

# **FINAL REPORT**

for the Florida Department of Transportation

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## **Real-Time Route Diversion**

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16. Abstract In this project, we investigate a computer model, and develop a software system that leverages real-time traffic data to help the <i>traffic management center</i> (TMC) to more effectively manage traffic incidents. The system is useful in four scenarios: (1) it provides a computer-aided environment to help the TMC to co-develop better diversion plans with the local authority; (2) when a pre-planned alternate route cannot be used due to some unforeseen event, this system can automatically generate alternative plans and rank them to assist the TMC in the decision making; (3) similarly, the system can be used if a pre-planned alternate route is not available for a given incident; and (4) if an initially effective alternate route becomes inadequate due to a secondary incident, the system can search for a better alternate route within seconds. The system provides a browser-based user interface and includes a built-in database for the TMC to manage information on past, current, and future incidents.			
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## EXECUTIVE SUMMARY

**Objective:** The objective of this research is twofold. First, original research is performed to develop novel computer technology for fast and effective response to traffic incident management under diverse scenarios. Second, the research results are applied to design and implement a Real-Time Route Diversion System (RTRDS) that is compatible with the Florida Department of Transportation (FDOT) environment.

**Research:** We presented our original research at three international conferences. The audience responses were very positive. Two of the papers were recognized as among the best papers presented at the conferences. We also published our findings in two journal publications.

**System Implementation:** To capitalize on the successful research, we developed a *Real-Time Route Diversion System* (RTRDS). This system is designed to cooperate with the SunGuide® environment. It retrieves real-time traffic data from SunGuide®, automatically generates alternate routes, and allows the user to disseminate route diversion information to dynamic message signs and highway advisory radio through SunGuide®, and to cellular phones. In support of this project, we also developed a software application called the *Topology Editor*. This is a semi-automatic software application to convert Dynamap data to a traffic network topology used by the Dynasmart-P simulator. In addition, we developed a software utility that reads the output of the Topology Editor and automatically generates the input files ready for running the simulation in Dynasmart-P.

**Benefits to FDOT:** The RTRDS represents the current state of the art in applying computer aided techniques to traffic incident management. This system offers the FDOT the following benefits:

- The proposed simulation-based alternate route generation approach is highly effective:
  - The quality of the alternate routes is optimal with respect to the current traffic conditions.
  - The alternate routes are systematically compared and ranked to provide informative data to help the user in decision making.
- This system has the potential to save time and costs in the investigation and development of route diversion plans.
- This system helps manage unforeseen incidents more efficiently using optimal alternate routes, which are systemically generated to minimize the impact on the surrounding area. Today's diversion plans are created independently for different anticipated incidents. These plans must be manually adjusted in the event of multiple incidents in the vicinity to ensure the safe flow of traffic around the effected roadways. This manual adjustment of diversion routes can be cumbersome. RTRDS is designed to devise a new set of alternate routes quickly while accounting changing traffic patterns.
- Cellular phones can retrieve the alternate route information at each affected intersection. This mobile user interface can be used to communicate the diversion plan to police officers to coordinate them in directing traffic and other workers in setting up route diversion equipment in a multiple-incident scenario.
- The Topology Editor and the Dynasmart-P Utility provide a set of independent software tools valuable to Dynasmart-P users at the FDOT.

**Deployment:** the RTRDS can be deployed at each traffic management center to assist in local/regional incident management.

**Other Potential Applications:** The RTRDS can be employed by police departments with the hardware and software supported by the FDOT. A self-contained portable RTRDS operating on a notebook computer can also be easily developed for mobile users such as Road Rangers. For the general public, RTRDS can be integrated into 511 to extend its functionality as a public information system.

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## LIST OF ABBREVIATIONS

Acronym	Definition
API	Application Program Interface
ATMS	Advanced Traffic Management System
C2C	Center-to-Center
CS	Computer Science
DMS	Dynamic Message Sign
DSG	Data Systems Group
DTA	Dynamic Traffic Assignment
FDOT	Florida Department of Transportation
GUI	Graphical User Interface
HAR	Highway Advisory Radio
HOV	High Occupancy Vehicle
IM	Incident Management
ITS	Intelligent Transportation Systems
OD	Origin/Destination
RTRDS	Real-Time Route Diversion System
STEMS	Smart Traffic Evacuation Management System
SwRI	Southwest Research Institute
TERL	Traffic Engineering Research Lab
TMC	Traffic Management Center
UCF	University of Central Florida

# Chapter 1 Introduction

The objective of this project is to investigate computer-aided techniques and to develop a software system that leverages real-time and historical traffic data to help the *traffic management center* (TMC) to more effectively manage traffic incidents. The system is useful in four scenarios: (1) it provides a computer-aided environment to help the TMC to co-develop better route diversion plans with the local authority; (2) when a pre-planned route diversion plan cannot be used due to some unforeseen event, this system can automatically generate alternative plans and rank them to assist the TMC in the decision making; (3) similarly, the system can be used if a pre-planned route diversion plan is not available for a given incident; and (4) if an initially effective alternate route becomes inadequate due to an incident, the system can search for a better alternate route within seconds. The system provides a browser-based user interface and includes a built-in database for the TMC to manage information on past, current, and future incidents.

The high-level architecture of the Real-Time Route Diversion System (RTRDS) is illustrated in Figure 1 comprised of two major subsystems, namely the RTRDS and SunGuide® adapter.

**RTRDS:** The RTRDS has two major subsystems.

- **Automatic Route Generator:**
  - It consumes real-time traffic data as input and produces a list of feasible alternate routes for a given incident.
  - It ranks and assesses the quality of the generated alternate routes based upon internal simulation results.
- **Route Diversion Management subsystem:**
  - It advises the TMC operator of the alternate routes and the quality of each route.
  - It assists the TMC operator in managing the alternate routes over the duration of the incident, including interaction with the dynamic message sign (DMS) and highway advisory radio (HAR) modules in SunGuide®.
  - It provides an environment to store and retrieve past, current, and future route diversion plans.

**SunGuide® Adapter:** The adapter receives near real-time data on traffic conditions from SunGuide®, and prepares the real-time travel times for the RTRDS. This adapter enables RTRDS to retrieve current traffic data seamlessly from a live data source. This modular design approach allows simple extension of the RTRDS for various operating environments. The Live Data Source, depicted in Figure 1, is provided by the Southwest Research Institute (SwRI) (based on actual SunGuide® data at District 5) to test our system for SunGuide® compliance.

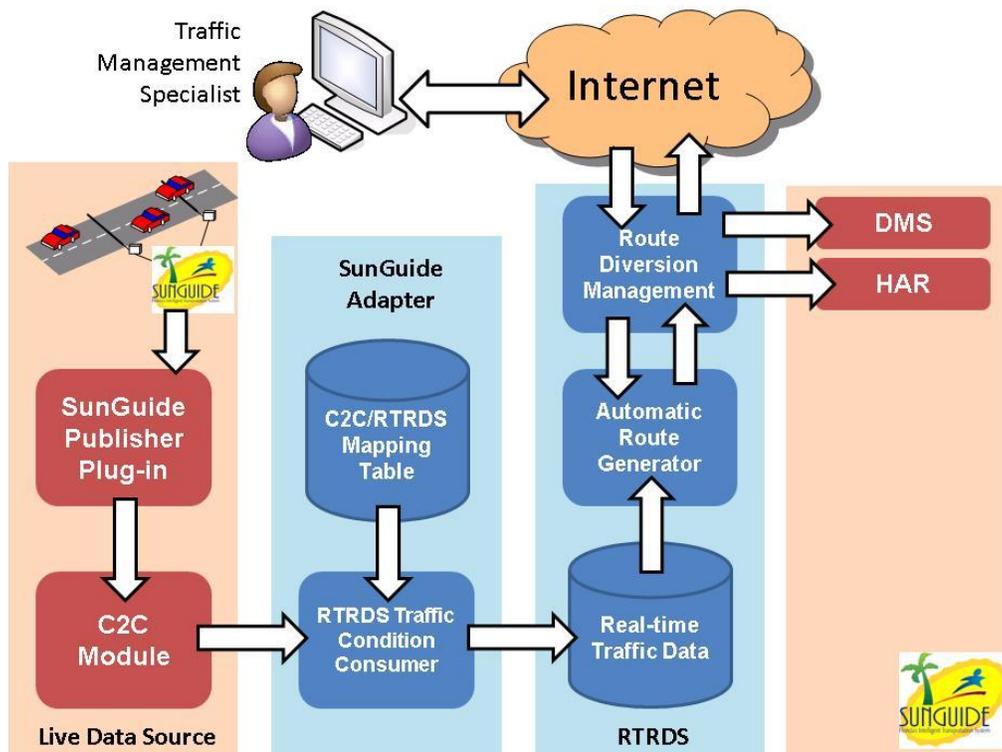


Figure 1. High-level architecture of the incident management system

In addition to the aforementioned software components, the system also includes a utility program for loading the maps into the RTRDS database. For this project, we utilize TeleAtlas’s Dynamap product for map data. Furthermore, the system also includes a mobile interface. This mobile interface enables officers to retrieve information of a route diversion plan from the field using a cellular phone.

The original Scope of Services and subsequent amendments defined twelve tasks, including: information gathering, software development, and testing tasks. The researchers in the Data Systems Group (DSG) at the University of Central Florida (UCF) solved many technical and non-technical issues culminating in a Real-Time Route Diversion System. During the project, they (1) investigated the feasibility of generating automated route diversion plans, (2) developed procedures and software solutions to convert a commercial map database into a form suitable for the Dynasmart-P simulator, (3) developed software to automatically create Dynasmart-P input files capable of modeling given scenarios, (4) developed a software system

capable of amalgamating sensor-generated real-time traffic data and user-specified static traffic data to construct multiple diversion routes, and (5) developed a browser-based graphical user interface permitting the route diversion software to be operated via any standard web browser.

## Chapter 2 Literature Review

As congestion and the increased demand for freeway and arterial road capacity continue to escalate, transportation engineers are becoming increasingly reliant on technology to assure the optimal utilization of available road capacity. Bundled broadly under the term Intelligent Transportation Systems (ITS), these include traffic sensing devices to detect vehicle movements, communication and information display devices, safety systems, etc. [1].

An advanced traffic management system (ATMS) generally consists of a suite of integrated components providing a solution for transportation operations. These include traffic/travel time sensors, DMS signs, video walls, incident detection capabilities, diagnostic capabilities for field devices, inventory and maintenance scheduling applications, etc. The technologies that can produce real-time data have generally advanced much more quickly than developments in algorithms and decision-making tools that can leverage the vast amounts of data being collected by these traffic management systems to the fullest extent. The result is generally data-rich, complex, semi-automated systems with many tunable parameters that rely heavily on human expertise.

Having identified the need to fill this algorithmic void, transportation researchers have proposed various simulation-based solutions to address this problem (the interested reader is referred to [2] and [3], who make the case for the simulation-based approach).

### ***2.1 Incident and Route Diversion Modeling with Traffic Simulators***

In [4], the authors present the necessity to simulate both arterial streets as well as freeways when studying the effects of incidents. Among their findings are (1) the benefits of route guidance increases with incident duration, (2) for freeway incidents of 10-30 minute durations, dynamic route guidance reduced travel times 11-21%, and (3) travel times could be reduced even further if arterial street signal timings could be coordinated with said route guidance.

Constructing a route diversion plan around an incident requires careful planning and consideration of many factors; how to communicate the alternate routes to drivers, how many of those will actually follow the alternate routes, whether the diverted traffic will cause other traffic bottlenecks if too many people divert, etc. A standard approach to addressing these challenges is with the utilization of traffic simulators. As examples, the studies reported in [5], [6], [7], [8], [9], [10], and [11] take this approach and the availability of travel information and driver behavior was reported in [4], [12], and [13].

There are a number of existing systems for evacuation. Some of these systems are reported in [14], [15], [16], [17], [18], [19]. The RTRDS developed for this project is a route diversion system. Route diversion systems differ fundamentally from evacuation systems. An evacuation system finds optimal or near-optimal ways to quickly move people a certain distance away from a large-scale incident such as a chemical spill. In contrast, a route diversion system such as the RTRDS directs traffic along alternate routes to circumvent incidents.

Our RTRDS, presented in this report, has a modular design with an interface to SunGuide® for real-time traffic information and message dissemination. Given an incident, the RTRDS leverages available real-time and historical traffic data to find efficient alternate routes with minimal operator input. The operator can use RTRDS to review and choose from alternate routes which can be generated on demand or previously constructed.

## ***2.2 SunGuide®***

SunGuide® is a suite of software developed for the state of Florida to control roadway devices and facilitate device control and communication between TMCs, with the goal of providing a common Intelligent Transportation System (ITS) software base throughout the state. SunGuide® is based on software developed by the states of Texas and Maryland, and customized for the state of Florida. SunGuide®'s databus, is a central service that the various components (modules) can connect to in order to exchange data and control information between other disparate modules, users, TMCs, and web servers for dissemination of information [20].

SunGuide® generates travel times via a subsystem that provides access to a variety of types of traffic detectors. The system uses speed data gathered from detectors, which is smoothed using a rolling average, for each lane. Travel times are then calculated for each road segment by adding all the individual lane speeds and dividing by the number of lanes. (More detailed information describing how SunGuide® calculates travel times is available in [22]).

## ***2.3 Road Ranger Incident Management Survey***

We conducted a survey pertaining to the Florida Department of Transportation (FDOT) Districts' current practices relating to the Road Rangers and the collection/storage of incident information. This survey collected technical information pertaining to incident management (IM) systems, data collection and retention policies; what information is retained, and for how long.

Survey responses among the districts varied greatly. In some districts, the Road Rangers use a computer system that is tied to incident management and track incidents in near real time. Other districts have separate incident management systems which are used by TMC

personnel, and the Road Rangers turn in reports on paper forms that are later filed in cabinets. Most validate incident data with other sources (e.g., Florida Highway Patrol). When asked about route diversion functionality, no one had an automated system with this functionality, although some responded saying they use pre-made route diversion maps, and one (District 2) planned to make use of the DMS template functionality available in SunGuide®. The surveys returned from Districts 1, 2, 3, 4, 5, 6, 7, and Florida's Turnpike Enterprise, are in Appendix B of this report.

## Chapter 3 Real-Time Route Diversion System Design

The RTRDS is a software system designed to produce optimal route diversion plans. The route diversion plans are generated automatically with the help of a traffic simulator. Dynasmart-P [21] (Version 1.3.0) was chosen as the traffic simulator in our system. The RTRDS consists of the following components:

- A software application and ArcView scripts to convert a commercial map database to traffic network topology files used by the Dynasmart-P simulator. For this task, we used TeleAtlas's Dynamap product as the commercial map database.
- An adapter, which listens for incoming traffic data and converts it into the RTRDS format. With the modular adapter-based design, the RTRDS can access a variety of data sources by simply using an appropriate adapter for each data source.
- The RTRDS core, which is referred to as the *Automatic Route Generator*, queries the RTRDS database for the current traffic conditions and incidents, prepares input files for Dynasmart-P, executes Dynasmart-P, processes the Dynasmart-P output to automatically create the route diversion plans, and finally stores them to the database where they will be accessible to the graphical user interface (GUI).
- A GUI for workstations, which permits users to create an incident, create/edit/modify/approve route diversion plans, query for existing plans, and interact with DMS and HAR modules of the SunGuide® system.
- A mobile GUI, which enables police officers to retrieve route diversion information from the field using a cellular phone.

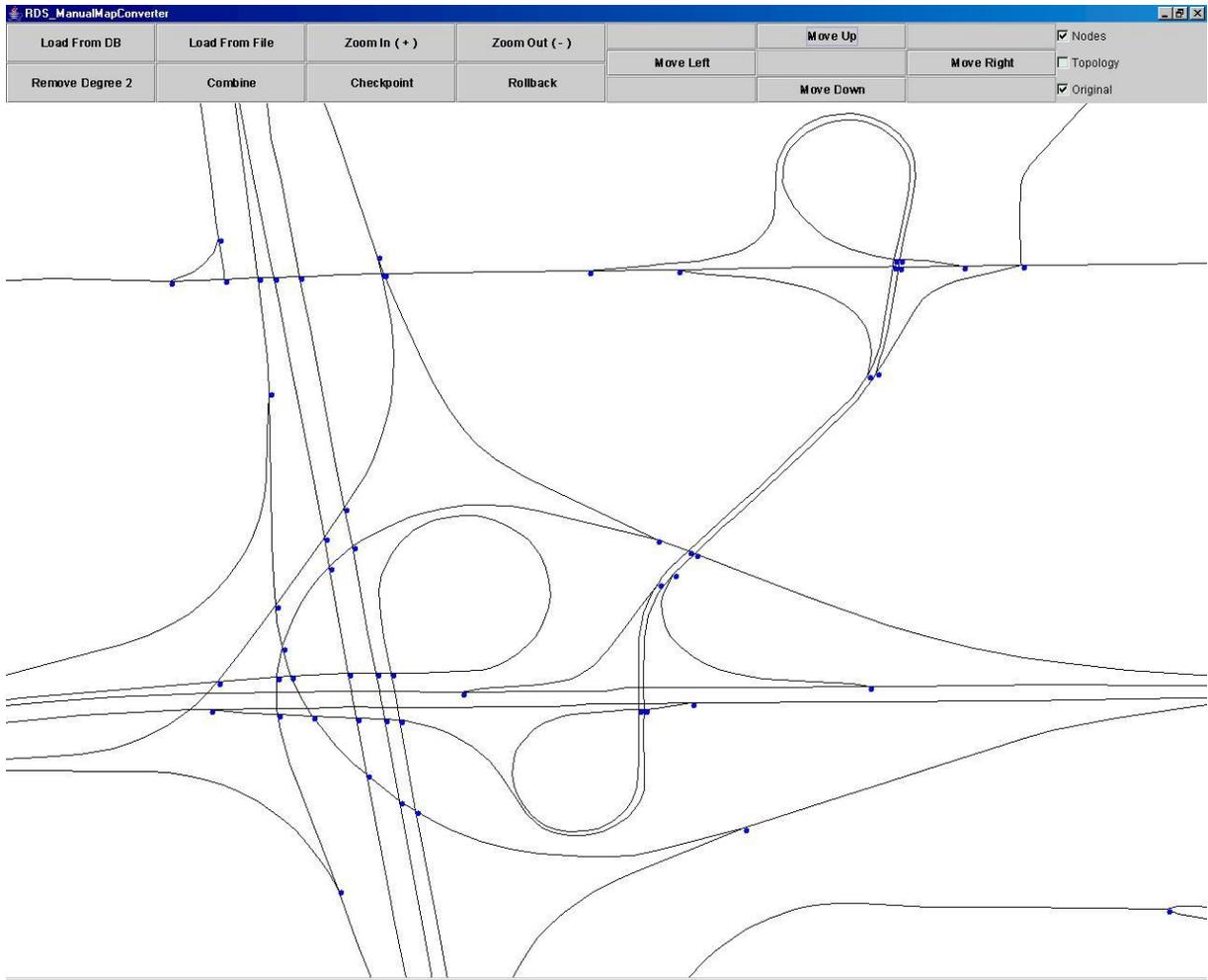
### 3.1 Translation of Dynamap to Network Topology

As suggested by FDOT, we adopted the TeleAtlas's Dynamap for this project. We developed a semi-automatic software application to convert Dynamap data to a traffic network topology used by the simulator and our RTRDS GUI. ArcGIS libraries are first used to read both the geometry and attributes of road segments from the Dynamap map files and output the information to an Oracle database. To use only major roads for route diversion, we select only freeways, ramps, highways, and state roads from the map. For more detailed information on the process of loading the commercial map database to the Oracle database, the reader can consult Appendix C.

The next step is to process freeway, road segments, and intersections (nodes). The system removes unnecessary nodes and edges as follows. All freeway segments that belong to the same freeway and are in between two exits/entrances are merged. Merging freeway segments simplifies the process of converting a freeway network to a Dynasmart-P topology because an endpoint of a merged freeway segment can be treated as an intersection between the freeway and a ramp or another freeway. This process also eliminates freeway segments that are shorter than the minimum segment length required by Dynasmart-P.

An intersection in Dynamap can consist of several segments, on which traffic needs to be coordinated as one intersection. However, Dynasmart-P requires each intersection to be represented as a single point. Besides, the names of segments that belong to the same road are not always consistent (e.g., road names suddenly changing, inconsistency in the use of abbreviations, and the field in which they are stored, etc.). Due to these issues, fully automated map conversion by software is not feasible. Instead, we developed the Topology Editor software (Figure 2) to facilitate and automate as much as possible the map conversion task, and to resolve complex scenarios with the help of the human user to assure accurate map conversion results. The Topology Editor displays the nodes and links of a map, and provides the user with four functionalities to edit the topology of the map as follows:

- The Topology Editor automatically removes from the map all intermediate nodes with degree two (i.e. those connecting only two road segments with the same road type). As an example, out of more than 17,000 nodes on major roads (excluding freeways) of Orange County, FL in our map database, there are over 15,000 such intermediate nodes; and thus the Topology Editor can initially reduce the size of the node set by 88%.
- The Topology Editor automatically removes nodes where one road overpasses another road. Dynamap segments roads at points of overpass, and labels the segments of each road with different elevation values. By comparing the values, the Topology Editor can merge the segments belonging to an overpass into one segment and does the same for the underpass.
- When multiple nodes and tiny segments are recognized as part of a logical intersection, the Topology Editor allows the user to select these nodes and combine them into one new node in the Dynasmart-P environment. Any segment that connects with an original node in the selection is connected to the new node.
- The Topology Editor permits the user to save the current topology with a checkpoint or to rollback to a previous checkpoint to undo changes.



**Figure 2. User interface of the Topology Editor.**

With this Topology Editor, we were able to convert the map of Orange County in less than one week, instead of several months.

### ***3.2 SunGuide® Adapter***

Figure 3 shows the design of the SunGuide® adapter. The main component of the adapter is a software program, called *Traffic Condition Consumer*. It continuously reads traffic condition data from the center-to-center (C2C) module, and assigns the traffic condition data of a C2C link (that is, a road segment as defined by the C2C provider) to the corresponding RTRDS link (a series of road segments logically grouped together in the RTRDS environment) using the C2C/RTRDS mapping table. This table contains the mapping between a C2C link and an RTRDS link. For more information on how the C2C/RTRDS mapping table is built, we refer the reader to Appendix C. As the Traffic Condition Consumer receives traffic data from the data provider through the C2C module, the Traffic Condition Consumer computes travel time data for the

corresponding RTRDS links, and stores them in the Travel Time database table in the RTRDS database.

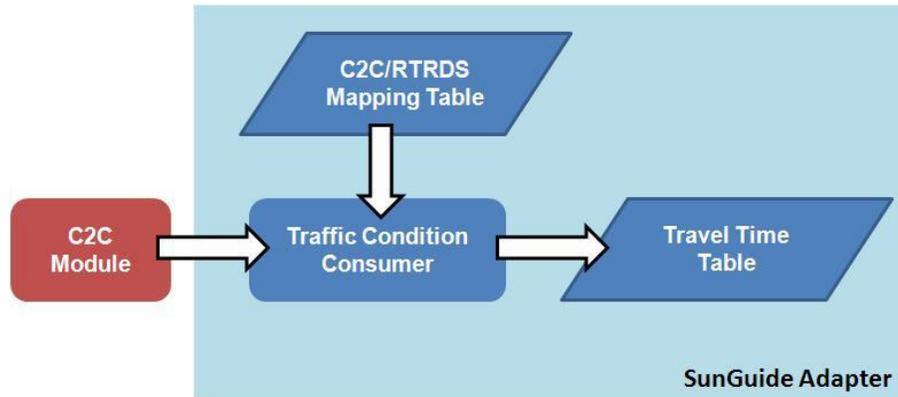


Figure 3 Design of the SunGuide® Adapter

### 3.3 Automatic Route Generator

The Automatic Route Generator utilizes Dynasmart-P for alternate route generation. A challenging task is to automatically generate input files for Dynasmart-P. More specifically, we have the state of the system stored in the database (the road map, current incidents, real-time and historical travel times, etc.). We need to develop logic to systematically transform this data, stored in a relational database, into the approximately 20 input files formatted specifically for Dynasmart-P. These input files model a given road topology and traffic conditions (including the incident). Once the input files are ready, the Automatic Route Generator runs Dynasmart-P and analyzes its output to generate and rank the feasible alternate routes (the system may suggest a single or multiple alternate routes). Human operators may then inspect these system-generated routes and make any changes if necessary. The steps for automated route generation are as follows:

- Step 1: The Automatic Route Generator starts by first isolating a sub-network area around the incident location (i.e., hot spot). This basically covers the freeway, several parallel arterial streets, and the DMS in the vicinity.
- Step 2: The system obtains travel times from the database. Current real-time traffic data are obtained from the loop detectors and other available sensing devices. These traffic data are used to automatically create the input files for Dynasmart-P. We assume that an incident occurs on a given link identified by its starting node  $ns$  and ending node  $ne$ .

