Technical Memorandum

SunGuide® Software System

Highway Advisory Radio Concept of Operations

Version 1.1

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Prepared for:

Florida Department of Transportation
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List of Acronyms and Abbreviations

ATMS ..... Advanced Traffic Management System

ConOps ..... Concept of Operations

DMS ..... Dynamic Message Sign

FDOT ..... Florida Department of Transportation

GUI ..... Graphical User Interface

HAR ..... Highway Advisory Radio

ITS ..... Intelligent Transportation Systems

RPG ..... Response Plan Generation

RTMC ..... Regional Transportation Management Center

SIM ..... Software Interface Module

TMC ..... Transportation Management Center

TTS ..... Text-to-Speech

WPF ..... Windows Presentation Foundation

1 Introduction

This document describes how the Florida Department of Transportation's (FDOT) regional transportation management centers (RTMC) utilize highway advisory radios (HAR) to report adverse traffic conditions to the travelling public and how HAR is integrated into FDOT's SunGuide® advanced traffic management system (ATMS) software. This document focuses on how HAR is currently used from an operations perspective and provides a brief overview of the flow of traveler data through the system.

1.1 Document Identification

This concept of operations (ConOps) was developed for the SunGuide software project.

1.2 Document Purpose

The purpose of this ConOps is to:

- Establish how HAR devices (transmitters and beacons) and systems should be used to communicate traveler information to the traveling public.
- Outline how RTMC operators should interface with HAR controls and various options and functionality available to operators for HAR data dissemination.

Note that the term "HAR devices" is used throughout the document to refer to both the HAR transmitters and their associated HAR beacons.

1.3 System Overview

FDOT's SunGuide Support, Maintenance, and Development Contract, contract number BDQ69, addresses the necessity of supporting, maintaining, and performing enhancement development to the SunGuide software. The SunGuide software was developed by FDOT through a contract from October 2003 through June 2010. SunGuide software is a set of intelligent transportation systems (ITS) software that allows control of roadway devices as well as information exchange across a variety of transportation agencies; it is deployed throughout the state of Florida. SunGuide software is based on ITS software available from the state of Texas with significant customization and development of new software modules to meet FDOT's needs. Figure 1 provides a graphical view of the SunGuide software.

