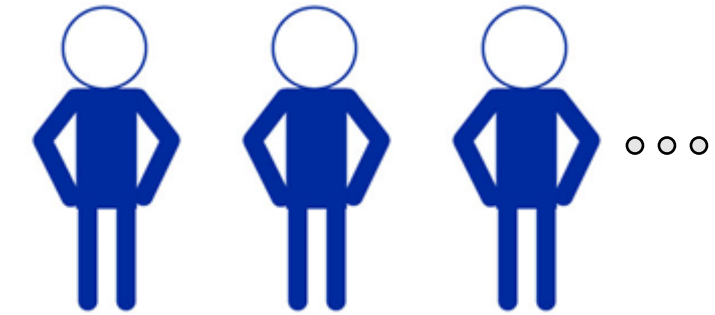


Image Credit: U.S. DOT

- 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

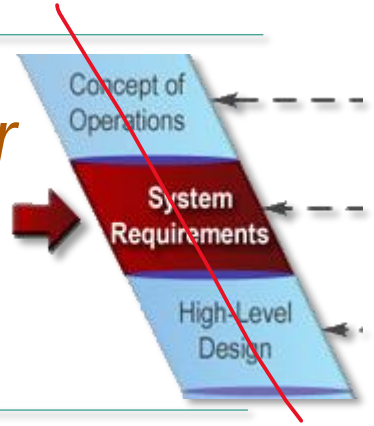
- Early stakeholder agreement on:
  - System capabilities
  - Users' Needs
  - Roles and responsibilities
  - Key performance measures and a basic plan for system validation
- Manage stakeholder expectations

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

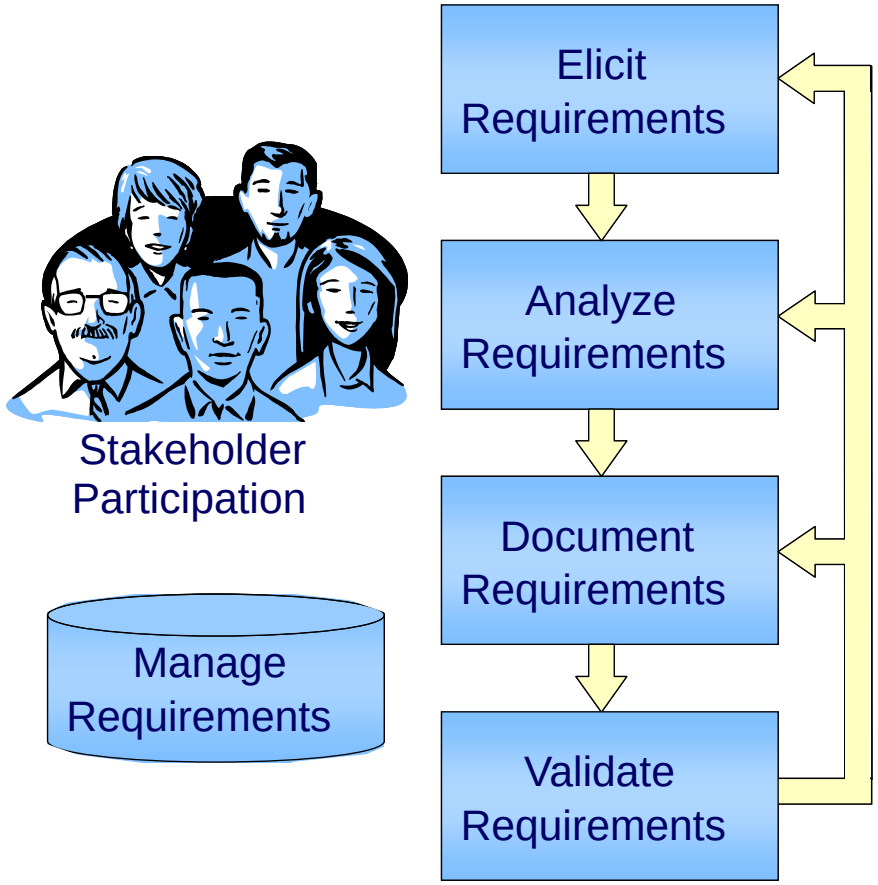


Image Credit: U.S. DOT

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

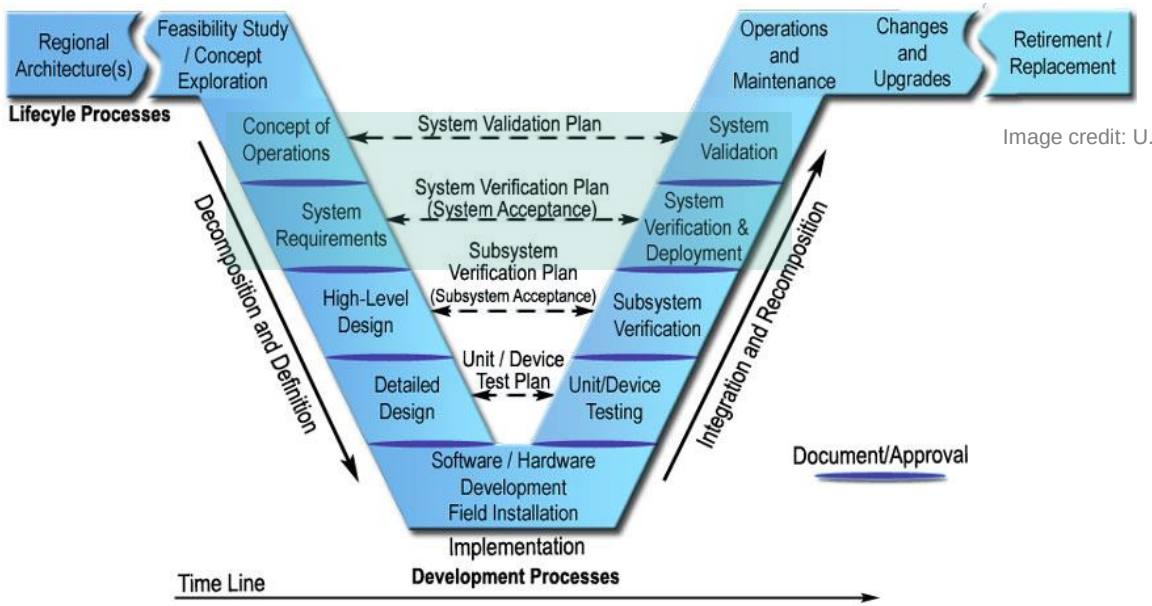


Image credit: U.S. DOT

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 15º status.”
4. “People shall feel safer about riding the bus.”

System Requirements

- Usually defined in a hierarchy – for example:

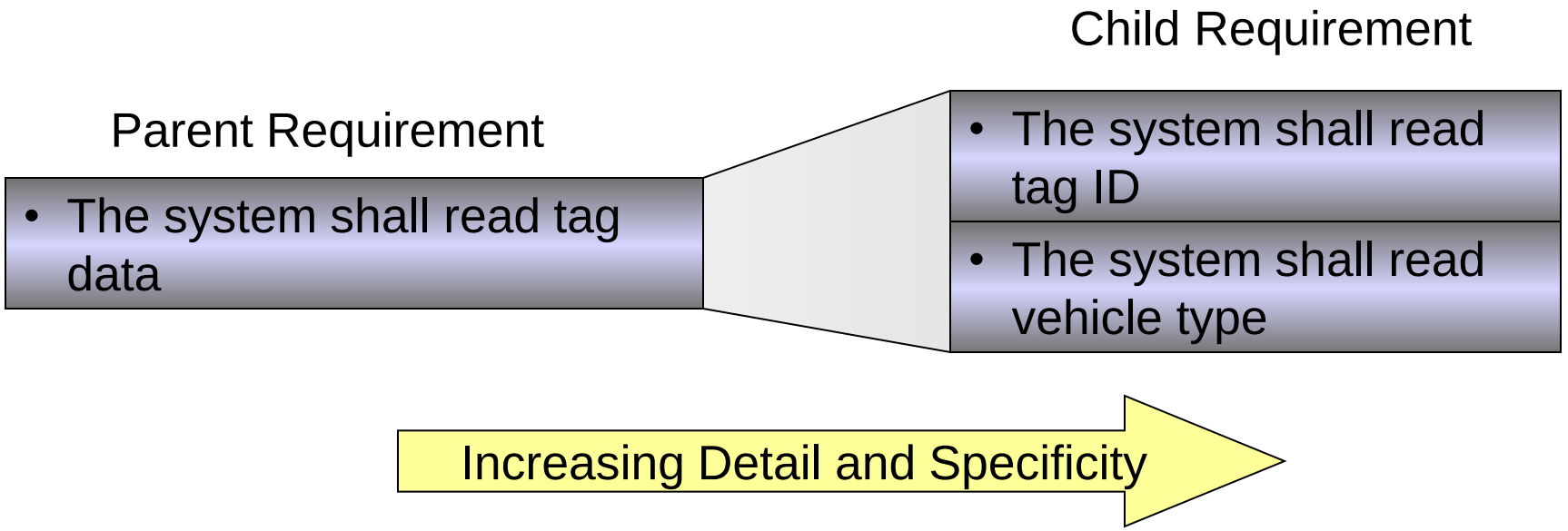


Image Credit: U.S. DOT

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

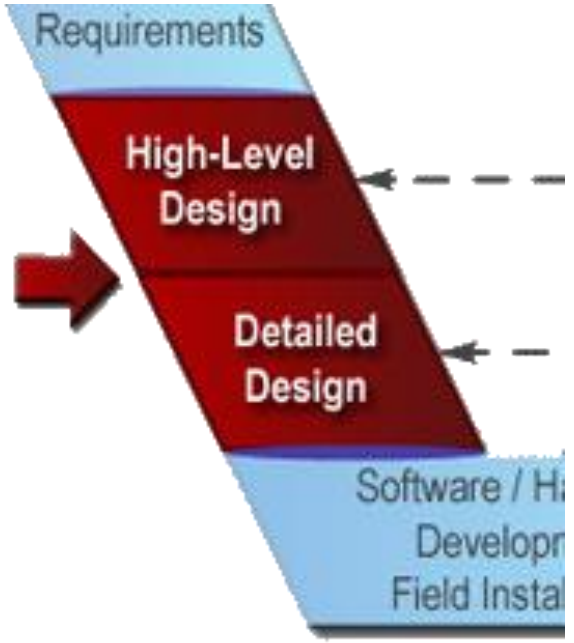
Benefits of System Requirements

- 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

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

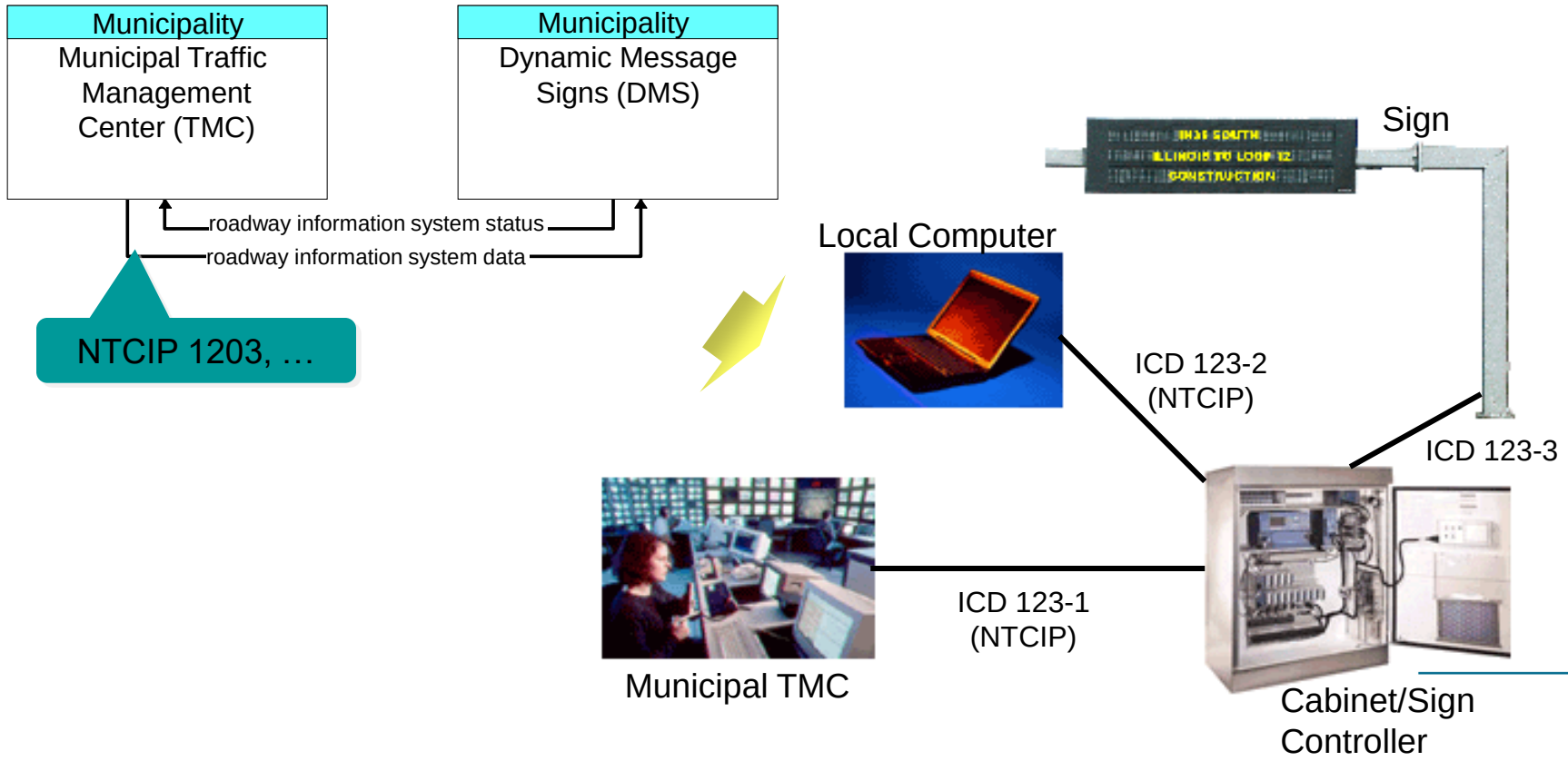
System Design

- 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 (0)
- EU: UTMC Data - UTMC (3)
- US: NTCIP Message Sign - SNMPv3/TLS (3)
- US: NTCIP Message Sign - SNMPv1/TLS (6)
- 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

