

## Technical Memorandum

## SunGuide<sup>®</sup> Software



## Color Dynamic Message Sign Support Concept of Operations

**Version 1.0**

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### **Prepared for:**

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## List of Acronyms and Abbreviations

CMS .....	Changeable Message Sign
DMS .....	Dynamic Message Signs
FDOT .....	Florida Department of Transportation
FHWA.....	Federal Highway Administration
ITS.....	Intelligent Transportation Systems
MIB.....	Management Information Base
<i>MUTCD</i> .....	<i>Manual on Uniform Traffic Control Devices</i>
NTCIP.....	National Transportation Communications for ITS Protocol
OOCEA.....	Orlando-Orange County Expressway Authority
SwRI .....	Southwest Research Institute

## 1 Introduction

To support new full-color dynamic message signs (DMS) being installed in Florida, the SunGuide® software requires updates to support the existing functionality as well as provide new functionality to take advantage of the color capabilities of the devices.

## 2 National Transportation Communications for ITS Protocol v2 Support

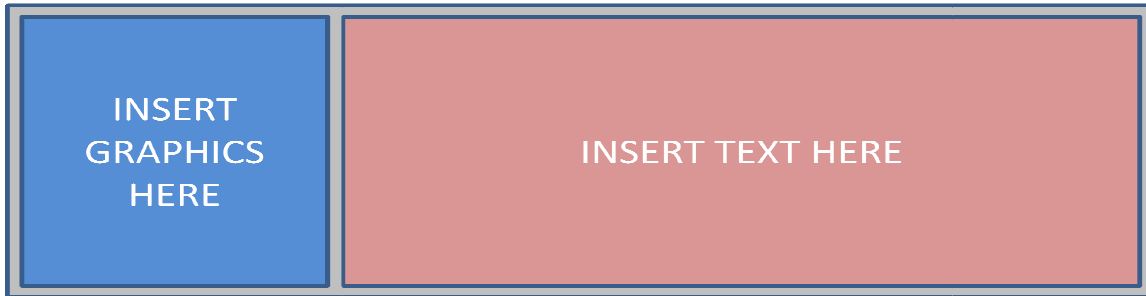
The SunGuide software's current DMS driver supports the National Transportation Communications for ITS Protocol (NTCIP) version 1 standard for DMS communication. The new color DMS devices being installed are designed to use later versions of that standard. As part of the enhancement to support these devices, support for version 2 of the NTCIP standard should be added to the DMS driver. Devices that use version 2 will be identified by specifying a different protocol name when configuring the signs. Note that there is also a version 3 of the NTCIP standard; this does not provide any functional differences and only incorporates an additional section regarding test cases.

The NTCIP version 2 standard (see Appendix) includes a management information base (MIB) providing a set of required and optional data elements for use in communicating with the DMS controller. The Florida Department of Transportation (FDOT) has listed in their DMS specification which optional data elements within this MIB are required to be supported by DMS devices deployed in the state of Florida. This requires DMS vendors to implement most of the objects within NTCIP version 2. However, the SunGuide software does not require all of these objects to accommodate the current user needs as discussed at the Intelligent Transportation Systems (ITS) Change Management Board on January 26, 2011, and at a special technical review chartered at that meeting. Southwest Research Institute (SwRI) will recommend a checklist of object names and MULTI tags within NTCIP version 2 to be implemented within the SunGuide software. Along with the object names, SwRI will also provide the recommended ranges for each object. This will be provided during the requirements phase of the software development.

There are two different types of signs supporting the NTCIP version 2 standard. Monochrome signs will display a monochrome bitmap image, while color DMS signs will display both a monochrome bitmap image and a 24-bit, full color bitmap image. These image formats will be consistent with the file format produced by off-the-shelf image editing software. The SunGuide software will accept these files as input during the configuration process; however, when transmitting these images to the DMS controller, the SunGuide software will follow NTCIP version 2 standard for message encoding. The software shall recognize whether the sign is a color sign or a monochrome sign, either automatically or by user specification during sign configuration. The software will use this information to ensure that color images are not sent to monochrome signs.

### 3 Color DMS Standard Template

SunGuide software will have a standard DMS template. It will allow for one graphic on the left and text on the right. It will not allow the graphic to be moved to the center or right. This would require the SunGuide DMS template editor to be more sophisticated. This could be considered for a later release, if needed. Research studies have found that travelers prefer graphics to the left and text to the right (See Appendix C). Also, these studies recommend that only one graphic be included in each phase of the message. Figure 1 illustrates the standard color DMS template.



