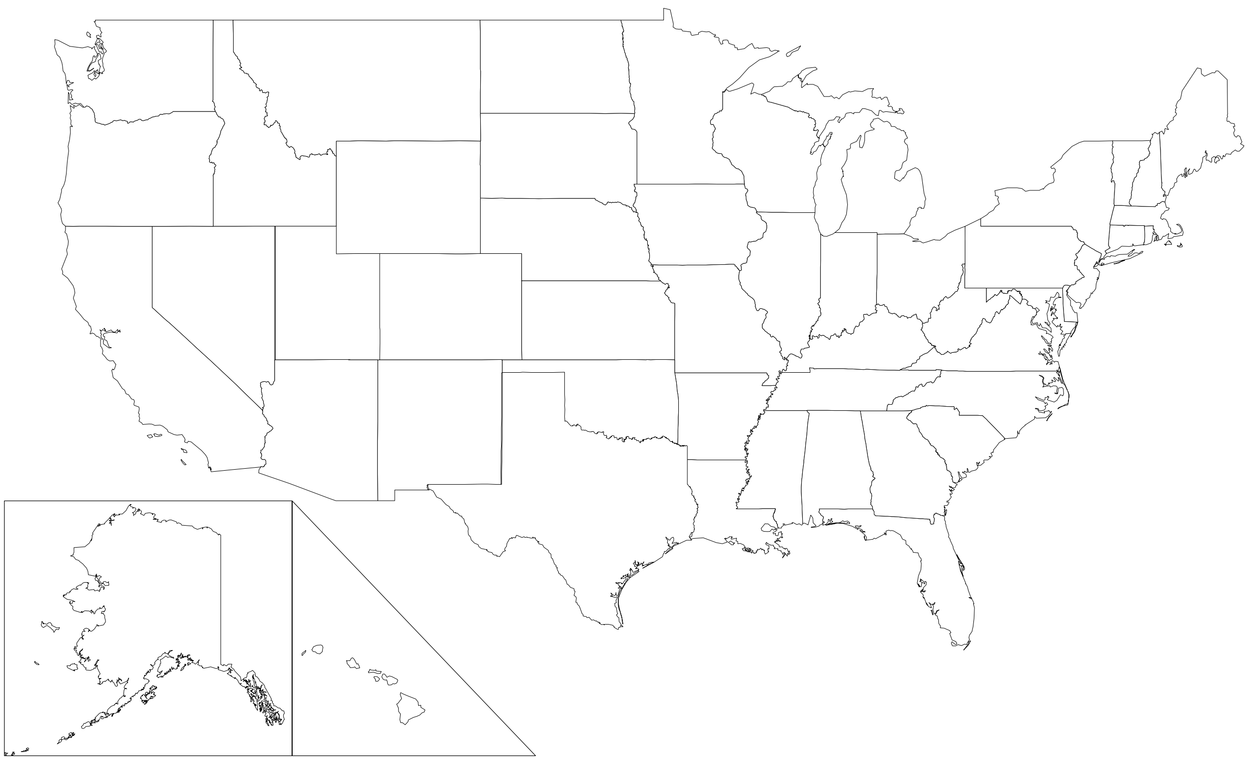
Statewide/Rural Intelligent Transportation Systems (ITS)

2002 Summary Report

April 2004



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ITS Joint Program Office
United States Department of Transportation
Washington, D.C.

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Preface

This report presents the results of a major nationwide data gathering effort to track the deployment of the metropolitan Intelligent Transportation Systems (ITS) technology in statewide and rural areas in the United States. This report summarizes the results of a survey conducted in 2002 of state departments of transportation in each of the 50 states. ITS deployment tracking has been on-going since 1996, but previous surveys were limited to major metropolitan areas exclusively. In 2002 this scope was expanded to include surveys of medium sized cities and tourist areas as well as statewide/rural deployments in each state.

Tracking the deployment of ITS infrastructure is an important element of ITS program assessment since implementation of ITS is an indirect measure of effectiveness of the ITS program. Information regarding deployment activities provides feedback on progress of the program that can help stakeholders establish strategies for continued market growth. Understanding the extent of ITS deployment can lead to insights regarding future program changes, redefinition of goals, or maintenance of current program direction.

