

SUCCESSFULLY DELIVERING COMPLEX ITS PROJECTS USING AGILE METHODOLOGIES

ITS-NY 30th Annual Meeting and Technology Exhibition –
A Connected World
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AGENDA

- ❖ **BACKGROUND**
- ❖ **TRADITIONAL SYSTEMS ENGINEERING CHALLENGES**
- ❖ **AGILE METHODOLOGY**
- ❖ **APPLICATION TO ALLROADS PROJECT**
- ❖ **ACHIEVED OUTCOMES, SUMMARY & CONCLUSION**
- ❖ **Q&A**

BACKGROUND

ADVANCED TRANSPORTATION & CONGESTION MGMT. TECHNOLOGY DEPLOYMENT PROJECT

A Connected Region:
Moving Technological
Innovations Forward
in the NITTEC Region

ADVANCED
TRANSPORTATION
AND CONGESTION
MANAGEMENT
TECHNOLOGIES
DEPLOYMENT INITIATIVE

AllRoads Project

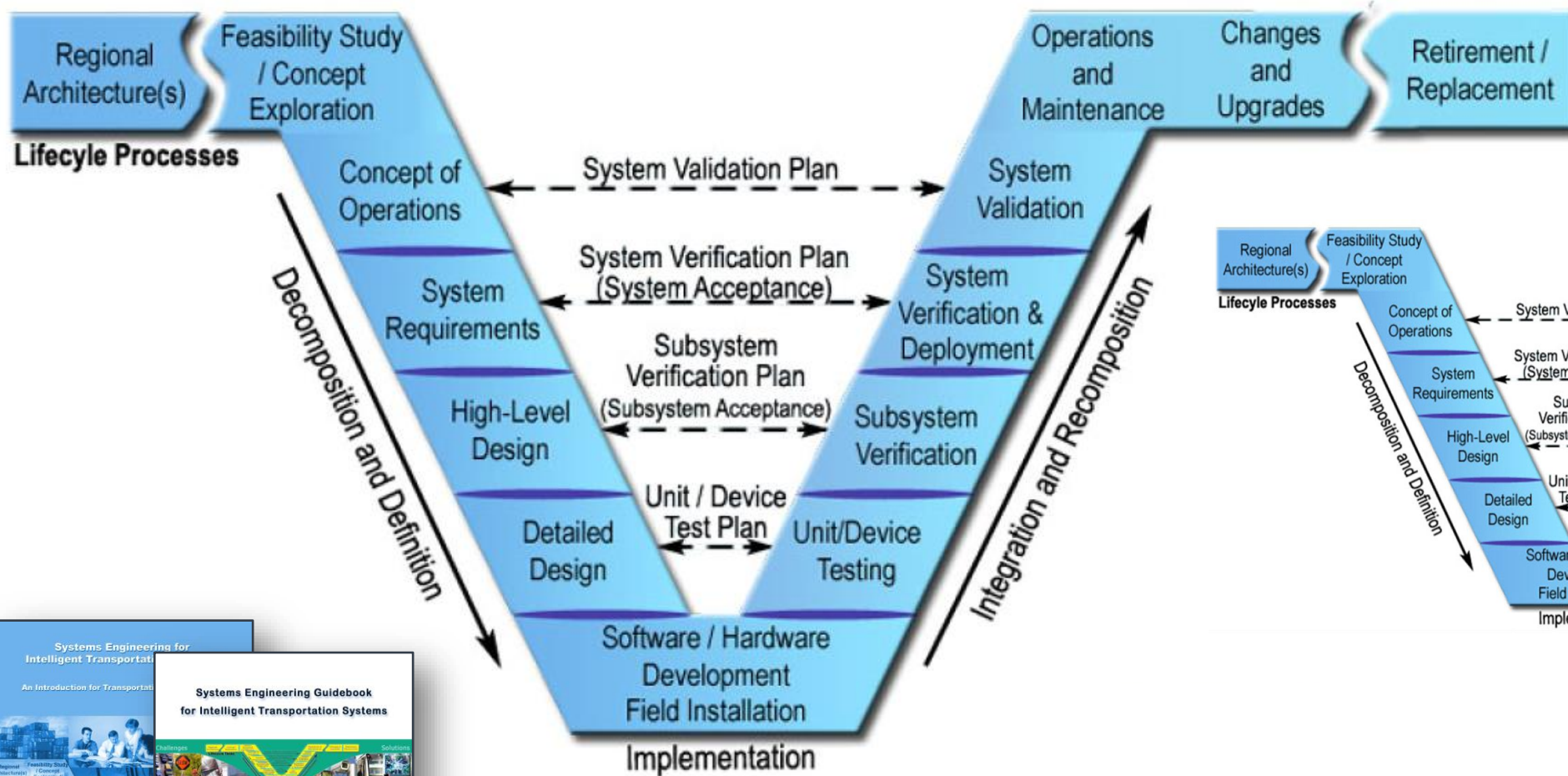
Niagara / Buffalo Region

Project focuses on following initiatives:

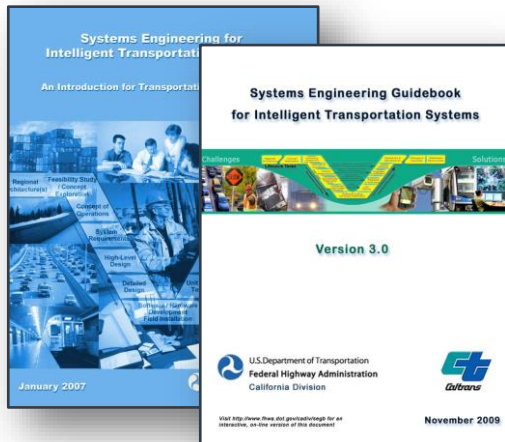
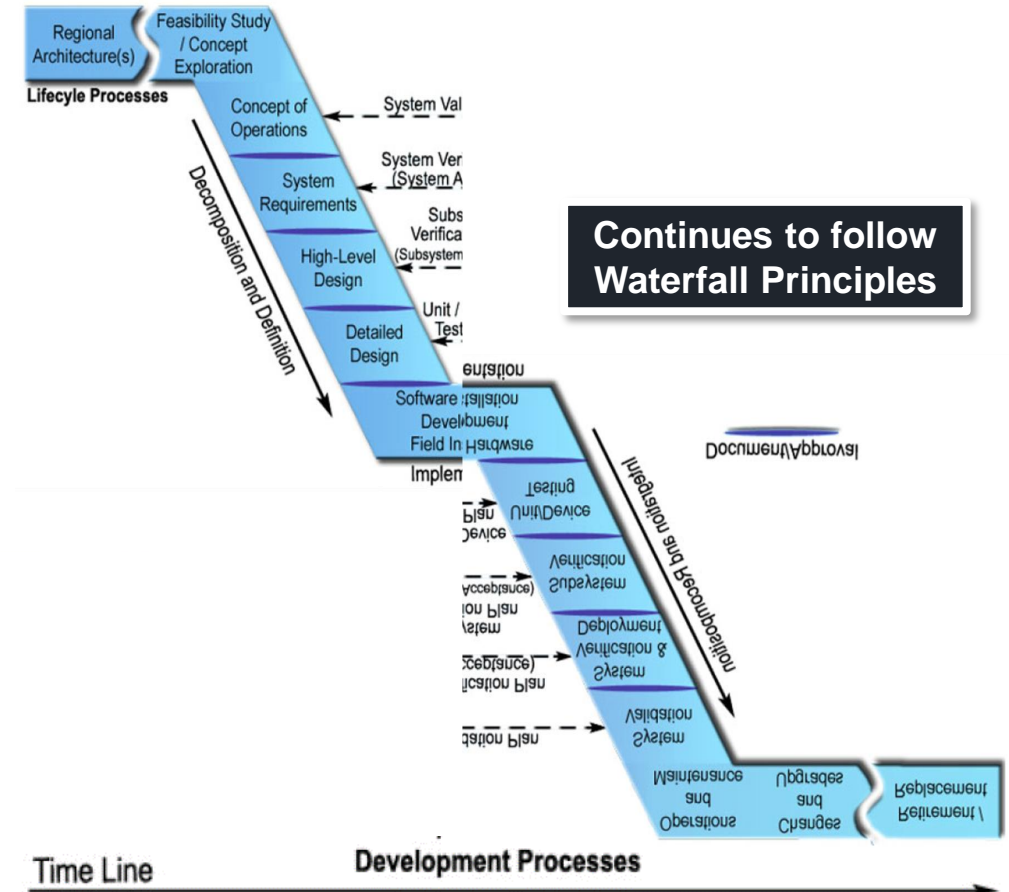
1. Improve Border Crossing Performance and Travel Time
2. Improve Commercial Vehicle Operations and Safety
3. Expand Regional Smart Mobility
4. Improve Incident Management
5. Provide for Operational Integration within NFTA and with Regional Smart Mobility
6. Using Real-time & Forecasted Weather Information for Active Traffic Management
7. Provide Enhanced Real-Time Information for Travelers
8. Enhance Data Collection, Fusion, Distribution and Archiving

