ITS Training Program

Module 3
Variable / Dynamic Message Signs
## ITS Training Program

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Evolution of Name Change

Changeable Message Signs (CMS)

Variable Message Signs (VMS)

Dynamic Message Signs (DMS)
Dynamic Message Signs

... Outline

- Purpose and Need
- Technologies
- Specifications
- Design Criteria
- Construction
- Maintenance
- Operations
- National Architecture
- ITS Standards

Inform motorists of changing traffic conditions and other related information.
Schedule

- 8:30 – 12:30  Presentation of Course Materials
- 12:30 – 2:00  Box Lunch
- 2:00 – 3:00  Workshop Exercise
- 3:00 – 3:30  Test on Module 3
- 3:30 – 4:00  Course Evaluation
Dynamic Message Signs

... Purpose and Need

- Visual information dissemination
- Advise motorist of potentially hazardous traffic ahead
- Special event information
- Construction information
- Alternate route information

Inform motorists of special event related traffic conditions and other related information.
Dynamic Message Signs

... Potential Benefits

- Reduce Secondary Accidents
- Reduce Travel Delay
- Appropriate/Fast Response to Incidents
- Proactive Traffic Management

DMS are used to inform motorists of changing Speed Limits based on various conditions.
Dynamic Message Signs

... Available Technologies

- Light-Emitting Diode (LED)
- Flip Disk
- Fiber Optic
- Hybrid Flip Disk
  - LED
  - Shuttered Fiber Optic
- Rotating Drum / Cylinder
- Bulb Matrix (Incandescent)
- Blank-Out
Light-Emitting Diode (LED)

- Pixel formed by a cluster of light emitting diodes
- Full Matrix
- Available in Colors
## Light-Emitting Diode (LED)

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low operating costs</td>
<td>High initial costs</td>
</tr>
<tr>
<td>Low power consumption rates</td>
<td>Signs are affected by ambient temperature - require environmental control units</td>
</tr>
<tr>
<td>Good legibility under all lighting conditions</td>
<td>LED output degrades with use - results in uneven illumination levels</td>
</tr>
<tr>
<td></td>
<td>Need battery backup to maintain messages during power failure</td>
</tr>
</tbody>
</table>
Flip Disk

- Array of Reflective Disks
- Black on One Side / Contrasting Color on Other Side
- Shaft Mounted
- Electromagnetic Controlled
Flip Disk

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide “cone of visibility”</td>
<td>Legibility is poor when sun is behind sign</td>
</tr>
<tr>
<td>Very low operating costs</td>
<td>Requires external illumination in low light conditions</td>
</tr>
<tr>
<td>Immune to ambient temperature changes</td>
<td>Reflective material deteriorates with time and sun exposure</td>
</tr>
<tr>
<td>Maintains message during power failure</td>
<td>Disks tend to “stick” causing unreadable messages</td>
</tr>
<tr>
<td>Minimal power consumption rates</td>
<td></td>
</tr>
</tbody>
</table>

- Disks tend to "stick", causing unreadable messages.
- Reflective material deteriorates with time and sun exposure.
- Requires external illumination in low light conditions.
- Legibility is poor when sun is behind the sign.
Fiber Optic

- Bundles of fiber optic cables
- Carries light from a bulb to the front panel
- Fibers are carried to a group of pixels
- Each pixel is shutter controlled by electrical impulses
- Shutter either passes or blocks light to “turn” pixel on or off
## Fiber Optic

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low operating costs</td>
<td>High initial costs</td>
</tr>
<tr>
<td>Moderate maintenance costs</td>
<td>Need battery backup during power failure to maintain message</td>
</tr>
<tr>
<td>Not adversely affected by ambient temperature</td>
<td>Light visible from sides when using external shutters</td>
</tr>
<tr>
<td>Good legibility under all lighting conditions</td>
<td>Shutters can fail and “stick”</td>
</tr>
<tr>
<td></td>
<td>Bulbs need to be replaced every 6000 hours</td>
</tr>
</tbody>
</table>
Hybrid Flip Disk

