USE OF INTELLIGENT TRANSPORTATION SYSTEMS IN WORK ZONES

A. INTRODUCTION

Intelligent Transportation Systems (ITS) are systems that utilize technology to improve safety and mobility in work zones. These systems can be divided into three main categories:

1) Outside the work zone – Includes work zone planning and design (i.e. software to analyze work zones) or pre-trip traveler information.
2) Approaching the work zone – Includes systems deployed on the roadway upstream of the work zone. These systems provide enroute information to motorists.
3) Inside the work zone – Includes applications that are used in the immediate vicinity of the work zone (e.g. Auto Flagging Systems, Lane Closure systems, Intrusion Alarms, etc.)

B. OBJECTIVE

- To improve safety and mobility through a work zone using technology.
- To provide accurate and timely information to motorists, which in turn helps to satisfy and make the motorist more compliant.

C. SYSTEM COMPONENTS

Factors to consider before deploying an ITS System in a work zone are:

1) Will the system provide real-time information?
2) Can the system provide accurate, credible, and meaningful information?
3) Is the system hardware and software reliable?
4) Is the system controlled by a manual operator, fully automated where the computer uses software logic to make decisions, or is it a combination of both?

5) Is the system going to be linked into a statewide ITS system or will it just be a local system?

After looking into the prior questions, an ITS system should contain the following components:

1) Mobile/portable;
2) Internet interface;
3) Wireless communications;
4) Quick deployment;
5) Downtime/malfunction strategy;
6) A comparison of the costs both Initial and Operation/Maintenance.

D. ITS IN WORK ZONES

Following are some examples of use of ITS systems in workzones.

D.1. DYNAMIC LATE MERGE SYSTEM

What is Dynamic Late Merge System?

Dynamic Late Merge is a merging concept used to instruct motorists to use both lanes and take turns merging as they approach a single lane closure situation.

How the system works?

The system is activated prior to a lane closure being set-up. All of the PCMSs will remain blank until the sensors detect a traffic back up. Once the system detects a back up, the signs display the messages shown in Figure 1, thus encouraging motorists to "Use Both Lanes to Merge Point". Once motorists reach the merge point, traffic in each lane should alternate the right of way. If the system does not detect a queue, then motorists will follow the standard static signs and merge when they obtain a gap in traffic.

Why use Dynamic Late Merge?

Under standard lane closure conditions, there is unused roadway capacity closer to the work zone due to motorist vacating the closed lane. By encouraging motorists to use both lanes to the merge point, that unused capacity is utilized and the queue lengths are reduced. Also, the system assists in discouraging dangerous, last second forced merges. The system will also promote less lane changes prior to the merge point and a uniform volume distribution in the travel lanes.

MDSHA Test Deployment

The Dynamic Late Merge System was deployed along Southbound I-83 near Cold Bottom Road in Northern Baltimore County. The system was operational from October 13, 2003 to November 17, 2003. The system included four (4) Portable Changeable Message Signs (PCMS), equipped with microwave sensors to monitor traffic flow through the work zone. Also, included in the system was a web camera, so that SHA could monitor traffic. The system utilized a cellular modem for communications and solar power with batteries to power the system. The figure on the following page shows the typical layout of the system. The system also provided traffic information to a website that was available for motorists use prior to leaving for their trip.

