

**SunGuide™:**  
**Using SunGuide Travel Times**  
**SunGuide-UTVT-3.0**



Prepared for:

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## LIST OF ACRONYMS

|           |                                      |
|-----------|--------------------------------------|
| C2C.....  | Center-to-Center                     |
| DA.....   | Data Archive                         |
| DMS.....  | Dynamic Message Subsystem            |
| FAQ.....  | Frequently Asked Questions           |
| FDOT..... | Florida Department of Transportation |
| GUI.....  | Graphical User Interface             |
| ITS.....  | Intelligent Transportation Systems   |
| MAS.....  | Message Arbitration Subsystem        |
| SUM.....  | Software Users Manual                |
| TSS.....  | Transportation Sensor Subsystem      |
| TVT.....  | Travel Times                         |
| VDD.....  | Version Description Document         |

## **Revision History**

| <b>Revision</b> | <b>Date</b>       | <b>Changes</b>                                                                                                                                                                                                             |
|-----------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.0.0-Draft     | November 14, 2006 | Initial Release.                                                                                                                                                                                                           |
| 1.0.0           | November 19, 2006 | Updated with FDOT Central Office comments                                                                                                                                                                                  |
| 1.0.1           | November 26, 2006 | Updated several typographical errors in the document                                                                                                                                                                       |
| 1.0.2           | February 9, 2007  | Modifications made:<br>Add text to clarify travel time concepts<br>Updated document with new figures<br>Corrected typographical errors<br>Added Section 3 containing questions about TVT calculations and traffic sensors. |
| 1.0.3           | February 13, 2007 | Modifications made to<br>Correct language usage and typos<br>Correct travel time examples 1, 2 and 4, add definition of NR as used in the examples.<br>Remove traffic sensor considerations from Section 3.                |
| 2.0.0-Draft     | November 7, 2008  | Updated based on Release 4.1 functionality                                                                                                                                                                                 |
| 2.0.0           | January 16, 2009  | Updated based on FDOT CO comments                                                                                                                                                                                          |
| 2.0.1           | January 27, 2009  | Updated based on D6 comments                                                                                                                                                                                               |
| 3.0             | March 14, 2019    | Updated based on latest code developments                                                                                                                                                                                  |

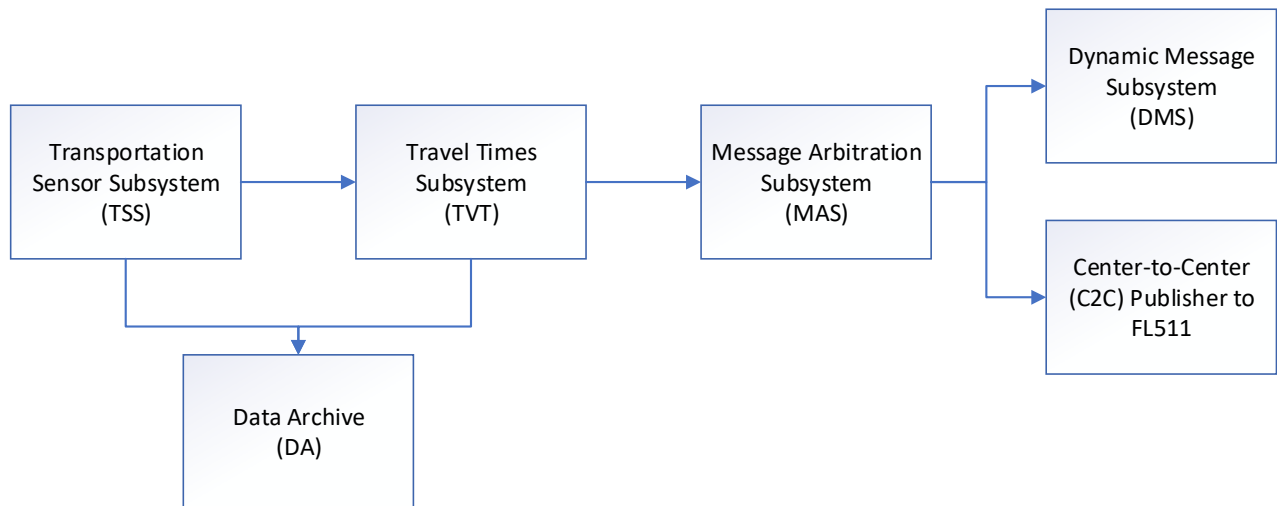
## **1 Scope**

### **1.1 Goal**

The goal of this document is to describe how an administrator would configure the Florida Department of Transportation (FDOT) SunGuide™ software to calculate and display travel times (TVT). The reader should refer to the SunGuide Software Users Manual (SUM) and SunGuide Training Material for additional information.

### **1.2 Overview**

The generation of messages for displaying travel times is a cooperative effort between various SunGuide subsystems. Figure 1 depicts the data flow that exists between the subsystems that are used to calculate and display travel times.



**Figure 1: Travel Time Creation and Distribution**

Data for travel times generation comes from the Transportation Sensor Subsystem (TSS); the TSS subsystem provides access to a variety of data sources (e.g. detector types). The data goes from TSS to the TVT subsystem where travel times are computed. Messages generated by the TVT subsystem are then sent to the Message Arbitration Subsystem (MAS) which is a message queuing subsystem that allows priorities to be assigned to messages and also controls when they are sent to the Dynamic Message Sign (DMS) subsystem for display.