TRADITIONAL SYSTEMS ENGINEERING CHALLENGES

SYSTEMS ENGINEERING STANDARDS FOR INTELLIGENT TRANSPORTATION SYSTEMS

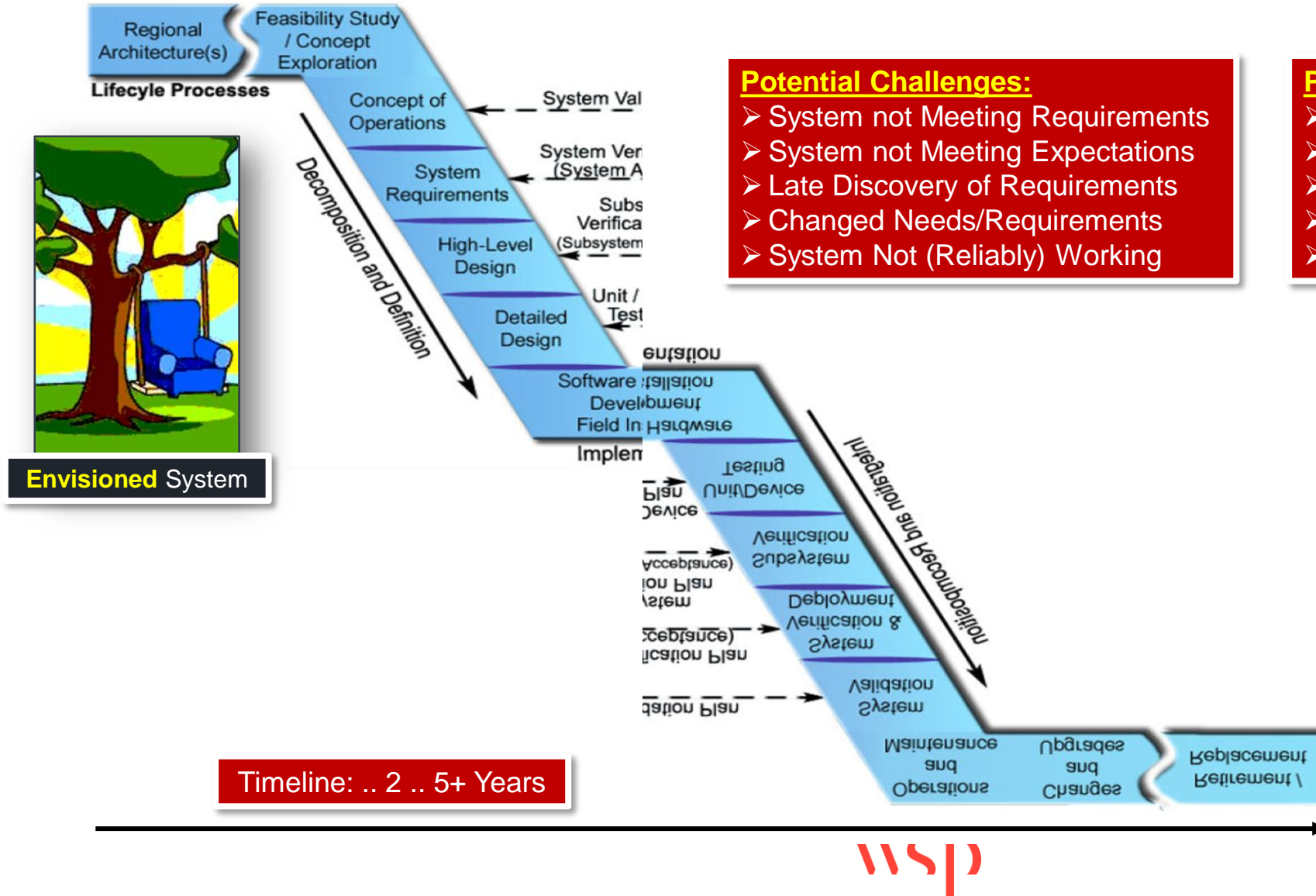


VEE Model



TRADITIONAL SYSTEMS ENGINEERING CHALLENGES

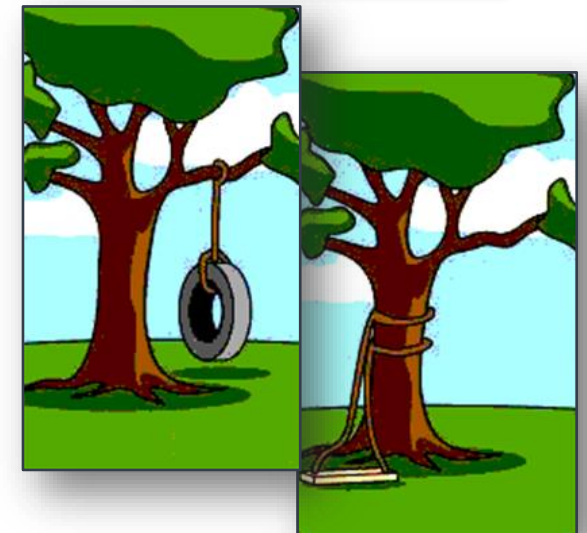
WATERFALL CHALLENGES



Potential Results:

- System not Usable as Implemented
- Project out of Time/Funds
- Contractor Unwilling to Make Changes
- Neither Client nor Contractor Happy
- Potential Litigation

Implemented System



AGILE METHODOLOGIES

MANIFESTO FOR AGILE SOFTWARE DEVELOPMENT (<https://agilemanifesto.org/>)

❖ 4 KEY VALUES:

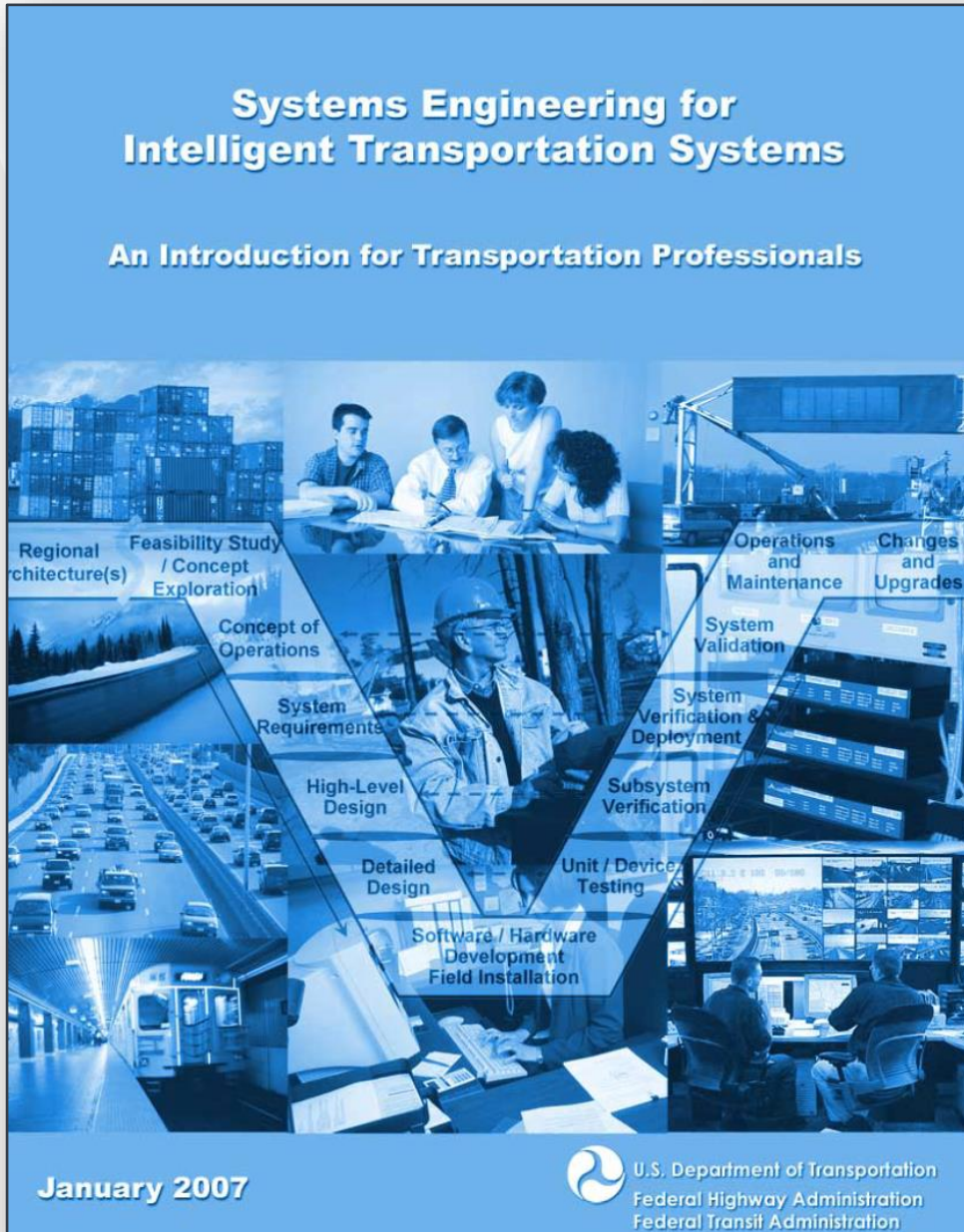
- Individuals and interactions over processes and tools
- **Working software** over comprehensive documentation
- **Customer collaboration** over contract negotiation
- Responding to change over following a plan

❖ 12 KEY PRINCIPLES (EXCERPT):

- The highest priority is to **satisfy the customer** through **early and continuous delivery of valuable software**
- Welcome changing requirements, even late in development
- The most efficient and effective method of conveying information is face-to-face
- **Working software** is the primary **measure of progress**
- At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

COMBINING SYSTEMS ENG. WITH AGILE SOFTWARE ENGINEERING

FEDERAL HIGHWAY ADMINISTRATION: APPLYING SCRUM METHODS TO ITS PROJECTS



Applying Scrum Methods to ITS Projects

www.its.dot.gov/index.htm
Final Report — August 2017
Publication Number: FHWA-JPO-17-508

Executive Summary:
... to find *innovative ways to better manage the development and deployment of Intelligent Transportation Systems (ITS) and Connected Vehicle (CV) projects* ...

2 Fundamentals of Agile and Scrum

Figure 2-1 is another way to show the Vee Model. This figure illustrates the Vee Model with multiple, concurrent product developments and where each departs and reenters the main system Vee.

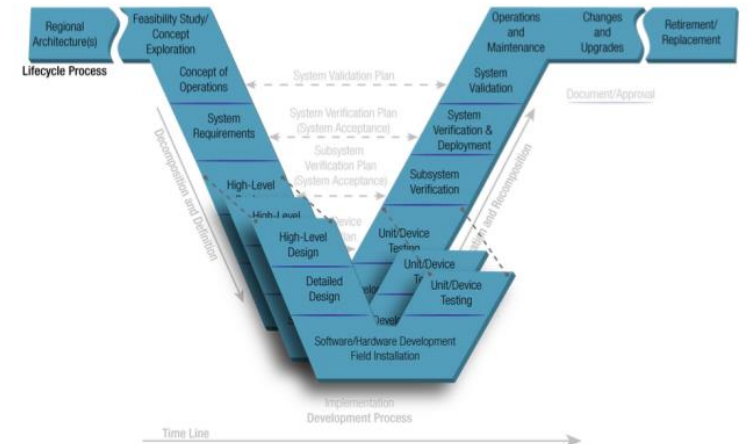


Figure 2-1: FHWA Systems Engineering "Vee" with Multiple Product Developments (Source: FHWA 2007 and modified by Noblis 2017)