The methodology followed to complete this effort is based on gathering data in five areas of statewide/rural ITS deployment: Crash Prevention and Security, Traffic Management, Operations and Maintenance, Surface Transportation Weather, and Traveler and Tourism Information. Systems and functions were defined for each of these areas and surveys developed and distributed to gather data on the extent and key characteristics of these systems and functions.

Questions or comments concerning the material presented in this report are encouraged and can be directed to:

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Executive Summary

This document reports on the results of a survey conducted in 2002 of each of the 50 states and aimed at gathering data on the deployment of Intelligent Transportation Systems (ITS) in rural and non-urban areas. This statewide survey was carried out as part of the ITS Deployment Tracking Project, which is tasked with tracking the level of deployment of ITS technology nationwide. This project, which is sponsored by the Federal Highway Administration (FHWA), has been gathering data on ITS deployment since 1997. Previous efforts were targeted at major metropolitan areas. In 2002, the scope of this project was expanded to include tracking rural deployments in each state.

This document reports on the results from the statewide survey. Seven development tracks were developed by the FHWA Rural ITS program to describe rural ITS. Individual rural systems are defined and grouped according to these development tracks. The seven development tracks are:

- Crash Prevention and Security
- Traffic Management
- Operations and Maintenance
- Surface Transportation Weather
- Traveler and Tourism Information
- Emergency Services
- Transit and Mobility

In the 2002 data gathering, only the first five of these development tracks were included. Because of the difficulty in defining ITS deployments with statewide coverage for emergency services or transit, these development tracks were set aside in the initial national survey. Figure 1 highlights the states that have deployed or plan to deploy a system in one of the five development tracks for which data were collected. Generally states report deployments in most or all of the five categories.

