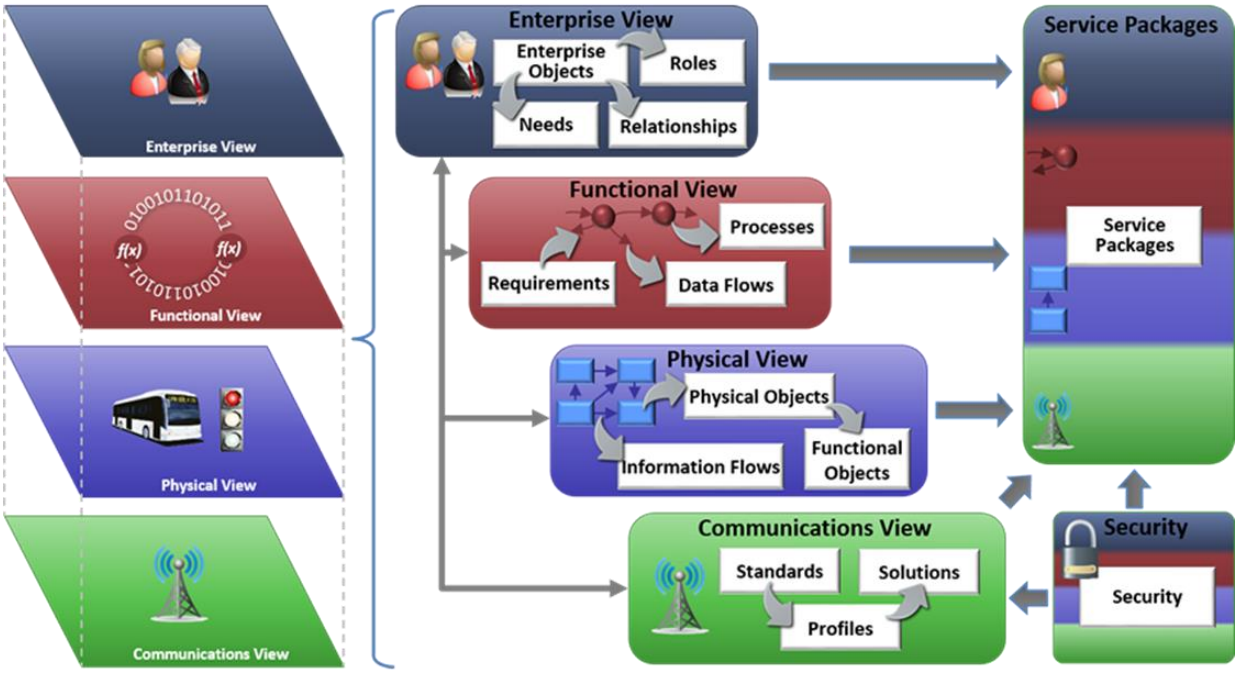
TRANSPORT CANADA

UPDATING THE ITS ARCHITECTURE FOR CANADA PHASE II – ENGLISH UPDATE AND SCOPING FOR FRENCH UPDATE

FINAL SUMMARY OF VERSION 3 UPDATE FOR THE ITS ARCHITECTURE FOR CANADA

APRIL 27, 2020



DISCLAIMER

This project received funding support through Transport Canada's Program to Advance Connectivity and Automation in the Transportation System (ACATS). The views and opinions expressed are those of the authors and do not necessarily reflect those of Transport Canada.

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LIST OF ACRONYMS

ACE	Automated Commercial Environment
ACI	Advance Commercial Information
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
C-TPAT	Customs – Trade Partnership Against Terrorism
CFIA	Canadian Food Inspection Agency
CV	Connected Vehicle
CVRIA	Connected Vehicle Reference Implementation Architecture
FAST	Free and Secure Trade
FDA	Food and Drug Administration
ITS	Intelligent Transportation Systems
PIP	Partners in Protection
RAD-IT	Regional Architecture Development for Intelligent Transportation
SET-IT	Systems Engineering Tool for Intelligent Transportation

1 INTRODUCTION

1.1 BACKGROUND

The Intelligent Transportation Systems (ITS) Architectures in Canada and U.S. have a long and intertwined history dating back over twenty years, as illustrated in **Figure 1**. With a goal to promote, unify, and ensure interoperability in the deployment of ITS across all modes of surface transportation throughout Canada, and within a North American context, the first version of the *ITS Architecture for Canada* was developed in 2000 as an expansion on the *U.S. National ITS Architecture* at that time (Version 3.0). The areas in which Canada enhanced the U.S. architecture are summarized in **Table 1** and highlights sixteen (16) services that were unique to Canada, as well as six (6) services that were in both architectures, but the Canadian version included some enhancements (identified as "*modified*").