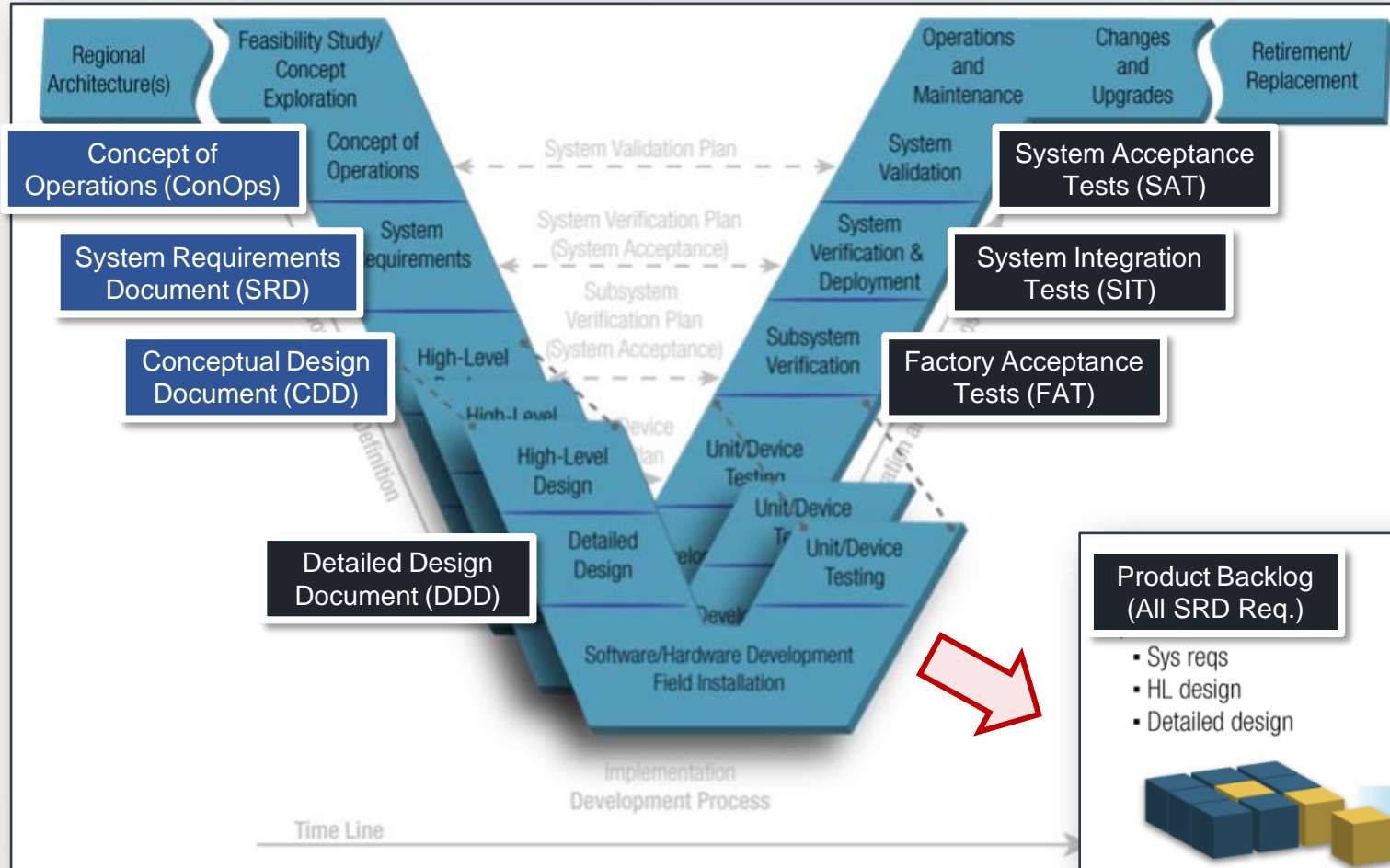
The Vee uses systems engineering documentation to control system development. The type of documents used to control the development, manage, and maintain the system can be found in the two ITS systems-engineering guidebooks [5] [6] and the International Council on Systems Engineering (INCOSE) Handbook [12].

2.2 Agile Methodologies

There are a variety of Agile methodologies which include Scrum [7], Kanban [14], Extreme Programming (XP) [15], and others, each with their own unique processes, timelines, terminology, and practices. This document uses Scrum methods because Scrum is a well-established and a broadly adopted Agile methodology. It is also well suited to the type of system development often encountered with ITS projects that are not impacted by safety of life or long-term maintenance.

APPLICATION TO ALLROADS PROJECT

TRADITIONAL SYSTEMS ENGINEERING, COMBINED WITH AGILE SOFTWARE DEVELOPMENT

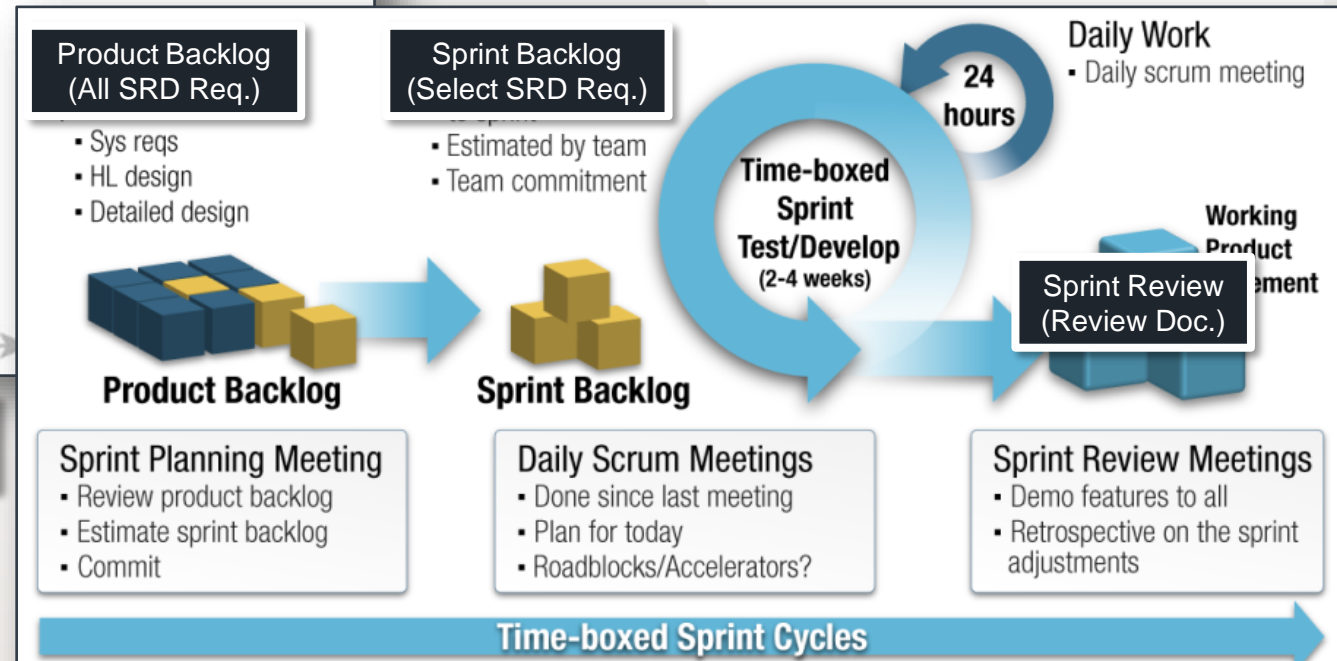


KEY PARTIES:

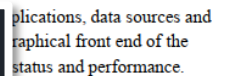
- **CLIENT:** NIAGARA INTERNATIONAL TRANSPORTATION TECHNOLOGY COALITION (NITTEC)
- **DESIGN CONSULTANT (WSP):** PRELIMINARY ENGINEERING
- **DESIGN BUILD(ER):** FINAL DESIGN, IMPLEMENTATION & TESTING, TRAINING
- **“CONSTRUCTION” OVERSIGHT:** WSP

- **16±1 SPRINTS (3 WEEKS EACH)**
- 4 FACTORY ACC. TEST EVERY 3 MONTHS
- 2 SYSTEM INTEGRATION TEST EVERY 6 MONTHS
- 2 SYSTEM ACCEPTANCE TESTS (2 THEMES)

Sprint Planning
(Planning Doc.)




formation is currently
(format), and mostly



APPLICATION TO ALLROADS PROJECT – FINAL DESIGN

DEVELOPMENT OF USER STORIES, ACCEPTANCE CRITERIA, SPRINT BACKLOG PLANNING



ATCMTD Requirements Traceability Matrix

Version: Version:

Date: Date:

Functional Area	Requirement #	Requirement Description	User Story	V&V	Acceptance Criteria	Sprint	Sprint_End
3.1.1 Border Crossing	[BC-SyR-0010]	The ATCMTD system shall allow border crossing operators to share border crossing delay information via dynamic message signs and the NFBC, PBA, and NITTEC websites to travelers en-route allowing allow to make route choices for border crossings	As a NITTEC user, I would like to be able to receive travel time DMS messages from the Crossroad system to assess and report conditions received from the DMS.	Test	iNET™ system will show the DMS messages as displayed in the Crossroads system	4,5	5
3.1.1 Border Crossing	[BC-SyR-0040]	<div>System Requirements</div> The ATCMTD system shall allow border crossing operators to measure travel time reliability to assess the efficiency of their operations. Context: Border crossing travel time reliability measurement is used by regional transportation planners (UN 7.1.3).	<div>User Story</div> As a NITTEC user, I would like to be able to store and see historical travel times within the ATCMTD system.	Demo	<div>Acceptance Criteria</div> border crossing/travel time modules that store and measure border crossing travel times	3	3
3.1.1 Border Crossing	[BC-SyR-0050]	The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time separately between truck traffic versus passenger vehicle. Context: NITTEC currently receives BluFax information that contains delay data for passenger vehicles and trucks, but NITTEC currently only reports the delay for passenger vehicles (UN 7.1.4).	1. As a NITTEC user, I would like to be able to measure travel time reliability and delay travel time for passenger vehicles to access vehicle delays at the border crossings. 2. As a NITTEC user, I would like to be able to measure travel time data for trucks so that I can assess truck delays at the crossings.	Test	The border wait time module that displays the border crossing wait time in the iNET™ system	2	2
3.1.1 Border Crossing	[BC-SyR-0060]	The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time) for truck traffic specific to truckers (UN 7.1.4).	As a NITTEC user, I would like to be able to store and see historical travel times within the ATCMTD system.	Demo	border crossing/travel time modules that store and measure border crossing travel times	3	3
3.1.1 Border Crossing	[BC-SyR-0070]	The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time) for passenger vehicle traffic specific to passenger vehicle operators (motorists) (UN 7.1.4).	As a NITTEC user, I would like to be able to store and see historical travel times within the ATCMTD system.	Demo	border crossing/travel time modules that store and measure border crossing travel times	3	3
		The ATCMTD system shall allow border crossing operators to share truck delays with transportation operators; including but	1. As a NITTEC user, I would like to be able to share truck delay info via a REST API in the Data Mart so that others can receive that delay info. 2. As a NITTEC user, I would like to be able to notify the stakeholders (trucking associations) via email when truck delays reach a certain				

APPLICATION TO ALLROADS PROJECT – FINAL DESIGN

DETAILED DESIGN DOCUMENT

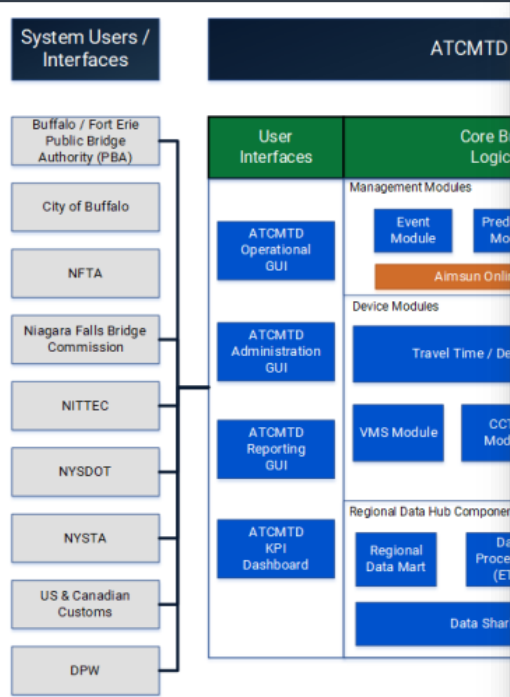


Figure 3-1: Full System Context Diagram

3.3 ATCMTD DETAILED SYSTEM ARCHITECTURE

The following section provides more detail with regard to identifying the sources of data, their flow into the system and necessary functions of the ATCMTD.