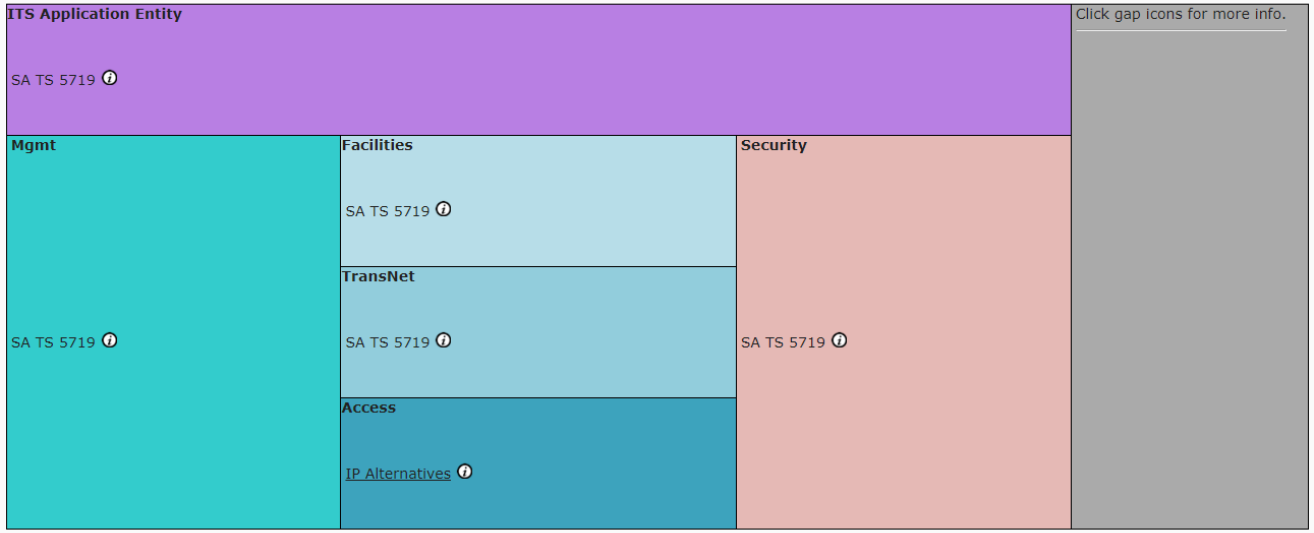
Solutions are sorted in ascending Gap Severity order. The Gap Severity is the parenthetical number at the end of the solution.

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.

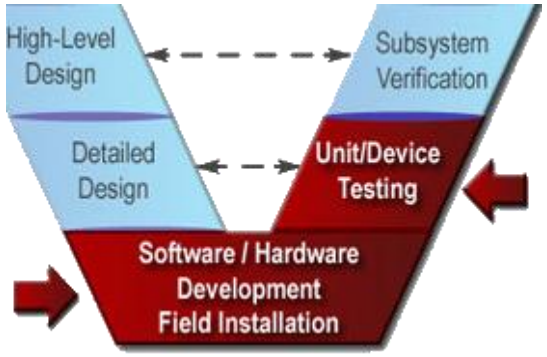
Measures of Success

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

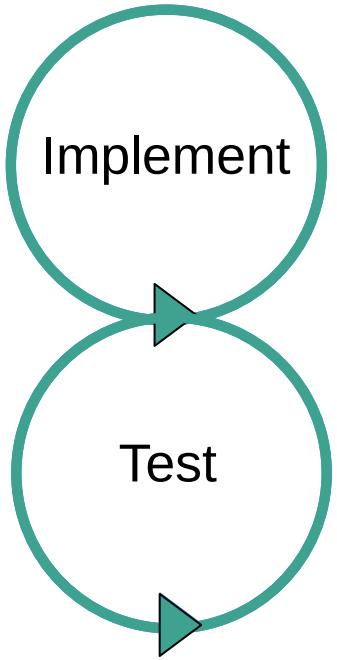
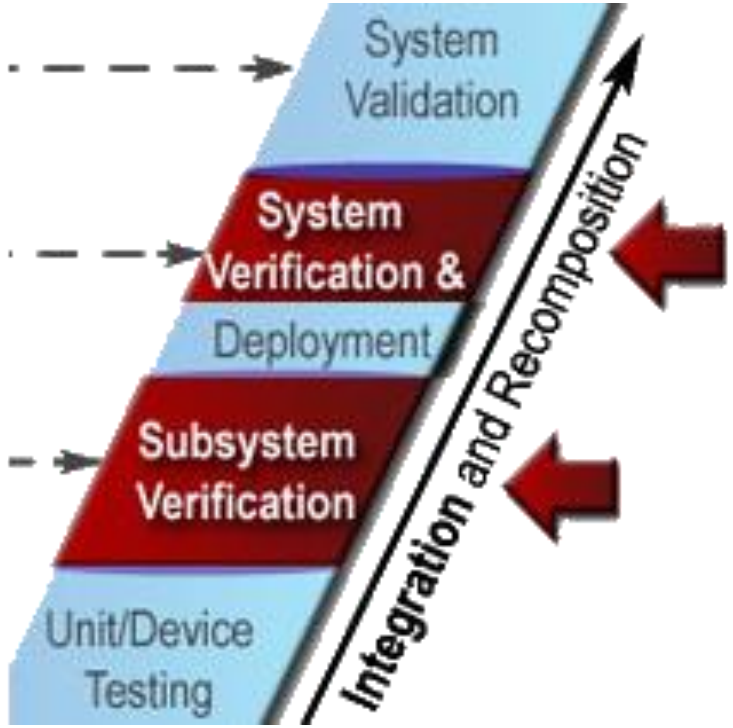


Image credit: U.S. DOT

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

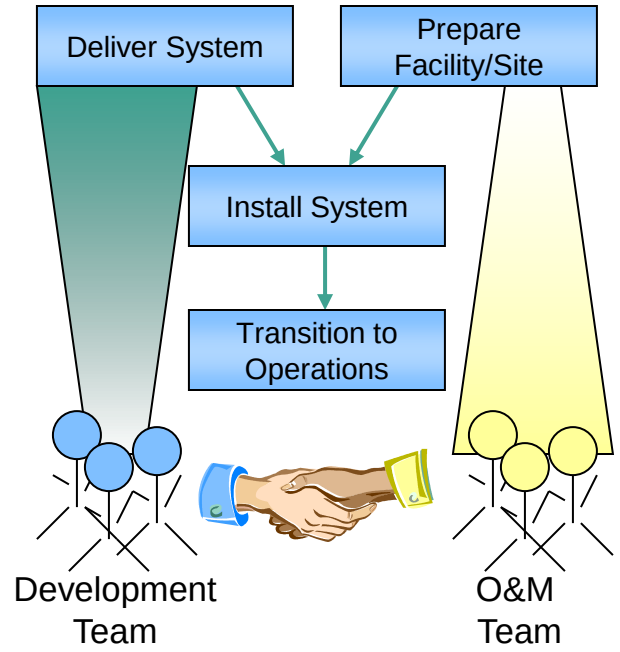


Image credit: U.S. DOT

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

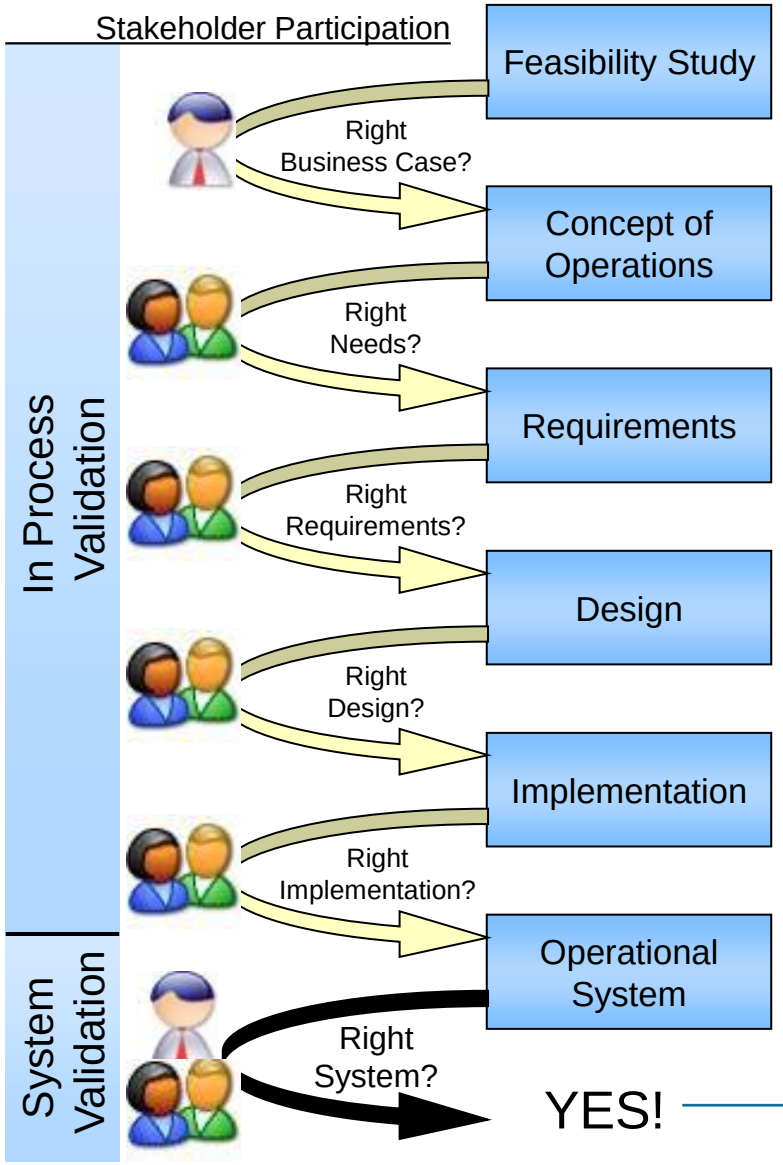


Image Credit: U.S. DOT

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

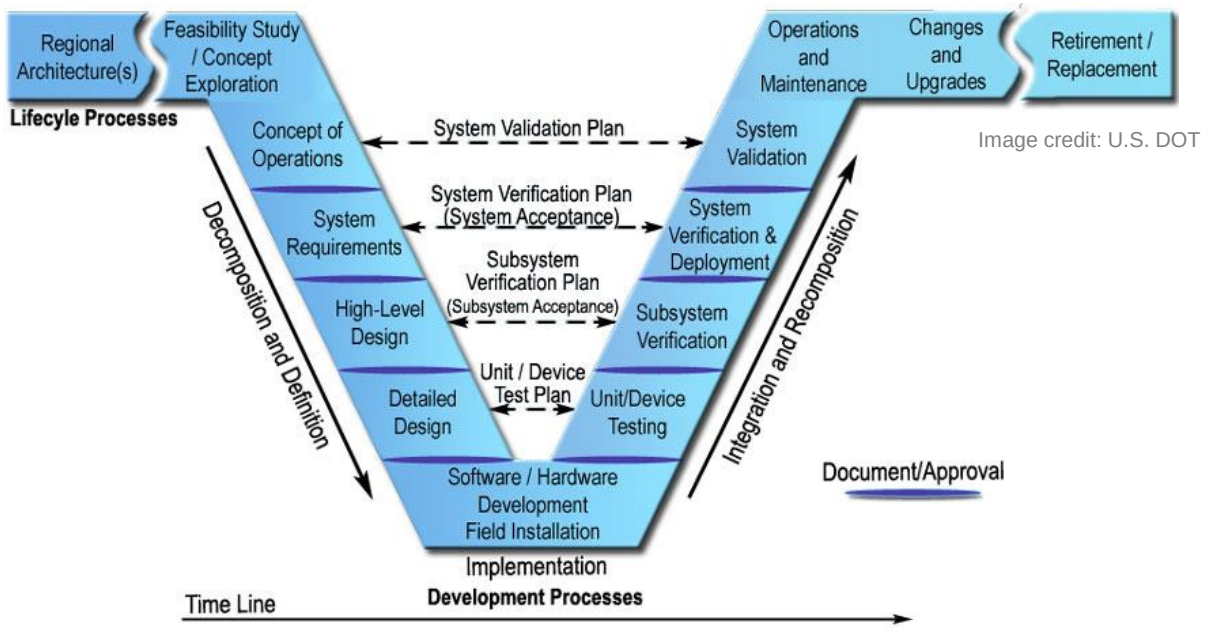


Image credit: U.S. DOT

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

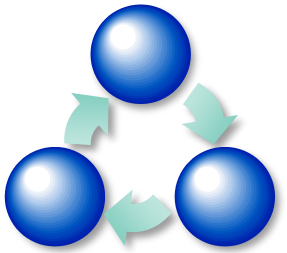
Don’t overlook the Information Technology Group

