Transportation Systems Management & Operations

BE521
Exhibit C
System/Subsystem Minimum Technical Requirements for the
Central Florida Regional Integrated Corridor Management System
Version: *2.0*

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

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System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

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List of Acronyms and Abbreviations

API	Application Programmable Interface
AVL	Automatic Vehicle Location
CCTV	Closed-circuit Television
CSV	Comma-separated Values
D5	District 5
DFE	Data Fusion Environment
DHSMV	Department of Highway Safety and Motor Vehicles
DMS	Dynamic Message Sign
DSS	Decision Support System
DW	Data Warehouse
ERE	Expert Rules Engine
ETL	Extract, Transform, and Load
EVE	Evaluation Engine
FDOT	Florida Department of Transportation
GEH	Geoffrey E. Havers
GIS	Geographical Information System
GPS	Global Positioning System
GUI	Graphical User Interface
I-4	Interstate 4
ICM	Integrated Corridor Management
ICMS	Integrated Corridor Management System
IEN	Information Exchange Network
ITS	Intelligent Transportation Systems
LCIS	Lane Closure Information System
MOE	Measure of Effectiveness
PRE	Prediction Engine
RDBMS	Relational Database Management System
SOT	Signal Optimization tool
TSM&O	Transportation Systems Management & Operations
UF	University of Florida

1 Overview

The System/Subsystem Minimum Technical Requirements establishes the functional, performance, design, development, and verification requirements for the Central Florida Regional Integrated Corridor Management System (ICMS) project. This document contains requirements gathered from the contractual elements typically consisting of the contract document, scope of work, concept of operations document, request for proposals, etc. The System/Subsystem Minimum Technical Requirements defines the set of requirements to be verified as part of the acceptance of the intelligent transportation systems (ITS) project.

1.1 Identification

This section contains a full identification of the system to which this document applies, including identification number(s), title(s), abbreviation(s), version number(s), and release number(s), as applicable.

2 Reference Documents

The following documents, of the exact issue shown, form a part of this document to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this document, this document shall be considered the superseding requirement.

Table 1: Reference Documents

Title and Date	Publisher
Central Florida Regional Integrated Corridor Management System Exhibit "A," Scope of Services	State of Florida Department of Transportation District 5 Procurement Office 719 S Woodland Blvd Deland, Florida 32720-5834

3 Requirements

This section covers the functional, performance, interface, data, and hardware requirements. It also covers non-functional and enabling requirements and constraints. For the requirements listed below, the requirement ID provides the level of requirement:

Level 1 – ICMS Software System = 1.
Level 2 – ICMS Software Subsystems = 1.X.
Level 3 – ICMS Software Subsystem Components = 1.X.Y
Level 4 – Functions and Data Elements = 1.X.Y.Z

Requirement Types

- F = Functional
- I = Interface (interface between ICMS and external systems)
- D = Data (internal storage, send and receive of data within the ICMS)
- C = Constraint
- P = Performance
- H = Hardware

Verification Method
- **Analysis** = The use of established technical or mathematical models or simulations, algorithms, or other scientific principles and procedures to provide evidence that the item meets its stated requirements.
- **Inspect** = The observation using one or more of the five senses, simple physical manipulation, and mechanical and electrical gauging and measurement to verify that the item conforms to its specified requirements.
- **Demonstrate** = The actual operation of an item to provide evidence that it accomplishes the required functions under specific scenarios.
- **Test** = The application of scientific principles and procedures to determine the properties or functional capabilities of items.)

Requirement Criticality
- H = High
- M = Medium
- L = Low

3.1 System Definition

The concept for the ICMS software is a system of systems that receives data from the data fusion system and SunGuide® software (SunGuide), and utilizes this data in the decision support system (DSS), as shown in Figure Figure 1. Figure Figure 1 shows the overall Florida Department of Transportation (FDOT) District 5 (D5) system of systems.

The DSS receives real-time data and models conditions within the region to select coordinated response plans for events (incidents, congestion) that require a multi-agency response. This data includes freeway, arterial, transit, weather, parking, and other data available in the region that could have an impact on the corridor. When local traffic signal corridors are operating outside of expected conditions, the DSS will provide recommended changes to the timing plans within the active arterial management corridors. For the ramp metering systems along Interstate-4 (I-4), the DSS will utilize the conditions on the approaching arterials and on I-4 to calculate the ramp metering rates. The DSS will also provide multi-agency, pre-agreed response plans for major events within the region, which may overrule the traffic signal and ramp meter recommendations.

The information exchange network (IEN) allows stakeholder agencies to view events within the region and provide information on events in the region. It also provides the notification and interface for coordination of response plans that the DSS generates.

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Data collected from stakeholder systems will be integrated into the data fusion environment (DFE) subsystem for use by the ICMS. The ICMS will have an application programmable interface (API) that will facilitate data requests and subscriptions to data stored within the DFE.

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TSM&O Data Fusion Architecture Road Map
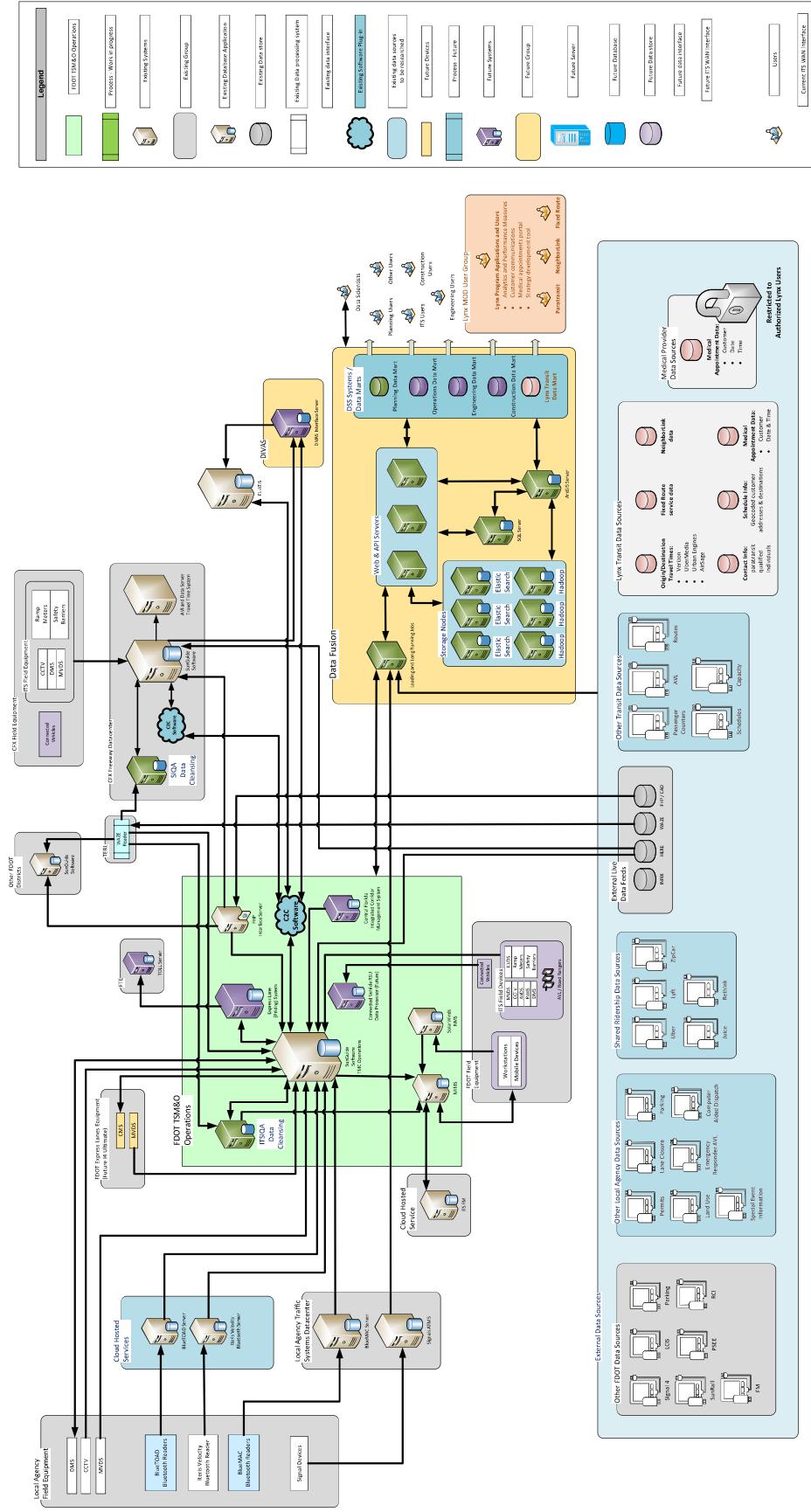
Figure 1: Data Fusion Architecture

3.2 System Requirements

This section itemizes the requirements associated with each of the system's capabilities based on the user needs described in Table 2.

Figure 2 shows the subsystem requirements hierarchy.
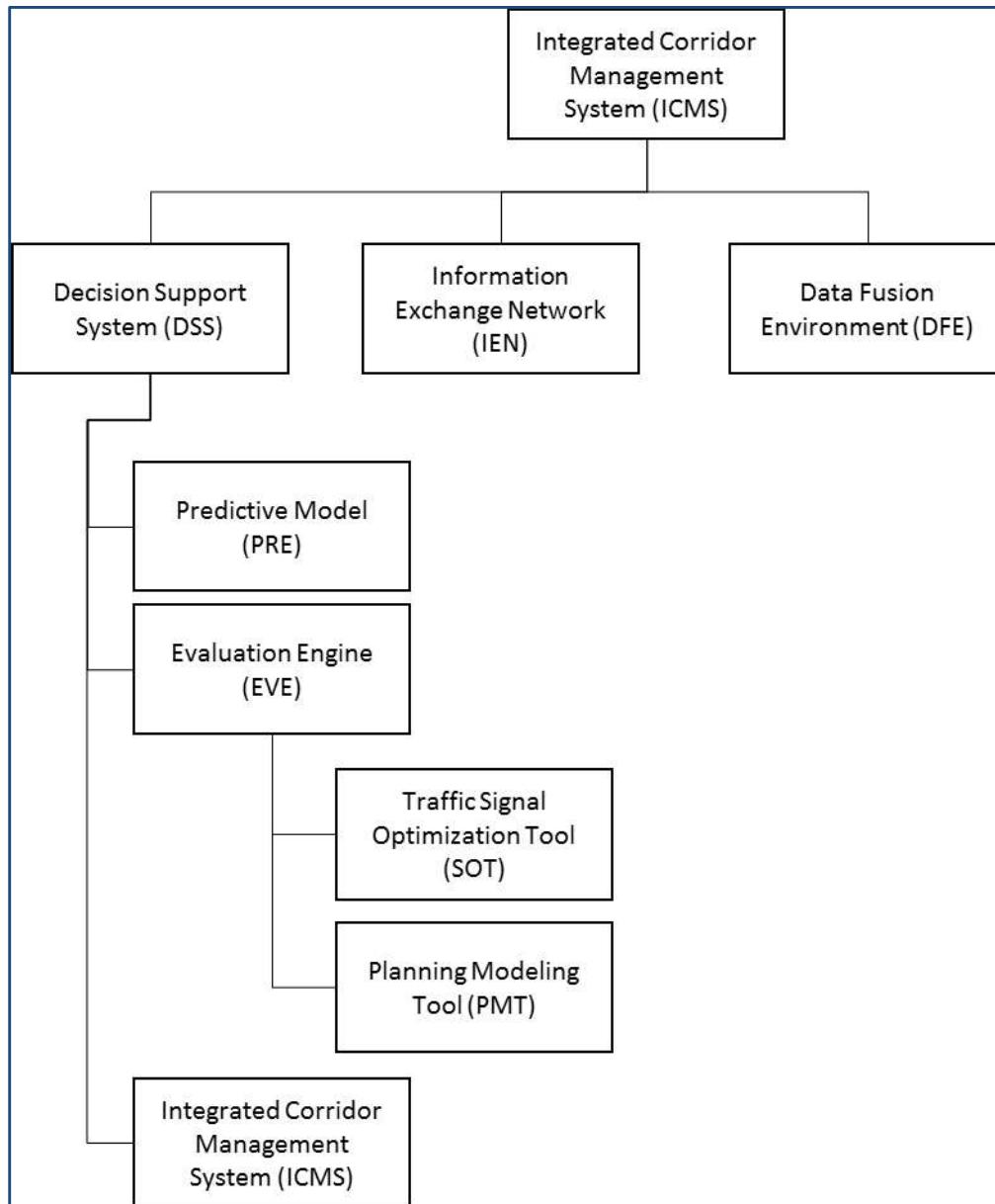
Figure 2: Requirements Hierarchy

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Table 2: User Needs

#	User Needs	User Need Description
1	Need for interactive communication among agencies	Agencies need to work together in order to plan for incident remediation and efficiently execute actions to clear incidents in a timely manner, in order to improve the collective response to events.
2	Need to obtain current status of ITS devices in the region	Agencies need to obtain current status of ITS devices and transportation network information (e.g. speed, travel time) within the corridor in order to make informed decisions on actions to be made to improve performance
3	Need to provide current status of ITS devices to the agencies	Agencies need to provide current status of their ITS devices to other agencies within the corridor in order for corridor agencies to make informed decisions on actions to be made to improve performance
4	Need to provide current performance of the transportation network to corridor agencies	Agencies need to provide current conditions of their transportation network (e.g. speed, travel time) to other agencies within the corridor in order to make informed decisions on actions to be made to improve performance.
5	Need to provide predicted performance of the transportation network to corridor agencies	Agencies need to receive near term predictions of transportation network in order to make proactive informed decisions.
6	Need to develop comprehensive incident response plans	Agencies need a means to develop, collect and store new response plans in order to improve response effectiveness in reacting to events within the corridor.
7	Need to provide roadway event information to travelers	Agencies need to provide event information to the public for planning trips and modifying trip plans enroute, in order to allow travelers to make informed decisions about their trips.
8	Need to provide transit event information to travelers	Agencies need to provide transit information to the public for planning trips and modifying trip plans enroute, in order to allow travelers to make informed decisions about their trips.
9	Need to store pre-agreed incident response plans	Agencies need a means to collect and store pre-agreed response plans in order to understand collective roles and responsibilities, communicate effectively, and improve response times when reacting to events within the corridor.

