Freight Advanced Traveler Information System

Functional Requirements

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Final Report — August 2012
FHWA-JPO-12-066

U.S. Department of Transportation

Produced by Cambridge Systematics, Inc
Southwest Research Institute
U.S. Department of Transportation
Federal Highway Administration
Research and Innovative Technology Administration
Intelligent Transportation System Joint Program Office

Notice

Source: Cover images – Truck Stop, Cambridge Systematics, Inc.; Cargo Port: Cambridge Systematics, Inc.; Truck Highway Sunset: Comstock, Inc.

Technical Report Documentation Page

1. Report No. **FHWA-JPO-12-066**	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Freight Advanced Traveler Information System Functional Requirements		**5. Report Date** August 2012 **6. Performing Organization Code**
7. Author(s) Mark Jensen, Roger Schiller, Tammy Duncan		**8. Performing Organization Report No.**
9. Performing Organization Name And Address Cambridge Systematics, Inc. 100 CambridgePark Drive, Suite 400 Cambridge, MA 02140		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.** DTFH61-11-D-00012
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration Research and Innovative Technology Administration Intelligent Transportation System Joint Program Office 1200 New Jersey Avenue, SE Washington, DC 20590		**13. Type of Report and Period Covered** Final Report August 2011 to August 2012 **14. Sponsoring Agency Code**

15. Supplementary Notes

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16. Abstract

This report describes the System Requirement Specifications (SyRS) for a Freight Advanced Traveler Information System (FRATIS). The SyRS is based on user needs described in the FRATIS Concept of Operations (ConOps), which cover the essential functions of freight-specific travel planning, dynamic routing, performance measurement, and drayage optimization described therein.

The SyRS describes the purpose, context, modes and states, capabilities, conditions, constraints, assumptions, and system and interface requirements of a generic FRATIS system. Requirement classifications pertain to system performance, security, information management, operations, and interfaces. Information management requirements are further subdivided into trip pre-planning, congestion avoidance dynamic routing, OSOW routing and permitting, real-time roadway information, weather conditions, public data, freight terminal queue delay, and container load-matching functional areas. Interface requirements cover both user and system (traffic management, trucking company, intermodal terminal, freight, load-matching, parking, and State OSOW routing and permitting) interfaces to the FRATIS system.

The SyRS also includes a traceability matrix linking each requirement to associated user needs and operational scenarios. This SyRS is intended as a foundational document for describing FRATIS system requirements – regional deployments will build upon these requirements, tailoring them for their specific deployment needs, and communicate their requirements to system developers and integrators.

17. Key Words FRATIS, requirements, user needs, freight, drayage, route, guidance, planning, optimization	**18. Distribution Statement** No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report)	**20. Security Classif. (of this page)**	**21. No. of Pages**	**22. Price**
Unclassified	Unclassified	**50**	N/A

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

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Scope

This document is the System Requirements Specification for the Freight Advanced Traveler Information System (FRATIS). The System Requirements Specification (SyRS) focuses primarily on the intended capabilities of the system as described in the FRATIS Concept of Operations (ConOps) document, constructed based on User Needs gathered through numerous face-to-face meetings with industry and extensive online surveys. More information about the needs-gathering process may be found in the ConOps; a synopsis of User Needs is shown in Table B-1. As indicated in Institute of Electrical and Electronics Engineers (IEEE) Standard 1233, this SyRS focuses on what the system should do rather than how the system should be constructed. While generating high-level requirements requires some level of specification of the overall expected architecture of the system, only the minimum architecture needed to specify the requirements will be included in this SyRS; more detailed architectures should be defined within a regional context, and will likely be developed in an iterative fashion over time.

System Purpose

The Federal Highway Administration (FHWA) wishes to develop freight-specific technology applications to improve freight operational efficiency. While there are many advanced traveler information systems (ATIS) geared towards passenger travel, freight has unique operational characteristics that require different data and methods/timeframes of information delivery.

More specifically, the FHWA wishes to develop two FRATIS application "bundles" as follows:

1. **Freight-Specific Dynamic Travel Planning and Performance**

   This application bundle will include all of the traveler information, dynamic routing, and performance monitoring elements identified in the development of user needs for this project. The application will leverage existing data in the public domain, as well as emerging private sector applications, to provide benefits to both sectors.

2. **Intermodal Drayage Operations Optimization**

   This application bundle will combine container load matching and freight information exchange systems to fully optimize drayage operations, thereby, minimizing bobtails/dry runs and wasted miles and spreading out truck arrivals at intermodal terminals throughout the day. These improvements would lead to corresponding benefits in terms of air quality and traffic congestion.

System Scope

To support its objectives, the FRATIS system will need to integrate data from multiple sources, as illustrated in Figure 1-1 below. Overseen by a regional public-private partnership (PPP), FRATIS will pull data from various sources using web services and/or application programming interfaces (API).

Data sources include:

- **Regional Intelligent Transportation System (ITS) data –** Such as real-time freeway/arterial speeds and traffic volumes, incident data, and route restrictions.
- **Truck movement data from third parties –** Such as truck speeds and position data from global positioning system (GPS) devices in trucks.
- **Intermodal terminal data –** Including real-time queue lengths and container availability updates.
- **Future U.S. Department of Transportation (USDOT) Connected Vehicle data –** This would include data outputs expected from the USDOT Connected Vehicle program, such as road-level weather information and Dedicated Short-Range Communications (DSRC) probe data from Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) technologies currently under development.

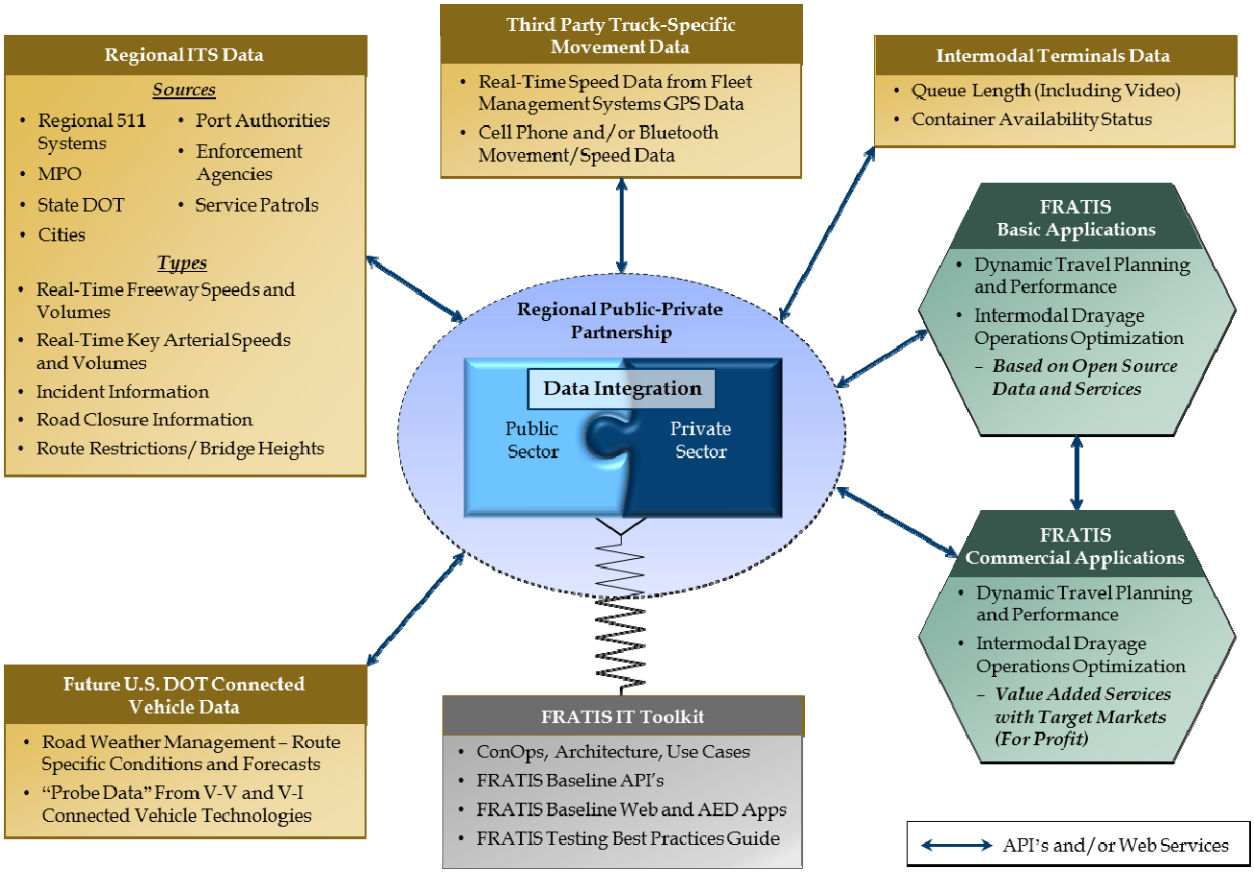

Figure 1-1. Proposed High-Level FRATIS System Concept
Source: Cambridge Systematics, Inc., August 2012

FRATIS would consist of two basic application packages (shown on the right side of Figure 1-1). The first would be basic applications, developed from open-source data and services, and available in the public realm. The second would consist of "value-added" commercial applications, targeted towards specific user groups.

An Information Technology (IT) Toolkit, comprised of background documentation including the ConOps, this SyRS, and baseline APIs and web applications, would allow public and private application developers to create the FRATIS applications. The following figure is a logical depiction of a sample FRATIS system; in this case the terminal queue delay component is detailed.