Provide staff training opportunities

Consider Systems Engineering experience when hiring consultants

Still need System Engineering skills within your organization

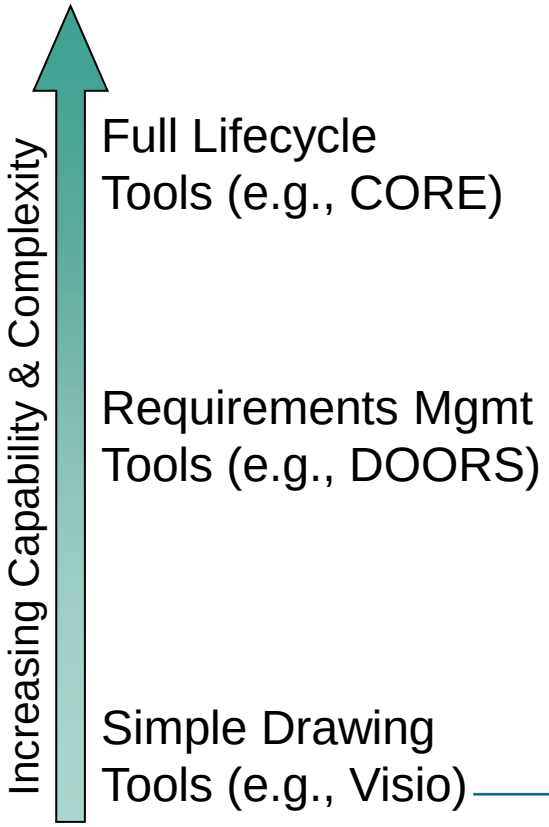
Process Improvement Recommendations



Pilot	Leverage	Improve	Establish	Implement
Pilot System Engineering processes on projects • Try one or two steps at a time then build on it	Leverage parallels in processes • System Engineering • Capital Projects • IT	Improve cross-cutting capabilities • Project Management • Risk Management • Configuration Management	Establish policies, document SE process	Implement across organization

Systems Engineering Tools

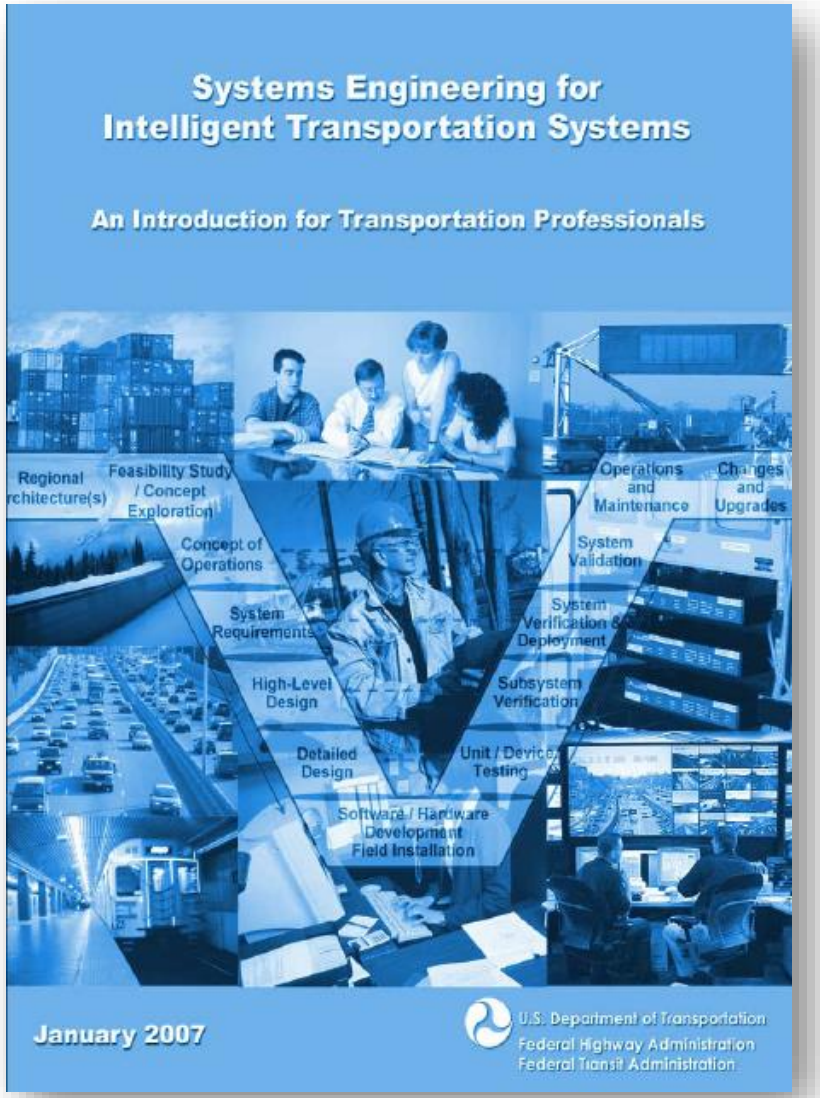
- Establish SE library (e.g., templates, best practices, decision support tools)
- Consider range of SE tools as organization gains experience
  - Project Management
  - Requirements Management
  - Systems Architecture
  - Testing/Problem Tracking
- Use complex tools based on project need



Systems Engineering Resources

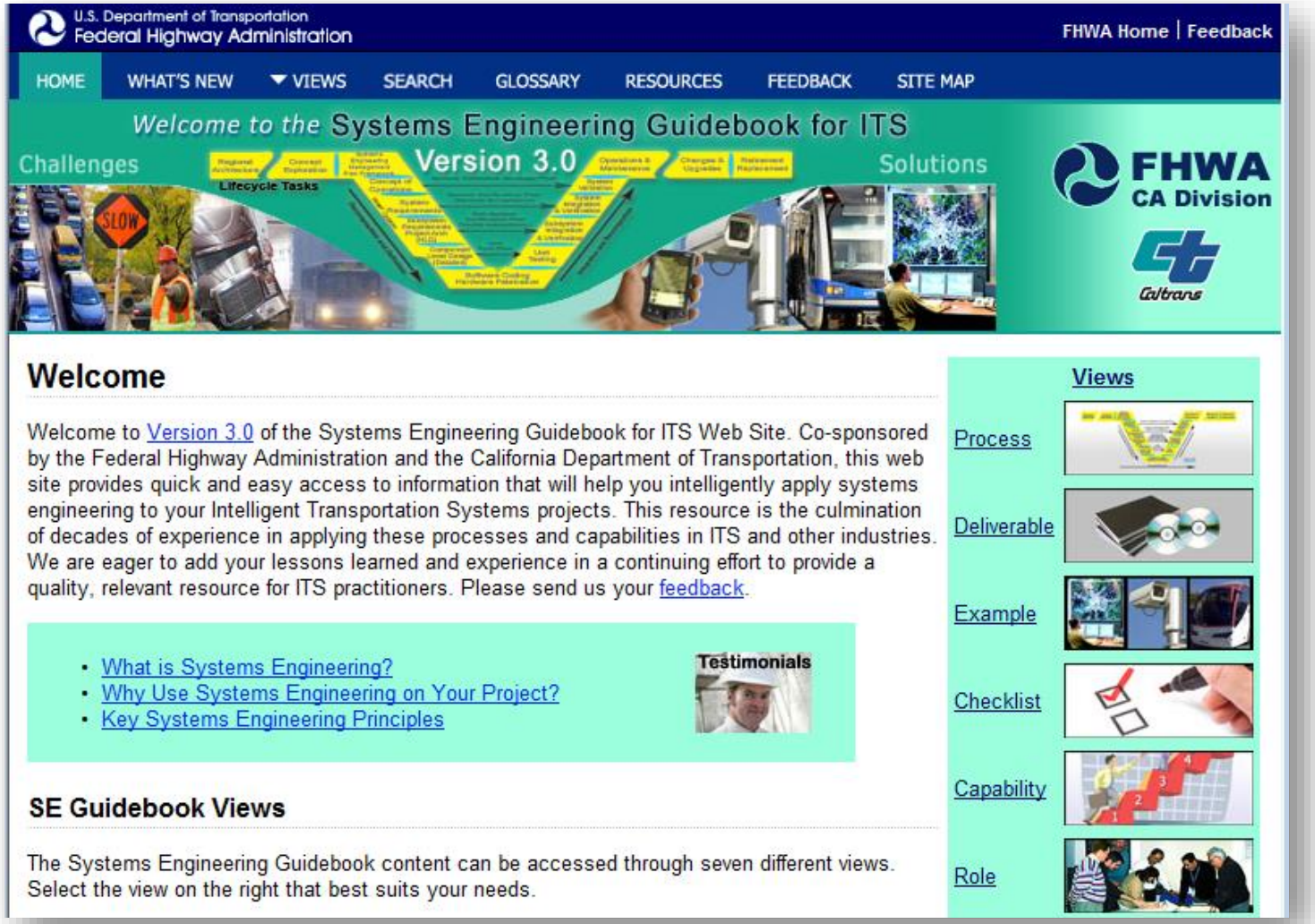
- Systems Engineering Handbook
- Systems Engineering Guidebook
- Guide to Contracting ITS
- Lessons Learned Database

