South Florida Freight Advanced Traveler Information System

Architecture and Implementation Options Summary Report

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16. Abstract

This Final Architecture and Design report has been prepared to describe the structure and design of all the system components for the South Florida FRATIS Demonstration Project. More specifically, this document provides:

- Detailed descriptions of the selected architecture implemented in the South Florida Region;
- A summary of the Agile development process; and
- Software development testing procedures, technologies selected for system development, and open-source development protocols for the South Florida FRATIS prototype.

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1.0 Project Overview and Purpose of This Document

South Florida is home to over 4 million residents, is visited by over 20 million tourists annually, and is the international trade gateway to the Americas. The greater Miami area is the leading U.S. port of entry for perishables, including flowers and produce. The region is home to 2 of the State's largest seaports that, combined, handle almost 2 million 20-foot equivalent units (TEU), over 6 million cruise passengers, and serves the petroleum needs of more than 9 counties – including the jet fuel for 3 major international airports. The region is home to an established intelligent transportation system (ITS) program, managed by multiple traffic management centers (TMC), consisting of cameras, message boards, detectors, and analytical capabilities to give real-time information on congestion, construction, weather, and incidents.

U.S. DOT is sponsoring cutting-edge research into freight ITS solutions in the South Florida region that can help alleviate congestion, pollution, and delays while promoting improved freight mobility in the nation's major freight gateways. The purpose of this project is to develop a prototype of the Freight Advanced Traveler Information System (FRATIS) bundle of applications, and conduct a small-scale prototype demonstration for assessing the effectiveness and impacts of a regional-based FRATIS implementation. "Before" and "After" data will be collected from the small-scale demonstration to support the FRATIS assessment activities. A range of public- and private-sector partners in the South Florida region are participating in FRATIS.

The FRATIS in South Florida will integrate and augment existing regional ITS and private-sector traffic data sources to provide freight-centric, real-time information to support improved truck routing and dispatcher decision-making, encompassing significant improvements in pretrip planning and real-time options for dynamic routing around congestion; and leverage mobile and freight information technologies already being deployed by the private sector, through new applications that will directly improve intermodal freight movement efficiencies, such as reductions in turn times, terminal queue avoidance, and reductions in bobtail movements.

The South Florida FRATIS will also include an emergency management component unique to South Florida. This component will consist of an Android smartphone application (app) designed to facilitate the collection and dissemination of information related to port status, traffic conditions, road closures/openings, fuel availability, supply locations, railroad status, and other pertinent information to assist in pre-event planning and postevent recovery. This app would facilitate collection of reconnaissance information in the field, which could be transmitted to emergency management personnel and traffic information systems; the app would also be able to receive data from these sources, allowing for rapid dissemination of critical information to users.

In order to meet these goals and objectives two system architecture options have been formulated. These alternate architectures are documented herein. The options are evaluated by their strengths and weaknesses in relation to the project goals, resources, and timeline. These criteria are then used to select one of the two options for implementation.

2.0 South Florida FRATIS Architecture Option 1

The structure of the South Florida FRATIS Integrated tool will have three major components, one for each key user. The three key users are the Dispatcher, the Driver, and Florida Emergency Management officials (including the state Division of Emergency Management, county Emergency Operations Centers (EOC), and FDOT emergency management officials). The system will consist mainly of a series of web interfaces for the different stakeholders and a third-party tool from TomTom Business Solutions. A more detailed description of the system is presented next. Figure 2-1 shows the detailed system architecture.

2.1 Dispatcher Web Site

The Dispatcher Web Site will be set up in such a way that once the Dispatcher has logged in, he can select which User Interface he would like to view based on the task at hand. To enter orders and generate daily itinerary plans for the company's fleet, the Dispatcher will select the Drayage Optimization Tool. To view travel information, such as weather conditions, roadway and traffic information, railroad terminal waiting times, and fleet tracking and communication, the Dispatcher will select the Real-Time Traveler Information Tool.