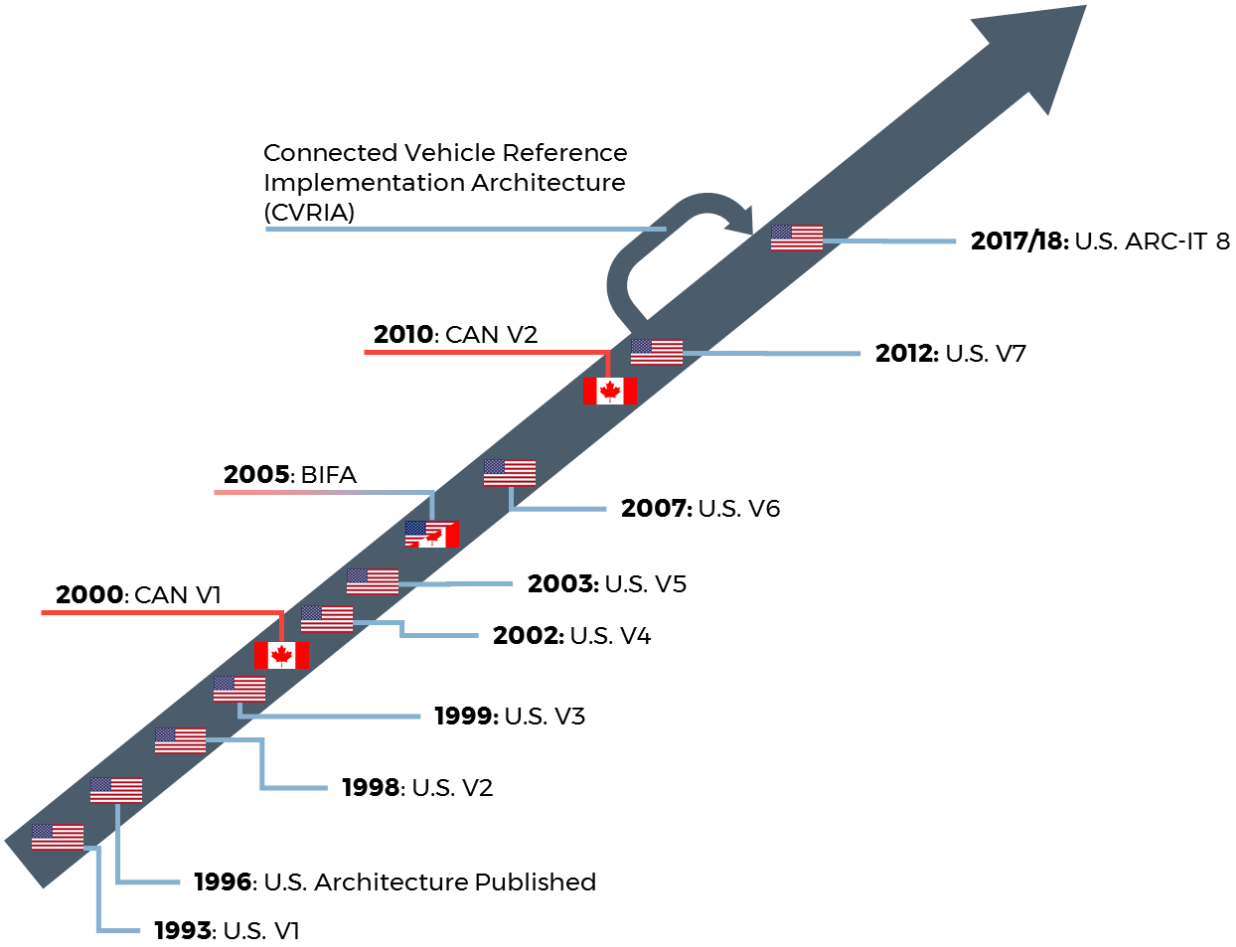


Figure 1: Summary of Canadian and U.S. ITS Architectures

Table 1: Areas of Enhancements in ITS Architecture for Canada V1 (in Comparison to U.S V3)