Systems Engineering Handbook



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

Systems Engineering Guidebook

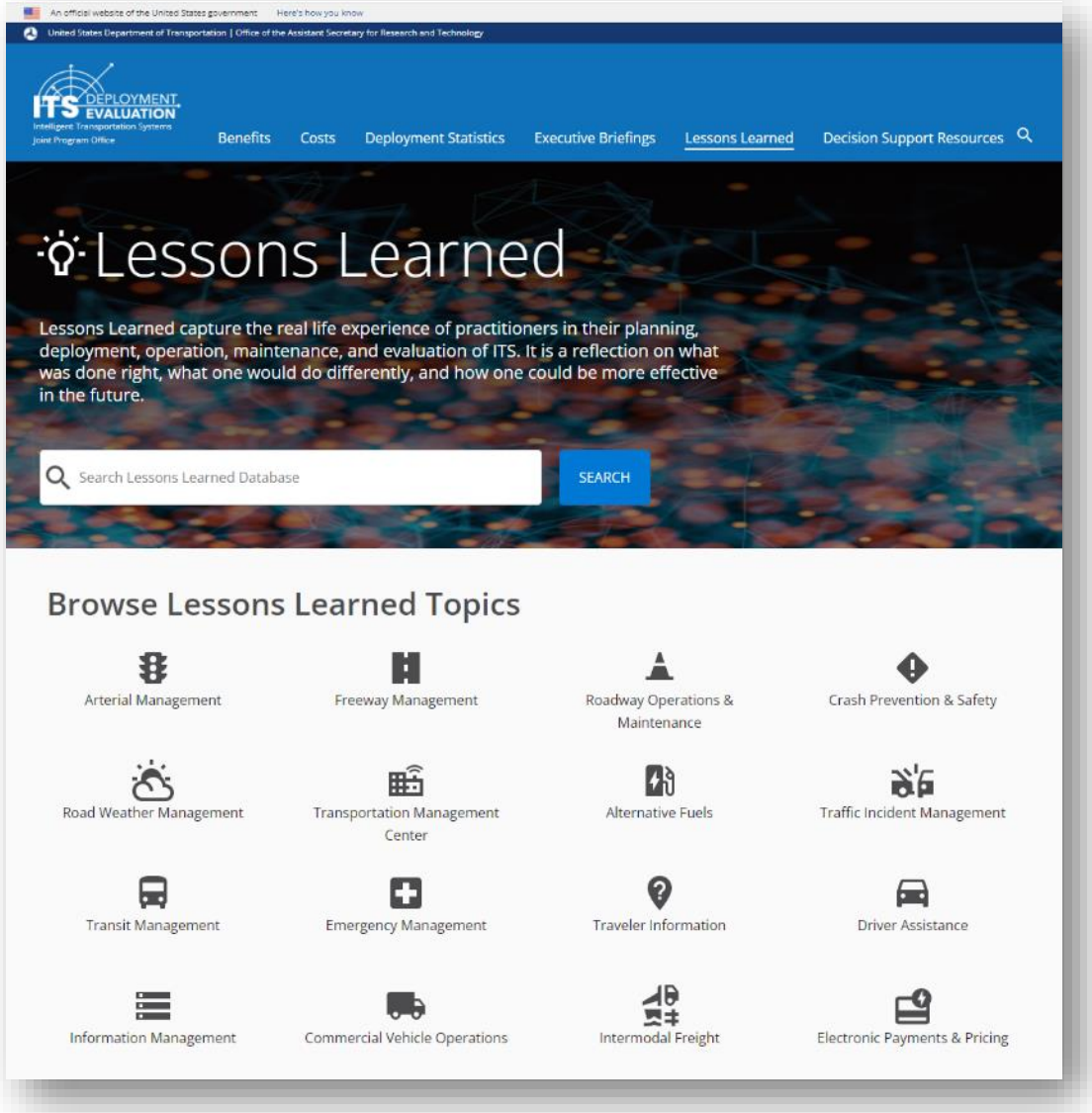


http://www.fhwa.dot.gov/cadiv/segb/

Choosing the Right Contracting Approach

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

Lessons Learned Database



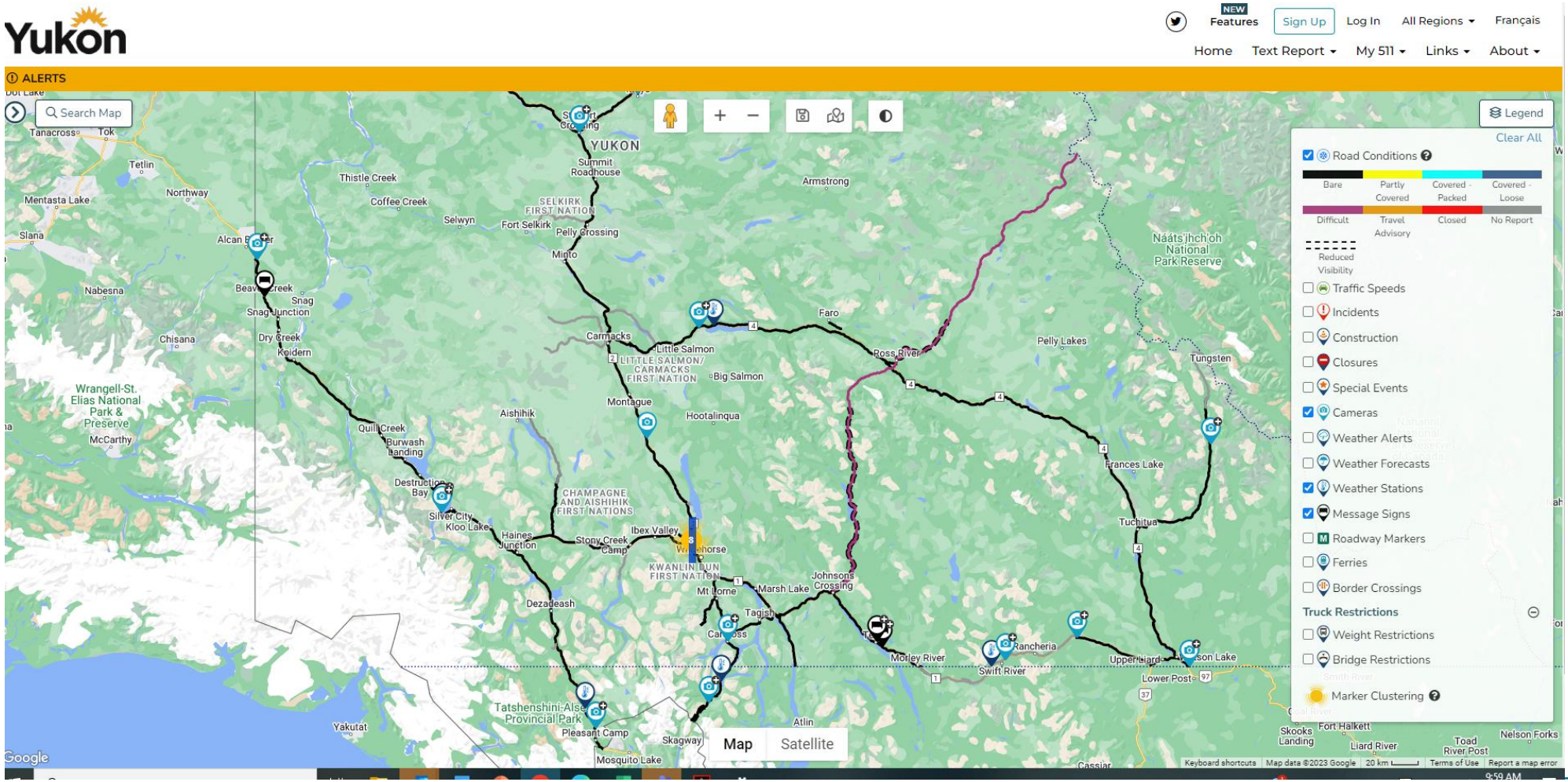
https://www.itskrs.its.dot.gov/lessons

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

Yukon ITS

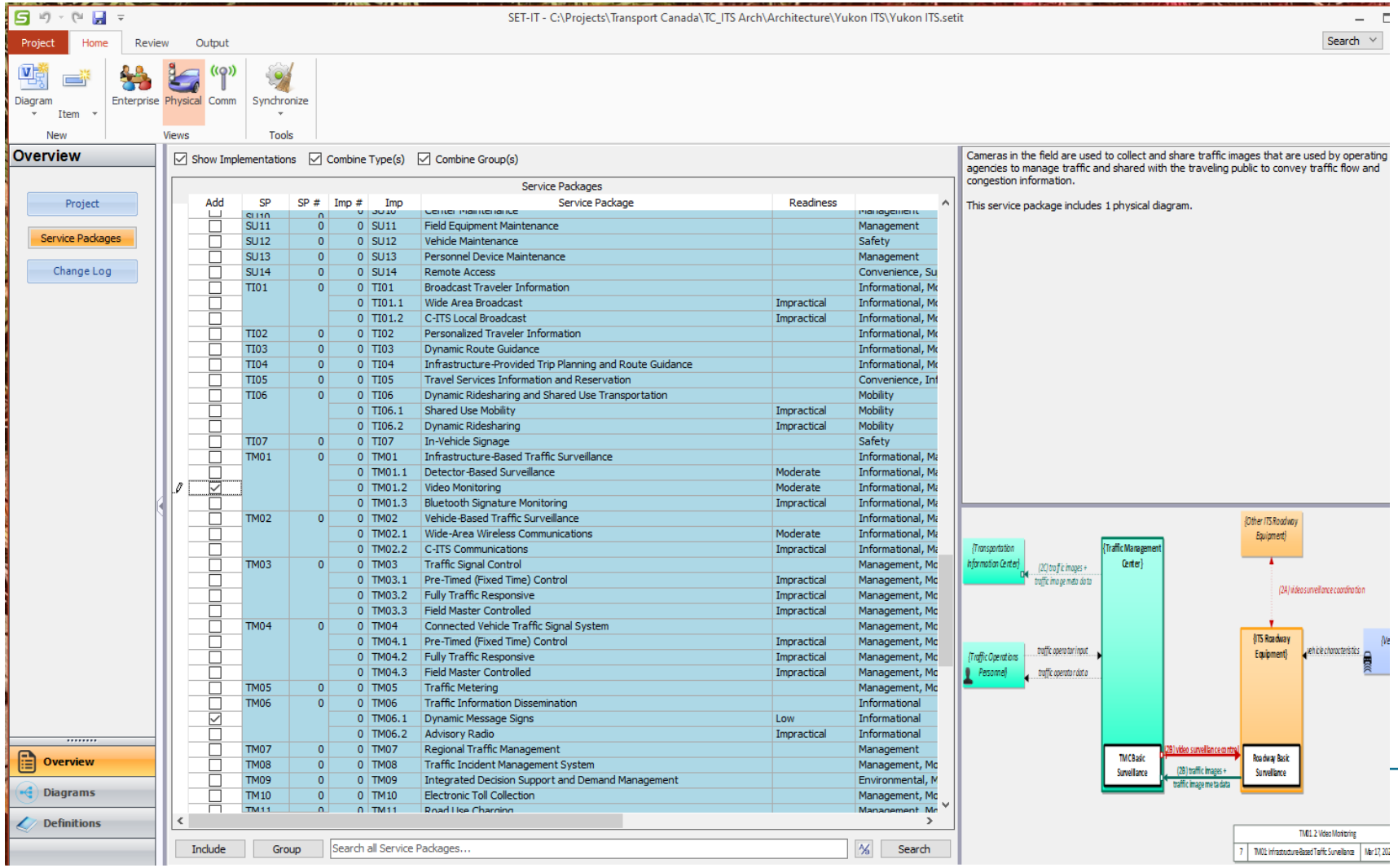

Yukon
NEW Features
Sign Up
Log In
All Regions
Français
Home
Text Report
My 511
Links
About
ALERTS
Search Map
Legend
Clear All
Road Conditions
Bare
Partly Covered
Covered - Packed
Covered - Loose
Difficult
Travel Advisory
Closed
No Report
Reduced Visibility
Traffic Speeds
Incidents
Construction
Closures
Special Events
Cameras
Weather Alerts
Weather Forecasts
Weather Stations
Message Signs
Roadway Markers
Ferries
Border Crossings
Truck Restrictions
Weight Restrictions
Bridge Restrictions
Marker Clustering
YUKON
Whitehorse
Carmacks
Faro
Ross River
Pelly Crossing
Dawson
Watson Lake
Teslin
Haines Junction
Destruction Bay
Burwash Landing
Beaver Creek
Snag Junction
Dry Creek
Keidern
Alcan Border
Tok
Tanacross
Northway
Tetlin
Mentasta Lake
Slana
Nabesna
Chisana
Wrangell-St. Elias National Park & Preserve
McCarthy
Kluane National Park Reserve
Nàáts'ihch'oh National Park Reserve
Tatshenshini-Alsek Provincial Park
Pleasant Camp
Mosquito Lake
Skagway
Atlin
Yakutat
Carcross
Tagish
Marsh Lake
Johnsons Crossing
Mt Lorne
Dezadeash
Ibex Valley
Stony Creek Camp
Silver City
Kloo Lake
Aishihik
Montague
Hootalinqua
Little Salmon
Big Salmon
Carmacks
Minto
Selwyn
Fort Selkirk
Thistle Creek
Coffee Creek
Summit Roadhouse
Armstrong
Pelly Lakes
Tungsten
Frances Lake
Tuchitua
Rancheria
Swift River
Morley River
Upper Liard
Lower Post
Fort Halkett
Liard River
Toad River Post
Nelson Forks
Skooks Landing
Map
Satellite
Google
Keyboard shortcuts
Map data ©2023 Google
20 km
Terms of Use
Report a map error

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

Search

Diagram | Item (New) | Enterprise | Physical | Comm (Views) | Synchronize (Tools)