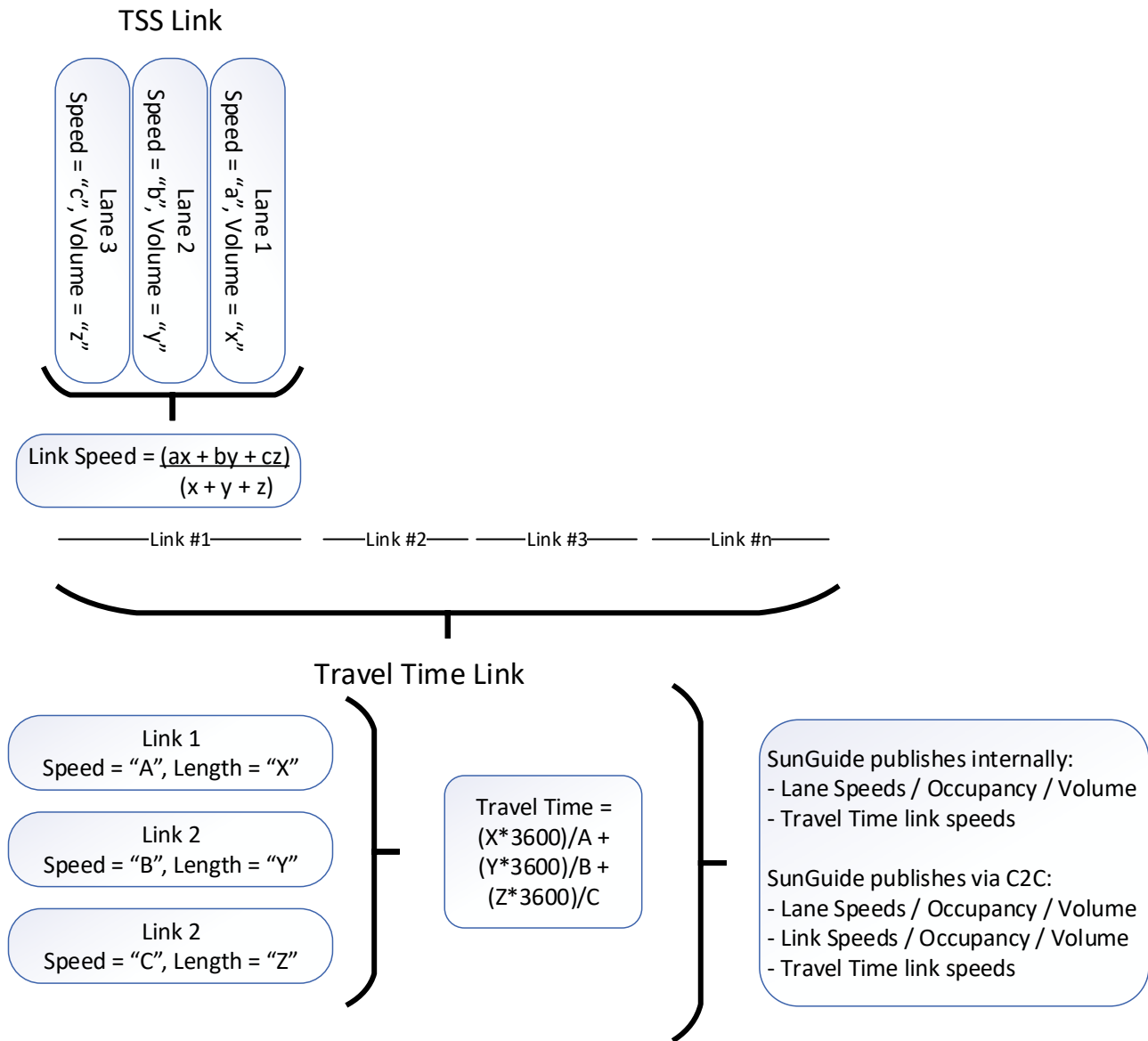
### **1.3 Travel Time Computation**

The travel time system utilizes smoothed speed data gathered from a detector subsystem to generate travel times. TSS uses a smoothed, rolling, volume weighted average for speed and combines the lanes to obtain the average speed of each TSS link that composes the TVT link. From these speeds the time to traverse each TSS link is computed and then the sum of the parts is the travel time over the TVT link.

## Using SunGuide Travel Times

### 1.3.1 High Level Discussion of Travel Time Computation

Figure 2 graphically depicts how speeds from the TSS subsystem are used to compute travel times.



**Figure 2: How SunGuide Computes Travel Time Link Speeds**

General comments about the computation of travel times include:

- When a "lane" is failed, the TVT algorithm adjusts and ignores the lane. This is typically due to some sort of controller or configuration error where some of the lanes report data, but not all of them.
- When a TSS poll returns an error, the error clears the data for the lane (no data)
- Freeflow time for a travel time link is calculated using the travel time of the link assuming the speed limit speeds are used in the calculation. These are manually configured on internal SunGuide links and reported through Center-to-Center for remote links.
- If reported speeds for a link are greater than the speed limit, the speed limit will be used in the travel time calculation.



## Using SunGuide Travel Times

- Travel time subsystem has variety of parameters including:
  - expireRate: length of time TvT can use old data (not updated, but also not failed)
  - percentLanesWithData: percent of lanes that must have data to compute a travel time link speed
- The travel time message template is customizable by SIGN
- Travel Time subsystem could be upgraded to utilize “historical data” for failed links but an algorithm would need to be developed.

|                                       |                                       |                                       |
|---------------------------------------|---------------------------------------|---------------------------------------|
| Link 1, Lane 1 -- 50 mph, 20 vehicles | Link 2, Lane 1 -- 50 mph, 5 vehicles  | Link 3, Lane 1 -- 40 mph, 20 vehicles |
| Link 1, Lane 2 -- 40 mph, 10 vehicles | Link 2, Lane 2 -- 30 mph, 15 vehicles | Link 3, Lane 2 -- 20 mph, 10 vehicles |

**Figure 3: Example TSS Values**

Using the data above, the travel time is computed as:

$$s1 = (50 \times 20 + 40 \times 10) / (20 + 10) = 46.667$$

$$s2 = (50 \times 5 + 30 \times 15) / (5 + 15) = 35$$

$$s3 = (40 \times 20 + 20 \times 10) / (20 + 10) = 33.33$$

$$d1 = 0.25 \text{ miles}$$

$$d2 = 0.50 \text{ miles}$$

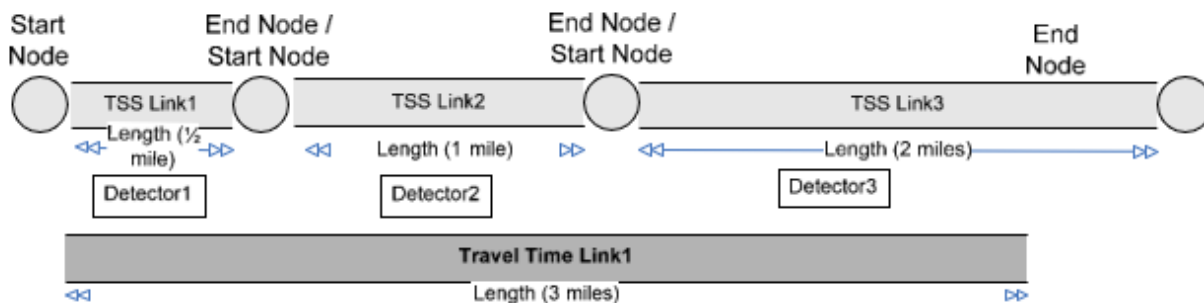
$$d3 = 0.25 \text{ miles}$$

Our travel time is  $(0.25 / 46.67) + (0.50 / 35) + (0.25 / 33.33) = 0.0271$  hours or 1.62 minutes

The TVT subsystem can generate travel times message using either the metric system or English system of measurements.

### 1.3.2 Detailed Discussion of Travel Time Computation

Travel time links are defined as one or more TSS links as shown in Figure 4. The TSS links may be from different detectors. When configuring a travel time link, the default length value for each TSS link is the length as stored in TSS. However, for travel time links which only require part of a TSS link to be used in calculations, partial TSS links can be used in the travel time link by modifying this default value. The length of TSS links used in a travel time link is stored independently of the length of the TSS link as utilized by TSS. In the travel time link depicted in Figure 4, the length of TSS Link3 is modified to 1 ½ miles to reflect the portion of the link used in the travel time link.

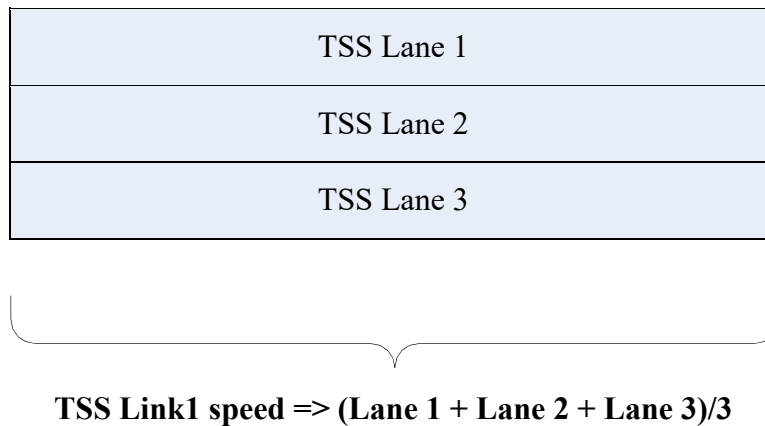


**Figure 4: Travel Time Link Definition**

## Using SunGuide Travel Times

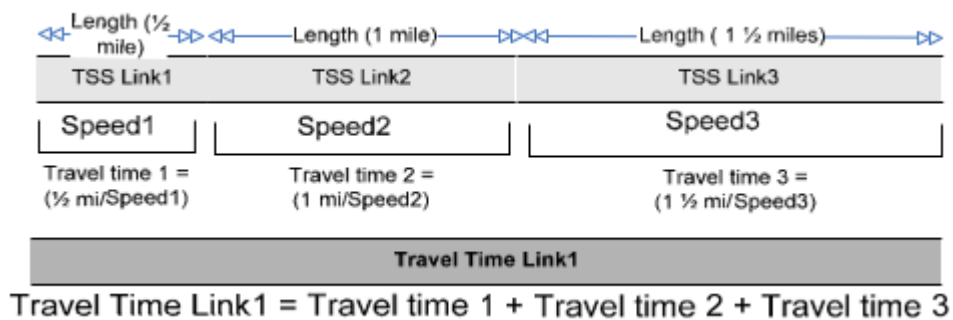
Once a TVT link has been defined, the travel times are calculated using the following steps:

1. TSS calculates the speed for each lane that is part of a TSS link. The TSS link speed is then calculated using a volume weighted average. as shown in Figure 5.