Area	Services
Automated Enforcement	• Signal Enforcement • Variable Speed Limit and Enforcement
Disaster Management	• Disaster Command and Control • Disaster Information Dissemination • Emergency Response Management (*modified*)
Environmental Monitoring	• Broadcast Traveller Information (*modified*) • Dynamic Roadway Warning • Environmental Information Dissemination • Interactive Traveller Information (*modified*) • Roadway and Weather Data Fusion • Roadway Environmental Sensing • Roadway Micro-Prediction • Traffic Network Flow Monitoring (*modified*)
Intermodal Freight	• Freight In-Transit Monitoring • Freight Terminal Management • International Border Crossing Clearance (*modified*)
Non-Vehicular Safety	• Automated Non-Vehicular Road User Protection • Incident Risk Prediction System (*modified*) • Mixed Use Warning Systems
Operations & Maintenance	• Infrastructure Maintenance Management • Smart Work Zones
Transit	• Multi-Modal Connection Protection

As illustrated in **Figure 1**, the *ITS Architecture for Canada* was updated last in 2010, at which time it was re-aligned with the then current version of the *U.S. National ITS Architecture* at that time (Version 6.0). In the interim between Versions 1 and 2 of the *ITS Architecture for Canada*, the U.S. had undertaken three (3) major revisions that consisted of incorporating many new services, including some which were previously unique to Canada. **Table 2** provides a summary of the differences between the Canadian and U.S. architectures that remained after the publication of the *Version 2 of the ITS Architecture for Canada* in 2010. It should be noted that for those services that were previously unique, but subsequently added to the U.S., the more current U.S. versions were adopted. "*Modified*" is again used to highlight common Service Packages where the Canadian versions include some enhancements.

Table 2: Remaining Enhancements in ITS Architecture for Canada V2 (in Comparison to U.S V6)

Area	Services
Automated Enforcement	• Signal Enforcement • Variable Speed Limit and Enforcement (*modified*)
Border Information	• International Border Inspection • International Border Pre-Processing • International Border Registration
Environmental Monitoring	• Roadway Micro-Prediction
Intermodal Freight	• Freight Administration (*modified*) • Freight Terminal Management
Transit	• Multi-Modal Connection Protection
Warnings	• Dynamic Roadway Warning • Advanced Mixed Use Warning • Standard Mixed Use Warning

1.2 OBJECTIVE AND SCOPE OF THE VERSION 3 UPDATE

Since the last update to the *ITS Architecture for Canada* in 2010, the U.S. has subsequently undergone two major revisions and integrated the *Connected Vehicle Reference Implementation Architecture* (*CVRIA*)[1] and re-branding its architecture as the *Architecture Reference for Cooperative and Intelligent Transportation* (*ARC-IT*)[2].

The objective of this project was to undertake an English update of the *ITS Architecture for Canada* to re-align with the current *U.S. ARC-IT* (Version 8.3) and incorporate the recent and substantial Connected Vehicle (CV) related enhancements, providing a framework and tools that have a national and international benefit, and:

— Better reflect new and emerging technologies and initiatives; and

— Map to current and relevant standards.

The scope of this current effort has focused on developing the English version of the updated *ITS Architecture for Canada* first. As part of this project, a separate Technical Memorandum provides details on options for providing support for the French language, along with level of effort estimates.

[1] https://local.iteris.com/cvria/

[2] https://local.iteris.com/arc-it/html/architecture/architecture.html

1.3 STEERING COMMITTEE

The effort to undertake this project, including the assessment of current differences between the Canadian and U.S. architectures and support on the technical approach to the update, has been guided by the insight and direction of Transport Canada, ITS Canada, and stakeholders from the ITS industry (see **Table 3**).

Table 3: Project Steering Committee

Member Name	Agency/Company
Peter Allaby	Crandell Engineering
Oliver Audet	Ville de Montréal
Brigid Canil	BC Ministry of Transportation and Infrastructure
Richard Chylinski	Parsons
Selma Coban	Ministère du Transport du Québec
Jonathan Foord	KPMG (previously City of Winnipeg)
Trevor Hanson	University of New Brunswick
Keenan Kitasaka	Associated Engineering
Ken Moshi	Transport Canada
Barry Pekilis	National Research Council Canada
Amanda Price	Yukon Government
Pierre Rasoldier	Transport Canada
Tony Qiu	U of A / ActiveAurora
Rajeev Roy	Regional Municipality of York
Janneke van der Zee	ITS Canada

Overall there were five (5) Steering Committee Meetings, as follows:

- November 29, 2018, 1:00 pm – 2:00 pm Eastern
- April 25, 2019, 1:00 pm – 2:30 pm Eastern
- June 24, 2019, 2:00 pm – 3:00 pm Eastern
- September 11, 2019, 1:00 pm – 2:00 pm Eastern
- November 25, 2019, 1:30 pm – 2:30 pm Eastern