Overview

Project | Service Packages | Change Log

Overview | Diagrams | Definitions

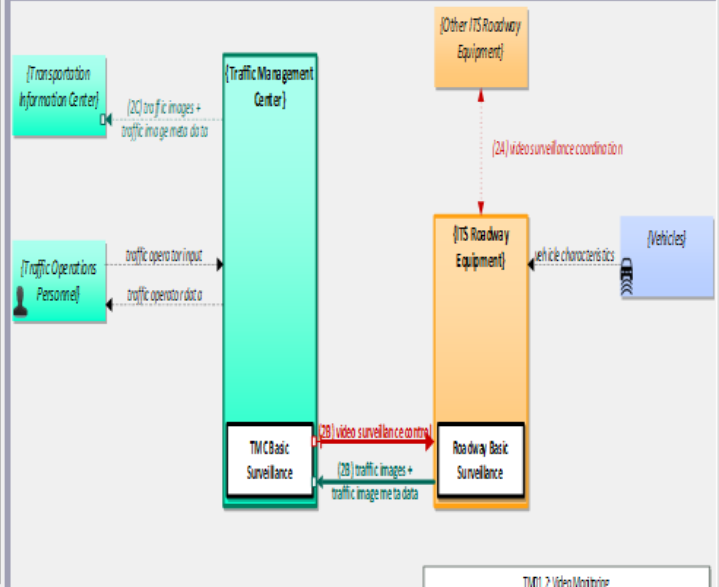
Show Implementations | Combine Type(s) | Combine Group(s)

Service Packages

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

Flow Status
Existing
Project
Future
Not Applicable

Flow Cardinality
Unicast
Multicast
Broadcast

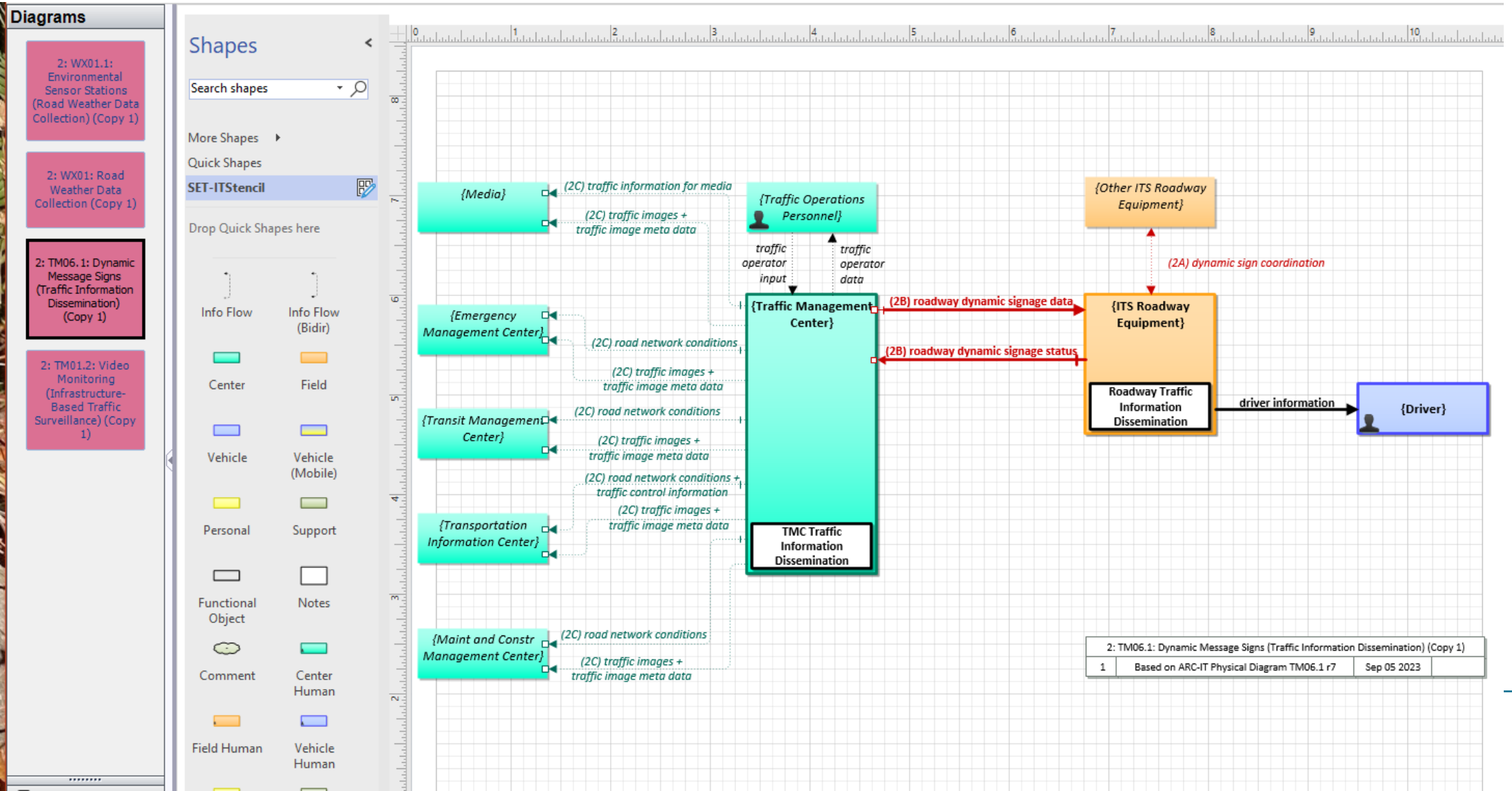
Flow Control
Transaction initiated
By left-hand party
Receipt acknowledged

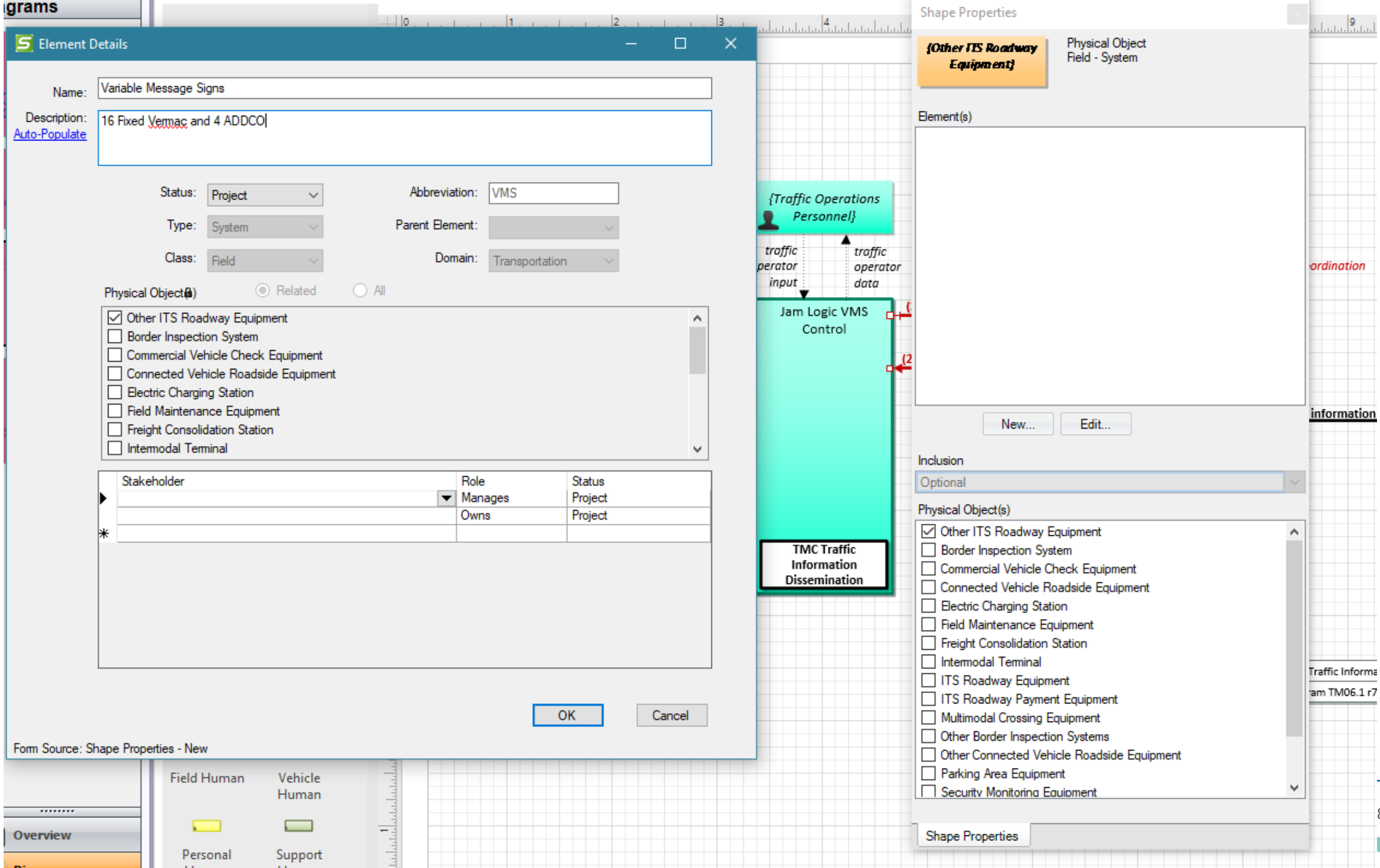
Flow Security
Clear text, No Authent.
Encrypted, No Authent.
Clear text, Authenticated
Encrypted, Authenticated

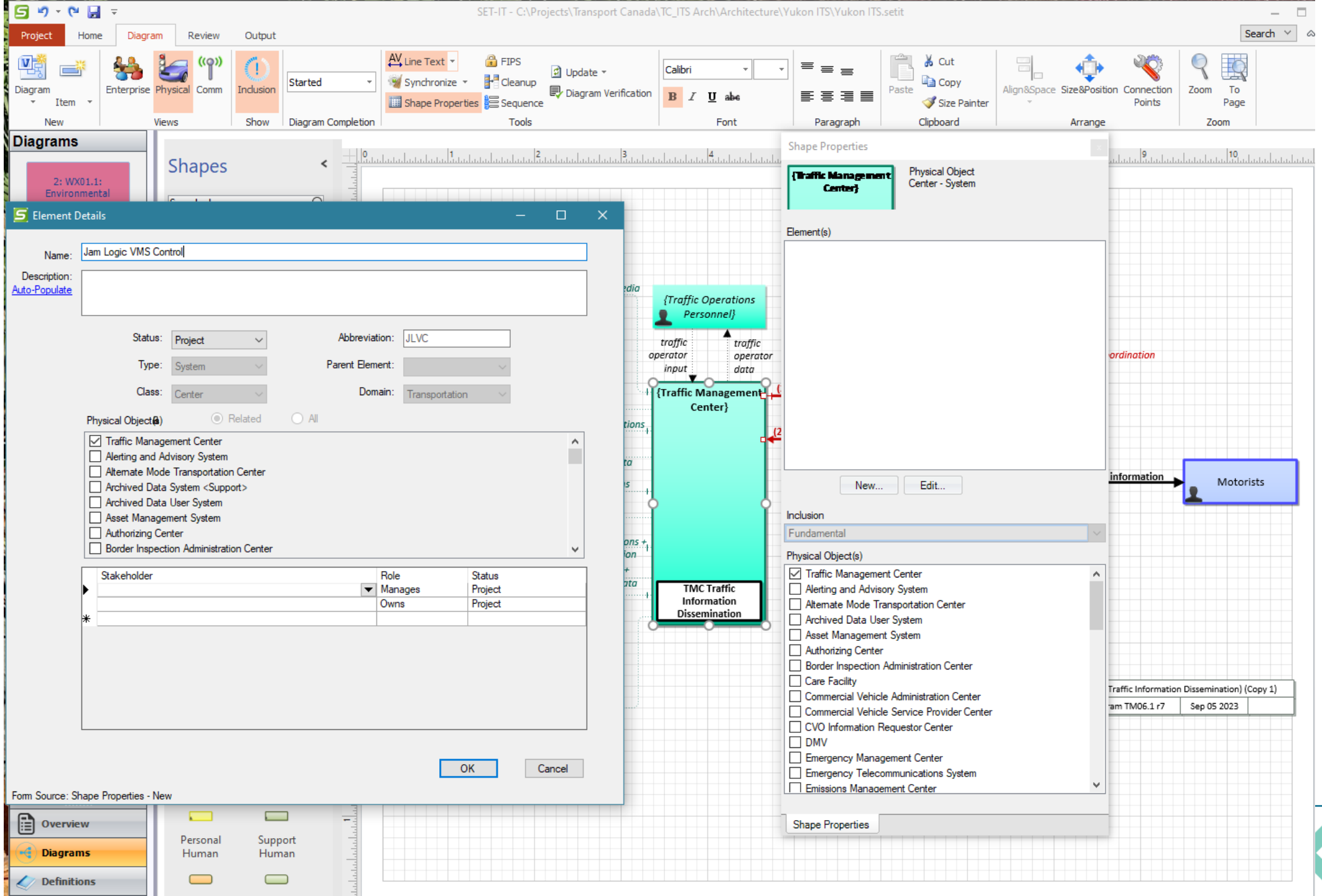
Elements
Center | Field
Vehicle | Personal
Support | ITS
People | Environment