**Figure 5: TSS Link Speeds**

2. To calculate the travel time for a travel time link, each individual TSS link's travel time is calculated and aggregated as shown in Figure 6.



**Figure 6: Travel Time Link Calculations**

- a. If the link reports a speed that is less than 0, the speed limit is substituted for the speed.
  - b. Each travel time link is also bound by the upper and lower bounds that are set for that link as described in Section 2.3.
3. A system configuration parameter for the percentage of lanes with data is used to determine whether enough data exists to publish travel times for a particular travel time link (this method can be accurate if speeds are consistent between adjacent links):
    - a. If percent of lanes with data is less than this number, no travel times are published for the travel time link.
    - b. If percent of lanes with data is greater than this number, links missing data use the average speed across all links in the travel time link for calculating travel times.

Note that the SunGuide Travel Time subsystem does not support dynamic linking. Dynamic linking is performed by the TSS subsystem only for probe based detectors.

## Using SunGuide Travel Times

### 1.3.3 Differences in TSS Links

TSS links for point based detectors are defined in travel times as depicted on the grey links below. The darker link is created by defining a path from Detector1 to Detector2. The probe detector links can be used in travel times the same as the point based detector links are used.

When computing the travel times for the link, the following formula is used:

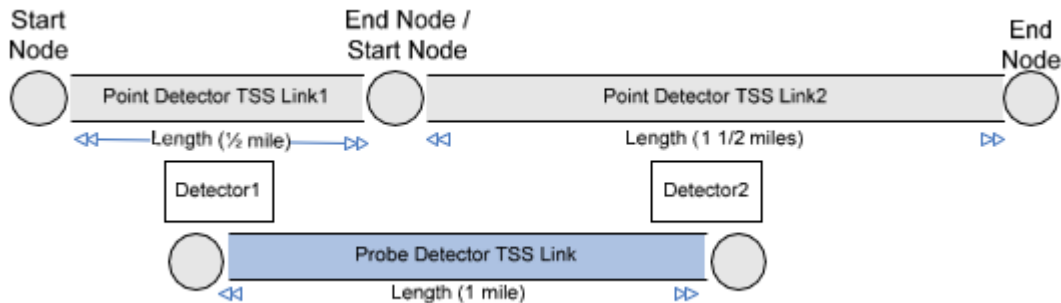


Figure 7: Link Comparisons

$$\sum Tss Links 3500 x \frac{linkLengths}{\max (avg speed of lanes)}$$

In the given example, if the speed for TSS Link1 = 60 and the speed of TSS Link2 = 40, the result would be:  $3600((1/2)/60 + (3/2)/40) = 165$  seconds. The max function is what is used to cap the travel time using the speed limit of the link. The travel time calculated for the defined probe detector link would be:  $(1/60 + 1/40)/2 = 85$  seconds. As the two methods are not comparing the same geographical area, the travel times cannot be compared. In order to accurately compare the travel times for a segment of road using alternate technologies, the link geography must be setup to allow the probe detector link to cover the same segment of road as shown in Figure 8.

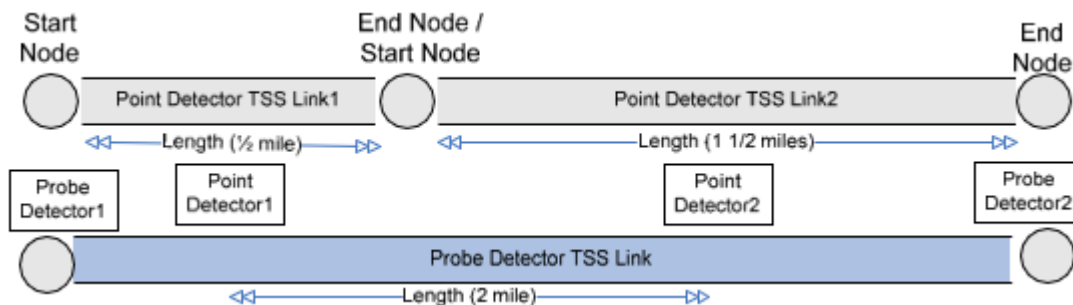


Figure 8: Revised Link Comparisons

### 1.4 TVT Integration with SunGuide

As with other subsystems created for SunGuide, the travel time system utilizes XML over TCP/IP for all communications. This interface is described in the TVT-ICD-6.2.pfd on the SunGuide™ website. Traffic sensor speed data is also received in an XML format, allowing the travel time system to interface with any traffic sensor system that supplies data corresponding to the same XML schema. All administrative functions such as setting up templates, assigning device templates, setting travel time options are defined XML requests and the SunGuide Operator Map can be used to set up these options.

### 1.5 Travel Time Computation Examples

The following examples are provided to demonstrate how Travel Times are computed. In each example, an entry of NR indicates that no speed was reported for the lane. This can be a result of the data that was last reported has expired (older than expireRate). When no data is reported for a link, the average speed across all links reporting data is used for calculations.

#### 1.5.1 Example 1

- Travel time link is composed of three TSS Links: A, B and C
- Each TSS link has lanes 1, 2 and 3.
- Number of lanes = 9
- percentLanesWithData = 50%
- Number of lanes reporting = 9 (100%)

| Lane | TSS Reported Speed (MPH) | TSS Link Avg | TvT Speed Reported | Link Length (Miles) | TSS Link Time (Seconds) | TVT Travel Time (Seconds) |
|------|--------------------------|--------------|--------------------|---------------------|-------------------------|---------------------------|
| A.1  | 50                       | 57           | 57                 | 5                   | 318                     | 1090                      |
| A.2  | 60                       |              |                    |                     |                         |                           |
| A.3  | 60                       |              |                    |                     |                         |                           |
| B.1  | 50                       | 50           | 50                 | 8                   | 576                     |                           |
| B.2  | 50                       |              |                    |                     |                         |                           |
| B.3  | 50                       |              |                    |                     |                         |                           |
| C.1  | 50                       | 55           | 55                 | 3                   | 196                     |                           |
| C.2  | 55                       |              |                    |                     |                         |                           |
| C.3  | 60                       |              |                    |                     |                         |                           |

#### 1.5.2 Example 2.

- Travel time link is composed of three TSS Links: A, B and C
- Each TSS link has lanes 1, 2 and 3.
- Number of lanes = 9
- percentLanesWithData = 50%
- Number of lanes reporting = 5 (55%)

| Lane | TSS Reported Speed (MPH) | TSS Link Avg | TvT Speed Reported | Link Length (Miles) | TSS Link Time (Seconds) | TVT Travel Time (Seconds) |
|------|--------------------------|--------------|--------------------|---------------------|-------------------------|---------------------------|
| A.1  | 10                       | 35           | 35                 | 5                   | 514                     | 1287                      |
| A.2  | NR                       |              |                    |                     |                         |                           |
| A.3  | 60                       |              |                    |                     |                         |                           |
| B.1  | NR                       | 50           | 50                 | 8                   | 576                     |                           |
| B.2  | 50                       |              |                    |                     |                         |                           |
| B.3  | NR                       |              |                    |                     |                         |                           |
| C.1  | 50                       | 55           | 55                 | 3                   | 196                     |                           |
| C.2  | NR                       |              |                    |                     |                         |                           |
| C.3  | 60                       |              |                    |                     |                         |                           |