- Step 3: The Automatic Route Generator runs Dynasmart-P with the input files prepared in Step 2.
- Step 4: The Automatic Route Generator analyzes the output file (VehTrajectory.dat) to identify the alternate routes given the incident. A route is deemed as an alternate route if it starts from the starting node  $ns$  and ends at the ending node  $ne$ . If multiple alternate routes exist, routes with quality above a pre-defined threshold are returned. They are ranked based on the number of vehicles that have traveled on these routes during the simulation. Thus, an alternate route with a better traffic flow is considered having better quality and is ranked higher among the alternate routes.

Overall, the objective of the Automatic Route Generator is to compute the optimal traffic flows that minimize the total system travel time for a network with known time-dependent demand. In other words, the system is trying to envision the traffic volumes of the roads in an ideal situation.

### ***3.4 RTRDS - Application Scenarios***

In this section, we discuss five different application scenarios of the RTRDS. It will be clear that some of these new capabilities are highly desirable in practice.

#### **3.4.1 Pre-plan a Diversion Plan**

This is probably the most common scenario. Many incidents can be foreseen; and their diversion plans can be planned in advanced as follows.

- Use the RTRDS as a computer-aided tool to develop the various diversion plans
- Discuss the alternative plans with the panel of experts including the local authority to select the best plan
- Enter information such as interagency agreements and incident clearance policies.
- Record information on the contact persons

When an incident occurs, a TMC operator can utilize the RTRDS to search through the database of pre-planned diversion plans. Any matched route diversion plan is brought to the operator for review if one exists. The operator will need to review and approve the route diversion plan before any DMS/HAR/Cell phone messages are dispatched. Only after the operator approves the plan, will the requests be sent to the devices around the incident area, which also marks the start of the plan execution.

### **3.4.2 When Pre-defined Plans Cannot be Used**

When an incident occurs, the pre-defined diversion plan sometimes may not be used due to an unforeseen event such as road construction or secondary incident. In this situation, the TMC operator can request the RTRDS to immediately generate currently feasible alternate routes. Based on their ranking, the operator can decide on the best alternate routes for the incident. As in the case of a pre-defined plan, the system-generated plan must also go through the operator for approval. Based on the operator's own judgment and experience, he/she can make necessary modifications to the diversion routes before they are deployed.

### **3.4.3 When No Pre-defined Plan Is Available**

It is not feasible to anticipate and construct route diversion plans for every possible incident. There are times when an unforeseen incident occurs and no previously-constructed diversion plan is available. When this happens, the ability to use the RTRDS to generate an optimal plan within minutes is invaluable. The TMC operators would be able to discuss the system-generated plans with the local authorities to quickly select and deploy the best plan. For some of such unforeseen incidents, quick response is sometime critical and an automatic route diversion management system can play an essential role. At the end of the incident, the RTRDS provides the option to save the current plan to the database for possible future use.

### **3.4.4 When a Good Plan Becomes Inadequate**

A plan in execution may need to be adjusted due to the dynamics of the traffic. This can be done simply by requesting the RTRDS to re-assess the current plan, and generate better ones as necessary based on the latest information on road conditions. Such adjustment can be done as frequently as necessary until the current incident is cleared.

### **3.4.5 When Multiple Incidents Occur**

Multiple incidents can occur in a number of ways. Some examples are as follows. An incident can cause secondary incidents. There can also be a situation, in which unrelated incidents occur near each other within a close proximity of time. When such multiple-incident scenarios occur, the user can register each incident separately with the RTRDS. Since the system takes into consideration the real-time road conditions, the alternate routes automatically generated for each incident takes into consideration the effect of the other concurrent incidents.

## **3.5 Workstation GUI**

The workstation graphical user interface (GUI) is a web-based application, which allows the user to interact with the RTRDS. The following list is the main items the user can accomplish through the GUI:

- Create and edit an incident. Retrieve an existing incident from the application database.
- Create, edit, view, and approve a diversion plan. Search for existing plans from the application database.
- Create an override travel time for a road segment.
- View diversion plans and incidents on the map.

Figure 4 shows the main GUI, which consists of the street map in the center section, and a menu on the upper portion of the page. The map view permits the operator to zoom and pan the map. By utilizing the menu, the operator may create new incidents and new plans, and search for existing plans, etc.

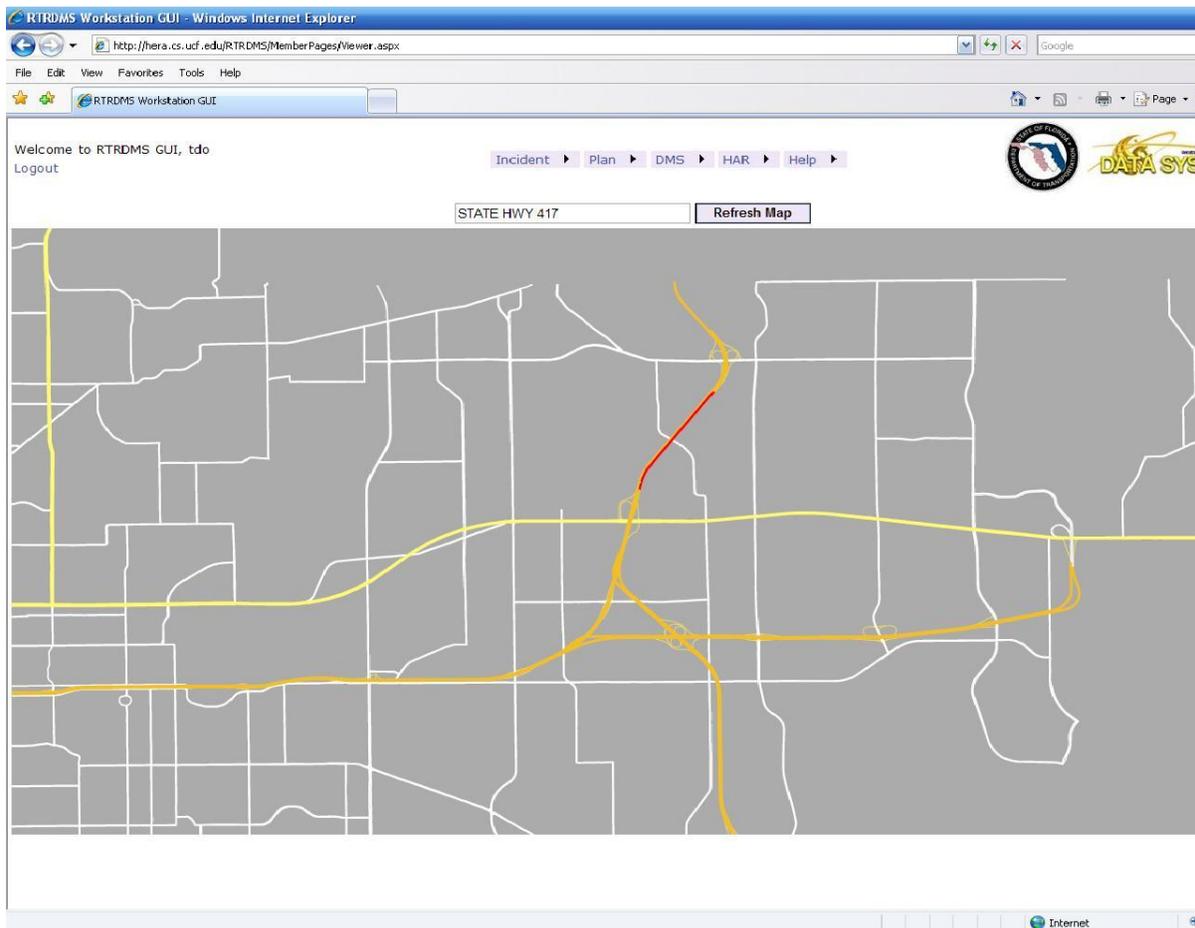


Figure 4. The Workstation GUI main page.

### 3.5.1 Map Features

The operator can zoom and pan the map. As the zoom level increases, additional details are visible as shown in Figure 5, Figure 6, and Figure 7.

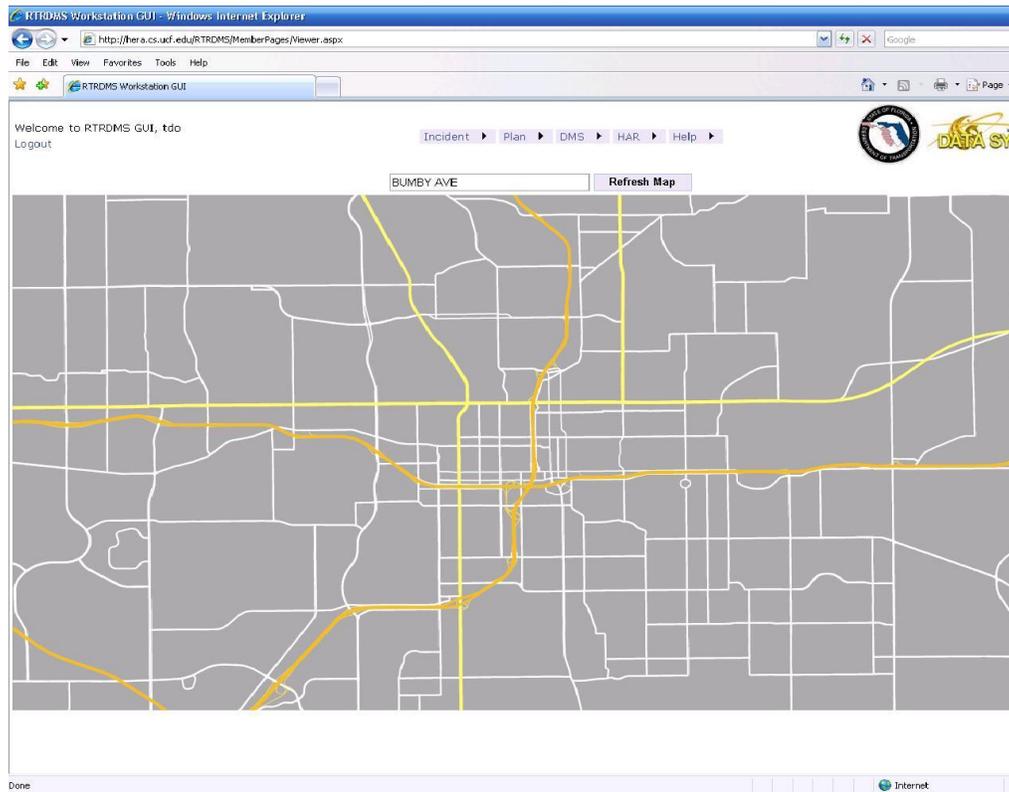


Figure 5. Map view, zoomed far away.

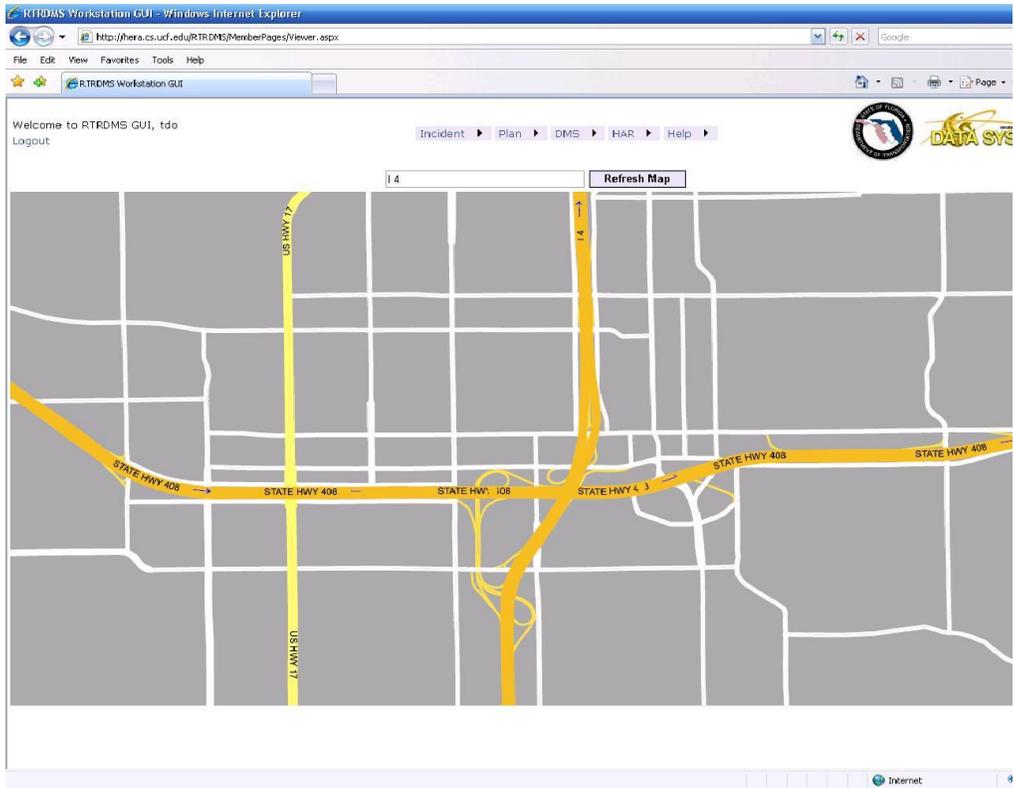


Figure 6. Map view, medium zoom.

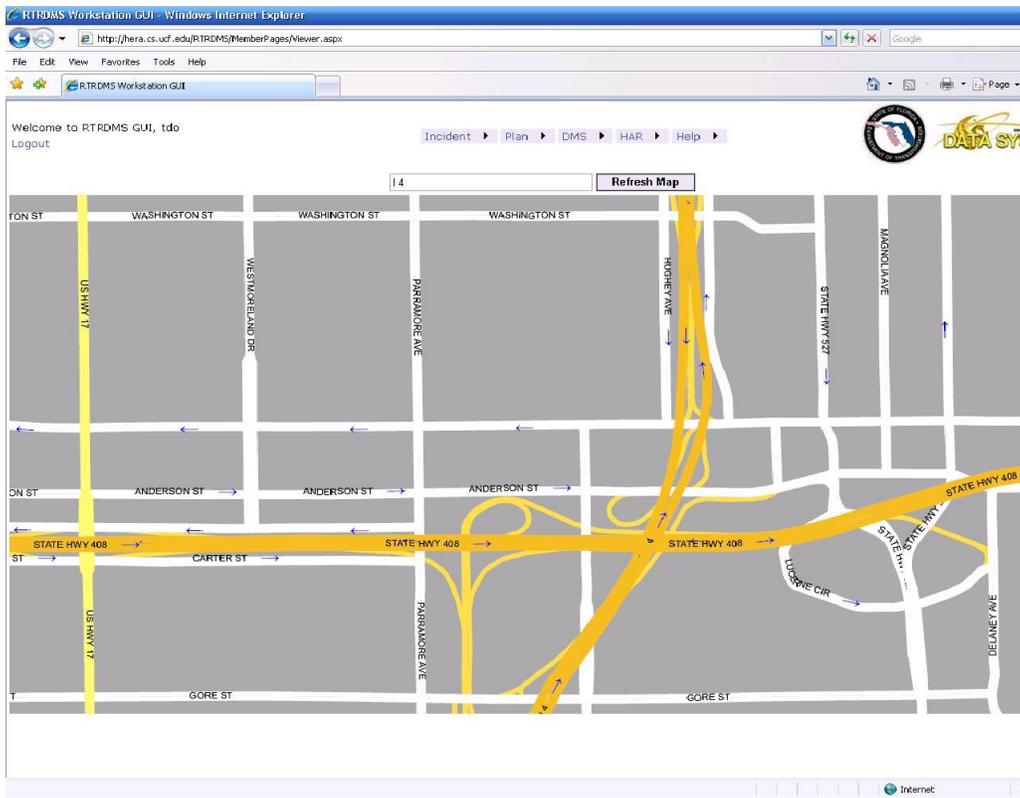


Figure 7. Map view, close-up zoom.

### 3.5.2 The Map Context Menu

The context menu is opened as a pop-up window when the user clicks on a link of the map as shown in Figure 8. The user has two options: update the travel time for the link, or create a new incident on that link. Notice that the selected link is highlighted in red in the map for better emphasis.

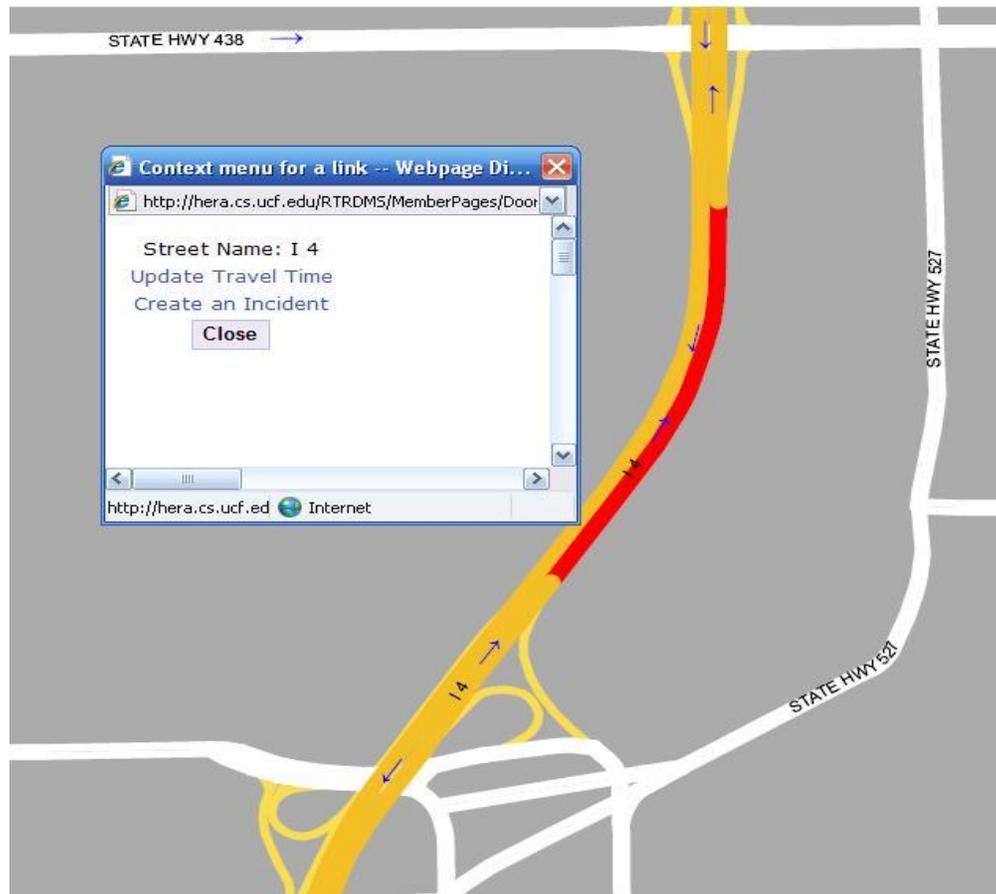


Figure 8. Map context menu.

### 3.5.3 Updating Travel Time for a Link

When the user clicks on the **Update Travel Time** hyperlink as shown in Figure 8, the window shown in Figure 9 is opened. The read-only part shows the current information of the street.

- **Street Name:** The name extracted from the original Dynamap file of the street.
- **Measured Travel Time:** Default to 0 (minutes). If travel time data for the street is available from SunGuide®, this field shows that value.

- **Override Travel Time:** Under some circumstance (e.g., real-time data is not available and the historical data is not reliable), the user can enter an override travel time for the street using this data field.
- **Duration From and To:** The effective period of the override travel time.

The second part, under **Override Info**, is editable:

- **New Travel Time:** Used to replace the current Override Travel Time value.
- **Duration:** Specify the effective time duration for the newly entered travel time.

When the user clicks the **Save** button, the new information will be saved to the database. Clicking the **Close** button will close the window.

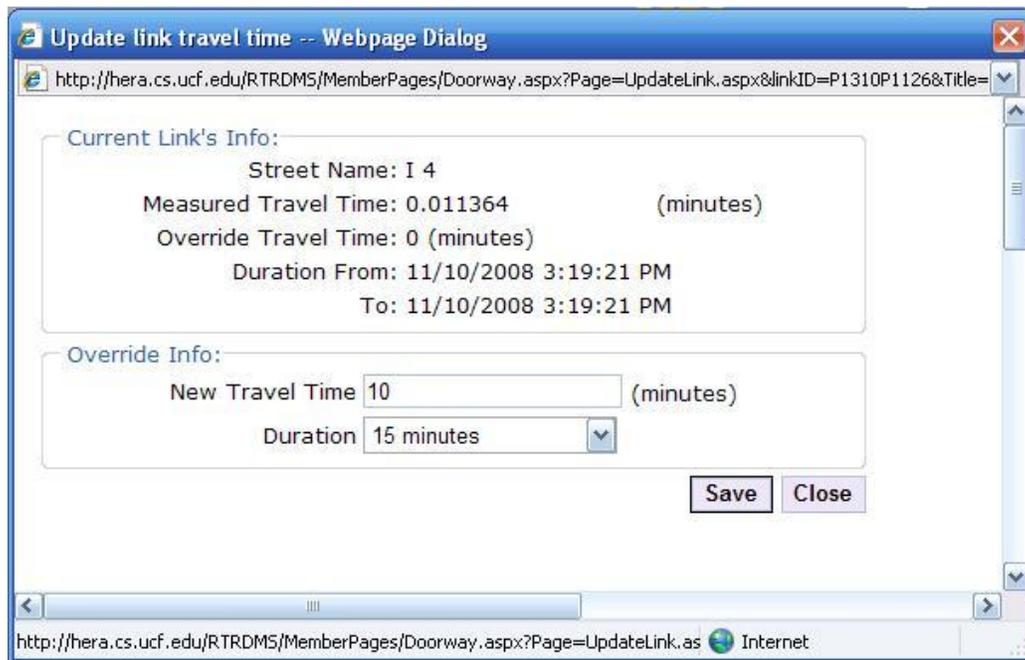


Figure 9. Update travel time for a link.

### 3.5.4 Creating a New Incident

The window, shown in Figure 10, allows the user to create a new incident. The **Incident ID** section shows the **Operator ID** and **Incident ID**. This section of the web page is read-only.

The **Incident Location** section shows the location of the incident. Note that we default the location of the incident to the middle point of the selected street. There are four data fields in this section:

- **INT\_ID1:** The id of the starting node of the selected street. This part is read-only.
- **INT\_ID2:** The id of the ending node of the selected street. This part is read-only.
- **Latitude:** The latitude of the incident location. This part is editable.
- **Longitude:** The longitude of the incident location. This part is editable.