... Fiber Optic Flip Disk

- Combination front shutter fiber optic / flip disk technology
- Flip disk acts as shutter to block or pass light to the pixel
Hybrid Flip Disk

... LED Flip Disk

- Combination LED / Flip Disk Technology
- LED pixels are positioned to be seen when flip disk is rotated
- Disks are illuminated when they are part of message
## Hybrid Flip Disk

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased sign visibility</td>
<td>Requires external illumination during low light conditions</td>
</tr>
<tr>
<td>Very low operating costs</td>
<td>Disk’s reflective material deteriorates with time and exposure to sun</td>
</tr>
<tr>
<td>Minimal power consumption rates</td>
<td>Disks may “stick” and cause unreadable messages</td>
</tr>
<tr>
<td>Not adversely affected by ambient temperature</td>
<td></td>
</tr>
<tr>
<td>Maintains message during power failure</td>
<td></td>
</tr>
</tbody>
</table>
Rotating Drum / Cylinder

- Triangular rotating drums
- Rotate mechanically
- Reflective sheeting for day or night operation
- Manual operation during power failure

A typical RDS has 3 or 4 possible fixed messages that can be displayed.
Bulb Matrix (Incandescent)

- Light emitting
- Full Matrix
- Easily read from many angles
- High maintenance costs
- High energy consumption
Blank Out Signs

- Fiber Optic and LED Technology
- Provide guidance
- Enhance Message Importance
- Usually have specific use
- Low cost
- Message size limited
## Typical Cost of DMS Technologies

<table>
<thead>
<tr>
<th>Sign Technology</th>
<th>Typical Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flip Disk</td>
<td>$45,000 to $60,000</td>
</tr>
<tr>
<td>LED</td>
<td>$65,000 to $80,000</td>
</tr>
<tr>
<td>Fiber Optic</td>
<td>$70,000 to $85,000</td>
</tr>
<tr>
<td>Hybrid Flip Disk</td>
<td>$85,000 to $105,000</td>
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</table>
Specifications

- Display technology
- DMS housing
- DMS Controllers
- Sign dimming system
- Power Requirements
- Communications
- Software
Display Technology

- Display Type
- Resolution
- Pitch
- Brightness
- Viewing Angles
- Display functions
- Character size and color
- Readability
- Automatic Dimming
Fog

- Visibility
- Rivers, lakes, bridges, low lying areas
DMS Housing

- Environmentally controlled – NEMA rated
- Defogging System
- Provide sufficient ventilation
- Anti-glare front panel
- Access for all maintenance activities

This style of access to DMS housing will allow the least amount of road disruption regarding maintenance repairs.
DMS Controllers

- Micro-based controller
- Commands accepted via RS 232 interface
- Sufficient memory for message storage
- Perform message operations
- Watchdog timer
- Fail safe prevention of improper display
- Local control mode
- Diagnostic testing through laptop computer
Sign Dimming System

- Provide adjustable intensities
- Contain photoelectric sensors
- Local or central control
Power Requirements

- Wiring
- Circuit Breakers
- Power Supply
- Battery Backup
- Surge Suppression
- Grounding
Communications Medium

- Voice grade telephone
- Cellular Digital Packet Data
- Fiber Optic
- Twisted Pair
- Spread Spectrum Radio
- Combinations of above
Software

- Communication
- Message Memory
- Sign Control
- Status Monitoring
- Reports
- Alarms
- Timekeeping
- Other Computer Interfaces
- DMS Memory Database
- Password Protection
- User Interface
- Testing and Documentation
Traffic Engineering Research Laboratory (TERL)

- Joint Laboratory with FSU
- Minimum Specifications for Permanent Mount DMS
- Prequalification Process
TERL Activities

- DMS Qualification
- Traffic Control Device Certification
- ATC (2070) Research
- Vehicle Detection Research
- NTCIP Testing (ATC & DMS)
- Signal Illumination Technology (LED)
- Technology Transfer
Minimum DMS Specifications