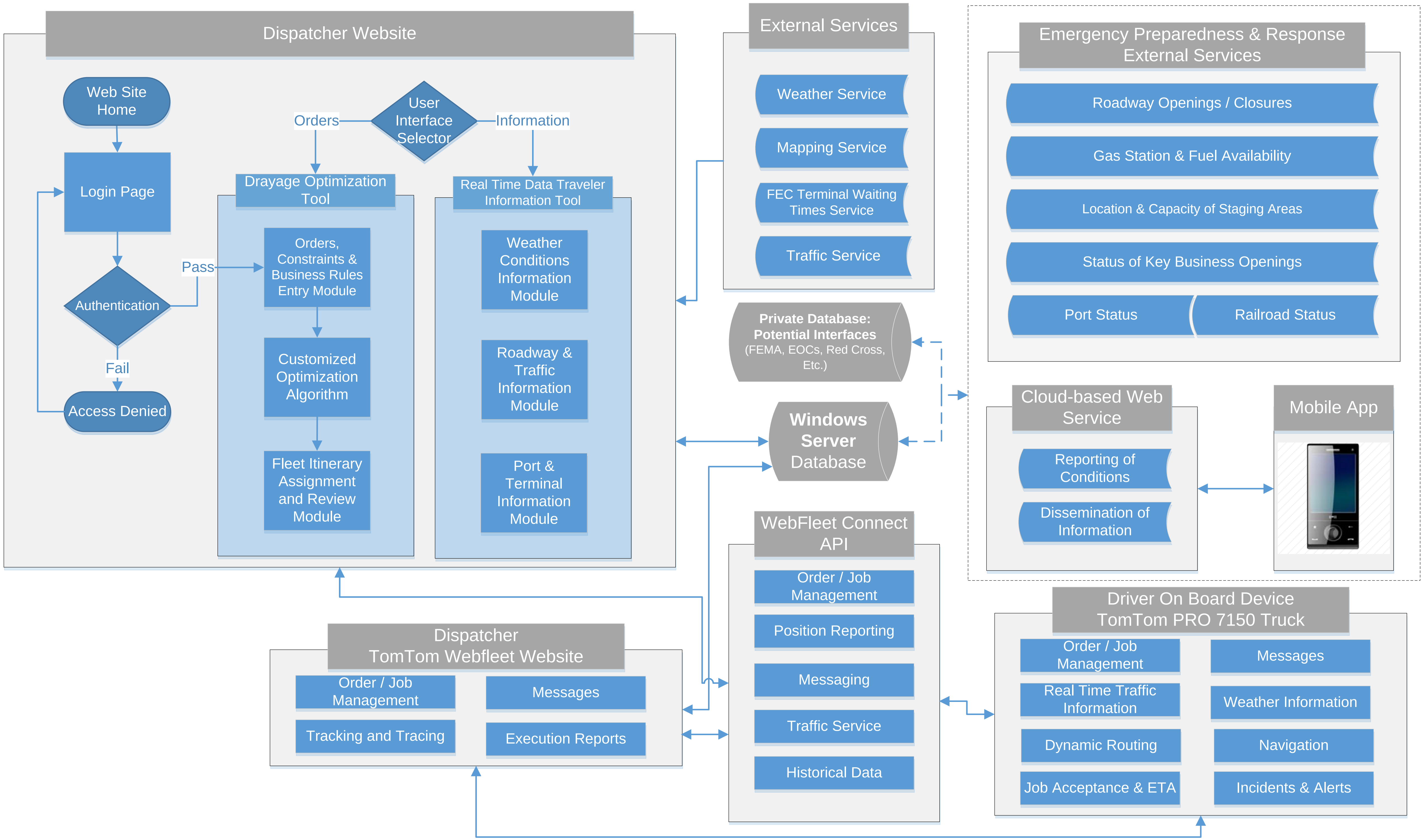
The Drayage Optimization Tool will be composed of three basic modules. These modules will provide capability for order collection, data processing, and provide optimized daily itineraries for truck fleet operations. The Orders, Constraints, and Business Rules Entry Module will be populated manually with order data by the company's Dispatcher, based upon all orders received and those necessary for scheduling.

The order data will include parameters like shipper and consignee locations, freight actions, stop time, time windows, due date, equipment details, and driver data, such as driving availability based on driver's hours of service. These orders will then be processed by the Customized Optimization Algorithm Module. The Customized Optimization Algorithm Module will use distances and travel time information, including real-time traffic information, traffic incidents, and historical traffic information from Google Maps API and NAVTEQ. Additionally, the optimization algorithm will use the waiting times collected by Acyclica at the FEC Rail Road terminal, using special equipment that will read signals of any truck with active Bluetooth and WiFi cell phones. The waiting times will be collected and analyzed in order to estimate and forecast waiting times to be used by the algorithm when running orders for a given day and time.

The information delivered from these providers will be tied into the Customized Optimization Algorithm. The Customized Optimization Algorithm will recognize the locations and stops required in the order, so that the system can simulate and identify the most efficient routes available for the drayage truck fleet. The optimization algorithm will take into account the time of day and estimate the accompanying traffic levels and waiting times during those time windows using historical data. The tool will then provide a near-optimal itinerary for the truck fleet from the Fleet Itinerary Assignment and Review Module, factoring in all of the previously stated parameters.

Regarding truck queue times at the FEC terminal, wait times by time of day will be captured by the Acyclica system during the baseline period and throughout the deployment. By analyzing the collected queue waiting time at the terminal, an estimated average of waiting time at the terminal by time of the day can be determined, which can be used later by the algorithm while it is building the route. When the algorithm runs, it estimates the arrival time at the terminal, then uses the associated waiting time at the terminal gate and adds it to the total time of the route. Since the algorithm minimizes the total route time it will select the solution that has the least waiting time at the rail road considering all other operational constraints.