Functional Objects
Existing | Project
Future | Not Applicable

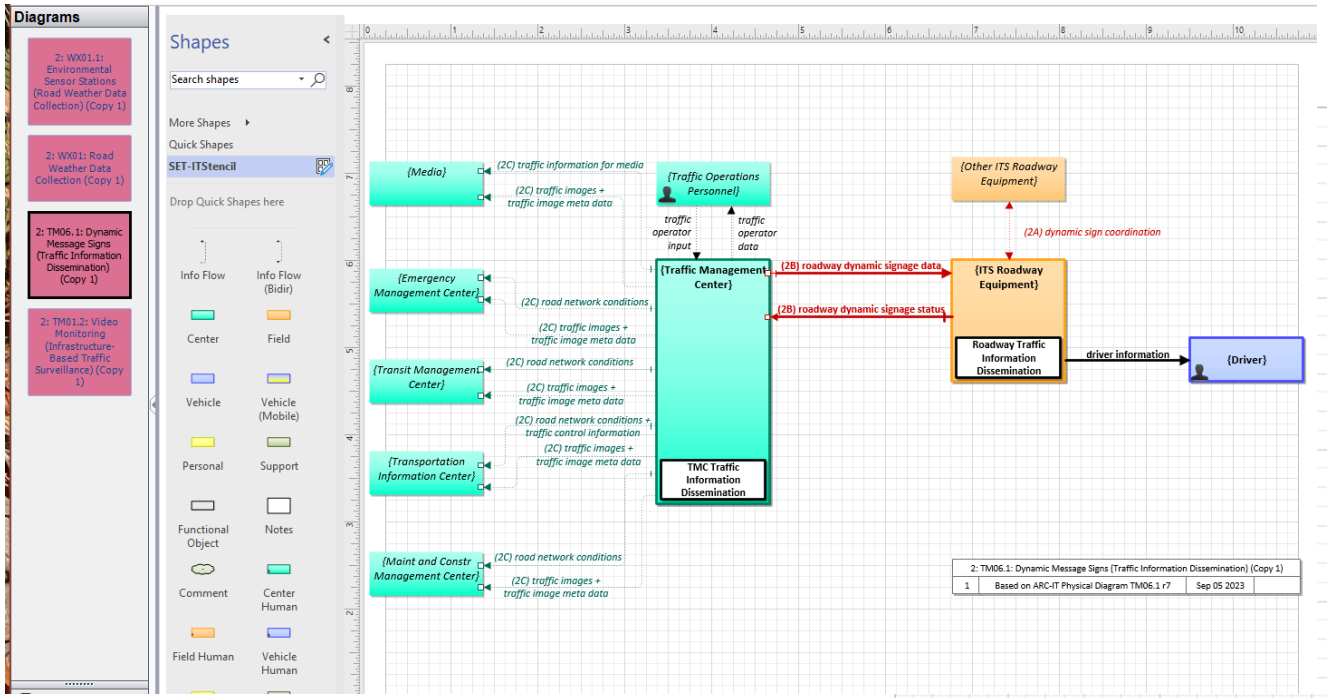
Editing a diagram

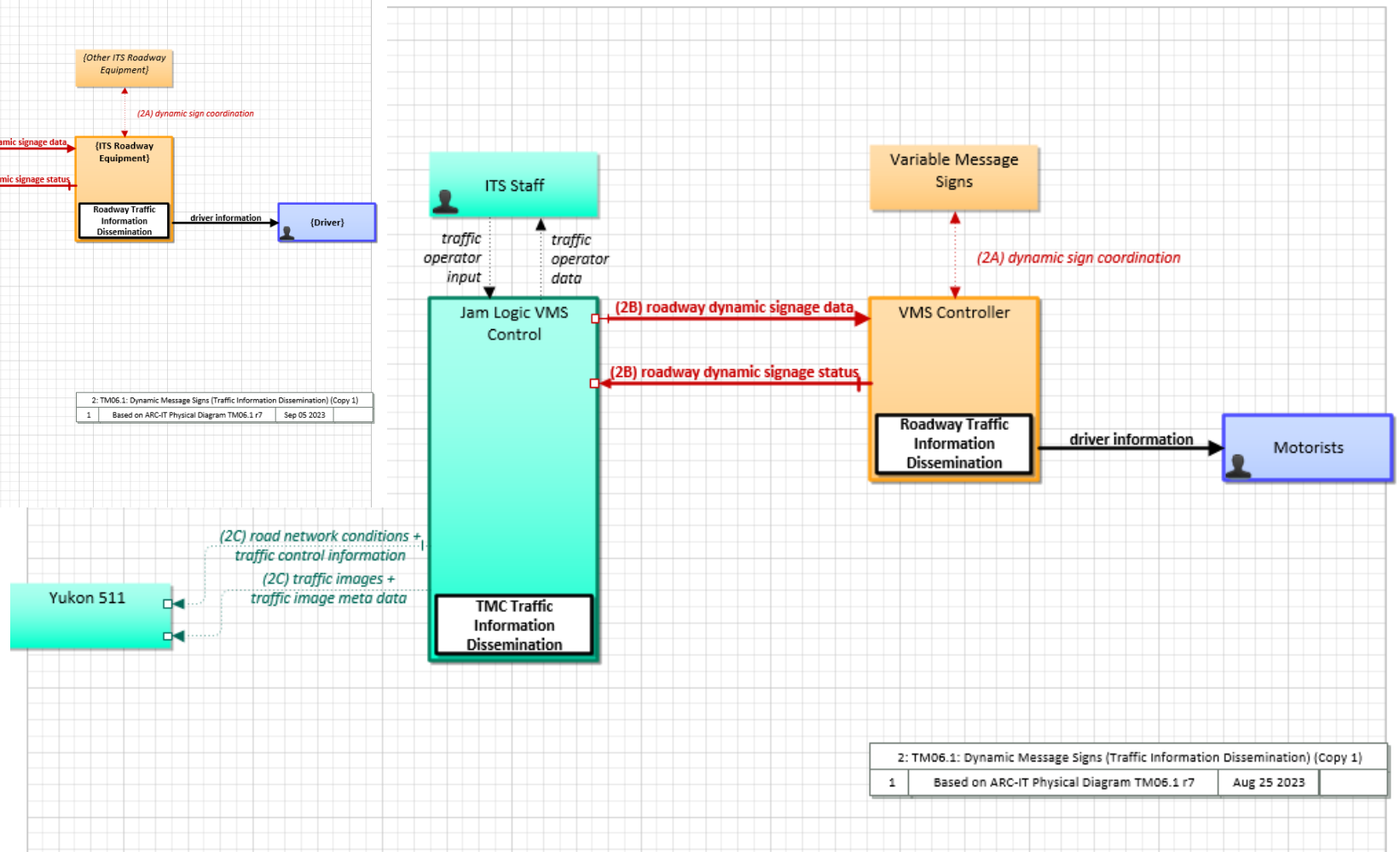


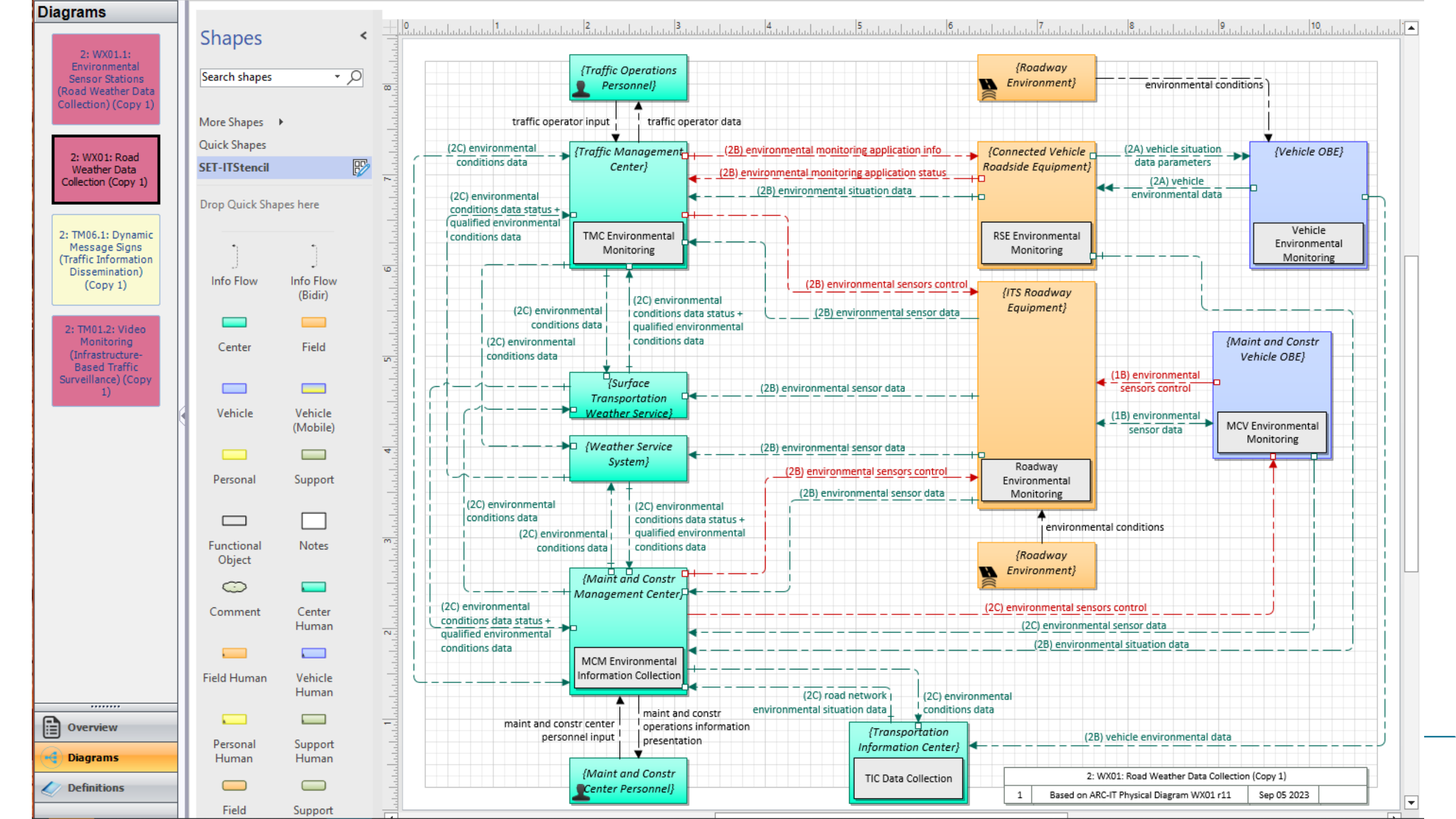

Element Details
Name:
Variable Message Signs
Description:
Auto-Populate
16 Fixed Vermac and 4 ADDCO
Status:
Project
Abbreviation:
VMS
Type:
System
Parent Element:
Class:
Field
Domain:
Transportation
Physical Object(s)
Related
All
Other ITS Roadway Equipment
Border Inspection System
Commercial Vehicle Check Equipment
Connected Vehicle Roadside Equipment
Electric Charging Station
Field Maintenance Equipment
Freight Consolidation Station
Intermodal Terminal
Stakeholder
Role
Status
Manages
Project
Owns
Project
OK
Cancel
Form Source: Shape Properties - New
Shape Properties
{Other ITS Roadway Equipment}
Physical Object
Field - System
Element(s)
New...
Edit...
Inclusion
Optional
Physical Object(s)
Other 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 Equipment
ITS Roadway Payment Equipment
Multimodal Crossing Equipment
Other Border Inspection Systems
Other Connected Vehicle Roadside Equipment
Parking Area Equipment
Security Monitoring Equipment
Shape Properties
{Traffic Operations Personnel}
traffic operator input
traffic operator data
Jam Logic VMS Control
TMC Traffic Information Dissemination
Field Human
Vehicle Human
Personal
Support
Overview