2 TECHNICAL APPROACH FOR UPDATE

2.1 GUIDING PRINCIPLES

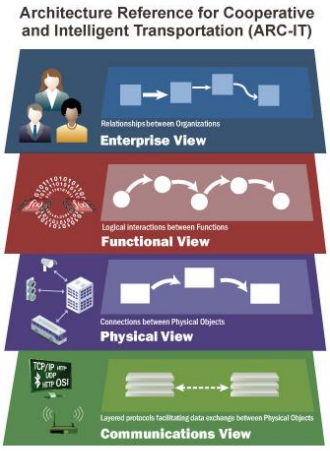
Through engagement with stakeholders and the steering committee, two guiding principles were identified that governed the overall update and shaped individual approaches, as follows:

- ***Re-align with the latest U.S. ARC-IT (Version 8.3)*** – to bring the Canadian architecture up to date; and
- ***Avoid, or at least minimize, differences in comparison to the latest U.S. ARC-IT (Version 8.3)*** – to facilitate adoption of future updates and reduce future maintenance needs.

2.2 STRUCTURE AND ORGANIZATION

The updated version of the *ITS Architecture for Canada* subsumes the most recent *US ARC-IT* (i.e. Version 8.3), and as such will support the same organization and the following four (4) complimentary and related views:

- ***Enterprise*** - Describes the relationships between organizations and the roles those organizations play within the connected vehicle environment.
- ***Functional*** - Describes abstract functional elements (processes) and their logical interactions (data flows) that satisfy the system requirements.
- ***Physical*** - Describes physical objects (systems and devices) and their functional objects as well as the high-level interfaces between those physical objects.
- ***Communications*** - Describes the layered sets of communications protocols that are required to support communications among the physical objects that participate in the connected vehicle environment.



Service Packages represent slices of the Physical View, and help organize and provide linkages between all views, and the updated version of the *ITS Architecture for Canada* is to adopt and conform to the organization and groups of Service Packages in the current *US ARC-IT*.

2.3 NEW AND UPDATED ARC-IT_V8 SERVICE PACKAGES AND SUPPORTING ELEMENTS

The *Assessment of Current Differences and Proposed Update Approach - Technical Memorandum (2019-07-24)* identified that there are forty-five (45) Service Packages that have been added to the U.S. architecture since 2010 and the majority of the remaining Service Packages have themselves been updated or modified in some way (e.g. added functionality and interfaces related to connected vehicles).

With these new and updated Service Packages Level there are many corresponding new and/or modified elements across the four views of *ARC-IT* (i.e. physical objects, information flows, and functional objects). The updated version of the *ITS Architecture for Canada* subsumes all of the most recent *US ARC-IT* (i.e. Version 8.3) elements and supporting material, as summarized in **Table 4**.

Table 4: Summary of the Scope of U.S. ARC-IT Adoption

Element Type	Summary
Service Packages	141 Total (137 core US, 4 linked to Australia)
Physical Objects	139 Total (135 core US, 4 linked to Australia)
Information Flows	809 Total (793 core US, 16 linked to Australia)
Functional Objects	361 Total (355 core US, 6 linked to Australia)

2.4 CANADIAN-UNIQUE FUNCTIONALITY

In line with the guiding principle of minimizing differences and future maintenance efforts, the approach for the update was to only support Canadian-unique functionality as warranted, and to ensure that all unique elements are isolated into separate Canadian-specific Service Packages. This also ensures that all other Service Packages include a complete 1-to-1 mapping with *ARC-IT*.

After reconciling the high-level differences between the current Canadian and U.S. architectures (see the *Assessment of Current Differences and Proposed Update Approach - Technical Memorandum (2019-07-24))* and subsequent detailed review and warrant analysis, four (4) Service Packages continue to be supported in the updated version of the *ITS Architecture for Canada*, as identified in **Table 5**. For each of the Canadian-unique Service Packages, lower level elements and supporting material will be developed and defined to support all four ARC-IT views (see **Section 2.2**).

Table 5: Canadian Unique Service Packages

Element Type	Summary
International Border Registration	Address the portions of registration in programs for expedited border crossings for shipments and travelers, which are not accounted for in ARC-IT's CVO05 International Border Electronic Clearance Service Package.
International Border Coordination	Address the portions of international coordination between border agencies, which are not accounted for in ARC-IT's TM23 Border Management Systems Service Package.
Signal Enforcement	Fully address the functionality and intent of the ATMS102 Signal Enforcement Service Package from Version 2 of the ITS Architecture for Canada.
Roadway Micro-Prediction	Fully address the functionality and intent of the MC101 Roadway Micro-Prediction Service Package from Version 2 of the ITS Architecture for Canada.