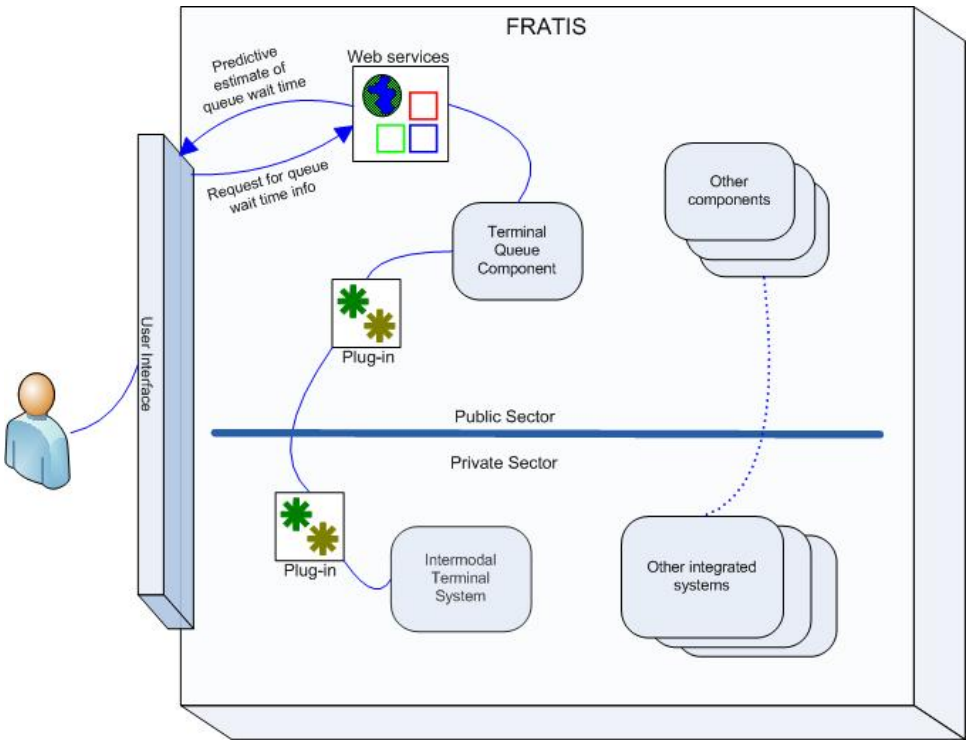

Figure 1-2. Sample Logical FRATIS Configuration
Source: Southwest Research Institute, August 2012

The example shown in Figure 1-2 illustrates how FRATIS is comprised of a union of public and private sector solutions. This example diagram shows "plug-ins" to represent some means for extending potentially existing systems to communicate with each other; an interface would be defined stipulating communications protocols between the systems.

It should be noted that USDOT does not intend to develop applications for which commercially-available solutions are available; rather, the intent is to determine which commercially-available products will best serve the needs of a regional solution, and integrate those systems/data via mutually agreed-upon criteria. FRATIS would encourage cooperation, serving as the "glue" to pull the various disparate components together, and possibly provide "missing pieces" when commercial solutions are not available, in a manner which serves the majority of stakeholder needs within a deployment area. Furthermore, the FRATIS architecture will be developed over time using appropriate public standards when available, and will develop and publish open standards in cases where they do not already exist.

System Overview

The initial version of the FRATIS is intended to provide a standard set of capabilities and interfaces that may be integrated into a region-specific system capable of providing support for dispatchers and operations managers and truck drivers involved in local freight operations. In particular, the system is intended to support intermodal freight operations, including support for freight-specific dynamic travel planning and performance and drayage operations optimization.

While implementation details and processes are not normally covered explicitly in a System Requirements Specification, there is an expectation that the federally funded portion of FRATIS will be open source and that the system will include the integration of both publically funded portions and private, for-profit capabilities.

Figure 1-1 provides a high-level view of the data sources and capabilities of FRATIS. It also shows the integration of public and private capabilities; the tools needed to integrate region-specific versions of FRATIS and the initial set of applications.

In addition to the two primary capabilities mentioned above, a number of secondary capabilities have been identified for FRATIS. These include support in collecting and analyzing anonymous/sanitized trip information to facilitate public investment planning.

General System Description

Since FRATIS will be region-specific and an initial region has not be selected or analyzed, the system requirements are still at a high level. Once a specific region is selected and analyzed, much more detailed system requirements can be developed for the FRATIS for that specific region; it is anticipated that this will be an iterative process as needs and technology change over time. For a regional deployment, it is expected that stakeholders would work together to discuss their particular needs, leverage the framework/toolkit that USDOT provides via its open source portal, procure commercial applications meeting documented regional requirements, and integrate them into the regional solution according to well-defined standardized interfaces. As there are also some valuable findings and lessons learned from previous USDOT work, such as the Cross-town Improvement Project (C-TIP)[1], FRATIS system developers should review this body of work during the system development process, and incorporate key findings and existing technologies as needed.

This SyRS provides high-level descriptions and requirements that should apply to regions as they are selected.

System Context

FRATIS is intended to operate in regions where there is significant intermodal freight traffic and where local drayage operations can be optimized by providing support for freight-specific traveler planning and drayage operations optimization. It is expected to interact with existing Traveler Information Systems intended for person transportation, as well as Freight-specific information systems, especially at nodes where freight changes modes. It is also expected to operate in an environment where there are already some services available, but where those services are not currently utilized across the board. FRATIS is expected to support the use of both public and private data, as well as the use of both public and private services.

System Modes and States

The primary mode of operation for FRATIS will be the ***Normal Operational Mode,*** which is focused on the application of FRATIS functionalities to the transportation operations of drayage and other trucking operations within a metropolitan region of the United States. This will be the normal, daily operational mode for the FRATIS system, with the primary users of the system being trucking company dispatchers and drivers. In this mode, other stakeholders such as Transportation/Traffic Management Center (TMC) operators and routing/ fleet management private sector companies will also be involved, and all will communicate data and information to each other seamlessly and automatically.

A secondary mode of operation for FRATIS will be the ***Peak/Degraded Operational Mode***. For this mode, the functionality is the same as for the normal Operations mode, except that the system is expected to have significantly more resource usage based on certain recurring and nonrecurring events. A requirement derived

[1] *USDOT, Cross-town Improvement Project Evaluation, Final Report, February 17, 2012*

from this mode is that FRATIS shall be designed to anticipate and respond to these peak/degraded conditions, such that ***no visible delay*** in FRATIS functionality is apparent to trucking company dispatchers and drivers. A technical approach will need to be developed to support this goal during the Development and Limited Testing phase.

The team also recognizes the possible need for an ***Emergency Operations Mode***. The exact nature of an emergency response will differ by region, depending on the types of natural disasters most frequently encountered, and type of emergency; some examples might be a hazardous material incident, terrorist attack, or natural disaster. The need and feasibility of this mode should be explored further during the Development and Limited Testing phase.

Major System Capabilities

For the initial implementation of FRATIS, the focus will be on providing two initial application "bundles":

1. **Freight-Specific Dynamic Travel Planning and Performance**

   This application bundle will include all of the traveler information, dynamic routing, and performance monitoring elements identified in the development of user needs for this project. The application will leverage existing data in the public domain, as well as emerging private sector applications, to provide benefits to both sectors.

2. **Intermodal Drayage Operations Optimization**

   This application bundle will combine container load matching and freight information exchange systems to optimize drayage operations, thereby minimizing bobtails/dry runs and wasted miles, and spreading out truck arrivals at intermodal terminals throughout the day. These improvements would lead to corresponding benefits in terms of air quality and traffic congestion.

While these are envisioned as separate application bundles, note that drayage optimization will be fully integrated with Freight-Specific Dynamic Travel Planning and Performance. To support these application bundles, the FRATIS system will need to integrate data from multiple sources:

- **Regional ITS data –** Such as real-time freeway/arterial speeds and traffic volumes, incident data, truck parking locations and availability, and route restrictions.
- **Truck movement data from third parties –** Such as truck speeds and position data from GPS devices in trucks.
- **Intermodal terminal data –** Including real-time queue lengths and container availability updates.
- **Future USDOT Connected Vehicle data –** This would include data outputs expected from the USDOT Connected Vehicle program, such as road-level weather information and probe data from V2I and V2V technologies, collectively referred to as V2X, currently under development.

The specific functions making up these bundles are listed below (Table 2-1) within larger functional groupings as described in the ConOps. Additional detail may be found in the ConOps.

Table 2-1. Essential Functions within Groups

Functional Group	Essential Function
Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials	Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials
Planning, Dynamic, and Regulatory Route Guidance	Preplanning Regional Truck Trips
	Congestion Avoidance Dynamic Routing of Trucks
	Automated Routing and Permitting for Oversize Overweight (OSOW) Trucks
Weather Information (including Predictive)	Real-Time Route-Specific Weather Conditions and Forecasting
Terminal Queue Status (including Video)	Real-Time Information on Length and Wait Times for Truck Queues at Freight Terminals
Appointment Status	Real-Time Information on Container Status and/or Pickup/Delivery Appointments at Intermodal Terminals
Public Sector Data Output – Performance Measures	FRATIS Open-Source Data Feed to Public Sector Agencies to Assist in Freight Transportation Performance Measurement
Container Load Matching	Container Load-Matching with Trucks to Support Reductions of Empty Container at Intermodal Terminals

Major System Conditions

FRATIS must operate in a regional mode and the specific conditions under which a particular implementation of FRATIS will operate will be, to a large extent, driven by the set of conditions within the specific region for which it is intended. The level of activity within the region, the types of terminals, ports, and other freight transportation nodes within the region, as well as the normal and extremes of activities at those nodes, will be the basis of the conditions under which FRATIS for a particular region will need to operate.