1.5.3 Example 3

Travel time link is composed of three TSS Links: A, B and C

- Each TSS Link has lanes 1, 2 and 3.
- percentLanesWithData = 50%
- Number of lanes = 9
- Number of lanes reporting = 5 (55%)

| Lane | TSS Reported Speed | TSS Link | TvT Speed Reported                       | Link Length | TSS Link Time | TVT Travel |
|------|--------------------|----------|------------------------------------------|-------------|---------------|------------|
| A.1  | NR                 | NR       | 51 (uses average speed across all links) | 5           | 353           | 1137       |
| A.2  | NR                 |          |                                          |             |               |            |
| A.3  | NR                 |          |                                          |             |               |            |
| B.1  | NR                 | 50       | 50                                       | 8           | 576           |            |
| B.2  | 50                 |          |                                          |             |               |            |
| B.3  | 50                 |          |                                          |             |               |            |
| C.1  | 51                 | 52       | 52                                       | 3           | 208           |            |
| C.2  | 52                 |          |                                          |             |               |            |
| C.3  | 53                 |          |                                          |             |               |            |

1.5.4 Example 4

- Travel time link is composed of three TSS Links: A, B and C
- Each TSS Link has lanes 1, 2 and 3.
- percentLanesWithData = 50%
- Number of lanes = 9
- Number of lanes reporting = 4 (44%)

### Using SunGuide Travel Times

In this example, the percentage of lanes reporting (44%) falls below 50%, so TVT does not compute a travel time.

| Lane | TSS Reported Speed | TSS Link Avg | TvT Speed Reported                       | Link Length (Miles) | TSS Link Time (Seconds) | TVT Travel Time |
|------|--------------------|--------------|------------------------------------------|---------------------|-------------------------|-----------------|
| A.1  | NR                 | NR           | 51 (uses average speed across all links) | 5                   | 353                     | None            |
| A.2  | NR                 |              |                                          |                     |                         |                 |
| A.3  | NR                 |              |                                          |                     |                         |                 |
| B.1  | NR                 | 50           | 50                                       | 8                   | 576                     |                 |
| B.2  | NR                 |              |                                          |                     |                         |                 |
| B.3  | 50                 |              |                                          |                     |                         |                 |
| C.1  | 51                 | 52           | 52                                       | 3                   | 208                     |                 |
| C.2  | 52                 |              |                                          |                     |                         |                 |
| C.3  | 53                 |              |                                          |                     |                         |                 |

#### 1.5.5 Example 5

- Travel time link is composed of three TSS Links: A, B and C
- Each TSS Link has lanes 1, 2 and 3.
- percentLanesWithData = 50%
- Number of lanes = 9
- Number of lanes reporting = 7 (77%)

| Lane | TSS Reported Speed (MPH) | TSS Link Avg | TvT Speed Reported | Link Length (Miles) | TSS Link Time (Seconds) | TVT Travel Time (Seconds) |
|------|--------------------------|--------------|--------------------|---------------------|-------------------------|---------------------------|
| A.1  | 0                        | 15           | 15                 | 5                   | 1200                    | 1984                      |
| A.2  | 0                        |              |                    |                     |                         |                           |
| A.3  | 45                       |              |                    |                     |                         |                           |
| B.1  | NR                       | 50           | 50                 | 8                   | 576                     |                           |
| B.2  | NR                       |              |                    |                     |                         |                           |
| B.3  | 50                       |              |                    |                     |                         |                           |
| C.1  | 51                       | 52           | 52                 | 3                   | 208                     |                           |
| C.2  | 52                       |              |                    |                     |                         |                           |
| C.3  | 53                       |              |                    |                     |                         |                           |

#### 1.5.6 Example 6

- Travel time link is composed of three TSS Links: A, B and C
- Each TSS Link has lanes 1, 2 and 3.
- percentLanesWithData = 100%
- Number of lanes = 9
- Number of lanes reporting = 9 (100%)
- Link 1 is reporting speeds of 0, the link's speed limit (freeflow) is used in calculations

*Using SunGuide Travel Times*

| Lane | TSS Reported Speed (MPH) | TSS Link Avg | TvT Speed Reported           | Link Length (Miles) | TSS Link Time (Seconds) | TVT Travel Time (Seconds) |
|------|--------------------------|--------------|------------------------------|---------------------|-------------------------|---------------------------|
| A.1  | 0                        | 15           | 0 7 60<br>MPH used<br>limit) | 5                   | 300                     | 1084                      |
| A.2  | 0                        |              |                              |                     |                         |                           |
| A.3  | 45                       |              |                              |                     |                         |                           |
| B.1  | NR                       | 50           | 50                           | 8                   | 576                     |                           |
| B.2  | NR                       |              |                              |                     |                         |                           |
| B.3  | 50                       |              |                              |                     |                         |                           |
| C.1  | 51                       | 52           | 52                           | 3                   | 208                     |                           |
| C.2  | 52                       |              |                              |                     |                         |                           |
| C.3  | 53                       |              |                              |                     |                         |                           |

## **2. Using Travel Times**

The following sections describe the various steps in using SunGuide to generate travel time messages. At a high level, the following steps must be performed:

- Configure the TVT subsystem (each SunGuide deployment has a number of configurable parameters that can be modified to effect how travel times are generated and displayed)
- Add each destination to the travel time system
- Create a travel time link from the DMS to each destination
- Create a travel time message template
- Assign the template and destination(s) to the DMS

The following sections described the process in more detail.

### **2.1 Configure TVT**

To allow the system to be tailored to the various TMCs, the following configuration file parameters were added to the system:

- `publishingRate`—the rate at which raw travel times are published
- `expireRate`—the age (in seconds) after which TSS data will no longer be valid for calculating travel times
- `percentLanesWithData`—designates what percentage of lanes in a travel time link must have current speed data in order for travel time messages to be generated.
- `blankIfNotGenerated`—if true, the travel time messages will be removed from any message sign for which the travel time link does not have enough current data. Note that if a travel time message is blanked then MAS will display the next highest priority message on the queue for that sign
- `msgIfNotGenerated`—If the message signs are not being blanked, this message will be displayed when the travel time link does not have enough current data.
- `useTimeRange`—This parameter specifies whether a time range should be used for the travel time (e.g., 8-10 MIN rather than 9 MIN).
- `timeRangeInterval`—Designates the amount of range to be used for the display (if set to 2, 8-10 MIN, if 3, 8-11 MIN).
- `changeRangeInterval`—Time value for which the time range should change (if 10, any time value over 10 will use a different range value specified in `largeTimeRangeInterval`).
- `largeTimeRangeInterval`—Value used for the range for any times over the `changeRangeInterval`.
- `minTimeInMins`—Lowest time value to display on the message sign. Anything lower or equal to this value will be displayed with the `lessThanText` value in front.
- `lessThanText`—Text to be displayed before the `minTimeInMins`.
- `maxTimeInMins`—Highest time value to display on the message sign. Anything higher than this value will be displayed with the `greaterThanText` value in front.
- `greaterThanText`—Text to be displayed before the `maxTimeInMins`.
- `distUnits`—Units for distance, allows the system to be used in MI or KM based systems.
- `systems.spdUnits`—Units for speed, allows the system to be used in MI or KM based systems.
- `minUnits`—Units for minutes text, allows the system to create travel time messages in a different language than English.



The sample configuration values shown in the left hand side of Table 1, will create the messages shown in the right hand side of the table:

**Table 1: Sample Configuration**

| Configuration Values   |       | Travel Time Messages                    |                                                                                                                      |
|------------------------|-------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------|
|                        |       | Travel Time                             | Display Message                                                                                                      |
| percentLanesWithData   | 75    | 3 Minutes                               | PALMETTO-EXIT 7<br>UNDER 5 MIN                                                                                       |
| blankIfNotGenerated    | True  |                                         |                                                                                                                      |
| msgIfNotGenerated      |       |                                         |                                                                                                                      |
| useTimeRange           | True  | 9 Minutes                               | 8-10 MIN TO I-95 – Exit 1                                                                                            |
| timeRangeInterval      | 2     |                                         |                                                                                                                      |
| changeRangeInterval    | 10    |                                         |                                                                                                                      |
| largeTimeRangeInterval | 5     |                                         |                                                                                                                      |
| minTimeInMins          | 3     | 17 Minutes                              | PALMETTO-EXIT 7<br>7 MI 16-19 MIN                                                                                    |
| lessThanText           | UNDER |                                         |                                                                                                                      |
| maxTimeInMins          | 30    |                                         |                                                                                                                      |
| greaterThanText        | OVER  | Less than 75 percent of lanes with data | Any travel time message currently on the device is removed (and MAS would display the next highest priority message) |
| distUnits              | MI    |                                         |                                                                                                                      |
| spdUnits               | MPH   |                                         |                                                                                                                      |
| minUnits               | MIN   |                                         |                                                                                                                      |
|                        |       |                                         |                                                                                                                      |

Changing the configuration values allows the displayed messages to change. Any change to the configuration file would require the travel time system to be restarted before message modifications would occur. Table 2, shows the travel time messages that would be generated based on the revised configuration values.