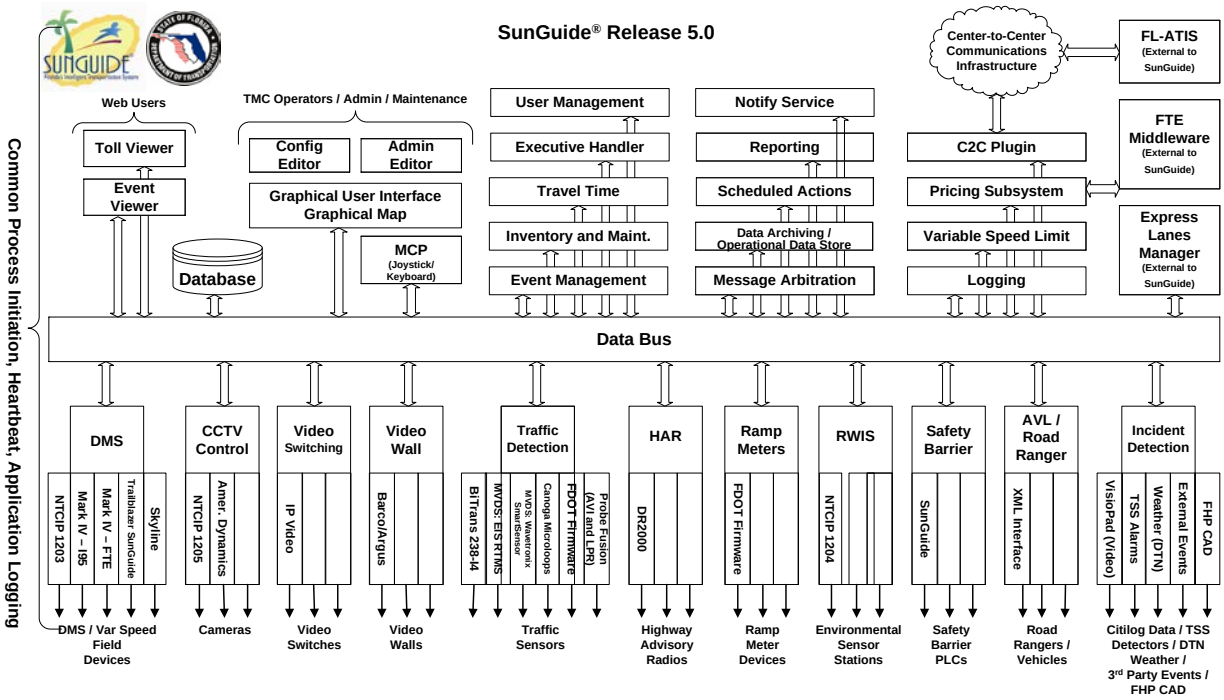

Figure 1.1 – High-Level Architectural Concept

SunGuide software's core interfaces with devices via data input interfaces and device control interfaces. The software performs calculations and automated actions within system processing, in which RTMC operators and other ITS staff use user interfaces to perform manual actions in response to changing traffic conditions. Based on operator actions and automated features, traffic information is disseminated via system output interfaces and external systems. SunGuide software functions using a number of shared services, ITS architecture libraries, and data definitions.

The HAR subsystem is one of many subsystems within SunGuide software that specifically handles the HAR data and device management and control. The HAR subsystem, as shown in Figure 1.1 above, currently uses one software driver to communicate to one or more HAR devices using the DR2000 protocol. Operators have the ability to view HAR status and control the HAR devices through the operator map that communicates with the HAR subsystem in order to send and receive HAR-related data.

Since SunGuide software development efforts began in October 2003, several major releases have been developed; this document addresses an incremental update of the most recent release. After development, the software will be deployed to a number of regional and local transportation management centers (TMC) throughout Florida and support activities will be performed.

2 References

2.1 Related Documents

Additional information regarding the SunGuide software project can be found in the following documents and electronic publications:

- FDOT Scope of Services: BDQ69, Standard Written Agreement for SunGuide Software Support, Maintenance, and Development, Exhibit A: Scope of Services. July 1, 2010.

These documents are available from the document library on the SunGuide software project web site at http://sunguidesoftware.com.

Alternatively, they can be obtained by request to:

Florida Department of Transportation
Traffic Engineering and Operations Office
605 Suwannee Street, M.S. 90
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2.2 Contacts

The following is a list of contacts for the SunGuide software project:

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- Arun Krishnamurthy, FDOT SunGuide Project Manager, arun.krishnamurthy@dot.state.fl.us, 850-410-5615
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3 Current System Situation

SunGuide software currently interfaces with the Platinum HAR Software Interface Module (SIM). The HAR SIM interfaces with the HAR server software, which directly communicates with HAR devices deployed in various locations throughout the state of Florida. This interface provides very limited messaging and control capabilities. Additionally, SunGuide software does

not provide much of the functionality, automated features, and error checking to HAR that is currently available in other areas of the software, such as with dynamic message sign (DMS) control.

3.1 Background, Objectives, and Scope

The SunGuide software HAR subsystem was originally developed with a "simple" interface to existing HAR control software. SunGuide software was not designed to communicate directly with the HAR devices; rather it allowed the HAR control software to handle device communications and management. This design methodology is not consistent with most devices configured within SunGuide software, in which there is typically no mediating software between SunGuide software and the devices other than the device firmware. This original interface is functional, but lacks many of the value-added features that the Platinum HAR SIM client graphical user interface (GUI) offers.

3.2 Operational Constraints

The features for managing HAR devices are shared between the device control and the server software.

Vehicles are within range of HAR messages for a much longer time than a DMS. Thus, more information can be disseminated to motorists from a HAR message. However, the range of reception is larger and omni-directional; therefore, the messages must identify the roadway and direction the message applies to and avoid terms such as "next 5 miles" or "ahead."

3.3 Description of the Current System

SunGuide software's interface with the HAR control software allows operators to push or clear HAR messages being reported from a HAR device by two methods:

- ***Manually Entered HAR Messages***: Manually typing in a text and sending this text to the selected HAR device

- ***Automated HAR Messages***: Sending automatically generated text to automatically selected HAR based on the location of an operator-entered event

Additionally, a header and footer HAR message can be added before and after the sent message, respectively. These messages are optional and, when configured, are always appended to the message sent, regardless of which the two methods above are used.