System Context Diagram

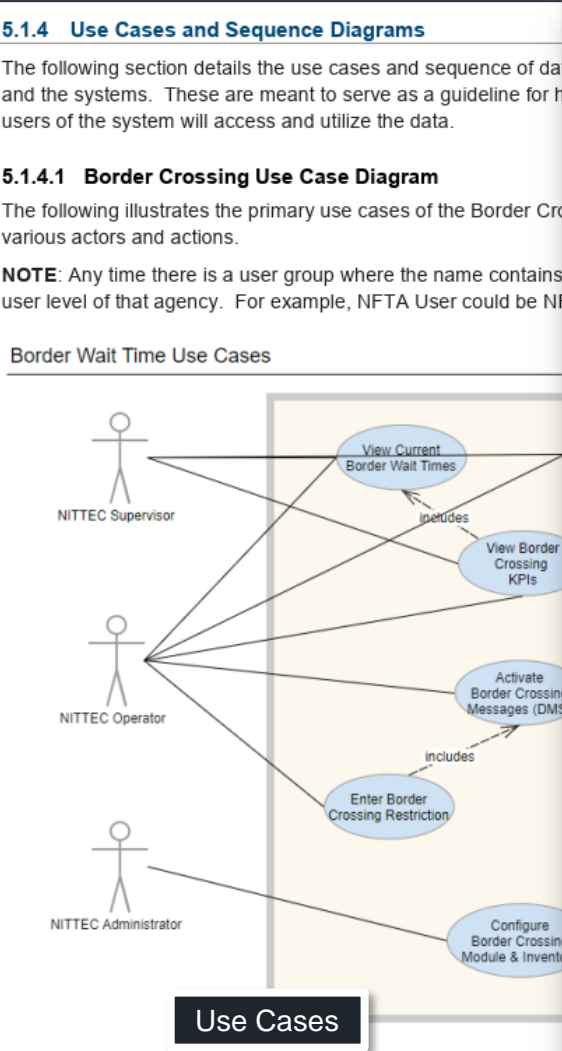


Figure 5-2: Border Crossing Use Case Diagram

Use Case Name	Activate Border Crossing DMS
Requirement(s)	BC-SyR-0010, BC-SyR-0020, BC-SyR-0110
Primary Actor	NITTEC User
Stakeholders	NITTEC Supervisor, PBA User, NFBC User, BNYSTA User
Description	The use case is centered around viewing and messages to inform motorists about delays and the border crossings. The control of these messages is either manual through the ATCMTD/Crossroad response plan generated by the DSS within ATCMTD.
Pre-Condition	A NITTEC Administrator or Supervisor account and has the proper view and control permission for the Travel Time and BWTMS module.
Typical Workflow	<ol style="list-style-type: none">1. Administrator logs into the iNET™ ATCMTD.2. The Administrator navigates to the Travel Time inventory, selects the Travel Time Sign, selects a new sign to be used for border crossing messaging.3. The Administrator selects the message used for the sign as well as assigning time segments to the message.<ol style="list-style-type: none">a. Travel Time Segments will be selected to correspond to each of the border crossings that they can be seamlessly tied into the messaging.4. The Administrator saves the travel time and the sign will start posting on the next schedule.5. The Administrator can deactivate the travel time messaging by removing the sign from the signing page.<ol style="list-style-type: none">a. This can be for normal events or disabled vehicles.

Use Case Descriptions

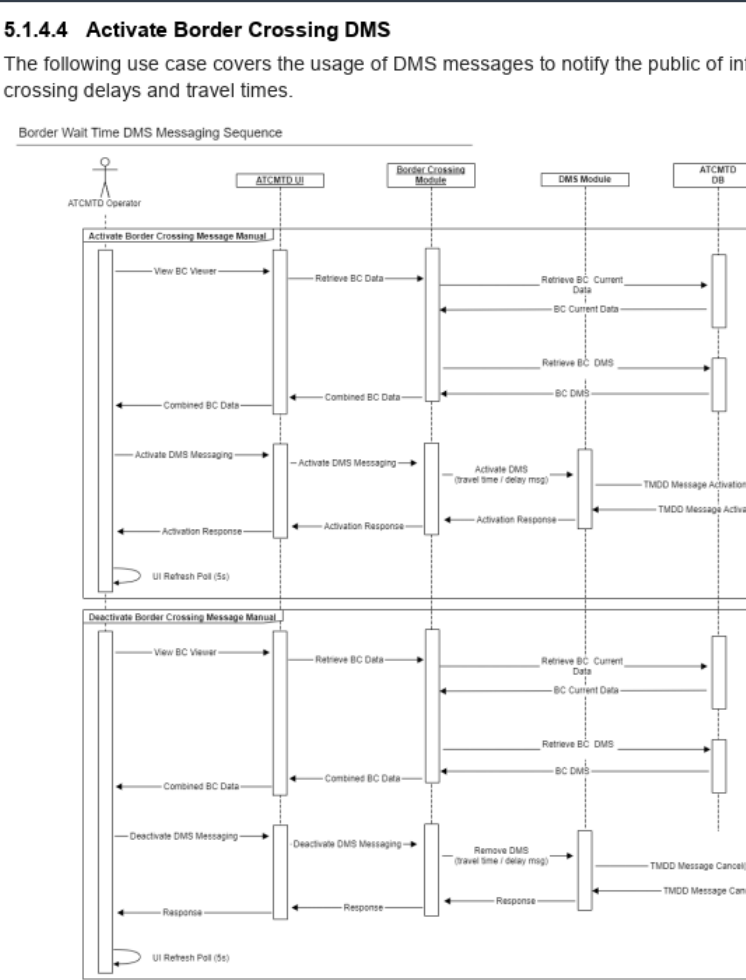
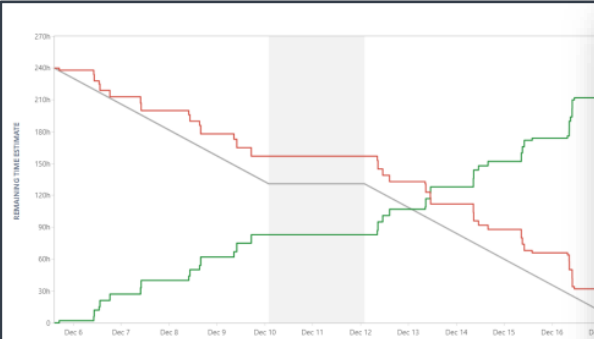


Figure 5-8: Border Crossing DMS Messaging Sequence Diagram

Sequence Diagrams (Interactions)

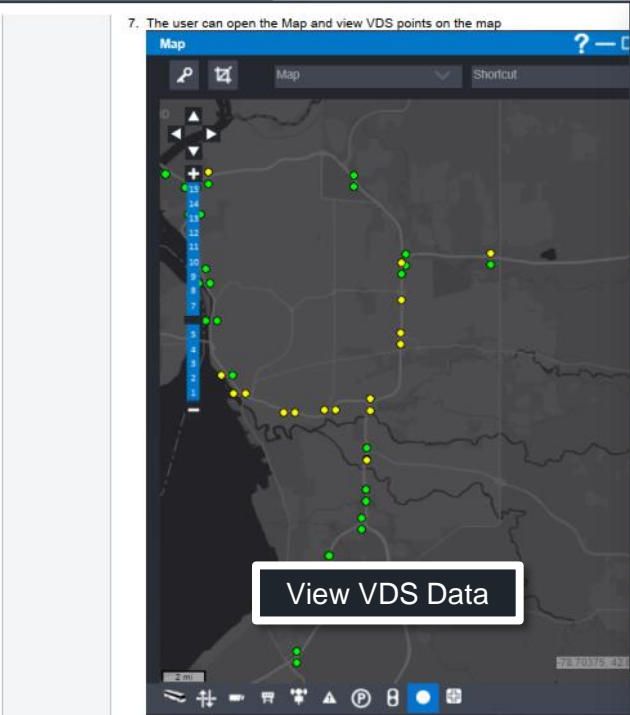
APPLICATION TO ALLROADS PROJECT – IMPLEMENTATION

SPRINT REVIEWS, USE CASE WALK-THROUGH, FOLLOWED BY SW DEMONSTRATION



Completed Issues

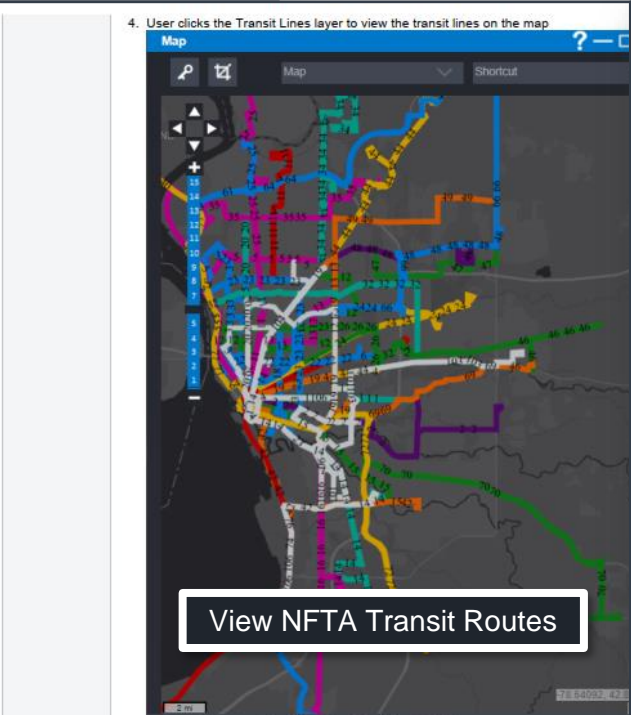
Key	Summary	Labels
NITTEC-245	Sprint 5 - Project Documentation: FAT, RTM, JIRA and Confluence	
NITTEC-244	FAT Procedure creation	
NITTEC-243	Clone Geoserver for NITTEC	
NITTEC-241	Update NWS graphs to assess weather conditions	WWO-SyR-4
NITTEC-239	Add auto and location based response to the build for NITTEC	
NITTEC-236	Add segment geometries in INET to support map layer	WWO-SyR-4
NITTEC-235	Create Road Condition list view tab on the ESS list view	WWO-SyR-4
NITTEC-234	Create DTN Road Condition Protocol and Poller	WWO-SyR-4
NITTEC-229	Create MTO I3B producer service lambda	IM-DM-0100 SyR-0120
NITTEC-228	Create I3B publisher service	IM-DM-0100 SyR-0120
NITTEC-227	Define message format for I3B event messages & document in an ICD to deliver to Erie County	IM-DM-0100 SyR-0120
NITTEC-226	Create I3B CAD event listener API in the Data Mart	IM-DM-0100 SyR-0120
NITTEC-225	Update data hub logic to use update or insert	
NITTEC-210	Integrate Transcom Data Fusion Engine into INET	TM23
NITTEC-161	Share truck delays via the Data Mart RESTful API.	BC-DM-005
NITTEC-110	Send SMS/email notifications about travel bans/restrictions	WWO-SyR-4