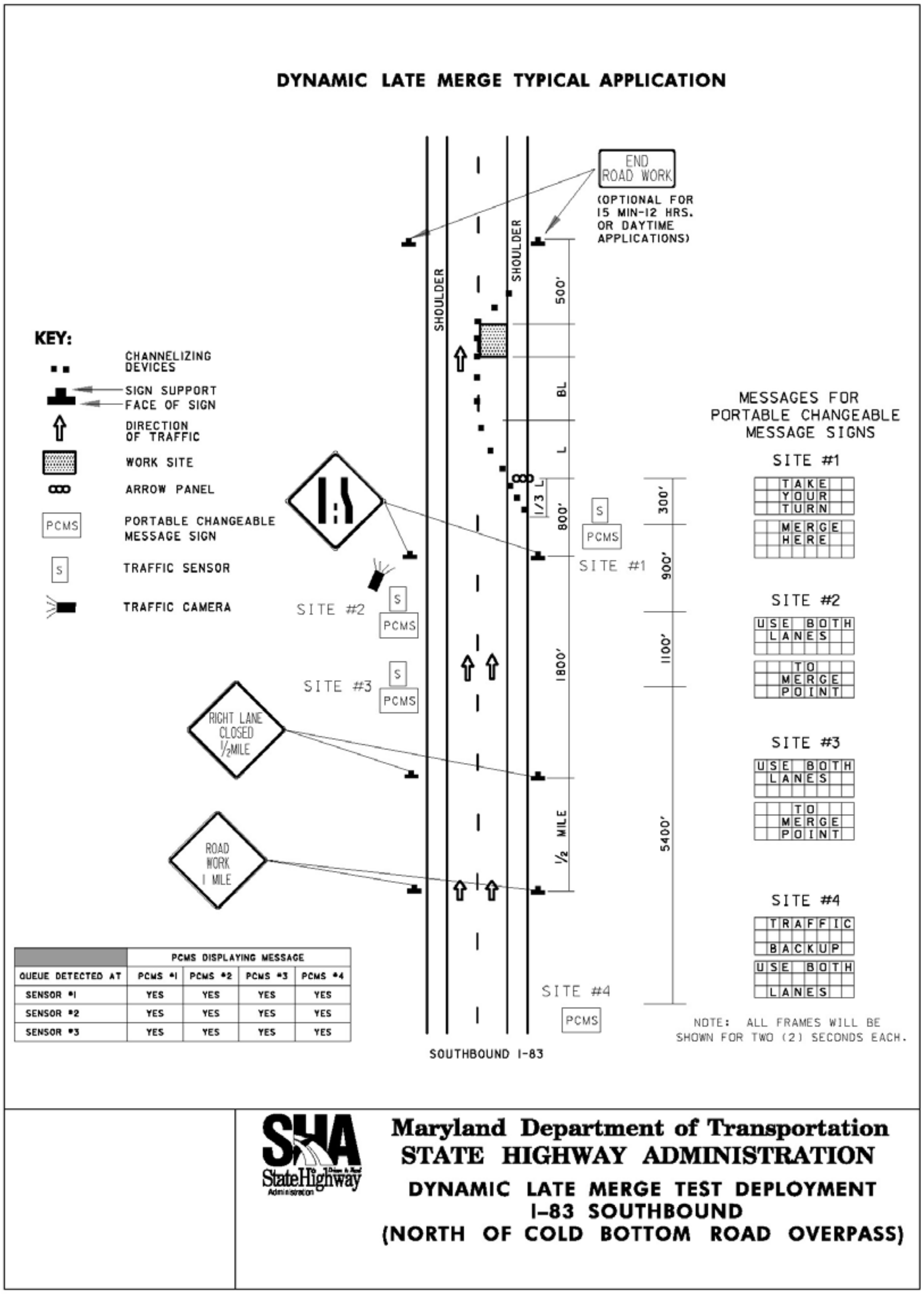


Figure 1. Dynamic Late Merge Set-up

Note: In order to reduce confusion amongst motorists due to messages on PCMSs and statics signs, standard lane closure signs may need to be modified when the system is implemented.

D.2. TRAVEL TIME ESTIMATION SYSTEM

What is Travel Time Estimation?