The FRATIS toolset and infrastructure must be capable of being used and configured to satisfy the conditions in the initial set of regions for which it will be developed. Additional tools and infrastructure may be required as FRATIS is further developed for additional capabilities within the regions where it is already operational, or as it is further developed for additional regions with different conditions.

Major System Constraints

Since FRATIS is intended to operate within a PPP, FRATIS must be capable of integrating both proprietary and public data and applications into an integrated view from the user's perspective without compromising the integrity of either the private data or private applications with which it is integrated. Interfaces supporting the integration of the public and private data and applications must be open and standardized to the extent possible, and allow the authorized flow of information across the interface while protecting proprietary information.

User Characteristics

There are both primary and secondary users of the system. The primary user groups for FRATIS can be categorized as follows:

- Trucking Company Dispatchers and Operations Managers
- Truck Drivers

Note that truck owner-operators may encompass both of these user groups. There are also several other entities that may have some system capabilities to transmit data related to appointments, pickup and delivery requirements, load/empty availability status, and drayage sequence direction; as well as government agencies that might interact with the system for performance monitoring and regulatory purposes. Such entities are:

- Transportation System Operators
- Enforcement Personnel
- Ocean Carriers
- Beneficial Cargo Owners
- Terminal Operators
- Trucking Services Buyers

Additional detail regarding these user groups may be found in the FRATIS Concept of Operations.

Assumptions and Dependencies

FRATIS will operate based on information sharing, data integration and application development between public sector ITS operators and private sector freight traveler information service operators. The driving force behind the public-private nature of FRATIS is the significant freight congestion, freight logistics, air quality, and other issues association with major U.S. metropolitan regions. The regions both create the problem set that USDOT and Metropolitan Planning Organizations (MPOs) are interested in solving, and also create a sizable FRATIS services market for private sector companies. The following summarizes these operational constraints for FRATIS deployment and operations:

- **Metropolitan Regional-Level Focus** – For two reasons, FRATIS should be deployed on a regional basis. First, based on the findings from the User Needs assessment, the primary target market for FRATIS applications is local and regional intermodal trucking drayage carriers, with a secondary market being small- and medium-sized local and regional carriers (non-intermodal). Secondly, the public sector information sources that will be utilized and integrated into FRATIS by the private sector vary vastly between major metropolitan regions in the U.S.
- **Public-Private Partnership Focus –** By its nature, for the FRATIS concept to succeed, public and private sector freight movement and other data will need to be integrated and managed so as to support the specific data needs of the FRATIS applications. This will require organized cooperation between public sector organizations (e.g., MPOs, DOTs, cities) and private sector companies, which are expected to deploy applications based on FRATIS.

The operational capabilities of FRATIS in a given region will thus be constrained by the data sharing/integration framework utilized by the public and private sector. Legal Agreements, Memorandums of Understanding, and Private Sector Return on Investment (ROI) will all need to be addressed by a regional data sharing/integration framework.

Operational Scenarios

The FRATIS Concept of Operations describes in detail ten operational scenarios in which the FRATIS system could significantly improve trucking and freight operations. These scenarios are summarized below in Table 2-2.

Table 2-2. Summary of FRATIS Scenarios, Essential Functions, Key Features, and Benefits

ID	Operational Scenario	FRATIS Essential Function(s)	Key Features	Benefits
OS01	Getting FRATIS Up and Running – Southern California	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Real-Time Information on Length and Wait Times for Truck Queues at Freight Terminals • Preplanning Regional Truck Trips • Congestion Avoidance Dynamic Routing for Trucks	• Real-time and historical traffic data • Terminal camera feeds • Audible driver notifications • Dynamic routing	• Initial deployment and ongoing operations of the FRATIS system in a region • Improved drayage productivity • Congestion avoidance • Reduced idling at terminal gates • Reduced emissions & fuel savings
OS02	Getting FRATIS Up and Running – South Florida	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Preplanning Regional Truck Trips • Congestion Avoidance Dynamic Routing for Trucks • Container Load-Matching with Trucks to Support Reductions of Empty Container at Intermodal Terminals	• Real-time and historical traffic data • Audible driver notifications • Load matching • Dynamic routing	• Initial deployment and ongoing operations of the FRATIS system in a region • Improved drayage productivity • Congestion avoidance • Reduced emissions & fuel savings • Better asset utilization
OS03	Improving Logistics Efficiency for a Trucking Company Dispatcher	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Preplanning Regional Truck Trips • Congestion Avoidance Dynamic Routing for Trucks	• Real-time and historical traffic data • Terminal camera feeds • Audible driver notifications	• Improved customer service/ adherence to delivery windows

ID	Operational Scenario	FRATIS Essential Function(s)	Key Features	Benefits
OS04	Increasing the Number of Turns Per Day For a Drayage Driver	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Real-Time Route-Specific Weather Conditions and Forecasting • Real-Time Information on Length and Wait Times for Truck Queues at Freight Terminals • Real-Time Information on Container Status and/or Pickup/Delivery Appointments at Intermodal Terminals • Container Load-Matching with Trucks to Support Reductions of Empty Container at Intermodal Terminals	• Load matching • Real-time traffic data • Pickup and delivery appointments at a port • Route-specific weather • Terminal camera feeds • Audible driver notifications	• Improved drayage productivity • Reduced emissions • Fuel savings • Congestion avoidance • Better asset utilization
OS05	Wind Turbine Regional Delivery	• Automated Routing and Permitting for OSOW Trucks • Real-Time Route-Specific Weather Conditions and Forecasting	• Automatic route/permit generation for OSOW loads • Route-specific weather/hazards	• Reduced permitting turnaround time • Reduced burden on permitting staff • Improved trip planning
OS06	Developing Freight Inputs to a Regional Transportation Improvement Plan (RTIP)	• FRATIS Open-Source Data Feed to Public Sector Agencies to Assist in Freight Transportation Performance Measurement	Anonymous truck movement data for planning Freight performance measurement	Improved data for freight planning Enabling a freight-beneficial project to compete for funding Fuel savings Reduced emissions
OS07	Improving Performance for a Time-Sensitive Air Cargo Supply Chain	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials	Real-time traffic data Truck parking information	Improved cold chain efficiency for perishable cargo Improved hours of service compliance

ID	Operational Scenario	FRATIS Essential Function(s)	Key Features	Benefits
OS08	Improving Productivity for Intermodal Drayage Moves Over 100 Miles	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Congestion Avoidance Dynamic Routing for Trucks • Preplanning Regional Truck Trips	Real-time traffic data Load matching Dynamic routing	Reduced driver turnover / enhanced driver income Improved regulatory compliance Better customer service
OS09	Reducing Operational Costs Through Better Asset Utilization	• Container Load-Matching with Trucks to Support Reductions of Empty Container at Intermodal Terminals • Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials	Terminal delay information Load matching	Better asset utilization Reduced idling emissions Reduced fuel expenditure Timely return of chassis
OS10	Increasing Emergency Preparedness and Response Efficiency	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Container Load-Matching with Trucks to Support Reductions of Empty Container at Intermodal Terminals • Preplanning Regional Truck Trips • Congestion Avoidance Dynamic Routing for Trucks	Real-time traffic data Dynamic routing Load matching Audible driver notifications	Better asset utilization for disaster preparation and recovery Optimization of truck trips and freight deliveries Enhancements to public agency emergency planning strategies

System Capabilities, Conditions, and Constraints

This section provides the system level capabilities, conditions and constraints for FRATIS. Since FRATIS is region-specific, some of the capabilities, conditions and constraints will need to be defined for the specific region for which a specific implementation of FRATIS is developed. However, the overall FRATIS infrastructure and toolkit can be defined as a part of this initial SyRS.

A naming convention has been established for requirements listed in this section as follows:

<mnemonic>-<primary identifier>.<secondary identifier>, where

- Mnemonic represents the classification of each requirement:

Table 3-1. Requirement Mnemonics

Mnemonic	Meaning
FSPR	FRATIS System Performance Requirement
FSSR	FRATIS System Security Requirement
FIMR	FRATIS Information Management Requirement
FSOR	FRATIS System Operations Requirement
FSIR	FRATIS System Interface Requirement

- Primary identifier represents the high-level or parent identification number within the requirement class.
- Secondary identifier represents the detail or child identification number within the requirement class. Detail/child requirements further refine their high-level/parent requirements.

Physical

The physical components of FRATIS will include existing systems accessed through networks and standard interfaces, user's systems such as smart phones, notebook, laptop or desktop computers, and FRATIS servers, which may be dedicated systems or may be hosted by a service or platform provider. The physical components of existing systems are not covered by this SyRS document.
The primary physical components covered by this SyRS document are the servers that host the basic FRATIS capabilities. Even these components will not be specified in detail in this SyRS since they may vary greatly by region. The variation by region may even include whether they are physically purchased as a part of a FRATIS implementation or whether the capabilities are hosted on physical systems that are part of a "cloud" infrastructure, either publically or privately owned. FRATIS capabilities could be provided in one region by servers that reside in and are integrated with a TMC

and in another region physically be resident on a variety of servers as a part of a privately owned application service provider. The interfaces to the services should be defined as standard web services to maximize the flexibility in implementing and accessing the services. As the services are further defined and then implemented, architectural choices will be made that may restrict the way the specific implementation of a service can be hosted. However, ensuring that the APIs are based on standard web services should allow successful interaction between different implementations of either services or systems that access the FRATIS services.