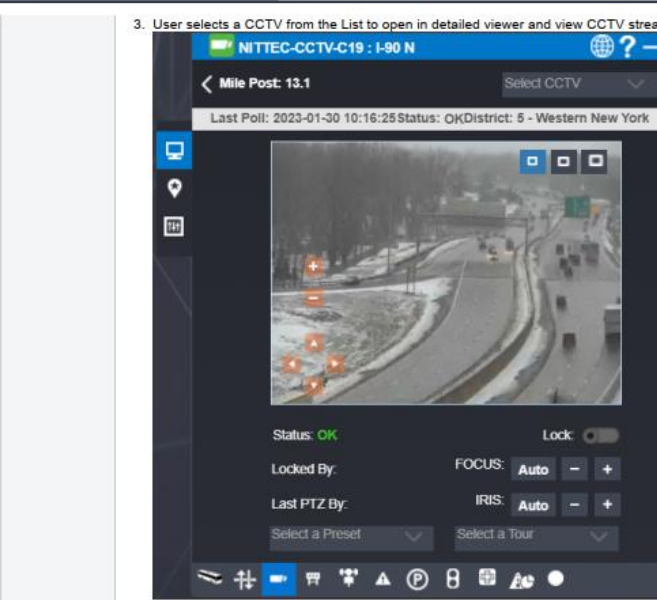
Use Case	View NFTA Transit Routes on Map
Requirement (s)	[NFTA-DM-0050] The ATCMTD data mart shall allow transit operators to inform transit riders as soon as possible to allow transit riders to make alternate travel plans, make an alternate travel plan for a schedule deviation (UN 7.5.4).
Primary Actor	NITTEC User / NFTA User
Description	This use case demonstrates the ability to view accurate NFTA transit routes on the map those routes.
User Stories	As a NITTEC user, I would like to be able to receive static schedule change info from GTFS public.
Acceptance Criteria	retrieve and display GTFS data for transit routes; map window that can display the NFTA

Workflow

Use Case Details



Use Case	View Waze Events in the ATCMTD system
Requirement (s)	BC-SyR-0300: The ATCMTD system shall integrate 3rd party travel time data sources (e.g., Waze) available from member agency systems (UN 7.1.27).
Primary Actor	NITTEC User
Description	This use case demonstrates the ability to store and display third-party data from Waze in the system. This use case demonstrates a user's ability to respond to and manage Waze events in the system.
User Stories	As a NITTEC user, I would like to be able to see Waze events in the system so that I can
Acceptance Criteria	integration with data sources that provides data and crowd sourced event data



View Waze Events

Use Case	View DMS Content Dashboard
Requirement (s)	[BC-SyR-0110] The ATCMTD system shall allow border crossing operators to know (e.g., what messages are on which dynamic message signs to provide a consistent set of message information is currently available from the U.S. side (though not all the information is in one place) from the Canada side (e.g., from MTO) (UN 7.1.8).
Primary Actor	NITTEC Admin
Description	The use case is centered around external users being able to access the dashboard for IT DMS data including status and current message.
User Stories	As a NITTEC user, I would like to be able to see, via a list or dashboards, what messages are being displayed to public.
Acceptance Criteria	List/dashboard that displays DMS messages
Workflow	

APPLICATION TO ALLROADS PROJECT – SYSTEM TESTING

FACTORY ACCEPTANCE TEST #01

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Test Case BC03 – View Border Crossing Travel Times

Purpose: This use case demonstrates the ability of the ATCMTD system to wait time information and display that information via dynamic message signs that a user can view and display travel times and delay data on DMS.

Requirements

BC-SyR-0010: The ATCMTD system shall allow border crossing operators to view information via dynamic message signs and the NFBC, PBA, and NITTE allow to make route choices for border crossings (UN 7.1.1).

BC-SyR-0040: The ATCMTD system shall allow border crossing operators to view crossing travel time reliability to assess the efficiency of their operations. This reliability measurement is used by regional transportation planners (UN 7.1.2).

BC-SyR-0050: The ATCMTD system shall allow border crossing operators to view delay/travel time separately between truck traffic versus passenger vehicle traffic. This BluFax information that contains delay data for passenger vehicles and truck delay for passenger vehicles (UN 7.1.4).

BC-SyR-0060: The ATCMTD system shall allow border crossing operators to view delay/travel time) for truck traffic specific to truckers (UN 7.1.4).

BC-SyR-0070: The ATCMTD system shall allow border crossing operators to view delay/travel time) for passenger vehicle traffic specific to passenger vehicles (UN 7.1.4).

BC-SyR-0110: The ATCMTD system shall allow border crossing operators to view customizable dashboard) what messages are on which dynamic message signs to the traveling public. Context: This information is currently available on the information is in one place or format), and mostly unavailable from the ATCMTD system.

BC-SyR-0180: The ATCMTD system shall allow border crossing operators to view for all access routes into/away from the border, to allow the border crossing volumes (e.g., open an additional lane in anticipation of the increased volume).

BC-SyR-0220: The ATCMTD system shall allow truckers to determine local options to make decisions regarding travel path, stops, and stop duration. This travel path, travel time, and stops, to enable cost-effective goods transportation (UN 7.1.19).

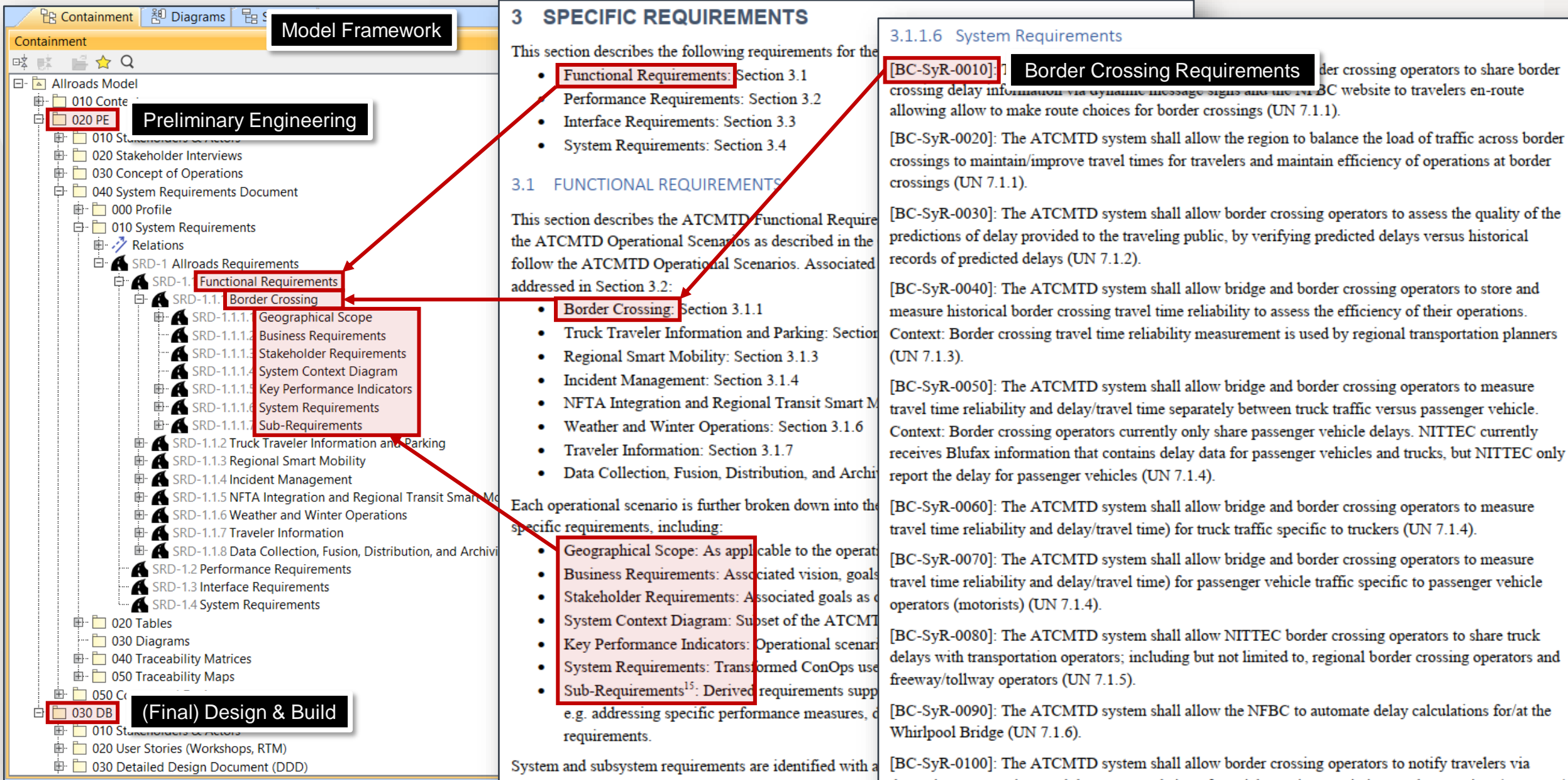
BC-SyR-0320: The ATCMTD system shall store 3rd party travel time information and calculation of performance measures (UN 7.1.29).

Test Steps

TEST CASE ID	TEST NAME	TEST STEPS	EXPECTED RESULT	PASS / FAIL / CAUTION
BC03_01	View Border Crossing Travel Time – List	<ol style="list-style-type: none">On the List window, select the <i>TT</i> icon on the switcher barObserve the list of Border Crossing Travel Times and the following data:<ol style="list-style-type: none">Section IDRoute DescriptionSection NameStart & End DescriptionStatusTravel TimeAverage SpeedFlowData Source	Verify that the ATCMTD system: <ul style="list-style-type: none">Displays a list of travel times for cars and trucks at each border crossing	
BC03_02	View Border Crossing Travel Time – DMS List	<ol style="list-style-type: none">On the list window, select the <i>DMS</i> icon on the switcher barObserve the list of DMS and the following data:<ol style="list-style-type: none">StateDevice NameRoadway & Cross StreetCity, Mile Marker, and DistrictStatusCurrent Message	Verify that the ATCMTD system: <ul style="list-style-type: none">Displays a list of DMS and accurate information for each	
BC03_03	View Border Crossing Travel Time on DMS	<ol style="list-style-type: none">On the <i>DMS</i> list window, select a DMS that displays a current message on the signObserve the following:<ol style="list-style-type: none">Last poll timeStatus	Verify that: <ul style="list-style-type: none">The DMS opens in a new detailed viewerThe last poll time is recent	






APPLICATION TO ALLROADS PROJECT – OVERSIGHT

REQUIREMENTS BASED REVIEWS USING MODEL-BASED SYSTEMS ENGINEERING (MBSE)