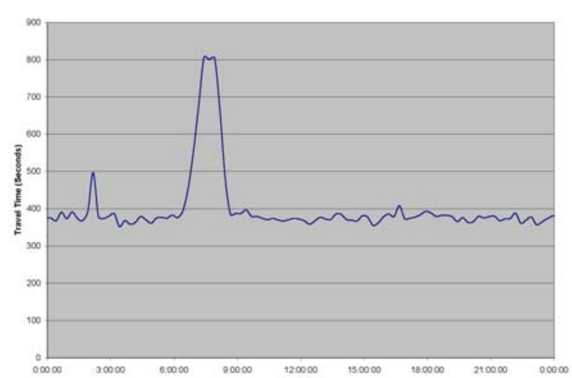
Travel time estimation obtains real-time traffic data and uses computer software to predict the current travel time on a section of roadway. The information can then be displayed to the motorist on a PCMS, displayed on the Internet, or sent to a pager/cell phone/PDA.

Why display Travel Times to motorists?

By obtaining traffic information and displaying travel times to motorists, the motorists can make an informed decision on which routes to take. If the travel times are high due to roadwork or an incident, motorists can use an alternate route, thus reducing the demand on the route. By providing motorists with traffic condition information, it reduces the stress and anxiety that can be caused by congested conditions. If the travel times are displayed on the Internet, a historical database can be maintained to advise motorists of typical travel times at certain times of the day. Also, graphs showing the average travel times can be provided over the Internet. A typical historical database and travel time graph can be seen below.

Historical Travel Times Last Updated (2005-01-02 11:36:26 PM)

Southbound I-95 from MD 198 to MD 212 - AM Peak		
Departure Time	Travel Time (mm:ss)	Average Speed (mph)
6:00-6:15	5:47	77.8
6:15-6:30	6:11	72.7
6:30-6:45	6:49	66.0
6:45-7:00	8:26	53.3
7:00-7:15	9:08	49.3
7:15-7:30	10:57	41.1
7:30-7:45	13:32	33.3
7:45-8:00	13:27	33.5
8:00-8:15	13:16	33.9
8:15-8:30	11:37	38.7
8:30-8:45	9:12	48.9
8:45-9:00	8:43	51.6