**Figure 1: Standard Color DMS Template**

As each graphic does not have the same width and height, it will not occupy the same amount of space on the sign. In addition, different signs vary in width and height. The SunGuide software will need to account for these variations. The SunGuide software will vertically center the graphic within the graphics area and horizontally left justify the graphic. The SunGuide software will center the text in the remaining space on the sign unless multi-text is used to position the sign with more specificity.

### 4 User Interface Modifications

To accommodate the functionality needed within these devices, the user interface will need to be modified to provide access to these functionalities. These are discussed below in the following sections.

#### **4.1 Message Editing**

In addition to entering text, users would be allowed the option of selecting an image. If a image were selected, it would be displayed next to the text for visual confirmation. If the image width is equivalent to the width of the sign, the text area would disappear. This functionality would be added to all local DMS editing tools and status windows. When the target sign is known, only graphics including one or more images that are supported by the sign would be available for use. This will help ensure that a graphic containing only 24-bit color images is not selected for a monochrome sign.

## 4.2 Message Templates

Several parts of SunGuide software, including response plans and travel times, use the concept of message templates to automatically generate DMS messages based on incident or travel conditions. These templates would need to be updated to allow a graphic to be specified for inclusion in appropriate messages. To support this configuration, both roadways and event types will be enhanced to allow a default graphic to be associated. These default graphics will be preselected wherever possible when a message or template is used or created.

### 4.2.1 Travel Time Message Templates

For travel time messages, the destination route shield will be added to the left. A configuration page will be created that maps a graphic to be used for each destination roadway.

Although considered, reassurance shields will not be included for travel time messages. Reassurance shields remind motorists of the freeway on which they are currently travelling. This is not included as most limited-access facilities have the static reassurance shields at regular intervals.

Also, SunGuide software will ensure that travel time messages follow the Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices (MUTCD)* guidelines. For travel time messages, the background of the message will be black and the text will be amber. This should be a default in the configuration editing process for use unless the user changes the foreground and background color in the configuration process.

If the graphic and text in a message do not fit, SunGuide software shall first use abbreviations to fit the information. However, if it still does not fit, SunGuide software shall remove the graphic, allowing the text to fit. It will also provide a notification to the operator that the graphic did not fit on the sign.





**Figure 2: Travel Time Templates**

#### **4.2.2 Event Management Message Templates**

Event management message templates could incorporate a shield indicating the event roadway shield or event type. The event type graphic will be given precedence over the event roadway shield. The process of incorporating graphics will be automated on signs that support graphics, while signs that do not support graphics would be left as is.

SunGuide software shall ensure that messages posted on DMSs via the event management message templates are *MUTCD*-compliant. The *MUTCD* provides limited guidance for some event types used in transportation management centers. Based on FDOT's interpretation of *MUTCD*, all events created using the event management message template, including vehicle alerts and public safety announcements, fall under "Warning" or "Incident Management." The message will contain yellow text on a black background.

If the graphic and text in a message do not fit, SunGuide software shall first use abbreviations to fit the information. However, if the entire message still does not fit, SunGuide software shall remove the graphic, allowing the text to fit. It will also provide a notification to the operator that the image did not fit on the sign.







**Figure 3: Event Management Message Templates**

#### ***4.2.3 Manual Message Templates***

It is difficult for software to automatically determine if the background and text colors are *MUTCD*-compliant in a manual message. As a result, the interface should allow the user to pick the background and text colors. The default colors should be amber text on a black background.

#### ***4.3 Graphics Library and Graphics Editing***

In the initial deployment, SunGuide software will contain the graphics library for each deployment. This graphics library will contain all of the graphics in Appendix D for all major roadways covered by SunGuide regional transportation management centers in Florida. The library will have both monochrome and color images for each graphic with dimensions of 54 by 54 pixels. However, there may be a need to add additional graphics for specific cases. When developing new graphics, the user must adhere to the *MUTCD* guidelines and the FDOT's DMS policy. There are several commercial, off-the-shelf tools available to develop these graphics, including Microsoft® Paint, Adobe®Photoshop, GNU Image Manipulation Program®, and Corel™ Paint Shop Pro.

The SunGuide software will allow management of graphics for use in a color DMS messages. A graphic will be considered as a picture that is intended to be placed in a DMS message, while an image is a bitmap of a specific set of dimensions, with a specific format of monochrome or 24-bit color. There can be several different images representing a particular graphic in order to

provide for the different dimensions and color formats needed. The software will choose one of the graphic's images for display on a specific sign to represent the intended graphic. The software will not adjust an image's dimensions or color properties on the fly due to problems with anti-aliasing, etc. Therefore, a SunGuide administrator will create and then store one or more images of different dimensions and color formats (either monochrome or 24-bit color) to represent a single graphic for use in a color DMS message. Multiple images of different dimensions will be needed if there are color DMSs of multiple dimensions available within SunGuide. Similarly, multiple images of different color formats will be needed if both full color DMSs and monochrome full matrix DMSs are available.