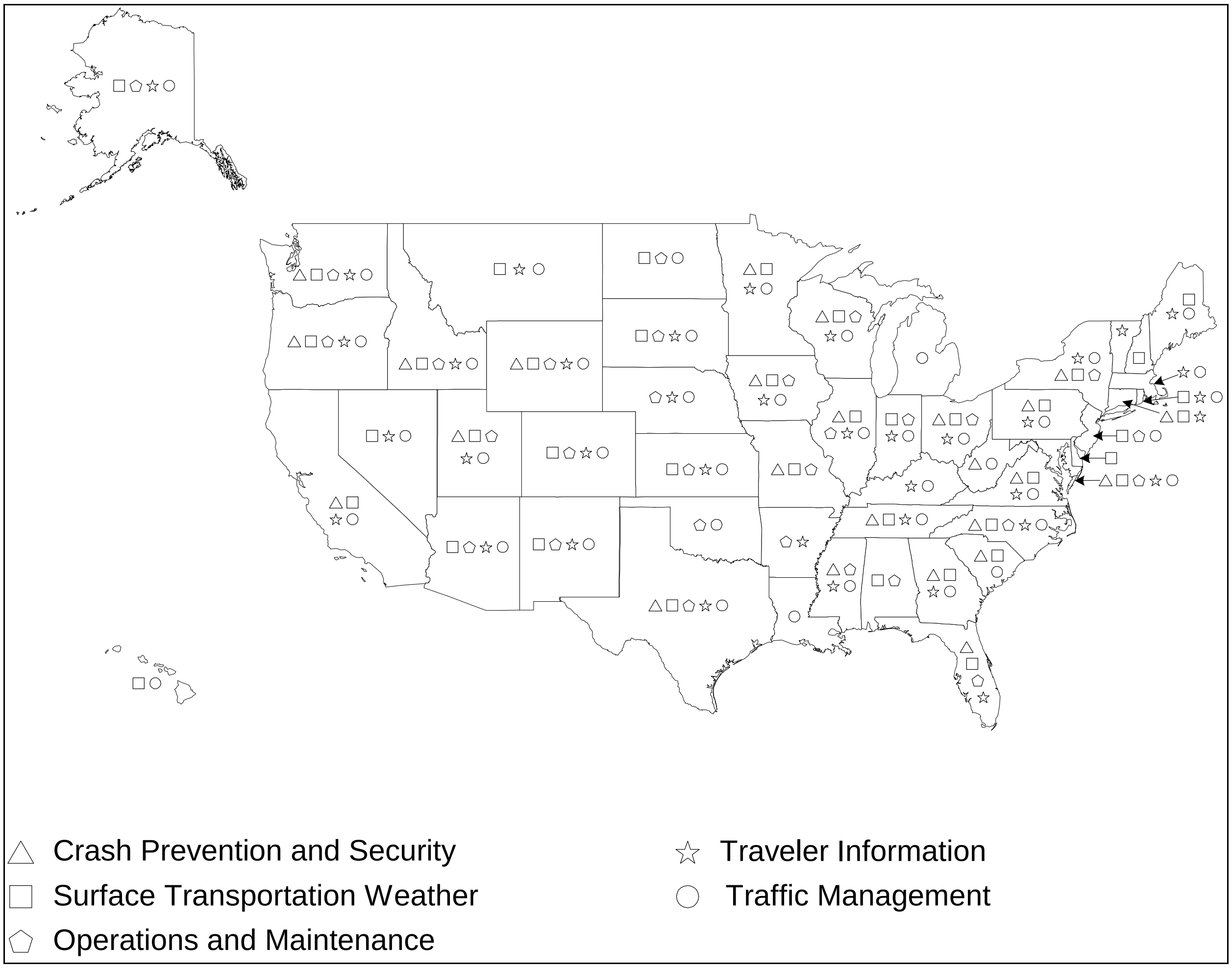


Figure 1. Statewide/Rural ITS Deployments

Crash Prevention and Security Systems

Crash Prevention and Security Systems employ technology to detect hazards or unsafe conditions, evaluate the severity of the hazard, and present a warning to travelers when warranted. These systems, deployed outside metropolitan areas, are generally designed to operate autonomously and accordingly often incorporate sophisticated technology. The 2002 survey covered a variety of types of Crash Prevention and Security Systems, distinguished by the type of hazard the systems address. Systems addressing the following types of hazards were included: environmental, road geometry, highway rail intersection, road intersection, large animal collision, bicyclists, and pedestrian crossings. The two most widely deployed are Environmental Road Hazard Warning Systems and Roadway Geometry Warning Systems.

- Environmental Road Hazard Warning Systems. These systems detect reduced visibility conditions or other environmental hazards and provide a warning to travelers. These systems employ sensors to detect conditions of low visibility due to fog, heavy rains, or snow white-out, or to detect icy or wet road conditions. Warnings are provided to travelers using changeable message signs or other means. Additional system capabilities sometimes include means to mitigate the hazard for travelers, such as the use of in-pavement lights to aid visibility. A total of 21 states identified 71 separate Environmental Road Hazard Warning Systems.

- Roadway Geometry Warning Systems. These are deployed to provide warnings to travelers at potentially hazardous roadway geometry features such as sharp curves and steep grades. These systems often employ sensors to detect road conditions as well as vehicle weight, height, and speed. Based on these data, warnings can be directed to general traffic or specific vehicles through dynamic messages signs, flashers, variable speed limits, or other means. A total of 16 states identified 56 separate Road Geometry Warning Systems.

- Other types of Crash Prevention and Security Systems. The remaining systems, involving warning for hazards associated with road/rail intersections, dangerous road intersections, animal crossings, and the presence of bicyclists and pedestrian, are lightly deployed, although there are a number of examples of operational systems in each category.

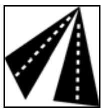
Traveler Information Systems

Traveler Information Systems included in this report have a statewide or at least regional scope. These systems are widely deployed. A total of 39 states have identified 65 separate statewide or regional Traveler Information Systems.

- Types of Information Provided. The data provided by these systems fall into three categories: roadway, tourism, and public transit. Information related to roadway is by far the most common type disseminated, with road closures and work zones most widely included, closely followed by information on incidents, road surface, weather, detours, and road restrictions. Additional real-time roadway information provided by Traveler Information Systems includes congestion, alternate routes, and closed circuit television (CCTV) images. Information on tourism (maps and directions) and transit (schedules) is also available through these systems, but is less frequently reported.