3.3.1 Manually Entered HAR Messages

HAR devices are displayed on the SunGuide software operator map as color-coded icons, based on operational status. When selected, operators can view the operational status, the message reported from the device, and the beacons status. Figure 3.1 is an example of the SunGuide

software HAR status window. From this window operators can select to listen to the text-to-speech message currently being reported on the device, change the operational status, turn on/off beacons, stop reporting the message, and send a new message to the selected HAR device.

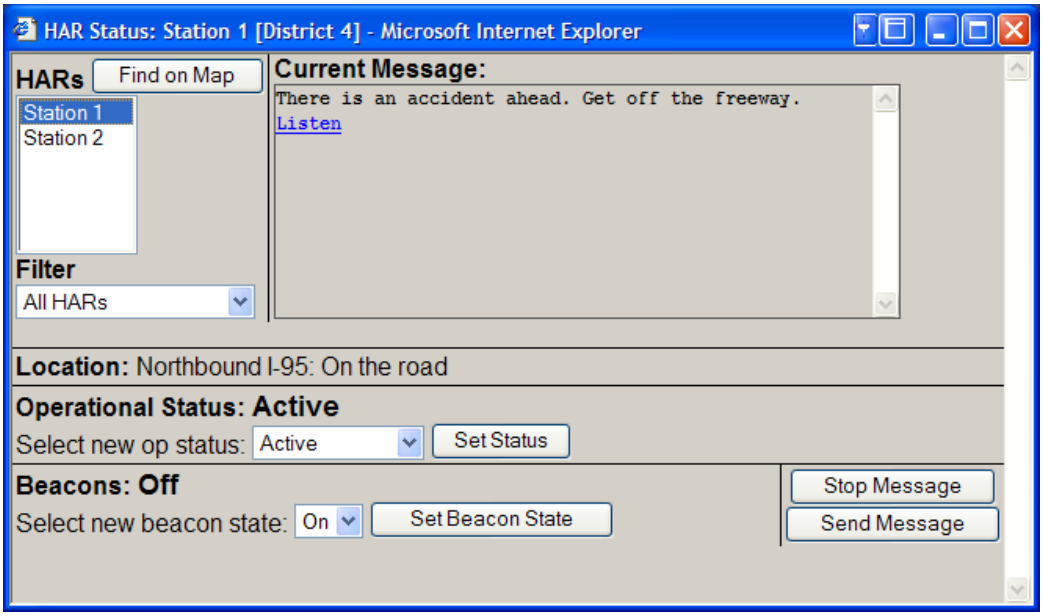

Figure 3.1 – SunGuide Software HAR Status Window Example

When operators select to send a message to a HAR device, the Send HAR Message window is opened. Figure 3.2 is an example of a Send HAR Message window.