APPLICATION TO ALLROADS PROJECT – OVERSIGHT


ESTABLISH TRACEABILITY: OWNERS, USER NEEDS, SYS-REQ., USER STORIES, ACCEPTANCE

Owner (ConOps)	User Need (ConOps)	△ Name	Text	User Stories (RTM)	Acceptance Criteria (RTM)
		☐  SRD-1.1.1.6 System Requirements			
NITTEC NYSDOT	UN 7.1.1	 SRD-1.1.1.6.1 [BC-SyR-0010]: Share border crossing performance	The ATCMTD system shall allow border crossing operators to share border crossing delay information via dynamic message signs and the NFBC, PBA, and NITTEC websites to travelers en-route allowing allow to make route choices for border crossings (UN 7.1.1).	As a NITTEC user, I would like to be able to receive travel time DMS messages from the Crossroad system to assess and report conditions received from the DMS.	iNET™ system will show the DMS messages as displayed in the Crossroads system
NITTEC	UN 7.1.3	 SRD-1.1.1.6.2 [BC-SyR-0040]: Historical border crossing travel time reliability	The ATCMTD system shall allow border crossing operators to store and measure historical border crossing travel time reliability to assess the efficiency of their operations . Context: Border crossing travel time reliability measurement is used by regional transportation planners (UN 7.1.3).	As a NITTEC user, I would like to be able to store and see historical travel times within the ATCMTD system.	border crossing/travel time modules that store and measure border crossing travel times
NITTEC	UN 7.1.4	 SRD-1.1.1.6.3 [BC-SyR-0050]: Measure (separate) travel time reliability and delay	The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time separately between truck traffic versus passenger vehicle . Context: NITTEC currently receives Blufax information that contains delay data for passenger vehicles and trucks, but NITTEC currently only reports the delay for passenger vehicles (UN 7.1.4).	1. As a NITTEC user, I would like to be able to measure travel time reliability and delay travel time for passenger vehicles to access vehicle delays at the border crossings. 2. As a NITTEC user, I would like to be able to measure travel time data for trucks so that I can assess truck delays at the crossings.	The border wait time module that displays the border crossing wait time in the iNET™ system
NITTEC	UN 7.1.4	 SRD-1.1.1.6.4 [BC-SyR-0060]: Truck travel time	The ATCMTD system shall allow border crossing operators	As a NITTEC user, I would like to be able to store and see historical trav	border crossing/travel time modules that border crossing travel

Concept of Operations (ConOps)

System Requirements Document (SRD)


User Stories & Acceptance Criteria (RTM)



NITTEC

Concept of Operations (ConOps)

NITTEC ATCMTD Project Planning – Phase 1
Concept of Operations



System Requirements Document (SRD)

• Usage level balance of the three crossings open to the public

PROJECT PLANNING – PHASE 1
System Requirement Document

User Stories & Acceptance Criteria (RTM)

Needs

1.1 - Bridge and border crossing operators need to share delay (measured as the travel time from the end of the queue to the border) to allow travelers to make route choices for border crossings. The region needs to balance the load of traffic across border crossings to maintain/improve travel times for travelers and maintain efficiency of operations at border crossings.

1.2 - Border crossing operators need to verify predicted delay versus historical records of predicted delay to assess the quality of the predictions of delay provided to the traveling public.

1.3 - Bridge and border crossing operators need to store and measure historical border crossing travel time reliability to assess the efficiency of their operations. Border crossing travel time reliability is a relevant measure used by regional transportation planners.

1.4 - Bridge and border crossing operators need separate measures (truck time reliability and delay/travel time) for truck traffic versus passenger vehicle traffic to provide traveler information specific to truckers and passenger vehicle operators (motorists). Border crossing operators currently only pass passenger vehicle delays. NITTEC currently receives Blufax information that contains delay data for passenger vehicles and trucks, but NITTEC only report the delay for passenger vehicles.

1.5 - Border crossing operators need to share truck delays with other regional transportation operators including other border crossing operators, and freeway/tollway operators.

1.6 - The NFBC needs to automate delay calculations that are currently done manually at Whirlpool Bridge. The delay information for the Whirlpool Bridge is not currently automated. This is a planned update for the future.

1.7 - Border crossing operators need to let travelers know (e.g., using overhead signs) about special crossing restrictions and constraints. *Constraint: The Whirlpool Bridge is for Nexus travelers only. The Whirlpool Bridge does not allow truck traffic.

1.8 - Border crossing operators need to know the (e.g., via a data feed or customizable dashboard) what messages are on which dynamic message signs (message boards) to provide a consistent set of messages to the traveling public. This information is currently available from the U.S. side (though not all the information is in one place or format), and mostly unavailable from the Canada side (e.g., from MTO).

1.9 - Bridge and border crossing operators need to share crossing status information with truck operators, including closing in the region, travel bans and restrictions, and high winds. Truckers use bridge and border crossing status information to make route choices.

1.10 - Bridge and border crossing operators need to share event status information with truck operators, including incidents, lane closing due

3.1.1.6 System Requirements

[BC-SyR-0010] The ATCMTD system shall allow border crossing operators to share border crossing delay information via dynamic message signs and the NFBC, PBA, and NITTEC websites to travelers en route allowing ability to make route choices for border crossings (UN 7.1.1).

[BC-SyR-0020] The ATCMTD system shall allow the region to balance the load of traffic across border crossings to maintain/improve travel times for travelers and maintain efficiency of operations at border crossings (UN 7.1.1).

[BC-SyR-0030] The ATCMTD system shall allow border crossing operators to assess the quality of the predictions of delay provided to the traveling public, by verifying predicted delays versus historical records of predicted delays (UN 7.1.2).

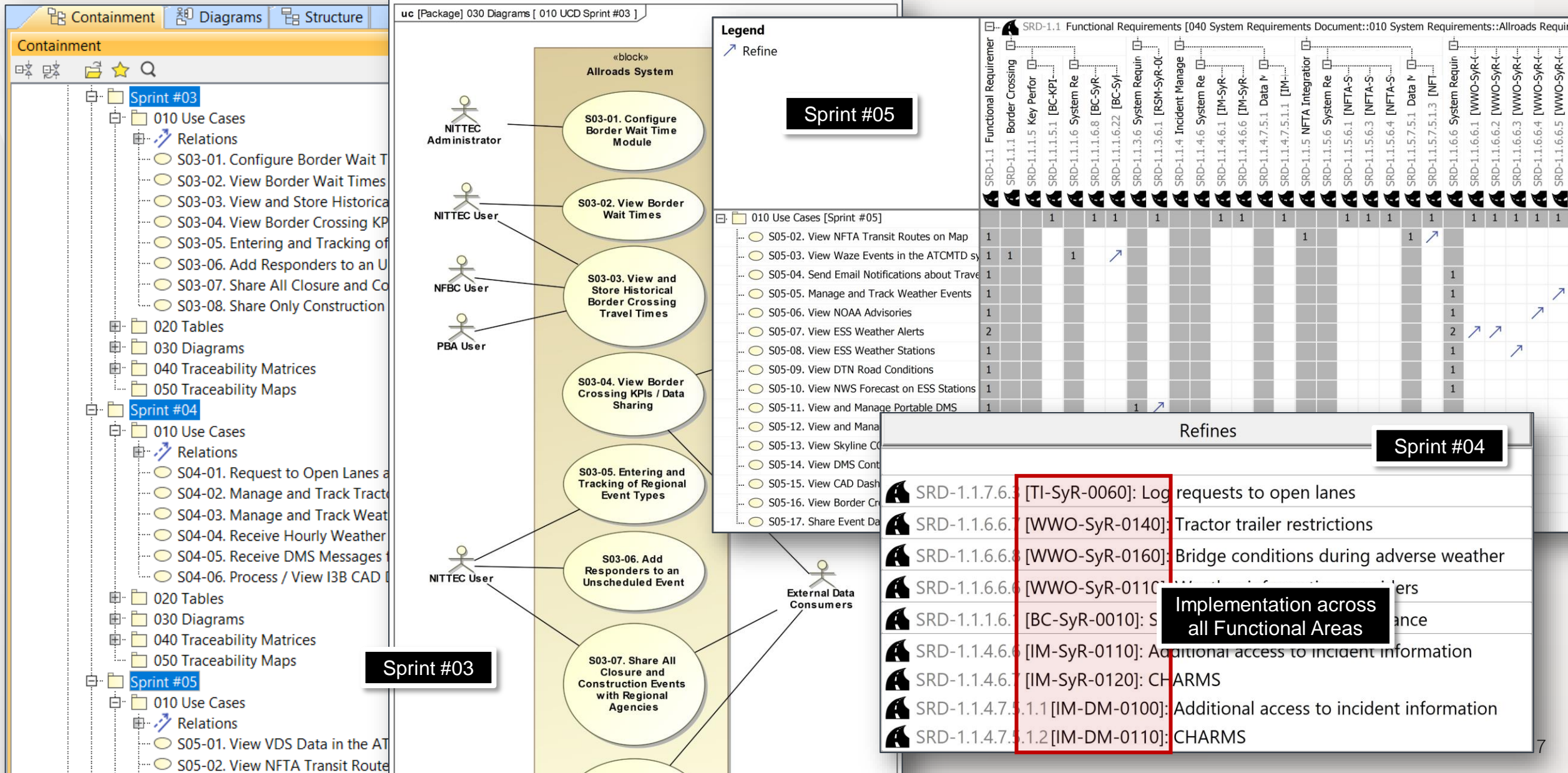
[BC-SyR-0040] The ATCMTD system shall allow border crossing operators to store and measure historical border crossing travel time reliability to assess the efficiency of their operations. Context: Border crossing travel time reliability measurement is used by regional transportation planners (UN 7.1.3).

[BC-SyR-0050] The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time separately between truck traffic versus passenger vehicle. Context: NITTEC currently receives Blufax information that contains delay data for passenger vehicles and trucks,

Requirement ID	Requirement Description	Category	Priority	Impact	Notes
3.1.1 Border Crossing	The ATCMTD shall share border crossing performance (e.g., delay) information via dynamic message signs and the NFBC, NITTEC, PBA, S11M, and S11 Ontario websites (UN 7.1.1).	Share Border Crossing Performance	High	Ontario websites via the Data Mart RESTful API. Dynamic message signs would not be updated by the data mart.	Demos
3.1.2 Border Crossing	The ATCMTD data mart shall allow border crossing operators to notify travelers via dynamic message signs and the NFBC, PBA, and NITTEC websites, of special crossing restrictions and constraints (UN 7.1.2).	Special Crossing Restrictions and Constraints	High	As a border crossing operator, I would like to be able to share special crossing restrictions and constraints via a Data Mart RESTful API so that partner websites and external consumers can access the data. Dynamic message signs would not be updated by the data mart.	Text
3.1.3 Border Crossing	The ATCMTD data mart shall allow border crossing operators to know what messages are on which dynamic message signs to provide a consistent set of messages to the traveling public (UN 7.1.3).	Dynamic Message Sign Content	High	As a border crossing operator, I would like to be able to share what messages are on which dynamic message signs via a Data Mart RESTful API so that partner websites and external consumers can access the data.	Text
3.1.4 Incident Management	In the event that there is a situation that is not a safety or law enforcement situation, the ATCMTD system shall allow law enforcement to notify regional transportation agencies to take over the lane closure responsibilities to allow law enforcement to continue with their safety and law enforcement responsibilities. Context: As first responders, law enforcement is able to arrive on scene faster than other agencies (UN 7.1.3).	Incident Management	High	As a NITTEC user, I would like to be able to track the response times in an event including their arrival and depart times so that I can assess who is responsible for the scene at any given time.	Demos
3.1.4 Incident Management	The ATCMTD system shall allow border crossing operators to share border crossing events (incidents, construction and closures) with regional transportation agencies to allow regional transportation agencies to respond to border crossing events (e.g., provide traveler information to motorists) (UN 7.1.4.2).	Incident Management	High	As a NITTEC user, I would like to enter events in the ATCMTD so that we can share that with stakeholders and respond to their event as necessary.	Demos