- Sources of Information. The variety of sources providing input to the Traveler Information Systems is impressive and indicates broad support for this service within the state infrastructure of most states. The most often mentioned sources are operations and maintenance, traffic management, and construction areas, followed by public safety, work zones, and the state police. Many additional sources are reported as well, and these systems appear to offer users a widely varied set of choices for traveler information.

- Media for Information Dissemination. Traveler Information Systems disseminate information using a variety of media. Most frequently used, not surprisingly, is the Internet. Statewide conditions reporting systems, highway advisory radio, and dynamic message signs are next in importance. The use of 511 telephone service is an important medium as well, and was reported about one third as frequently as the Internet. Other important media for disseminating traveler information are: non-511 automated telephone, email, fax, television, and kiosks.



Traffic Management

Traffic Management in non-urban areas employs many of the same technologies for surveillance, information dissemination, and traffic control as in metropolitan areas, but technology is generally deployed at spot locations rather than continuous miles of instrumentation. Road Closure Systems, and Route Diversion Systems are important in rural areas and were included in the 2002 survey.

- Closed Circuit Television . The survey results show that the most important function supported by statewide CCTV systems is to detect and verify incidents. Other important functions are to monitor road conditions, manage events, monitor weather, and verify dynamic message signs. Security is mentioned as a consideration for a small number of CCTV deployments.

- Dynamic Message Signs (DMS). Statewide deployments of DMS support a variety of functions by providing different types of information. The most common type of information disseminated by DMS reported in the survey is related to the roadway and includes work zone information, followed closely by roadway status, accident sites, diversions, and congestion. Speed warnings are also provided, but only by about one fourth as many signs as the other roadway information. Other types of information frequently disseminated by DMS are weather alerts and special events. These signs are also used to disseminate information on parking availability and transit operations, but to a much smaller extent.

- Traffic Surveillance. Traffic Surveillance Systems involve instrumentation of sections of roadway or spot locations to gather information on traffic conditions and incidents. These systems are typically located on sections of road with special characteristics or heavy use, such as freight routes, evacuation routes, military deployment routes, special event routes, and snow and ice routes. In addition, surveillance systems may be placed at spot locations such as bridges or tunnel entrances. A total of 23 states report deployment of Traffic Surveillance Systems.

- Road Closure Systems. Rural freeway incident management systems typically use combinations of freeway closure gates (either remote controlled or manual) and information systems to alert travelers of the closures. There are a total of 17 states that have identified 25 separate Roadway Closure Systems. The majority of these systems are deployed on freeways or limited access highways.

- Route Diversion Systems. These systems assist in the management of traffic diversions resulting from temporary road closures due to weather or other causes. Route Diversion Management Systems attempt to spread the number of vehicles diverted off freeways over a larger geographic area such that sufficient services, such as hotels and restaurants, are available, and small rural towns are not overcrowded. They depend on up to date information on resource availability in areas likely to be impacted by a diversion and on information dissemination capability to provide travelers with diversion guidance. A total of 13 states identified 19 separate Route Diversion Management Systems.

- Traffic Management Centers (TMC). There are a total of 27 states that have identified 55 separate Transportation Management Centers. Four key functions are reported by more than half of the TMCs: incident management, information dissemination, surveillance, and special event traffic management. Just about half of the TMCs report providing en-route traveler information, emergency management, and disaster management coordination. About one third support network performance monitoring, environmental monitoring, and corridor management. Fewer than 20% of the TMCs exercise traffic control through ramp or lane management.

Operations and Maintenance

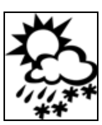
Operations and maintenance systems support safety and improve operational capabilities, and include Automatic Anti-icing Systems, Avalanche/Slide Management Systems, and Work Zone Management. Maintenance Fleet Management Systems, also included in the survey, can improve operations and take advantage of maintenance vehicles as a source of information.