- Defines Minimum Material, Operational, and Installation Requirements for DMS in Florida
- Recommends LED
- Sign Configuration
- Sign Control System
- Pre-Qualification of DMS Vendor
- Factory Acceptance Test
- Acceptance Requirements
Prequalification Process

- Quality Control and Experience
  - ISO 9001 Registration
  - References
- DMS System Review
- DMS Prototype Demonstration
- DMS Testing
  - Display Characteristics
  - NTCIP Compliance
Florida Management Information Base (MIB)

- Florida “Customization” of NTCIP DMS MIB
- Compliance for TERL
  - NTCIP 1101 Base Standard
  - NTCIP Simple Management Framework
  - Compliance Level 1
- Appendix A: Global Object Definitions
- Appendix B: DMS Objects
- Appendix C: FDOT Specific DMS Objects
Status of Testing

- Two DMS Manufacturers undergoing tests:
  - Skyline: seeking full qualification
  - Vultron: seeking NTCIP compliance only

- Sixty day testing schedule
TERL Program Summary

• Evaluation and Testing:
  – Quality Control and Experience Evaluation
  – DMS Display Properties Testing
  – DMS NTCIP Testing

• Testing Done **Before** the DMS is Sold in Florida

• Will Provide For:
  – Better Quality of DMS
  – Better Compliance to Specs (NTCIP / Display Properties)
  – Reduction of Problems After Installation
  – Training
TERL Contact

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FDOT Project Manager
jeffrey.morgan@dot.state.fl.us
DMS Design Process

- Collect Preliminary Data
- Collect site-specific data
- DMS Type
- Corridor Placement
- DMS Site Design
Collect Preliminary Data

- Determine the area
- Determine the corridor
- Identify alternate route diversion points
Collect Site-Specific Data

- Base Mapping
- Roadway Horizontal and Vertical Alignment
- Existing Sign Inventory
- Location of Power
DMS Type

- Intended purpose of DMS
- Type of information to display
- Type of DMS technology
Corridor Placement

- Route Diversion Points
- Existing Overhead Structures
- Identify maximum visibility and impact
- Speed
- Right of way
DMS Site Design

- Foundations / Structures
- Physical requirements
- Safety considerations
- Cabinet locating
- Underground infrastructure
- Conduit / cable routing
Foundations / Structures

- Post Mounted
- Cantilever
- Truss Mounted
- Center / Butterfly Mounted
Physical Requirements

- 18 foot minimum height
- Horizontal and vertical alignment
- Location of power
Safety Considerations

- Easy access to sign
- Exposure of maintenance vehicles and staff to traffic
- Access to controller cabinet
Cabinet Placement

- Freeways
  - Away from sign
  - Sign visible from cabinet

- Arterials
  - Close to sign
  - Mounted on structure
Underground Infrastructure

- Pull box spacing
- Terrain
- Conduit size
- Conduit fill
Conduit / Cable Routing

- Sign to Controller Cabinet
- Cabinet to Source
  - Power
  - Communications
Break
Construction

- Utility Conflicts
- Surrounding Land Use
- Right of Way
- Maintenance of Traffic
- Maintenance
- Field of Vision
- Future Projects
Foundations

- Drilled Shafts
- Auger Cast Piles
- Bolt Pattern
  - Fitting within Rebar Cage
  - Maintaining Straight Bolts
- Surveying
DMS Structure

- Truss or Cantilever
  - Custom Design
  - Standard Structure
- Attachment to Upright
- Catwalk or Walkway
- Material Certifications
- Welding
- Galvanization
Grounding / Lightning Protection

- Air Terminal
- Ground Rods
- Cadweld Everything
- Resistance Testing
- UL-96A
Type of DMS

- Fiber Optic, LED, Flip Disk, Flip Disk Hybrid
  - Light Source
  - Power Cables
- Walk-In Housing vs. Rear Access
  - Communication and Power
  - Control Cables
- Ventilation System
- Dimming
- Location of SCU
Power