The **Incident Info** section contains other relevant information of the incident as follows:

- **Description:** The description of the incident. This part is editable.
- **Start Time:** The start time of the incident. This can be the time the operator first receives the report on the incident. This part is editable.
- **Creation Time:** The creation time of this incident entry. This part is read-only and is default to the system time when the user creates this incident entry in the application.
- **Severity:** This entry indicates the severity of the incident. The user can select one of three levels, 1, 2, and 3, with level 3 being the most severe level. This part is editable.

When the user clicks the **Save** button, the new information will be saved to the database. Clicking the **Close** button will close the window.

Figure 10. Create a new incident.

### 3.5.5 Creating a New Plan

Creating a plan can be done in three different ways: by copying an existing plan, by manually creating a new plan, and by utilizing the Automatic Route Generator to generate a new plan. We discuss these options in this subsection.

#### Creating a plan from an existing plan.

Given an incident, the user can search for an existing plan in the database to serve as the initial diversion plan or the final diversion plan of the current incident. The user can search for a plan based on time and location as shown in Figure 11:

- **Search Period:** Use this criterion to limit the search to only plans that have been created within a certain period from the creation time of the current incident.

- **Search Radius:** Use this criterion to limit the search to only plans whose locations are within a defined radius from the location of the current incident. If the box is left empty, all plans will be considered.
- **Search button:** When the search criteria are ready, clicking the Search button will search the database.
- **Search Results:** This section displays existing plans that satisfy the specified conditions on time and location. The displayed results are sorted based on distance first, then by time.

To select a plan, select an item in the **Search Results**, then click the **Select & Close** button.

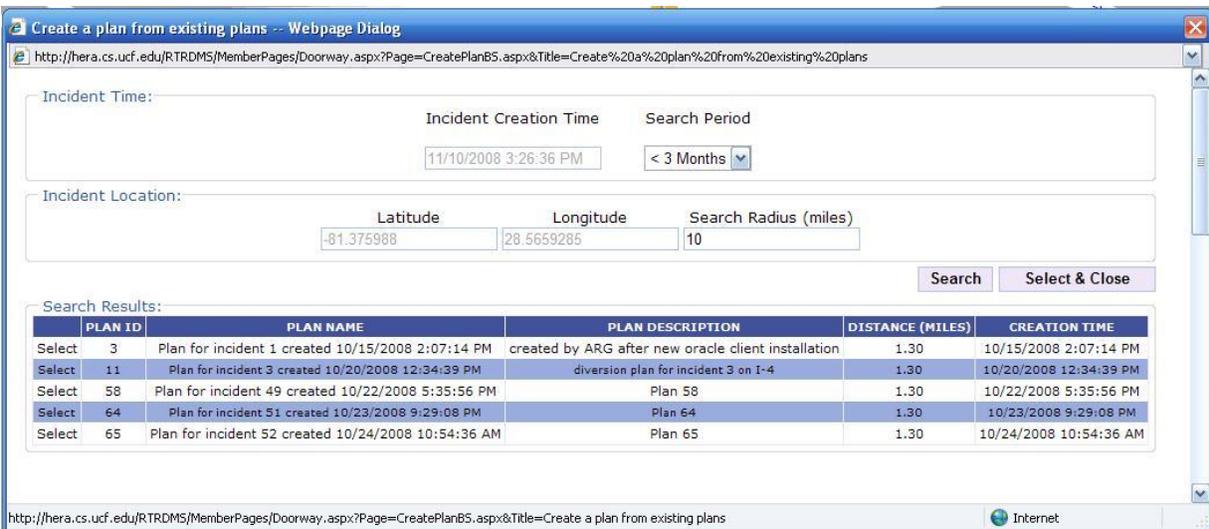


Figure 11. Search for an existing diversion plan.

### Creating a plan manually.

The window shown in Figure 12 allows the user to create a plan manually. The **Plan ID** section shows the **Operator ID**, **Plan ID**, and **Plan Name**. This section of the web page is read-only.

The **Plan Location** section shows the location of the incident. The plan location is default to the location of the incident this diversion plan is created for. This part is editable.

The **Plan Info** section contains other relevant information of the plan.

- **Description:** This is the description of the plan. This part is editable.
- **Creation Time:** This is the creation time of this plan. This part is read-only and default to the system time when the user creates this diversion plan entry in the application.

When the user clicks the **Save** button, the new information will be saved to the database. Clicking the **Close** button will close the window. Clicking **Create Plan** button will open the window that allows the user to edit the topology of the plan on a map. For further information on editing the topology of a plan, the reader is referred to Section 3.5.6 .

The screenshot shows a web browser window with the following form fields and controls:

- Plan ID:**
  - Plan ID: 80
  - Operator ID: Operator
  - Plan Name: Plan for incident 61 created
- Plan Location:**
  - Latitude: 28.5659285
  - Longitude: -81.375988
- Plan Info:**
  - Description: Manually create a plan for incident 61
  - Creation Time: 11/10/2008 16:07:01

Buttons: Create Plan, Save, Close

Figure 12. Create a plan manually.

### Creating a plan with the Automatic Route Generator.

The user can request the system to generate a plan automatically using the window shown in Figure 13. The **Plan ID**, **Plan Location**, and **Plan Info** parts are similar to the above section on creating a plan manually. There are two additional buttons:

- **Generate Diversion Plan** button: Clicking this button evokes the application to generate a diversion plan automatically.
- **View Diversion Plan** button: The user can click on this button to view the generated plan. For further information, the reader is referred to Section 3.5.8 .

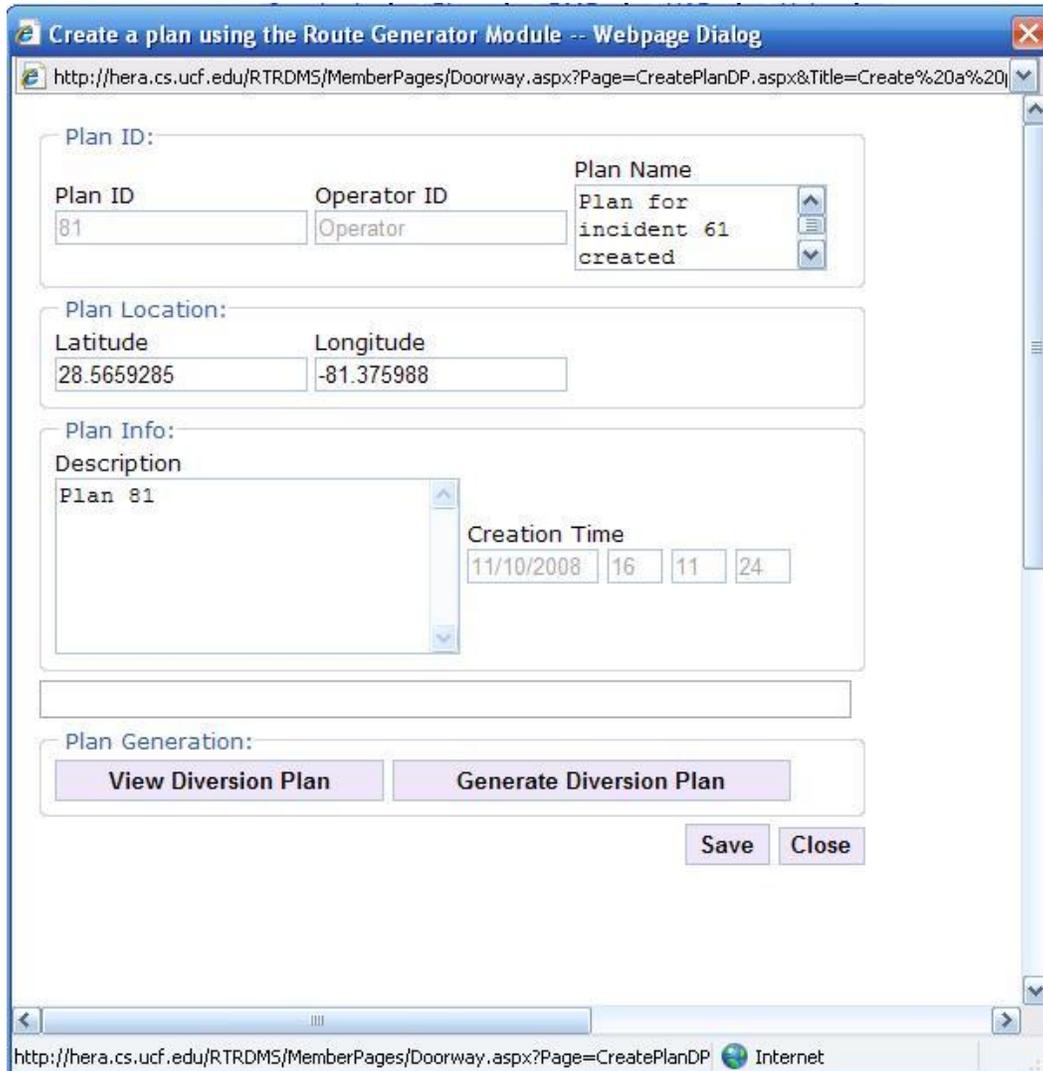


Figure 13. Create a plan automatically.

### 3.5.6 Editing a Plan

Figure 14 shows the page to edit a diversion plan. There are two editing modes, **Plan Editing** mode and **Route Editing** mode. In the **Plan Editing** mode, the user can add or remove a route from the diversion plan. In the **Route Editing** mode, the user can add or remove a link from the selected diversion route. To change to Plan Editing mode or Route Editing mode, the user can uncheck or check the **Change Mode** select box, respectively.

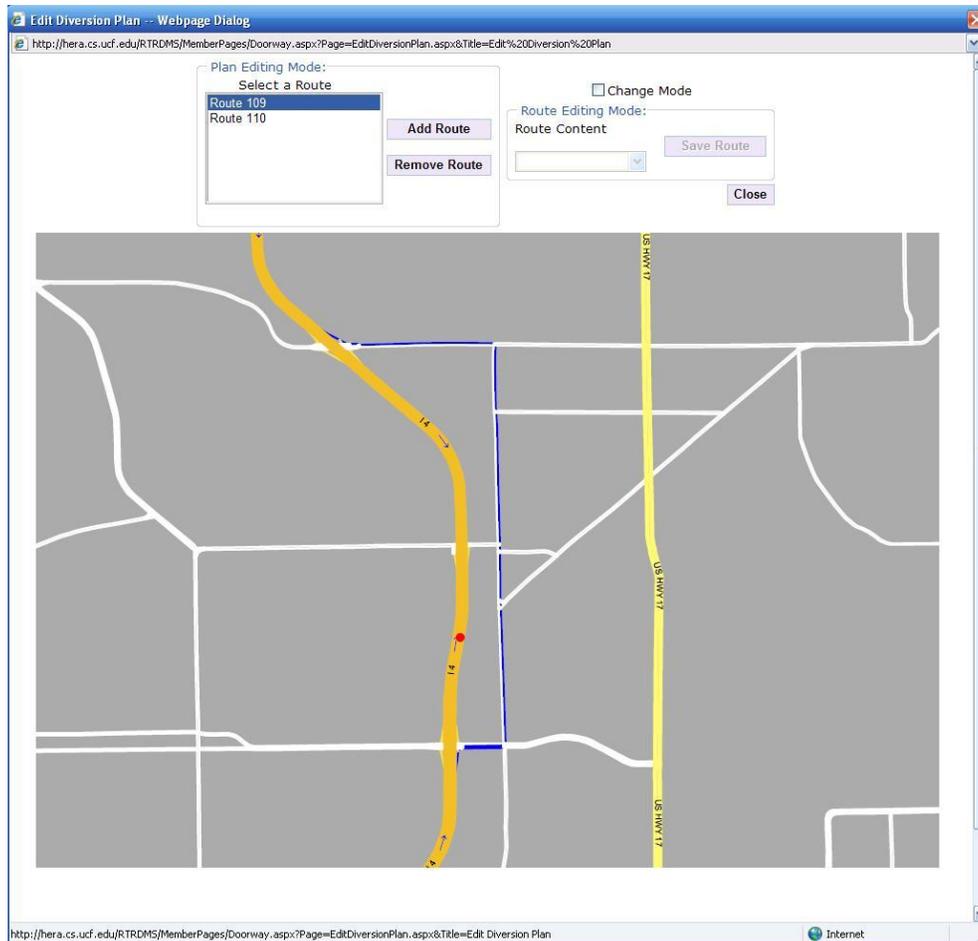


Figure 14. Edit a diversion plan.

### 3.5.7 Approving a Plan

Figure 15 shows the page to approve a plan. The **Approve Plan** page is similar to the **Create a Plan Manually** page described in subsection 3.5.5 with the following additional information:

- **Associated Information** section: this section allows the user to enter associated information including interagency agreements, incident clearance policies, and contact persons.
- **Approve Plan** button: clicking on this button will approve the plan.
- **View Diversion Plan** button: the user can click on this button to view the plan topology. For further information, the reader is referred to the subsection 3.5.8

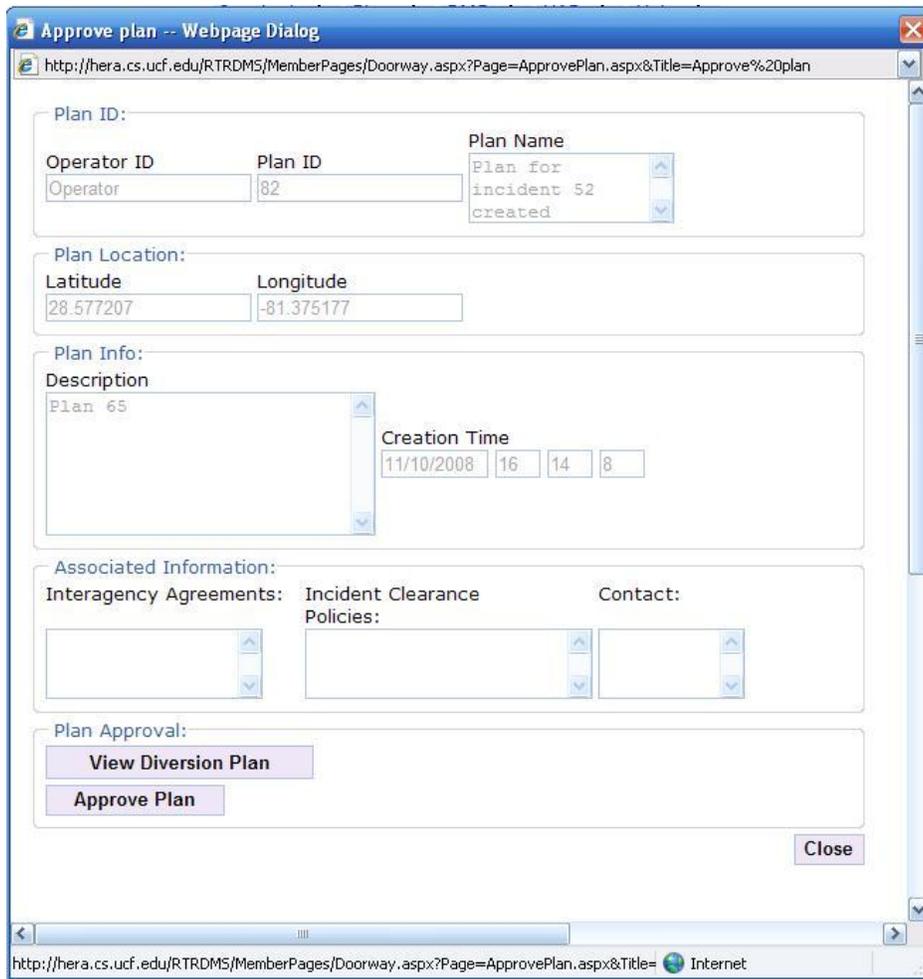


Figure 15. Dialog to approve a plan.

### 3.5.8 Viewing a Route Diversion Plan

As shown in Figure 16, the operator may select an alternate route, from the list of alternate routes associated with a given diversion plan. When a route is selected, all road segments associated with this alternate route are highlighted on the map in blue color as shown in Figure 16. The user can also select a link's description in the textbox, and the corresponding link will be highlighted in red color on the map.

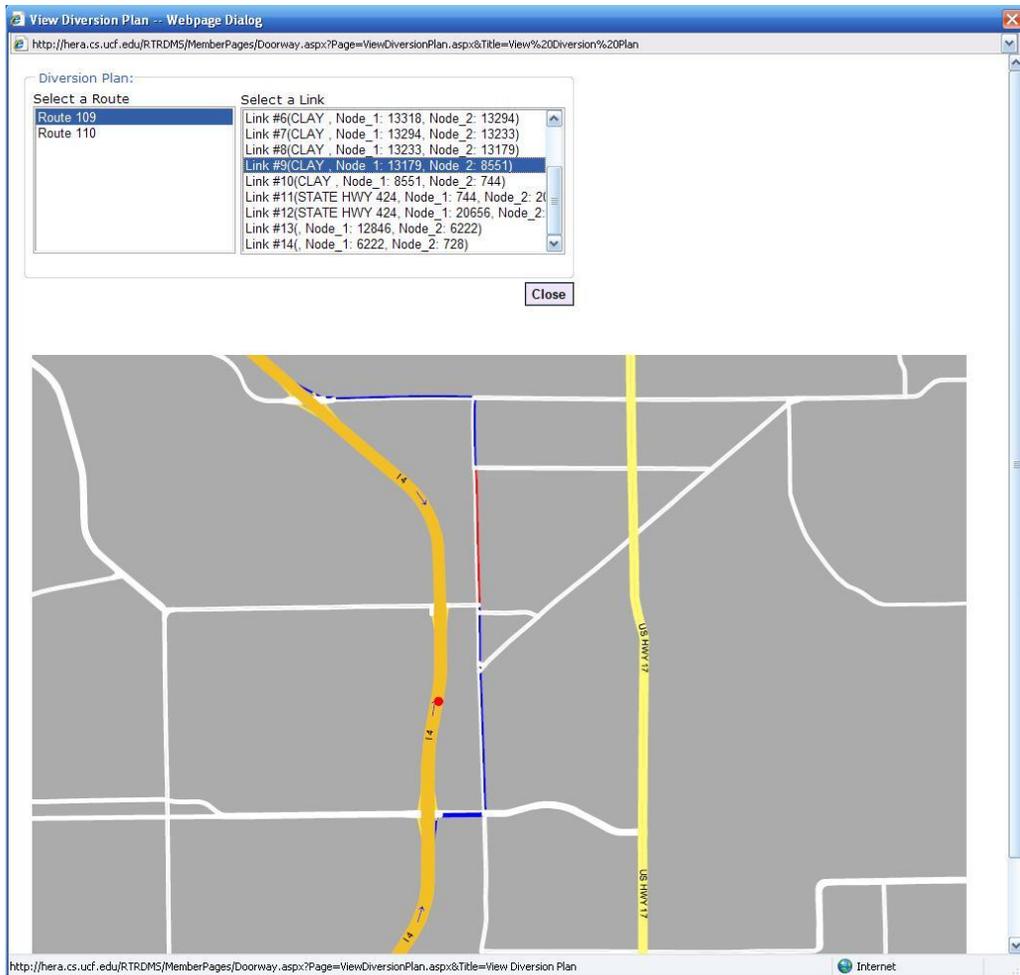


Figure 16. View a diversion plan on the map.

### 3.5.9 Assisting the Operator to Interact with SunGuide® DMS/HAR Modules

RTRDS provides a centralized place for the user to visualize and verify incident information as well as the system-suggested diversion plan. In Figure 17, important information of the incident is displayed in the upper left area of the page. For more incident details, the user can click on the **Incident Details** button. Text-based description of the diversion plan is displayed in the upper right area of the page. Each diversion plan can have multiple alternate routes. Each alternate route is presented as a series of names of road segments. This series of names of the road segments forms a message, which gives the user a precise way to describe each alternate route. The lower half area of the page visualizes the incident location and the diversion plan on a street-level map. The selected diversion route is highlighted on the map with a distinct color in blue. When the description of a diversion link is clicked, that link will be highlighted in a red color on the map.

From this page, the user can directly open the SunGuide® DMS/HAR dialogs by clicking the **SunGuideDMS** and **SunGuideHAR** buttons, respectively. The user can easily convert the provided RTRDS message into a DMS/HAR message, and enter the DMS/HAR message using the dialogs as shown in Figure 18 and Figure 19. Finally, the DMS and HAR messages can be displayed on the Intelligent Transportation System devices when the user clicks the **Send Message** button in Figure 18 and Figure 19, respectively.

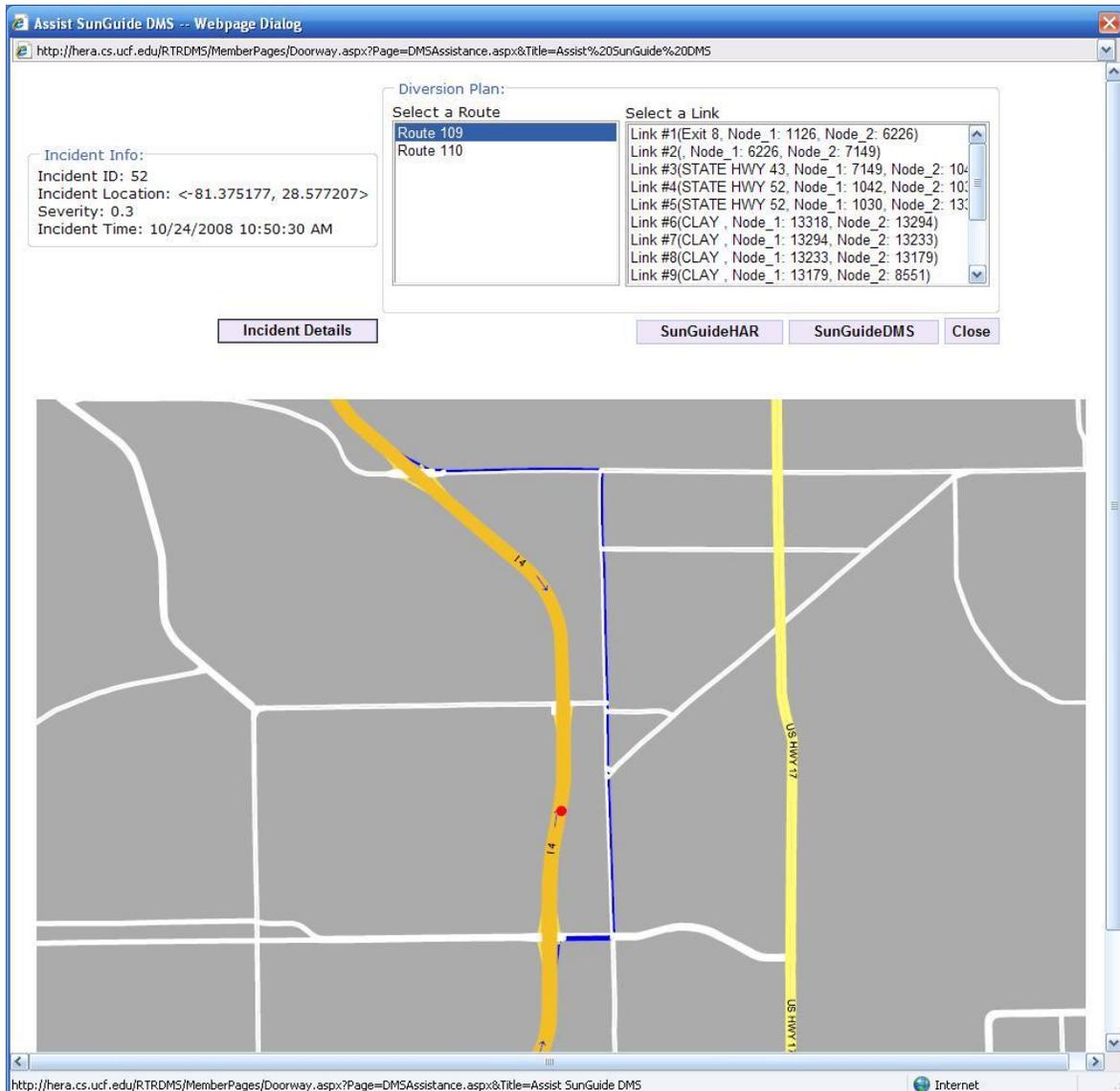


Figure 17. Assist operators to interact with SunGuide® DMS/HAR modules.