Data from the external services shown in Figure 2-1 will be used by both the Drayage Optimization Tool and the Real Time Data Traveler Information Tool. For example, Traffic Services (NAVTEQ in this case) will be used in the Roadway & Traffic Information Module, as well as in the calculation of the routes for the solution of the Optimization Algorithm. The Traveler Information Tool and the Drayage Optimization Tool are two independent but complementary components of the system that use the same data providers from the external services. For instance, the Real Time Data Traveler Information Tool will provide real-time information regarding weather, traffic (NAVTEQ), and current waiting times in the port (Acyclica); and the Drayage Optimization Tool will collect orders and provide a solution (itinerary for the fleet), taking into account the route's historical traffic (from NAVTEQ too) and historical waiting times at the Terminal (collected from Acyclica).



Note: Solid lines represent components and connections of the FRATIS Integrated Tool. Dotted lines represent the Emergency Management app (a standalone system) and related future connections to the tool.

Figure 2-1. South Florida FRATIS Architecture Option 1 Diagram
(Source: Productivity Apex, Inc.)

The Dispatchers can share the Fleet Itinerary Assignment and Review Module with the Drivers by using the WebFleet Services (WebFleet Connect API). The Dispatcher will run the optimization algorithm once, usually in the afternoon, for execution of next-day orders after most of them are received and entered into the system. Additionally, the algorithm could be run more than once a day to update and recalculate the itinerary based on the orders that were completed, stop delays, and new locations of certain drivers; however, updating the algorithm is an additional task for Dispatchers since they need to keep track of orders' status and the position of each truck and then update the driver with the new modifications in the itinerary.

The **Real-Time Data Traveler Information Tool** will provide the users with real-time information specific to freight operations, allowing stakeholders in the freight industry – particularly the Dispatcher – to better plan for their operations. This tool will be integrated by a Weather Condition Information Module that will display current weather condition information, warnings, and alerts on specific areas for freight operations. The Weather Condition Information Module will draw this relevant data from a weather information web service, which will provide the information for the aforementioned parties and areas of interest. A Roadway and Traffic Module will use data from regional sources, if available, and data from NAVTEQ web services to provide real-time traffic and accident information, allowing Dispatchers to better plan routes and redirect drivers in case of incidents. The FEC Terminal Information Module will display terminal queue time from third-party systems, such as Acyclica, deployed at FEC terminal. This queue time will be shown in real time, providing both dispatchers and drivers the ability to schedule and plan around both expected and unexpected terminal queues. The Real-Time Data Traveler Information Tool will provide all of this data and information, which will be drawn together through one central web site for ease of accessibility.

The **TomTom WebFleet Web Site** will allow Dispatchers to track vehicle positions, as well as manage all the addresses for the different customers, terminals, and depot locations. The system will receive the orders coming from the Drayage Optimization Tool and will allow dispatchers to send the orders to drivers through the Pro 7150 Truck Navigation Device. Also, WebFleet will provide the capability to exchange messages with drivers and receive warnings and notifications every time drivers reach their destination, accept orders, and even speed or perform harsh turns. Furthermore, WebFleet will provide detailed reports for the evaluation of driver's itinerary execution, allowing for tracking of each action performed by the drivers in one minute intervals.

2.2 Driver On-Board Device

The Driver On-Board Device to use in Option 1 consists of the TomTom WebFleet Tracking and Navigation System integrated with the TomTom WebFleet Web Site, the TomTom Pro 7150 Truck Navigation Device, and TomTom Link 510 GPS Tracking Device. This system creates a seamless way to manage orders, communicate with Dispatchers, report positions, and provide dynamic routing all through the TomTom WebFleet Tracking and Navigation System.

The TomTom Pro 7150 Truck Navigation Device will be placed inside the vehicles and will receive the daily itinerary per truck coming from the Drayage Optimization Tool. The Pro 7150 Truck Navigation Device, in collaboration with the Link 510 GPS Tracking Device, will also receive messages from the Dispatcher through the WebFleet web service (WebFleet Connect API). These messages will provide drivers with their scheduled order itineraries, which they can accept and update as they are executed through the touchscreen on the Pro 7150 Truck Navigation Device. These updates will let the Dispatcher know whether or not the Driver has started a job, if the job is in progress, and when the job is completed. Dispatchers can also send and receive unique messages and notifications through the WebFleet web site between themselves and the drivers. Once a Driver accepts a job order, the Pro 7150 will guide the Drivers to their destination using GPS technology. The device will also offer the capability of dynamic routing, rerouting the drivers in case there is an incident or traffic delay on the road, and will always take into consideration the best and fastest truck route to get to the final destination. The device will also be able to provide Drivers with weather information, provided through the TomTom web service. The TomTom Link 510 GPS Tracking Device and TomTom Pro 7150 Truck Navigation Device will be installed in every truck and will be used to collect data regarding vehicle position, speed, and idling time, which may allow for stop-time data collection at specific locations for algorithm input.

2.3 Emergency Management Tool

The emergency preparedness and response activities element will consist of an Android smartphone application (app) designed to facilitate the collection and dissemination of information related to traffic conditions, road closures, fuel availability, supply locations, and other information useful for emergency preparedness planning and recovery efforts.

The FRATIS app will have two basic capabilities: reporting of conditions and data dissemination (each are described below). It would feed recon information collected in the field by app users to emergency management personnel (e.g., emergency operations centers or EOC, GATOR system) and directly or indirectly to the region’s traffic information systems (e.g., 511/SunGuide). The app would then be fed by EOC status reports and 511 traffic updates, for dissemination to the wider group of users.