- Coordination with FPL
- Inspect and Certify Grounding
- Meter
- Panel Board
- NEC Requirements
Communications

- Communication Medium
  - Fiber Optic
  - Cellular Digital Packet Data
  - Spread Spectrum
  - Plain Old Telephone System

- Hardware
  - Modems
  - Transceiver
Fiber Optics

- Splicing
- Connectors
- Testing
  - Optical Time Delay
  - Reflectometer (OTDR)
  - Light Source / Power Meter
Testing

- Test Procedures
- Factory Acceptance Test
- Pre-Installation Test
- Stand Alone Test
- Subsystem Test
- System Test
- Burn-In Period
Maintenance of Traffic

- Work Zone Safety
- Lane Closures
- Rolling Road Block
- Coordination with FHP
- Coordination with Emergency Operations
Maintenance

- Develop Maintenance Schedule
- Periodically Exercise Moving Parts
- Display
  - Components
  - DMS Face Cleaning
- Light Source
- Sign Controller Unit
- Communication Equipment
- Use of UPS
- Availability of Spare Parts
- Technical Support
Operations

ACCIDENT AHEAD
2 RIGHT LANES BLOCKED
Describe the chain of events that might occur today if there were a two car non-injury accident along I-95 NB in the left lane during the AM rush hour.
Operator Response

- Detected Incident
- Contact FDOT and FHP
- Provide Traveler Information
  - DMS
  - HAR
  - Media
DMS Messaging

- User Guidelines Do’s and Don’ts
- Message Types
- Message Priorities
- Message Structure
DMS User Guidelines Do’s

- **Do** use DMS for all travel lane incidents.
- **Do** keep info current – update as conditions change.
- **Do** keep information concise and traffic related.
- **Do** create all messages with a consistent format.
DMS User Guidelines Don'ts

- **Do not** use DMS for unauthorized messages.
  - Personalized messages
  - Commercial advertisements
- **Do not** display inaccurate information.
- **Do not** make spelling mistakes.
Potential Pitfalls of DMS Messages

- Drivers will know when information is wrong.

- One incorrect message can cause hundreds of drivers to mistrust sign information.

- Too much information sometimes leads to confusion.
DMS Message Types

- **Stop** – warns of confirmed traffic event within threshold distance.
- **Closed** – advises of scheduled or emergency road closure.
- **Event** – advises of lane blocking incident within threshold distance.
- **Queue** – advises of queue of threshold length, if less than a threshold distance downstream.
- **Caught in Queue** – advises of location of head of queue if sign is between head and tail.
- **Soft** – warns of possibility of slow traffic, for unconfirmed incidents, i.e. not verifiable by CCTV view.
DMS Message Priority

- Message priorities are determined by Operator based on:
  - Distance of event from sign,
  - Length of queue,
  - Amount of lanes blocked, and
  - Which lanes are blocked.

- Message types from highest to lowest priority:
  - Stop – REDUCE SPEED SLOW TRAFFIC AHEAD
  - Closed – I-95 CLOSED AFTER BROWARD BLVD ALL TRAFFIC MUST EXIT
  - Event – TWO RIGHT LANES BLOCKED AT GRIFFIN RD
  - Queue – I-95 MOVING SLOWLY COPANS TO SAMPLE
  - Caught in Queue – TRAFFIC MOVING SLOWLY TO SAMPLE
  - Soft – CAUTION SLOW TRAFFIC AHEAD
DMS Messaging Structure

- **Day of Event** Messaging:
  - **Definition**
    - 1st line - WHEN
    - 2nd line - WHAT
    - 3rd line - WHERE
  - **Example**
    - 1st line - TONIGHT 10PM (or FRIDAY)
    - 2nd line - NB I-95 CLOSED
    - 3rd line - COPANS TO SAMPLE
DMS Messaging Structure

- During Event Messaging:
  - Definition
    - 1st line - WHAT
    - 2nd line - WHERE
    - 3rd line - WHEN
  - Example
    - 1st line - NB I-95 CLOSED
    - 2nd line - COPANS TO SAMPLE
    - 3rd line - UNTIL SUNDAY 10PM
Message Library Flow Chart