2.5 OTHER NON-FUNCTIONAL CONSIDERATIONS

The *Assessment of Current Differences and Proposed Update Approach - Technical Memorandum (2019-07-24)* identified several non-functional areas where, in the past, the Canadian and U.S. architectures differed, as described in the following sub-sections. These non-functional differences, particularly as they relate to common services and elements, can lead to potential confusion for users of both architectures, as well as results in something other than 1-to-1 mapping, which impacts maintenance and the ability to easily adopt U.S. updates to elements in common between the architectures.

2.5.1 SPELLING

Previously, all text in the *ITS Architecture for Canada* has used Canadian spelling, such as using 'centre' where the U.S. uses 'center' and using 'traveller' where the U.S. uses 'traveler'. These two examples are common in transportation and are prevalent throughout past version of the Canadian architecture.

It was assessed that Canadian and U.S. spelling is often used interchangeably, and in line with guiding principle of avoiding unnecessary differences and maintain 1-to-1 mapping of common elements, the approach for the updated version of the *ITS Architecture for Canada* is to use U.S. spelling.

2.5.2 ELEMENT NAMES

In past versions of the *ITS Architecture for Canada* there were a limited number of element names that differed from their counterparts in the U.S. architecture. Some of these differences related to differences in common nomenclature names (e.g. 'Hazardous Materials' as opposed to 'HAZMAT' in U.S.) or to specifically highlight attributes (e.g. 'Intermodal Freight Equipment' instead of 'Freight Equipment' in the U.S.).

Although the names may have differed, the elements are otherwise identical, and in line with guiding principle of avoiding unnecessary differences and maintain 1-to-1 mapping of common elements, it was assessed that these differences are not warranted, and the approach for the updated version of the *ITS Architecture for Canada* is to use U.S. element naming.

2.5.3 COUNTRY-SPECIFIC REFERENCES

Descriptions of elements can use examples to provide context, and in some cases the U.S. architecture uses references to U.S.-specific examples (e.g. 'State' as opposed to Province, 'U.S. Food and Drug Administration (FDA)' instead of 'Canadian Food Inspection Agency (CFIA)' or the 'Department of Health Canada (Health Canada)').

In line with guiding principle of avoiding unnecessary differences and maintain 1-to-1 mapping of common elements, the approach for the updated version of the *ITS Architecture for Canada* is to assume U.S.-specific references.

2.5.4 SUMMARY

To address any lingering concerns regarding the above approaches, and to minimize confusion and ensure a clear understanding, an introduction primer on the update and a table of comparable words, terms, and names will be included where the updated *ITS Architecture for Canada* is accessed (i.e. websites).

3 VERSION 3 OF THE ITS ARCHITECTURE FOR CANADA

As with past *ITS Architecture for Canada* development and update efforts, there was active coordination with the USDOT, in order to facilitate alignment.

ARC-IT supports inclusion of international services that provide complementary expansion on its core content. For example, a handful of European Union and Australian service packages have been integrated into ARC-IT.

Section 3.1 provides a summary of how the updated Canadian-unique Service Packages have been developed and defined for all four (4) architecture views for easy integration by the U.S. into *ARC-IT*, and the following sub-sections provide details on what that means with respect to accessing and using the updated version of the *ITS Architecture for Canada*.

3.1 CANADIAN-UNIQUE SERVICE PACKAGES

This Version 3 update to the *ITS Architecture for Canada* included the full definition of the four (4) Canadian-Unique Services Packages to support all four (4) architecture views, including the use of existing elements from *ARC-IT Version 8* and development of unique elements and configuration of element relationships (e.g. which Physical Objects communicate, and with what Information Flow). The following provides a summary of the magnitude of unique elements:

- 2 unique Physical Objects
- 9 unique Information Flows
- 5 unique Functional Objects
- 3 unique Processes
- 27 unique Data Flows
- 9 unique Needs
- 25 unique Requirements

3.1.1 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.