**Table 2: Revised Configuration**

| Configuration Values   |                                                | Travel Time Messages                    |                                            |
|------------------------|------------------------------------------------|-----------------------------------------|--------------------------------------------|
|                        |                                                | Travel Time                             | Display Message                            |
| percentLanesWithData   | 75                                             | 3 Minutes                               | PALMETTO-EXIT 7<br>UNDER 3 MIN             |
| blankIfNotGenerated    | false                                          |                                         |                                            |
| msgIfNotGenerated      | [pt30o0][j13]<br>Travel<br>Time[nl]<br>Unknown |                                         |                                            |
| useTimeRange           | true                                           | 9 Minutes                               | 8-11 MIN TO I-95 – EXIT 1                  |
| timeRangeInterval      | 3                                              | 17 Minutes                              | PALMETTO-EXIT 7<br>7 MI >15 MIN AT 4:26 AM |
| changeRangeInterval    | 10                                             |                                         |                                            |
| largeTimeRangeInterval | 5                                              |                                         |                                            |
| minTimeInMins          | 3                                              |                                         |                                            |
| lessThanText           | &lt;                                           | Less than 75 percent of lanes with data | TRAVEL TIME<br>UNKNOWN                     |
| maxTimeInMins          | 15                                             |                                         |                                            |
| greaterThanText        | &gt;                                           |                                         |                                            |
| distUnits              | MI                                             |                                         |                                            |
| spdUnits               | MPH                                            |                                         |                                            |
| minUnits               | MIN                                            |                                         |                                            |

## 2.2 Add Travel Time Destinations

The TVT Destinations Editor enables the administrator to manage TVT destinations (tags that are used in the generation of travel time messages). These destination names are the actual text displayed on a DMS when a travel time message is generated containing a destination tag.

**NOTE:** Destination names must be valid approved words to prevent spelling conflicts. Destinations may be entered using a simple text field as shown in Figure 9. These are provided primarily to save duplicate data when the same destination is used for multiple devices.

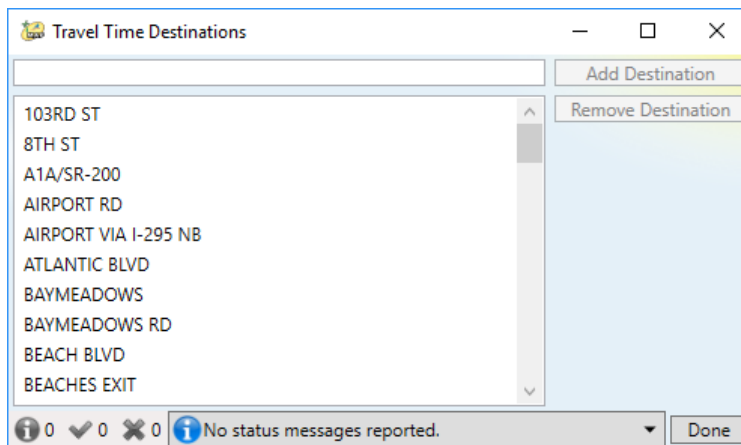


Figure 9: TVT Destinations

## 2.3 Create Travel Time Links

After the initial setup of configuration parameters, an administrator must configure the travel time links, message templates and device templates for the system. Section titled “TSS Editor” of the SunGuide Software Users Manual (SUM) describes the process of creating TSS links. The Travel Time Link Editor enables the system administrator to manipulate travel time link data in the database. The initial screen of the editor is shown in Figure 10.

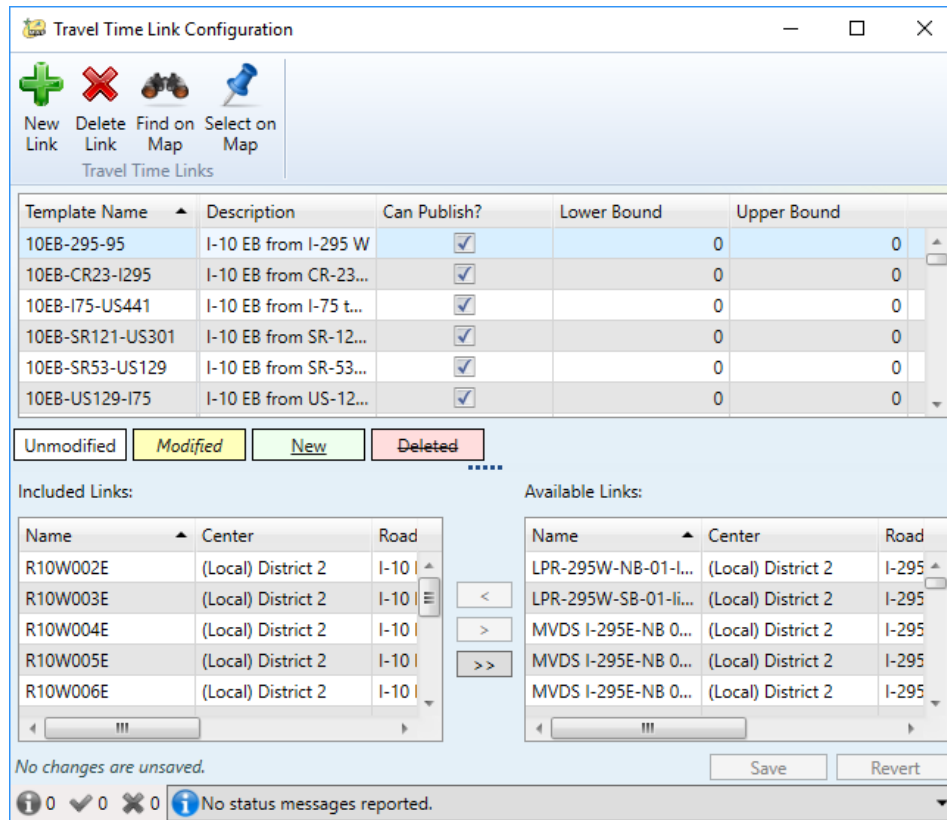


Figure 10: TVT Links

A travel time link consists of one or more traffic sensor links with associated lengths. Travel time links may be named according to the route they define or even the device name to which the link is assigned. A description field is added to provide additional information if needed. The TSS link length can be adjusted if only part of the link is applicable to this travel time link. The upper and lower bounds can be used to specify the time in minutes between which travel times should be bound. In the travel time link below, travel time calculations would be bound at the lower end by 7 minutes and the higher end by 30 minutes.

**NOTE:** Only the calculations are bound, display of travel time ranges is performed based upon the calculated value.

In the example below, the calculated travel time is bound by 30 minutes for both the 30 and 31. The displayed numbers are 29-31 MIN for both values.

|                                                                                                                                                                                                                        |                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Based on the values above and configuration values in Table 1, the following values would be reported for travel times for the link shown in Figure 10. These values are also based on a freeflow time of six minutes. | Displayed Travel Time |
| Calculated Travel Time                                                                                                                                                                                                 |                       |
| 6 MIN                                                                                                                                                                                                                  | 6-8 MIN               |
| 5 MIN<br>7 bound to 6 MIN                                                                                                                                                                                              | 6-8 MIN               |
| 30 MIN                                                                                                                                                                                                                 | 29-31 MIN             |
| 31 MIN<br>7 bound to 30 MIN                                                                                                                                                                                            | 29-31 MIN             |

## **2.4 Create Travel Time Message Templates**

In addition to the configuration parameters available in the system, message templates are used to specify the format of the display on a message sign. When a message template is created, a name and a number of destinations are associated with the template. Depending upon the number of destinations, several formatting tags are available.