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#	User Needs	User Need Description
10	Need to coordinate incident responses among agencies to ensure that conflicting responses are not enacted	Agencies need to coordinate responses and understand roles and responsibilities as well as jurisdictional boundaries, such that conflicting responses are not enacted and the correct information is being provided to the public.
11	Need to coordinate incident responses among agencies to ensure prompt response to events	Agencies need to coordinate responses such that agencies understand roles and responsibilities and jurisdictional boundaries in order to ensure prompt response to events and accurate information is provided to the public.
12	Need to coordinate ramp metering systems	Agencies need to be able to view ramp meter system status, and when requested, implement ramp meter rate changes.
13	Need to generate transportation system performance reports	Agencies need to be able track the overall performance of the network through the generation of summary reports to better understand the historical operation of the system.
14	Need to generate transportation system performance dashboards	Agencies need to be able to track current performance on multiple levels of the system through the use of dashboards.
15	Need to track and store history of enacted response plans	Agencies need to be able to track and store history of actions associated with a pre-approved response plan after they have been enacted to determine if any changes are required to improve the response plans.
16	Need to assess the impact of an enacted response plan on the transportation network	During the response to an event in the corridor, agencies need to be able to determine if the pre-agreed response plan is effective and if is having the intended effect. This includes verifying what conditions exist after implementation of the response plan. If the operators of the systems determine that their response is not effective, they should be able to change components of their response plans or implement a new response plan.
17	Need to maintain and modify enacted response plans	As an event progresses and conditions change, agency operators should be able to modify the current response, and communicate changes with other agencies within the corridor in order to effectively adjust to changing conditions and improve conditions in the corridor.

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#	User Needs	User Need Description
18	Need to maintain and modify stored pre-approved response plans	Agencies need to be able to make recommendations and modify pre-approved response plans, and communicate ideas with other agencies within the corridor, in order to improve response to conditions that will impact the corridor.
19	Need to coordinate traffic signal systems	Agencies need to be able to view traffic signal system status, and when requested implement signal timing plans.
20	Need to optimize traffic signal operations.	Agencies need a tool to be able to optimize traffic signals along pre-defined routes.
21	Need to provide current performance of the transportation network to the public	Corridor agencies need to provide transportation network performance information to the public for use by 3rd party applications.

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Table 3: Business Requirements

Requirement Number	Requirement Description	Type	User Needs	ICMS	Notes
1.1	The ICMS shall provide interactive communication among agencies.	F	1	IEN	
1.2	The ICMS shall receive current status of the transportation network in the region.	I	2	DF, DSS	
1.3	The ICMS shall send current status of ITS devices to the stakeholder agencies, as available.	I	3	IEN, DF	
1.4	The ICMS shall provide current performance of the transportation network to stakeholder agencies.	F	4	IEN, DF	
1.7	The ICMS shall provide roadway event information to travelers.	I	7	DF	Send to 511 and dynamic message sign (DMS)
1.8	The ICMS shall provide transit event information to travelers.	I	8	DF	Send to 511 and DMS
1.9	The ICMS shall store pre-agreed incident response plans.	D	9	DSS	
1.10	The ICMS shall send incident response plans to agency users to insure appropriate response time.	F	10, 11	DSS	
1.15	The ICMS shall store history of enacted response plans.	D	15	DSS	

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Requirement Number	Requirement Description	Type	User Needs	ICMS	Notes
1.16	The ICMS shall evaluate the impact of enacted response plans on the transportation network.	F	16	DSS	
1.17	The ICMS shall send updated incident response plans to agency users.	I	17	DSS	
1.18	The ICMS shall store updated pre-approved response plans.	D	18	DSS	
1.19	The ICMS shall coordinate the activation of traffic signal timing plans.	F	19	TSC	
1.20	The ICMS shall recommend a set of response plans based on a pre-determined set of rules, and current and predicted network conditions for the user to review.	F	4,5	DSS	A design detail will determine if the user has the ability to select or if the user can only approve the DSS-recommended response plan.
1.21	The ICMS shall coordinate the activation of ramp meter metering rates.	F	12	TSC	
1.22	The ICMS shall provide the capability to develop and store new response plans.	F	6,9	DSS	
1.23	The ICMS shall provide the capability to generate and manage reports.	F	13	IEN	
1.24	The ICMS shall provide access to system dashboards.	F	14	IEN	
1.25	The ICMS shall provide an offline signal optimization tool	F	20	SOT	

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Requirement Number	Requirement Description	Type	User Needs	ICMS	Notes
1.26	The ICMS shall provide a data dissemination service	F	21	DFE	

Table 4: System Constraint Requirements

Requirement Number	Requirement Description	Type	ICMS	Notes
1.31	The ICMS shall be hosted in the FDOT D5 hosting environment.	C	All	
1.33	The ICMS shall provide evaluation data to the DFE Subsystem.	C	DSS, DF	
1.37	The Prediction Engine shall calculate and store model accuracy.	C	DSS	

3.2.1 Performance

This section identifies a required system capability and itemizes the requirements associated with the capability. The requirements specify the required behavior of the system and include applicable parameters, such as response times, throughput times, other timing constraints, sequencing, accuracy, capacities (i.e., how much/how many), priorities, continuous operation requirements, and allowable deviations based on operating conditions. The requirements will include, as applicable, required behavior under unexpected, unallowed, or "out-of-bounds conditions; requirements for error handling; and any provisions to be incorporated into the system to provide continuity of operations in the event of emergencies.

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Table 5: System Performance Requirements

Requirement Number	Requirement Description	Type	User Needs	ICMS	Notes
1.41	The ICMS shall provide 99.5 percent availability.	P		ALL	99% for first 90 days
1.42	The ICMS shall provide data latency of less than or equal to three seconds from the time a new value for a status currently being shown on a user display screen is available to the DFE to the time the status is available from the DFE for display on the user's screen.	P		ALL	
1.43	The ICMS shall provide automated monitoring capabilities to alert operators of outages.	P		ALL	
1.44	The ICMS shall provide failover capabilities within 45 minutes.	P		ALL	This assumes the Department provides sufficient hardware and network infrastructure to support the failover.
1.45	The Decision Support Subsystem shall send the Information Exchange Network a response plan recommendation within five minutes of incident conditions that trigger a response plan recommendation.	P	20	DSS	This assumes the prediction modelling engine meet its respective performance requirements.

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Requirement Number	Requirement Description	Type	User Needs	ICMS	Notes
1.47	The ICMS shall not recommend a change to a signal that has changed within the last 15 minutes	P	20	DSS	
1.48	The ICMS shall not recommend a change to a ramp meter that has changed within the last 5 minutes.	P	20	DSS	
1.49	The DFE shall track system usage, size of data being transferred and the data sets that were requested	P		DSS	
1.50	The usage data collected shall be available to an administrator via a report	P		DSS	This would be one of the six reports the initial system has to support.

3.2.2 Physical Characteristics

Table 6: Physical Characteristic Requirements

Requirement Number	Requirement Description	Type	User Needs	ICMS	Notes
1.51	The ICMS shall be hosted in the FDOT D5 hosting environment.	C		All	
1.52	The ICMS shall follow FDOT D5 standards for hosted systems.	C		All	

3.3 Subsystem Requirements

This section identifies a required system capability and will itemize the requirements associated with the capability. The requirements will specify the required behavior of the system and will include applicable parameters, such as response times, throughput times, other timing constraints, sequencing, accuracy, capacities (i.e., how much/how many), priorities, continuous operation requirements, and allowable deviations based on operating conditions. The requirements will include, as applicable, required behavior under unexpected, un-allowed, or out of bounds conditions; requirements for error handling; and any provisions to be incorporated into the system to provide continuity of operations in the event of emergencies.

3.3.1 Data Fusion Environment Subsystem

3.3.1.1 Definition

The purpose of the DFE is to provide the data processing, fusion, and data dissemination functions for the ICMS. The DFE receives data from and provides data to the other ICMS subsystems – the IEN and DSS. The DFE also receives data from external interfaces described in this document. The DFE is the data layer for the ICMS and other transportation systems management and operations (TSM&O) in simplest terms.

The main functionality of the DFE needed for the ICMS is:

- Retrieve data from specified data sources available to TSM&O including real-time data streams and less frequently and even manually updated data;
- Catalog data received in an electronically accessible data catalog;
- Transform data received into a format suitable for storage, further processing, and retrieval by users and other applications;
- Secure data to only be accessible according to the usage policy of the data and authorization of the DEPARTMENT;
- Provide user and application account management, authentication, and authorization for accessing the DFE using user authentication and authorization systems provided by the DEPARTMENT;
- Provide encryption of communications and data between the DFE and its users external to the ICMS using industry standard tools and functions;
- Provide access to the catalog of all data available specific to the user making the request;
- Provide data available to authenticated and authorized users, including data in storage and real-time data streams;
- Provide availability and performance as specified to support TSM&O; and
- Produce and provide status and diagnostic information to support the operations, maintenance, and management of the DFE.

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The specific functionality of the DFE needed for the DSS and IEN is:

- Receive the current status of specified devices and roadway and transit network within the corridor;
- Provide roadway link information to external systems to include link speeds, volumes, travel times, and weather conditions;
- Provide event, and special event information to stakeholder agencies and to external systems;
- Store inventory of specified ITS devices, network data, and device ownership for the corridor network;
- Store pre-agreed incident response plans developed and approved by corridor stakeholders;
- Store history of implementation of pre-agreed incident response plans;
-
- Provide transit information to external systems to include routes, schedules, and current location of transit vehicles for the calculation of alternate routes and modes.

The DFE includes the following underlying components for retrieving, transforming, storing, and disseminating data as well as relaying response plan recommendations and approvals:

- Extract, Transform, and Load (ETL) Component – retrieves data from sources, transforms the data, and loads the data into the DFE
- Data Warehouse (DW) Component – stores the data within the DFE
- Application Programmable Interface (API) Component – provides security and access to data within the DFE

3.3.1.2 Inputs/Outputs

- ETL extracts data from external sources in as input into the DFE;
- API provides TSM&O users and applications with access to data as the primary outputs of the DFE;
- API provides the DFE administrators with administration and management of the DFE as an input and an output to the DFE
- The DFE will contain specified additional internal data management and processing functions directly accessible by users with appropriate access for additional data analytics and processing.

3.3.1.3 Data Stores

The DW within the DFE will contain the following data store types:

- Structured data – relational database management system containing data in a relational format, typically from existing external databases
- Unstructured data – file system of data not stored in a relational database management system

- Geographical information system (GIS) data store – data stored in GIS and formatted to support GIS-specific data applications, analytics, and presentation

To support the ICMS specifically, the DFE data stores will contain the dynamic and static data records listed in Table 7:

3.3.1.4 Dependencies/Constraints

- Data sources must be available and accessible to the DFE via the network
- Data source interface protocol must be defined
- The presence of data must not be provided to users who are not authorized to have disclosure of the data's presence within the ICSM
- Data must not be provided to users who are not authorized to have access to the data
- Data must not be provided to users whose identity is not authenticated
- Data and communication between users and the DFE must be encrypted if being provided to users outside of the FDOT network

3.3.1.5 Interfaces

External User Interfaces represent components external to the DFE and their respective interaction within the DFE. There are many external interfaces required for the DFE. These interfaces are divided into three types supported by the DFE:

1. Data Providers: Provides data to the DFE; the provider dictates these data interfaces and the DFE must develop the interface to meet the process, protocols, and formats of the provider. The provider must have an associated schema or data definition for the DFE to follow.

2. Data Subscribers: Receives data from the DFE; the DFE dictates these data interfaces and the provider must develop their interface to meet the process, protocols, and formats developed by the DFE. The DFE must provide the subscriber an associated schema or data definition.

3. Data Providers/ Subscribers (bi-directional): Receives data and provides data to the ICMS; SunGuide is one planned interface; SunGuide already has defined processes, protocols, and formats for data subscriber and data publishing. The DSS is also a planned interface. It is internal and the interfaces will be defined as a part of the ICMS development.

The following sections describe the interfaces for the DFE; there are several existing data interfaces.

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3.3.1.6 High-Level Logical Architecture
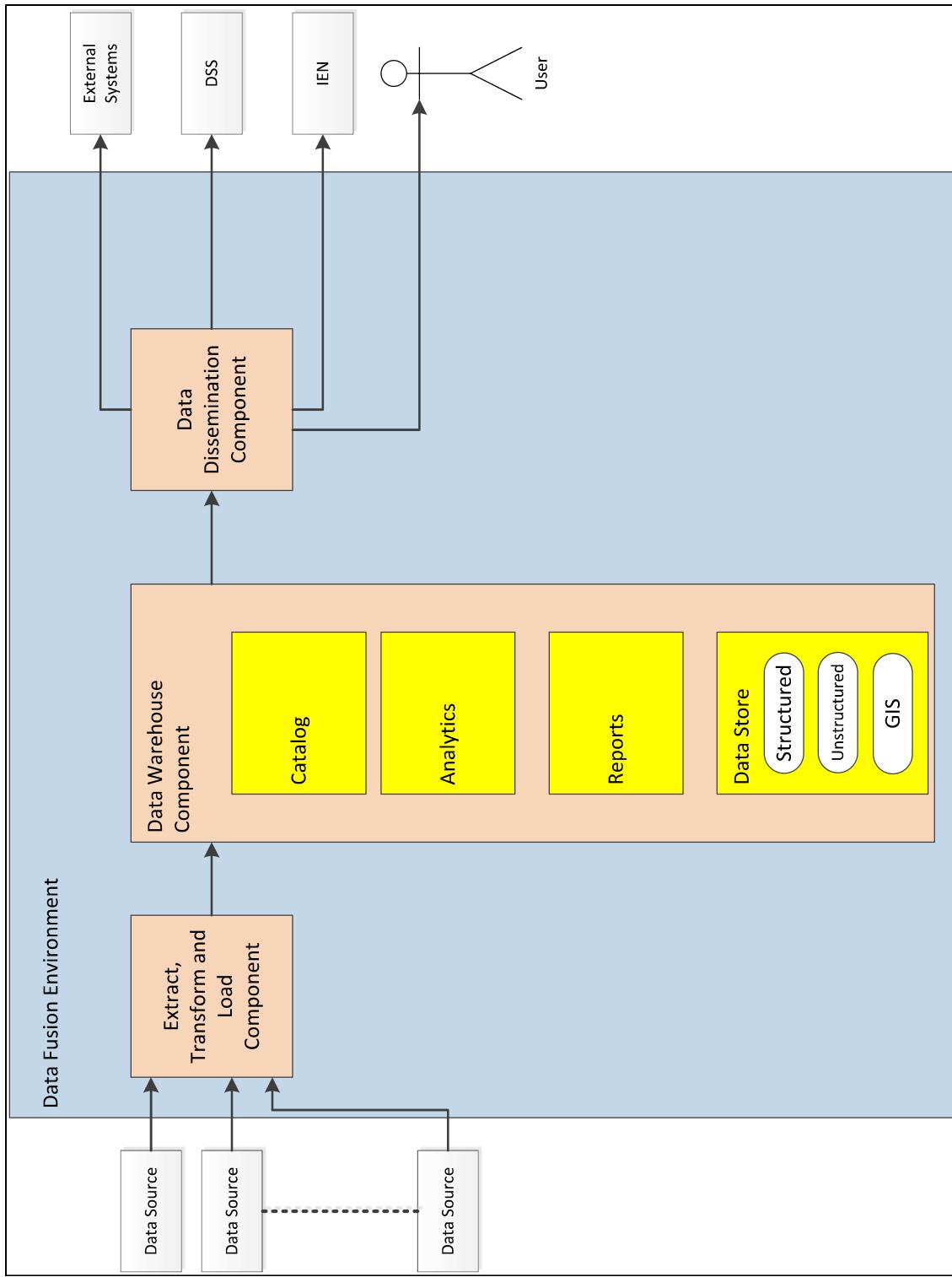
Figure 3: Data Fusion Environment