When sending a message to a sign, the software will select the image with the highest color format and the largest dimensions as possible within the images available for an intended graphic. Color images will be selected for color signs if color images are available, while monochrome images will be selected if no color images are available or if the sign is a monochrome sign. From the images of the determined color format, the largest image that will fit into the dimensions of the sign will be used. In the current layout concept, the largest image that fits in the vertical dimension of the sign will be used for the graphic and will be vertically centered. Then, the horizontal space used by the image will automatically consume the needed horizontal length of the sign from the leftmost portion of the sign up to the entire width of the sign.

## **5 Center-to-Center Functionality**

The center-to-center (C2C) functionality to send full matrix DMS messages, including color and monochrome images, will be used by remote C2C users to control signs managed by remote centers. The Orlando-Orange County Expressway Authority (OOCEA) specifically requires this ability to allow District Five operators to control signs managed by OOCEA's SunGuide deployment. District Five remote operators also need the ability to merge messages on OOCEA's signs as described in issue number 1886 in the footprints issue tracking web site.

In addition to remote control, the status channel of C2C is also needed to send the full matrix DMS messages, including color and monochrome images. The FL511.com web site will need to show an exact replica of the DMS message. The software team will need to coordinate with the FL511 team to ensure that appropriate changes are made on both ends.

## **6 Conclusion**

Full color DMSs with graphic images have a great potential to quickly and accurately improve motorist comprehension. Integrating this functionality into SunGuide will be beneficial to the travelers.

## APPENDIX A – MUTCD 2009 / Message Color

Table A-1: Type of Sign Message

Type of Sign Message	Legend						Background		
	Red	White	Yellow	Orange	Fluorescent Yellow-Green	Fluorescent Pink	Black	Blue	Green
Regulatory	X	X					X		
Warning			X				X		
Temporary Traffic Control			X	X			X		
Guide		X					X		X
Motorist Services		X					X	X	
Incident Management			X			X	X		
School, Pedestrian, Bicycle			X		X		X		

## APPENDIX B – MUTCD 2009 Summary

### *MUTCD 2009*

The *MUTCD 2009* combined all information pertaining to changeable message signs (CMS) into Chapter 2L. In the previous edition (*MUTCD 2003*), CMS information was included in Sections 2A.07 and 2E.21. The provisions of *MUTCD 2009* Chapter 2L apply to both permanent and portable CMSs with electronic displays. The following is a summary from Chapter 2L:

- Except as provided in Section 2L.02, CMSs shall display only traffic operational, regulatory, warning, and guidance information.
- Section 2L.04: CMSs shall not include advertising, animation, rapid flashing, dissolving, exploding, scrolling, or other dynamic elements.
- The colors used for the legends and backgrounds on CMSs shall be as provided in *MUTCD 2009*, Table 2A-5.
- Guidance in Section 2L.04 states that if used, the CMS should not display symbols or route shields unless they can do so in the appropriate color combinations.
- Message length and units of information are covered in Section 2L.05.
- Guidance in Section 2L.04 suggests that the contrast orientation of CMSs should always be positive; that is, with luminous characters on a dark or less luminous background. Positive-contrast messages have increased legibility distances over negative-contrast messages.

## APPENDIX C – Summary of Best Practices from Previous Research








1. Graphic-aided messages are significantly better than text-only messages in terms of preference, response time, and accuracy (2).
2. Overall, the majority of surveyed drivers preferred amber-colored messages (2).
3. The color red is not a good choice of color for DMS messages and is not recommended for use on DMS (2). Red-colored messages resulted in the slowest response time.
4. Comprehension by elder drivers was found to be improved with the use of graphic-aided messages (2).
5. Adding graphics on DMS messages noticeably enhanced the message comprehension time for non-native English speakers (2).
6. Graphic-aided DMS with a graphic image on the left was significantly preferred by the majority of subjects during a previous study (2).
7. Most people preferred a graphic frame similar to those they usually see on conventional traffic signs (4). This agrees with the MUTCD standards regarding shape of the warning and regulatory signs.