### *2.4.1 Generic Tags*

Generic tags are general tags which are not tied to a particular travel time link or destination. The available generic tags are as follows:

- *FreeText*—Allows for any text to be created for the template. For instance, “TRAVEL TIME TO” or “AT”.
- [NEW LINE]—Forces the display to place a new line character in the message, displaying subsequent text on the next lower line of the DMS.
- [NEW PAGE]—Forces the display to place a new page character in the message, all text following this character should display on the next page of the DMS.
- [SPACE]—Adds a space between two tags (normally, spaces are included in free text sections, but a single space at the beginning or end of free text may not render).
- [TIME]—Adds the current time (from the system running travel times) to the message.

### *2.4.2 Destination Tags*

Other tags are specifically related to a destination. Travel time templates can be configured to allow a specific number of travel time links to display information. Each of the following tags is associated to one of those links based on the number at the end of the tag. For instance, [DEST1] would apply to the first travel time link, while [DEST2] would apply to the second. In the tag names below, the trailing “x” should be replaced by the appropriate link number.

- [STARTx] – Indicates the start of a section of the travel time message related to a particular travel time link. (Discussed in detail below.)
- [DESTx] – Replaced with the name of the destination (e.g., PALMETTO-EXIT 7) associated to the travel time link in the device template.
- [TVTx] – Replaced with the current travel time of the travel time link, in minutes. This usually is displayed as a range with a suffix, such as “6-8 MINS”. The range and suffix are specified in the configuration file, described in Section 2.1.
- [SPEEDx] – Replaced with the current average speed of the travel time link, in miles per hour.
- [DISTx] – Replaced with the length of the travel time link, in miles.
- [ENDx] – Indicates the end of a section of a travel time message related to a particular travel time link.

**2.4.3 Grouped Tags**

The START and END tags allow portions of a message to be grouped. They do not display anything directly on a sign, but instead are used to show which portion of a message relates to a particular travel time link. If no data is available for that link, then all text and tags between the matching START and END tags for the link will be removed. For example, the following message template can be used to group each travel time link onto a separate DMS message page.

```
[START1]TRAVEL
TIME TO [DEST1]
[TVT1][END1]
```

```
[START2]TRAVEL
TIME TO [DEST2]
[TVT2][END2]
```

If either travel time link reports no data, the message generated will be a single-phase message for the remaining travel time link only. To ensure a consistent message, all data tags for a particular link must be placed between their corresponding START and END tags, and no data tags for one link should appear within another link’s START and END tags. Any template which does not follow these guidelines will fail to save and report an error about the template formatting to the user. If all links of a message report no data, the normal travel time message will not be generated. These tags are always required when using destination tags. An error will be returned from the subsystem if a user tries to save a template containing destination tags that are not within the corresponding start and end tags.

**2.4.4 Example Templates**

Table 3, shows some sample message templates and the corresponding messages that are generated. Tags are denoted by a beginning and ending [] while free text is not contained within tag delimiters.

**Table 3: Template Examples**

| Template Text                                                                        | Travel Time Message                            |
|--------------------------------------------------------------------------------------|------------------------------------------------|
| [START1][DEST1][NEW LINE][DIST1]<br>[SPACE][TVT1][NEW LINE]<br>AT[SPACE][TIME][END1] | PALMETTO-EXIT 7<br>15 MI 27-30 MIN AT          |
| [START1] [TVT1][SPACE]TO [NEW LINE][DEST1] [END1]                                    | 27-30 MIN TO<br>PALMETTO-EXIT 7                |
| [START1] [DEST1]<br>[NEW LINE][TVT1] [END1]                                          | PALMETTO-EXIT 7<br>27-30 MIN                   |
| [START1]TRAVEL TIME TO [NEW LINE][DEST1]<br>[NEW LINE][TVT1] [END1]                  | TRAVEL TIME TO<br>PALMETTO-EXIT 7<br>27-30 MIN |

An example with multiple travel time links/destination is shown in Table 4. The generated message will vary depending upon whether data is available for one link, two links, or neither link. In this example, the system is configured to not generate a message if no data exists.

**Table 4: Grouped Template**

| Message Template                                                                                                     | One link w/data                      | Two links w/data                                 | Neither link w/data |
|----------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------------------------------------------------|---------------------|
| [START1]TRAVEL TIME TO[NEW LINE]<br>[DEST1][NEW LINE]<br>[TVT1][END1] [NEW PAGE]<br>[START2]TRAVEL TIME TO[NEW LINE] | TRAVEL TIME TO<br>PALMETTO-EXIT<br>7 | TRAVEL TIME TO<br>PALMETTO-EXIT<br>7<br>8-10 MIN |                     |

### **2.5 Assigning Templates**

The message templates that are created can then be assigned to message signs along with a destination name and a travel time link. If a template is modified after being assigned to a message sign, the next time a message is generated for the device, the modified template is used. Each message sign can have its own template, the same template can be used for all message signs, or some combination—whichever best suits the TMC setting up the system. In the messages shown in Table 3, the following should be noted: the range values used in the first, second and fourth messages are configured using the parameters previously delineated. The word “UNDER” used in message three is also a configuration parameter—the system could have used “<” or whatever other text the TMC setup.

The next step to configuring the system is defining message templates for travel times. Only one must be created as the same template may be used for all devices. However different device dimensions, travel time link configurations, or multiple destinations would require additional templates be created.