- Automatic Anti-icing Systems. These systems address a number of safety issues and provide solutions for improving road conditions by preventing formation of ice in spot locations. Automatic Anti-icing Systems detect conditions conducive to ice formation in locations such as bridge decks or shady areas, and treat the roadway before it becomes hazardous to drivers. These systems require environmental or in-road sensors, a processor to determine when conditions for ice formation exist, and a device for preventing ice formation. There are a total of 17 states that have identified 21 separate Automatic Anti-Icing Systems. Of the 21 systems, 16 are deployed and five were still in the planning stage.

- Avalanche/Slide Management Systems. These systems are designed to improve safety along roadways with a high number of avalanches or slides. Traffic logging stations are installed at either end of an avalanche/slide prone corridor, and avalanche/slide sensors are installed at the roadside. If a hazard is detected based on readings from the roadside sensors, automatic gates prevent drivers from entering the corridor. Four states identified five separate Avalanche/Slide Management Systems.

- Maintenance Fleet Management Systems. Maintenance Fleet Management Systems are designed to increase the efficiency of public vehicle fleet management operations. The widespread use of new technologies such as global positioning systems (GPS) and hand-held computers with wireless capability allows for many new and innovative ways of improving operations efficiency in many transportation related areas. There are a total of 15 states that have identified 24 separate Maintenance Fleet Management Systems. It was reported that a variety of sensors and technologies are deployed on these vehicles to improve management capabilities and improve safety. The two most common technologies used for data collection are automatic vehicle location (AVL) and road surface condition sensors. A number of systems include weather sensors on the vehicles, supporting the use of these vehicles as weather probes.

- Work Zone Management Systems. The purpose of these systems is to ensure safe roadway operations and improve operational efficiencies during construction and other work zone activities. Work Zone Management Systems provide automated systems that enforce speed limits, provide vehicle intrusion warnings, and track individual crew movements. Through interfaces with other systems, information concerning location, duration, and operational impact of work zones are communicated to travelers. A total of 14 states report the use of ITS technology in rural work zones. The most common sensor deployed at work zones detects vehicle speed. Traffic volume and travel time through the work zone are tracked by about half the reported systems. A variety of technologies are deployed to communicate warnings to vehicles operating near work zones. The use of dynamic message signs, both mobile and permanent, is the most commonly reported communications method, followed by highway advisory radio. The use of temporary speed limits is deployed widely as well.



Surface Transportation Weather

Information for evaluating surface transportation weather is gathered from a variety of sources, including national and statewide databases. In addition, sensors are deployed throughout a state to gather atmospheric conditions as well as road surface temperature and conditions and subsurface temperatures. A total of 41 states have deployed or are planning to deploy statewide weather systems. The total number of systems reported was 55, as some states have multiple regional systems.

- Sources of Weather Information. Statewide weather systems receive data from a wide variety of sources. The most common sources are environmental sensor stations operated by state departments of transportation (DOTs), followed by the National Weather Service. Also included are sensor inputs from other agencies, including airports, agricultural stations, air pollution sensors, and vehicle probes.

- Users of Weather Data. Surface Transportation Weather Systems provide tailored weather products to a number of agencies. Survey results show that maintenance crews are the biggest user of tailored products, followed by traffic management centers, traveler information systems, and public safety agencies.

- Media for Disseminating Weather Information. The most popular method of weather information dissemination reported is the Internet followed closely by dynamic message signs. Other important media are email, telephone, fax, personal communications devices, and kiosks.

Overall Results

Subsequent sections of this report contain summarized data on each of the development tracks gathered nationwide. For those interested in more detailed information, access the ITS Deployment Tracking web site at http://www.itsdeployment.its.dot.gov and select the Statewide Results tab. At this web site users can access a detailed report of all data received for each state. In addition, survey summary reports, which summarize responses to each survey question, are available for each of the five survey types. Because this is the first time these data were collected, no trend information is available. Another statewide survey is planned for 2004. Agencies are encouraged to review the data presented in this report for completeness and accuracy and to direct any comments or corrections to the contacts listed below:

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Background and Purpose

This document reports on the results of a survey aimed at gathering data on the deployment of Intelligent Transportation Systems (ITS) in rural and non-urban areas. Conducted in 2002 and administered to each of the 50 states, this statewide survey was carried out as part of the ITS Deployment Tracking Project, which is tasked with tracking the level of deployment of ITS technology nationwide. This project, which is sponsored by the U. S. Department of Transportation, has been gathering data on ITS deployment since 1997. Previous efforts were targeted at major metropolitan areas. In 2002, the scope of this project was expanded to include tracking rural deployments in each state.