Note that the Emergency Management Tool will be a standalone app utilizing a cloud-based server or database to receive and disseminate information to a limited user group to be defined during the test. No integration with other agency systems or with the wider FRATIS system will occur during this test. Rather, the intent is to prove the concept and enable future development of such connections based on stakeholder interest. Testing of the Emergency Management app will consist of simulation exercises with key stakeholders in South Florida using pre-defined scenarios.

Reporting of Conditions

FRATIS users in the field will access the emergency management app through their Android smartphones. Users reporting post-event information would primarily include emergency management officials conducting reconnaissance who would upload information about conditions either using the app or through the app. In order to avoid potential issues with distracted driving, truck drivers will not participate in the uploading of condition information to the app. However, dispatchers will have an opportunity to upload relevant information based on communications with their drivers.

The app will contain preloaded features with drop-down menus and use GPS location information provided by the smartphone. Once a feature has been selected for reporting, any available reports for the same location will be reviewed and provided to the user in real time. Users then will be able to indicate if these conditions still hold true or if the situation has changed. In adding this level, multiple similar reports can be avoided and allow for an easy, consolidated look at conditions. As more reports come in, confirmation of previous reports can also show for how long the conditions existed and yield a better estimate of how long it takes for conditions to return to normal.

In addition, app users will have their GPS location feature turned on. The FRATIS database will ping or collect location information at predetermined intervals to help create “open” status information for all roadways traveled. Following an event, all roadways are classified as “unknown”; this will help update these unknown segments without any action by the users.

All user-generated information would be uploaded real-time (as networks allow) to a FRATIS cloud-connected database which would potentially be available through an open source portal to county, state, and Federal agencies responsible for recon and information dissemination following an event.

Dissemination of Information

The real-time database created and maintained as part of Level 1 (above) will be disseminated in two ways. First, the database will be available through an open source portal for integration with partner systems. Although actual integration with existing emergency management systems will not occur as part of the small-scale test, data summaries – illustrating a real-time database – will be generated to help partner agencies evaluate the potential impact of the system on EOC operations.

Second, the database will feed the app with real-time information that can be accessed and used by app users to navigate the transportation system. Use of GIS-based, color-coded maps will be explored to facilitate these dissemination activities. For trucking purposes, some of the most important and dynamic features that need to be included following an event consist of (but are not limited to):

- Roadway openings/closures;
- Port status;
- Gas station and fuel availability;
- Location and capacity of staging areas;
- Railroad status; and
- Status of key business openings.

This information would be provided to drivers through a push feed with no input required from drivers. Truck drivers using the app would therefore be able to make more informed routing decisions based on real-time road opening status. Dispatchers could also allocate truck resources more effectively if they know the operating status of ports (for instance, the tank farms at Port Everglades), railroads, and key staging areas. If dispatchers or drivers know a particular area is inaccessible altogether, they could avoid going there until conditions improve, focusing instead on affected areas that are accessible.

The emergency management app will receive and transmit data via a cloud-based web services platform. As developed for this project, it will not interact with the FRATIS system; however, such an interface could be developed in the future as a follow-on project or by an outside app developer.

Information Exchange Standards for the Emergency Management App

Where possible, traffic condition data reporting will occur using Traffic Management Data Dictionary (TMDD) standards, following Section 1201 Data Exchange Format Specification (DXFS) protocols. Similarly, if incident details are being reported to a Traffic Management Center (TMC), the app will use IEEE 1512 standard (the app will convert human-entered information to this standard prior to dissemination to the TMC). TMCs receiving information from the app would be responsible for converting into the appropriate format for wider dissemination, such as ATIS. Note that for purposes of simulation testing, regional TMCs would be provided with static reports showing road status and other information for assessing the usefulness of the data for their operations – no interface with TMC systems will occur for this project.

2.4 Assessment of FRATIS Architecture Option 1

The strengths, weaknesses, and short- and long-term implications of Option 1 are summarized below.

Strengths

- Dynamic routing capability by using the TomTom Pro 7150 Truck Navigation Device, which will reroute the vehicle in real-time based on the current traffic conditions and incidents on the road.
- The Tracking and Navigation system from TomTom is a well-established and reliable system.
- Reduced probability of system errors to provide near-optimum solutions for truck itineraries given the requirement of the user to enter all the necessary data parameters from the orders.
- Great capability for tracking and reporting truck status and plan executions.
- The optimization algorithm would use FEC terminal waiting times to calculate near-optimum route itineraries, scheduling more efficient orders based on historic terminal wait times.
- The optimization algorithm would use historical and real-time traffic provided by Google API (free) and NAVTEQ (proprietary) to help generate near-optimal itineraries.
- Seamless communication between driver and dispatcher through TomTom Devices by means of text messages.
- Emergency Management is integrated with the FRATIS Tool.

Weaknesses

- Entering the orders in the Drayage Optimization Tool could be time consuming.
- Considerable training is required for data entry and data collection.