### References



1. *Manual on Uniform Traffic Control Devices*. Federal Highway Administration, 2009.
2. *Employing Graphics to Aid Message Display on Dynamic Message Signs*. University of Rhode Island Transportation Center, 2006.
3. *Guidelines for the Use of Dynamic Message Signs on the Florida State Highway System*. Florida Department of Transportation, 2008.
4. *Adding Graphics to Dynamic Message Sign Messages*, Wang, J., Hesar, S. G., Collyer, C. E. , Transportation Research Record: Journal of the Transportation Research Board, No. 2018, 2007.
5. *Use of Graphics and Symbols on Dynamic Message Signs: Technical Report*, FHWA/TX-08/0-5256-1, 2009.

## APPENDIX D - Sign Size Requirements

Table D-1: Route Shield Size Requirements

Description	Reference	Mainline DMS Size Requirements (width x height)	Arterial DMS Size Requirements (width x height)	Route Shield
Florida's Turnpike	TPPPH (Turnpike Plans Preparation and Practice Handbook); Index 17355	40 x 48	30 x 36	
US-41	MUTCD 2009 U.S. Route Sign (1 or 2 digits)	36 x 36	24 x 24	
US-441	MUTCD 2009 U.S. Route Sign (3 digits)	45 x 36	30 x 24	
SR-528 (Toll)	TEM (Traffic Engineering Manual) 2.23; Index 17355	36 x 48	24 x 30	
SR-52	Index 17355 State Route Sign (1 or 2 digits)	42 x 36	24 x 24	
SR-434	Index 17355 State Route Sign (3 digits)	45 x 36	30 x 24	
I-4	MUTCD 2009 Interstate Route Sign (1 or 2 digits)	36 x 36	24 x 24	
I-95	MUTCD 2009 Interstate Route Sign (1 or 2 digits)	36 x 36	24 x 24	
I-595	MUTCD 2009 Interstate Route Sign (3 digits)	45 x 36	30 x 24	
CR-470	Index 17355 MUTCD 2009 County Route Sign	48 x 48	24 x 24	

**Table D-2: Warning Sign Size Requirements**

Description	Reference	Mainline DMS Size Requirements (width x height)	Arterial DMS Size Requirements (width x height)	Route Shield
Slippery When Wet, W8-5	MUTCD 2009	65 x 65 (actual panel is 48 x 48)	49 x 49 (actual panel is 36 x 36)	
Workers, W21-1	MUTCD 2009	65 x 65 (actual panel is 48 x 48)	49 x 49 (actual panel is 36 x 36)	

## APPENDIX E – Excerpt From *FDOT NTCIP Requirements for Dynamic Message Signs*

*FDOT NTCIP Requirements for Dynamic Message Signs*

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### I PURPOSE

This document defines National Transportation Communications for ITS Protocol (NTCIP) requirements for dynamic message signs (DMS). Please note that if the group is mandatory, then all objects within that group listed as mandatory shall be supported. If the DMS does not support the functionality associated with a specific object or group of objects, yet still meets Florida Department of Transportation (FDOT) specifications, then the device must respond with a noSuchName error response when requests are made for those objects.

### II NTCIP Requirements

Table 1: Abbreviations used in this document

Abbreviation	Description
M	<i>Mandatory</i>
O	<i>Optional</i>
D	<i>Deprecated</i>

Table 2: FDOT DMS NTCIP Requirements Table

Conformance Group / Object Name	Reference	FDOT Requirement	Additional Notes and Requirements
<b>dmsSignCfg</b>	<b>NTCIP 1203.02.39 5.2</b>	<b>M</b>	
dmsSignAccess	5.2.1	M	
dmsSignType	5.2.2	M	
dmsSignHeight	5.2.3	M	
dmsSignWidth	5.2.4	M	
dmsHorizontalBorder	5.2.5	M	
dmsVerticalBorder	5.2.6	M	
dmsLegend	5.2.7	M	
dmsBeaconType	5.2.8	M	
dmsSignTechnology	5.2.9	M	
<b>vmsCfg</b>	<b>5.3</b>	<b>M</b>	
vmsCharacterHeightPixels	5.3.1	M	
vmsCharacterWidthPixels	5.3.2	M	
vmsSignHeightPixels	5.3.3	M	
vmsSignWidthPixels	5.3.4	M	
vmsHorizontalPitch	5.3.5	M	
vmsVerticalPitch	5.3.6	M	
monochromeColor	5.3.7	M	
<b>fontDefinition</b>	<b>5.4</b>	<b>M</b>	
numFonts	5.4.1	M	The device must support a minimum of 4 fonts.
fontTable	5.4.2	M	
fontIndex	5.4.2.1	M	