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Table 7: TSM&O Data Sources

Data Source	Data Source Detail	Data Source availability mechanism	When Available	Update Interval
District 5 SunGuide System	Traffic Conditions Data	ITSIQA	9/1/2017	1 min
District 5 SunGuide System	Traffic Incident Data	SunGuide / Databus / EM	now	real-time
District 5 SunGuide System	CCTV Status	SunGuide / Databus / CCTV	now	real-time
District 5 SunGuide System	Ramp Meter Status	SunGuide / Databus / RMS	now	real-time
District 5 SunGuide System	Dynamic Message Signs Status	SunGuide / Databus / DMS	now	real-time
District 5 SunGuide System	Connected Vehicle Roadside unit status	SunGuide / Databus / CV	now	real-time
Signal Performance Measures	Volume for each movement	ATSPM D5 Deployment	9/1/2017	
Signal Performance Measures	Arrival timing per movement	ATSPM D5 Deployment	9/1/2017	
Transit AVL	Bus AVL data from Lynx (Clever and Trapeze), Votran, Space Coast Area Transit (SCAT), Lake Express, SunTran, SunRail	GTSF-RT only (from IBI app)	12/31/2017	real-time
Transit Routes and Stops and Schedules	Transit Routes from Lynx (Clever and Trapeze), Votran, Space Coast Area Transit (SCAT), Lake Express, SunTran, SunRail	GTSF only (from IBI app)	12/31/2017	quarterly
Weather	National Weather Service Watches and Warnings	NOAA; Is there capability to do weather radar for map overlay for IEN	TBD	real-time
Parking Data	Garages, surface lots, weigh stations, rest areas, beaches, on-street parking	SunGuide / Databus / TPS or Parking Subsystem	TBD / March 2018	real-time
base map "backdrop"		HERE Navstreets or ESRI ArcGIS system	now	quarterly
base map links		FDOT (manually corrected version of HERE.com basemap)	9/1/2017	quarterly
Roadway Characteristics Inventory (RCI)	# lanes at intersection	FDOT RCI	now	
Predictive Engine Data		PRE	ICMS Schedule	
Expert Rules Engine – Response Plans		ERE	ICMS Schedule	
Evaluation Engine		EVE	ICMS Schedule	
Intersection Geometry Data		TBD	TBD	

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Intersection Plans and Schedules		TBD	TBD
Intersection Movement Counts Data	turning movement counts	IMC	TBD
Intersection Movement Counts Data	approach/direction	IMC	TBD
Intersection Movement Counts Data	# lanes	IMC	TBD
Intersection Movement Counts Data	saturation flow rates	IMC	TBD
Intersection Movement Counts Data	bike detection	IMC	TBD
Intersection Movement Counts Data	pedestrian detection	IMC	TBD
Intersection Movement Counts Data	vehicle detection	IMC	TBD
Intersection Movement Counts Data	turning movement counts	IMC	TBD
Intersection Movement Counts Data	saturation flow rates	IMC	TBD
Origin Destination	BlueTOAD	SunGuide D4 Enhancement	TBD
Origin Destination	BlueMAC	SunGuide	TBD
Controller or ATMS	Signal Phasing	ATMS Software or SunGuide	TBD
Controller or ATMS	Detector Status Data (Vehicular and Pedestrian)	ATMS Software or SunGuide	TBD
Controller or ATMS	Controller Data	ATMS Software or SunGuide	TBD
Controller or ATMS	Available Controller Timing Patterns with timing plan details	ATMS Software or SunGuide	TBD
Controller or ATMS	Controller Timing pattern status	ATMS Software or SunGuide	TBD
Controller or ATMS	Corridor Plan	ATMS Software or SunGuide	TBD
Special Event Information		AAM Dashboard	9/1/2017
School locations		FDOT provided GIS layer	12/31/2017
School zones		FDOT provided GIS layer	12/31/2017
School schedules		FDOT provided data	12/31/2017
Express lanes status	status, current price, current pricing model, if the system has any dynamic features such as changeable toll rates, changeable lane configurations	Express Lanes Software	TBD

3.3.1.7 Data Fusion Environment Requirements

Table 8: Data Fusion Environment Subsystem Requirements

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.1	The DFE shall receive data from external systems shown in the TSM&O Data Sources Table.	D	1.2	DF	Demonstrate
1.2.2	The DFE shall ingest data from the data sources shown in the TSM&O Data Sources Table 7.	F	1.2	DF	Demonstrate
1.2.2.1	The ETL component shall retrieve data from each data source specified in the TSM&O Data Sources Table.	F	1.2.2	DF	Demonstrate
1.2.2.2	The ETL component shall follow the protocol of each data source specified in the TSM&O Data Sources Table.	F	1.2.2	DF	Demonstrate
1.2.2.3	The ETL component shall receive data from data sources specified in the TSM&O Data Sources Table according to the update interval specified	F	1.2.2	DF	Demonstrate
1.2.2.4	The ETL component shall re-establish a lost connection to the data sources specified in the TSM&O Data Sources Table where appropriate.	F	1.2.2	DF	Demonstrate
1.2.2.5	The ETL component shall request data not received due to temporary lost connections if the data source supports such a request.	F	1.2.2	DF	Demonstrate
1.2.2.6	The ETL component shall request data on the specified interval for data within that interval if the data source does not support a data feed.	F	1.2.2	DF	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.2.7	The ETL component shall transform the data received from each data source into the format specified for that data in the Data Sources Table.	F	1.2.2	DF	Demonstrate
1.2.2.8	The ETL component shall use the fields specified in the Data Sources Table from the data received from each data source .	F	1.2.2	DF	Demonstrate
1.2.2.9	The ETL component shall append the data with a date and time stamp that the data was received from the server's system clock, when appropriate.	F	1.2.2	DF	Demonstrate
1.2.2.10	The ETL component shall append or associate the data with a geolocation reference or region corresponding to the location represented by the data when appropriate.	F	1.2.2	DF	Demonstrate
1.2.2.11	The ETL component shall load the transformed data received from each data source into the DW destination specified for the data source.	F	1.2.2	DF	Demonstrate
1.2.3	The DW component shall store specified data received from external systems.	F	1.2	DF	Demonstrate
1.2.4.1	The DW component shall store data across reboots of the DFE equipment.	F	1.2.4	DF	Demonstrate
1.2.4.4	The DW component shall store unstructured data in an internal file system data store.	F	1.2.4	DF	Demonstrate
1.2.4.5	The DW component shall store GIS data in a GIS data store.	F	1.2.4	DF	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.4.6	The DW component shall be able to expand the capacity of data stores.	F	1.2.4	DF	Demonstrate
1.2.4.7	The DW component shall organize data within a data store.	F	1.2.4	DF	Demonstrate
1.2.4.8	The DW component shall use the source of the data as an element in the organization of the data within a data store when appropriate.	F	1.2.4	DF	Demonstrate
1.2.4.9	The DW component shall use the date interval of the data as an element in the organization of the data within the data source's hierarchy within a data store when appropriate.	F	1.2.4	DF	Demonstrate
1.2.5	The DW component shall provide the capability for administrators to create a report from specified collected data.	F	1.2	DF	Demonstrate
1.2.5.1	The DW component shall collect and store availability status information of each data source within the DW.	F	1.2.5	DF	Demonstrate
1.2.5.2	The DW component shall monitor the availability of the data store.	F	1.2.5	DF	Demonstrate
1.2.5.3	The DW component shall collect and store errors detected by each data store.	F	1.2.5	DF	Demonstrate
1.2.5.4	The DW component shall collect and store available data storage capacity for each data store.	F	1.2.5	DF	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.3.1	The Data Dissemination component shall publish data.	F	1.3	DF	Demonstrate
1.3.1.1	The Data Dissemination component shall provide a secure interface to TSM&O data resources using industry standard tools and best practices such as token and role-based, SSL layer, and RESTful endpoints.	F	1.3.1	DF	Demonstrate
1.3.1.9	Data Dissemination Component user credential information, along with last successful authentication token, shall be stored in a secure database.	F	1.3.1	DF	Demonstrate
1.3.1.10	The Data Dissemination Component support staff shall have the ability to revoke user access if misuse of the system is detected.	F	1.3.1	DF	Demonstrate
1.3.1.11	The Data Dissemination Component shall have the configurable ability to log usage statistics for users.	F	1.3.1	DF	Demonstrate
1.3.1.11.1	The Data Dissemination Component shall have the configurable ability to log computer resource usage statistics for users	F	1.3.1	DF	Demonstrate
1.3.1.11.2	The Data Dissemination Component shall have the configurable ability to log data transfer usage statistics for users	F	1.3.1	DF	Demonstrate
1.3.1.15	The Data Dissemination Component shall be provided on a non-production test platform for verifying system changes before being applied to production.	F	1.3.1	DF	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.6	The DFE shall use user accounts provided by the authentication system.	F	1.2	DF	Demonstrate
1.2.6.1	The DFE shall provide the capability for an administrator to define up to two types of access permissions specific to a data source for real-time and non-real time data.	F	1.2.6	DF	Demonstrate
1.2.7	The DFE shall provide the capability for an administrator to manage user accounts.	F	1.2	DF	Demonstrate
1.2.7.1	The DFE shall provide the capability for an administrator to modify permissions specific to a data source.	F	1.2.6	DF	Demonstrate
1.3.2	The Data Dissemination component shall authenticate users.	F	1.3	DF	Demonstrate
1.3.2.1	The Data Dissemination component shall use a token-based authentication and authorization protocol.	C	1.3.2	DF	Demonstrate
1.3.3	The Data Dissemination component shall deny requests from unauthenticated users.	F	1.3	DF	Demonstrate
1.3.4	The Data Dissemination component shall verify that users making requests to data sources have appropriate permission to that source.	F	1.3	DF	Demonstrate
1.3.4.1	The Data Dissemination component shall deny requests from users who do not have the permission to access the requested resource.	F	1.3.4	DF	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.3.4.2	The Data Dissemination component shall verify that users making requests to modify data sources have permission to modify the requested resource.	F	1.3.4	DF	Demonstrate
1.3.4.3	The Data Dissemination component shall deny requests to modify data sources from users who do not have the permission to modify the requested resource.	F	1.3.4	DF	Demonstrate
1.3.5	The Data Dissemination component shall provide an interface to the data stored in the DW specified in Table 7.	F	1.3	DF	Demonstrate
1.3.6	The Data Dissemination component shall provide a representational state transfer web services interface if appropriate.	C	1.3	DF	Demonstrate
1.3.6.1	The Data Dissemination component shall return the data requested by a data access request.	F	1.3.6	DF	Demonstrate
1.3.6.2	The Data Dissemination component shall support the specified filters defined for specified data sources in the TSM&O Data Sources Table.	F	1.3.6	DF	Demonstrate
1.3.6.3	The Data Dissemination component shall filter the data requested by the filter parameters used in the request.	F	1.3.6	DF	Demonstrate
1.3.6.4	The Data Dissemination component shall provide a push interface to provide data feeds to user.	F	1.3.6	DF	Demonstrate
1.3.6.5	The Data Dissemination component shall provide a subscription service interface to provide data feeds to user.	F	1.3.6	DF	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.9	The DFE shall provide a data catalog.	F	1.2	DF	Demonstrate
1.2.9.1	The Data Catalog shall store a list of data sources.	F	1.2.9	DF	Demonstrate
1.2.9.2	Data Catalog shall provide the capability for a user to insert entries into the data catalogs.	F	1.2.9	DF	Demonstrate
1.2.9.4	Data Catalog shall provide the capability for an administrator to view access permission for each data source entry in the catalog.	F	1.2.9	DF	Demonstrate
1.2.9.5	Data Catalog shall provide the capability for an administrator to modify access permissions for each data source entry in the catalog.	F	1.2.9	DF	Demonstrate
1.2.9.6	DFE shall provide the capability for a user to create new data sources.	F	1.2.9	DF	Demonstrate
1.2.9.7	DFE shall provide the capability for a user to access permitted data sources.	F	1.2.9	DF	Demonstrate
1.2.9.8	Data Catalog shall provide the capability for a user to modify permitted data sources.	F	1.2.9	DF	Demonstrate
1.2.9.9	The Data Catalog shall provide users the requested permitted data catalog entries.	F	1.2.9	DF	Demonstrate
1.2.9.10	The Data Catalog shall provide the ability for a user to modify permitted catalog entries.	F	1.2.9	DF	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.3.7	The Data Dissemination component shall report status information of permitted data sources.	F	1.3	DF	Demonstrate
1.3.7.2	The Data Dissemination component shall report the first date and time represented by the data loaded for each data source.	F	1.3.7	DF	Demonstrate
1.3.7.3	The Data Dissemination component shall report the last date and time represented by the data loaded for each data source.	F	1.3.7	DF	Demonstrate
1.3.7.4	The Data Dissemination component shall report the ranges of missing data based on temporal coverage for periodic data sources greater than a configurable number (with a default of 10) of periods of contiguous missing data.	F	1.3.7	DF	Demonstrate
1.3.7.5	The Data Dissemination component shall alert when data is not received for a data source for greater than a configurable number (with a default of 10) periods.	F	1.3.7	DF	Demonstrate
1.3.7.6	The Data Dissemination component shall alert when data is first received after being alerted as missing data.	F	1.3.7	DF	Demonstrate
1.2.11	The DFE shall provide a data analytics toolset.	F	1.2	DF	Demonstrate
1.2.12	The DFE shall index specified unstructured data sets to be searchable without scanning the entire contents.	F	1.2	DF	Demonstrate
1.2.13	The DFE shall provide the capability for a user to query unstructured data.	F	1.2	DF	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.13.1	The DFE shall provide requested indexed data resources with a latency of no more than1 second.	P	1.2.13	DF	Demonstrate
1.2.13.2	The DFE shall make current traffic condition updates available to the other components of the ICMS, including the external Modeling Engine, at a rate and volume sufficient to support the well-designed use of that data to provide status to users and to predict future traffic conditions within five minutes.	P	1.2.13	DF	Demonstrate
1.2.13.2	The DFE shall allow queries to specify a date range, time range, and spatial range as appropriate.	P	1.2.13	DF	Demonstrate
1.2.14	The DFE shall be modular and provide the capability for an administrator to install additional tools such as data analytics tools.	C	1.2	DF	Demonstrate
1.2.15	The DFE shall provide specified static Transportation Network data to the ICMS.	F	1.2	DF	Demonstrate
1.3.8	The DFE shall provide specified dynamic transportation network data to the ICMS.	F	1.3	DF	Demonstrate
1.3.9	The DFE shall monitor the available bandwidth of the communication network.	F	1.3	DF	Inspect

3.3.2 Decision Support Subsystem

3.3.2.1 Definition

The Decision Support System (DSS) provides candidate response plans to the region based on network conditions received from the DFE, prediction analysis, and on a rule-based assessment of the recommended response plans. The DSS consists of three major components:

- Expert Rules Engine,
- Prediction Engine, and
- Evaluation Engine.