Message Library

Sequences

Frames

Grids
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Opening DMS Software
    - Double click on icon on desk top.
    - Login window will open.
    - ✓ Enter in your Login ID and Password and click the “Login” icon.
DMS Software

... Messaging

Operational Instructions for Dynamic Message Sign Control

- Using DMS software
  - Software will open as seen below (left picture).
  - Select DMS by using mouse and right clicking on sign icon.
  - Select "Status" which will open up the "DMS Status" dialogue box of selected sign.
DMS Software

... Messaging

Operational Instructions for Dynamic Message Sign Control

- Using DMS software
  - Select “Update Status” icon which will download the current status from selected sign.
  - When finished verifying status information select the “Close” icon to return to main map.
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using DMS software
    - Select DMS by using mouse and right clicking on sign icon.
    - Select "Override" which will open up the "Sequence Editor" dialogue box.
Operational Instructions for Dynamic Message Sign Control

- Using DMS software to select a message in the current library.
  - Select "Find" which will open the current library message set.
  - When pull down menu appears with the current list of library messages, scroll through list until you find the appropriate message and select using your mouse.
Operational Instructions for Dynamic Message Sign Control

Using DMS software to select a message in the current library.

- Selected message will appear in the “Sequence Name” field and also display in the “Editing Grid” field.
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using DMS software to select a message in the current library.
    - Once you have verified the message selected is the one you would like to send to a sign, select the “Override” icon.
    - The “Select DMS” dialogue box will open where you choose which signs you would like the selected message to display on. Once you have selected the appropriate signs, select the “Ok” icon which will send the message to the selected sign(s).
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using the DMS software to select a message in the current library.
    - The “signctrl” dialogue box will appear asking you to override the current message sequence. Then select the “Yes” icon which will send the message to the selected sign(s).
    - A communication field will appear indicating the status of the message being sent to the selected DMS.
Operational Instructions for Dynamic Message Sign Control

- Using the DMS software to create a new message in the library.
  - From the “Sequence Editor” screen, select the “Add Sequence” icon.
  - The “Sequence Name” dialogue box will change to state “New Sequence”.
  - In the “Sequence Name” dialogue box, type in the name of the new message and select the “Save Sequence” icon to save sequence.
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using the DMS software to create a new message in the library.
    - From the “Sequence Editor” screen, select the “Edit Text” icon.
    - The “Text Editor” dialogue box will appear.
Operational Instructions for Dynamic Message Sign Control

- Using the DMS software to create a new message in the library.
  - Enter text message into blank input fields – one letter per box, letters will be automatically capitalized.
    - After message is typed in and verified select the “OK” icon.
  - Text Editor features
    - Text input field
    - Font
    - Strokes
    - Text Color
    - Background Color
    - Line Justification
    - Page Center
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using the DMS software to create a new message in the library.
    - After the message was entered in the “Text Editor” dialogue box and accepted, the “Sequence Edit” dialogue box will reappear.
      - In the “Sequence Edit” dialogue box, select the “Save Grid” icon. This will save the created sign message into the new sequence.
      - In the “Sequence Edit” dialogue box, select the “Save Sequence” icon.
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using the DMS software to create a new message in the library.

  After the “Save Sequence” icon was selected, the “Sequence Saved” dialogue box will appear and select the “OK” icon to resave the Message Sequence.
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using the DMS software
    - Selected message will appear in the “Sequence Name” field and also display in the “Editing Grid” field.
DMS Software

... Messaging

- Operational Instructions for Dynamic Message Sign Control
  - Using the DMS software
    - Once you have verified the message selected is the one you would like to send to a sign, select the "Override" icon.
    - The "Select DMS" dialogue box will open where you choose which signs you would like the selected message to display on. Once you have selected the appropriate signs, select the "OK" icon which will send the message to the selected sign(s).
DMS Software