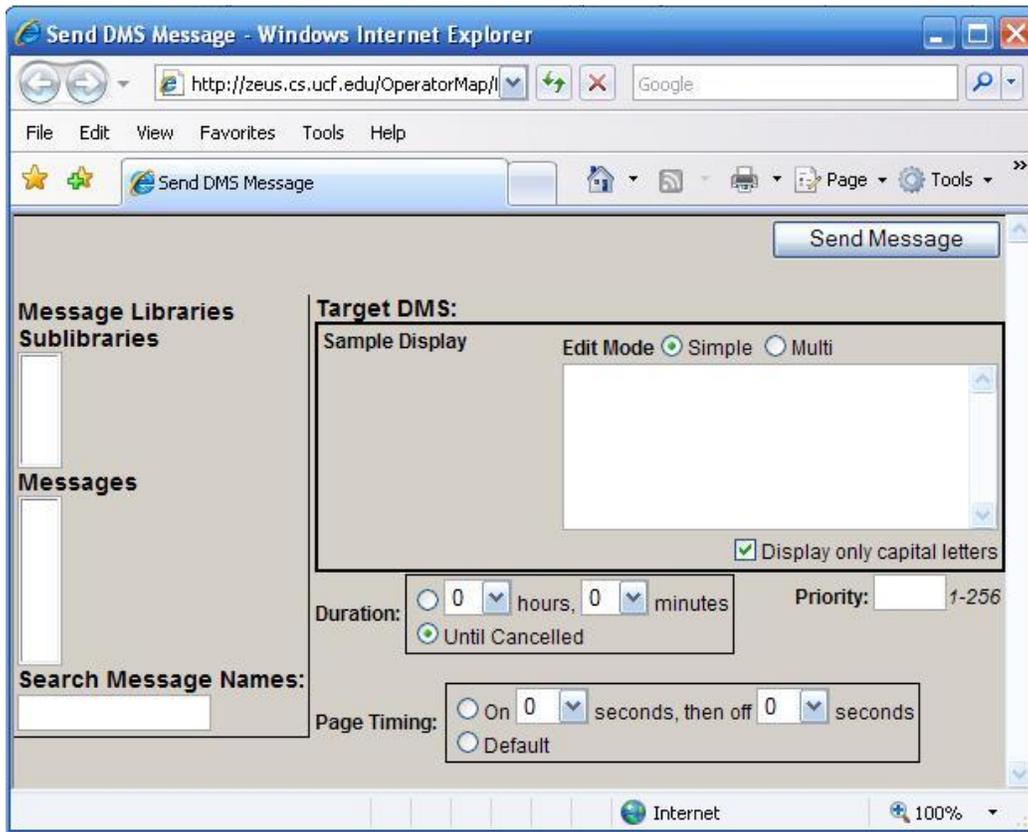


Figure 18. Dialog for SunGuide® DMS Module.

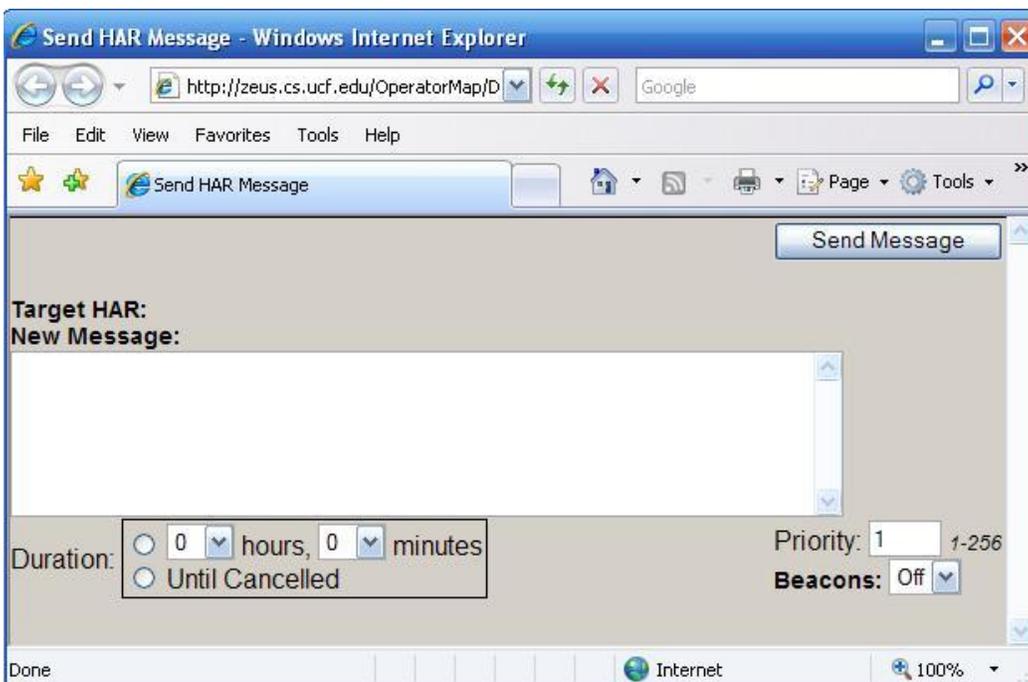


Figure 19. Dialog for SunGuide® HAR module.

### 3.6 Mobile GUI

The RTRDS mobile GUI utilizes cellular telephone-based web browsers to display incident and route diversion information. Figure 20 shows two types of map views that may be viewed: (1) a view showing a single intersection, displaying the street segments connected directly to said intersection and indicating which segments traffic may flow upon, in accordance to the current route diversion plan, and (2) a map of the area surrounding an incident and the alternate route. The purpose of the first view is to make it easier for police officers who may be directing traffic or other workers who may be setting up route diversion equipment.



Figure 20. Cellular-based GUI designed for use with mobile web browsers, facilitates dissemination of route diversion information.

## Chapter 4 System Evaluation and Results

As part of the system evaluation, we have successfully demonstrated the RTRDS to FDOT and FDOT District 5 office members on three occasions [23][24][25]. In this section, we describe systematically how we evaluate the system to satisfy the project requirements.

### 4.1 Task 4 Results

Task 4 is stated as follows in the Scope of Services:

*Apply FHWA DYNASMART Model to Test Results*

*Coordinate with FDOT TMCs regarding the test cases to be used in this modeling task. The Coordinator must provide FDOT a report with DYNASMART input data and output results.*

To accomplish this task, we worked with District 2. Mr. Peter Vega provided us real data and two test scenarios. This section provides the route diversion plans generated for these two test scenarios to satisfy Task 4 in the scope of services. In this study, road capacities are estimated using speed ratings, extracted from TeleAtlas Dynamap data.

#### 4.1.1 Test Scenario 1

In the test scenario 1, there is an accident on I-95 south bound. The incident is shown as a black dot in Figure 21. Given this incident, our system selects a bounding rectangle and calls the RTRDS core to generate alternate routes. Figure 22 shows that the Dynasmart-P simulator is running based on the automatically generated input files. In Figure 22, the accident is represented by a red triangle. Two alternate routes are generated by the RTRDS core. The first route is shown as thick red lines in Figure 23. This alternate route bypasses the incident and re-directs the traffic back to the freeway. The second route is shown in Figure 24 as thick red lines as well. This route also bypasses the accident and directs traffic back to the freeway, but from the other side of the freeway. Between these two routes, our simulation shows that 88% of the traffic takes the first route, while the remaining 12% of the traffic takes the second route. This observation is expected because the first route utilizes a highway (US-1), and the secondary route uses smaller roads.

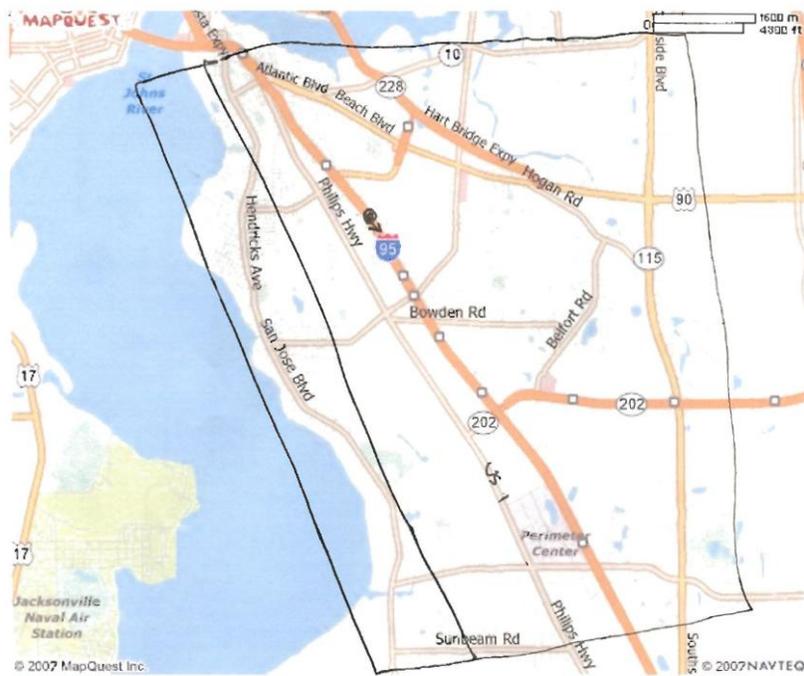


Figure 21. The first accident scenario on I-95 south bound, drawn by Mr. Vega of FDOT District 2.

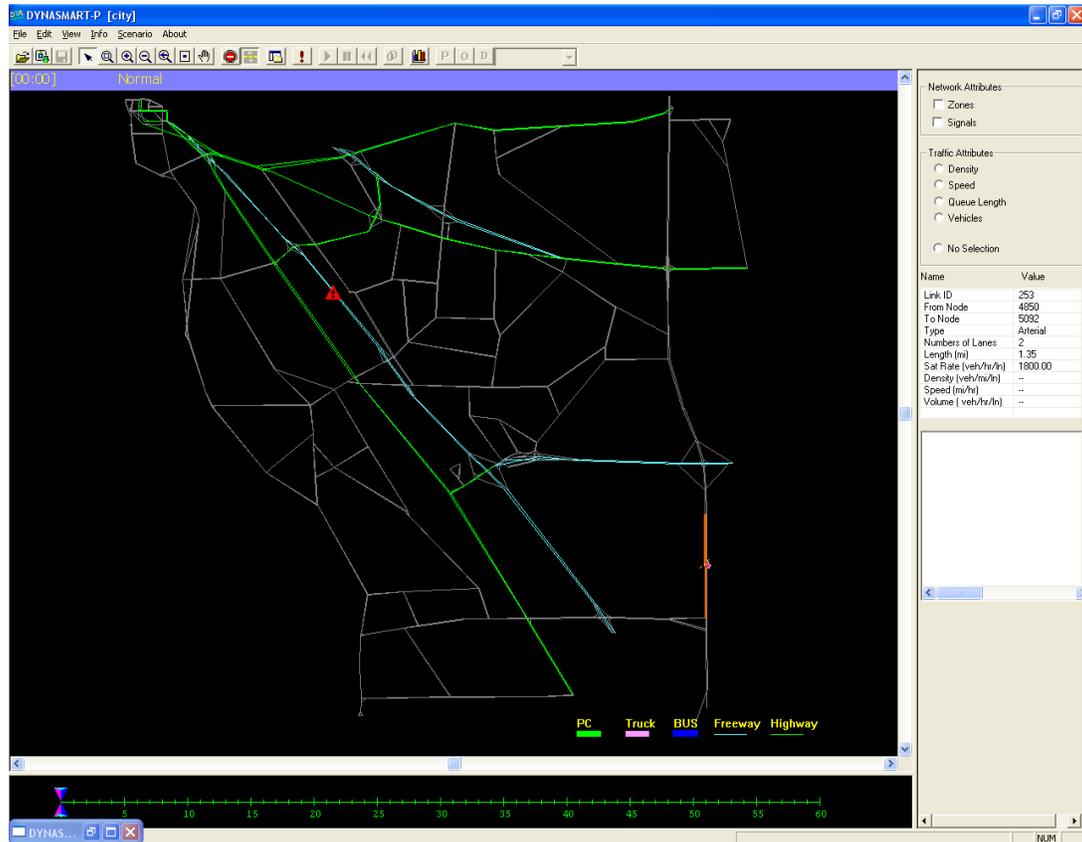


Figure 22. Dynasmart-P is executing test scenario 1.

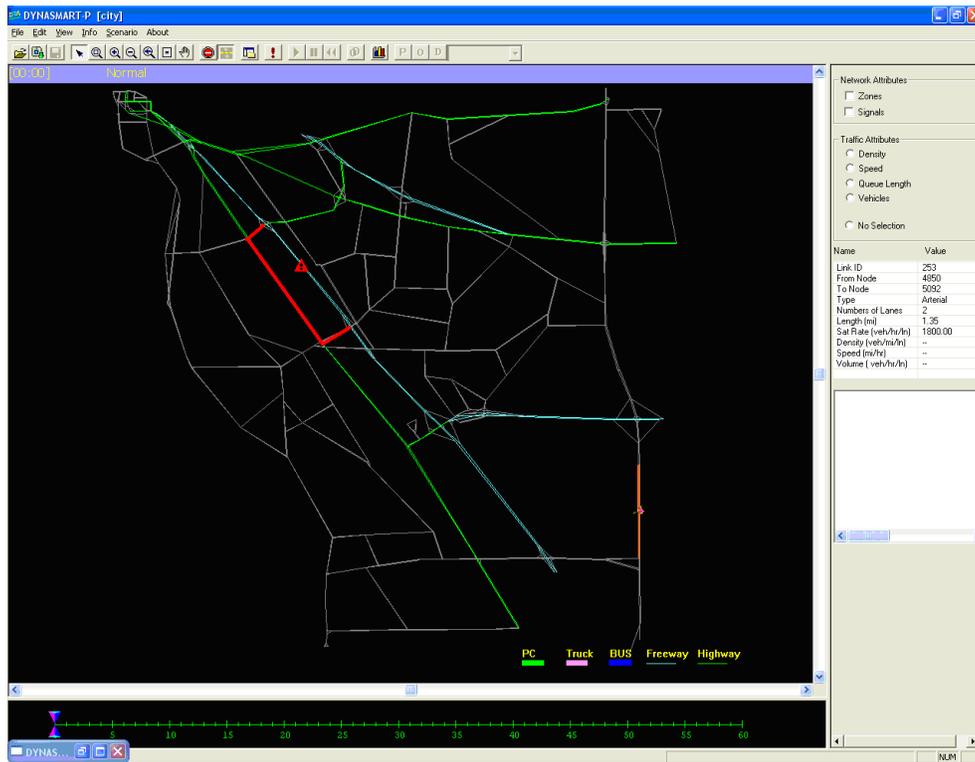


Figure 23. The first generated route for test scenario 1 (red segments in the center of the map).

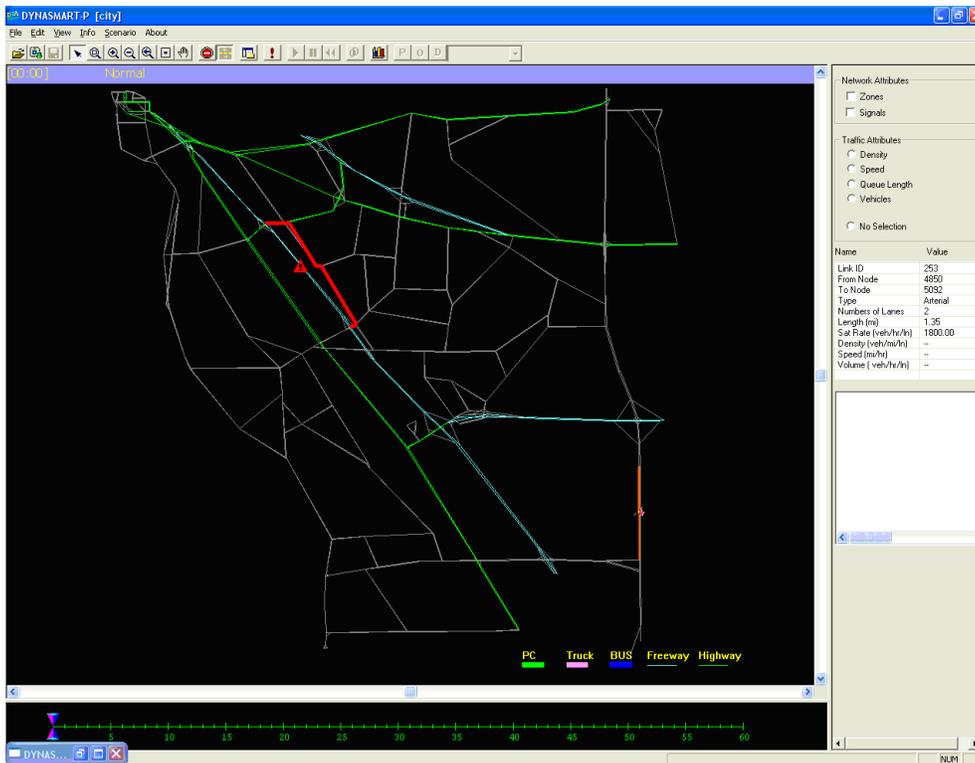


Figure 24. The second generated route for test scenario 1 (red segments in the center of the map).

### 4.1.2 Test Scenario 2

In the second test scenario, an accident occurs on I-10 east bound. The incident is shown as a black dot in Figure 25. Similar to the test scenario 1, our system selects a bounding rectangle and calls the RTRDS core to find alternate routes. Figure 26 shows that the Dynasmart-P simulator is running based on the automatically generated input files. In Figure 26, the incident is represented by a red triangle.

Multiple alternate routes are generated by the RTRDS core in this test. The three most significant ones are drawn in thick red lines in Figure 27, Figure 28, and Figure 29, respectively. The route shown in Figure 27 has the highest traffic volume, which accounts for about 65% of the traffic. Since the location of the accident is right after the merging of I-10 and the Roosevelt Expressway, the three alternate routes generated by our RTRDS core all start from an exit point of Roosevelt.



Figure 25. The second accident scenario on I-10 east bound, drawn by Mr. Vega of FDOT District 2.

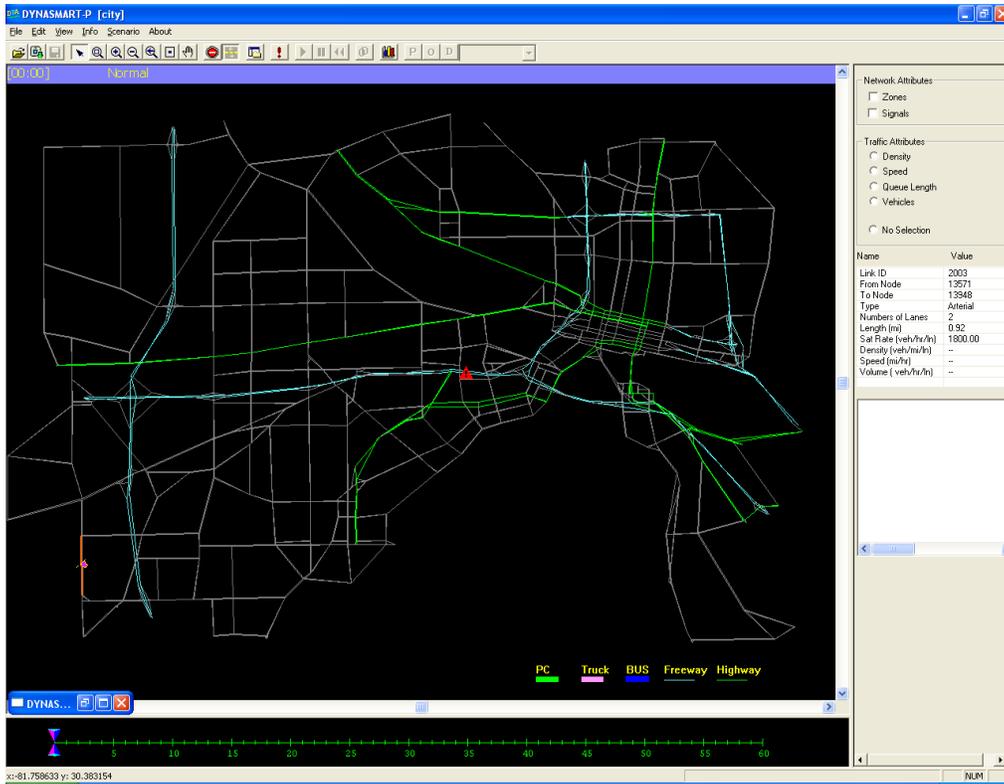


Figure 26. Dynasmart-P is executing test scenario 2.

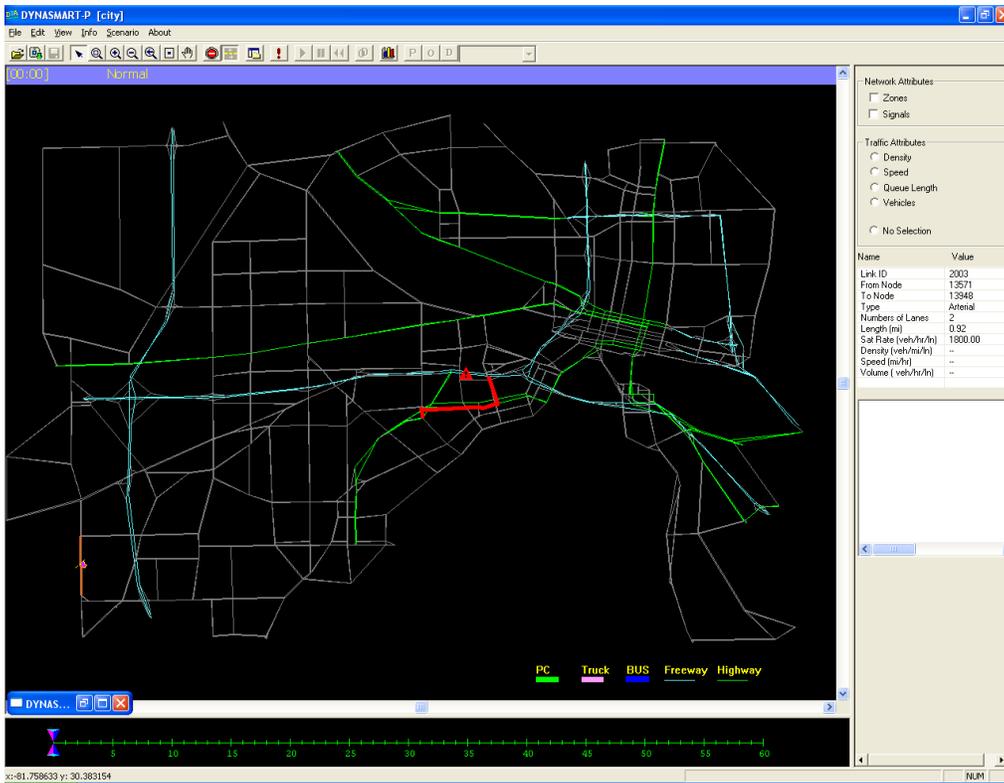


Figure 27. The first generated route for test scenario 2 (red segments in the center of the map).