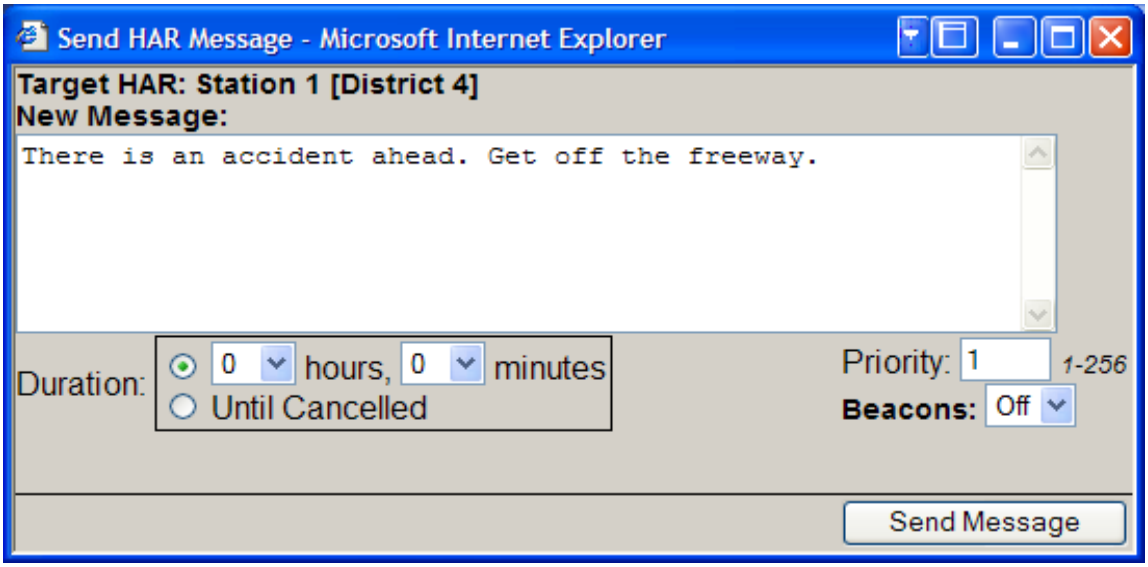

Figure 3.2 – SunGuide Software Send HAR Message Window Example

From the Send HAR Message window, operators can manually type the desired message, set the message duration, set the priority level, and set the beacons status when the message is sent.

3.3.2 Automated HAR Messages

SunGuide software operators have the ability to automatically generate HAR messages from operator-entered event reports. RTMC operators can create event reports, selecting an event location, type, impact, and other event information. Using the selected information, operators can choose to generate a response plan, which prompts SunGuide software to automatically select nearby DMS and HAR devices and create an event-related message that can be pushed to DMS, HAR, email, and a 511 travel information system.

Figure 3.3 is an example of the response plan that SunGuide software generates from an operator-created event report.

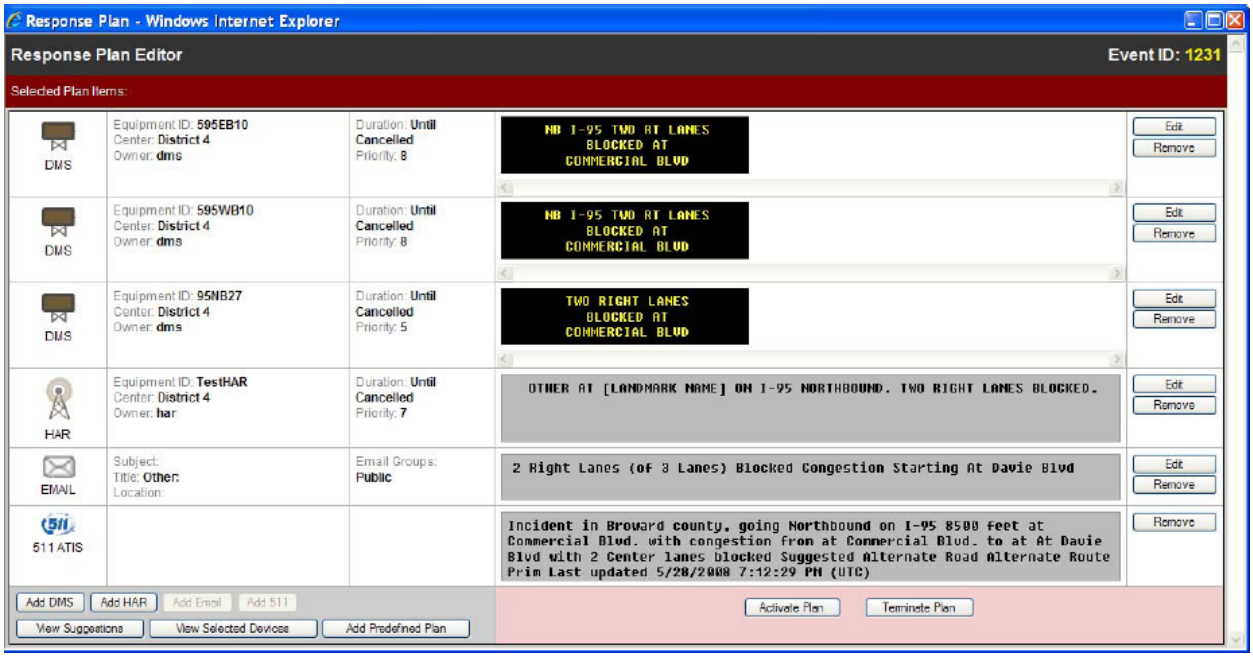

Figure 3.3 – SunGuide Software Send HAR Message Window Example

After a response plan is created, operators can choose to edit the automatically generated HAR message and/or add or remove HAR devices from the plan. Once edits are completed, activating the plan prompts SunGuide software to send messages out to all devices within the plan.