3.3.2.2 Inputs/Outputs

- Current network conditions data, such as highway link speeds and volumes, arterial speeds, and event data, will be provided by the DFE.

- The DSS shall provide modeling engine current network conditions data , such as highway link speeds, and volumes, arterial speeds, and event data.

- The results of model executions will be provided to the DSS by the modeling engine.

- Recommended response plans will be provided to the DSS agency user interface for distribution to agency users.

- Expert rules, response plans, and results of modeling engine runs will be provided to the DFE

- The results of previously saved expert rules, response plans, and modeling engine runs will be provided by the DFE.

3.3.2.3 Data Stores

The DSS is the business layer of the ICMS and does not store data locally. Some data may be stored in the external Modeling Engine.

3.3.2.4 Dependencies/Constraints

- All current network data for the transportation system performance and operations will be provided by the DFE;
- Non-modeling engine static data for network representation, rules, and other parameters will be updated periodically by the DSS in the DFE.

3.3.2.5 Use Case Diagram

The use case shown in Figure 4 illustrates the basic high-level activities of the DSS.
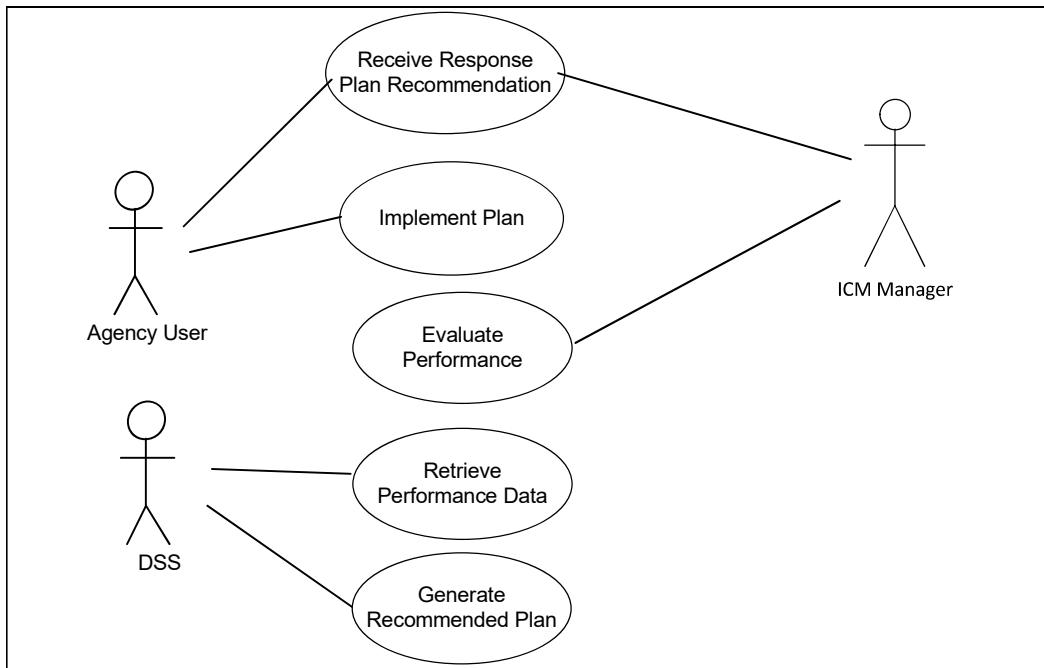
Figure 4: DSS Use Case

This use case includes the following activities:

- Receive response plan recommendation – Response plan is generated by the DSS and provided to the Integrated Corridor Management (ICM) manager and agency users through the DSS Agency Interface of the IEN, and more specifically the Plan Coordination user interface.
- Implement plan – The agency user will implement a recommended plan via the IEN once the ICM Manager approves the plan.
- Evaluate performance – The DSS develops metrics that represent the performance of the system and provides it to the ICM Manager via the IEN.
- Retrieve performance data – The DSS will retrieve performance data including current network conditions from the DFE.
- Generate recommended plan – The DSS will generate recommended response plans based on performance data and prediction analysis.

Table 8: DSS Use Case Description

Use Case ID	1.1.1.01
Description	The DSS selects candidate recommended response plans for the ICM Manager based on existing and predicted roadway network conditions.

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Actors	ICM Manager and agency users
Preconditions	ICM Manager and agency users are authenticated users. The DSS is collecting and fusing roadway data.
Post Conditions	Recommended response plan is selected and provided to Agency Operators for implementation.
Normal Course of Events	1. Operators logs in. 2. Expert Rules Engine collects roadway conditions data from the DFE. 3. Prediction Engine uses roadway conditions data to assess existing roadway conditions and predict the impact of candidate response plans. 4. Expert Rules Engine selects a set of recommended response plans. 5. DSS distributes recommended response plans via the IEN Interface to the ICMS Manager who selects a plan for distribution to the Agency operators.

3.3.2.6 Interfaces

The DSS has the following interfaces:
- Data Interface to DFE – the DSS will receive data from the DFE and send data to the DFE.
- Recommended Response Plan Generation Interface to DSS Agency Interface via the IEN – Once the expert rules subsystem determines that a response is needed based on conditions and events within the transportation network, a response plan request is generated. The DSS will interface to the DSS Agency Interface via the IEN so that agency users receive alerts from the system to select and implement one of the recommended response plans.

The interfaces to the DSS include the data defined in the System Requirements document, and further defined in the data dictionary.

3.3.2.7 Decision Support System Requirements

Table 9: Decision Support System Requirements

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.1	The ICMS shall receive ITS infrastructure status data from the DFE.	D	1.2	DSS	Demonstrate
1.2.2	The ICMS shall receive event data from the DFE.	D	1.2	DSS	Demonstrate
1.2.3	The ICMS shall receive transit data from the DFE.	D	1.2	DSS	Demonstrate
1.2.4	The ICMS shall receive transportation network data from the DFE.	D	1.2	DSS	Demonstrate
1.4.1	The DSS shall evaluate the current performance of the network.	F	1.4	DSS	Demonstrate
1.9.1	The DSS shall store pre-agreed incident response plans as defined in the data dictionary.	F	1.9	DSS	Demonstrate
1.9.2	The DSS shall provide an interface to the IEN to allow the ICM Manager the capability to add pre-agreed incident response plans for a specified incident.	F	1.9	DSS	Demonstrate
1.9.3	The DSS shall provide an interface to the IEN to allow the ICM Manager the capability to query pre-agreed incident response plans.	F	1.9	DSS	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.9.4	The DSS shall provide an interface to the IEN to allow the ICM Manager the capability to edit pre-agreed incident response plans for a specified incident.	F	1.9	DSS	Demonstrate
1.9.5	The DSS shall provide an interface to the IEN to allow the ICM Manager the capability to delete pre-agreed incident response plans for specified events.	F	1.9	DSS	Demonstrate
1.10.1	The DSS shall send a proposed response plan to the ICM Manager via the IEN.	I	1.10	DSS	Demonstrate
1.10.2	The DSS shall initiate the distribution of proposed response plans to agency users.	I	1.10	DSS	Demonstrate
1.10.3	The DSS shall receive response plan coordination data from the IEN.	I	1.10	DSS	Demonstrate
1.10.4	The DSS shall send response plan requests to the IEN.	I	1.11	DSS	Demonstrate
1.15.1	The DSS shall send the history of actions enacted during response plan implementation to the DFE for storage.	D	1.15	DSS	Demonstrate
1.16.1	The DSS shall evaluate the impact of enacted response plans.	F	1.16	DSS	Demonstrate
1.16.2	The DSS shall evaluate the impact on the transportation network of not enacting a response plan.	F	1.16	DSS	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.16.3	The DSS shall evaluate the impact on the transportation network of alternative response plans not enacted.	F	1.16	DSS	Demonstrate
1.17.1	The DSS shall monitor the performance of enacted response plans.	F	1.17	DSS	Demonstrate
1.17.2	The DSS shall provide an interface to the IEN to allow it to send a proposed updated response plan to the ICM Manager.	I	1.17	DSS	Demonstrate
1.17.3	The DSS shall provide an interface to the IEN to allow it to send a proposed updated response plan to agency users.	I	1.17	DSS	Demonstrate
1.18.1	The DSS shall send updated response plans to the DFE for storage.	D	1.18	DSS	Demonstrate
1.18.2	The DSS shall send the history of changes to response plans to the DFE for storage.	D	1.18	DSS	Demonstrate
1.19.15	The DSS shall evaluate traffic signal timing plans for specified arterial corridors.	F	1.19	DSS	Demonstrate
1.20.1	The DSS shall receive agency status from the DSS Agency Interface of the DFE as defined in data dictionary.	D	1.20	DSS	Demonstrate
1.20.2	The DSS shall receive historical data from the DFE.	D	1.20	DSS	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.20.3	The DSS shall provide the information to the IEN to allow a user to select a response plan recommendation based on the response plan list.	F	1.20	DSS	Demonstrate
1.21.1	The DSS shall evaluate ramp metering strategies for metered on-ramps.	F	1.21	DSS	Demonstrate
1.22.1	The DSS shall allow users to develop new response plans via the IEN and send the response plans to the DFE to be added to the response plan repository.	F	1.22	DSS	Demonstrate
1.22.2	The DSS shall evaluate new response plans.	F	1.22	DSS	Demonstrate
1.40.1	The DSS shall sent the prediction model accuracy to the DFE to be stored.	F	1.40	DSS	Demonstrate
1.45.1	The DSS shall provide a set of recommended response plans within 2 minutes of receiving a trigger to select alternative response plans from the modeling engine exclusive of time spent simulating the results of applying the response plans,	F	1.45	DSS	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
	The DSS shall store the following time stamps: • Start of evaluation of conditions • Evaluation completion, • Response plan set selection, • Simulation completion, • Simulation results stored in the DFE,				
1.45.2	• Response plan set display to the ICM Manager, • Response plan selection, • Response Plan delivery to agency operators, • Response plan approval, • Delivery of response plan to the SunGuide software for any iterations that result in a response plan implementation.	F	1.45	DSS	Demonstrate

3.3.3 Expert Rules Engine

3.3.3.1 Definition

The expert rules engine provides the rules that are used to dictate the logic for selections made by the DSS. The primary software component of the expert rules engine is the DSS manager. The DSS manager is essentially the liaison between the DFE, the prediction engine, and the rules engine software component.

The expert rules engine provides recommended response plans based on network conditions, predicted conditions, and a defined set of rules.

The expert rules engine begins with an assessment of existing roadway conditions. It develops that assessment based on monitoring of incidents through the DFE and through monitoring of roadway conditions (such as speeds). The prediction engine also uses this assessment of roadway conditions by submitting modeling tasks to the Modeling Engine. Candidate response plans may also be evaluated using the Modeling Engine. The expert rules engine selects the recommended response plans based on existing roadway conditions, predicted future system performance, and potentially the predicted performance of candidate response plans.

Once a recommended candidate response plan has been developed and authorized by the ICM Manager via the IEN, that plan is communicated to agency users through the IEN.

3.3.3.2 Inputs/Outputs

- Current network conditions data, such as highway link speeds and volumes, arterial speeds, and event data, will be provided by the DFE.
- Recommended response plans will be provided to the IEN for distribution to agency users.
- Expert rules, static plan information and static network needed for DSS will be provided by the DFE.

3.3.3.3 Data Stores

- The ERE is a component of the business layer of the ICMS and does not store data locally. Data is provided by the DFE and sent to the DFE for storage.

3.3.3.4 Dependencies/Constraints

- All current network data for transportation system performance and operations will be provided by the DFE.

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

- Static data for the network representation, rules, and other parameters will be updated periodically in DFE.