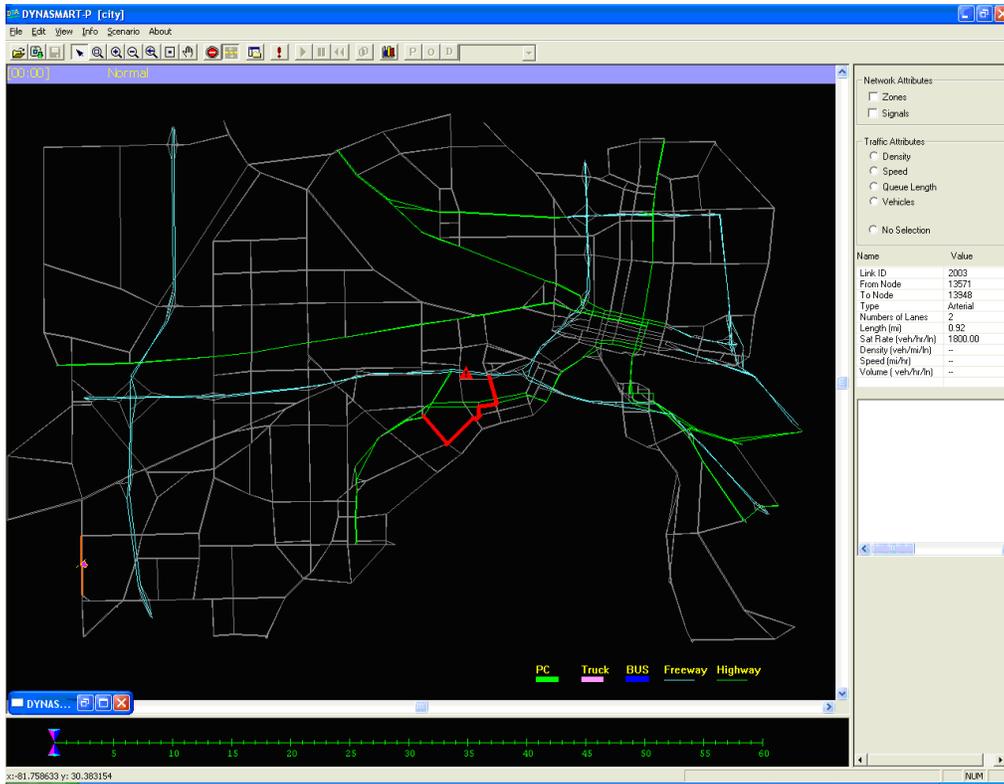


Figure 28 The second generated route for test scenario 2 (red segments in the center of the map).

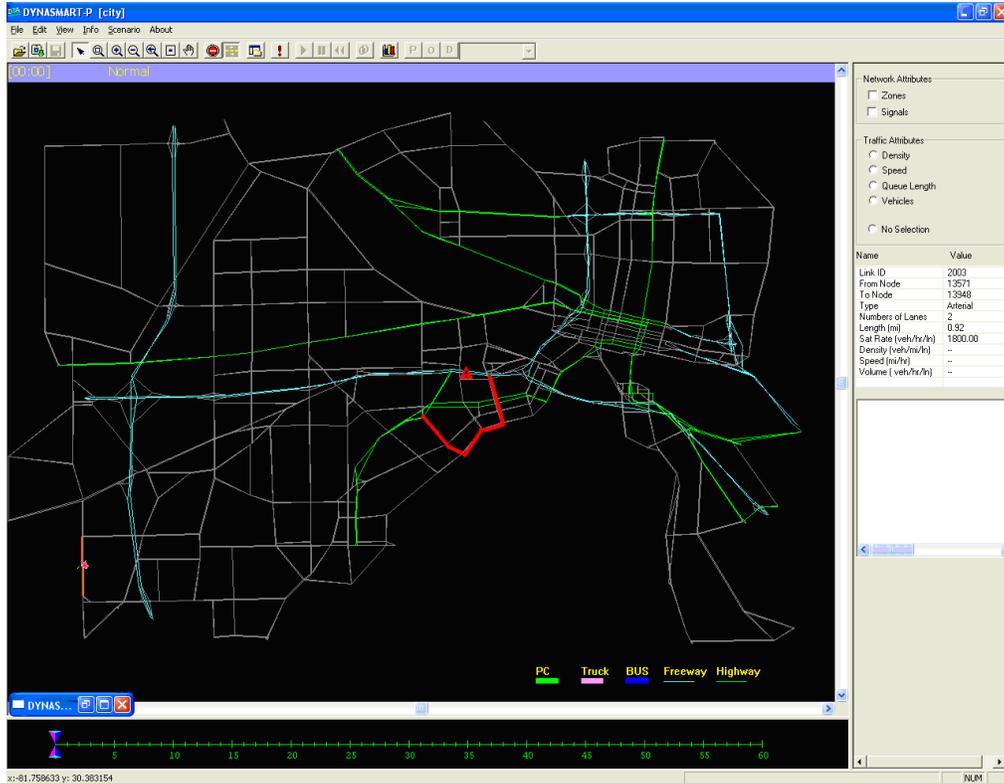


Figure 29. The third generated route for test scenario 2 (red segments in the center of the map).

## **4.2 Task 5 Results**

This section provides two test scenarios for Task 5 of the RTRDS scope of services. Mr. Peter Vega of FDOT District 2 provided the real travel time on I-95, which was used in this task to study the effectiveness of the system.

Task 5 is stated as follows in the Scope of Services:

*Develop Realistic Simulation Model to Evaluate the STEMS (Smart Traffic Evacuation Management System) (Note: RTRDS was initially called STEMS in the Scope of Services)*

*The Contractor must be able to verify before and after results of the system based upon realistic simulation. To accomplish this task, the Contractor shall develop the necessary software and investigate the possibility of using real-time incident data from the District 5 Central Data Warehouse. In addition, meaningful graphical user interface must be included in the implementation to visualize the effectiveness of the STEMS system.*

### **4.2.1 Test Scenario 1**

In test scenario 1, there is an accident on I-95 south bound. The incident is shown as a black dot in Figure 30. Given this incident, our system calls the RTRDS core to generate alternate routes. Figure 31 shows that the Dynasmart-P simulator is running based on the automatically generated input files. The accident is represented by a red triangle. Four alternate routes are generated by the RTRDS core. The first route is shown as thick red lines in Figure 32. As we can see, this alternate route bypasses the incident and re-directs the traffic back to the freeway. The second route is almost the same as the first one, except there is an extra U-turn included, as shown in Figure 33. The third route is shown in Figure 34 as thick red lines as well. This route also bypasses the accident and directs traffic back to the freeway, but from the other side of the freeway. The fourth route is shown in Figure 35. Among these four routes, our simulation shows that 90% of the traffic takes the first and the second route, 8% of the traffic takes the third route, while the remaining 2% of the traffic takes the fourth route. This observation is expected because the first and the second route utilize a highway (US-1), while the third and the fourth routes are on smaller roads.

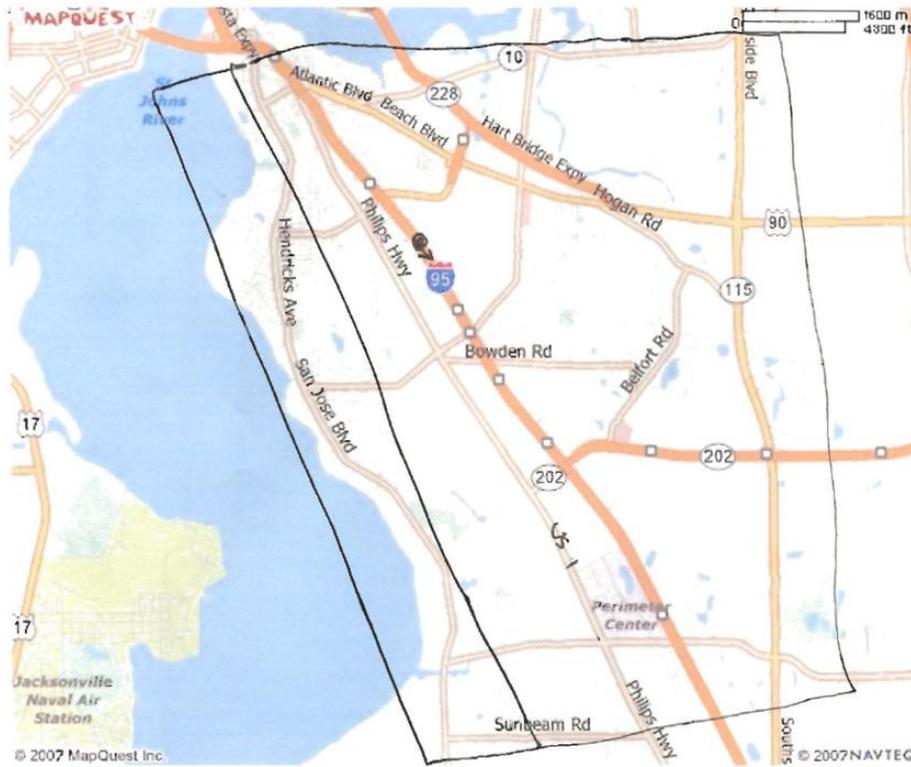


Figure 30 The first accident scenario on I-95 south bound, drawn by Mr. Vega of FDOT District 2.

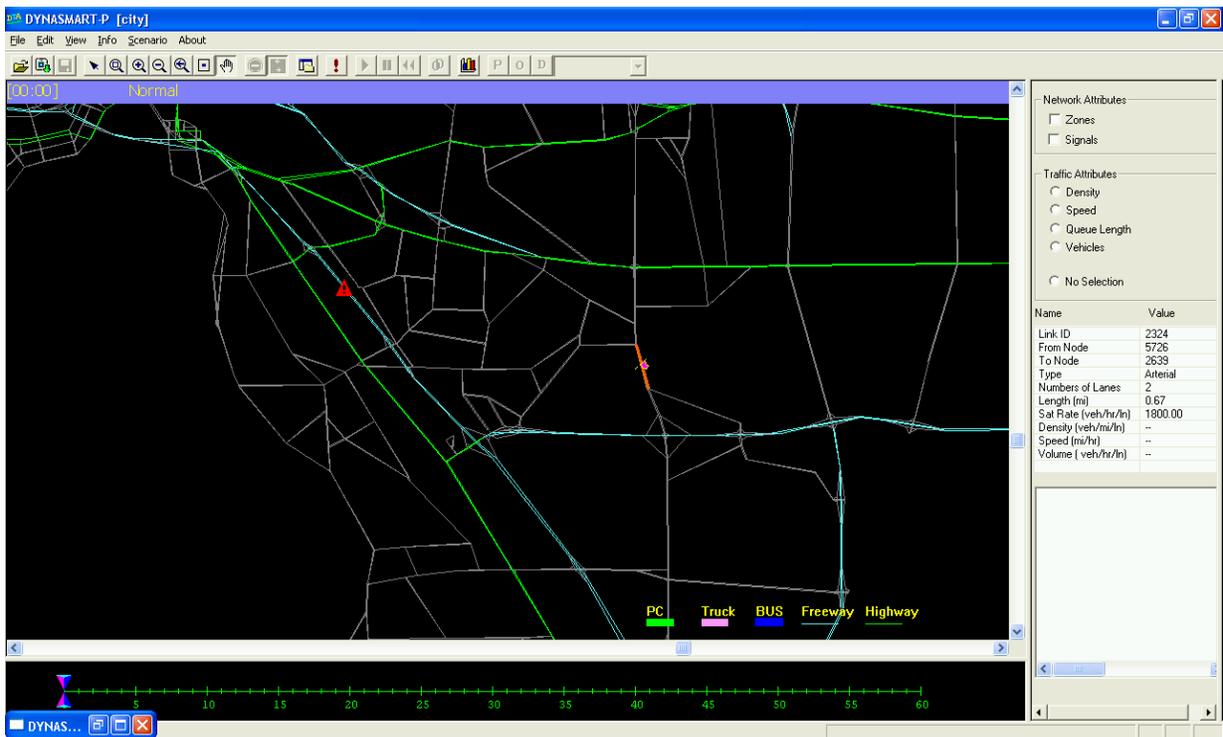


Figure 31. Dynasmart-P is executing test scenario 1 for task 5.

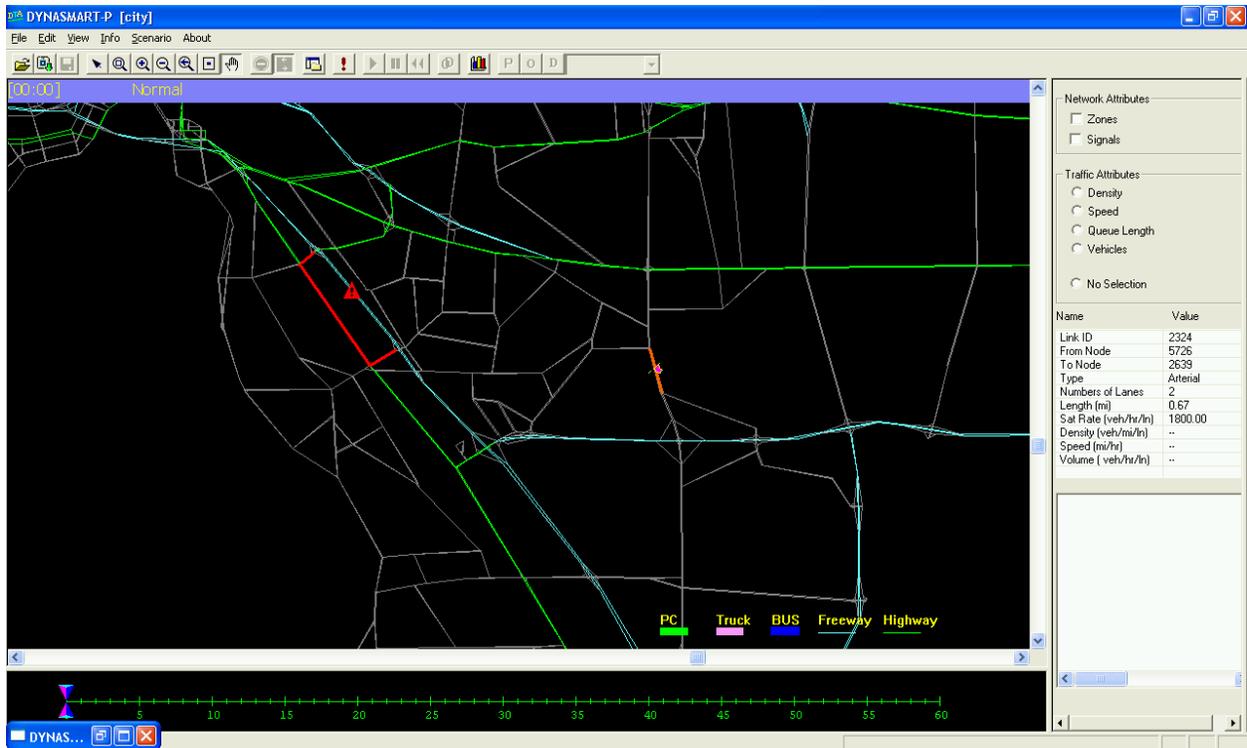


Figure 32. The first generated routes for test scenario 1 (red segments in the center of the map).

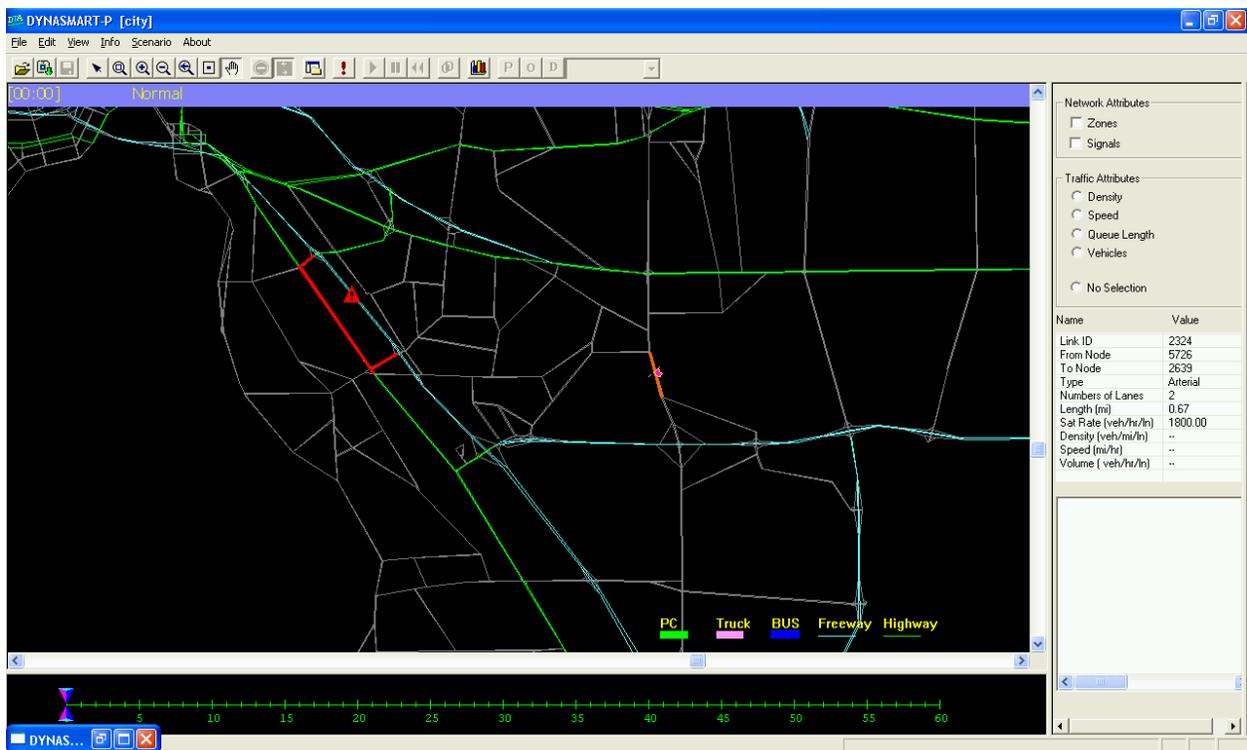


Figure 33. The second generated route for test scenario 1 (red segments in the center of the map).

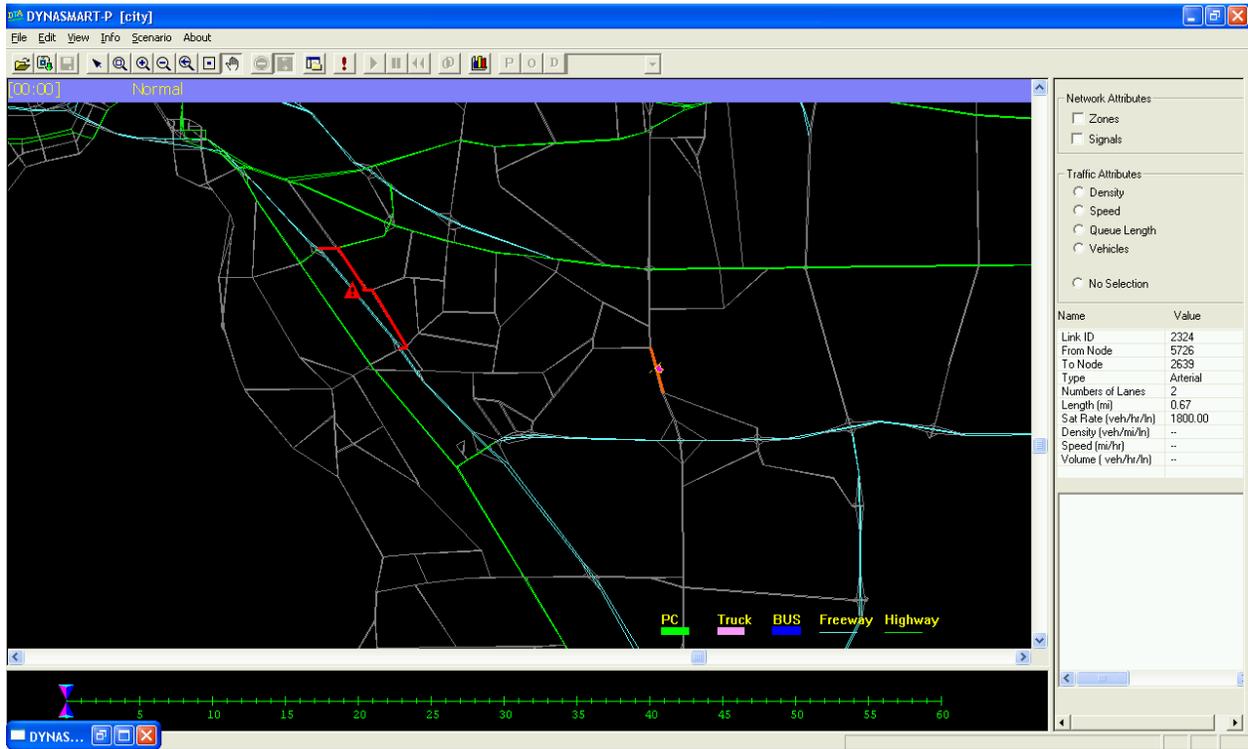


Figure 34. The third generated route for test scenario 1 (red segments in the center of the map).

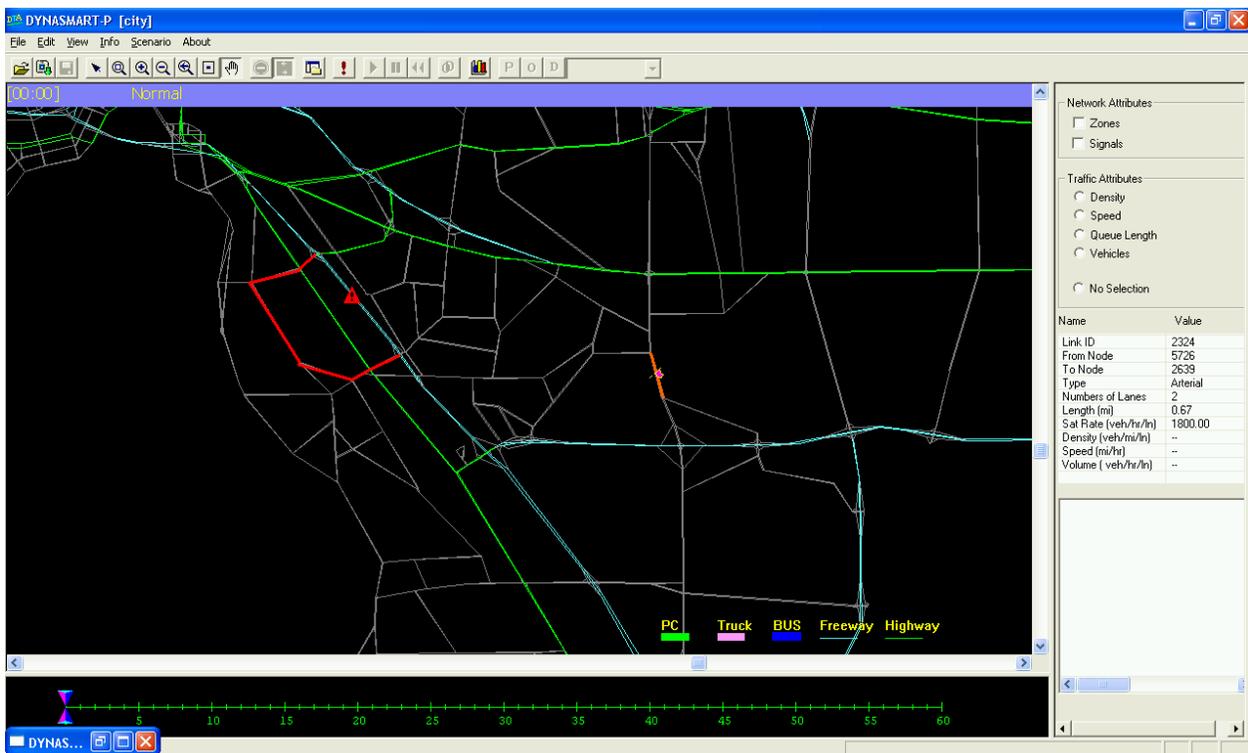


Figure 35. The fourth generated route for test scenario 1 (red segments in the center of the map).