3.4 User Profiles

RTMC operators, management, and administrative staff are solely responsible the messaging and operation of HAR devices. Recipients of traveler information are the traveling public in range of the HAR devices.

3.5 Support Environment

HAR devices are maintained at the FDOT District level by District ITS staff and/or ITS maintenance staff. SunGuide software is maintained by District ITS staff and supported by FDOT Central Office and contracted staff.

4 Justification and Nature of the Changes

4.1 Justification for Changes

The limited functionality and control of the HAR interface within SunGuide software does not allow operators to utilize HAR devices as efficiently and effectively as with other ITS devices. Adding functionality to the HAR subsystem within SunGuide software could resolve these issues. Additionally, the current design routes communications through a third-party HAR application, which not only introduces a dependency and potential point of failure, but further limits control and capabilities that may be available to operators.

4.2 Description of the Desired Changes

The proposed changes to the current system only affect SunGuide software and how it communicates with HAR devices. These changes include:

- ***Direct Connection with the HAR Transmitters and Beacons***: Rather than relying on the HAR SIM control software to handle device communications and management, SunGuide software would take on this role. This not only eliminates the need for the intermediate HAR SIM control software in normal operation of the devices, but it allows SunGuide software to receive direct feedback from the HAR transmitter and/or beacon to confirm whether the message was successfully transmitted and if there are changes to the current status of the HAR device. This change requires generating an audio file from an operator-entered text message or using a saved or uploaded audio file. All selected audio files would be sent to the selected HAR transmitters and saved within SunGuide software to allow operators to play back the message. The SunGuide software should have a separate HAR transmitter and HAR beacon software drivers; this would allow interfacing with different makes of HAR transmitters and/or beacons. Consequently, the HAR transmitters and HAR beacons should be configured separately. However, each HAR beacon should be associated with a HAR transmitter. A HAR transmitter could have multiple HAR beacons.

- ***Text-To-Speech Audio File Generator***: The SunGuide software will need to generate an audio file from an operator-entered, response plan-generated, or HAR library text. The text-to-speech (TTS) generator should be configurable to allow different voices to be used.

- ***Operator Map Control and Monitoring***: To stay consistent with the SunGuide software design shift to use Windows Presentation Foundation (WPF) to render a thin client user interfaces, all windows used to control and monitor HAR should be built using WPF. The re-designed windows should be consistent in look and feel to the DMS control and monitoring windows. Basic functionally should include reporting device status; and the ability to manually change the device status, send a text message, edit a previously sent message, clear a sent message, make a voice recording of a HAR message (similar to floodgate messages), upload an audio WAV file from an operator workstation, and play back the audio messages that were sent to a HAR transmitter. Sound files that are recorded or uploaded should allow an operator to enter a text description of the message for future reference. The HAR control window should allow selection of one or multiple HAR transmitters and beacons, allowing an operator to send the same message to one or more HAR devices or clear a message from one or more HAR devices in one action. The HAR control window should also allow operators to set or clear beacons independently or in parallel with sending HAR message(s). This would allow operators to enable/disable beacons for one direction of travel, but not the other, if the HAR message is only applicable to one direction of travel.

- ***Operator Map Configuration***: To stay consistent with the SunGuide software design shift to move device configuration from the SunGuide Administrative Editor to the operator map, additional GUI windows will need to be added to the operator map to allow administrators to configure HAR transmitters and beacons. These configuration windows will need to include the necessary configuration parameters to allow SunGuide software to connect and communicate directly with HAR devices. Note that this configuration must differentiate the HAR transmitter from the HAR beacons since operators should have the ability to activate/deactivate beacons independently of HAR messages. The windows should also utilize WPF to render the user interface to remain consistent with DMS configuration windows.

- ***HAR Message Libraries***: SunGuide software's DMS messaging currently has the ability to save a library of common messages and message templates to ensure that messaging follows established operating procedures. This functionality should be extended to HAR messages to allow administrators to save messages into libraries and operators to select messages from these libraries and use and/or edit them appropriately before being sent to HAR transmitters. The HAR message libraries should consist of both text messages and audio files. The text messages should be translated to audio using text-to-speech functionality when the message is sent to the HAR transmitter. Operators should have the ability to type and text messages into the HAR Message Libraries. The audio files should have a text description associated with each. Operators should have the ability to save voice recordings to the HAR Message Libraries similarly to how floodgate messages are recorded, or upload WAV files to the HAR Message Libraries.