- Route distances, incidents, and traffic data coming from Google API and NAVTEQ cannot be integrated with TomTom system, which implies that dispatcher and drivers may have access to different traffic information.

Short-Term Implications

- The system is developed around an already existing system like TomTom WebFleet, which, by providing a well-documented open API, expedites the development process of the FRATIS Integrated Tool.
- If there are any updates on the TomTom API, these need to be addressed in the FRATIS Integrated Tool to ensure project continuity.

Long-Term Implications

- Functionality of the system depends on the monthly subscription fee to TomTom for the use of the Tracking and Navigation System.
- Functionality of the system depends on the subscription fee to NAVTEQ for accessibility to traffic information.
- Third-party company (TomTom) takes care of the maintenance and guarantees operability of the system for continued functionality of the FRATIS Integrated Tool.

3.0 South Florida FRATIS Architecture Option 2

South Florida FRATIS Architecture Option 2 is in many ways similar to Option 1, but it will instead consist of two major components: the dispatcher web site and the driver's on-board device. The main differences are:

- The company's current Order Management System would be integrated with the proposed Data Entry Module for the Optimization Algorithm in the Dispatcher Web Site;
- A Depot and Terminal Web Site would be created to track equipment availability in order to be integrated into the Drayage Optimization Tool; and
- A Mobile Application for Android devices would be used to provide navigation and other on-board services to the drivers.

Figure 3-1 illustrates the architecture for Option 2.

3.1 Dispatcher Web Site

In Option 2, the company's existing Order Management System will be directly integrated through a web service with the Orders, Constraints, and Business Rules Entry Module within the Drayage Optimization Tool. Assuming the orders from the company's system contain all the necessary parameters to run the optimization algorithm, these orders will then be processed by the Customized Optimization Algorithm Module, which will use distances and travel time information provided through the Google Maps API and NAVTEQ. The tool will then provide a near-optimal itinerary for the truck fleet through the Fleet Itinerary Assignment and Review Module. Dispatchers can share this information with the drivers, track all the trucks in the fleet, and interact with the drivers by sending them orders from the Fleet Itinerary and Assignment and Review through a desktop user interface or by calling them on the phone.

3.2 Depots and Terminal Web Site for Equipment Availability

A web site for Depots and Terminals in the South Florida Area will be developed in order to capture and track equipment availability. Currently, drayage companies receive updated information about equipment pickups and drop-offs via phone call or email, which makes the planning process difficult. The new system will help capture in real time the accurate location and schedule for picking up and returning empty containers and chassis. This information would be available to dispatchers via the Dispatcher Web Site. Additionally, this information will be used by the Drayage Optimization Tool in order to determine the best location and time to pickup or return an empty box needed or used in an order.