**... Messaging**

- **Operational Instructions for Dynamic Message Sign Control**
  - Using the DMS software
    - The “signcrtl” dialogue box will appear asking you to override the current message sequence. Then select the “Yes” icon which will send the message to the selected sign(s).
    - A **communication field** will appear indicating the status of the message being sent to the selected DMS.
Dynamic Message Signs

- Current DMS standards approved and in use
- Next version of standard due in 2003
  - Include graphics
  - Will incorporate the system engineering process
    - Concept of Operations
    - Dialogues
    - Requirements traceability matrix
  - More structured format for ease of agency specification

Reference: ITS Standards Program Update
Mike Schagrin, 2002 ITS America Annual Meeting
April 30, 2002
Traffic Engineering Research Lab

• Evaluation and Testing:
  – Quality Control and Experience Evaluation
  – DMS Display Properties Testing
  – DMS NTCIP Testing

• Testing Done **Before** the DMS is Sold in Florida

• Will Provide For:
  – Better Quality of DMS
  – Better Compliance to Specs (NTCIP / Display Properties)
  – Reduction of Problems After Installation
  – Training
DMS Standards Case Studies

NATIONAL TRANSPORTATION COMMUNICATIONS FOR ITS PROTOCOL (NTCIP)

CASE STUDY REPORT

NTCIP 9002 v01.04
Virginia DOT Statewide VMS Project

NTCIP 9003 v01.04
Washington State DOT
NTCIP VMS Software Upgrade
ITS Standards Contacts

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- **Brian Cronin**, of the Federal Transit Administration (FTA), coordinates ITS standards activities relating to transit. Telephone: 202-366-8841 E-mail: brian.cronin@fta.dot.gov

- **Jim Smailes**, of the Federal Railroad Administration (FRA), coordinates ITS standards activities relating to the highway-rail intersections. Telephone: 202-493-6360 E-mail: james.smailes@fra.dot.gov
About ITS Standards

ITS standards are industry-consensus standards that define how system components operate within a consistent framework. The framework is known as the National ITS Architecture. By specifying how systems and components interconnect, the standards promote interoperability.

To expedite deployment of nationally interoperable ITS systems and services, the U.S. DOT supports specific ITS standards initiatives, especially in areas that have significant public benefit.

The ITS Standards Program

The U.S. DOT ITS Standards Program is working toward the widespread use of standards to encourage the interoperability of ITS systems. Through cooperative agreements with five standards development organizations (SDOs), the Standards Program is accelerating development of about 100 non-proprietary, industry-based, consensus ITS standards, and is encouraging public-sector participation in the development process.

The Standards Program is maturing from a primarily standards development program to a standards deployment program by providing standards-based support. Such support includes training and the “learned,” and assisting the concessions of standards IT deployment. In addition, the program is coordinating U.S. ITS standards efforts with international standardization.
Questions?
Lunch Break

- Vendor Demonstration
  - ADDCO
Once every year, between Thanksgiving and Christmas, I-95 is closed down dedicating the entire facility to the “Toys for Tots” event. The event is a motorcade of motorcycles, accompanied by police escorts, that travel from north of the Broward County Line to Markham Park using I-95 and I-595 (Exit at 136th Avenue). The event typically takes place on a weekend morning and lasts for approximately three hours. Develop a series of DMS message sets for inbound traffic.
Develop a series of DMS message sets for a hazmat spill along I-595 between Hiatus Road and Pine Island Road. The event occurs on a typical Wednesday morning at 7:30 am. All lanes are closed in the eastbound direction for approximately four hours.
Workshop

... Group 3

Develop a series of message sets to provide motorist advisories regarding night-time construction along I-95. The construction features a new pedestrian bridge to be built over I-95 just south of Broward Boulevard. This pedestrian bridge will link the Tri Rail Station on the west side of I-95 to a new development to be located on the east side of I-95. I-95 would be narrowed from three lanes to only one lane, during the hours of 10 pm to 5 am, for three consecutive weekdays.
Test