- ***HAR TTS Dictionary***: There are many roadway names that are not pronounced properly within a TTS English Dictionary. This HAR TTS Dictionary would search and replace configured words within a HAR message, replacing these words with phonetic spelling, before the message is sent to the HAR transmitter. The HAR TTS Dictionary should allow operators to configure words or phrases that are commonly used for reporting traffic conditions.

- ***HAR Sequencing***: SunGuide software should support the concept of sequencing several HAR beacons along multiple roadways, similar to the existing DMS Message Sequencing concept. SunGuide software should allow configuration of HAR Sequencing and using this configuration to automatically select appropriate HAR device beacons when generating a response plan. HAR transmitters should still be selected based on a radial distance from events. However, since HAR beacons may be direction-specific (i.e. there may be separate eastbound and westbound, or separate northbound and southbound, beacons for each HAR transmitter), then the sequencing should select HAR beacons based on location and direction of travel.

- ***HAR Message Management***: SunGuide software currently sends only one message to a HAR device at a time with a single priority. However, HAR devices have the ability to report multiple messages at a time, as long as the total length of all messages does not exceed a configurable amount of time. SunGuide software should have the ability to manage and send multiple messages per HAR transmitter. Operators should have the ability to send any number of messages to a HAR device's message queue, ranking the messages in priority order and then in the order in which messages were sent (i.e. if two or more HAR messages have the same priority, they should be order in the order the message was sent to the HAR message queue; the most recent message outranking the next most recent, etc). SunGuide software should then send as many messages as it can to a HAR transmitter, as long as the total length of messages sent does not exceed a configurable amount of time, which is set per HAR transmitter. For example, if five messages are sent to a HAR queue and only the top three can fit within the time limit, then only the top three are sent. SunGuide software should warn an operator if the highest priority message alone exceeds the time limit. The HAR message queue GUI should indicate which messages were sent to the HAR transmitter, which ones were not, and whether the transmission of the message(s) was successful. Messages not sent to a HAR transmitter should be kept queued until removed or they expire. When higher priority messages are removed or expire, lower priority messages should be sent, provided they fit within the allotted time limit. Similar to DMS, HAR priorities should be ranked from 1 to 256, in which 1 is the highest priority and 256 is the lowest. The messages sent to the HAR transmitter should play in priority order. SunGuide software should also allow operators to send the same message to any number of HAR transmitters. A HAR message header and footer should be configurable, and like the current functionality, this header

and footer would be appended to each message sent to the HAR transmitter. Note that the total length of a HAR message includes the message header, the actual message, and the message footer. The SunGuide software will sum the total length of the HAR message when determining if a message can fit within the allotted time limit. The HAR message manager window should also allow operators to select multiple messages and remove them with a single "Remove Message(s)" button click. The HAR message manager window should allow operators to forcibly disable selected HAR message(s), which would stop reporting the disabled HAR message(s) while keeping them in the HAR message queue. This would allow an operator to report emergency messages only. Later, an operator could select to re-enable lower priority HAR messages.

- ***Expanded HAR Response Plan Generation (RPG) Message Template***: SunGuide software currently uses a template when creating a message posted to a HAR transmitter. However, some of the messaging is not as detailed as other messages generated within SunGuide software's RPG module. For example, for event type "object in roadway," SunGuide software currently reports "incident" for the HAR message. The HAR RPG template should be able to report the same amount of detail as that currently reported in the "SAE Description" field within SunGuide software. The HAR RPG template should be configurable to system administrators similar to how other message templates are configured and managed within SunGuide software. In addition to providing more detail, SunGuide software should allow administrators to configure which event severities and event types will generate a HAR message. By default, RPG would possibly generate a HAR message for all severities and event types unless otherwise specified.

- ***HAR RPG Broadcast Area***: SunGuide software currently defines a radius from a reported incident and adds all HAR transmitters and beacons within this radius to a response plan. Rather than using this concept of defining a radius from an event, SunGuide software should allow HAR broadcast area definition. When a HAR transmitter and/or beacon are configured, SunGuide software should, by default, define a circular broadcast area with a configurable distance from the HAR transmitter or beacon. An administrator should then have the ability to tweak this region by altering the shape of the region to a polygon with a variable number of nodes, variable shape, and variable size. When a response plan is generated, SunGuide software should select all HAR transmitters and beacons whose broadcast region encompasses the event location.