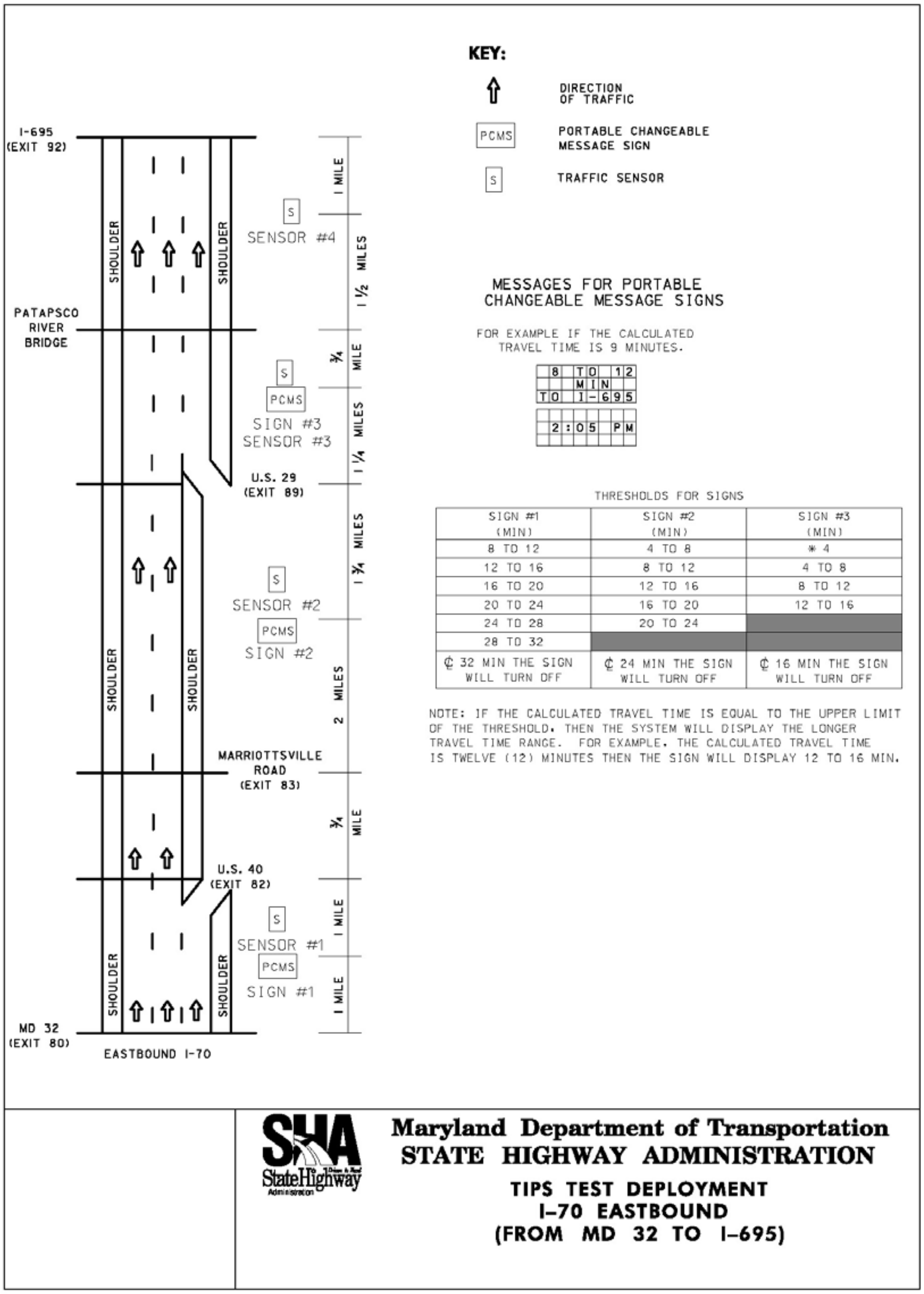
D.2.1 USING MICROWAVE SENSORS

How the system works?

The system is constantly obtaining data from microwave traffic sensors along the section of roadway being monitored. This data is sent to a base station, which is housed in the project field office. At the base station, the software conducts calculations to predict the current travel times, based on the speed and volume data obtained from the sensor. The predicted travel times are then sent to the PCMS to be displayed to the motorists. It is recommended that the PCMS should also display the current time to let motorists know that the travel time data is up to date. The base station can be connected to the Internet to provide information to motorists, prior to leaving their home or office.

MDSHA Test Deployment

This travel time system was deployed along Eastbound I-70 between MD 32 and I-695 in Howard and Baltimore Counties. The system was operational from November 12, 2003 to December 3, 2003. The system included three (3) Portable Changeable Message Signs (PCMS) and four (4) microwave sensors to monitor traffic flow through the work zone. The system utilized a 220 MHz Radio for communications and solar power with batteries to power the system. The figure on the following page shows the typical layout of the system. The system also provided traffic information to a website that was available for motorists use prior to leaving for their trip.



SIGN #1 (MIN)	SIGN #2 (MIN)	SIGN #3 (MIN)
8 TO 12	4 TO 8	* 4
12 TO 16	8 TO 12	4 TO 8
16 TO 20	12 TO 16	8 TO 12
20 TO 24	16 TO 20	12 TO 16
24 TO 28	20 TO 24	
28 TO 32		
¢ 32 MIN THE SIGN WILL TURN OFF	¢ 24 MIN THE SIGN WILL TURN OFF	¢ 16 MIN THE SIGN WILL TURN OFF

Figure 2. Travel Time Estimation System

D.2.2 USING VIDEO IMAGE RECOGNITION

How the system works?

Each camera deployed on the roadway will monitor one lane of traffic. The camera will take an image as each car passes the camera and store the encrypted information in a database. The system will then try to match two images to obtain a travel time. If the travel times are within a certain tolerance then the travel time is accepted and included in the real-time travel time calculation. The system has the capability of displaying travel times on a PCMS or over the Internet.