3.3.3.5 Expert Rules Engine Requirements

Table 10: Expert Rules Engine Requirements

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.1.1	The ERE shall receive DMS status data from the DFE.	D	1.2.1	ERE	Demonstrate
1.2.1.2	The ERE shall receive traffic signal status data from the DFE.	D	1.2.1	ERE	Demonstrate
1.2.1.3	The ERE shall receive parking availability data from the DFE.	D	1.2.1	ERE	Demonstrate
1.2.1.4	The ERE shall receive weather alerts from the DFE.	D	1.2.1	ERE	Demonstrate
1.2.1.6	The ERE shall receive ramp meter status data from the DFE.	D	1.2.1	ERE	Demonstrate
1.2.1.7	The ERE shall receive advanced transportation management systems detector status data from the DFE.	D	1.2.1	ERE	Demonstrate
1.2.2.1	The ERE shall receive incident data from the DFE.	D	1.2.2	ERE	Demonstrate
1.2.2.3	The ERE shall receive special event data from the DFE.	D	1.2.2	ERE	Demonstrate
1.2.2.5	The ERE shall receive planned special event data from the DFE.	D	1.2.2	ERE	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.2.3.1	The ERE shall receive bus (transit) global positioning system (GPS)/ AVL data from the DFE.	D	1.2.3	ERE	Demonstrate
1.2.3.2	The ERE shall receive SunRail GPS/ AVL data from the DFE.	D	1.2.3	ERE	Demonstrate
1.2.4.1	The ERE shall receive link speed data from the DFE.	D	1.2.4	ERE	Demonstrate
1.2.4.2	The ERE shall receive link travel time data from the DFE.	D	1.2.4	ERE	Demonstrate
1.2.4.3	The ERE shall receive link volume data from the DFE	D	1.2.4	ERE	Demonstrate
1.9.1.1	The ERE shall send pre-agreed response plans to the DFE for storage.	F	1.9.1	ERE	Demonstrate
1.9.1.2	The ERE shall provide the Prediction Engine with pre-agreed response plans.	F	1.9.1	ERE	Demonstrate
1.9.1.3	The ERE shall provide the Evaluation Engine with pre-agreed response plans.	F	1.9.1	ERE	Demonstrate
1.9.2.1	The Expert Rules Engine shall provide the DSS Administrator via the IEN the capability to add pre-agreed incident response plans for a specified incident to the DFE.	F	1.9.2	ERE	Demonstrate
1.9.3.1	The Expert Rules Engine shall provide the DSS Administrator via the IEN the capability to query pre-agreed incident response plans.	F	1.9.3	ERE	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.9.4.1	The Expert Rules Engine shall provide the DSS Administrator via the IEN the capability to edit pre-agreed incident response plans for a specified incident.	F	1.9.4	ERE	Demonstrate
1.9.5.1	The Expert Rules Engine shall provide the DSS Administrator via the IEN the capability to delete pre-agreed incident response plans for specified events.	F	1.9.5	ERE	Demonstrate
1.19.15.1	The Expert Rules Engine shall send recommended traffic signal timing plans to the Prediction Engine for evaluation.	F	1.19.15	ERE	Demonstrate
1.19.15.2	The Expert Rules Engine shall send recommended traffic signal timing plans to the Evaluation Engine.	F	1.19.15	ERE	Demonstrate
1.19.15.3	The Expert Rules Engine shall provide the Prediction Engine with identified corridors for optimization of traffic signal timing plans.	F	1.19.15	ERE	Demonstrate
1.20.3.2	The ERE shall get response plans from the DFE.	F	1.20.3	ERE	Demonstrate
1.20.3.3	The ERE shall determine if and which response plans should be evaluated by the Prediction Engine.	F	1.20.3	ERE	Demonstrate
1.20.3.4	The ERE shall send a set of recommended response plans to the Prediction Engine for evaluation.	F	1.20.3	ERE	Demonstrate
1.20.3.5	The ERE shall receive predicted network condition from the Prediction Engine.	F	1.20.3	ERE	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.20.4.1	The ERE shall send a set of recommended response plans to the IEN.	F	1.20.4	ERE	Demonstrate
1.20.4.2	The ERE shall receive agency status data from the IEN.	F	1.20.4	ERE	Demonstrate
1.20.4.3	The ERE shall send an agency status request to the IEN.	F	1.20.4	ERE	Demonstrate
1.22.1.2	The ERE shall make the engine parameters configurable to the system administrators through a graphical user interface (GUI) via the IEN.	I	1.22.1	ERE	Demonstrate

3.3.4 Prediction Engine Requirements

3.3.4.1 Definition

The PRE provides prediction of the transportation network within the Orlando region. The PRE will utilize an external Modeling Engine component to predict the conditions of the transportation network. The external Modeling Engine will return two types of prediction including future conditions (30 minutes) without any change in strategies implemented, and future conditions (30 minutes) with different response strategies.

3.3.4.1.1 Inputs/Outputs

- Inputs include data from the DFE. Some inputs may go directly from the DFE to the Modeling Engine.
- Outputs include Model Engine run outputs that are provided to the expert rules engine. Modeling Engine outputs may also be provided directly to the DFE.

3.3.4.1.2 Data Stores

The PRE is a component of the business layer of the ICMS and does not store data locally. Data is provided by the DFE and sent to the DFE for storage. The Modeling Engine may store historical data and network data to optimize simulation times.

3.3.4.1.3 Dependencies/Constraints

The prediction engine will use the external Modeling Engine validated during the project.

3.3.4.1.4 Use Case Diagram

The following use case diagram in Figure 5 illustrates the major activities of the prediction engine.

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS
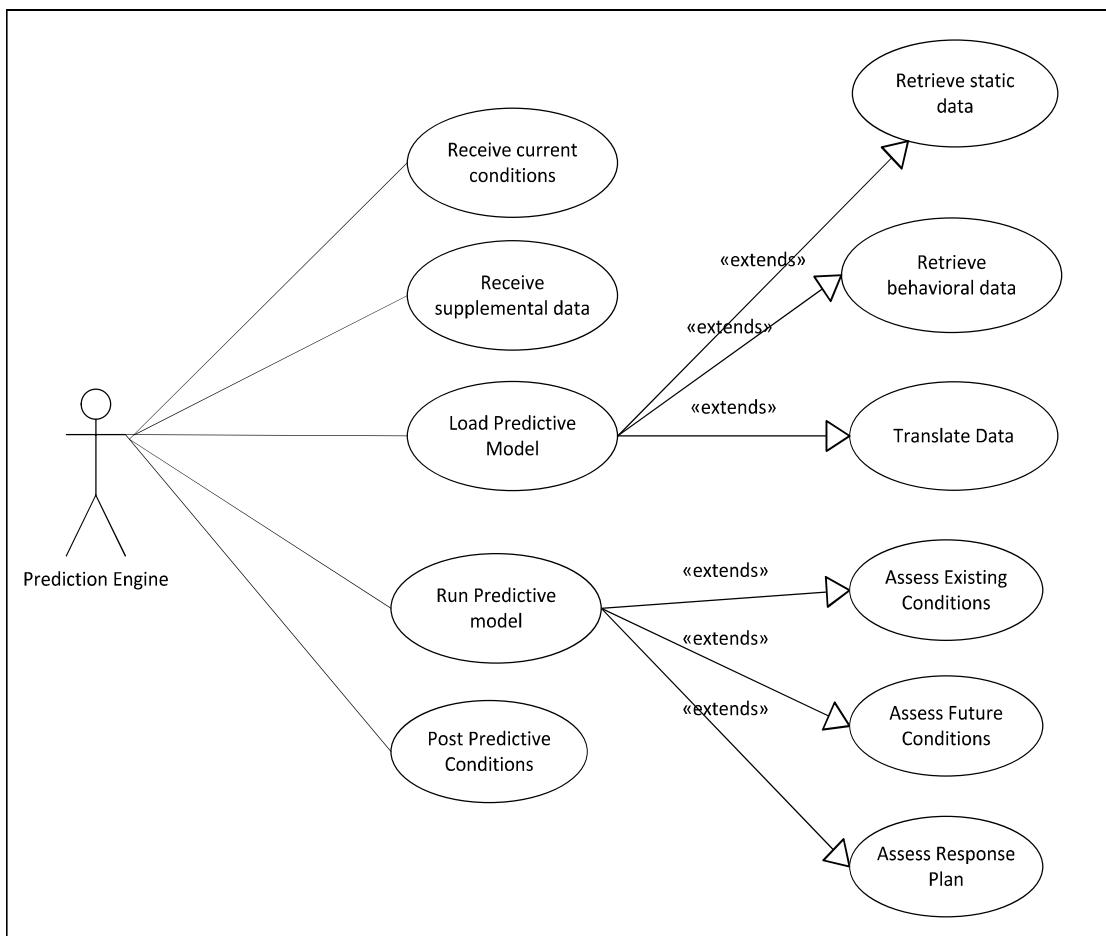
Figure 5: Prediction Engine Use Case Diagram

- Receive Current Conditions – The prediction engine receives dynamic data, such as link speeds and incident data, from the fused data in the DFE.
- Retrieve Plan Data – The prediction engine receives additional model parameters (such as recommended response plan and traffic signal plan and schedule) from the expert rules engine.
- Load Predictive Model – The Modeling Engine requires static data (such as a model specific network description), behavioral data (for instance, to represent the amount of driver diversion based on reading a DMS), and current roadway conditions data. This function populates the Modeling Engine with roadway conditions information. Some of this data may be stored in the Modeling Engine for efficiency.
- Run Modeling Engine – The prediction manager software component calls the Modeling Engine to assess current and future conditions and future conditions if plans are enacted.

3.3.4.2 Data Interfaces

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3.3.4.3   Prediction Engine Requirements

Table 11: Prediction Engine Requirements

Requirement Number	Requirement Text	Type	Parent Requirement	System	Reference	Verification
1.2.1.8	The Prediction Engine shall receive DMS status data from the DFE as defined in the data dictionary.	D	1.2.1	PRE		Demonstrate
1.2.1.9	The PRE shall receive traffic signal status data from the DFE as defined in the data dictionary.	D	1.2.1	PRE		Demonstrate
1.2.1.10	The PRE shall receive parking availability data from the DFE as defined in the data dictionary.	D	1.2.1	PRE		Demonstrate
1.2.1.11	The PRE shall receive weather alerts from the DFE as defined in the data dictionary.	D	1.2.1	PRE		Demonstrate
1.2.1.13	The PRE shall receive ramp meter status data from the DFE as defined in the data dictionary.	D	1.2.1	PRE		Demonstrate
1.2.1.14	The PRE shall receive static SunGuide data from the DFE as defined in the data dictionary.	D	1.2.1	PRE		Demonstrate
1.2.1.15	The PRE shall receive static traffic signal data from the DFE as defined in the data dictionary.	D	1.2.1	PRE		Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Reference	Verification
1.2.2.6	The PRE shall receive incident data from the DFE.	D	1.2.2	PRE		Demonstrate
1.2.2.8	The PRE shall receive special event data from the DFE special.	D	1.2.2	PRE		Demonstrate
1.2.2.10	The PRE shall receive planned special event data from the DFE.	D	1.2.2	PRE		Demonstrate
1.2.3.3	The PRE shall receive bus (Transit) GPS/ AVL data from the DFE as defined in the data dictionary.	D	1.2.3	PRE		Demonstrate
1.2.3.4	The PRE shall receive SunRail GPS/AVL data from the DFE as defined in the data dictionary.	D	1.2.3	PRE		Demonstrate
1.2.3.5	The PRE shall receive static SunRail data from the DFE as defined in the data dictionary.	D	1.2.3	PRE		Demonstrate
1.2.3.6	The PRE shall receive static LYNX data from the DFE as defined in the data dictionary.	D	1.2.3	PRE		Demonstrate
1.2.4.4	The PRE shall receive link speed data from the DFE as defined in the data dictionary.	D	1.2.4	PRE		Demonstrate
1.2.4.5	The PRE shall receive link travel time data from the DFE as defined in the data dictionary.	D	1.2.4	PRE		Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Reference	Verification
1.2.4.6	The PRE shall collect segment travel times from the simulation engine for mapping and evaluation.	D	1.2.4	PRE		Demonstrate
1.2.4.7	The PRE shall receive link volume data from the DFE as defined in the data dictionary.	D	1.2.4	PRE		Demonstrate
1.19.15.4	The PRE shall send traffic signal timing plan recommendations to the Expert Rules Engine.	D	1.19.15	PRE		Demonstrate
1.19.15.5	The PRE shall generate traffic signal timing plan recommendations for defined alternative arterial corridors.	D	1.19.15	PRE		Demonstrate
1.20.1.1	The PRE shall receive agency status from the DFE as defined in the data dictionary.	D	1.20.1	PRE		Demonstrate
1.20.2.1	The PRE shall receive historical data from the DFE.	D	1.20.2	PRE		Demonstrate
1.20.3.3	The PRE shall request future network conditions for the "do nothing" case from the external Modeling Engine.	F	1.20.3	PRE		Demonstrate
1.20.3.4	The PRE shall request future network conditions for a set of proposed response plans from the external Modeling Engine.	F	1.20.3	PRE		Demonstrate
1.20.3.5	The PRE shall evaluate the predicted transportation network conditions to compute the performance measures.	F	1.20.3	PRE		Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Reference	Verification
1.20.3.6	The PRE shall compare the forecasted performances against field measurements received once the prediction period has passed.	F	1.20.3	PRE		Demonstrate
1.20.3.7	The PRE shall provide operational measures of effectiveness (MOE) with each response plan prediction to Evaluation Engine.	F	1.20.3	PRE		Demonstrate
1.20.3.12	The PRE shall request predictions with a rolling horizon of 30 minutes in the future from the external Modeling Engine.	F	1.20.3	PRE		Demonstrate
1.20.3.13	The PRE shall request the evaluation of response plans developed for the area near an incident.	F	1.20.3	PRE		Demonstrate
1.20.3.14	The PRE shall provide MOEs for each evaluated response plan for a 10, 15, and 30-minute time horizon.	F	1.20.3	PRE		Demonstrate
1.20.3.16	The PRE shall send data between the DFE and the simulation engine to include response elements, and changes thereof, of the following types: ○ Signal Timing Plans ○ DMS messages ○ Connected Vehicle Travel Information Messages ○ Ramp Metering ○ Lane Control Sign (Hard Shoulder Running)	F	1.20.3	PRE		Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Reference	Verification
1.20.3.17	The PRE shall provide prediction quality summary reports.	F	1.20.3	PRE		Demonstrate
1.22.1.3	The PRE shall include a planning tool to develop new response plans.	I	1.22.1	PRE		Demonstrate
1.22.1.4	The PRE shall be capable of requesting that the external Modeling Engine evaluate new response plans.	F	1.22.1	PRE		Demonstrate
1.40.1.1	The PRE shall receive a calculated Geoffrey E. Havers (GEH) statistic for each prediction.	F	1.40.1	PRE		Demonstration
1.40.1.3	The PRE shall calculate the travel time accuracy for each prediction for the mapped traffic time route segments.	F	1.40.1	PRE		Demonstration

3.3.5 Evaluation Engine Subsystem

The evaluation engine uses historical data, static network data, and real-time data to calculate the various MOEs that are used to evaluate the performance of the system.

3.3.5.1 Inputs/Outputs

- Inputs: Past, current, and predicted network conditions, such as highway link speeds and volumes, arterial speeds, plan decisions, and event data, will be provided by the DFE.
- Outputs: MOEs for response plans.

3.3.5.2 Data Stores

- The EVE is a component of the business layer of the ICMS and does not store data locally. Data is provided by the DFE and sent to the DFE for storage.