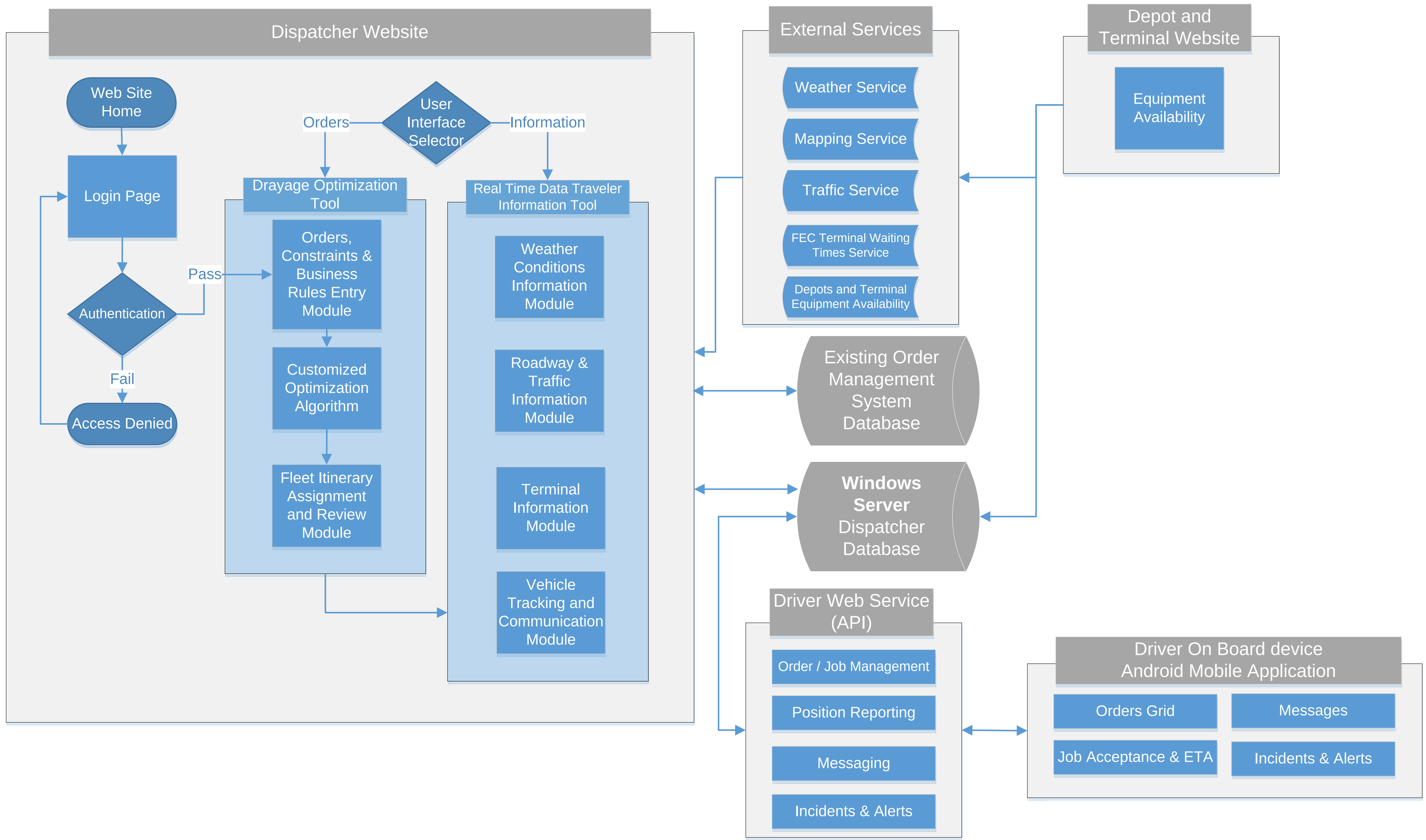


Figure 3-1. South Florida FRATIS Architecture Option 2 Diagram
(Source: Productivity Apex, Inc.)

3.3 Driver On-Board Device

The drivers will be provided with a Tracking and Communication system consisting of a mobile application installed on cell phones with the Android platform, which will capture the truck location and display messages. The mobile application will be installed on the truck drivers' phones to carry with them on board the truck. It will need to be activated every time the drivers start their workday. The application would collect latitude and longitude location of the driver at any time while performing their labor through the cell phones' built-in GPS. The application would also allow the drivers to receive their entire itineraries for the day, as well as messages by the dispatcher to communicate important information.

3.4 Assessment of FRATIS Architecture Option 2

The strengths, weaknesses, and short- and long-term implications of **Option 2** are summarized below.

Strengths

- May reduce data entry time for data collection due to direct integration with company's Order Management System.
- The optimization algorithm will use terminal waiting times to calculate near-optimum route itineraries, scheduling more efficient orders based on historic terminal wait times.
- The optimization algorithm would use historical and real-time traffic provided by Google API (free) and NAVTEQ (proprietary) to help generate near-optimal itineraries.
- The system will provide updated equipment availability at the Depots and Terminals to the dispatcher, and this information will also feed the algorithm.
- Seamless communication between driver and dispatcher.

Weaknesses

- Entering the orders in the Drayage Optimization Tool could be time-consuming if the company system does not provide all the necessary parameters per order for the algorithm to run properly.
- Access to the Company's Order Management System API may not be available.
- It may generate double work for Depots and Terminals, given that it requires their commitment for using a new system in order to provide updates regarding equipment availability – or they may choose not to update the system at all.
- The Emergency Management component is not integrated with the FRATIS Tool.
- The Tracking and Communication system does not provide navigation or dynamic routing capability.
- System does not provide drivers with en-route incident and traffic information.
- Limited capability for tracking and reporting truck status and plan executions.

Short-Term Implications

- Updates and bug fixes may have to be published regularly while the system is being used for testing.

Long-Term Implications

- Functionality of the system depends on the subscription fee to NAVTEQ for accessibility to traffic information.
- Once the concept is proved, a better tracking and communication system could be developed offering additional features like navigation and dynamic routing.

4.0 Evaluation of Architecture Options

4.1 Cost and Level of Effort

The following table shows an estimate of the level of effort in man-hours for the software development, testing, and debugging of the proposed architecture options. The below level of effort does not include any management, hardware, or installation.

Options	Level of Service
South Florida FRATIS Architecture Option 1	1,500 hours[a]
South Florida FRATIS Architecture Option 2	1,900 hours

[a] Does not include man-hours to develop the Emergency Management application – this effort will be more fully scoped once the approach is finalized and a technology developer is selected.

4.2 Option Selection

The South Florida FRATIS Architecture Option 1 meets all of the expectations stated for the project. Option 1 will deliver all the options and features of the FRATIS application that are stated in the ConOps and the functional requirements and is expected to be the most economical and the most feasible solution within the allotted time and budget. Option 1 also includes the Emergency Management element, which is a unique FRATIS application for the South Florida prototype test.

5.0 Technology Considerations, Standards, and Software Testing Procedures

5.1 Technology Used

Significant consideration has been given in the design of the FRATIS project infrastructure. Modern, secure, and flexible technologies have been selected based upon their time-tested reliability and ease of deployment, while giving strong consideration to maintainability due to future code or service modifications. Figure 5-1 shows the high-level web infrastructure architecture for the FRATIS tool in South Florida.