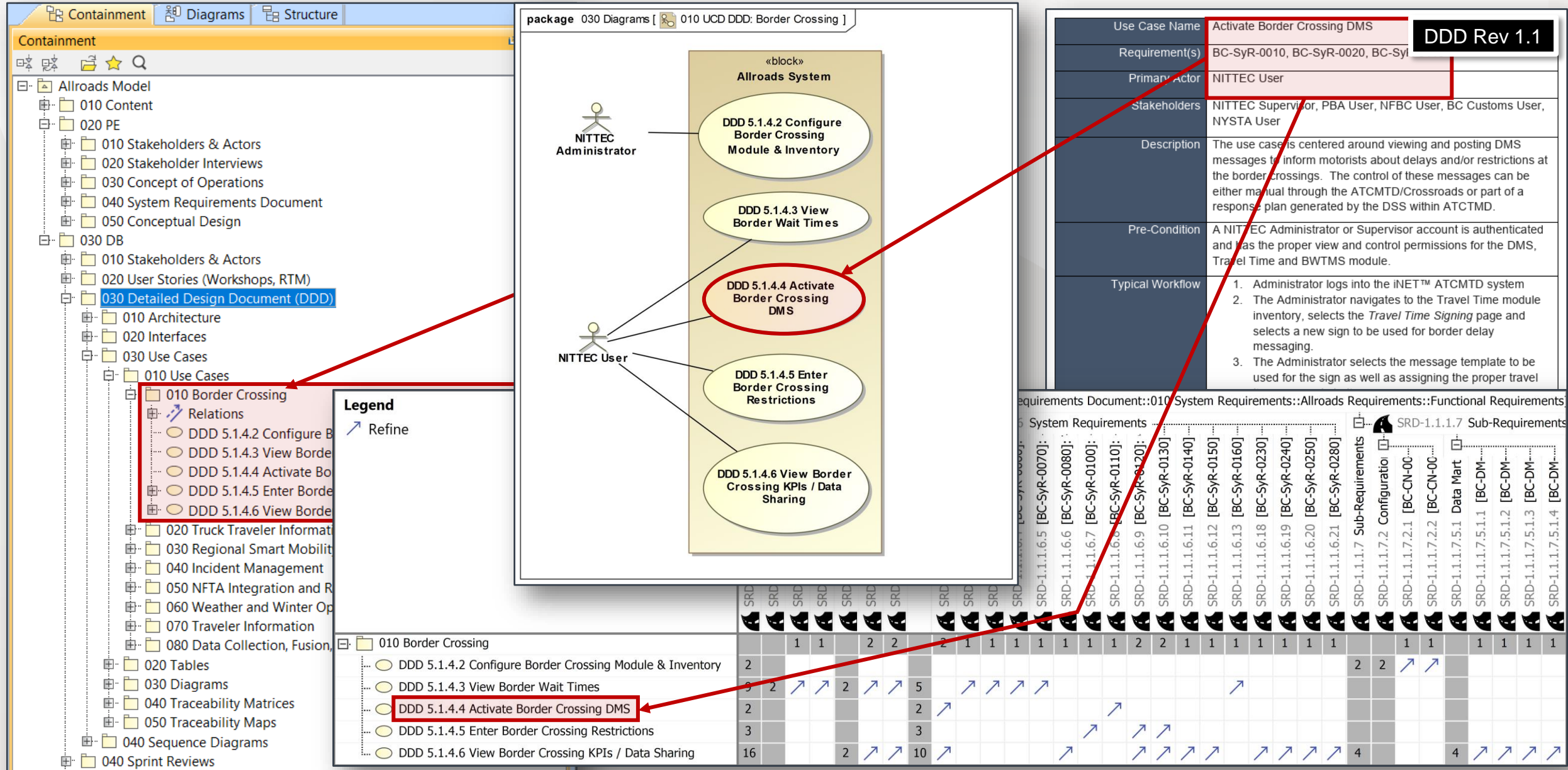
APPLICATION TO ALLROADS PROJECT – OVERSIGHT

CAPTURING SPRINTS IN SYSTEM MODEL



APPLICATION TO ALLROADS PROJECT – OVERSIGHT

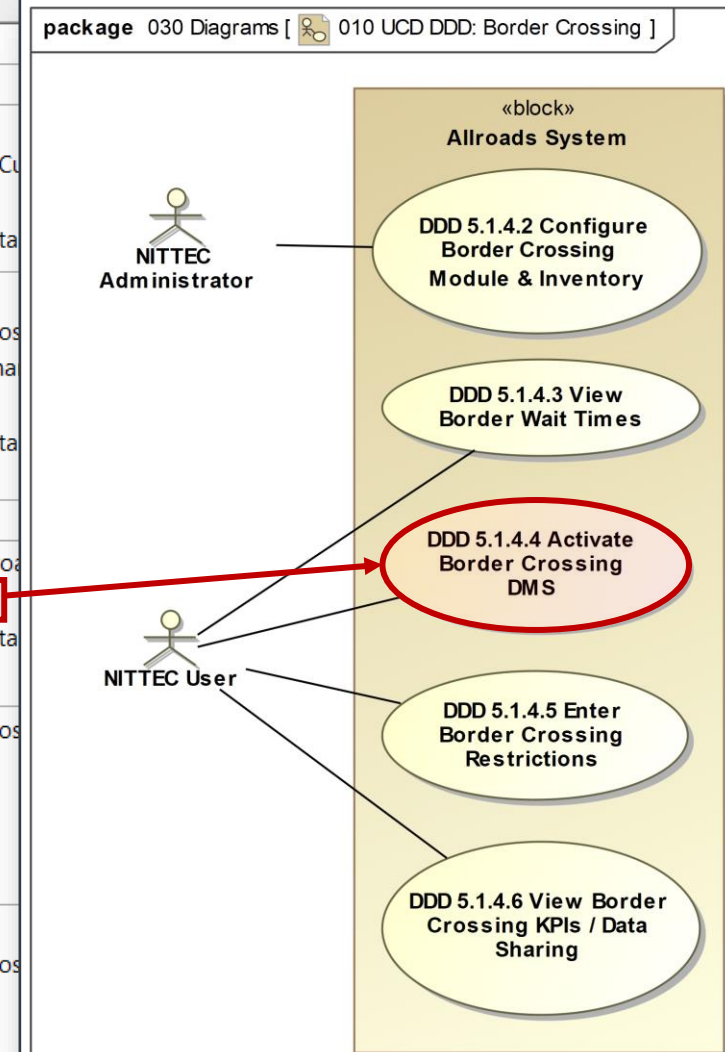
CAPTURING & TRACING DETAILED DESIGN IN SYSTEM MODEL



APPLICATION TO ALLROADS PROJECT – OVERSIGHT

USE CASE REVIEW AGAINST SYSTEM REQUIREMENTS

△ Name	Text	Use Cases
☐ 🖱 SRD-1.1.1 Border Crossing		
☐ 🖱 SRD-1.1.1.5 Key Performance Indicators		
🖱 SRD-1.1.1.5.1 [BC-KPI-0010]: Measure spatial and temporal shifts of congestion	The ATCMTD system shall measure the shifts in spatial and temporal extent of congestion at various border crossings during specific periods where one or more border crossings experiences a delay as part of the key performance measures (GR 1.9.1).	<ul style="list-style-type: none"> ○ S03-02. View Border Wait Times ○ S05-16. View Border Crossing Dashboard – Cu ○ DDD 5.1.4.3 View Border Wait Times ○ DDD 5.1.4.6 View Border Crossing KPIs / Data
🖱 SRD-1.1.1.5.2 [BC-KPI-0020]: Measure and report key performance indicators	The ATCMTD system shall measure and report the following border crossing key performance indicators (KPI) (CO 5.1): <ul style="list-style-type: none"> • Border crossing delay • Border crossing travel time • Usage level balance of the three crossings open to the public 	<ul style="list-style-type: none"> ○ S03-02. View Border Wait Times ○ S03-03. View and Store Historical Border Cros ○ S03-04. View Border Crossing KPIs / Data Sha ○ DDD 5.1.4.3 View Border Wait Times ○ DDD 5.1.4.6 View Border Crossing KPIs / Data
☐ 🖱 SRD-1.1.1.6 System Requirements		
🖱 SRD-1.1.1.6.1 [BC-SyR-0010]: Share border crossing performance	The ATCMTD system shall allow border crossing operators to share border crossing delay information via dynamic message signs and the NFBC, PBA, and NITTEC websites to travelers en-route allowing allow to make route choices for border crossings (UN 7.1.1).	<ul style="list-style-type: none"> ○ S04-05. Receive DMS Messages from Crossro ○ DDD 5.1.4.4 Activate Border Crossing DMS ○ DDD 5.1.4.6 View Border Crossing KPIs / Data
🖱 SRD-1.1.1.6.2 [BC-SyR-0040]: Historical border crossing travel time reliability	The ATCMTD system shall allow border crossing operators to store and measure historical border crossing travel time reliability to assess the efficiency of their operations . Context: Border crossing travel time reliability measurement is used by regional transportation planners (UN 7.1.3).	<ul style="list-style-type: none"> ○ S03-03. View and Store Historical Border Cros ○ DDD 5.1.4.3 View Border Wait Times
🖱 SRD-1.1.1.6.3 [BC-SyR-0050]: Measure (separate) travel time reliability and delay	The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time separately between truck traffic versus passenger vehicle . Context: NITTEC currently receives Blufax information that contains delay data for passenger vehicles and trucks, but NITTEC currently only reports the delay for passenger vehicles (UN 7.1.4).	<ul style="list-style-type: none"> ○ S02-01. View Border Wait Times ○ S03-03. View and Store Historical Border Cros ○ DDD 5.1.4.3 View Border Wait Times



APPLICATION TO ALLROADS PROJECT – OVERSIGHT

USE CASE REVIEW AGAINST SYSTEM REQUIREMENTS

Text	
The ATCMTD system shall measure the shifts in spatial and temporal extent of congestion at various border crossings during specific periods where one or more border crossings experiences a delay as part of the key performance measures (GR 1.9.1).	<ul style="list-style-type: none">S03-02. View Border Wait TimeS05-16. View Border CrossingDDD 5.1.4.3 View Border Wait TimesDDD 5.1.4.6 View Border Crossing KPIs / Data Sharing
The ATCMTD system shall measure and report the following border crossing key performance indicators (KPI) (CO 5.1): <ul style="list-style-type: none">• Border crossing delay• Border crossing travel time• Usage level balance of the three crossings open to the public	<ul style="list-style-type: none">S03-02. View Border Wait TimeS03-03. View and Store Historical DataS03-04. View Border CrossingDDD 5.1.4.3 View Border Wait TimesDDD 5.1.4.6 View Border Crossing KPIs / Data Sharing
The ATCMTD system shall allow border crossing operators to share border crossing delay information via dynamic message signs and the NFBC, PBA, and NITTEC websites to travelers en-route allowing allow to make route choices for border crossings (UN 7.1.1).	<ul style="list-style-type: none">S04-05. Receive DMS MessageDDD 5.1.4.4 Activate Border Crossing DMSDDD 5.1.4.6 View Border Crossing KPIs / Data Sharing
The ATCMTD system shall allow border crossing operators to store and measure historical border crossing travel time reliability to assess the efficiency of their operations . Context: Border crossing travel time reliability measurement is used by regional transportation planners (UN 7.1.3).	<ul style="list-style-type: none">S03-03. View and Store Historical DataDDD 5.1.4.3 View Border Wait Times
The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time separately between truck traffic versus passenger vehicle . Context: NITTEC currently receives Blufax information that contains delay data for passenger vehicles and trucks, but NITTEC currently only reports the delay for passenger vehicles (UN 7.1.4).	<ul style="list-style-type: none">S02-01. View Border Wait TimeS03-03. View and Store Historical DataDDD 5.1.4.3 View Border Wait Times

package 030 Diagrams [010 UCD DDD: Border Crossing]

The diagram shows a package titled '030 Diagrams' containing a use case diagram for '010 UCD DDD: Border Crossing'. It features two actors: 'NITTEC Administrator' and 'NITTEC User'. The 'NITTEC Administrator' is connected to four use cases: 'DDD 5.1.4.2 Configure Border Crossing Module & Inventory', 'DDD 5.1.4.3 View Border Wait Times', 'DDD 5.1.4.4 Activate Border Crossing DMS', and 'DDD 5.1.4.5 Enter Border Crossing Restrictions'. The 'NITTEC User' is connected to 'DDD 5.1.4.4 Activate Border Crossing DMS' and 'DDD 5.1.4.6 View Border Crossing KPIs / Data Sharing'. A red circle highlights the 'DDD 5.1.4.4 Activate Border Crossing DMS' use case, with a red arrow pointing from it to the 'Typical Workflow' section of the adjacent table.