Physical aspects of the FRATIS system are described below.

Construction

FRATIS should be developed using standard interfaces and well-defined, open implementation tools and components to ensure that it meets the flexibility, durability, adaptability and other required characteristics for a system that must integrate both public and private data and applications and that must be able to be implemented in multiple regions with disparate needs.

Durability

FRATIS must establish an architecture that standardizes important interfaces and provides integrating functionality, yet it must be capable of integrating with a variety of commercial, private, and open source components. Use of common interface definition and other standards, tools, libraries, and best practices provided through USDOT's open source portal is strongly encouraged to ensure that FRATIS will be able to endure as IT systems continue to evolve. Care should be taken to ensure that low-level hardware concerns are encapsulated so that the services and applications can operate on new hardware as it becomes appropriate to do so. The FRATIS architecture will be developed over time using appropriate public standards when available, and will develop and publish open standards in cases where they do not already exist.

Adaptability

FRATIS must be adaptable both for different regions with differing characteristics, needs, and implementation concerns and interests, but also as additional systems, users, and capabilities are integrated into the system. FRATIS functions and interfaces should be encapsulated in such a way as to minimize the impact that changes within one capability have on other capabilities.

Environmental Conditions

The physical environmental conditions under which FRATIS will operate are region-specific and will be defined as a part of defining the region-specific implementation requirements.

System Performance Characteristics

While many of the performance characteristics of FRATIS are region-specific and will be defined in the requirements documents and Statements of Work for the specific implementations, there are a few basic performance requirements set forth by users within the FRATIS ConOps described here.

Data Currency

FSPR-1.0 and FSPR-2.0 attempt to define ***real-time*** as it would pertain to the expected currency of different types of data. To clarify, for FRATIS to be effective, all data should be fresh/current to the extent that is feasible with respect to frequency of updates within/to the source system, and within the cost constraints of a regional deployment. In that respect, all data transmissions within a FRATIS deployment should be done in real-time, meaning that they should occur as frequently as a region determines is practical and economically feasible for each essential function.

For the purposes of this SyRS, these two requirements effectively distinguish between ***near real-time*** for weather-related, and ***real-time*** for all other, data communications. Real-time communications in general should occur in less than 10 minutes, with a desired goal of 3-5 minutes (or less); however, some data simply may not be available from source systems within that time frame, such as weather-related data (as stated in the ConOps), so a more lenient communication rate has been specified (i.e., within 20 minutes). Other data transmissions, such as those made available via DSRC for V2X communications, should occur at a much faster rate, generally within milliseconds; however, a requirement with such specificity is difficult to quantify in a general sense, so one has not been included in this document.

Regional deployments will need to consider their own particular needs in developing detailed requirements.

Processing Performance within Operational Modes

In general, requirements within this document refer to expected characteristics within the normal operating mode. Additional performance requirements (such as expected percentage uptime and other service level objectives) for this and other operating modes will be determined for individual regional implementations.

As a robust system, FRATIS should monitor processing performance and react accordingly in response to degraded conditions. FSPR-3.0 alludes to system processing changes in reaction to performance degradation that might occur during peak travel times or other periods of high usage when large volumes of data may be moving through the system. FRATIS might respond by moving to Peak/Degraded Operational Mode wherein it might, for example, utilize algorithms that are less computation-intensive so that delayed response times to users are not apparent or are minimized to the extent possible. Regional deployments will need to consider their own particular needs in developing detailed requirements.

A FRATIS deployment should also provide a secondary/duplicate system that will allow operations to continue in the event that the primary system fails. This is captured in FSPR-4.0; further details may need to be stated in additional regional requirements.

Table 3-2. Performance Requirements

ID	Requirement
FSPR-1.0	FRATIS shall provide current information in real-time (i.e., data is no more than 10 minutes old) or as available from integrated data sources

ID	Requirement
FSPR-2.0	FRATIS shall provide current weather-related information in near real-time (i.e., data is no more than 20 minutes old) or as available from an integrated weather system)
FSPR-3.0	FRATIS shall be designed to anticipate and respond to peak/degraded conditions such that there is no apparent visible delay in performance
FSPR-4.0	FRATIS shall continue to function in the event of the loss of the use of its primary operational site

System Security

Since one of the principal goals of FRATIS is that it be implemented as a PPP, security must be carefully built into the architecture, design, and implementation. As region-specific implementations are designed, additional security requirements must be defined to implement the high-level security requirements listed in this document.

While not stated as a requirement below, it should be noted for inclusion in regional requirements that FRATIS applications making use of Connected Vehicle applications or data feeds should adhere to Connected Vehicle data security requirements. It is recommended that these be reviewed prior to any regional implementation to determine their applicability to each situation.

Table 3-3. Security Requirements

ID	Requirement
FSSR-1.0	FRATIS shall protect personal data from unauthorized access
FSSR-2.0	FRATIS shall protect proprietary information from unauthorized access
FSSR-3.0	FRATIS shall protect proprietary systems from unauthorized access

Information Management

Since FRATIS is primarily an information system, the functional capabilities of FRATIS are defined in this section. The requirements are organized based on the essential functions defined in the FRATIS ConOps. Note that these requirements are a ***superset*** of the requirements that may be satisfied by FRATIS in a specific region or for a specific intermodal terminal since many of the requirements can only be implemented if supporting functionality is available. If functionality for essential feature groupings is implemented, it should be done according to the requirements listed for each implemented group. Additional requirements may also be specified for a region-specific implementation (potentially making this list a ***subset*** of requirements). Also, specific data package details should be clearly defined within appropriate Interface Control Documents (ICD).

Pre-Planning Regional Truck Trips

Note that the requirements below encompass the exchange of a variety of information needed for pre-planning regional trips, and while OSOW routing and permitting information is not specifically distinguished here from “normal” route information, neither is precluded from the pre-planning

information intended for exchange in FIMR-1.4 and FIMR-1.5 below. Regions should determine whether or not additional requirements should be added to these to further clarify their needs.

Table 3-4. Trip Pre-planning Requirements

ID	Requirement
FIMR-1.0	FRATIS shall allow users to obtain regional truck trip planning information
FIMR-1.1	FRATIS shall provide historical traffic pattern data along a designated truck route
FIMR-1.2	FRATIS shall provide real-time traffic information along a designated truck route
FIMR-1.3	FRATIS shall provide near real-time weather conditions along a designated truck route
FIMR-1.4	FRATIS shall provide truck-specific route designations along a designated truck route
FIMR-1.5	FRATIS shall provide truck-specific route restrictions along a designated truck route
FIMR-1.6	FRATIS shall provide bridge heights along a designated truck route
FIMR-1.7	FRATIS shall provide bridge weight restrictions along a designated truck route
FIMR-1.8	FRATIS shall provide preferred freeway access paths along a designated truck route
FIMR-1.9	FRATIS shall provide toll road information along a designated truck route
FIMR-1.10	FRATIS shall provide construction zone information along a designated truck route

Congestion Avoidance Dynamic Routing of Trucks

Table 3-5. Congestion Avoidance Dynamic Routing Requirements

ID	Requirement
FIMR-2.0	FRATIS shall notify a user when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion
FIMR-2.1	FRATIS shall provide a notification when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion
FIMR-2.2	FRATIS shall provide an alternate route when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion

Automated Routing and Permitting for OSOW Trucks

FRATIS will not itself issue permits, but will interface to a State system or commercial off-the-shelf (COTS) product to perform this function; FRATIS will serve only to disseminate information between the OSOW system and the FRATIS user. If a State permitting system is to be integrated with a regional solution, then the following requirements should apply. Requirements should be further refined to include detail specific to a regional solution, such as (high-level) descriptions of the data to be transmitted within routing and permitting requests and results.

Table 3-6. OSOW Routing and Permitting Requirements

ID	Requirement
FIMR-3.0	FRATIS shall support the exchange of information needed for automated OSOW permitting and routing by State systems
FIMR-3.1	FRATIS shall allow a stationary user to submit requests for automated permitting for OSOW regional truck trips
FIMR-3.2	FRATIS shall allow a user to retrieve the results of an automated permitting request for OSOW regional truck trips

Real-Time Reliable Information for Freeways, Port/Terminal/Border Regions, and Major Freight Arterials

Data needed to satisfy the following requirements is expected to come from local TMCs, ports, and FHWA and/or private truck stop systems. Note that references to ports and intermodal terminals apply to inland ports, seaports, airports, rail yards, and Intermodal Container Transfer Facilities (ICTF).