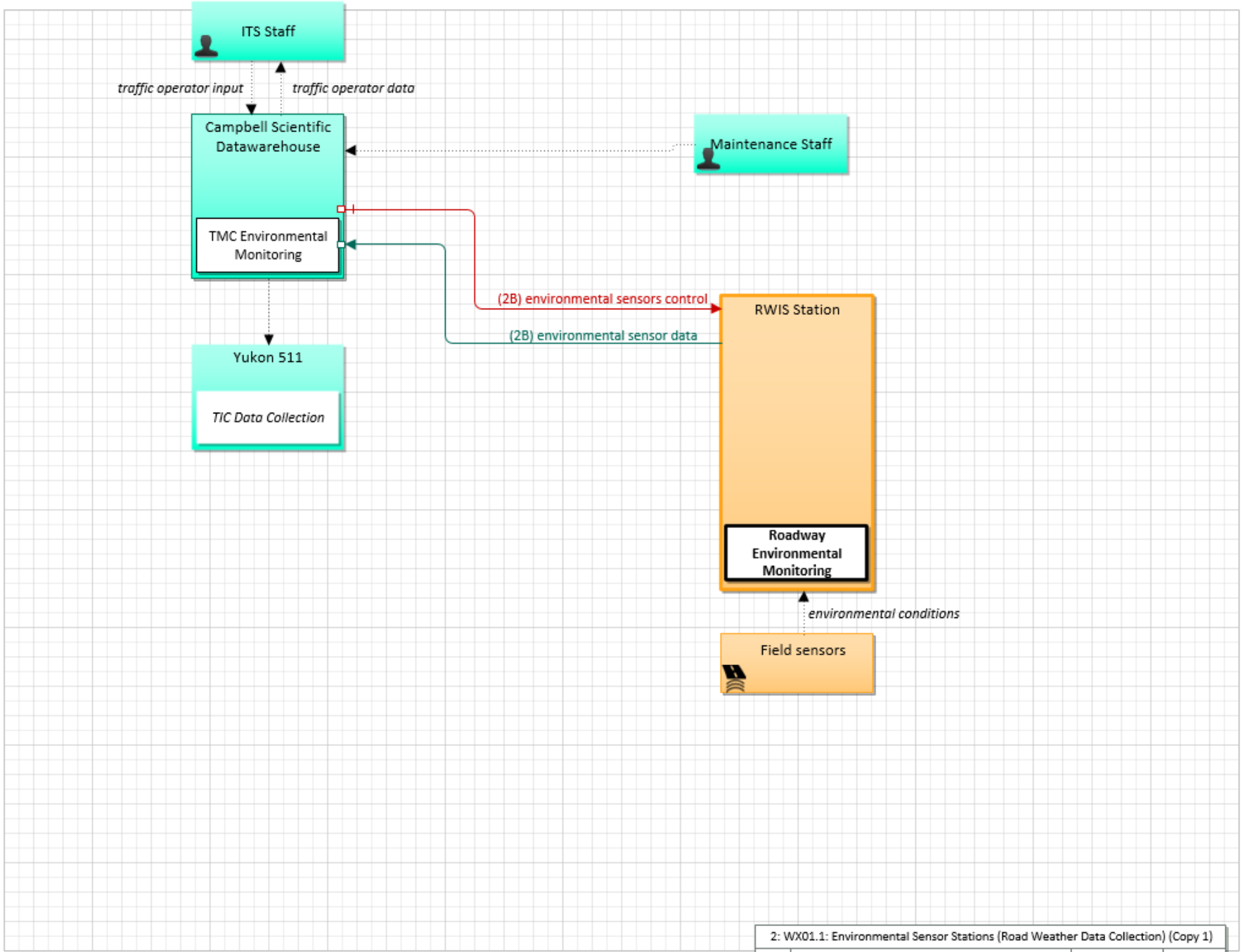

SET-IT - C:\Projects\Transport Canada\TC_ITS Arch\Architecture\Yukon ITS\Yukon ITS.setit
Project
Home
Diagram
Review
Output
Search
Diagram
Item
New
Enterprise
Physical
Comm
Views
Inclusion
Show
Started
Diagram Completion
Line Text
Synchronize
Shape Properties
FIPS
Cleanup
Sequence
Update
Diagram Verification
Tools
Calibri
Font
Paragraph
Paste
Cut
Copy
Size Painter
Clipboard
Align&Space
Size&Position
Connection Points
Arrange
Zoom
To Page
Zoom
Diagrams
2: WX01.1: Environmental
Shapes
Element Details
Name:
Jam Logic VMS Control
Description:
Auto-Populate
Status:
Project
Abbreviation:
JLVC
Type:
System
Parent Element:
Class:
Center
Domain:
Transportation
Physical Object(s)
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
Form Source: Shape Properties - New
{Traffic Operations Personnel}
traffic operator input
traffic operator data
{Traffic Management Center}
TMC Traffic Information Dissemination
Shape Properties
{Traffic Management Center}
Physical Object
Center - System
Element(s)
New...
Edit...
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
information
Motorists
Traffic Information Dissemination) (Copy 1)
am TM06.1 r7
Sep 05 2023
Overview
Diagrams
Definitions
Personal Human
Support Human

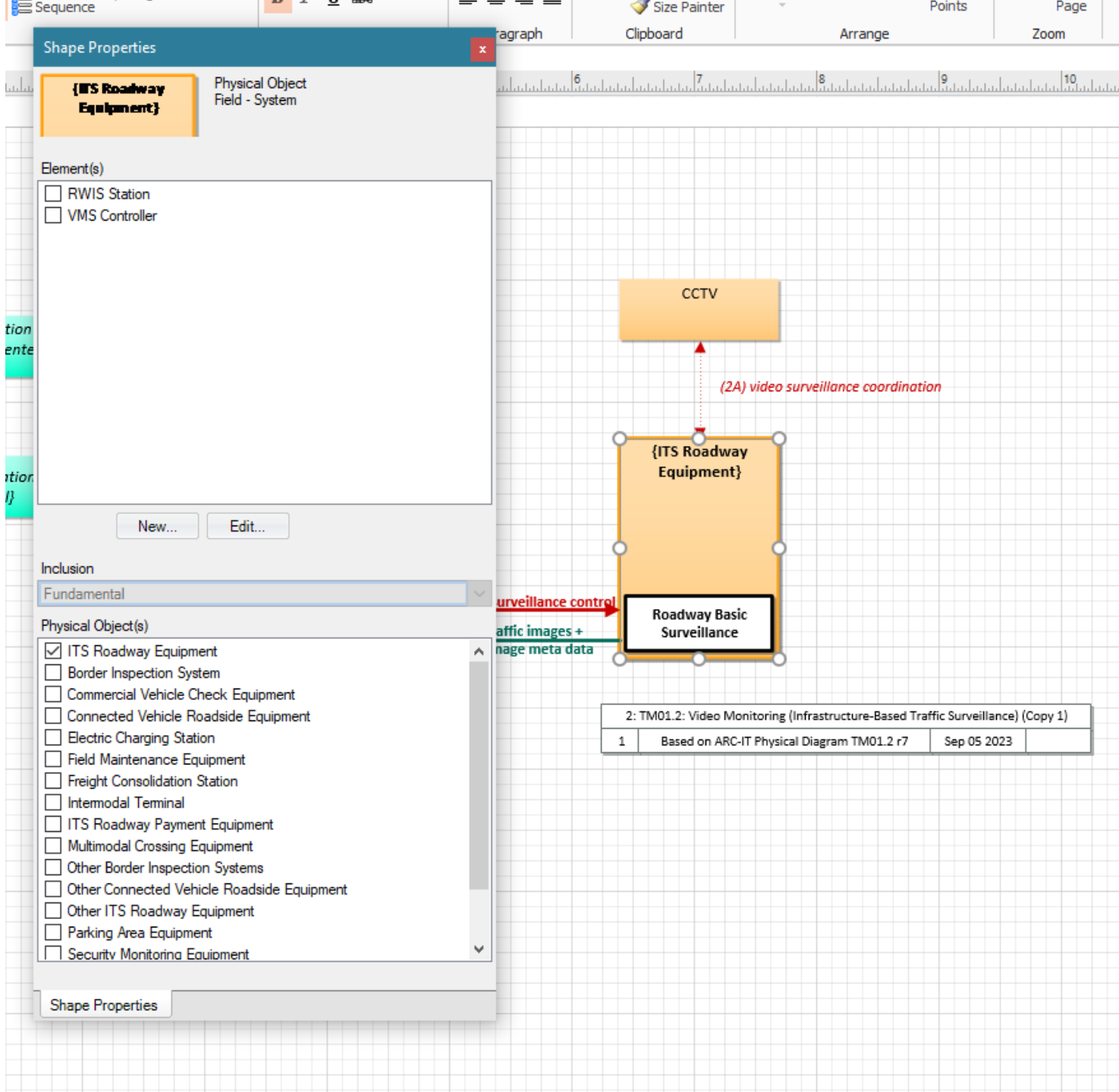
Editing a diagram

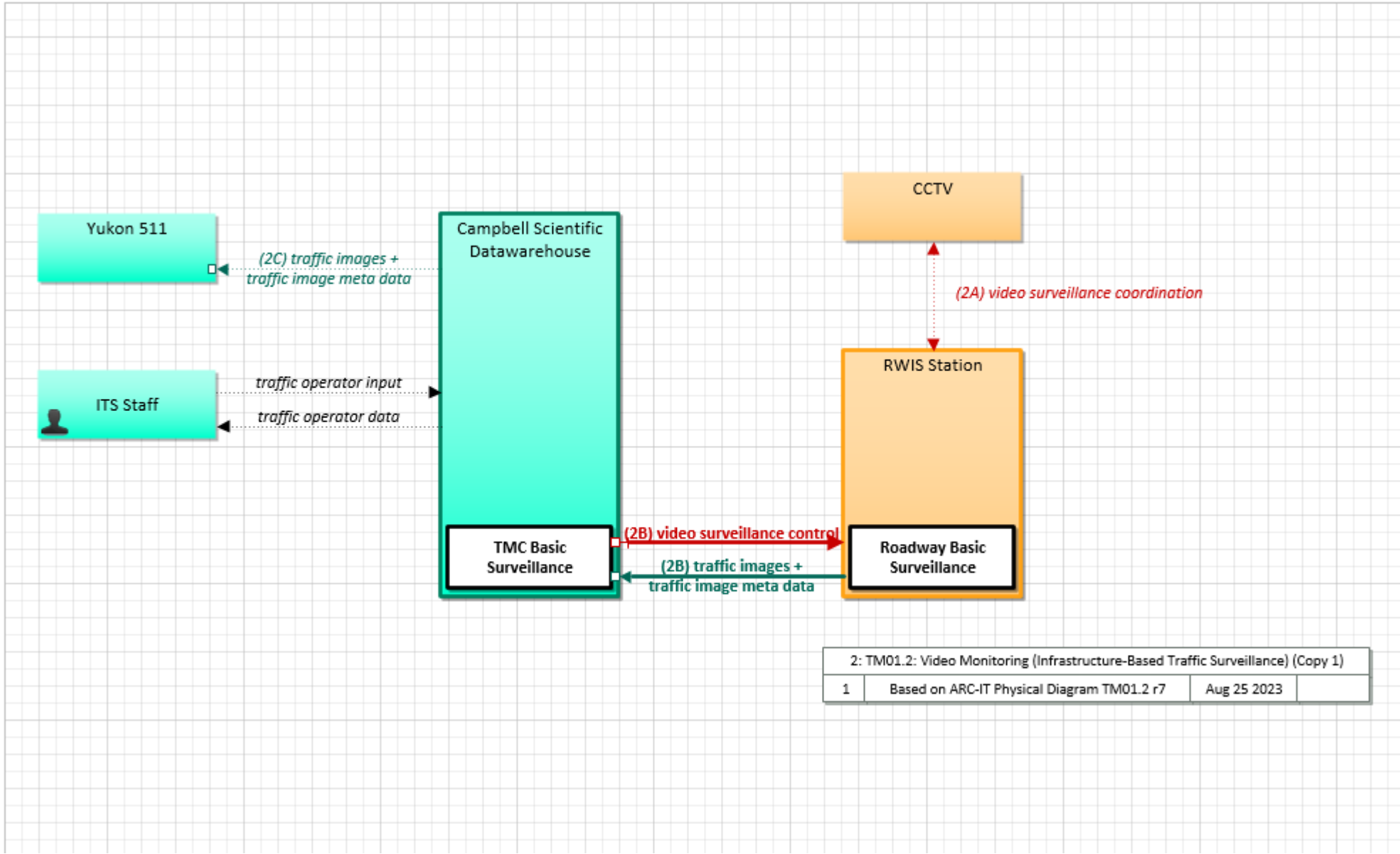





Diagrams
2: WX01.1: Environmental Sensor Stations (Road Weather Data Collection) (Copy 1)
2: WX01: Road Weather Data Collection (Copy 1)
2: TM06.1: Dynamic Message Signs (Traffic Information Dissemination) (Copy 1)
2: TM01.2: Video Monitoring (Infrastructure-Based Traffic Surveillance) (Copy 1)
Overview
Diagrams
Definitions
Shapes
Search shapes
More Shapes
Quick Shapes
SET-ITStencil
Drop Quick Shapes here
Info Flow
Info Flow (Bidir)
Center
Field
Vehicle
Vehicle (Mobile)
Personal
Support
Functional Object
Notes
Comment
Center Human
Field Human
Vehicle Human
Personal Human
Support Human
Field
Support
{Traffic Operations Personnel}
{Roadway Environment}
environmental conditions
traffic operator input
traffic operator data
(2C) environmental conditions data
{Traffic Management Center}
(2B) environmental monitoring application info
(2B) environmental monitoring application status
(2B) environmental situation data
{Connected Vehicle Roadside Equipment}
(2A) vehicle situation data parameters
(2A) vehicle environmental data
{Vehicle OBE}
(2C) environmental conditions data status + qualified environmental conditions data
TMC Environmental Monitoring
RSE Environmental Monitoring
Vehicle Environmental Monitoring
(2B) environmental sensors control
(2B) environmental sensor data
{ITS Roadway Equipment}
(2C) environmental conditions data
(2C) environmental conditions data status + qualified environmental conditions data
{Maint and Constr Vehicle OBE}
(1B) environmental sensors control
(1B) environmental sensor data
{Surface Transportation Weather Service}
{Weather Service System}
MCV Environmental Monitoring
Roadway Environmental Monitoring
environmental conditions
{Roadway Environment}
{Maint and Constr Management Center}
(2C) environmental sensors control
(2C) environmental sensor data
(2B) environmental situation data
MCM Environmental Information Collection
(2C) road network environmental situation data
maint and constr center personnel input
maint and constr operations information presentation
{Transportation Information Center}
TIC Data Collection
(2B) vehicle environmental data
{Maint and Constr Center Personnel}
2: WX01: Road Weather Data Collection (Copy 1)
1
Based on ARC-IT Physical Diagram WX01 r11
Sep 05 2023