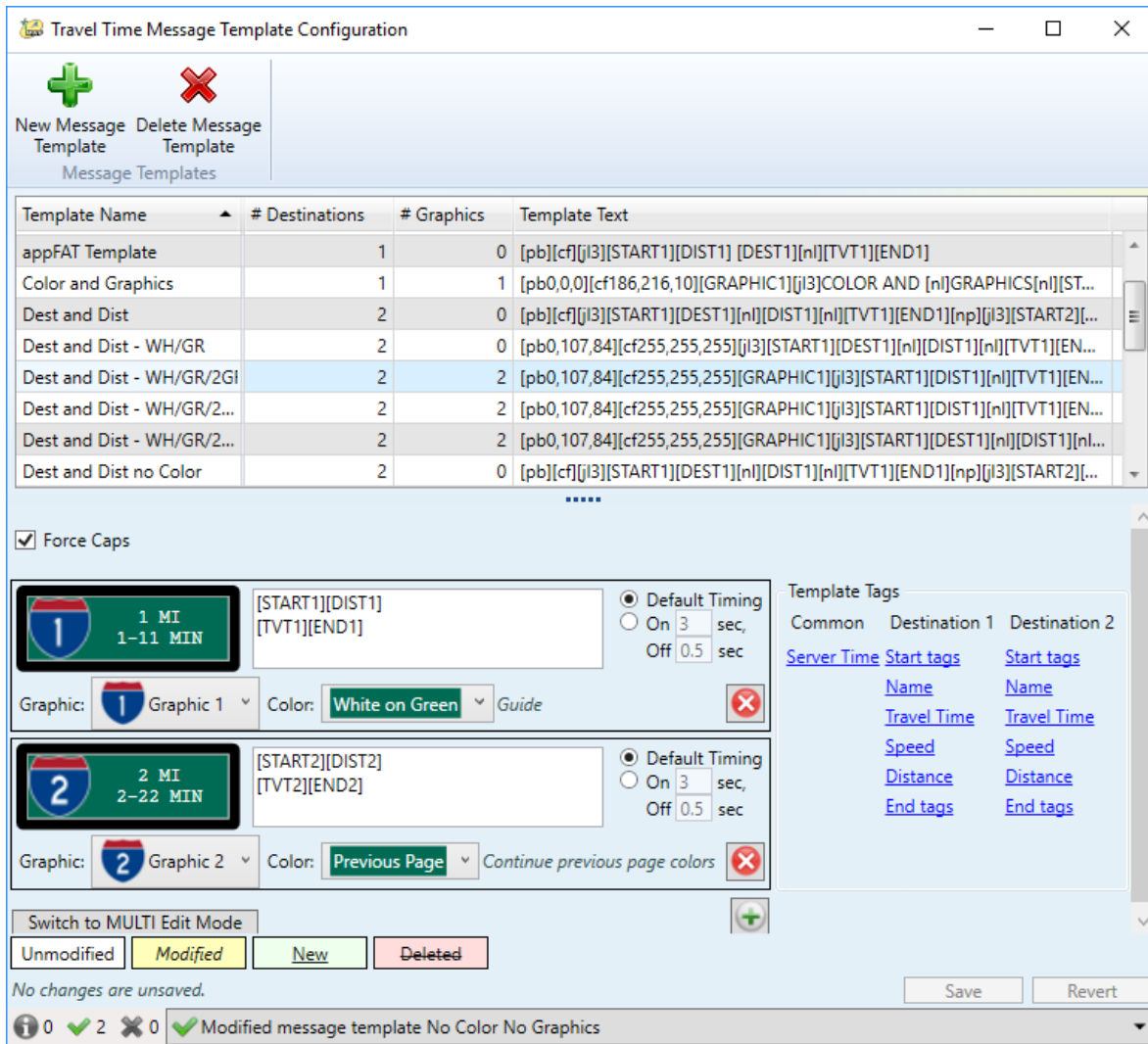


Figure 11: TVT Message Template Listing

An example message template is shown in Figure 11. The text tags are applicable to a particular template while the destination tags provide information for a particular destination and travel time link. The functionality provided by this screen includes:

- Arranges fields of Travel Time messages for display
- Specify number of destinations shown on sign
- Add fields to template using links to right
- Reorder fields in message using arrow buttons
- Sample message layout shown at top of display

## 2.6 Assign Travel Time Templates /Destination

The next step is to assign a message template to a device. The first step is to select a sign and then a template must be assigned to the sign. The selection of a sign is depicted in Figure 12.

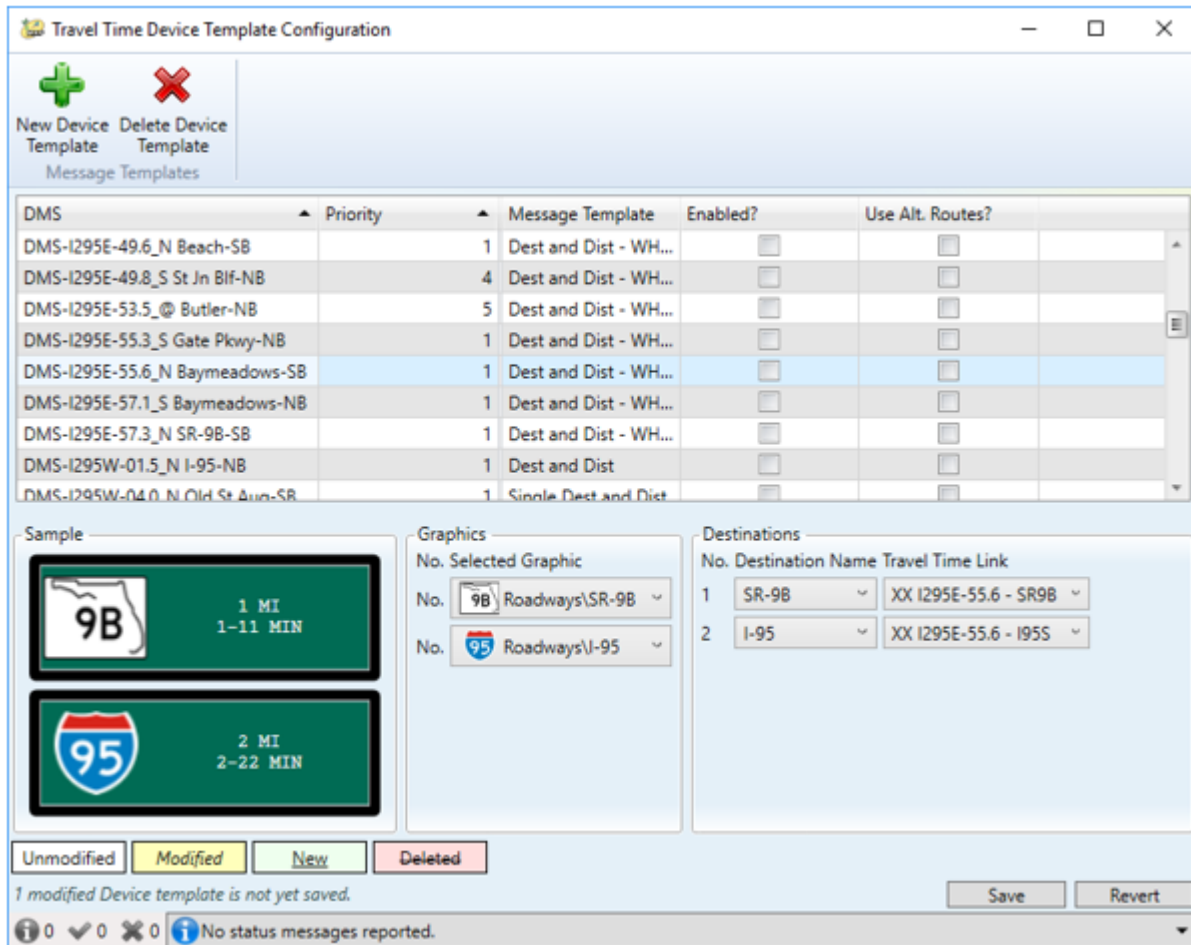


Figure 12: Sign List

Once a sign is selected, the screen to select a template is displayed. For each destination, a travel time link is selected to provide data. If device templates and message templates are modified while the system is running, the travel time messages generated are updated accordingly.

For each device, travel times may be enabled or disabled for a particular DMS, either during initial setup or as a separate request.



## 2.7 Alternate Routes

Alternate routes may be defined when one or more travel time links may be traversed from point A to point B. These routes can be created using the the Admin Editor as shown in Figure 13. The alternate route contains two or more travel time links which have route names.

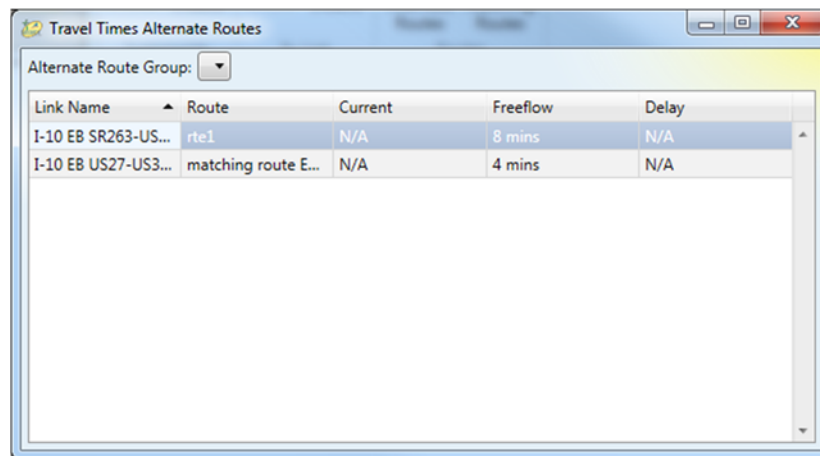


Figure 13: Alternate Routes

When determining whether an alternate route should be displayed, the time value set for the alternate route difference is used. If an alternate to the current route is available and the time savings is equal to or greater than that value, the alternate route message is displayed.

This occurs when the following criteria are met:

- The device template specifies that alternate route replacement is allowed on the device,
- The route to be replaced is the only route on its page of the message,
- The route is part of a set of alternate routes defined in the TVT subsystem, and
- Another route in the set of alternate routes is faster than the route normally included in the message by at least the value specified in the Alternate Route Time Difference field of the Administrative Editor Travel Times Options page.