While the test scenarios presented in sections 4.1.1 and 4.2.1 involve the same incident point, the traffic conditions are different in these two cases. Due to these differences, the sets of alternate routes generated for these two test scenarios are different as follows. While the set of alternate routes generated for the test scenario presented in section 4.1.1 has only two routes, the set of alternate routes for the test scenario presented in section 4.2.1 includes four routes. Moreover, the alternate route ranked second in the test scenario in section 4.1.1 is ranked third in the test scenario in section 4.2.1

#### **4.2.2 Test Scenario 2**

In an ideal situation, like what we have with the test scenarios presented in sections 4.1.1 and 4.2.1 we would like the test scenario considered in this subsection (section 4.2.2) to have the same incident point as that in the test scenario presented in section 4.1.2. This way, we would be able to observe the differences in the sets of alternate routes generated for two test scenarios that have the same incident point but different traffic conditions. Unfortunately, we were provided only real time information for road segments on I-95, while the incident location in the test scenario presented in section 4.1.2 is on I-10. Although we could set the incident location in the test scenario in section 4.2.2 on I-10, the provided real time data are for road segments far away from the incident location and would not have any significant impact on the set of alternate routes generated. Therefore, to further illustrate the functionality of our system in using real-time traffic information, we set the incident on I-95 south bound, further south of the accident used in the test scenario presented in section 4.2.1

Our system calls the RTRDS core to find alternate routes. Figure 36 shows that the Dynasmart-P simulator is running based on the automatically generated input files. The accident is represented by a red triangle. Multiple alternate routes are generated by our module. The two most significant ones are drawn in thick red lines in Figure 37 and Figure 38, respectively. The route shown in Figure 37 has the highest traffic volume, which accounts for about 97% of the traffic. This is as expected as the other route (shown in Figure 38) needs a much longer path and is thus less favorable.

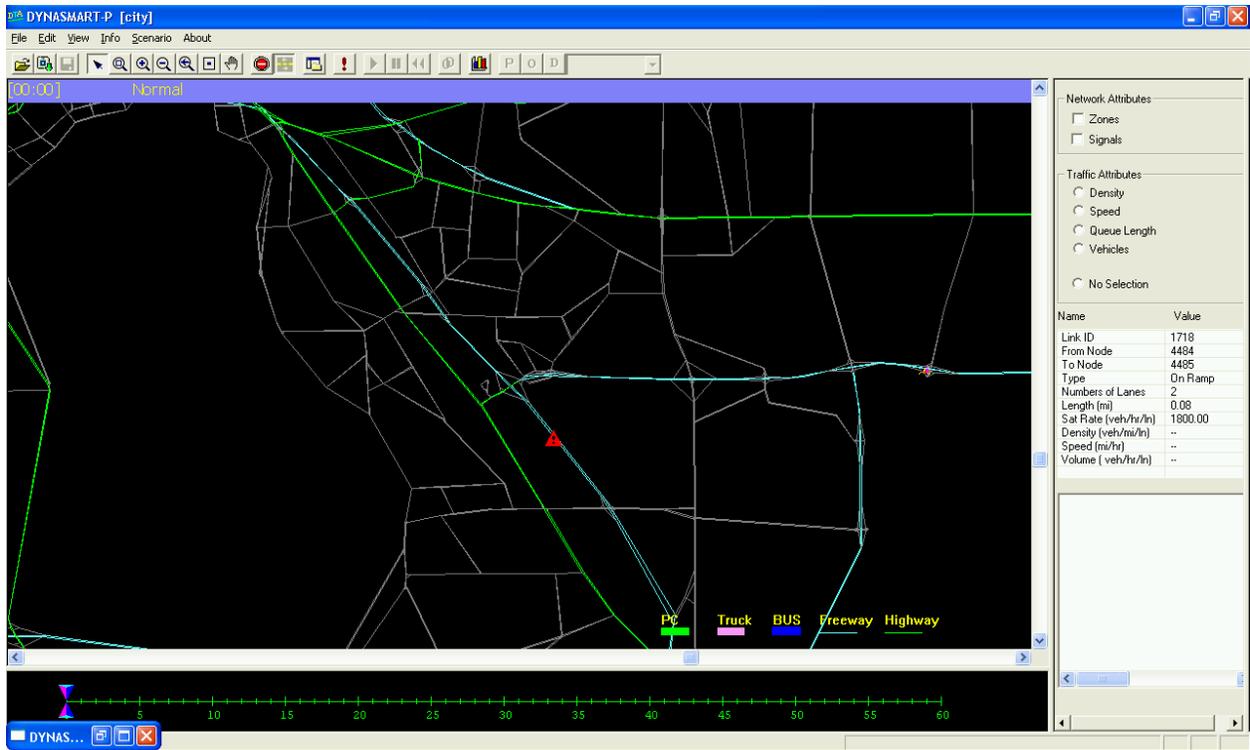


Figure 36. Dynasmart-P is executing test scenario 2 for task 5.

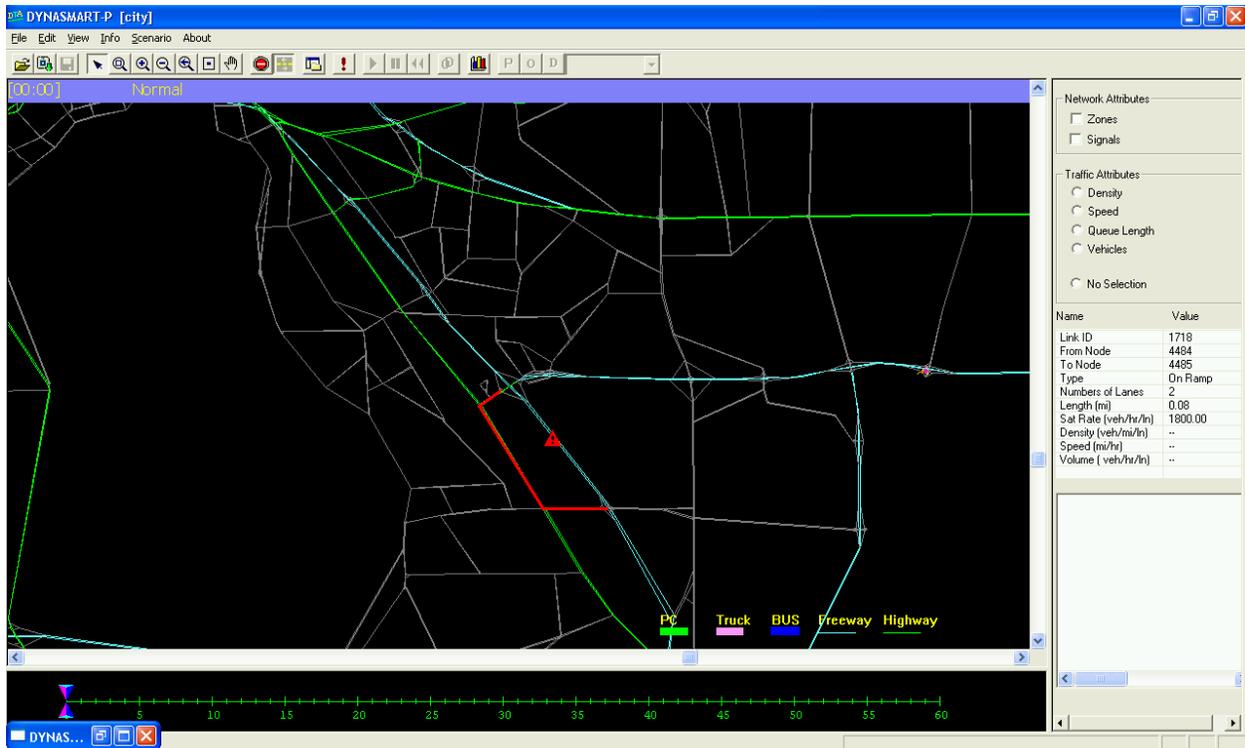


Figure 37. The first generated route for test scenario 2 (red segments in the center of the map).

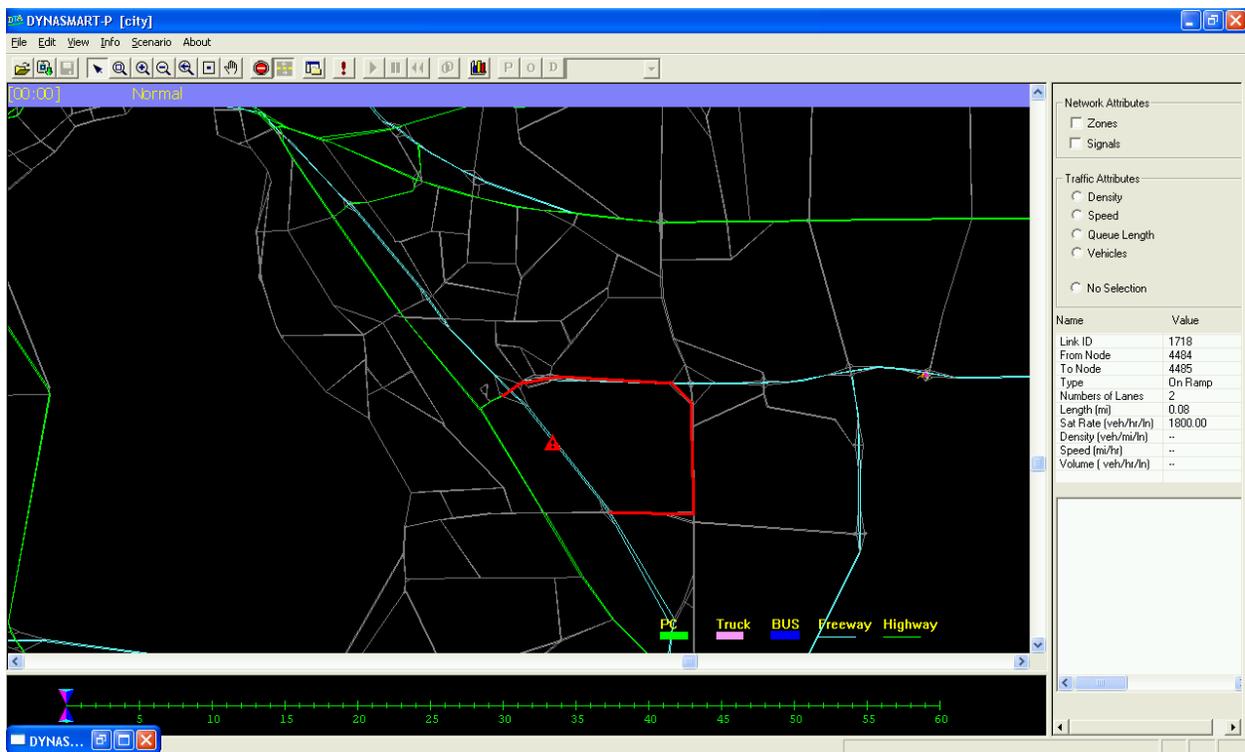


Figure 38. The second generated route for test scenario 2 (red segments in the center of the map).

## Chapter 5 Benefits to the FDOT

In this section, we discuss how our findings are relevant to and benefit the FDOT. The section includes two parts. In the first part, we estimate the time and cost savings in using one of our utility applications, the Topology Editor, to prepare network input data for Dynasmart-P. In the second part, we describe how the RTRDS can assist FDOT in a number of scenarios to manage diversion plans before, during, and after an incident, with an emphasis on time and cost savings whenever a meaningful estimation can be made.

### ***5.1 Operational Benefits of the Topology Editor***

As discussed in section 3.1, the Topology Editor is a semi-automatic software application that converts commercial map data to a traffic network topology used by the Dynasmart-P simulator. The Topology Editor displays the nodes and links of a map and provides the user with four functions to edit the topology of the map. First, it removes all intermediate nodes with degree two (i.e. those connecting only two road segments with the same road type) on the map. For example, out of more than 17,000 nodes on major roads (excluding freeways) of Orange County, FL in our map database, there are over 15,000 of these intermediate nodes, and thus the Topology Editor can initially reduce the size of the node set by 88%. Second, it removes the nodes where one road overpasses another road. Third, it allows the user to select multiple nodes and quickly combine them into one new node. Fourth, it permits the user to save the current topology with a checkpoint or to rollback to a previous checkpoint to undo some changes.

During a recent Dynasmart-P training workshop [26], it was pointed out that using the Dynasmart-P editor (DSPEd) to convert commercial map data of Orange County, FL to traffic network topology, suitable for the Dynasmart-P simulator, would take one full-time employee six months to complete. This task is complex, tedious, and error prone. On the other hand, when using our Topology Editor, it took less than two weeks for one of our research associates to perform the same task. This tool provides a great productivity benefit with high quality output. Evidently, while the Topology Editor is a byproduct of the RTRDS project, it can be a valuable independent software tool to Dynasmart-P users at the FDOT.

### ***5.2 Operational Benefits of the RTRDS***

We discussed five application scenarios of the RTRDS in section 3.4. It is clear that some of the new capabilities discussed therein are highly desirable in practice. To demonstrate the applicability of RTRDS to a wide range of situations, we demonstrated four scenarios at FDOT in Tallahassee, on October 24, 2008 [25]. We showed that the RTRDS can be used to expedite the

decision making process in both time-critical and time-uncritical cases. We discuss these demonstrations in this subsection although some of the discussions overlap with those presented in section 3.4.

### **5.2.1 Pre-construct a Diversion Plan for an Anticipated Incident**

Suppose that a route diversion plan needs to be created for some anticipated incidents. We demonstrated how the RTRDS can be used as a computer-aided tool to quickly develop various good diversion plans. Once the initial plan is available, a panel of experts including any relevant local authorities may then discuss these alternative plans to select the best diversion plan for the anticipated incidents. The benefits of the RTRDS in this scenario are twofold. First, since the alternative diversion plans could be generated automatically, the RTRDS reduces significantly the time and cost it takes to develop the set of alternative plans to be presented to the panel of experts. Second, since the RTRDS systematically analyzes and ranks the quality of the alternative diversion plans, it provides very valuable information that could be overlooked otherwise, for the panel to make a sound decision.

Once a diversion plan is selected, the RTRDS also allows the user to enter information such as interagency agreements, incident clearance policies, and contact persons. Maintaining such information in a database facilitates efficient response to the incidents when they occur.

### **5.2.2 When a Pre-defined Plan Cannot Be Used**

When an incident occurs, the pre-defined diversion plan sometimes may not be used due to an unforeseen event such as road construction or a secondary incident. In this situation, we demonstrated how a TMC operator can request the RTRDS to immediately generate a set of currently feasible alternate routes. Based on their ranking, the operator can decide on the best alternate routes for the current incident. The operator can also make any necessary modifications to the diversion routes based on his/her own judgment and experience before they are deployed. In this scenario, the benefits of the RTRDS are clear. It benefits the motorists because the FDOT would be able to respond to the unanticipated situation more quickly with the most effective alternate routes which take into consideration the current traffic conditions in the affected region. The RTRDS is designed to leverage real-time traffic data. If such information is not available for a given road segment, the system turns to the database for historical data. In the worst case, the RTRDS relies on the speed limits. In any case, such information is used only to initialize the capacities of the road segments for a simulation run using Dynasmart-P. Based on the simulation results, RTRDS adjusts these street capacities (e.g., the posted speeds) accordingly taking into consideration the extra traffic from the incident. The ultimate alternate routes are created to optimize the overall traffic for the affected area. This predictive approach (based on simulation results) is a capability not available in practice today. Thus, the RTRDS is immediately useful with today's infrastructure,

and it's benefit will increase as the FDOT continues to deploy more sensing devices along roadways.

### **5.2.3 When a Pre-defined Plan Is not Available**

As we have discussed, not all future incidents can be foreseen. When such incidents happen, a pre-defined diversion plan is not available. We demonstrated that the RTRDS can generate an optimal plan within minutes. This capability is particularly valuable when multiple incidents occur. For some of such unforeseen incidents, quick response is sometime critical. Having the support of the RTRDS can make a big difference in ensuring a timely and sound response to the incident.

### **5.2.4 When a Good Plan Becomes Inadequate**

In most situations, when an incident occurs, a pre-made diversion plan is ready to be deployed. The challenge is during the deployment of this plan, unexpected situations can happen that render the pre-planned plan inadequate for the route diversion. In particular, today's diversion plans are devised independently for different anticipated incidents. Although these plans are effective for the incidents they are designed for, these plans can be less than adequate when some of these neighboring incidents occur at about the same time. Consider a scenario in which a second incident occurs in the neighboring area. In this case, traffic conditions on the surrounding roads as assumed by the two preplanned diversion plans are all wrong. These two pre-constructed plans could actually direct traffic toward each other. In this situation, having a computer-aided environment, such as the RTRDS, is very helpful to devise a new set of alternate routes quickly taking into account changing traffic patterns. We demonstrated how RTRDS could leverage real-time traffic information including possible effect due to multiple incidents or changes in the traffic pattern.

## Chapter 6 Conclusions and Future Work

This project involves both original research and system implementation. In terms of research, the results from this work represent the current state of the art in applying computer-aided techniques to enable fast and effective response to traffic incidents under diverse scenarios. We presented our original work at the following international conferences:

- IEEE 2006 International Intelligent Transportation Systems Conference (ITSC)
- IEEE 2007 International Intelligent Transportation Systems Conference (ITSC)
- 2008 World Congress on Intelligent Transportation Systems

The responses from the international experts were very positive. In fact, all three of the above papers were recognized as among the best papers presented at the conferences. We also published our findings in the following international journals:

- Journal of E-Commerce Research & Applications, December 2007.
- IEEE Transactions on Intelligent Transportation Systems, December 2008

In summary, our research demonstrated the following benefits of applying advanced computing technology to traffic incident management:

- Automatic alternate routes generation saves time and costs in the investigation and development of route diversion plans.
- Automatic alternate routes generation is a potentially more effective option for handling unforeseen incidents in a timely manner, particularly for a multiple-incident scenario.
- The proposed simulation-based alternate route generation approach is highly effective:
  - The quality of the alternate routes is optimal with respect to the current traffic conditions.
  - The alternate routes can be systematically compared and ranked to provide informative data to help the user in decision making.
- Mobile computing technology can be used to coordinate police officers in directing traffic and other workers in setting up route diversion equipment.

To capitalize on our successful research, we have developed a *Real-Time Route Diversion System* (RTRDS). In addition to the aforementioned benefits, the RTRDS offers a well thought out graphical user interface including a mobile interface to support users in the field. This system is designed to cooperate with the SunGuide® environment. It retrieves real-time traffic data from SunGuide®, and allows the user to disseminate route diversion information to dynamic message signs and highway advisory radio through SunGuide®.

To support this project, we also developed a software application called *Topology Editor*. This is a semi-automatic software application to convert Dynamap data to a traffic network topology used by the Dynasmart-P simulator. Currently, this process must be done manually at the FDOT, which is complex, tedious, and error prone. Using the Topology Editor not only save time by a factor of ten, but also produce more reliable results. In addition, we developed a software utility that reads the output of the Topology Editor and automatically generates the input files ready for running the simulation in Dynasmart-P. This software utility and the Topology Editor can provide a set of valuable independent software tools to Dynasmart-P users at the FDOT.

In terms of deployment, the RTRDS can be deployed at each traffic management center to assist in local/regional incident management. It can also be employed by police departments with the hardware and software supported by the FDOT. A self-contained portable RTRDS operating on a notebook computer can also be easily developed for mobile users such as road rangers. Such a laptop system would rely on generalized historical traffic data from an integrated database, instead of real-time information from SunGuide®. For the general public, RTRDS can be integrated into 511 to extend its functionality as a public information system.

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## Appendix A Comparison of Traffic Simulators

We considered several traffic simulators and selected four of them for in-depth comparison: TSIS, Dynasmart-P, Paramics, and Transmodeler. Their features are summarized in the table on following three pages. Paramics and Transmodeler, while very capable simulators, are also very expensive (e.g., a single user license of Paramics is about \$22,000) and include functionality not necessarily relevant to the RTRDS project. TSIS and Dynasmart are more suitable to this project; particularly Dynasmart, which has support for dynamic traffic assignment. During this project, we evaluated Dynasmart-P version 1.0, obtained from McTrans, in greater detail, investigating the integration of its programming interface for the proposed RTRDS project and its compatibility with the SunGuide environment.