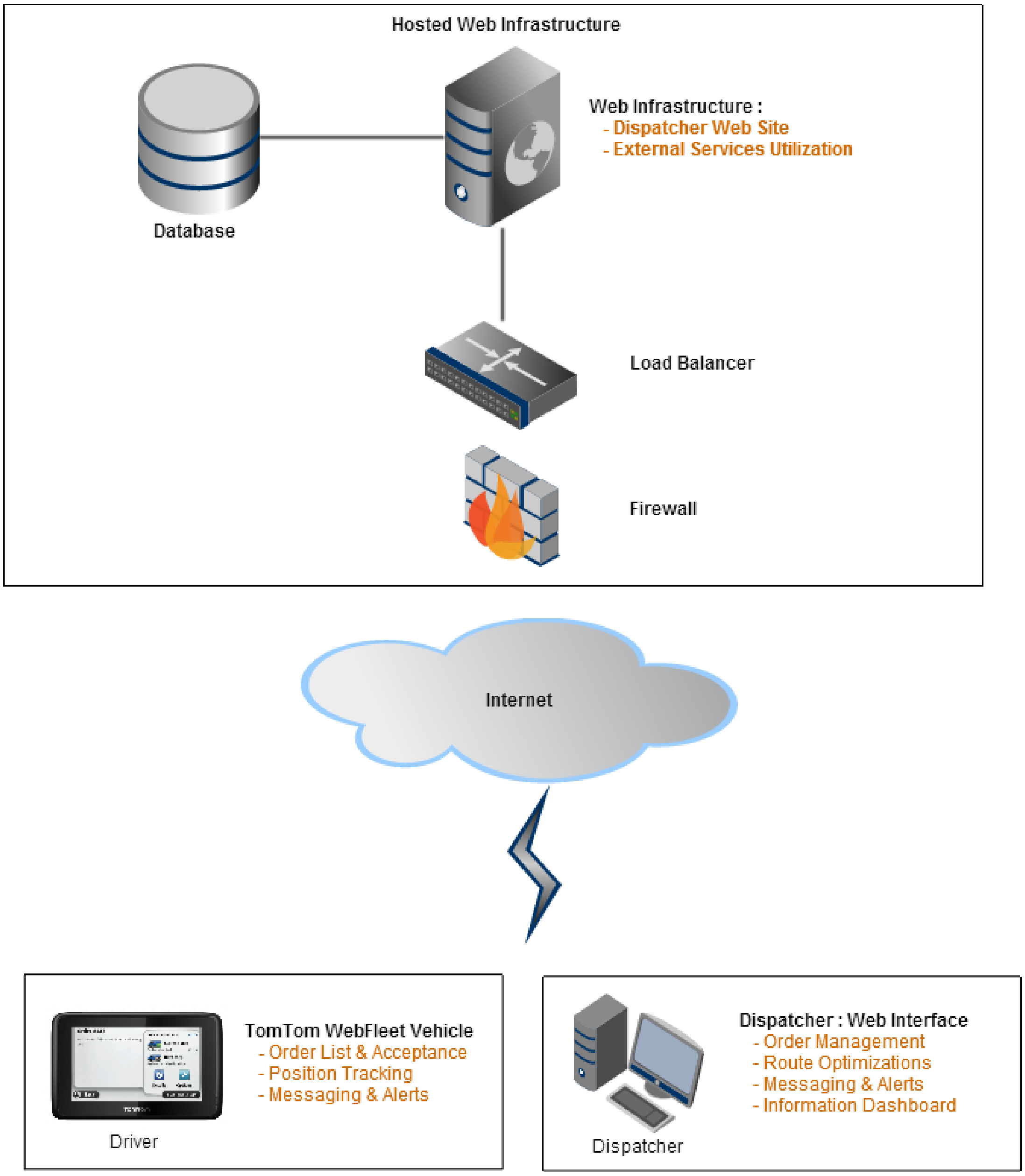


Figure 5-1. South Florida FRATIS Web Infrastructure
(Source: Productivity Apex, Inc.)

In designing and implementing the FRATIS Architecture, heavy use of Microsoft .NET technologies and methodologies are leveraged. All operating systems, database servers, web servers, and code utilize Microsoft technologies. External services are employed to provide functionality for traffic/incident reporting, marine terminal waiting times, emergency management functions, and weather conditions. Tables 5-1 and 5-2 illustrate the technologies/data feeds to be used for the FRATIS core and external services respectively.