If those conditions hold, TVT will attempt to replace the message on the sign. If the message is a single-phase message, then it will be replaced with a two-phase message – the first phase shows the travel time along the normal route, the second phase shows the travel time along the fastest alternate route. If the original message was already more than one phase, the affected phase will be replaced by a single phase showing the fastest alternate route.

The subsystem will first attempt to use the following template to format each message:

TO [DEST]  
VIA [ROUTE]  
[DIST] [TVT]

If the message does not fit using this template, an alternate template will be attempted:

TO [DEST]  
VIA [ROUTE]  
[DIST] [TVT]

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For a message which was originally more than one phase, if neither message fits, the original travel time message will be displayed. For a message which was originally one phase, if either new phase would not fit, the original travel time message will be displayed. In either of these cases, an alert will be broadcast to any currently logged in users to indicate that the alternate route configuration failed to generate a valid message.

### 2.8 TVT Options

From the SunGuide Operator map, a user may disable/enable the generation of travel time messages systemwide. This is depicted in Figure 14.

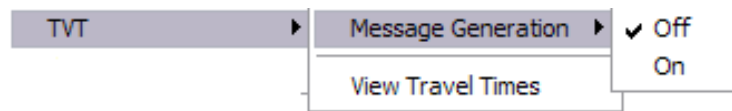


Figure 14: SunGuide Operator Map – TVT Context Menu

The system also has three parameters that may be set at run-time, message priority, the frequency at which messages should be generated, and the time difference for evaluating alternate routes. As a note, the message generation frequency is for generating travel time device messages and is different from the publishing Rate for raw travel time values described in Section 2.1. The options that can be set using the administrative editor are depicted in Figure 15.

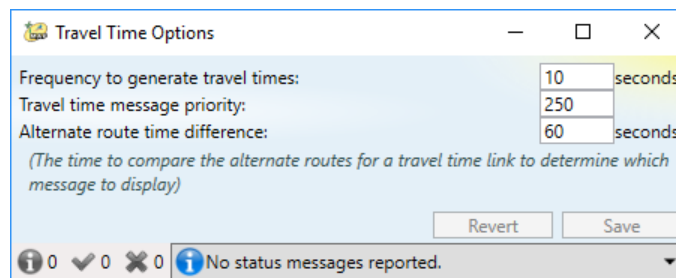


Figure 15: TVT Administrative Editor Options

### 2.9 Display TvTs on Map

When travel times are being generated by the SunGuide system, an operator may wish to view the travel times being generated on the operator map. The figure below displays the travel times currently generated by the system. Links for which valid travel times are not being generated will not have values in the current/freeflow/delay columns. Any travel time links which are not generating travel times will report a travel time of -1 or unavailable. Any travel time messages relying on that link will not be generated.

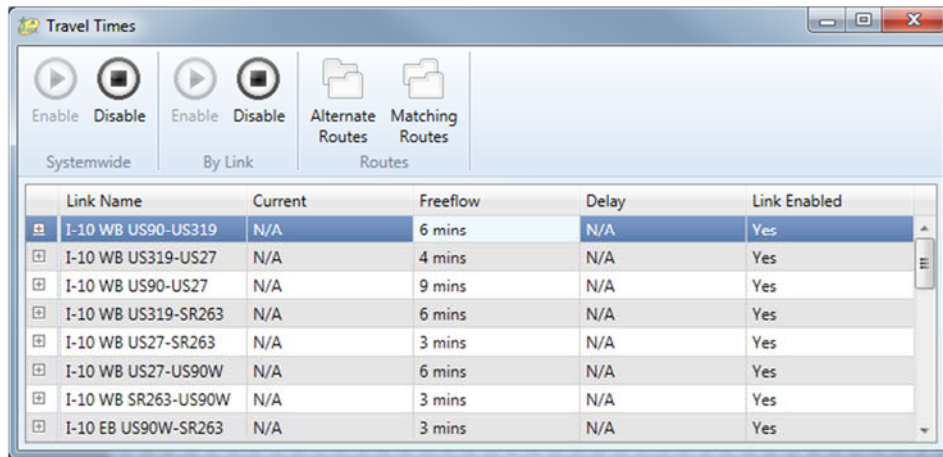


Figure 21. Displaying Travel Times on the Map

In addition to viewing a list of the travel time links, the currently generated travel time message for a DMS or DMSs can be viewed. The last column of the display has a “Show” link which if selected, will display the formatted message for any DMSs associated with this link. This does not necessarily reflect what is displayed on the device. The border for messages which match the message currently on the DMS is green. Purple denotes the message does not match what is currently on the DMS.

### 2.10 TVT Archiving

The SunGuide data archiving module supports the archiving of Travel Time data. The SunGuide Software Users Manual and Version Description Document (VDD) should be consulted as to how data archiving is configured.

### **3. Notes**

The following are insight/observations that have been made about the SunGuide Travel Time subsystem since it was developed and deployed:

- During system testing, travel time messages for different routes were generated every thirty seconds for twenty-five Dynamic Message Signs (DMS). The test system was utilizing two servers, each having dual 3.2 GHz CPUs and 2 Gigabytes of RAM. The Oracle database was running on a third server, also 3.2 GHz with 4 Gigabytes of RAM. The travel time system consumed 38MB of RAM and less than 10% of the CPU processing cycles. The generation of travel times was performed by a software process independent of the process that posting the messages to the DMS devices. The generation of travel times is an extremely efficient process that can create several hundred messages in less than a second once the detector data is available to the process. In SunGuide, the travel time process submits the recommended messages to a DMS queue manager that subsequently posts messages to each sign. Messages can be posted in less than three seconds for directly connected signs while dial-up signs experience a longer post time. The DMS subsystem is capable of posting on average at least ten messages every second to different DMS devices.
- When a travel time is computed for a TSS link, if the computed speed for links are above the configured speed limit (each link has a speed limit entered in the Administrative Editor) then the computed speed will be lowered to the configured speed limit. This will ensure that travel times that are above the speed limits will not be generated.
- During testing of Travel Times in District 2, the District personnel set the priority of the travel times to be low; they then generated a blank message for each sign that had a priority higher than the travel time's priority. This allowed the District personnel to review the travel times in MAS but since the blank message had a higher priority they were not displayed to the traveling public. This process allowed a "quality assurance" check to be performed on the validity of the travel times computed.

#### 4. Frequently Asked Questions (FAQs)

The follow Frequently Asked Questions (FAQs) are often asked about SunGuide Travel Times:

1. Is the timestamp in the data archive csv file the time recorded by the detector in the field, the time received by the SunGuide software or the time when the system archive the data?
  - a. If the timestamp is in the data received for the lane and can be parsed correctly, that date is used. If not, the time received by the data archive process is used.
2. What is the meaning of smooth rolling average for speed data? Does the software average the past few readings or use smoothing equations? How many time steps in the past are used in this smoothing?
  - a. The rolling average takes the readings received during the previous n seconds. When a reading is older than the current time – n seconds, it is no longer used. The number of readings used depends upon the average period, which is configurable (**avgPeriod** in the TSS portion of the configuration file), and the polling frequency of the detector (which can be set per detector).
3. What is the time step to calculate the travel time? (the period that the SunGuide aggregates the 20-second data to when calculating travel time).
  - a. The travel times process uses the smoothed speed from TSS (see answer to question 2) when calculating a travel time. The most recently calculated smoothed speed is used when travel times are generated. Travel times are generated on a configurable frequency located in a configuration dialog with the Operator Map (Configuration >> Travel Times >> Options)
4. When estimating travel time, does the SunGuide software have a filtering mechanism such as excluding the zero speed or unusually high speeds?
  - a. Travel times uses smoothed TSS data. When smoothing TSS data, the speeds are capped by the speed limit set for the link. If the speed for the link is 0, 0 is averaged in unless both the volume and the occupancy are also 0.
5. Our sign only displays freeflow time as a travel time even though we know speeds are varying?
  - a. If the upper bound is less than the freeflow time, the sign could show the freeflow travel time when not expected. This configuration should be modified so the upper bound is greater than freeflow time.