- ***HAR RPG Multiple Edit***: Once a response plan has been generated, SunGuide software should allow operators to select multiple HAR transmitters and edit a common message to be sent to all selected HAR transmitters, rather than editing each HAR transmitter one at a time. This is similar functionality that already exists for DMS.

4.3 Assumptions and Constraints

It is assumed that the desired features for the updated HAR system will be completed in conjunction with or after the SunGuide Release 6.0 operator map changes, which includes a large number of user interface changes. Changes made for the HAR subsystem should be consistent with these changes. For example, one of the major SunGuide Release 6.0 changes includes moving all DMS device configuration from the SunGuide Administrative Editor to the operator map using WPF user interface rendering. The HAR changes should also use WPF using similar style and design philosophies to maintain a consistent look and feel to the operator map.

5 Concepts for the Proposed System

5.1 Objectives and Scope

It is not desired to create additional work for RTMC operators as a result of these changes. Instead, one of the main goals of the HAR changes is to create an interface and subsystem that is aligned with existing RTMC operations and procedures. Also, it is important to maintain a consistent level of functionality between different types of ITS dissemination devices, such as between HAR and DMS.

5.2 Operational Policies and Constraints

Use of the HAR will fit into existing RTMC operations and procedures.

5.3 Description of the Proposed System

HAR devices are used similarly to DMSs, both providing travel information to the traveling public related to roadways and conditions in the vicinity of the HAR device. Existing RTMC procedures include monitoring and managing traffic events on major roadways within the RTMC's managed areas. As part of these traffic management activities, travel information that is pertinent to the traveling public can be provided to HAR devices using the two methods previously described in this document.

5.4 Modes of Operation

HAR devices are monitored and maintained by their owning FDOT District, which by large operate their RTMCs on a 24/7/365 basis. HAR devices are used in either normal or emergency situations in order to disseminate travel information. This information may include traffic events, traveler advisory messages, emergency information, special alerts, such as Law Enforcement Officer, America's Missing: Broadcast Emergency Response, or Silver alerts, or other information that may impact traffic.

5.5 User Involvement and Interaction

RTMC operators, supervisors, and administration are the sole users of the HAR devices, and consequently the SunGuide software HAR subsystem and functionality discussed in this document.

5.6 Support Environment

SunGuide software is managed and maintained by FDOT Districts or other agencies, and FDOT Central Office and/or their maintenance contractor. SunGuide software is hosted in facilities that are owned and operated by the FDOT District or agency that is operating SunGuide software, licensed from FDOT Central Office. FDOT Districts and agencies may have contracted ITS maintenance staff to help further support the software. The HAR vendor is also typically under contract to provide support to HAR devices and servers.

If issues are discovered by the FDOT District or agency operating SunGuide software, then support is provided by FDOT Central Office and/or their maintenance contractor.

6 Operational Scenarios

6.1 Event Management Scenario

A Road Ranger patrolling I-95 comes upon a disabled vehicle blocking the right lane. The Road Ranger sets up maintenance of traffic cones and signage and reports the vehicle to the RTMC operators. The operator creates an event report in SunGuide software, specifying the event location on I-95 before Okeechobee Road, the event type of "Disabled Vehicle," and the lane blockage information. The operator then creates a response plan, which includes two DMSs upstream of the disabled vehicle and a HAR device also upstream of the vehicle. The operator activates the plan. Before the message is sent to the HAR, SunGuide software's HAR TTS Dictionary discovers the word "Okeechobee" in the message about lane blockage and replaces it with its phonetic equivalent, "Oakkeechoebbee." The modified message is then sent and the HAR beacons are activated. After activating the HAR, the operator checks the HAR device from the operator map, ensures that the message has been successfully sent based on the reported device status, and then listens to the TTS message to confirm that words and names are pronounced properly.

Travelers pass the HAR transmitter, notice the flashing beacons, and tune into the radio frequency of the HAR. Travelers listen to a TTS message and respond appropriately, avoiding the right lane in the area of I-95 where the disabled vehicle is located.