3.3.5.3 Use Case Diagram

The use case shown in Figure 6 illustrates the basic high-level activities of the evaluation engine.
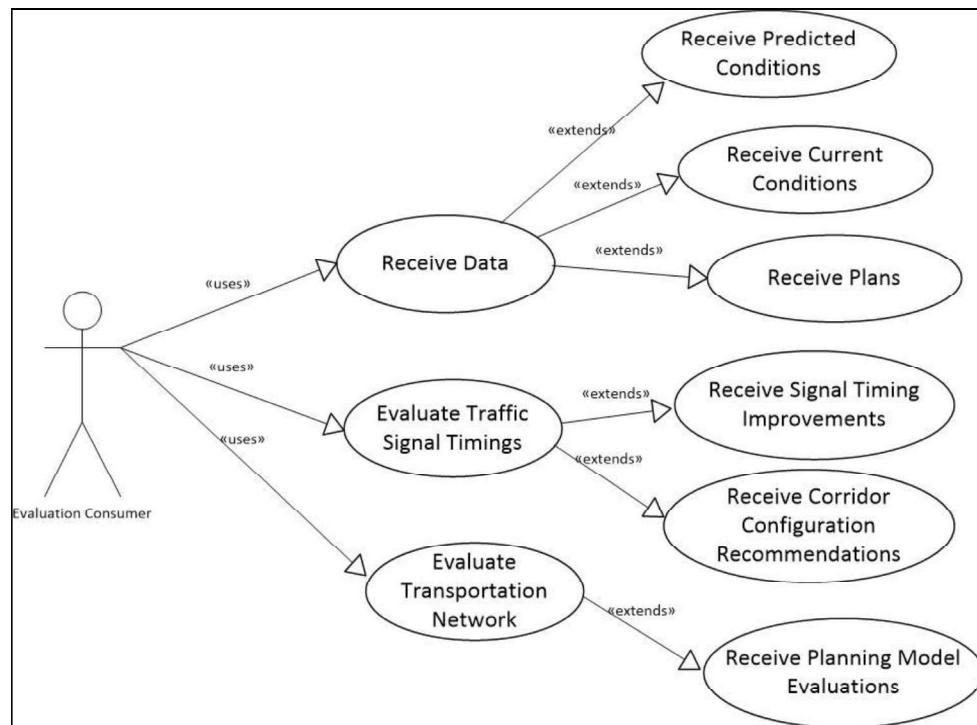

Figure 6: Evaluation Use Case

The evaluation engine retrieves historical data from several sources and makes it available to others for analysis.

- Receive Data – The evaluation engine provides a unified interface for evaluation consumers to receive data.
- Receive Predicted Conditions – At the request of an evaluation consumer, the evaluation engine retrieves stored prediction data from the DFE.
- Receive Current Conditions – At the request of an evaluation consumer, the evaluation engine retrieves current condition data from the DFE.
- Receive Plans – At the request of an evaluation consumer, the evaluation engine requests the disposition of response plans from the DFE.

Table 12: Evaluation Engine Use Case Description

Use Case ID	1.1.4.01
Description	The evaluation engine provides performance measures on the effectiveness of response plans that were implemented as part of the system.
Actors	Evaluation Consumer
Preconditions	1. The DFE provides fused current roadway conditions data. 2. Model-specific static and behavioral data are provided by the DFE. 3. The evaluation engine develops or receives performance measures.
Post Conditions	The evaluation engine is provided an assessment of the effectiveness of response plans implemented.
Normal Course of Events	1. Existing conditions data is collected from the DFE. 2. The Evaluation Engine evaluates the current and predicted conditions 3. The Evaluation Engine provides the evaluators, via the IEN, an the information neede to evaluate candidate response plans.

3.3.5.4 Sequence Diagram

The sequence diagram shown in Figure 7 describes a high-level sequence of activities performed by the evaluation engine.

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS
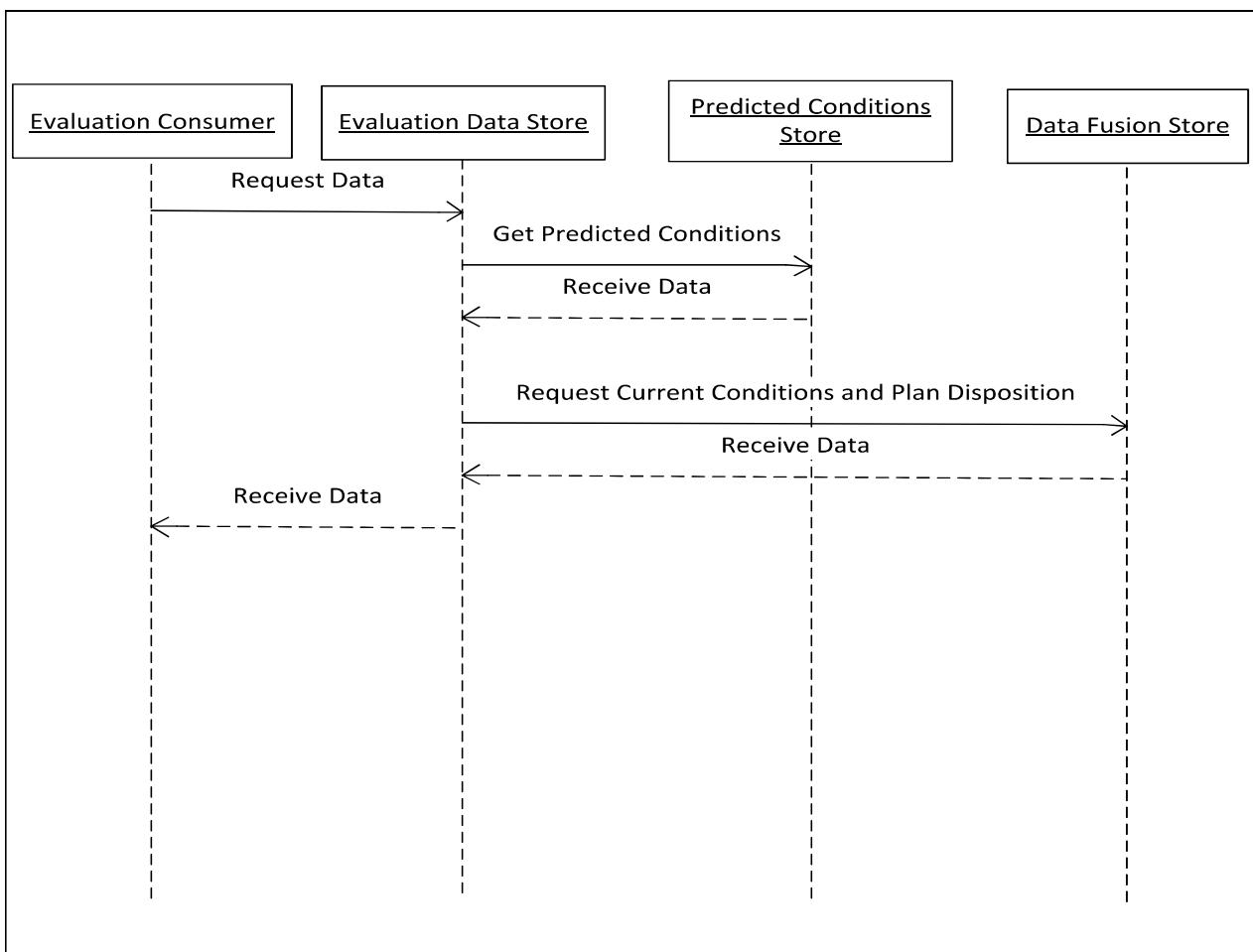
Figure 7: Evaluation Engine Sequence Diagram

The evaluation engine performs the following sequence of activities to evaluate a plan response to existing conditions:

1. The evaluation software component (evaluation consumer) requests data from the evaluation data store.
2. The evaluation data store requests predicted conditions from the prediction data store.
3. The evaluation data store requests current conditions and plan dispositions from the data store engine.

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3.3.5.5 Evaluation Engine Requirements

Table 13: Evaluation Engine Requirements

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.16.1.1	The EVE shall receive ITS infrastructure status data from the DFE.	F	1.16.1	EVE	Demonstrate
1.16.1.2	The EVE shall receive event data from the DFE.	F	1.16.1	EVE	Demonstrate
1.16.1.3	The EVE shall receive transit data from the DFE.	F	1.16.1	EVE	Demonstrate
1.16.1.4	The EVE shall receive transportation network data from the DFE.	F	1.16.1	EVE	Demonstrate
1.16.1.5	The EVE shall evaluate the measures of performance for enacted response plans.	F	1.16.1	EVE	Demonstrate
1.16.1.6	The EVE shall send calculated performance measures to the DFE.	F	1.16.1	EVE	Demonstrate
1.16.2.5	The EVE shall evaluate the measures of performance for the transportation network without implementing a response plan.	F	1.16.2	EVE	Demonstrate
1.16.2.7	The EVE shall receive predicted link status data from the Prediction Engine for the do nothing scenario.	F	1.16.2	EVE	Demonstrate
1.16.2.8	The EVE shall receive predicted node status data from the Prediction Engine for the do nothing scenario.	F	1.16.2	EVE	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.16.3.5	The EVE shall receive the predicted node status data from the Prediction Engine for the response plan scenarios.	F	1.16.3	EVE	Demonstrate
1.16.3.6	The EVE shall receive the predicted link status data from the Prediction Engine for the response plan scenarios.	F	1.16.3	EVE	Demonstrate
1.16.3.7	The EVE shall receive the predicted route status data from the Prediction Engine for the response plan scenarios.	F	1.16.3	EVE	Demonstrate
1.16.3.8	The EVE shall evaluate the measures of performance for the transportation network for alternative response plans.	F	1.16.3	EVE	Demonstrate
1.16.3.9	The EVE shall send calculated performance measures to the DFE.	F	1.16.3	EVE	Demonstrate

3.3.5.6 Signal Optimization Tool

The Signal Optimization Tool (SOT) analyzes pre-defined corridors to determine if a new, more efficient timing plan is required. The tool can be used to view recommended timing plans as well as allow users to analyze and create a new timing plan.

Table 14: Signal Optimization Tool Requirements

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.1	The SOT will allow users to enter comments.	F	1.25.1	SOT	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.2	The SOT will automatically analyze Corridors to determine a more efficient set of timing plans.	F	1.25.1	SOT	Demonstrate
1.25.1.2.1	The automation cycle shall be configurable by a user with the appropriate permissions.	F	1.25.1.2	SOT	Demonstrate
1.25.1.3	The SOT shall have varying level of user groups	F	1.25.1	SOT	Demonstrate
1.25.1.3.1	Users can be added to the different group by a system administrator	F	1.25.1.3	SOT	Demonstrate
1.25.1.3.2	The user groups shall include, but not be limited to Traffic Signal Engineer, ICM Manager, Operator, Analyst, and others.	F	1.25.1.3	SOT	Demonstrate
1.25.1.3.3	Each user group shall have an assigned set of permissions.	F	1.25.1.3	SOT	Demonstrate
1.25.1.3.4	The ICM Manager shall be able to modify and read permissions.	F	1.25.1.3	SOT	Demonstrate
1.25.1.3.5	The ICM Manager and the Traffic Signal Engineer shall have the right to approve or deny recommended changes.	F	1.25.1.3	SOT	Demonstrate
1.25.1.3.6	Analysts shall have the right to change signal timing plans and submit them for approval.	F	1.25.1.3	SOT	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.4	Approved plans must be digitally signed by a Professional Engineer.	F	1.25.1	SOT	Demonstrate
1.25.1.4.1	PE Digital signatures must be in accordance with Florida State law.	F	1.25.1.4	SOT	Demonstrate
1.25.1.5	Subscribed users shall receive notifications about recommended signal timing plans via email as well as the information feed.	F	1.25.1	SOT	Demonstrate
1.25.1.6	Clicking on the recommended signal plan on the information feed will take the user to that specific timing plan.	F	1.25.1	SOT	Demonstrate
1.25.1.7	The SOT will have a home page	F	1.25.1	SOT	Demonstrate
1.25.1.7.1	The SOT home page will display a table of corridors with the latest set of recommendations.	F	1.25.1.7	SOT	Demonstrate
1.25.1.7.1.2	The recommendation table shall include the name of the corridor, requested by, analysis date/time pattern, FIT, applicability, level of service, delay MOE and associated agencies.	F	1.25.1.7.1	SOT	Demonstrate

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.7.1.3	The "requested by" column shall display by whom the recommended plans were created. i.e., by the system or by an individual user.	F	1.25.1.7.1	SOT	Demonstrate
1.25.1.7.2	The SOT home page shall include a scalable map feature displaying corridors with optimization recommendations	F	1.25.1.7	SOT	Demonstrate
1.25.1.7.3	The SOT home page shall provide the ability for users to perform additional analysis via a corridor analysis interface.	F	1.25.1.7	SOT	Demonstrate
1.25.1.7.4	The SOT home page will provide the ability for the user to select a corridor.	F	1.25.1.7	SOT	Demonstrate
1.25.1.8	The SOT will have a corridor recommendation page.	F	1.25.1	SOT	Demonstrate
1.25.1.8.1	The corridor recommendation page shall display a heat map for the following MOE: • FIT Improvement% • Travel Time • Speed • Queue • Delay • Level of Service (LOS).	F	1.25.1.8	SOT	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.8.2	Metrics shown on the page shall correspond to the period selected by the user.	F	1.25.1.8	SOT	Demonstrate
1.25.1.8.3	The page shall display a table which consists of intersection, FIT improvement, applicability, level of service, delay, agencies, and action.	F	1.25.1.8	SOT	Demonstrate
1.25.1.8.3.1	The first row of the table shall display the aggregate corridor results.	F	1.25.1.8.3	SOT	Demonstrate
1.25.1.8.3.2	The aggregated corridor row shall include an action to allow the user to navigate to the Offset details page.	F	1.25.1.8.3	SOT	Demonstrate.2
1.25.1.8.3.3	Rows after that shall display the individual intersection details.	F	1.25.1.8.3	SOT	Demonstrate.3
1.25.1.8.3.4	Each intersection shall have a details button linked to the intersection details page	F	1.25.1.8.3	SOT	Demonstrate
1.25.1.8.3.5	Detail buttons shall be color coded to display the state of the review.	F	1.25.1.8.3	SOT	Demonstrate
1.25.1.8.4	The corridor recommendation page shall provide a way to generate summary reports.	F	1.25.1.8	SOT	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.8.4.1	The corridor summary report shall allow users to select elements to include in the report. Elements shall include but not be limited to MOEs, Metrics, individual intersections within the corridor, and agencies.	F	1.25.1.8.4	SOT	Demonstrate
1.25.1.8.4.2	The user will have the ability to select the time of day pattern from AM, PM, off-peak, or 24 hours as part of the report.	F	1.25.1.8.4	SOT	Demonstrate
1.25.1.8.4.3	Selected timing plan details will be displayed in the report.	F	1.25.1.8.4	SOT	Demonstrate
1.25.1.9	The Corridor Offset Details page shall provide a drop-down menu for selecting a recommended or existing timing plan	F	1.25.1	SOT	Demonstrate
1.25.1.9.1	The Corridor Offset Details page shall include a scrollable Time Space diagram.	F	1.25.1.9	SOT	Demonstrate
1.25.1.9.2	The corridor intersection offset details shall be provided in a table, include but not limited to name, offset, and agency.	F	1.25.1.9	SOT	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.9.3	The Time Space Diagram should provide users the ability to modify individual intersection offsets.	F	1.25.1.9	SOT	Demonstrate
1.25.1.9.4	Users will be able to recommend, approve and digitally sign the signal offset recommendations or modifications.	F	1.25.1.9	SOT	Demonstrate
1.25.1.9.5	If modifications have been made to the recommended plan by a user with the appropriate permission, it must be submitted for review.	F	1.25.1.9	SOT	Demonstrate
1.25.1.9.6	When the user clicks save, an alert is displayed providing them the option of re-running the calculations.	F	1.25.1.9	SOT	Demonstrate
1.25.1.9.7	When a modified plan is submitted for review, a notification is sent to the identified approvers for the corridor.	F	1.25.1.9	SOT	Demonstrate
1.25.1.10	The SOT shall contain a details page for each intersection.	F	1.25.1	SOT	Demonstrate
1.25.1.10.1	The intersection details page shall provide a detail geometric layout.	F	1.25.1.10	SOT	Demonstrate
1.25.1.10.2	The user will have the ability to select the time of day pattern from AM, PM, or off-peak.	F	1.25.1.10	SOT	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.10.3	For the selected time period, a table shall present the recommended plans compared to the existing plans. It will provide activate time, the FIT and the applicability of each plan, where applicability is the percentage [of the intervals for which that plan will be used] of the total number of intervals.	F	1.25.1.10	SOT	Demonstrate
1.25.1.10.4	By selecting a time plan from the table, a split diagram is displayed for the signal within that plan.	F	1.25.1.10	SOT	Demonstrate
1.25.1.10.4.1	Split diagram will display both the effective green time and the available green time, and provide the present breakdown for each phase.	F	1.25.1.10.4	SOT	Demonstrate
1.25.1.10.4.2	The user will be able to make modifications to the split diagram by sliding the splits.	F	1.25.1.10.4	SOT	Demonstrate
1.25.1.10.4.3	The user will be able to save or undo the modification.	F	1.25.1.10.4	SOT	Demonstrate
1.25.1.10.4.4	Previous versions of the timing plan shall be added to the table allowing the user to revisit.	F	1.25.1.10.4	SOT	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.25.1.11	The SOT main page will provide the ability for users to request a new optimization from the SOT.	F	1.25.1	SOT	Demonstrate
1.25.1.11.1	Users will be able to select the time window for source data to be analyzed, examples – last week, last month, last quarter.	F	1.25.1.11	SOT	Demonstrate
1.25.1.11.2	Users will be able to select the time period to be analyzed, examples – AM, PM, Off-Peak, 24-hour.	F	1.25.1.11	SOT	Demonstrate
1.25.1.11.3	Users will select the corridor to be analyzed through the use of a drop down list.	F	1.25.1.11	SOT	Demonstrate
1.25.1.11.4	Users will select whether special days will be included in the source data or not	F	1.25.1.11	SOT	Demonstrate
1.25.1.12	Newly analyzed corridors will be added to the recommended table on the main page should an improvement be found.	F	1.25.1	SOT	Demonstrate
1.25.1.13	Recommended corridor plans should be archived and retrievable by users.	F	1.25.1	SOT	Demonstrate