ITS Staff
traffic operator input
traffic operator data
Campbell Scientific Datawarehouse
Maintenance Staff
TMC Environmental Monitoring
(2B) environmental sensors control
(2B) environmental sensor data
RWIS Station
Yukon 511
TIC Data Collection
Roadway Environmental Monitoring
environmental conditions
Field sensors
2: WX01.1: Environmental Sensor Stations (Road Weather Data Collection) (Copy 1)
1
Based on ARC-IT Physical Diagram WX01.1 r11
Aug 25 2023


Sequence
Size Painter
Points
Page
Clipboard
Arrange
Zoom
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
CCTV
(2A) video surveillance coordination
{ITS Roadway Equipment}
Roadway Basic Surveillance
urveillance control
affic images +
nage meta data
2: TM01.2: Video Monitoring (Infrastructure-Based Traffic Surveillance) (Copy 1)
1
Based on ARC-IT Physical Diagram TM01.2 r7
Sep 05 2023



2: TM01.2: Video Monitoring (Infrastructure-Based Traffic Surveillance) (Copy 1)			
1	Based on ARC-IT Physical Diagram TM01.2 r7	Aug 25 2023	

Shapes

Search shapes

More Shapes

SET-ITStencil

Drop Quick Shapes here

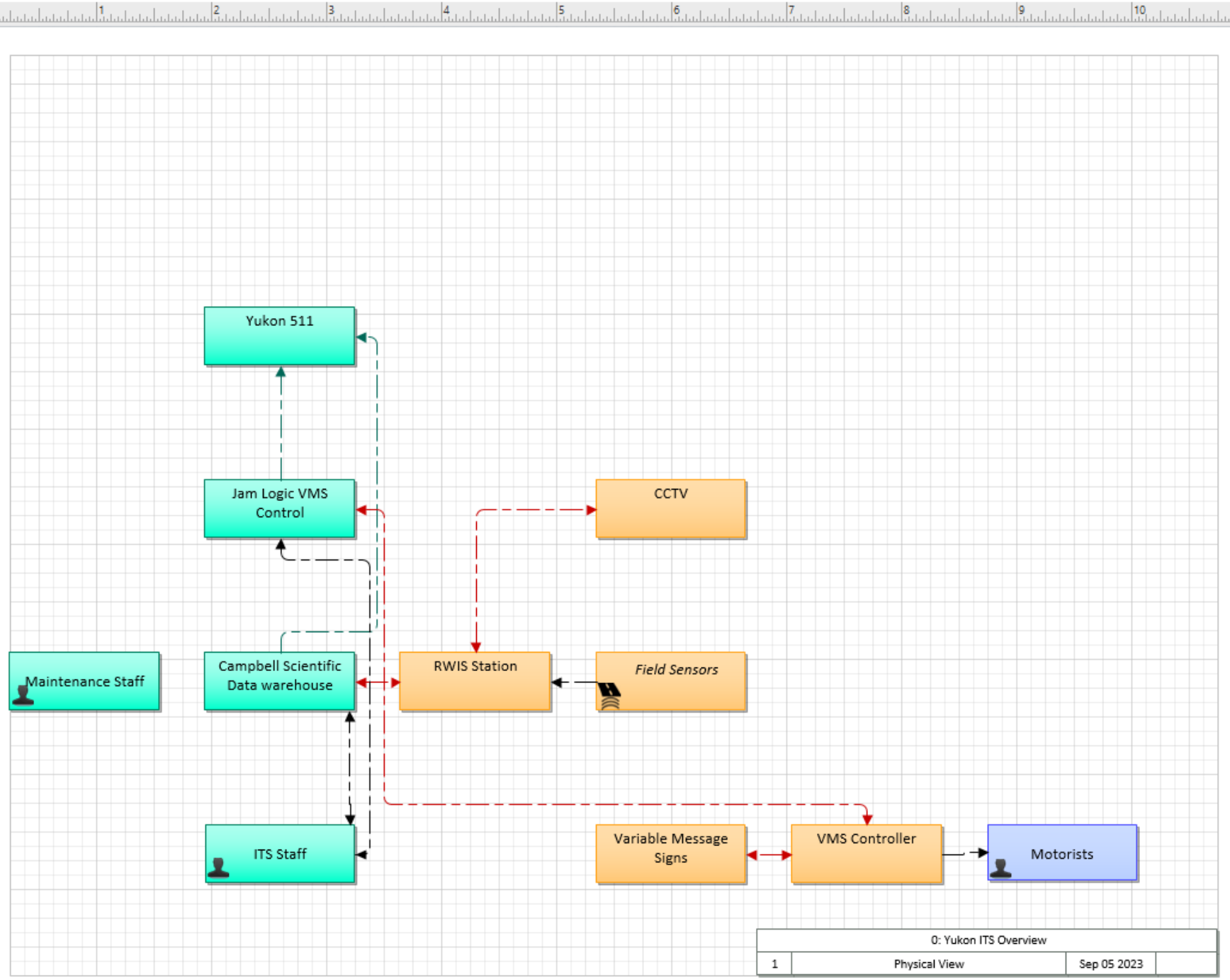
Notes

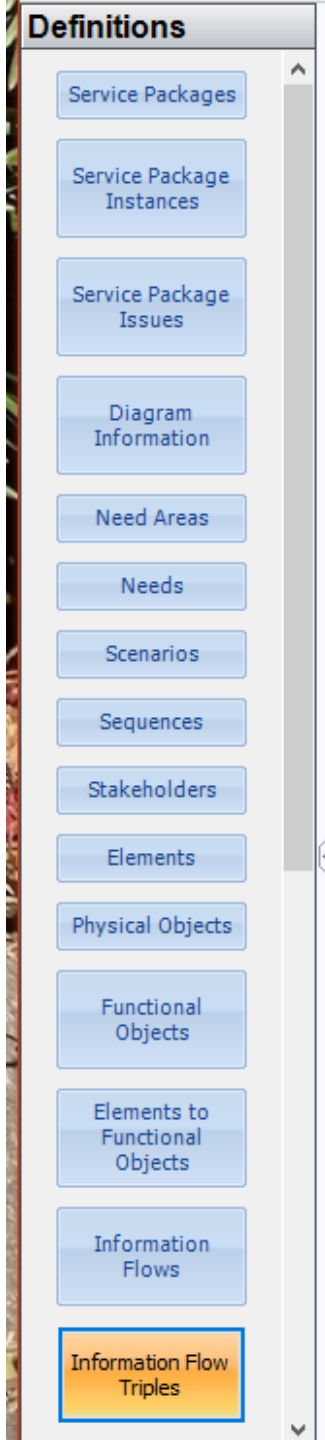
Comment

Terminal

Legend Physical Lay...

Legend Physical ...

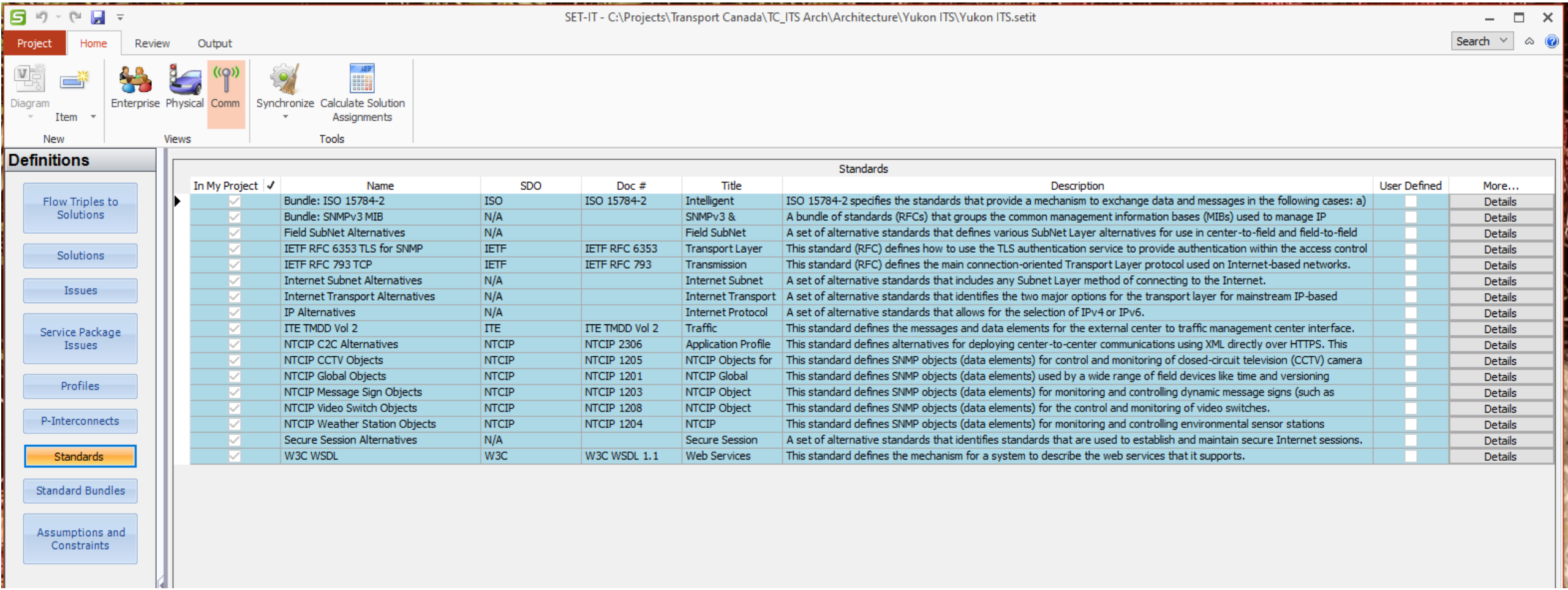




Information Flow Triples

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

Communications View



Standards

In My Project	Name	SDO	Doc #	Title	Description	User Defined	More...
☑	Bundle: ISO 15784-2	ISO	ISO 15784-2	Intelligent	ISO 15784-2 specifies the standards that provide a mechanism to exchange data and messages in the following cases: a)	☐	Details
☑	Bundle: SNMPv3 MIB	N/A		SNMPv3 &	A bundle of standards (RFCs) that groups the common management information bases (MIBs) used to manage IP	☐	Details
☑	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	☐	Details
☑	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	☐	Details
☑	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.	☐	Details
☑	Internet Subnet Alternatives	N/A		Internet Subnet	A set of alternative standards that includes any Subnet Layer method of connecting to the Internet.	☐	Details
☑	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	☐	Details
☑	IP Alternatives	N/A		Internet Protocol	A set of alternative standards that allows for the selection of IPv4 or IPv6.	☐	Details
☑	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.	☐	Details
☑	NTCIP C2C Alternatives	NTCIP	NTCIP 2306	Application Profile	This standard defines alternatives for deploying center-to-center communications using XML directly over HTTPS. This	☐	Details
☑	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	☐	Details
☑	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	☐	Details
☑	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	☐	Details
☑	NTCIP Video Switch Objects	NTCIP	NTCIP 1208	NTCIP Object	This standard defines SNMP objects (data elements) for the control and monitoring of video switches.	☐	Details
☑	NTCIP Weather Station Objects	NTCIP	NTCIP 1204	NTCIP	This standard defines SNMP objects (data elements) for monitoring and controlling environmental sensor stations	☐	Details
☑	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.	☐	Details
☑	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.	☐	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 Transports Canada
- Mara Bullock mara.bullock@wsp.com

Thank You for Joining!