Table 3-7. Real-time Roadway Information Requirements

ID	Requirement
FIMR-4.0	FRATIS shall allow users to obtain real-time information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region and along its borders
FIMR-4.1	FRATIS shall provide real-time travel volumes for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-4.2	FRATIS shall provide real-time average speeds for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-4.3	FRATIS shall provide real-time point-to-point travel time predictive information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-4.4	FRATIS shall provide real-time incident information for incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-4.5	FRATIS shall provide real-time estimated clearance time for congestion caused by incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-4.6	FRATIS shall provide construction information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-4.7	FRATIS shall provide extended arterial outage information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-4.8	FRATIS shall provide special event traffic information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
FIMR-5.0	FRATIS shall support the real-time exchange of truck parking information
FIMR-5.1	FRATIS shall allow users to obtain real-time information about truck parking locations and availability within and/or near the covered region
FIMR-5.2	FRATIS shall allow users to place parking reservations in real-time

Real-Time Route-Specific Weather Conditions and Forecasting

As described in the section on Data Currency above, it is anticipated that weather systems may not have information available within the prescribed timeframe for ***real-time*** communications, so ***near real-time*** is being used here to stipulate the desired timeframe for weather system communications within the FRATIS integrated system. It is hoped that weather data can be communicated in no more than 20 minutes; however, a region will need to refine these requirements based on its own needs and the capabilities of its integrated weather data source system. If an integrated weather system is capable of providing its data more frequently, then the regional FRATIS should consider working within a lower bound.

Table 3-8. Weather Conditions Requirements

ID	Requirement
FIMR-6.0	FRATIS shall allow users to obtain weather conditions for the covered region within near real-time
FIMR-6.1	FRATIS shall provide temperature for the covered region within near real-time
FIMR-6.2	FRATIS shall provide sky conditions for the covered region within near real-time
FIMR-6.3	FRATIS shall provide precipitation information for the covered region within near real-time
FIMR-6.4	FRATIS shall provide near real-time fog information for the covered region within near real-time
FIMR-6.5	FRATIS shall provide weather-related pavement conditions for the covered region within near real-time
FIMR-7.0	FRATIS shall allow users to obtain weather-related information along the trip path within near real-time for the expected duration of the trip
FIMR-7.1	FRATIS shall provide predicted temperatures along the trip path within near real-time for the expected duration of the trip
FIMR-7.2	FRATIS shall provide predicted sky conditions along the trip path within near real-time for the expected duration of the trip
FIMR-7.3	FRATIS shall provide predicted precipitation along the trip path within near real-time for the expected duration of the trip
FIMR-7.4	FRATIS shall provide predicted fog along the trip path within near real-time for the expected duration of the trip
FIMR-7.5	FRATIS shall provide predicted weather-related pavement conditions along the trip path within near real-time for the expected duration of the trip

FRATIS Open-Source Data Feed to Public Sector Agencies to Assist in Freight Transportation Performance Measurement

Open-source in the heading above implies that data moving through FRATIS that would be useful for measuring system performance will be made freely available to stakeholders via a public web portal or system-to-system communications, without restrictions. This data would of course be ***sanitized***, meaning that proprietary or sensitive information would be removed.

While the heading implies that this data would be available to public sector agencies for the purpose of measuring the performance of their freight transportation systems, the information/statistics compiled from the collected data could, in actuality, also be provided to the general public via a website.

Table 3-9. Public Data Requirements

ID	Requirement
FIMR-8.0	FRATIS shall allow users to obtain sanitized public data in support of anticipated data analysis needs
FIMR-8.1	FRATIS shall collect sanitized truck route data within the region
FIMR-8.2	FRATIS shall collect sanitized truck speed data within the region
FIMR-8.3	FRATIS shall collect congestion data within the region
FIMR-8.4	FRATIS shall collect sanitized alternate route data within the region
FIMR-8.5	FRATIS shall provide sanitized public data collected by the system

Real-Time Information on Length and Wait Times for Truck Queues at Freight Terminals

Table 3-10. Freight Terminal Queue Delay Requirements

ID	Requirement
FIMR-9.0	FRATIS shall allow users to obtain real-time intermodal terminal queue information
FIMR-9.1	FRATIS shall provide queue length for intermodal terminal queues within the region
FIMR-9.2	FRATIS shall provide estimated wait times from the back of the queue to the gate for intermodal terminal queues within the region

Container Load-Matching with Trucks to Support Reductions of Empty Container at Intermodal Terminals

FRATIS will not provide load-matching capability itself, but will be capable of integrating with commercial load-matching applications if they are available to a region. Interaction between FRATIS and the application(s) would be bidirectional – FRATIS would receive as well as send data to the integrated application(s).

Table 3-11. Container Load-Matching Requirements

ID	Requirement
FIMR-10.0	FRATIS shall allow users to match an empty (future or current) container with a truck expected to return to the terminal

System Operations

FRATIS must be designed to be operated in different regions with different sets of requirements. However, the overall basic system operations requirements will be common to the different implementations of FRATIS.

System Human Factors

Table 3-12. Human Factors Requirements

ID	Requirement
FSOR-1.0	FRATIS shall allow driver interaction only when vehicle is not moving

System Maintainability

System maintainability describes the expected requirements for maintaining and supporting the FRATIS system based on measures such as complexity, turnaround time, maintenance costs per operating hour, and frequency of preventive maintenance. Such requirements are to be determined (TBD) and will be defined later in the system lifecycle or allocated to the region-specific requirements.

System Reliability

System reliability is an important aspect of the FRATIS system, particularly with respect to minimizing system downtime and failures; region-specific requirements should consider current best practices for ensuring reliability of related systems engineering projects. FRATIS system reliability requirements are TBD and will be defined later in the system lifecycle or allocated to the region-specific requirements.

Policy and Regulation

The initial set of overall goals of the policies and regulations related to FRATIS are described in the FRATIS ConOps. The policy-related goals that will have the most impact on these requirements are the regional focus and the focus on public-private partnerships. Each of these goals has had an impact on the development of these requirements. These goals are also interrelated since the desire for the program to consist of a PPP is one of the driving forces behind the goal of focusing on implementation by region.

Regional implementation will require organized cooperation between public sector organizations (e.g., MPOs, DOTs, cities) and private sector companies deploying applications based on FRATIS' architecture. Legal Agreements, Memorandums of Understanding, and Private Sector ROI will all need to be addressed by a regional data sharing/integration framework.

As such, the operational capabilities of FRATIS in a given region will thus be constrained by the data sharing/integration framework utilized by the public and private sector within that region. This combination of regional focus and PPP will drive the architecture toward one that includes flexibility of both functionality and components. Different regions may need different capabilities, and there will likely be different systems from disparate companies to be integrated within the different regions. As a

result, the architecture of FRATIS must standardize important interfaces and provide integrating functionality, yet be capable itself of integrating with a variety of commercial, private, and open source components.

To ensure compliance with a regional and/or national FRATIS architecture of those systems and components selected for integration, it may prove beneficial to implement a certification process. This should be considered at some future time when the framework for a FRATIS system has matured to the level that this appears to be feasible, possibly after a pilot deployment.

System Life Cycle Sustainment

FRATIS should be designed to provide for adequate quality assurance activities, such as regular error checking and reporting, periodic review of operations, and measurement collection and analysis. Such lifecycle sustainment requirements are region-specific and will be specified in the appropriate region-specific requirements documentation or statements of work.

System Interfaces

While the specific interfaces needed for operation of a region-specific implementation of FRATIS will vary and must be further specified in the region-specific requirements documentation or statements of work, certain basic capabilities are specified below.

User Interfaces

FRATIS is intended to be accessed by a variety of user types – from stationary dispatcher, operators, drivers, and traffic analysts, to non-stationary drivers needing timely information in a safe, non-distracting format. The following general user interface requirements describe high-level needs associated with the delivery format for various categories of users. Note that in requirements FSIR-4.x below, user interfaces to FRATIS data imply a unidirectional flow of data from the FRATIS system to users, and those in -5.x imply a bidirectional flow of messages between users and integrated systems.

Table 4-1. User Interface Requirements

ID	Requirement
FSIR-1.0	FRATIS shall provide a graphical interface to stationary (i.e., dispatcher/operator/driver/traffic analyst/other) users
FSIR-1.1	FRATIS shall allow access to its functionality by back-office users primarily via the Internet
FSIR-1.2	FRATIS shall support graphical interfaces to stationary drivers using Application Enabled Device (AED)
FSIR-2.0	FRATIS shall support audible interfaces to non-stationary drivers using AED
FSIR-2.1	FRATIS shall provide an audible alert for selected updates to information about freeways, port and terminal intermodal connectors, and major freight arterials within the covered region for non-stationary users
FSIR-3.0	FRATIS may support visual interfaces to non-stationary drivers when integrated or approved 3rd-party in-vehicle display devices/systems exist
FSIR-4.0	FRATIS shall provide users an interface to its data via supported methods
FSIR-4.1	FRATIS shall provide users an interface to its sanitized public data via supported methods
FSIR-4.2	FRATIS shall provide users an interface to its weather data via supported methods
FSIR-4.3	FRATIS shall provide users an interface to its traffic data via supported methods
FSIR-5.0	FRATIS shall provide users an interface to related systems via supported methods
FSIR-5.1	FRATIS shall provide users an interface to related routing systems via supported methods

ID	Requirement
FSIR-5.2	FRATIS shall provide users an interface to related permit systems via supported methods
FSIR-5.3	FRATIS shall provide users an interface to related terminal queue systems via supported methods
FSIR-5.4	FRATIS shall provide users an interface to related terminal appointment systems via supported methods
FSIR-5.5	FRATIS shall provide users an interface to related parking systems via supported methods
FSIR-5.6	FRATIS shall provide users an interface to related container/load matching systems via supported methods

System-to-System Interfaces

Many of the system interfaces within FRATIS will be region-specific. Interfaces listed below define a sample set of system-to-system interactions which FRATIS should be capable of providing, if applicable systems and data are available; however, individual regions will need to determine how best to specify requirements for their own purposes.