Table 5-1. Technologies Selected for FRATIS Core Components

Core System Component	Technology
Web Site	Microsoft Server Operating System Microsoft IIS 7 Web Server (Internet Information Services) Microsoft .NET Framework v4.5 MVC Web Site (Model-View-Controller)
Object Persistence	Microsoft .NET Framework v4.5 Microsoft Entity Framework v5
Database/Repository	Microsoft SQL Server 2008 R2
Optimization Algorithm	Microsoft .NET Framework v4.5

Table 5-2. FRATIS South Florida External Services and Data Feeds

External Service	Description
Vehicle Reporting and Order Management	TomTom WebFleet Connect SOAP/REST External Service • Vehicle reporting • Order management • Messaging and notifications • Driver/route reporting
Mapping and Traffic Reporting	SOAP/REST External Service • Estimated Time of Arrival Calculations • Distance Calculations • Incident Reporting
Terminal Waiting Times	SOAP/REST External Service • Reporting of Predicted/Actual Waiting Time
Weather Conditions	SOAP/REST External Service • Live Conditions • Severe Weather Alerts • Weather Forecast
Emergency Management	SOAP/REST External Service • Roadway openings/closures • Port status • Railroad status • Key business openings • Location and capacity of staging areas • Gas station and fuel availability and locations

5.2 Test Support and Procedures

A series of tests will be performed over the different stages of the project, during development, predeployment, and postdeployment. This ensures the functionality of the system and demonstrates the effects associated with the system implementation. The acceptance criteria and data to be collected to ensure proper functionality of the system are further described in the Demonstration Plan.

A list of the core programming test procedures to be performed on the FRATIS System during the development stage is presented in Table 5-3.

Table 5-3. Software Development Test Procedures

System	Elements	Test Hypothesis
Unit Tests	Calculation Tests	• Numeric conversions • Geo conversions: latitude/longitude, z/x/y, quadkey • Distance/Euclidean distance • Taxicab tests
	Optimization Algorithm	• Pheromone matrix tests • Probability matrix tests • Node connection and timing tests • Feasible route solution tests • Statistic service tests
Integration Tests	Data and Database Integration	• Database interactions • Entity framework • Can save to backend • Can update records on backend • Can delete record on backend
	Optimization Algorithm	• Solution testing • Sample data • Test solution results • Test for infeasible solutions • Test output with traffic logic • Test output without traffic logic unit tests
External Service Tests	Weather	• Can get weather for city • Can get critical advisories • Can get wind conditions
	Traffic	• Can get incidents within region • Can get traffic image overlay • Can estimate travel time with traffic • Can fetch historical traffic data • Can predict future traffic data
	Location and Distance	• Can get distance between points • Can get travel time between points
	Mapping	• Can plot multiple POI on map image

In addition to the above tests, a validation test will be performed to assess the impact of the system on current drayage operations in the region. The tests will primarily consist of collecting and comparing data during the pre- and postdeployment phases in order to validate the algorithm impact on scheduling and itinerary creation, as well as to evaluate the effect of using real-time information (e.g., traffic, weather, and terminal waiting time) in making prompt decisions regarding changes to the itinerary plan. An overview of the potential test procedures to execute during the project is presented in Table 5-4. In the predeployment stage, the results of these tests will allow for tweaking and bug fixes to improve the overall performance of the system; after deployment, they will continue to serve this function while also providing data to facilitate the Impacts Assessment.

Table 5-4. FRATIS South Florida System Validation Tests

<table>
<tr><th>System</th><th>Elements</th><th>Test Hypothesis</th><th>Impacted Variables</th></tr>
<tr><td rowspan="2">Predeployment</td><td>Manual Plan versus Algorithm Plan</td><td>Validate algorithm performance</td><td>• Required fleet size to execute plan
• Bobtail miles
• Total miles
• Number of backhauls
• Driving time utilization
• Unproductive/productive moves ratio</td></tr>
<tr><td>Manual Plan versus Execution</td><td>Capture deviation between plan and execution</td><td rowspan="2">• Bobtail miles
• Total miles
• Total time for execution
• Number of backhauls
• Driving time utilization</td></tr>
<tr><td rowspan="2">Postdeployment</td><td>Algorithm Plan versus Execution</td><td>Capture the effect of deploying the algorithm on the execution

Capture deviation between plan and execution

Improve planning process to enhance plan robustness</td></tr>
<tr><td>Predeployment Execution versus Postdeployment Execution</td><td>Measure the long-term impact of deploying the algorithm</td><td>• Average daily bobtail miles
• Average number of orders per truck
• Average number of backhauls
• Average daily total miles
• Unproductive/productive moves ratio</td></tr>
</table>

5.3 Open Source Publication

All software developed within this task order will be released as open source through the OSADP, excluding proprietary code or commercial off-the-shelf (COTS) software used in the task order. Proprietary source code or COTS software that will not be published includes:

- Source Code or API Documentation for TomTom WebFleet Connect;
- Nokia Maps API Documentation or Source Code;
- Weather API documentation or Source Code;
- Acyclica (Waiting time system) Source Code;
- Google Maps API or Source Code; and
- Any other third-party, proprietary system used during development.

5.4 Compliance with DOT Standards

All of the software and processes described within this document, to be developed in the system architecture Options 1 and 2, will comply with DOT data, security, and web standards. Security protocols will follow the standards provided in the U.S. DOT Secure Web Application Standards, published February 10, 2006. Since FRATIS will reside on networks not connected to the DOT's own internal network and is not perceived to be an attractive target of opportunity, a risk rating of "Low" applies here.

Deliverables subject to 508 compliance are defined in the technical proposal. Additionally, the TomTom hardware, available for navigation inside trucks, offers the capability to have received messages read aloud by voice to prevent distracted driving issues.

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