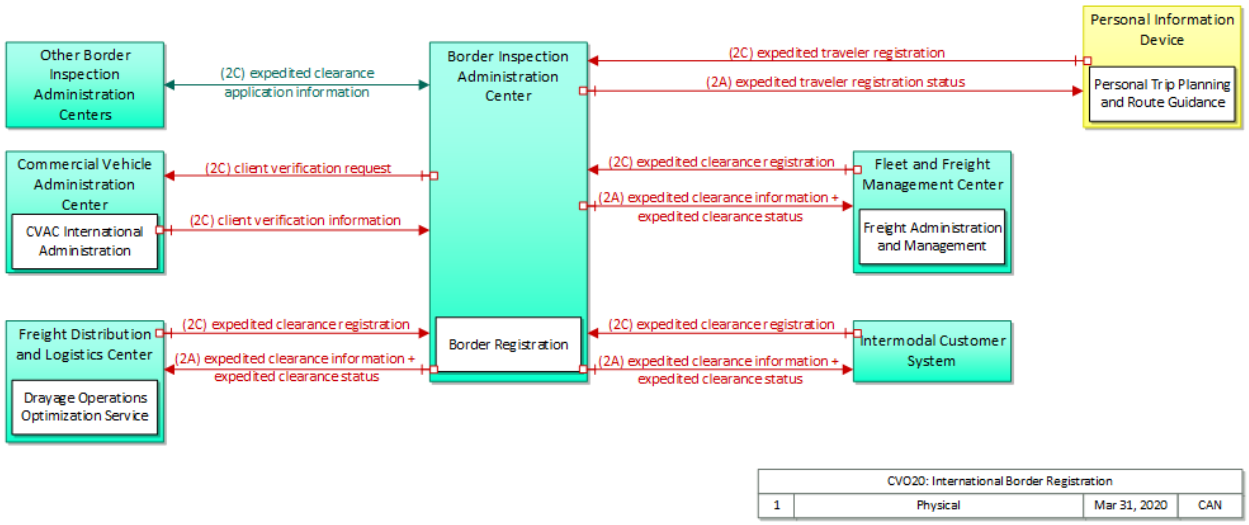


Figure 2: Physical Diagram of CVO21 – International Border Registration

3.1.2 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.

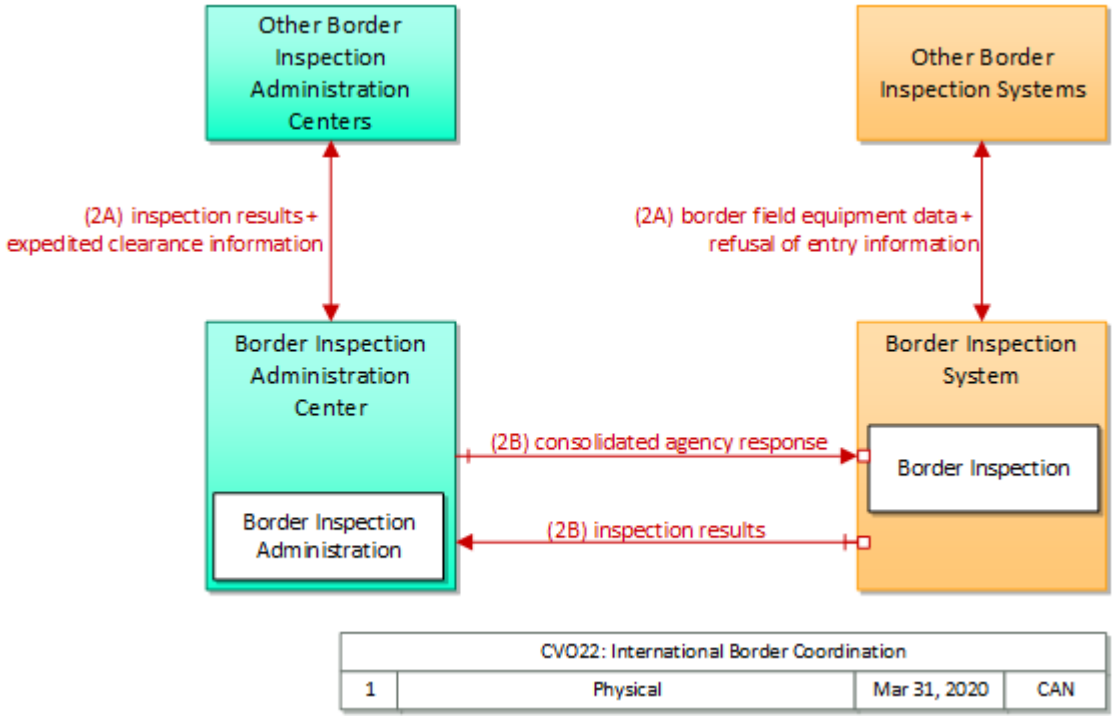


Figure 3: Physical Diagram of CVO22 – International Border Coordination

3.1.3 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. This service package is a logical predecessor to "Intersection Safety Warning" and "Intersection Collision Avoidance", where the signal violation detection is also used to reduce the likelihood of a traffic accident. This same relationship also exists to "Mixed Use Warning Systems" and "Automated Non-Vehicular Road User Protection", since pedestrians, bicyclists, and other non-vehicle traffic may be threatened by signal violations.