Benefits of Video Image System

The travel time system using video image recognition can provide more reliable travel time information than the microwave sensor system, provided the distance between the cameras is not too great. Since the video image system tracks individual vehicles between the two points, the travel time provided is the actual travel time. As the distance between the cameras increases, the probability of matches decreases due to vehicles exiting the roadway. The microwave sensor system obtains traffic information at certain points and while the sensor may be obtaining free flow conditions, one (1) mile downstream there may be an incident and that delay is not accounted in the travel time estimation. Also, the video image system can be used on an arterial since the system accounts for the possible delays incurred at a traffic signal.

MDSHA Test Deployment

This travel time system was deployed along Southbound I-95 between MD 32 and MD 212 (approximately 7.5 miles) and along Southbound U.S. 29 between MD 32 and Industrial Parkway (approximately 11.25 miles) in Howard, Montgomery, and Prince George's Counties. The system was operational from November 18, 2004 to January 14, 2005. For the first month, the system included the following components:

1) Two (2) cameras along Southbound I-95 just south of MD 32 with web camera;
2) Two (2) cameras along Southbound I-95 just north of MD 212;
3) One (1) camera along Southbound U.S. 29 just north of MD 32;
4) One (1) camera along Southbound U.S. 29 just south of Industrial Parkway with web camera.

For the second month, the cameras locations were modified to the following:

1) Three (3) camera along Southbound U.S. 29 just north of MD 32 with web camera;
2) Three (3) camera along Southbound U.S. 29 just south of Industrial Parkway with web camera.

Each camera can monitor one lane of traffic. The system utilized a cellular modem for communications and solar power with batteries to power the system. The system also provided traffic information to a website that was available for motorists use prior to leaving for their trip.

D.3. ADVANCED SPEED INFORMATION SYSTEM USING MICROWAVE SENSORS

What is an advanced speed information system?

An advanced speed information system is an ITS system that utilizes microwave traffic sensors and PCMSs to alert motorists of upcoming traffic conditions. This information can also be displayed on the Internet or sent to a pager/cell phone/PDA.

How the system works?

A downstream traffic sensor detects vehicle speeds as the vehicles pass the sensor and provides this information to an upstream PCMS. The speed ahead information is then displayed to the motorist. All of the traffic data can be sent to the base station in the project field office to be placed on the

Internet. If the downstream speeds are free flow conditions then the signs can display a message reminding motorists of the speed limit. As speeds reduce, the signs can display the downstream speeds in five (5) MPH increments. If the downstream speeds are very slow, the signs can display a message alerting motorists of congested or stopped traffic ahead.

Why display Advanced Speed Information to motorists?

By displaying speed information to motorists, the hope is to prepare the motorists for upcoming traffic conditions. By alerting motorists of reduced speeds ahead, the vehicle speed differentials may be reduced, thus reducing the probability of rear-end collisions.

MDSHA Test Deployment

This system was deployed along Eastbound I-70 between MD 32 and I-695 in Howard and Baltimore Counties. The system was operational from December 10 to December 23, 2003 and January 3 to January 10, 2004. The system included three (3) Portable Changeable Message Signs (PCMS) and four (4) microwave sensors to monitor traffic flow through the work zone. The system utilized a 220 MHz Radio for communications and solar power with batteries to power the system. The figure on the following page shows the typical layout of the system. The system also provided traffic information to a website that was available for motorists use prior to leaving for their trip.

Disclaimer

The information provided in this section of the Maryland State Highway Administration's Work Zone Safety Tool Box is only to provide guidance. The Work Zone Safety Tool Box supplements current practices and standards provided in the current edition of the following documents:

1) The Manual on Uniform Traffic Control Devices (MUTCD)
2) The Maryland Supplement to the Manual on Uniform Traffic Control Devices
3) Maryland State Highway Administration Standard Sign Book
4) Maryland State Highway Administration Book of Standards for Highway and Incidental Structures
5) Maryland Department of Transportation State Highway Administration Standard Specifications for Construction and Materials