Use Case Name	Activate Border Crossing DMS
Requirement(s)	BC-SyR-0010, BC-SyR-0020, BC-SyR-0110
Primary Actor	NITTEC User
Stakeholders	NITTEC Supervisor, PBA User, NFBC User, BC Customs User, NYSTA User
Description	The use case is centered around viewing and posting DMS messages to inform motorists about delays and/or restrictions at the border crossings. The control of these messages can be either manual through the ATCMTD/Crossroads or part of a response plan generated by the DSS within ATCTMD.
Pre-Condition	A NITTEC Administrator or Supervisor account is authenticated and has the proper view and control permissions for the DMS, Travel Time and BWTMS module.
Typical Workflow	<ol style="list-style-type: none">1. Administrator logs into the iNET™ ATCMTD system2. The Administrator navigates to the Travel Time module inventory, selects the <i>Travel Time Signing</i> page and selects a new sign to be used for border delay messaging.3. The Administrator selects the message template to be used for the sign as well as assigning the proper travel time segments to the message.<ol style="list-style-type: none">a. Travel Time Segments will be setup to correspond to each of the border crossings so that they can be seamlessly tied into the DMS messaging4. The Administrator saves the travel time configuration, and the sign will start posting on the normal travel time schedule.5. The Administrator can deactivate the travel time messaging by removing the sign from the travel time signing page. <ol style="list-style-type: none">1. A NITTEC User logs into the system and navigates to the Event list view.2. The User selects an event from the list and either sees it's confirmed or takes the necessary steps to confirm the event.<ol style="list-style-type: none">a. This can be for normal events such as crashes or disabled vehicles

APPLICATION TO ALLROADS PROJECT – OVERSIGHT

CAPTURING & TRACING TEST CASES IN SYSTEM MODEL

Legend

Verify

SRD-1.1 Functional Requirements [040 System Requirements Document::010 System Requirements::Allroads Requirements]

SRD-1.1.1 Border Crossing

SRD-1.1.1.6 System Requirements

SRD-1.1.1.7 Sub-Requirements

SRD-1.1.1.8 Regional Smart Mobility

Test Cases

010 Test Cases [010 Factory Acceptance Tests (FAT)::FAT 01]

010 Border Crossing

BC01 - Configure Border Crossing Wait Time

BC02 - View Border Crossing Data

BC03 - View Border Crossing Travel Times

BC04 - Create Border Crossing Open Lane Request Event

BC05 - Create Border Crossing Ban/Restriction, Weather, and

BC06 - Share Border Crossing Event Data via API

BC07 - Share Border Crossing Delays via API

BC08 - Share Border Crossing DMS Messages via API

BC09 - View Border Crossing Dashboards

030 Regional Smart Mobility

RSM01 - Configure DMS Inventory

040 Incident Management

IM01 - Create and Manage Scheduled Events

IM02 - Create and Manage Unscheduled Events

IM03 - View Third Party Events

IM04 - Share Event Data via API

050 NFTA Integration and Regional Transit Smart Mobilit

NFTA01 - View NFTA Transit Lines

NFTA02 - View Park and Ride Data

NFTA03 - Create and Manage Transit Events

NFTA04 - Share Transit Event Data via API

060 Weather and Winter Operations

WWO01 - View Weather Conditions and Forecasts

WWO02 - View NWS and ClearPath Weather Events

080 Data Collection, Fusion, Distribution, and Archiving

DATA01 - Create User Groups, Roles, and User Accounts

DATA02 - Configure Data Pollers







DATA03 - Authorized Users Can Access Data Man

#	Name	Verifies
1	SRD-1.1.1.6.1 [BC-SyR-0010]: Share border crossing performance	
2	SRD-1.1.1.6.2 [BC-SyR-0040]: Historical border crossing travel time reliability	
3	SRD-1.1.1.6.3 [BC-SyR-0050]: Measure (separate) travel time reliability and delay	
4	SRD-1.1.1.6.4 [BC-SyR-0060]: Truck travel time reliability	
5	SRD-1.1.1.6.5 [BC-SyR-0070]: Passenger vehicle travel time reliability	
6	SRD-1.1.1.6.8 [BC-SyR-0110]: Dynamic message sign content	
7	SRD-1.1.1.6.14 [BC-SyR-0180]: Traffic conditions for access routes into/away from the border	
8	SRD-1.1.1.6.17 [BC-SyR-0220]: Long distance travel times	
9	SRD-1.1.1.6.23 [BC-SyR-0320]: 3rd party travel time data storage	

**Nine (9) Requirements
for this Test Case**

APPLICATION TO ALLROADS PROJECT – OVERSIGHT

SYSTEM TEST REVIEW AGAINST SYSTEM REQUIREMENTS

△ Name	Text	User Stories (RTM)	Acceptance Criteria (RTM)	Verified By	Test Cases (FAT #01)	Review Comments												
 SRD-1.1.1.6 System Requirements																		
 SRD-1.1.1.6.1	<div>[BC-SyR-0010]: Share border crossing performance</div> <p>The ATCMTD system shall allow border crossing operators to share border crossing delay information via dynamic message signs and the NFBC, PBA, and NITTEC websites to travelers en-route allowing allow to make route choices for border crossings (UN 7.1.1).</p>	As a NITTEC user, I would like to be able to receive travel time DMS messages from the Crossroad system to assess and report conditions received from the DMS.	iNET™ system will show the DMS messages as displayed in the Crossroads system	 BC03 – View Border Crossing Travel Times	Purpose: This use case demonstrates the ability of the ATCMTD system to collect, store, and archive BluFax border wait time information and display that information via dynamic message signs (DMS). This use case demonstrates that a user can view and display travel times and delay data on DMS. Test ID/Name: <ul style="list-style-type: none">• BC03_01 View Border Crossing Travel Time – List• BC03_02 View Border Crossing Travel Time – DMS List• BC03_03 View Border Crossing Travel Time on DMS	WSP: Compliant												
 SRD-1.1.1.6.2	<div>[BC-SyR-0040]: Historical border crossing travel time reliability</div> <p>The ATCMTD system shall allow border crossing operators to store and measure historical border crossing travel time reliability to assess the efficiency of their operations Context: Border crossing travel time reliability measurement is used by regional transportation planners (UN 7.1.3).</p>	As a NITTEC user, I would like to be able to store and	border crossing/travel time modules that	 BC03 – View Border Crossing Travel Times	Purpose: This use case demonstrates the ability of the ATCMTD system to collect, store, and archive BluFax	WSP: Compliance Not Demonstrated <ul style="list-style-type: none">• Req. refers to <u>storing</u>, and <u>measuring</u> of historical (long-term) travel times and/to assess(ing) operational efficiency• TC describes <u>viewing</u> travel times												
 SRD-1.1.1.6.3	<div>[BC-SyR-0050]: Measure (separate) travel time reliability</div> <p>The ATCMTD system shall allow border crossing operators to measure travel time reliability and delay/travel time separately between truck traffic versus passenger vehicle. Context: NITTEC currently receives Blufax information that contains delay data for passenger vehicles and trucks, but NITTEC currently only reports the delay for</p>	for trucks so that I can assess truck delays at the			<div>Test Steps</div> <table><tr><th>TEST CASE ID</th><th>TEST NAME</th><th>TEST STEPS</th><th>EXPECTED RESULT</th><th>PASS / FAIL / CAUTION</th><th>COMMENTS</th></tr><tr><td>BC03_03</td><td>View Border Crossing Travel Time on DMS</td><td>1. On the <i>DMS</i> list window, select a DMS that displays a current message on the sign 2. Observe the following:<ul style="list-style-type: none">a. Last poll timeb. Statusc. Districtd. Travel time message3. Close the DMS viewer 4. Close the DMS list window</td><td>Verify that:<ul style="list-style-type: none">• The DMS opens in a new detailed viewer• The last poll time is recent• The travel time delay for cars and trucks displays</td><td></td><td></td></tr></table> <div>• BC02_03 View Border Crossing Wait Time Trends</div>	TEST CASE ID	TEST NAME	TEST STEPS	EXPECTED RESULT	PASS / FAIL / CAUTION	COMMENTS	BC03_03	View Border Crossing Travel Time on DMS	1. On the <i>DMS</i> list window, select a DMS that displays a current message on the sign 2. Observe the following: <ul style="list-style-type: none">a. Last poll timeb. Statusc. Districtd. Travel time message 3. Close the DMS viewer 4. Close the DMS list window	Verify that: <ul style="list-style-type: none">• The DMS opens in a new detailed viewer• The last poll time is recent• The travel time delay for cars and trucks displays			WSP: Compliant
TEST CASE ID	TEST NAME	TEST STEPS	EXPECTED RESULT	PASS / FAIL / CAUTION	COMMENTS													
BC03_03	View Border Crossing Travel Time on DMS	1. On the <i>DMS</i> list window, select a DMS that displays a current message on the sign 2. Observe the following: <ul style="list-style-type: none">a. Last poll timeb. Statusc. Districtd. Travel time message 3. Close the DMS viewer 4. Close the DMS list window	Verify that: <ul style="list-style-type: none">• The DMS opens in a new detailed viewer• The last poll time is recent• The travel time delay for cars and trucks displays															

ACHIEVED OUTCOMES, SUMMARY & CONCLUSION

❖ **BACKGROUND:**

- Mar 2022: Project Start (Design-Build)
- May 2022: System Design Start (Detailed Design Doc., Requirements Workshops)
- Oct 2022: Implementation Start (Sprints)
- Feb 2023: 5 Sprints Completed, 1 FAT Executed, 100+ Req. Demonstrated
- May 2023: 10 Sprints Completed, 2 FAT & 1 SIT Executed, 235+ Req. Demonstrated
- Apr 2024: Project End (Final Test)

❖ **AGILE METHODOLOGY, COMBINED WITH STRONG OVERSIGHT:**

- Has been delivering early and continuously working software
- Working software is used as primary measure of progress
- Has allowed prioritizing requirements and changes to requirements interpretations
- Traceability and requirements based review ensure compliance to contract

❖ **CONCLUSION:**

- Agile Methodology Highly Recommended for Complex ITS Projects

Thank you!

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