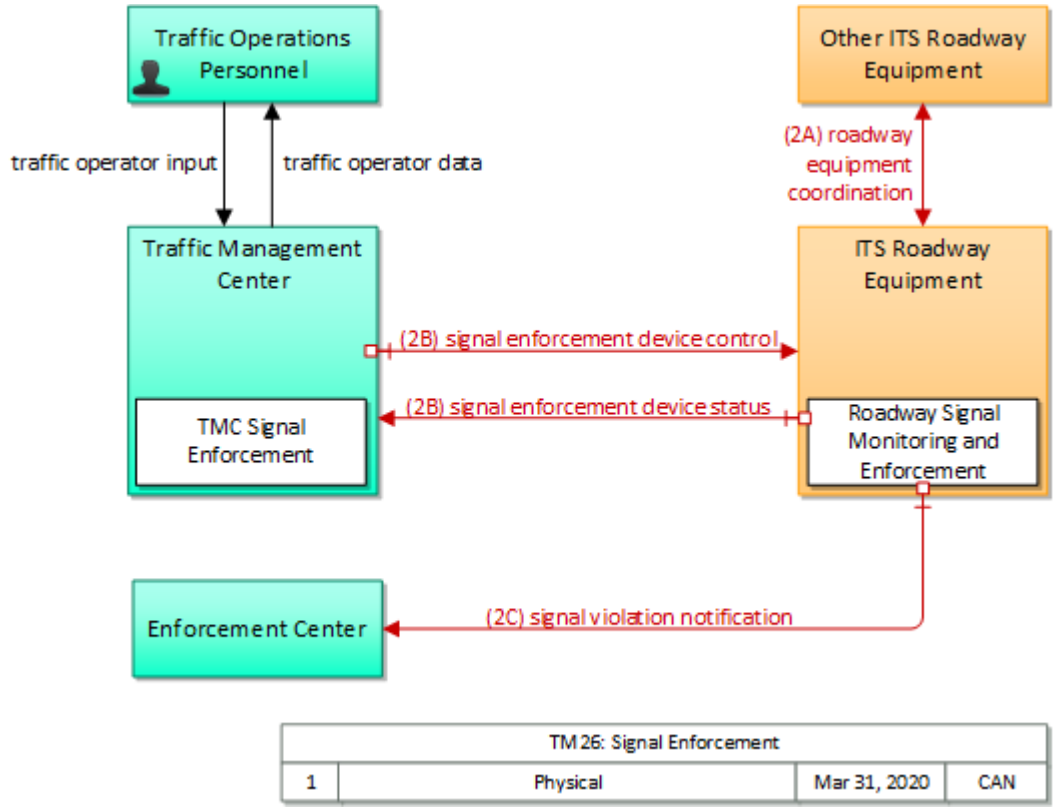


Figure 4: Physical Diagram of TM26 – Signal Enforcement

3.1.4 WX04 – ROADWAY MICRO-PREDICTION

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

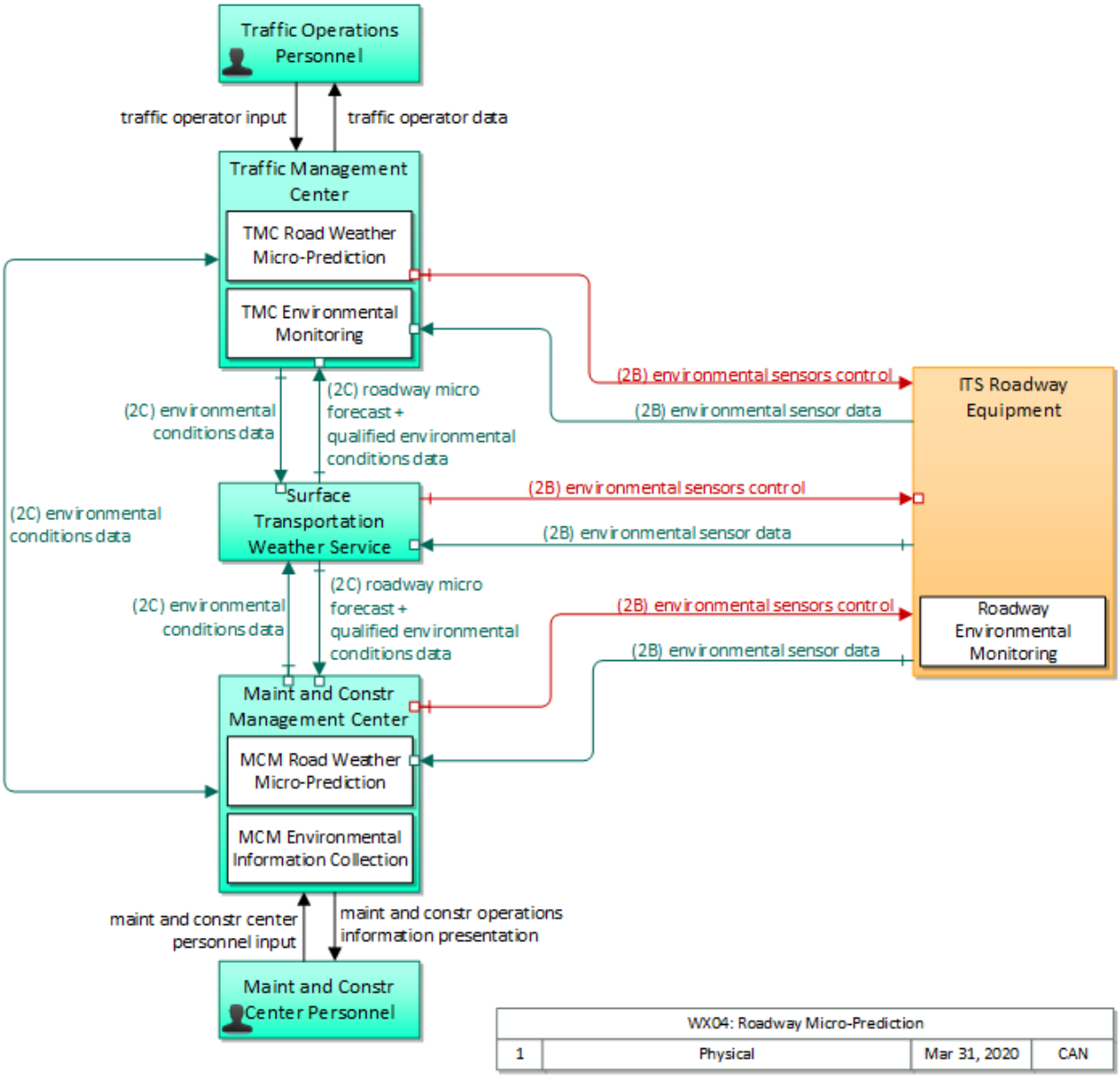


Figure 5: Physical Diagram of WX04 – Roadway Micro-Prediction

3.2 DATABASES

A set of interrelated databases are the core of how the Canadian and U.S. architectures are maintained. As part of this *ITS Architecture for Canada* effort the latest databases published by the U.S. (i.e. *ARC-IT 8.3*) were used to define and document the additional elements and relationships needed to support the Canadian-unique Service Packages. **Table 6** provides a summary of the databases and indicates which have been updated.

Table 6: Summary of Interim Databases

Database Name	Status in Comparison to ARC-IT 8.3
ITSArchCommunications	Same
ITSArchEnterprise	Updated
ITSArchFunctional	Updated
ITSArchGlossary	Same
ITSArchPhysical	Updated
ITSArchPlanning	Updated
ITSArchRequirements	Updated
ITSArchSecurity	Same
ITSArchServicePackages	Updated

U.S. ARC-IT supports inclusion of international services that provide complementary expansion on its core content. The Canadian-unique Service Packages have been designed to the specifications of ARC-IT, in order to facilitate their integration into future versions, and the above databases have been provided to the ARC-IT Team, for their consideration.

3.3 SUPPORTING TOOLS

Users can access the majority of updated *ITS Architecture for Canada Version 3* (as described below) using the following common tools provided by the USDOT and accessible through the ARC-IT website:

- RAD-IT - the Regional Architecture Development for Intelligent Transportation (*RAD-IT*), formally known as Turbo, supports professionals focused on the transportation planning, and the development of Regional ITS Architectures and high-level specification of projects.
- SET-IT - the Systems Engineering Tool for Intelligent Transportation (*SET-IT*) supports systems engineers focused on developing various pre-design documentation. *SET-IT* was developed to support the *CVRIA* to create diagram-based project architectures covering the Physical, Enterprise and Communications Viewpoints

As stated in the guiding principles, Canadian stakeholders expressed their desire to avoid the need for a separate architecture and supporting tools. For this reason, separate RAD-IT and SET-IT tools were not developed as part of the update. Instead, the current versions of the tools from U.S. can be used as they fully support the 141 Service Packages that Canada has in common with the U.S. If users are interested in the Canadian-unique Service Packages, both tools support input and configuration of custom elements.