Traffic Management System Interfaces

Requirements listed here include the exchange of data typically related to Traffic Management System (TMS), as well as those related to road-weather information that may or may not be made available by a TMS; it is possible that such data would be supplied directly by a separate 511 or Road Weather Information System (RWIS). Individual regions will need to determine how best to specify related requirements for their own purposes.

Table 4-2. Traffic Management System Interface Requirements

ID	Requirement
FSIR-6.0	FRATIS shall interact with TMS within the region to receive traffic information
FSIR-6.1	FSIR-0051 – FRATIS shall interact with regional TMS to receive traffic congestion information
FSIR-6.2	FRATIS shall interact with regional TMS to receive current travel volume information
FSIR-6.3	FRATIS shall interact with regional TMS to receive current speed information
FSIR-6.4	FRATIS shall interact with regional TMS to receive current point-to-point predictive travel time information
FSIR-6.5	FRATIS shall interact with regional TMS to receive ongoing and new incident information (including clearance estimation)
FSIR-6.6	FRATIS shall interact with regional TMS to receive current and expected construction information
FSIR-6.7	FRATIS shall interact with regional TMS to receive extended arterial outage information

ID	Requirement
FSIR-6.8	FRATIS shall interact with regional TMS to receive current and expected event traffic information
FSIR-7.0	FRATIS shall interact with TMS to receive current weather information for roads in the region
FSIR-7.1	FRATIS shall interact with TMS systems to receive current temperature information for roads in the region
FSIR-7.2	FRATIS shall interact with TMS systems to receive current sky condition information for roads in the region
FSIR-7.3	FRATIS shall interact with TMS systems to receive current precipitation information for roads in the region
FSIR-7.4	FRATIS shall interact with TMS systems to receive current humidity levels for roads in the region
FSIR-7.5	FRATIS shall interact with TMS systems to receive current weather-related pavement conditions for roads in the region
FSIR-8.0	FRATIS shall interact with TMS systems to receive predicted weather information for roads in the region
FSIR-8.1	FRATIS shall interact with TMS systems to receive predicted temperature information for roads in the region
FSIR-8.2	FRATIS shall interact with TMS systems to receive predicted sky condition information for roads in the region
FSIR-8.3	FRATIS shall interact with TMS systems to receive predicted precipitation information for roads in the region
FSIR-8.4	FRATIS shall interact with TMS systems to receive predicted humidity levels for roads in the region
FSIR-8.5	FRATIS shall interact with TMS systems to receive predicted weather-related pavement conditions for roads in the region

Trucking Company System Interfaces

Requirements listed within this section pertain to data exchanges directly from/to trucking company systems, as well as indirectly from/to related third-party systems acting on behalf of trucking companies.

Table 4-3. Trucking Company System Interface Requirements

ID	Requirement
FSIR-9.0	FRATIS shall interact with regional trucking company systems to receive truck trip information (including information about the load for the trip)
FSIR-9.1	FRATIS shall interact with regional trucking companies to receive planned/selected truck route information
FSIR-9.2	FRATIS shall interact with regional trucking companies to receive current truck locations

ID	Requirement
FSIR-9.3	FRATIS shall interact with regional trucking companies to receive sanitized truck route information
FSIR-9.4	FRATIS shall interact with regional trucking companies to receive sanitized truck speed information
FSIR-9.5	FRATIS shall interact with regional trucking companies to receive alternate route selection information
FSIR-10.0	FRATIS shall interact with regional trucking company systems to provide truck trip information
FSIR-10.1	FRATIS shall interact with regional trucking company systems to provide congestion information
FSIR-10.2	FRATIS shall interact with regional trucking company systems to provide weather information
FSIR-11.0	FRATIS shall interact with regional trucking company systems to support OSOW permitting

Intermodal Terminal System Interfaces

Table 4-4. Intermodal Terminal System Interface Requirements

ID	Requirement
FSIR-12.0	FRATIS shall interact with intermodal terminal systems to receive queue length information
FSIR-12.1	FRATIS shall interact with intermodal terminal systems to receive video of queues at intermodal terminals
FSIR-12.2	FRATIS shall interact with intermodal terminal systems to receive non-visual queue length information
FSIR-13.0	FRATIS shall interact with intermodal terminal systems to receive estimated queue wait time information
FSIR-14.0	FRATIS shall interact with intermodal terminal systems to receive information about empty containers available for pickup
FSIR-15.0	FRATIS shall interact with an intermodal terminal system's appointment-making function
FSIR-15.1	FRATIS shall interact with an intermodal terminal system's appointment-making function to schedule appointments
FSIR-15.2	FRATIS shall interact with an intermodal terminal system's appointment-making function to receive appointment information

Freight System Interfaces

Interface requirements defined here pertain to those between FRATIS and several freight/cargo-related user systems, such as those of beneficial cargo owners, trucking services buyers, shippers, freight forwarders, ocean carriers, and railroads. Within individual regions these may be further defined, and perhaps split into separate groupings for the respective user types.

Table 4-5. Freight System Interface Requirements

ID	Requirement
FSIR-16.0	FRATIS shall interact with appointment functions of freight systems
FSIR-16.1	FRATIS shall interact with appointment functions of freight systems to receive appointment status and exception information
FSIR-16.2	FRATIS shall interact with appointment functions of freight systems to provide appointment-related information
FSIR-17.0	FRATIS shall interact with freight systems to support load-matching of empty containers

Load-Matching System Interfaces

Table 4-6. Load-Matching System Interface Requirements

ID	Requirement
FSIR-18.0	FRATIS shall interact with load-matching systems to support load-matching of empty containers

Parking System Interfaces

Table 4-7. Parking System Interface Requirements

ID	Requirement
FSIR-19.0	FRATIS shall interact with parking systems to support truck parking functionality

State OSOW Routing and Permitting System Interfaces

Table 4-8. State OSOW Routing and Permitting System Interface Requirements

ID	Requirement
FSIR-20.0	FRATIS shall interact with State OSOW routing and permitting systems to support OSOW permitting

Traceability Matrix

Table 5-1 contains the traceability matrix mapping FRATIS system requirements to corresponding user needs and operational scenarios. Note that for those requirements that are more global in nature, i.e., they should be considered as fundamental to all FRATIS implementations, the term "global" has been added to the mapping columns rather than listing all user needs and/or operational scenarios.

Table 5-1. Requirement Traceability

Requirement ID	Requirement	User Need	Op Scenario
FSPR-1.0	FRATIS shall provide current information in real-time (i.e., data is no more than 10 minutes old) or as available from integrated data sources	UN04	global
FSPR-2.0	FRATIS shall provide current weather-related information in near real-time (i.e., data is no more than 20 minutes old) or as available from an integrated weather system)	UN04	OS04 OS05
FSPR-3.0	FRATIS shall be designed to anticipate and respond to peak/degraded conditions such that there is no apparent visible delay in performance	global	global
FSPR-4.0	FRATIS shall continue to function in the event of the loss of the use of its primary operational site	global	global
FSSR-1.0	FRATIS shall protect personal data from unauthorized access	global	global
FSSR-2.0	FRATIS shall protect proprietary information from unauthorized access	global	global
FSSR-3.0	FRATIS shall protect proprietary systems from unauthorized access	global	global
FIMR-1.0	FRATIS shall allow users to obtain regional truck trip planning information	UN01 UN03 UN05 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.1	FRATIS shall provide historical traffic pattern data along a designated truck route	UN01 UN03 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.2	FRATIS shall provide real-time traffic information along a designated truck route	UN01 UN03 UN05 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.3	FRATIS shall provide near real-time weather conditions along a designated truck route	UN01 UN03 UN05	OS01 OS02 OS03 OS08 OS10
FIMR-1.4	FRATIS shall provide truck-specific route designations along a designated truck route	UN01 UN03 UN05 UN08	OS01 OS02 OS03 OS08 OS10

Requirement ID	Requirement	User Need	Op Scenario
FIMR-1.5	FRATIS shall provide truck-specific route restrictions along a designated truck route	UN01 UN03 UN05 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.6	FRATIS shall provide bridge heights along a designated truck route	UN01 UN03 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.7	FRATIS shall provide bridge weight restrictions along a designated truck route	UN01 UN03 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.8	FRATIS shall provide preferred freeway access paths along a designated truck route	UN01 UN03 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.9	FRATIS shall provide toll road information along a designated truck route	UN01 UN03 UN05 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-1.10	FRATIS shall provide construction zone information along a designated truck route	UN01 UN03 UN05 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-2.0	FRATIS shall notify a user when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion	UN01 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-2.1	FRATIS shall provide a notification when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion	UN01 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-2.2	FRATIS shall provide an alternate route when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion	UN01 UN08	OS01 OS02 OS03 OS08 OS10
FIMR-3.0	FRATIS shall support the exchange of information needed for automated OSOW permitting and routing by State systems	UN08	OS05
FIMR-3.1	FRATIS shall allow a stationary user to submit requests for automated permitting for OSOW regional truck trips	UN08	OS05
FIMR-3.2	FRATIS shall allow a user to retrieve the results of an automated permitting request for OSOW regional truck trips	UN08	OS05