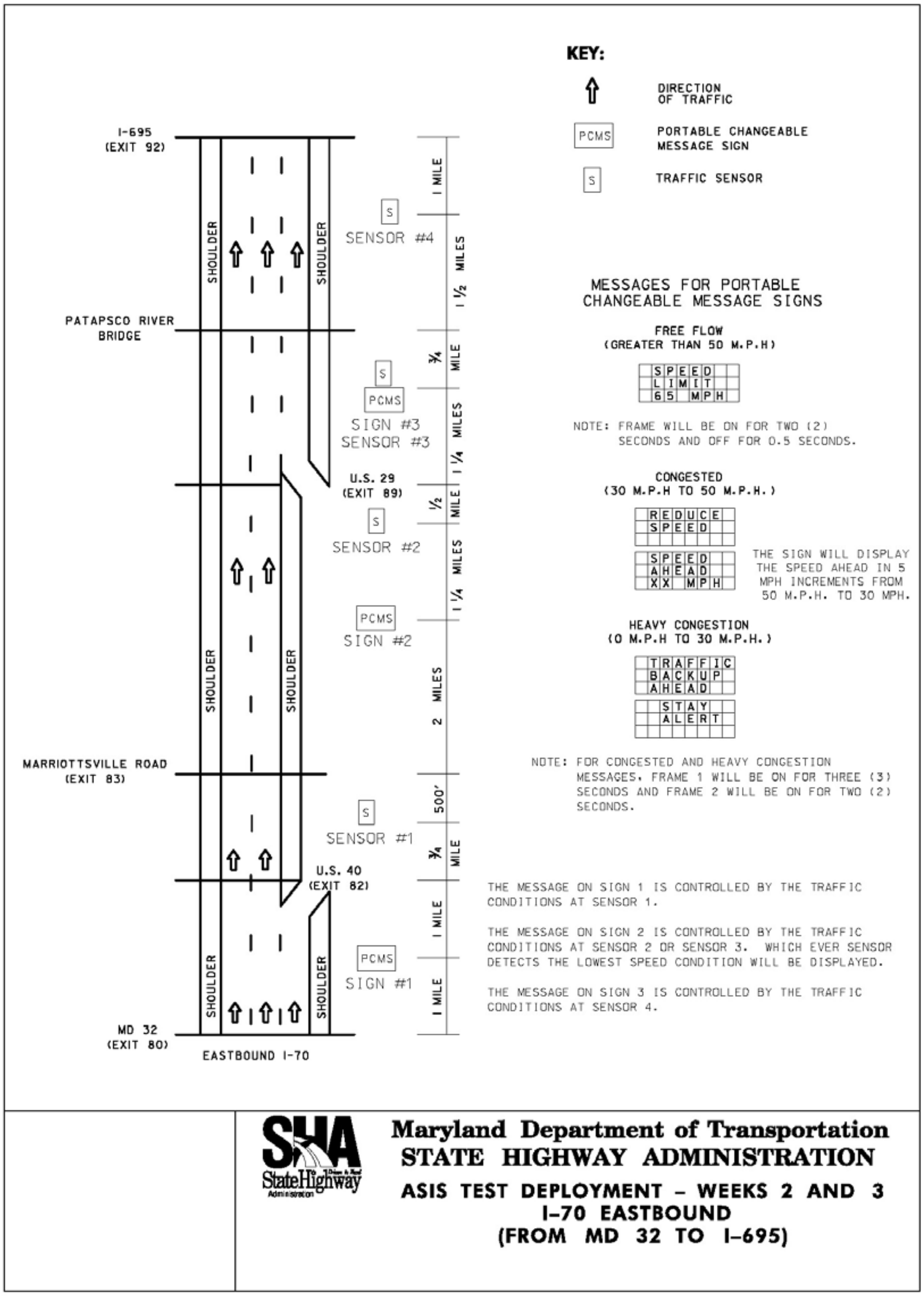


Figure 3. Advanced Speed Information System