	<b>TSIS (Corsim)</b>	<b>Dynasmart</b>	<b>Paramics</b>	<b>Transmodeler</b>
<b>Type</b>	Microscopic	Mesososcopic	Microscopic	Micro/Macro/Mesososcopic/Hybrid
<b>Traffic devices &amp; control strategies</b>	<ul style="list-style-type: none"> <li>• freeways + surface streets</li> <li>• interchanges, weaving-sections</li> <li>• ramp metering (4 types)</li> <li>• pre-timed/actuated signals</li> <li>• coordinated signals</li> <li>• stop/yield signs/all-way stops</li> <li>• unsignalized intersections</li> <li>• NO transit signal priority</li> <li>• truck, HOV (high occupancy vehicle) lanes, bus lanes, on-street parking</li> <li>• work zones, barriers, lane closures, incidents</li> <li>• U-turns, roundabouts, 2-way left turns, weight stations, tolls can be modeled using other elements</li> <li>• pedestrians</li> <li>• surveillance</li> </ul>	<ul style="list-style-type: none"> <li>• freeways + surface streets</li> <li>• pre-timed/actuated signals</li> <li>• coordinated signals</li> <li>• ramp metering</li> <li>• incidents</li> </ul>	<ul style="list-style-type: none"> <li>• freeways + surface streets</li> <li>• roundabouts</li> <li>• ramp metering</li> <li>• priority/signalized (actuated) intersections</li> <li>• signal preemption for transit/emergency vehicles</li> <li>• truck, HOV lanes</li> <li>• DMS control, variable speed signs / traffic calming</li> <li>• car parking</li> <li>• public transportation</li> <li>• right-hand and left-hand drive capabilities</li> <li>• work zones, incidents</li> </ul>	<ul style="list-style-type: none"> <li>• freeways + surface streets</li> <li>• rotaries</li> <li>• ramp metering</li> <li>• pre-timed/actuated signals</li> <li>• coordinated (actuated) signals</li> <li>• signal preemption for transit or emergency vehicles</li> <li>• HOV lanes, DMS &amp; variable speed limit signs/ traffic calming</li> <li>• tolls, work zones, incidents</li> <li>• public transportation (bus &amp; rail transit systems)</li> <li>• timing plans generation based on turning movement volume tables</li> </ul>
<b>Driver Behavior &amp; Vehicle Interactions</b>	<ul style="list-style-type: none"> <li>• different vehicle types, &amp; driver behavioral characteristics</li> <li>• sophisticated car-following and lane-changing logic to simulate vehicle movements on a second-by-second basic</li> </ul>	<ul style="list-style-type: none"> <li>• traffic flow is simulated macroscopically based on the continuity equation and modified Greenshields speed-density relationships</li> </ul>	<ul style="list-style-type: none"> <li>• Driver/vehicle type characteristics</li> <li>• Sophisticated car-following &amp; lane-changing models</li> </ul>	<ul style="list-style-type: none"> <li>• acceleration, deceleration, car-following, lane-changing, merging/ yielding, and movements at intersections are affected by driver aggressiveness, vehicle characteristics, and road geometry (default parameters of these models can be easily changed)</li> </ul>

	<b>TSIS (Corsim)</b>	<b>Dynasmart</b>	<b>Paramics</b>	<b>Transmodeler</b>
<b>Demand &amp; Traffic Modeling</b>	<ul style="list-style-type: none"> <li>• Time varying demand</li> <li>• Models bottlenecks, Oversaturation</li> <li>• Static Traffic Assignment</li> <li>• NO Route guidance</li> </ul>	<ul style="list-style-type: none"> <li>• Dynamic traffic assignment</li> <li>• calculates optimal travel paths based on the simulated travel times and simulates the movements and routing decisions by individual drivers</li> </ul>	<ul style="list-style-type: none"> <li>• origin-destination matrices can be generated using the <b>Estimator</b></li> <li>• Dynamic traffic assignment</li> <li>• ATT systems, route guidance, route choice</li> </ul>	<ul style="list-style-type: none"> <li>• origin-destination trip matrices model vehicle demand with time-variant departure rates and multiple vehicle classes</li> <li>• create &amp; manage alternative paths available to drivers</li> <li>• Dynamic traffic assignment (DTA)</li> <li>• DTA can simulate the impact of real-time traffic information on dynamic driver rerouting</li> <li>• models evacuation plans and scenarios for response to emergencies</li> </ul>
<b>Network conditions estimations &amp; predictions</b>	<ul style="list-style-type: none"> <li>• variety of parameters</li> <li>• fuel consumption and pollutant emission rates</li> <li>• NO traffic prediction</li> </ul>	<ul style="list-style-type: none"> <li>• NO individual speeds &amp; travel times</li> <li>• provides reliable estimates of network traffic conditions</li> <li>• provides predictions of network flow patterns over the near and medium terms</li> </ul>	<ul style="list-style-type: none"> <li>• variety of parameters</li> <li>• pollution monitoring</li> <li>• NO traffic prediction</li> </ul>	<ul style="list-style-type: none"> <li>• variety of parameters</li> <li>• works with travel demand forecasting software</li> </ul>
<b>Platform</b>	Windows 2000/XP	Windows 2000/XP	Windows 95/98/NT/2000/XP, Sun/Solaris & Linux	Windows 2000/XP
<b>Simulation Engine</b>	<b>CORSIM</b> = microscopic traffic simulator	<b>Dynasmart</b>	<b>Modeller</b> = Transportation Modeling Tool = GUIs for:	<b>Transmodeller</b>

	<b>TSIS (Corsim)</b>	<b>Dynasmart</b>	<b>Paramics</b>	<b>Transmodeler</b>
<b>Traffic Network Builder</b>	<p><b>TRAFED</b> = point-and-click GUI for creating and editing traffic networks and simulation input</p> <p><b>Text Editor</b> = understands Corsim files</p> <p><b>Translator</b> = from Trafed files to Corsim input files &amp;viceversa</p>		<ul style="list-style-type: none"> <li>• building networks</li> <li>• traffic simulation</li> <li>• statistical output</li> </ul> <p><b>Converter</b> = from emme/2, Mapinfo, ESRI, Synchro, Corsim, Cube/TP+/Viper, flat ascii, and CSV to Paramics</p>	
<b>Output Analyzer</b>	Output files		<b>Analysers</b> - Statistical data analysis tool	
<b>Simulation Visualization</b>	<b>TRAFVU</b> = displays & animates		<b>Viewer</b> = network simulation/	
	simulated traffic flow operations and MOEs		visualization tool	
<b>Batch Tools</b>	<p><b>TShell</b> = GUI to provide access to the pre-defined tools</p> <p><b>Script Tool</b> = runs VB scripts to automate simulation processes</p>		<b>Processor</b> = tool to automate simulation and analysis processes	

	<b>TSIS (Corsim)</b>	<b>Dynasmart</b>	<b>Paramics</b>	<b>Transmodeler</b>
<b>Other Tools</b>			<p><b>Estimator</b> = Origin/Destination (OD) matrix estimator</p> <p><b>Designer</b> = 3D model building &amp; editing tool</p> <p><b>Monitor</b> = pollution evaluation framework</p> <p><b>Programmer</b> = research &amp; customization API (application program interface)</p>	
<b>Pricing</b>	Inexpensive	Inexpensive	Very expensive	Very expensive

## Appendix B Real-Time Route Diversion Research Project Survey Results

In this appendix, we provide the eight completed surveys received from FDOT Districts 1, 2, 3, 4, 5, 6, 7, and Florida's Turnpike Enterprise, concerning current Road Ranger wireless and PDA incident management systems.

Survey responses among the districts varied greatly. In some districts, the Road Rangers use a computer system that is tied to incident management and tracks incidents in near real-time. Other districts have separate IM systems which are used by TMC personnel, and the Road Rangers turn in reports on paper forms that are later filed in cabinets. Most validate incident data with other sources (i.e., Florida Highway Patrol dispatch logs). When asked about route diversion functionality, no one currently has an automated system with this functionality, although some responded saying they use pre-made route diversion maps, and one (District 2) plans to make use of the DMS template functionality available in SunGuide.

DSG is grateful for the work done by the districts to complete the surveys. Without the efforts of numerous personnel at the eight districts, it would not have been possible for DSG to complete Task 1.

## B.1 Survey for District 1

Received Friday July 7, 2006

FROM:

B J Kirby

Vice President

Coastland Auto Road Rangers, Inc.

(Office) 239-643-4357

(Fax) 352-344-3141

[bjkirby@flroadrangers.com](mailto:bjkirby@flroadrangers.com)

## (1/3) Technical questions about incident management system

1. Do you have a name for your incident management system? What is it?

No, we do not have a system.

2. Approximately how long have you used this system?

N/A

3. How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

Log-sheets are used to track each stop.

4. How is incident information entered into the system? (E.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

N/A

**5a.** Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

Yes, initial response to interstate incidents.

**5b.** Does your incident management system currently have any route diversion functionality? If yes, please describe.

No

## (2/3) Questions about information pertaining to incidents

1. What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<input checked="" type="checkbox"/> <i>Example data collected</i>	<input type="checkbox"/> Road/highway name	<input checked="" type="checkbox"/> Cross street/mile marker
<input type="checkbox"/> Detector station #	<input type="checkbox"/> Latitude/longitude	<input checked="" type="checkbox"/> incident type
<input checked="" type="checkbox"/> source of incident report <sup>1</sup>	<input checked="" type="checkbox"/> incident status <sup>2</sup>	<input type="checkbox"/> time incident detected
<input checked="" type="checkbox"/> time incident verified	<input checked="" type="checkbox"/> response time to location	<input type="checkbox"/> time incident cleared <sup>3</sup>
<input type="checkbox"/> road/light condition <sup>4</sup>	<input checked="" type="checkbox"/> injuries present	<input type="checkbox"/> types of vehicles involved

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

No

## (3/3) Questions about incident reporting

1. How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

<sup>1</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

<sup>2</sup> E.g., canceled, verified, cleared, etc.

<sup>3</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<sup>4</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

Interstate mile marker – by county for reports

**2.** What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

Monthly – they are accurate. We tabulate only

1. Motorist assists
2. debris removal
3. abandoned vehicles

**3.** Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

Response times randomly.

**4.** How long is incident information retained? (E.g., 7 years, etc.)

Not sure. Another contractor maintains records.

5. (Optional) What type of reporting would you like to see that you currently don't have available with your current incident management system?

I would like to see every stop logged automatically.

1. Time stopped
2. Location (not GPS) real useable location (mile marker)
3. User entered "reason for stop"
4. User entered "visual traffic impact" upon arrival
5. Resources needed/time requested/agency(s) notified
6. Resource arrival and departure times
7. Resource efforts utilized and deemed necessary
8. Incident numbers cross-referenced/crash report numbers if they exist/agency information for future reference.
9. Impact on traffic lessened (time-line) since arrival
10. Time incident cleared – no affecting traffic
11. Request for post incident review of accidents affecting traffic more than 90 minutes.  
-- Find out why and how to do better next time.

## B.2 Survey for District 2

Received Wed, May 3, 2006

FROM:

Peter Vega, P.E.

District 2 ITS Engineer

Phone: (904) 360-5463

Fax: (904) 360-5639

Email: [peter.vega@dot.state.fl.us](mailto:peter.vega@dot.state.fl.us)

## (1/3) Technical questions about incident management system

**1.** Do you have a name for your incident management system? What is it?

We utilize the SunGuide software package designed by SouthWest Research Institute.

**2.** Approximately how long have you used this system?

Six months.

**3.** How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

Electronically. No screen shots available, however you can coordinate through Liang Hsia to get a copy of the software for this project (I believe).

**4.** How is incident information entered into the system? (E.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

Entered by the 511/TMC Operator into SunGuide during the event.

**5a.** Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

We do both. We coordinate with Maintenance, Fire/Rescue, FHP/Sheriff and City Traffic Engineering.

**5b.** Does your incident management system currently have any route diversion functionality? If yes, please describe.

No it does not. We have the capability of installing pre-planned responses for the DMS information but have not implemented it as of yet.

## (2/3) Questions about information pertaining to incidents

1. What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<input checked="" type="checkbox"/> <i>Example data collected</i>	<input type="checkbox"/> Road/highway name	<input type="checkbox"/> Cross street/exit number
<input checked="" type="checkbox"/> Detector station #	<input checked="" type="checkbox"/> Latitude/longitude	<input checked="" type="checkbox"/> incident type
<input checked="" type="checkbox"/> source of incident report <sup>5</sup>	<input checked="" type="checkbox"/> incident status <sup>6</sup>	<input checked="" type="checkbox"/> time incident detected
<input checked="" type="checkbox"/> time incident verified	<input checked="" type="checkbox"/> response time to location	<input checked="" type="checkbox"/> time incident cleared <sup>7</sup>
<input type="checkbox"/> road/light condition <sup>8</sup>	<input type="checkbox"/> injuries present	<input type="checkbox"/> types of vehicles involved

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

Not as of yet. Need to do so for Statewide performance measures.

## (3/3) Questions about incident reporting

<sup>5</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

<sup>6</sup> E.g., canceled, verified, cleared, etc.

<sup>7</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<sup>8</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

**1.** How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

Data is reported by road name (Interstate number) and milepost (including lat/long info). Need to run approval through Liang Hsia. May need to follow Public Records process.

**2.** What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

No statistics are generated as of yet. SunGuide is still in the testing phase. Tweaking of the software should be completed by this Summer.

**3.** Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

Not yet. Plan to do so in the near future.

**4.** How long is incident information retained? (E.g., 7 years, etc.)

We will keep this information for the minimum 3 year criteria.

**5. (Optional)** What type of reporting would you like to see that you currently don't have available with your current incident management system?

## Survey for District 3

Conducted via telephone, May 1, 2005

FROM:

Dominic Richard

Construction Project Manager

Direct number: 850-981-2803

Cell: 850-698-2928

Email: [dominic.richard@dot.state.fl.us](mailto:dominic.richard@dot.state.fl.us)

## (1/3) Technical questions about incident management system

1. Do you have a name for your incident management system? What is it?

SERVICE PATROL

2. Approximately how long have you used this system?

3 YEARS

3. How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

ROAD RANGERS FILL OUT PAPER FORMS AT THE SCENE.

4. How is incident information entered into the system? (E.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

FORM DATA MANUALLY ENTERED INTO COMPUTER SYSTEM

**5a.** Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

YES

**5b.** Does your incident management system currently have any route diversion functionality? If yes, please describe.

NO. THERE IS INVOLVEMENT IN ROUTE DIVERSION FOR CONSTRUCTION ZONES

## (2/3) Questions about information pertaining to incidents

1. What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<input checked="" type="checkbox"/> <i>Example data collected</i>	<input type="checkbox"/> Road/highway name	<input type="checkbox"/> Cross street/exit number
<input type="checkbox"/> Detector station #	<input type="checkbox"/> Latitude/longitude	<input type="checkbox"/> incident type
<input type="checkbox"/> source of incident report <sup>9</sup>	<input type="checkbox"/> incident status <sup>10</sup>	<input type="checkbox"/> time incident detected
<input type="checkbox"/> time incident verified	<input type="checkbox"/> response time to location	<input type="checkbox"/> time incident cleared <sup>11</sup>
<input type="checkbox"/> road/light condition <sup>12</sup>	<input type="checkbox"/> injuries present	<input type="checkbox"/> types of vehicles involved

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

YES, FLORIDA HIGHWAY PATROL ACCIDENT REPORTS

## (3/3) Questions about incident reporting

1. How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

<sup>9</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

<sup>10</sup> E.g., canceled, verified, cleared, etc.

<sup>11</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<sup>12</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

## DISTRICT REPORTS VIA TMC

**2.** What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

**3.** Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

**4.** How long is incident information retained? (E.g., 7 years, etc.)

2-3 YEARS

**5. (Optional)** What type of reporting would you like to see that you currently don't have available with your current incident management system?

## B.3 Survey for District 4

Received Friday, March 10, 2006

FROM:

Gaetano (Guy) Francese  
Freeway Operations Manager  
District 4 Traffic Operations  
Phone: (954) 777-4366/Suncom: 436-4366  
Fax: (954) 777-4398  
Email: [gaetano.francese@dot.state.fl.us](mailto:gaetano.francese@dot.state.fl.us)

## (1/3) Technical questions about incident management system

1. Do you have a name for your incident management system? What is it?

SMART (Systems Management for Advanced Roadway Technologies)

2. Approximately how long have you used this system?

2 Years

3. How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

SQL Server database, interface uses ASP.NET/C++ (browser based). A screenshot would be available. There is a Manual but it is the original design document and has not been updated with all the revisions and modifications that have been made.

4. How is incident information entered into the system? (E.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

Currently entered by dispatch operator via radio communications. Specifications have been completed for a PC Tablet which will be advertised for bids in the next two weeks. The PC Tablet will transmit data in real-time.

**5a.** Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

Involvement in actual incident management. (Detection, verification and response, DMS signing, agency notification, maintenance of traffic, roadway clearance, first responder).

**5b.** Does your incident management system currently have any route diversion functionality? If yes, please describe.

No.

### (2/3) Questions about information pertaining to incidents

**1.** What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<input checked="" type="checkbox"/> <i>Example data collected</i>	<input checked="" type="checkbox"/> Road/highway name	<input checked="" type="checkbox"/> Cross street/exit number
<input type="checkbox"/> Detector station #	<input checked="" type="checkbox"/> Latitude/longitude	<input checked="" type="checkbox"/> incident type
<input checked="" type="checkbox"/> source of incident report <sup>13</sup>	<input checked="" type="checkbox"/> incident status <sup>14</sup>	<input checked="" type="checkbox"/> time incident detected
<input checked="" type="checkbox"/> time incident verified	<input checked="" type="checkbox"/> response time to location	<input checked="" type="checkbox"/> time incident cleared <sup>15</sup>

<sup>13</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

<sup>14</sup> E.g., canceled, verified, cleared, etc.

<sup>15</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<input checked="" type="checkbox"/> road/light condition <sup>16</sup>	<input checked="" type="checkbox"/> injuries present	<input checked="" type="checkbox"/> types of vehicles involved
--	--	--

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

FHP dispatch logs.

### (3/3) Questions about incident reporting

1. How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

Road/highway, systemwide, road segment, incident severity, incident type, am, pm, off peak periods.

2. What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

Type of incident, number of vehicles, description of vehicles, Tag numbers, injuries, time of notification, duration of incident, response times, clearance time. This information is provided real-time by on-scene personnel.

3. Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

Yes.

---

<sup>16</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

4. How long is incident information retained? (E.g., 7 years, etc.)

Indefinitely.

5. *(Optional)* What type of reporting would you like to see that you currently don't have available with your current incident management system?

None. We have all the reporting we need.

## B.4 Survey for District 5

Received Wednesday June 6, 2006

FROM:

Jennifer D. Heller  
Florida Department of Transportation  
Traffic Operations, District 5  
719 S. Woodland Blvd.  
DeLand, FL 32720  
Office: 386-943-5322  
Suncom: 373-5322  
Fax: 386-736-5349  
Cell: 407-466-5862  
Nextel Direct: 158\*42\*1644  
Jennifer.heller@dot.state.fl.us

## (1/3) Technical questions about incident management system

1. Do you have a name for your incident management system? What is it?

We have a Regional Traffic Management Center (RTMC), which is our traffic management center co-located with the Florida Highway Patrol. We manage incidents, provide motorists traveler information via 511 and Dynamic Message Signs and manage the Road Ranger Service Patrol from this facility. Data is sent to the RTMC, video from CCTV and traffic data from road sensors, is sent via fiber and microwave towers.

2. Approximately how long have you used this system?

Since the early 1990's.

3. How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

Data is stored electronically. We are working on a new Central Florida Data Warehouse project that data will be stored and queried into different formats.

4. How is incident information entered into the system? (E.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

Incident information is now sent from FHP CAD to our Conditions Reporting System and then to the Central Florida Data Warehouse (CFDW). The CFDW is under development and hoping to be finished sometime this year. Also all data from vehicle detector stations are collected.

**5a.** Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

The RTMC manages incidents, collects the data and provides real time information to motorists.

**5b.** Does your incident management system currently have any route diversion functionality? If yes, please describe.

Travel times via I-4 and via SR 417 are provided via a DMS. Travel times for other routes are also provided via 511.

## (2/3) Questions about information pertaining to incidents

1. What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<input checked="" type="checkbox"/> <i>Example data collected</i>	<input checked="" type="checkbox"/> Road/highway name	<input checked="" type="checkbox"/> Cross street/exit number
<input type="checkbox"/> Detector station #	<input checked="" type="checkbox"/> Latitude/longitude	<input checked="" type="checkbox"/> incident type
<input checked="" type="checkbox"/> source of incident report <sup>17</sup>	<input checked="" type="checkbox"/> incident status <sup>18</sup>	<input checked="" type="checkbox"/> time incident detected
<input checked="" type="checkbox"/> time incident verified	<input checked="" type="checkbox"/> response time to location	<input checked="" type="checkbox"/> time incident cleared <sup>19</sup>
<input type="checkbox"/> road/light condition <sup>20</sup>	<input checked="" type="checkbox"/> injuries present	<input checked="" type="checkbox"/> types of vehicles involved

Incident information is now sent from FHP CAD to our Conditions Reporting System and then to the Central Florida Data Warehouse (CFDW). The CFDW is under development and hoping to be finished sometime this year. The X indicates information we will be able to access in the CFDW.

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

We receive real time data from FHP CAD, but we verify information verbally to FHP, call other police departments, receive information from Road Rangers, see incidents from CCTV, etc.

## (3/3) Questions about incident reporting

<sup>17</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

<sup>18</sup> E.g., canceled, verified, cleared, etc.

<sup>19</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<sup>20</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

**1.** How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

Incident information is collected from FHP Crash Reports. Check with FDOT Safety Engineer Tony Nosse at [Anthony.nosse@dot.state.fl.us](mailto:Anthony.nosse@dot.state.fl.us) for this information.

**2.** What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

Check with FDOT Safety Engineer Tony Nosse at [Anthony.nosse@dot.state.fl.us](mailto:Anthony.nosse@dot.state.fl.us) for this information.

**3.** Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

We do not calculate this information at this time.

**4.** How long is incident information retained? (E.g., 7 years, etc.)

Check with FDOT Safety Engineer Tony Nosse at [Anthony.nosse@dot.state.fl.us](mailto:Anthony.nosse@dot.state.fl.us) for this information.

**5. (Optional)** What type of reporting would you like to see that you currently don't have available with your current incident management system?

## B.5 Survey for District 6

Received Friday March 31, 2006

FROM:

Manuel Fontain, E. I.

Florida Department of Transportation

ITS Project Manager, District 6

(305) 499-2493, SC 429-2493, Fax (305) 470-5823

Manuel.Fontain@dot.state.fl.us

In the 2006-04-25 comments to for the 1<sup>st</sup> quarterly report, the following question was posed, which we forwarded to District 6 personnel:

**Question:** Provide FDOT with recommendation of statewide incident information retaining duration.

The following two responses were received:

(1)

Subject: Re: Road Ranger Incident MGMT Sys Survey  
To: "Alex J. Aved" <aaved@cs.ucf.edu>  
Cc: alphonso.clay@dot.state.fl.us, Genaro.Montas@dot.state.fl.us,  
Ignacio.Machin@dot.state.fl.us, Javier.Rodriguez2@dot.state.fl.us  
X-Mailer: Lotus Notes 653HF789 January 11, 2006  
From: Manuel.Fontan@dot.state.fl.us  
Date: Tue, 16 May 2006 11:23:27 -0400  
Mr. Alex Aved,

The answer to your question that was stated below is that we do not delete any of our incident information as of this point. Remember we have only been keeping record for about a year and a half now. If anyone else has any other comments they would like to provide to Mr. Aved please feel free to do so. Mr. Aved if you have any other questions please feel free to contact us.

(2)

To: Manuel.Fontan@dot.state.fl.us  
Cc: "Alex J. Aved" <aaved@cs.ucf.edu>, alphonso.clay@dot.state.fl.us,  
Genaro.Montas@dot.state.fl.us, Javier.Rodriguez2@dot.state.fl.us  
Subject: Re: Road Ranger Incident MGMT Sys Survey  
From: Ignacio.Machin@dot.state.fl.us  
Date: Tue, 16 May 2006 13:18:16 -0400  
Hi,

That's right, we keep all the info we have collected. At some point we will move the old data to a historic DB we have created with the same structure, this DB will become our data warehousing.