The Road Ranger jump starts the disabled vehicle, enabling the driver to exit I-95 and seek further repair elsewhere. He communicates his actions to the RTMC operator managing this event. The operator clears the lane blockage from the event report, regenerates the response plan, and activates it, which clears the DMS and HAR. The lane blockage, however, created heavy

congestion in the area of the event, so the operator "clones" the event in SunGuide software. This automatically copies the event information to a new event report. The operator changes the event type in the cloned event from "Disabled Vehicle" to "Congestion," generates a response plan for the new event, and sends a congestion message to the HAR device.

Travelers now passing the HAR notice the flashing beacons, tune into the radio frequency of the HAR, and hear a message about heavy congestion ahead. Some travelers exit I-95 early to avoid the congestion and take an alternate route, while others adjust their travel plans accordingly as they wait out the congestion.

After the congestion clears, the RTMC operator closes the congestion event, which automatically clears the HAR message and stops the HAR's beacons from flashing.

6.2 Traveler Advisory Message Scenario

A major hurricane is approaching the Fort Myers area and southwest Florida is receiving large amounts of rain. Sections of I-75 in the Fort Myers area are currently under construction and proper water management has not yet been completed.

An RTMC operator in FDOT District One opens the HAR device control window from the SunGuide software operator map and selects all HAR devices on I-75 in the Fort Myers area. The operator follows standard procedures and selects a message that was already created and saved in the HAR message library, providing a warning for possible flooding. After selecting the message, the operator edits the message, including information that drivers may expect heavy flooding in areas currently under construction. The operator sets the priority of this HAR message to "100." The operator sends the edited message to all selected HAR devices with a single "Send Message" click. The operator verifies that the message was successfully posted to all selected HAR devices from the HAR device control window.

The operator continually monitors the approaching storm and roadways. An hour later, upon scanning the cameras in the construction area, the operator notices that a three-vehicle accident has occurred, blocking all northbound lanes on I-75 in the Fort Myers area. The operator creates an event report and generates a response plan, which includes all HAR devices on I-75 in the Fort Myers area. Activating the plan, a priority "1" message is queued in the HAR message manager. SunGuide software determines that the total length of both the new lane blockage message and the traveler advisory flooding message do not exceed the maximum total message length, so both messages are sent to the HAR.

After the lane blockage event and subsequent congestion are cleared, the event reports are closed and the event messages are automatically removed from the HAR devices. The HAR message manager then automatically posts only the traveler advisory flooding message.

The hurricane makes a turn out to sea and the heavy rains stop. The RTMC operator checks the roadways and notes that flooding has also cleared. The operator opens the HAR message manager, selects all HAR devices that are reporting the traveler advisory flooding message, and clears all messages with a single "Clear Message" click. Clearing the final message also deactivates the beacons on all HAR devices that are no longer reporting any messages.

7 Summary of Impacts

One overall goal of the changes described in this document is to make the HAR functionality comparable to the existing functionality available for DMSs and the HAR SIM. Both HAR and DMS are used similarly from an RTMC operator's perspective, so providing equivalent functionality to both makes SunGuide software more streamlined and easier to use and learn in order for operators to accomplish their goals and objectives of maintaining an area's roadways in an efficient manner.

Another overall goal is to make the HAR subsystem more reliable. SunGuide software's HAR subsystem currently interfaces and relies on an external HAR SIM control software to manage HAR devices. This dependency inhibits SunGuide software from directly controlling and possibly diagnosing communications and/or device issues, which complicates device maintenance and may delay device repair, making HAR devices less available.

8 Analysis of the Proposed System

The primary advantage for the changes described in this document is to help make traffic operations more efficient and traveler information more accessible to the traveling public. Currently, users are using the HAR vendor software because it offers more overall value with the additional features. Once many of these features are brought into the SunGuide software, operators will be able to disseminate traveler information to HAR devices without wasting time manually checking back and forth and re-entering information in multiple software packages. The streamlined, fully integrated SunGuide software will provide more value to operators and more users will take advantage of SunGuide software to interface with HAR. Additionally, the efficiency gained would allow operators to select and disseminate information in a timely manner and possibly avoid common typing errors. Administrative staff will also no longer need to operate and maintain separate HAR control software; this would further help to ensure a high level of reliability and uptime.