Requirement ID	Requirement	User Need	Op Scenario
FIMR-4.0	FRATIS shall allow users to obtain real-time information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region and along its borders	UN01 UN02 UN03 UN04 UN05	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-4.1	FRATIS shall provide real-time travel volumes for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03 UN04	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-4.2	FRATIS shall provide real-time average speeds for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03 UN04	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-4.3	FRATIS shall provide real-time point-to-point travel time predictive information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-4.4	FRATIS shall provide real-time incident information for incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03 UN04 UN05	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-4.5	FRATIS shall provide real-time estimated clearance time for congestion caused by incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03 UN05	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10

Requirement ID	Requirement	User Need	Op Scenario
FIMR-4.6	FRATIS shall provide construction information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03 UN05	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-4.7	FRATIS shall provide extended arterial outage information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03 UN05	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-4.8	FRATIS shall provide special event traffic information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region	UN01 UN03	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FIMR-5.0	FRATIS shall support the real-time exchange of truck parking information	UN04 UN10	OS07
FIMR-5.1	FRATIS shall allow users to obtain real-time information about truck parking locations and availability within and/or near the covered region	UN04 UN10	OS07
FIMR-5.2	FRATIS shall allow users to place parking reservations in real-time	UN04 UN10	OS07
FIMR-6.0	FRATIS shall allow users to obtain weather conditions for the covered region within near real-time	UN04 UN05	OS04 OS05
FIMR-6.1	FRATIS shall provide temperature for the covered region within near real-time	UN04 UN05	OS04 OS05
FIMR-6.2	FRATIS shall provide sky conditions for the covered region within near real-time	UN04 UN05	OS04 OS05
FIMR-6.3	FRATIS shall provide precipitation information for the covered region within near real-time	UN04 UN05	OS04 OS05
FIMR-6.4	FRATIS shall provide near real-time fog information for the covered region within near real-time	UN04 UN05	OS04 OS05
FIMR-6.5	FRATIS shall provide weather-related pavement conditions for the covered region within near real-time	UN04 UN05	OS04 OS05
FIMR-7.0	FRATIS shall allow users to obtain weather-related information along the trip path within near real-time for the expected duration of the trip	UN05	OS04 OS05
FIMR-7.1	FRATIS shall provide predicted temperatures along the trip path within near real-time for the expected duration of the trip	UN05	OS04 OS05
FIMR-7.2	FRATIS shall provide predicted sky conditions along the trip path within near real-time for the expected duration of the trip	UN05	OS04 OS05
FIMR-7.3	FRATIS shall provide predicted precipitation along the trip path within near real-time for the expected duration of the trip	UN05	OS04 OS05
FIMR-7.4	FRATIS shall provide predicted fog along the trip path within near real-time for the expected duration of the trip	UN05	OS04 OS05

Requirement ID	Requirement	User Need	Op Scenario
FIMR-7.5	FRATIS shall provide predicted weather-related pavement conditions along the trip path within near real-time for the expected duration of the trip	UN05	OS04 OS05
FIMR-8.0	FRATIS shall allow users to obtain sanitized public data in support of anticipated data analysis needs	UN07	OS06
FIMR-8.1	FRATIS shall collect sanitized truck route data within the region	UN07	OS06
FIMR-8.2	FRATIS shall collect sanitized truck speed data within the region	UN07	OS06
FIMR-8.3	FRATIS shall collect congestion data within the region	UN07	OS06
FIMR-8.4	FRATIS shall collect sanitized alternate route data within the region	UN07	OS06
FIMR-8.5	FRATIS shall provide sanitized public data collected by the system	UN07	global
FIMR-9.0	FRATIS shall allow users to obtain real-time intermodal terminal queue information	UN01 UN02 UN04	OS01 OS04
FIMR-9.1	FRATIS shall provide queue length for intermodal terminal queues within the region	UN01 UN02 UN04	OS01 OS04
FIMR-9.2	FRATIS shall provide estimated wait times from the back of the queue to the gate for intermodal terminal queues within the region	UN01 UN02 UN04	OS01 OS04
FIMR-10.0	FRATIS shall allow users to match an empty (future or current) container with a truck expected to return to the terminal	UN02 UN09	OS02 OS04 OS09 OS10
FIMR-10.1	FRATIS shall allow users to match an empty container for return only if the container is in reloadable condition (determination process is TBD)	UN09	OS02 OS04 OS09 OS10
FIMR-10.2	FRATIS shall allow users to match an empty container for return only if the trucking company determines that the value of the reload is sufficient to justify picking it up (determination process is TBD)	UN09	OS02 OS04 OS09 OS10
FSOR-1.0	FRATIS shall allow driver interaction only when vehicle is not moving	global	global
FSIR-1.0	FRATIS shall provide a graphical interface to stationary (i.e., dispatcher/operator/driver/traffic analyst/other) users	global	global
FSIR-1.1	FRATIS shall allow access to its functionality by back-office users primarily via the Internet	global	global
FSIR-1.2	FRATIS shall support graphical interfaces to stationary drivers using AED	global	OS01 OS02 OS03 OS04 OS05 OS07 OS10
FSIR-2.0	FRATIS shall support audible interfaces to non-stationary drivers using AED	global	OS01 OS02 OS03 OS04 OS05 OS07 OS10

Requirement ID	Requirement	User Need	Op Scenario
FSIR-2.1	FRATIS shall provide an audible alert for selected updates to information about freeways, port and terminal intermodal connectors, and major freight arterials within the covered region for non-stationary users	UN01 UN02 UN03 UN04 UN05	OS01 OS02 OS03 OS08 OS10
FSIR-3.0	FRATIS shall support graphical interfaces to non-stationary drivers when integrated in-vehicle display systems exist	global	OS01 OS02 OS03 OS04 OS05 OS07 OS10
FSIR-4.0	FRATIS shall provide users an interface to its data via supported methods	global	global
FSIR-4.1	FRATIS shall provide users an interface to its sanitized public data via supported methods	global	global
FSIR-4.2	FRATIS shall provide users an interface to its weather data via supported methods	UN02 UN04 UN05	OS04 OS05
FSIR-4.3	FRATIS shall provide users an interface to its traffic data via supported methods	UN01 UN02 UN03 UN04 UN05 UN08	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FSIR-5.0	FRATIS shall provide users an interface to related systems via supported methods	global	global
FSIR-5.1	FRATIS shall provide users an interface to related routing systems via supported methods	UN02 UN04 UN08	global
FSIR-5.2	FRATIS shall provide users an interface to related permit systems via supported methods	UN02 UN04 UN08	OS05 OS09
FSIR-5.3	FRATIS shall provide users an interface to related terminal queue systems via supported methods	UN04 UN06	OS01 OS03 OS04
FSIR-5.4	FRATIS shall provide users an interface to related terminal appointment systems via supported methods	UN04 UN06	OS01 OS03 OS04
FSIR-5.5	FRATIS shall provide users an interface to related parking systems via supported methods	UN10	OS07
FSIR-5.6	FRATIS shall provide users an interface to related container/load matching systems via supported methods	UN09	OS02 OS04 OS08 OS09 OS10

Requirement ID	Requirement	User Need	Op Scenario
FSIR-6.0	FRATIS shall interact with TMS within the region to receive traffic information	UN02 UN05	OS01 OS02 OS03 OS07 OS10
FSIR-6.1	FSIR-0051 – FRATIS shall interact with regional TMS to receive traffic congestion information	UN01 UN02 UN05	OS01 OS02 OS03 OS07 OS10
FSIR-6.2	FRATIS shall interact with regional TMS to receive current travel volume information	UN01 UN02 UN03 UN04 UN05 UN06	OS01 OS02 OS03 OS07 OS10
FSIR-6.3	FRATIS shall interact with regional TMS to receive current speed information	UN01 UN02 UN03 UN04 UN05 UN06	OS01 OS02 OS03 OS07 OS10
FSIR-6.4	FRATIS shall interact with regional TMS to receive current point-to-point predictive travel time information	UN01 UN02 UN03 UN04 UN05 UN06	OS01 OS02 OS03 OS07 OS10
FSIR-6.5	FRATIS shall interact with regional TMS to receive ongoing and new incident information (including clearance estimation)	UN01 UN02 UN03 UN04 UN05 UN06	OS01 OS02 OS03 OS07 OS10
FSIR-6.6	FRATIS shall interact with regional TMS to receive current and expected construction information	UN01 UN02 UN03 UN04 UN05 UN06	OS01 OS02 OS03 OS07 OS10
FSIR-6.7	FRATIS shall interact with regional TMS to receive extended arterial outage information	UN02 UN03 UN05	OS01 OS02 OS03 OS07 OS10
FSIR-6.8	FRATIS shall interact with regional TMS to receive current and expected event traffic information	UN01 UN02 UN03 UN04 UN05 UN06	OS01 OS02 OS03 OS07 OS10