The interface of the system will be capable of searching using both DBs.

let me know if I can be of further help,

Ignacio

## (1/3) Technical questions about incident management system

1. Do you have a name for your incident management system? What is it?

***Sunguide Incident Management System (SIMS)***

2. Approximately how long have you used this system?

***2 years***

3. How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

***Structured Query Language database, Active Server Page.NET front end. (see screenshot below), ask Ignacio Machin (305) 470 - 5830 about any manual.***

Logged as: alphonso

ID	Operator	Time	Type	Source	Location	Truck	Status
0201-03/30/2006	Tekesha	14:22 (01:43)	Construction	Road Ranger	SR-874 Toll Plaza - LRM 1.2 --	608	Open
0232-03/30/2006	Tekesha	15:29 (00:36)	Accident with NO Injuries	FHP Website	I-75 Miami Gardens Drive --	--	Open
0235-03/30/2006	Tekesha	15:49 (00:16)	Lunch	Road Ranger	SR-924 -- --	642	Open
0236-03/30/2006	alex	15:50 (00:15)	Lunch	Road Ranger	I-95 -- --	620	Open
0237-03/30/2006	alex	15:51 (00:14)	Lunch	Road Ranger	I-95 -- --	617	Open
0239-03/30/2006	alex	16:02 (00:03)	Disabled Vehicle	FHP	I-95 Miami Gardens Drive --	--	Open
0238-03/30/2006	alex	16:03 (00:02)	Break	Road Ranger	I-95 -- --	625	Open

4. How is incident information entered into the system? (e.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

**1) First step in incident report is utilizing SIMS, a Web hosted Active Service Page webpage (a dynamic scripting language), using a form that updates and maintains the incidents, through SQL.**

**Each new incident auto-generates an incident number when inputted into the system and is connected to an SQL server for data collection.**

**2) Second step, is the Road Ranger receiving the auto generated incident through a two way communication with the Transportation Management Center (TMC) and once received the road ranger inputs the incident number into the PDA, later after synching the PDA, the incidents are compiled and correlated with the incident numbers generated by the system in a final report. The PDA does not account for any real-time data; it contains only information that is to be correlated later with SIMS data.**

**5a.** Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

***Both, but where it concerns the District 6 SunGuide TMC.***

***We alert other agencies and depending on severity, cause and effect they may or may not take over the scene.***

**5b.** Does your incident management system currently have any route diversion functionality? If yes, please describe.

***Not at this time, just incident data collection. However it is definitely something that should be looked into.***

## (2/3) Questions about information pertaining to incidents

1. What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<input checked="" type="checkbox"/> <i>Example data collected</i>	<input type="checkbox"/> Road/highway name	<input type="checkbox"/> Cross street/exit number
<input type="checkbox"/> Detector station #	<input type="checkbox"/> Latitude/longitude	<input type="checkbox"/> incident type
<input type="checkbox"/> source of incident report <sup>21</sup>	<input type="checkbox"/> incident status <sup>22</sup>	<input type="checkbox"/> time incident detected
<input type="checkbox"/> time incident verified	<input type="checkbox"/> response time to location	<input type="checkbox"/> time incident cleared <sup>23</sup>
<input type="checkbox"/> road/light condition <sup>24</sup>	<input type="checkbox"/> injuries present	<input type="checkbox"/> types of vehicles involved

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

**No**

## (3/3) Questions about incident reporting

<sup>21</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

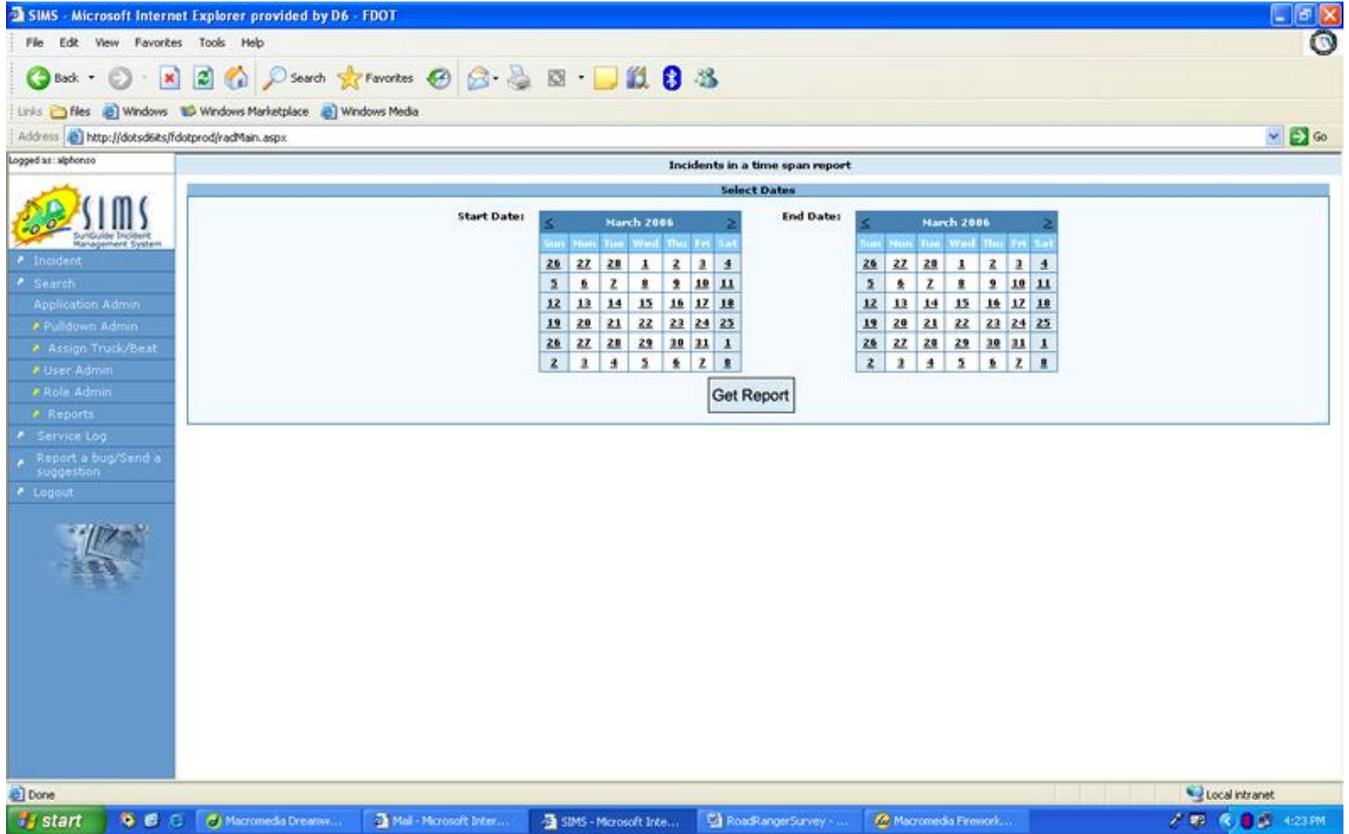
<sup>22</sup> E.g., canceled, verified, cleared, etc.

<sup>23</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<sup>24</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

1. How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

**By road i.e., (Interstate 95), see screenshot below!**



2. What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

**Number of incidents per road, weekly, yes it is accurate.**

3. Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

***Yes, randomly.***

4. How long is incident information retained? (E.g., 7 years, etc.)

***10 years***

5. *(Optional)* What type of reporting would you like to see that you currently don't have available with your current incident management system?

***Custom queries, a SQL expression box and/or some text box for our own queries.***

***Nothing built-in, the custom feature will give more flexibility as performance measures change and would give us more adaptability.***

## B.6 Survey for District 7

Received Tuesday March 21, 2006

FROM:

Terry Hensley  
Traffic Incident Manager  
FDOT - District 7  
(Office) 813-975-6259  
(Suncom) 512-7716  
(Cell) 813-323-1155  
terry.hensley@dot.state.fl.us

## (1/3) Technical questions about incident management system

1. Do you have a name for your incident management system? What is it?

**Road Ranger CATS (Computer Aided Tracking System)**

2. Approximately how long have you used this system?

**1 year**

3. How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

**It's in a Microsoft SQL Server database. Here is a screenshot of the incident screen.**

Road Ranger CATS - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://rr.tbsunguide.com/newrr/scripts/pushview.asp

MailEnable Web Mail Client (Version 1.1) Road Ranger CATS



**ROAD RANGER**  
*CATS*  
Computerized Activity  
Tracking System

**FLORIDA DEPARTMENT OF TRANSPORTATION**  
**DISTRICT 7**



**3/20/2006 20:57**

Trk ID	Operator	Event Date	Event Time	Status	Status Data	Location	Comments
<a href="#">702</a>	Biggam	3/20/2006	18:43	Logged On			
<a href="#">704</a>	Kinder	3/20/2006	19:47	10-8			
<a href="#">705</a>	Barrett	3/20/2006	19:44	10-8			
<a href="#">706</a>	Williams	3/20/2006	18:24	10-8		I-75	
<a href="#">707</a>	Invalid Op ID	3/20/2006	20:36	10-97	S-76	HFB EB at East End	
<a href="#">708</a>	McBride	3/20/2006	19:59	10-8		Pinellas	
<a href="#">710</a>	Cerrato	3/20/2006	20:27	10-8		Hillsborough	







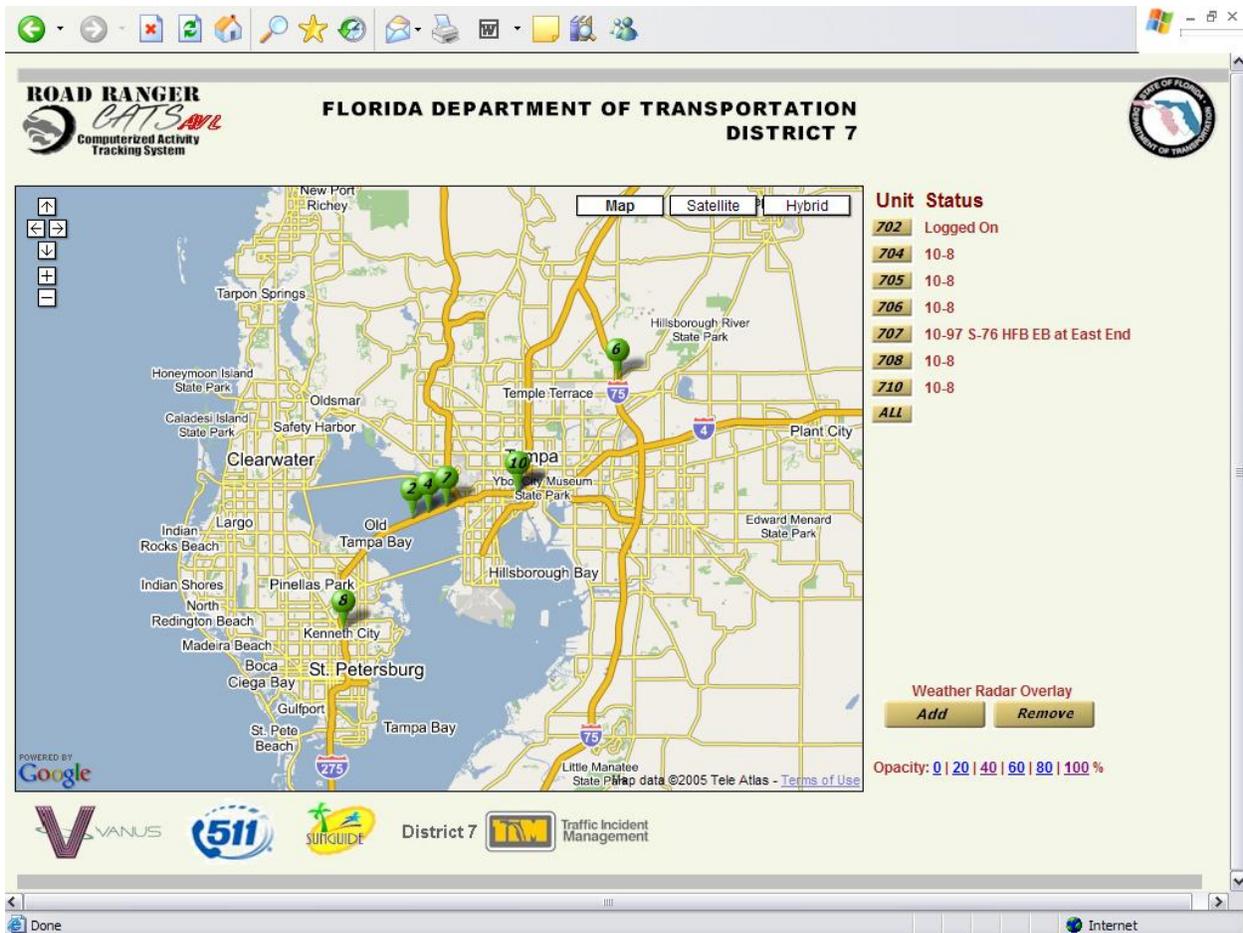
District 7



Traffic Incident Management

Done

Here is a screenshot of the AVL screen:



4. How is incident information entered into the system? (E.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

**Entered mostly by 511 operators. Status is updated in real-time by Road Ranger drivers**

5a. Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

**Road Rangers perform incident management on scene**

5b. Does your incident management system currently have any route diversion functionality? If yes, please describe.

No

(2/3) Questions about information pertaining to incidents

1. What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<i><u>_x_</u> Example data collected</i>	X__ Road/highway name	_X_ Cross street/exit number
___ Detector station #	X_ Latitude/longitude	_X_ incident type
_X_ source of incident report <sup>25</sup>	_X_ incident status <sup>26</sup>	X__ time incident detected
___ time incident verified	___ response time to location	_X_ time incident cleared <sup>27</sup>
___ road/light condition <sup>28</sup>	X__ injuries present	_X types of vehicles involved

<sup>25</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

<sup>26</sup> E.g., canceled, verified, cleared, etc.

<sup>27</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<sup>28</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

**511 Operators check web sites of local PD, utilize scanners, and have mobile units to report on incidents during rush hour.**

### (3/3) Questions about incident reporting

1. How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

**The data reports module is under development at this time. It will be able to report by a wide variety of parameters.**

2. What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

**We currently generate summaries of the number and types of incidents. See below.**

CATS Report Module - Microsoft Internet Explorer

Address: http://rravl.tbsunguide.com/newrr/scripts/reportframe.htm

## Road Ranger Logging System

For Period 3/1/06 to 3/20/06  
Truck:All



**Select Report :**

Activity

Date From:

Date To:

Time From:

Time To:

Event Type:

Disposition:

Truck:



Activity Summary									
Flats	Fuel	Mechanical	Jump	Debris	Phone	Tag	Tow/Push	MOT	Other
478	239	240	41	139	10	254	58	324	411

Incident Summary						
Accident	DAV	Abandoned Veh	Fire	Agency Assist	Pedestrian	Other
227	1620	192	7	2	0	6

3. Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

**Just numbers for types as shown above.**

4. How long is incident information retained? (E.g., 7 years, etc.)

**Not determined yet.**

5. *(Optional)* What type of reporting would you like to see that you currently don't have available with your current incident management system?

**We expect to be able to specify different types of parameters and get reports.**

## B.7 Survey for Florida's Turnpike Enterprise

Friday, March 31, 2006

FROM:

Christopher Ryan Amour  
TMC Management Team  
Florida's Turnpike Enterprise  
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## (1/3) Technical questions about incident management system

1. Do you have a name for your incident management system? What is it?

**SUN NAV**

2. Approximately how long have you used this system?

**INCIDENT MGMT – 4 YEARS, ROAD RANGER – 1 YEAR**

3. How is incident information stored? (E.g., paper form in filing cabinet, electronic file, database that can be queried. If by paper form, can we get a copy of the form, or screenshot of incident screen in the computer software? Could we have a copy of the manual if available electronically?)

**ELECTRONIC DATABASE**

4. How is incident information entered into the system? (E.g., entered by dispatch operator after reported by cellular telephone call or radio communication, PDA, Tablet PC, etc. If via PDA/Tablet PC/etc., is this information communicated to the database in real-time, or is the portable computer synched up at the end of the shift?)

**CALLED IN VIA RADIO COMMUNICATION OR NEXTEL AND THEN IT'S ENTERED INTO SUN NAV BY TMC ROAD RANGER DISPATCHER**

**5a.** Are you involved in the actual management of incidents (i.e., incident response, such as diverting traffic, etc.) or only concerned with data collection, incident reporting and verification?

**YES**

**5b.** Does your incident management system currently have any route diversion functionality? If yes, please describe.

**NO, WE HAVE DIVERSION MAPS**

## (2/3) Questions about information pertaining to incidents

1. What kind of information is collected about each incident that is tracked? Please place an “x” next to each item in the below table that is collected.

<input checked="" type="checkbox"/> <i>Example data collected</i>	<input type="checkbox"/> Road/highway name	<input type="checkbox"/> Cross street/exit number
<input type="checkbox"/> Detector station #	<input type="checkbox"/> Latitude/longitude	<input type="checkbox"/> incident type
<input type="checkbox"/> source of incident report <sup>29</sup>	<input type="checkbox"/> incident status <sup>30</sup>	<input type="checkbox"/> time incident detected
<input type="checkbox"/> time incident verified	<input type="checkbox"/> response time to location	<input type="checkbox"/> time incident cleared <sup>31</sup>
<input type="checkbox"/> road/light condition <sup>32</sup>	<input type="checkbox"/> injuries present	<input type="checkbox"/> types of vehicles involved

2. Do you cross-reference other sources of information (or do others cross-reference your data) to verify incidents? (E.g., police logs, accident reports, etc.)

### BY MILEPOST

## (3/3) Questions about incident reporting

1. How is data reported? By road/highway, system wide, road segment? Can we get a copy of a representative (example) report?

### MONTHLY

<sup>29</sup> E.g., incident detected by automated system, cellular telephone call, police patrol, etc.

<sup>30</sup> E.g., canceled, verified, cleared, etc.

<sup>31</sup> E.g., time Road Ranger left; vehicle moved to road shoulder, etc.

<sup>32</sup> E.g., surface is wet, dry, etc.; daylight, night, etc. light conditions

2. What types of summary statistics are generated? How often are they produced? (e.g., weekly, monthly, etc.) Do you feel this information is accurate?

**MONTHLY, YES**

3. Do you calculate performance metrics from your information? (E.g., incident duration, response times, etc.)

**NO, NOT FOR ROAD RANGERS**

4. How long is incident information retained? (E.g., 7 years, etc.)

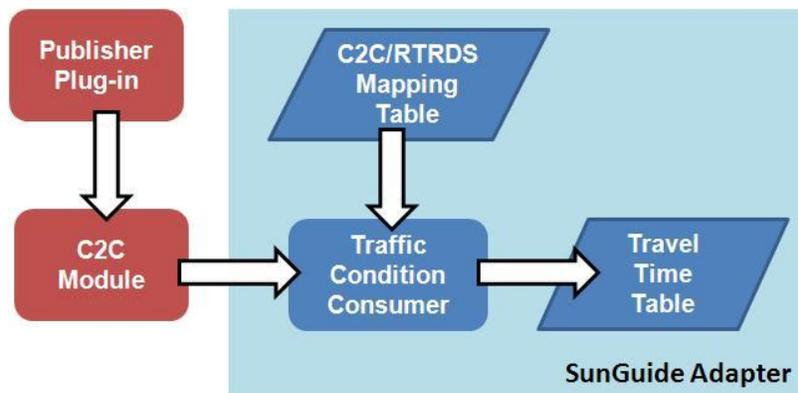
**FOREVER**

5. *(Optional)* What type of reporting would you like to see that you currently don't have available with your current incident management system?

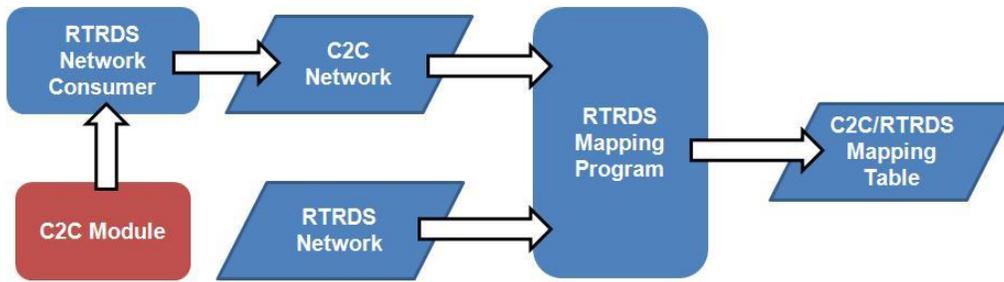
## Appendix C RTRDS Software Architecture

This appendix provides more detailed design description of the following RTRDS components: (1) the C2C module and SunGuide adapter, (2) the workstation GUI, and (3) how TeleAtlas Dynamap data is transformed into the Real-Time Route Diversion System map.

### C.1 The C2C Module and SunGuide Adapter



- The C2C (*Center-to-Center*) Module is an interface developed by SwRI to permit external software to communicate with SunGuide. SunGuide uses a custom Publisher Plug-in to publish data. For the purpose of testing, we set up a “local loop” as a publisher to realistically emulate a real time data feed. In this local loop, the publisher continuously reads an offline database of traffic conditions and forwards the data to the C2C module. Both the C2C module software and the offline data are from District 5 and provided to us by Clay Packard from SwRI. In a production environment, SunGuide can provide the live data feed to the C2C Module.
- In the RTRDS Adapter, the RTRDS Traffic Condition Consumer continuously reads traffic condition data from the C2C Module, and assigns the traffic condition data of a C2C link to the corresponding RTRDS link using the C2C/RTRDS Mapping table. It then calculates the travel time of RTRDS links based on the speed information from the traffic condition data and the length of the RTRDS links. The travel time is stored in a travel time table in the database.

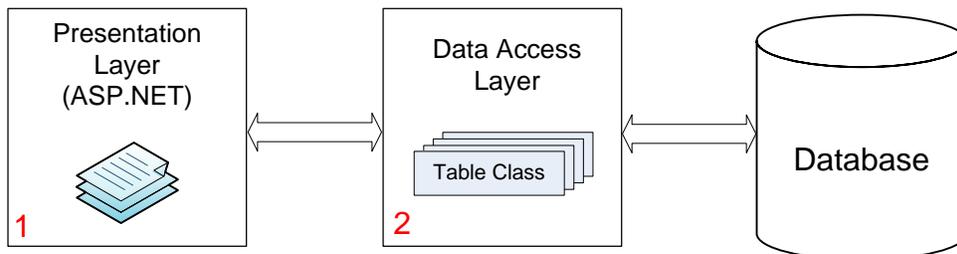


The C2C/RTRDS Mapping table is generated as follows:

- First, the RTRDS Network Consumer reads the C2C network data from the C2C Module, and stores the data in the C2C Network table.
- Next, the RTRDS Mapping Program reads both the C2C Network table and the RTRDS Network table from the RTRDS database, and associates each C2C link with the corresponding RTRDS link based on its location on the map and direction of travel. The association of the links is then stored in the C2C/RTRDS Mapping table.

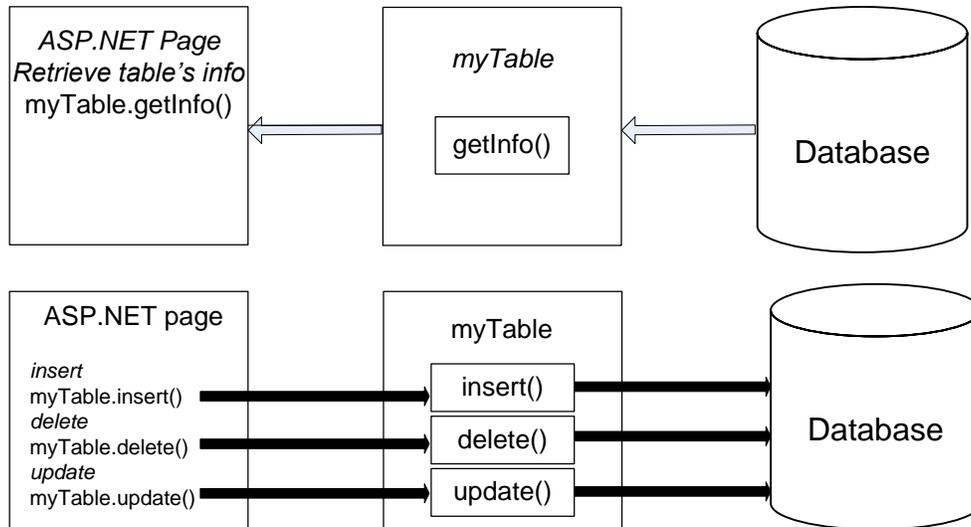
## C.2 RTRDS Workstation GUI

### RTRDS Workstation GUI Software Architecture



- (1) **Presentation Layer:** contains web pages (ASP.NET) which collect, summarize, and display information to the operator.
- (2) **Data Access Layer:** contains code to retrieve and modify data from the presentation layer. The data access layer serves as an intermediary between the ASP.NET logic (which renders the web pages seen by the operator) and the database (which makes the state of the Real-Time Route Diversion System persistent). This layer also enforces business logic rules. As an example, it verifies that a set of road segments that comprise a diversion route form a connected path through the road topology.

## Information Retrieval



The above figures present an alternative view of the data manipulation tasks, which are performed in the data access layer. The result is a separation of presentation logic and business logic.

### C.3 Map Data Flow

- (1) **readingStreetLayerOfDynamap ArcMap VBA module:** reads in the street layer of a Dynamap map and outputs the information to RDS\_DmStDbf and RDS\_DmFeaturePoints tables in an Oracle database.
- (2) **RTRDS Topology Editor:** displays the map in RDS\_DmFeaturePoints and RDS\_DmStDbf tables. The user can then use the editor to make the map more suitable for the Dynasmart-P simulator, which requires that each intersection consists of one point. After completing the editing, the user outputs the new map to RDS\_ROAD\_INT, RDS\_ROAD\_SEG, and RDS\_FEATURE\_PNT tables.
- (3) **RTRDS Movement Generator:** reads in the RDS\_ROAD\_INT and RDS\_ROAD\_SEG tables and generates RDS\_SEG\_MOVEMENT table that contains the traffic movement in every intersection.

(4) **RTRDS Signal Generator:** reads in RDS\_ROAD\_INT and RDS\_SEG\_MOVEMENT tables and generates default traffic signal information in every intersection. The generator stores traffic information in the following tables: RDS\_CONTROL, RDS\_SIGNAL\_TIMING\_PLAN, RDS\_SIGNALIZED, RDS\_SIGNALIZED\_INB\_LNK, and RDS\_SIGNALIZED\_MOV tables.