3.3.6 Information Exchange Network Subsystem

3.3.6.1 Inputs/Outputs

Inputs represent event data, object status and inventory updates, plan recommendations and approvals. Outputs represent the same data as inputs. All data received in the data store is made available to the DSS Agency User Interface Subsystem and includes:

- Operational user input of incidents;
- Inputs received from the data store including incidents and special events;
- Inputs received from the plan decision associated with recommended response plans.

3.3.6.2 Data Stores

The IEN is the presentation layer of the ICMS and does not store data locally. Data is provided by the DSS and sent to the DSS for storage within the DFE. Some data may be accessed directly from the DFE.

Data accessed by the IEN include the following:
- Events and associated status, and alarms;
- Organization settings;
- User settings including login and password information;
- Event, object, and static network data for the CFR-ICMS system.

3.3.6.3   Sequence Diagram

The sequence diagram shown in Figure 8 describes a high-level sequence of activities performed by the IEN.

System/Subsystem Minimum Technical Requirements for the Central Florida Regional ICMS
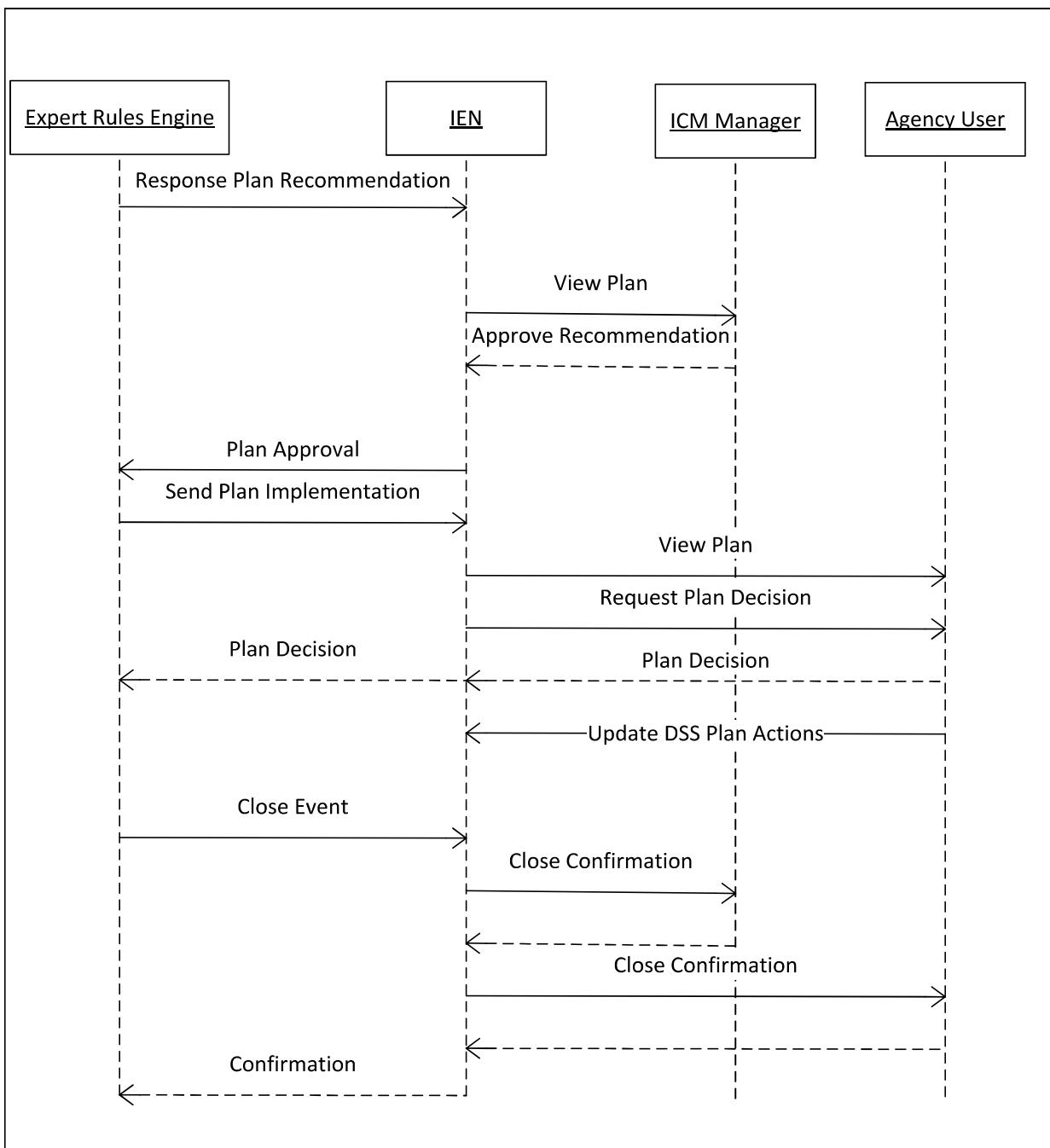
Figure 8: IEN Sequence Diagram