Requirement ID	Requirement	User Need	Op Scenario
FSIR-7.0	FRATIS shall interact with TMS to receive current weather information for roads in the region	UN02 UN05	OS04 OS05
FSIR-7.1	FRATIS shall interact with TMS systems to receive current temperature information for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-7.2	FRATIS shall interact with TMS systems to receive current sky condition information for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-7.3	FRATIS shall interact with TMS systems to receive current precipitation information for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-7.4	FRATIS shall interact with TMS systems to receive current humidity levels for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-7.5	FRATIS shall interact with TMS systems to receive current weather-related pavement conditions for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-8.0	FRATIS shall interact with TMS systems to receive predicted weather information for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-8.1	FRATIS shall interact with TMS systems to receive predicted temperature information for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-8.2	FRATIS shall interact with TMS systems to receive predicted sky condition information for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-8.3	FRATIS shall interact with TMS systems to receive predicted precipitation information for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-8.4	FRATIS shall interact with TMS systems to receive predicted humidity levels for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-8.5	FRATIS shall interact with TMS systems to receive predicted weather-related pavement conditions for roads in the region	UN01 UN04 UN05	OS04 OS05
FSIR-9.0	FRATIS shall interact with regional trucking company systems to receive truck trip information (including information about the load for the trip)	UN02	global
FSIR-9.1	FRATIS shall interact with regional trucking companies to receive planned/selected truck route information	UN02	OS01 OS02 OS03 OS08 OS10
FSIR-9.2	FRATIS shall interact with regional trucking companies to receive current truck locations	UN02	OS01 OS02 OS03 OS08 OS10

Requirement ID	Requirement	User Need	Op Scenario
FSIR-9.3	FRATIS shall interact with regional trucking companies to receive sanitized truck route information	UN02	OS01 OS02 OS03 OS08 OS10
FSIR-9.4	FRATIS shall interact with regional trucking companies to receive sanitized truck speed information	UN02	OS01 OS02 OS03 OS08 OS10
FSIR-9.5	FRATIS shall interact with regional trucking companies to receive alternate route selection information	UN02	OS01 OS02 OS03 OS08 OS10
FSIR-10.0	FRATIS shall interact with regional trucking company systems to provide truck trip information	global	global
FSIR-10.1	FRATIS shall interact with regional trucking company systems to provide congestion information	UN01	OS01 OS02 OS03 OS04 OS07 OS08 OS09 OS10
FSIR-10.2	FRATIS shall interact with regional trucking company systems to provide weather information	UN05	OS04 OS05
FSIR-11.0	FRATIS shall interact with regional trucking company systems to support OSOW permitting	UN08	OS05
FSIR-12.0	FRATIS shall interact with intermodal terminal systems to receive queue length information	UN01 UN02	OS01 OS03 OS04
FSIR-12.1	FRATIS shall interact with intermodal terminal systems to receive video of queues at intermodal terminals	UN01 UN02	OS01 OS03 OS04
FSIR-12.2	FRATIS shall interact with intermodal terminal systems to receive non-visual queue length information	UN02 UN04	OS01 OS04
FSIR-13.0	FRATIS shall interact with intermodal terminal systems to receive estimated queue wait time information	UN01 UN02	OS01 OS03 OS04
FSIR-14.0	FRATIS shall interact with intermodal terminal systems to receive information about empty containers available for pickup	UN02	OS02 OS04 OS09 OS10
FSIR-15.0	FRATIS shall interact with an intermodal terminal system's appointment-making function	UN01 UN02	OS04
FSIR-15.1	FRATIS shall interact with an intermodal terminal system's appointment-making function to schedule appointments	UN01 UN02	OS04
FSIR-15.2	FRATIS shall interact with an intermodal terminal system's appointment-making function to receive appointment information	UN01 UN02	OS04
FSIR-16.0	FRATIS shall interact with appointment functions of freight systems	UN01 UN02	OS04

Requirement ID	Requirement	User Need	Op Scenario
FSIR-16.1	FRATIS shall interact with appointment functions of freight systems to receive appointment status and exception information	UN01 UN02	OS04
FSIR-16.2	FRATIS shall interact with appointment functions of freight systems to provide appointment-related information	UN01 UN02	OS04
FSIR-17.0	FRATIS shall interact with freight systems to support load-matching of empty containers	UN02 UN04 UN06 UN09	OS02 OS04 OS09 OS10
FSIR-18.0	FRATIS shall interact with load-matching systems to support load-matching of empty containers	UN02 UN04 UN06 UN09	OS02 OS04 OS09 OS10
FSIR-19.0	FRATIS shall interact with parking systems to support truck parking functionality	UN04 UN10	OS07
FSIR-20.0	FRATIS shall interact with State OSOW routing and permitting systems to support OSOW permitting	UN08	OS05

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APPENDIX A. List of Acronyms

AED	Application Enabled Device
API	Application Programming Interface
ATIS	Advanced Traveler Information Systems
C-TIP	Cross-town Improvement Project
ConOps	Concept of Operations
COTS	Commercial off-the-shelf
DSRC	Dedicated Short-Range Communications
FHWA	Federal Highway Administration
FIMR	FRATIS Information Management Requirement
FRATIS	Freight Advanced Traveler Information System
FSIR	FRATIS System Interface Requirement
FSOR	FRATIS System Operations Requirement
FSPR	FRATIS System Performance Requirement
FSSR	FRATIS System Security Requirement
GPS	Global Positioning System
ICD	Interface Control Document
ICTF	Intermodal Container Transfer Facility
IEEE	Institute of Electrical and Electronics Engineers
IFTWG	Intermodal Freight Technology Working Group
IT	Information Technology
ITS	Intelligent Transportation Systems
MPO	Metropolitan Planning Organization
OSOW	Oversize Overweight
PPP	Public-Private Partnership
RFTP	Request for Technical Proposals
ROI	Return on Investment
RTIP	Regional Transportation Improvement Plan
RWIS	Road Weather Information System
SyRS	System Requirements Specification
TMC	Transportation/Traffic Management Center

TBD	To Be Determined
TMS	Traffic Management System
USDOT	United States Department of Transportation
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
V2X	Collective term referring to both V2V and V2I communications

APPENDIX B. Summary of User Needs

This table describes User Needs as identified in the FRATIS ConOps.

Table B-1. Traceability of Essential FRATIS Functions to User Needs

ID	User Need Title	User Need Description	Essential FRATIS Function(s)
UN01	Designed for areas with significant freight congestion	FRATIS should be implemented in areas with significant freight congestion or for terminals/border regions with routine lengthy truck queues in order to maximize the public and private benefits of the system. It should be designed for both nonrecurrent and recurrent congestion (with historical data).	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Preplanning Regional Truck Trips • Congestion Avoidance Dynamic Routing for Trucks
UN02	Comprehensive coverage	FRATIS should provide coverage along an entire land-based transportation supply chain (from marine/rail terminal, to warehouse, to customers), in order to cover a key information gap in existing travel information systems.	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Real-Time Information on Length and Wait Times for Truck Queues at Freight Terminals • Real-Time Information on Container Status and/or Pickup/Delivery Appointments at Intermodal Terminals • Container Load-Matching with Trucks to Support Reductions of Empty Container at Intermodal Terminals
UN03	Roadway functional classifications	The system should provide coverage on most levels of the roadway network including major arterials and freeways so that information is provided on all key freight routes in a region.	• Preplanning Regional Truck Trips • Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials

ID	User Need Title	User Need Description	Essential FRATIS Function(s)
UN04	Near real-time	FRATIS should be near real time with roadway conditions and terminal/border queues information no more than 10 minutes old to maximize its usefulness to the freight community. Older, and thus less accurate/relevant information, needs to be clearly indicated.	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Real-Time Route-Specific Weather Conditions and Forecasting • Real-Time Information on Length and Wait Times for Truck Queues at Freight Terminals • Real-Time Information on Container Status and/or Pickup/Delivery Appointments at Intermodal Terminals
UN05	Targeting of information	FRATIS should provide incident and road condition information to drivers and dispatchers so they can make route planning and navigation decisions internally in keeping with prevailing business practices in the industry.	• Preplanning Regional Truck Trips • Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Real-Time Route-Specific Weather Conditions and Forecasting
UN06	Accuracy	FRATIS needs to be designed to avoid pushing out inaccurate information, and should include robust error checking and data cleaning to encourage adoption of the system in the private marketplace.	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials • Real-Time Route-Specific Weather Conditions and Forecasting • Real-Time Information on Length and Wait Times for Truck Queues at Freight Terminals • Real-Time Information on Container Status and/or Pickup/Delivery Appointments at Intermodal Terminals
UN07	Performance measurement	The system should provide performance measures to public agencies for use in transportation planning and management as an incentive for public sector participation as a data provider and to promote better transportation planning and policy.	• FRATIS Open-Source Data Feed to Public Sector Agencies to Assist in Freight Transportation Performance Measurement
UN08	Information content	FRATIS should suggest routing, travel timing, and scheduling for logistics intermediaries so they have a complete data packet for informed decision making.	• Preplanning Regional Truck Trips • Automated Routing and Permitting for OSOW Trucks • Congestion Avoidance Dynamic Routing for Trucks

ID	User Need Title	User Need Description	Essential FRATIS Function(s)
UN09	External linkages – load matching*	FRATIS should be able to link to systems that support load matching for empty containers in order to maximize Congestion avoidance, air quality, and efficiency benefits.	• Container Load Matching with Trucks to Support Reductions of Empty Containers at Intermodal Terminals
UN10	Truck parking**	FRATIS needs to provide real-time information about truck parking locations and availability to drivers and dispatchers to improve safety and compliance with hours of service rules.	• Real-Time Reliable Information for Freeways, Port/Terminal Regions, and Major Freight Arterials

* Dependent upon logistics intermediary willingness to permit linkage and data transfer.

** Need was added through consensus opinion at the FRATIS ConOps walkthrough meeting.

Note that user need #11 *External Linkages – Dispatch Platforms* was omitted since it is regarded as optional.

Source: Cambridge Systematics analysis of survey data and Intermodal Freight Technology Working Group (IFTWG) meeting input.

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