3.3.6.4 Information Exchange Network Requirements

Table 15: Information Exchange Network Requirements

Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.1	The IEN shall provide agency users the capability to view current status of the transportation network.	F	1.1	IEN	Demonstrate
1.1.1.1	The IEN shall provide an event list that shall allow an agency user the capability to view open, unconfirmed, and recently closed incidents in the region on the covered facilities.	F	1.1.1	IEN	Demonstrate
1.1.1.3	The IEN shall provide an event list that shall allow an agency user the capability to view all open and recently closed special events in the region on the covered facilities.	F	1.1.1	IEN	Demonstrate
1.1.1.4	The IEN event list shall contain the following fields, as available: • Status • Location • Start and End Date • Organization • Owner • Type • Severity • Code • Description	F	1.1.1	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.1.5	The IEN event list shall allow for a user to select an event from the list and view it on the map.	F	1.1.1	IEN	Demonstrate
1.1.1.6	The IEN event list shall allow for a user to select an event from the list and view/edit events in the event detail form.	F	1.1.1	IEN	Demonstrate
1.1.1.7	The IEN event list shall allow a user to filter events by the following categories, as available: • Dates • Organization • Event Category • Event Type • Severity	F	1.1.1	IEN	Demonstrate
1.1.1.8	The IEN event list shall allow for a user to create custom filters to filter events into/from their event list.	F	1.1.1	IEN	Demonstrate
1.1.1.9	The IEN event list shall allow for a user to search the event list for a specific string of text.	F	1.1.1	IEN	Demonstrate
1.1.1.10	The IEN shall refresh the Event list in real time, based on event updates on the system.	F	1.1.1	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.1.11	The IEN shall allow an agency user to create an event list report from the event list tab.	F	1.1.1	IEN	Demonstrate
1.1.2	The IEN shall receive current status of the transportation network.	F	1.1	IEN	Demonstrate
1.1.2.1	The IEN shall receive DMS data from the DFE.	F	1.1.2	IEN	Demonstrate
1.1.2.2	The IEN shall receive CCTV data from the DFE.	F	1.1.2	IEN	Demonstrate
1.1.2.4	The IEN shall receive transit vehicle location data from the DFE.	F	1.1.2	IEN	Demonstrate
1.1.2.5	The IEN shall receive weather data from the DFE.	F	1.1.2	IEN	Demonstrate
1.1.2.6	The IEN shall receive incident data from the DFE.	F	1.1.2	IEN	Demonstrate
1.1.2.7	The IEN shall receive parking data from the DFE.	F	1.1.2	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.2.9	The IEN shall receive link dynamic data from the DFE	F	1.1.2	IEN	Demonstrate
1.1.2.11	The IEN shall receive special event data from the DFE.	F	1.1.2	IEN	Demonstrate
1.1.3	The IEN shall allow an agency user to login via a web browser.	D	1.1	IEN	Demonstrate
1.1.4	The IEN shall provide the capability to administer user privileges.	F	1.1	IEN	Demonstrate
1.1.4.1	The IEN shall notify an agency user when the user's login request is rejected due to invalid credentials.	F	1.1.4	IEN	Demonstrate
1.1.4.3	The IEN shall allow for single sign on for authentication requests.	F	1.1.4	IEN	Demonstrate
1.1.4.4	The IEN shall allow an agency user to modify their password.	F	1.1.4	IEN	Demonstrate
1.1.4.5	The IEN shall require minimum password requirements, such as alphanumeric characters, minimum length, special characters, and password expiration.	F	1.1.4	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.4.7	The IEN shall provide an administrative user the capability to configure at least 32 agencies in the system.	F	1.1.4	IEN	Demonstrate
1.1.4.8	The IEN shall provide an administrative user the capability to roll the list of configured agencies up to a list of eight groups with up to 16 agencies per group.	F	1.1.4	IEN	Demonstrate
1.1.28	The IEN shall provide the capability to select an approval profile for each agency.	F	1.1	IEN	Demonstrate
1.1.28.1	The IEN shall provide the capability to select a jurisdiction for each agency.	F	1.1.28	IEN	Demonstrate
1.1.28.1	The IEN shall provide the capability to add asset permissions to a jurisdiction.	F	1.1.28	IEN	Demonstrate
1.1.5.1	The IEN shall provide an administrative user the capability to create an agency user profile in the DFE.	F	1.1.5	IEN	Demonstrate
1.1.5.2	The IEN shall provide an agency user the capability to modify an agency user profile in the DFE.	F	1.1.5	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.5.3	The IEN shall provide an agency administrator the capability to deactivate an agency user profile in the DFE.	F	1.1.5	IEN	Demonstrate
1.1.1.1	The IEN shall provide agency users the capability to view current roadway conditions.	F	1.1.1	IEN	Demonstrate
1.1.1.2	The IEN shall provide agency users the capability to view current status of managed lane facilities in the corridor.	F	1.1.1	IEN	Demonstrate
1.1.5	The IEN shall provide an agency user the capability to manage events.	F	1.1	IEN	Demonstrate
1.1.6	The IEN shall provide an agency user the capability to send via email the incident description as defined in the data dictionary.	F	1.1	IEN	Demonstrate
1.1.5.1	The IEN shall provide an agency user the capability to create an incident event.	F	1.1.5	IEN	Demonstrate
1.1.5.6	The IEN shall provide an agency user the capability to modify an incident.	F	1.1.5	IEN	Demonstrate
1.1.5.7	The IEN shall provide an agency user the capability to close an incident.	F	1.1.5	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.5.10	The IEN shall provide an agency user the capability to create associated response plan actions for an incident.	F	1.1.5	IEN	Demonstrate
1.1.7	The IEN shall provide an agency user the capability to send via email the incident description as defined in the data dictionary.	F	1.1	IEN	Demonstrate
1.1.1.3	The IEN shall provide an agency user the capability to view information layers on a GIS-based map as defined in the data dictionary.	F	1.1.1	IEN	Demonstrate
1.1.1.4	The IEN GIS-based map shall allow for static and dynamic layers to be added or removed as necessary.	F	1.1.1	IEN	Demonstrate
1.1.1.4.1	Information icons on the GIS-based map shall be grouped when they overlap to avoid cluttering on the map.	F	1.1.1.4	IEN	Demonstrate
1.1.1.4.2	When information icons are grouped on the GIS-based map, the parent/grouped icon shall contain the number of nested icons that have been grouped to form the parent icon.	F	1.1.1.4	IEN	Demonstrate
1.1.1.4.3	A parent/grouped information icon shall, when clicked, display the nested icons along with color coding.	F	1.1.1.4	IEN	Demonstrate
1.1.1.4.4	Nested icons, when clicked, shall show the nested sub-icons, along with color coding.	F	1.1.1.4	IEN	Demonstrate
1.1.1.4.5	A nested icon, when clicked, shall display information associated with the clicked icon in the IEN.	F	1.1.1.4	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
	Icons representing devices shall display the status of the device they represent.				
1.1.1.5	The IEN shall provide an agency user the capability to view incident information in the corridor as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate
1.1.1.5.1	The IEN shall provide an agency user the capability to filter incidents based on specified data fields	F	1.1.1.5	IEN	Demonstrate
1.1.1.8	The IEN shall provide an agency user the capability to view active special event information in the corridor as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate
1.1.1.8.1	The IEN shall provide an agency user the capability to filter special events based on specified data fields.	F	1.1.1.8	IEN	Demonstrate
1.1.1.9	The IEN shall provide an agency user the capability to view planned special event information in the corridor as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate
1.1.1.9.1	The IEN shall provide an agency user the capability to filter planned special events based on specified data fields.	F	1.1.1.9	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.8	An event icon, when clicked, shall provide the following event information: • Timeline of Event (Event Start) • Lanes Affected • Last Updated Date/Time • Event Type • Event Location • Nearest CCTV	F	1.1	IEN	Demonstrate
1.1.9	The nearest CCTV to an event, when displayed in the event information GUI, shall be determined by searching a configurable radius X miles from the event, where X is a configurable value.	F	1.1	IEN	Demonstrate
1.1.11	The IEN shall provide an agency user the capability to view signal status information in the corridor as a selectable layer on a GIS-based map as available.	F	1.1	IEN	Demonstrate
1.1.13	The IEN shall provide agency users the capability to view transit vehicle locations as a selectable layer on a GIS-based map for passenger rail providers, denoted as a unique icon located at the last known position of the vehicle.	F	1.1	IEN	Demonstrate
1.1.16	The IEN shall provide agency users the capability to view transit vehicle locations as a selectable layer on a GIS-based map for transit providers, denoted as a unique icon located at the last known position of the vehicle.	F	1.1	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.19	The IEN shall provide agency users the capability to view the vehicle locations of up to 8 bus provider agencies in the region as a selectable layer on a GIS-based map.	F	1.1	IEN	Demonstrate
1.1.19.1	The IEN shall provide agency users the capability to view the location of bus transit vehicles for LYNX.	F	1.1.19	IEN	Demonstrate
1.1.19.2	The IEN shall provide agency users the capability to view the location of bus transit vehicles for Votran.	F	1.1.19	IEN	Demonstrate
1.1.20	The IEN shall provide agency users the capability to view the vehicle locations of up to 8 rail provider agencies in the region as a selectable layer on a GIS-based map.	F	1.1	IEN	Demonstrate
1.1.20.4	The IEN shall provide agency users the capability to view the location of rail transit vehicles for SunRail.	F	1.1.20	IEN	Demonstrate
1.1.23	The IEN shall provide agency users the capability to view on-street parking data in the region as a selectable layer on a GIS-based map, grouped by block, per direction.	F	1.1	IEN	Demonstrate
1.1.23.1	The IEN shall provide agency users the capability to view parking garage/surface lot data in the region as a selectable layer on a GIS-based map.	F	1.1.23	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.23.2	The IEN shall provide agency users the capability to view rest area/weigh station parking data in the region as a selectable layer on a GIS-based map.	F	1.1.23	IEN	Demonstrate
1.1.23.3	The IEN shall provide agency users the capability to view parking data in the region as a selectable layer on a GIS-based map.	F	1.1.23	IEN	Demonstrate
1.1.23.4	On-street parking shall be presented on the GIS-based map as polyline segments on the roadway at the corresponding geographic location.	F	1.1.23	IEN	Demonstrate
1.1.23.5	Sections of on-street parking shall be combined to form sections greater than a block if zoom level/resolution does not support the ability for a user to differentiate locations	F	1.1.23	IEN	Demonstrate
1.1.23.6	on-street parking spaces initially shall be grouped by block, and display the number of spaces and number of available spaces.	F	1.1.23	IEN	Demonstrate
1.1.23.6.1	For overlapping icons representing blocks of on-street parking, rather than grouping the icons, group the total number of spaces and available spaces	F	1.1.23.6	IEN	Demonstrate
1.1.23.7	Garage parking shall be presented on the GIS-based map as approximations of the representations of the building dimensions at the corresponding geographic location.	F	1.1.23	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.23.8	If a garage parking lot is too small to discern based on approximations of the representations of the building dimensions, the garage parking lot shall be presented on the GIS-based map in the form of an icon.	F	1.1.23	IEN	Demonstrate
1.1.23.10	Upon clicking a parking garage icon, garage color, or on-street parking block, the following information shall be provided: • Total number of spaces • Number of occupied spaces	F	1.1.23	IEN	Demonstrate
1.1.23.11	On-street parking segment polylines on the GIS-based map shall be color coded with up to 5 system-wide configurable values to indicate current occupancy, least occupied to most occupied.	F	1.1.23	IEN	Demonstrate
1.1.23.12	For rest areas, the number of spaces and the number of occupied spaces shall displayed with the same color scheme as above	F	1.1.23	IEN	Demonstrate
1.1.23.13	Beach parking shall be grouped by access points and shall conform to the requirements of a parking garage.	F	1.1.23	IEN	Demonstrate
1.1.23.14	Weigh station and rest area truck parking shall conform to the requirements of a parking garage.	F	1.1.23	IEN	Demonstrate
1.1.1.2	The IEN shall provide agency users the capability to view dynamic link data as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.1.3	Each link shall be clickable in the IEN GIS map and when clicked, shall display currently available data for speed, travel time, occupancy, or volume for the link – traffic conditions data as available	F	1.1.1	IEN	Demonstrate
1.1.1.4	The IEN shall provide an agency user the capability to view location, current status, and current message of DMS in the corridor as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate
1.1.1.5	The IEN shall provide an agency user the capability to view location, current status, and current image snapshot of CCTVs as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate
1.1.1.6	The IEN shall provide an agency user the capability to view location, current status, and timing plan of traffic signals as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate
1.1.1.7	The IEN shall provide an agency user the capability to view current weather alerts from the National Weather Service as a selectable layer on a GIS-based map.	F	1.1.1	IEN	Demonstrate
1.1.1.7.1	National Weather Service weather alerts shall be color coded to indicate the following alert types: • Fire • Flood • Hurricane • Thunderstorm • Tornado	F	1.1.1.7	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.1.7.2	The IEN shall provide an agency user the capability to view a weather radar overlay as a selectable layer on a GIS map.	F	1.1.1	IEN	Demonstrate
1.1.1.7.3	The IEN weather radar overlay shall be provided in a motion loop, indicating changing weather conditions in real-time.	F	1.1.1.7	IEN	Demonstrate
1.1.1.7.4	The IEN shall include a legend describing the weather alert types, and associated color codes.	F	1.1.1.7	IEN	Demonstrate
1.1.1.7.5	The weather alert legend color codes shall be configurable in the system to allow for changes to colors for the different conditions.	F	1.1.1.7	IEN	Demonstrate
1.1.1.7.6	The IEN shall include a legend describing the weather radar overlay rainfall intensities and associated color codes.	F	1.1.1.7	IEN	Demonstrate
1.1.1.7.7	The weather radar overlay legend color codes shall be configurable in the system to allow for changes to colors for the different conditions.	F	1.1.1.7	IEN	Demonstrate
1.1.3.1	The IEN shall provide an agency user the capability to create an approval profile.	F	1.1.3	IEN	Demonstrate
1.1.3.2	The IEN shall provide an agency user the capability to configure the system to automatically approve a response request after a period of time defined by the user.	F	1.1.3	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.3.3	The IEN shall provide an agency user the capability to configure the systems to automatically reject a response request after a period of time defined by the user.	F	1.1.3	IEN	Demonstrate
1.1.3.4	The IEN shall provide an agency user the capability to configure the system to automatically approve a response request during defined hours of the day after a period of time defined by the user.	F	1.1.3	IEN	Demonstrate
1.1.5.1	The IEN shall provide a logged on agency user with an alarm indicator when a response plan recommendation is made by the DSS	F	1.1.5	IEN	Demonstrate
1.1.5.1.1	The IEN shall provide a logged on agency user with a pop-up indicating when a response plan recommendation is made by the DSS.	F	1.1.5.1	IEN	Demonstrate
1.1.5.1.2	The IEN shall create an alarm once a response plan has been recommended by the DSS	F	1.1.5.1	IEN	Demonstrate
1.1.5.1.3	The IEN shall provide a user the capability to view an alarm	F	1.1.5.1	IEN	Demonstrate
1.1.5.1.4	The IEN shall provide a user the capability to confirm an alarm	F	1.1.5.1	IEN	Demonstrate
1.1.5.1.5	The IEN shall provide a user the capability to ignore an alarm	F	1.1.5.1	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.1.5.1.6	The IEN shall provide a user the capability to acknowledge an alarm	F	1.1.5.1	IEN	Demonstrate
1.1.5.1.7	The IEN shall provide a user the capability to open the event associated with the alarm	F	1.1.5.1	IEN	Demonstrate
1.1.1.7.8	The IEN shall provide an agency user with a pop-up indicating a National Weather Service weather alert.	F	1.1.1.7	IEN	Demonstrate
1.23.1	The IEN shall allow an agency user to run custom reports.	F	1.23	IEN	Demonstrate
1.23.2	The report component of the IEN shall be accessible via main menu navigation.	F	1.23	IEN	Demonstrate
1.23.2.1	The report component of the IEN shall be initially configured with, at a minimum, 6 report templates.	F	1.23.2	IEN	Demonstrate
1.23.2.2	The report component of the IEN shall allow for an administrative user to be able to add new reports after the system is deployed.	F	1.23.2	IEN	Demonstrate
1.23.2.3	The report component of the IEN shall provide the capability for a user to apply filters to filter data when running a report in the system.	F	1.23.2	IEN	Demonstrate
1.23.2.4	The report component of the IEN shall provide the capability for a user to generate a report in PDF, HTML, and Excel formats.	F	1.23.2	IEN	Demonstrate
1.24.1	The IEN shall provide the capability for a user to select a pre-defined dashboard.	F	1.24	IEN	Demonstrate

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Requirement Number	Requirement Text	Type	Parent Requirement	System	Verification
1.24.1.1	The IEN shall provide the capability for a user with the ability to configure the data displayed on a dashboard.	F	1.24.1	IEN	Demonstrate
1.25.1.15	The IEN shall include a menu item to open the SOT module.	F	1.25.1	IEN	Demonstrate

4 User Definitions

This section defines the terms and definitions used in the requirements document.

Real-time – receipt or calculation of conditions within 2 minutes of occurrence

Near real-time - receipt or calculation of conditions more than 2 minutes of occurrence, but within 30 minutes of occurrence

Status – condition of infrastructure

Active - not marked as out-of-order or in-maintenance

Link - the portion of a model connecting two nodes. The link is defined within the model as:
- Facility type
- Number of lanes
- Capacity per lane
- Speed limit
- Average jam density

Node – point of branching of physical connections, or terminating a physical connection within a simulation model

Average jam density - the maximum number of vehicles per unit length of the highway link

Intermodal network conditions – current status and state of modes of travel within the network

Consistency – the system's estimation error will fall within a pre-determined range

Real-world conditions – model capabilities to match conditions of actual network

Corridor management strategy – management plan for an event or incident within the corridor. These strategies include:
- Pre-trip and en-route traveler information provision
- Congestion pricing
- Traffic signal timing modification
- Transit service modification
- Transit signal priority
- Parking management and pricing
- Combinations of the above

Traffic management scheme – a traffic management scheme consists of the different actions that will be implemented by all agencies to manage the corridor. These actions are:

- List of DMS to be activated along with their messages
- Transit vehicle service pattern including any route and headway modifications
- Traffic signal timing plan(s) of all signalized intersections

Environment-oriented – factor relating to the environment of the system

4.1 Action Verbs and Terms

This section defines the action verbs and terms and definitions used in this requirements document.

Table 16: Action Verbs

VERB	DEFINITION
Accept	to receive (e.g. data feed from another system)
Activate	to make active; cause to function or act (e.g. to make a planned event an active incident)
Add	to add (e.g. add a timestamp to a record)
Aggregate	to bring together; collect into one
Allow	to give permission to or for
Authorize	to give authority or official power to (associated with security authentication requirement)
Collect	to get from source; assemble
Compare	to examine (two or more objects, ideas, people, etc.) in order to note similarities and differences
Compute	to determine or ascertain by mathematical or logical means
Confirm	to make valid or binding by some formal or legal act; sanction; ratify
Determine	to settle or decide (a dispute, question, etc.) by an authoritative or conclusive decision
Display	to output (data) on a monitor or other screen
Evaluate	to judge or determine the significance, worth, or quality of; assess
Execute	to run (a program or routine) or to carry out (an instruction in a program)
FIT	FIT is used as a calculation of nearness between a timing plan and an optimal timing plan for a given interval.
FIT Improvement	The difference between the FIT of two timing plans
Filter	to remove by the action of a filter
Generate	to bring into existence; cause to be; produce (erg. generate a log file)
Import	to bring (documents, data, etc.) into one software program from another, implies translate
Index	a value that identifies and is used to locate a particular element within a data array or table
Manage	to handle, direct, govern, or control in action or use (e.g. manage the add, change, delete of an object)
Merge	to combine or blend
Monitor	to watch closely for purposes of control, surveillance, etc.; keep track of; check continually
Notify	to inform (someone) or give notice to
Parse	to analyze (a string of characters) in order to associate groups of characters with the syntactic units of the underlying grammar
Predict	to declare or tell in advance; prophesy; foretell
Provide	to make available (e.g. provide a function to a user)

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VERB	DEFINITION
Publish	to make generally known (e.g. publish to center-to-center)
Receive	to get or be informed of
Recommend	to advise, as an alternative; suggest (a choice, course of action, etc.)
Refresh	to read and write (the contents of dynamic storage) at intervals in order to avoid loss of data
Remove	to get rid of; do away with (e.g. remove from User Interface display)
Reside	- Hardware constraint - e.g. reside in a controller cabinet
Restore	to bring back to a former, original, or normal condition
Restrict	to confine or keep within limits, as of space, action, choice, intensity, or quantity
Retrieve	to locate and read (data) from storage, as for display on a monitor
Save	to copy (a file) from RAM onto a disk or other storage medium
Search	to examine (one or more files, as databases or texts) electronically, to locate specified items
Select	to make a choice; pick
Send	to cause to be transmitted to a destination
Simulate	to create a simulation, likeness, or model of (a situation, system, or the like)
Sort	to arrange according to sort, kind, or class; separate into sorts; classify
Start	to set in operation
Store	to put or retain (data) in a memory unit
Translate	to convert (a program, data, code, etc.) from one form to another
Update	to incorporate new or more accurate information in (a database, program, procedure, etc.)
Use	- Constraint Only - to utilize a specific technology
Validate	to substantiate