The ITS Deployment Tracking Project was initiated to track progress toward accomplishment of a goal for the deployment of ITS in major metropolitan areas. In January 1996, the Secretary of Transportation set a goal of deploying the integrated metropolitan Intelligent Transportation System (ITS) infrastructure in 75[1] of the nation's largest metropolitan areas by the end of 2005.

> *"I'm setting a national goal: to build an intelligent transportation infrastructure across the United States to save time and lives, and improve the quality of life for Americans. I believe that what we do, we must measure . . . Let us set a very tangible target that will focus our attention . . . I want 75 of our largest metropolitan areas outfitted with a complete intelligent transportation infrastructure in 10 years."*[2]
>
> -- *Former Secretary Peña, 1996*

In order to track progress toward fulfillment of the Secretary's goal for deployment, the U.S. DOT ITS Joint Program Office developed the metropolitan ITS deployment tracking methodology. This methodology tracks deployment of the nine components that make up the Metropolitan ITS infrastructure: Freeway Management; Incident Management; Arterial Management; Emergency Management; Transit Management; Electronic Toll Collection; Electronic Fare Payment; Highway-Rail Intersections; and Regional Multimodal Traveler Information. Through a set of indicators tied to the major functions of each component, the level of deployment is tracked for the nation's largest metropolitan areas. In addition, the integration links between agencies operating the infrastructure are also tracked.

Data were gathered on deployment and integration in the 78 major metropolitan areas in 1997, 1999, 2000, and 2002. However, limiting the scope of the effort to major metropolitan areas does not provide a true national picture of the status of ITS deployment and misses important deployments in medium sized cities and non-urban (rural) statewide areas. During the spring and summer of 2002, the ITS Joint Program Office undertook a new data collection effort for the

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[1] Since former Secretary Peña's speech, the number of metropolitan areas that DOT will measure has been increased from 75 to 78. However, to maintain reporting consistency across the 10-year goal period, this report considers only the original 75 metropolitan areas.

[2] Excerpt of a speech delivered by former Secretary of Transportation Peña at the Transportation Research Board in Washington, DC on January 10, 1996.

purpose of examining ITS deployment in the nation's largest metropolitan areas and addressed this issue by expanding the survey to include statewide and rural deployment as well as selected small and medium sized cities.

This document reports on the results from the statewide survey. Measurement of deployment is based on counts of systems deployed, and an assessment of the characteristics and capabilities of these systems, rather than deployment indicators familiar to users of metropolitan deployment tracking data. In metropolitan deployment tracking, indicators are used to quantify the extent of deployment. Indicators describe the deployment in terms of the percentage of the maximum possible, for example comparing miles of highway covered by a particular technology to total miles available or number of transit vehicles instrumented to total fleet size. No such indicators have been developed yet for statewide deployment tracking, which is in part a reflection of differences in the way ITS technology is deployed in rural environments. Statewide/rural ITS, compared to metropolitan, is more a matter of separate systems of technologies, frequently operating autonomously and in remote locations, rather than as an integrated infrastructure.

In defining metropolitan ITS, the organizing principle was the concept of an infrastructure of nine functionally integrated components, a concept that led directly to a data gathering strategy, because individual agencies could be associated with each component. For statewide ITS, there is as yet no well-established infrastructure to use as the basis for defining ITS. Instead of infrastructure components, seven development tracks were developed by the Rural ITS program to describe rural ITS. Individual rural systems are defined and grouped according to these development tracks. The seven development tracks are:

- Crash Prevention and Security
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In the 2002 data gathering, only the first five of these development tracks were included. Because of the difficulty in defining ITS deployments with statewide coverage for emergency services or transit, these development tracks were set aside in the initial national survey. Figure 2 highlights the states that have deployed or plan to deploy a system in one of the five development tracks for which data were collected. Generally, states report deployments in most or all of the five categories.

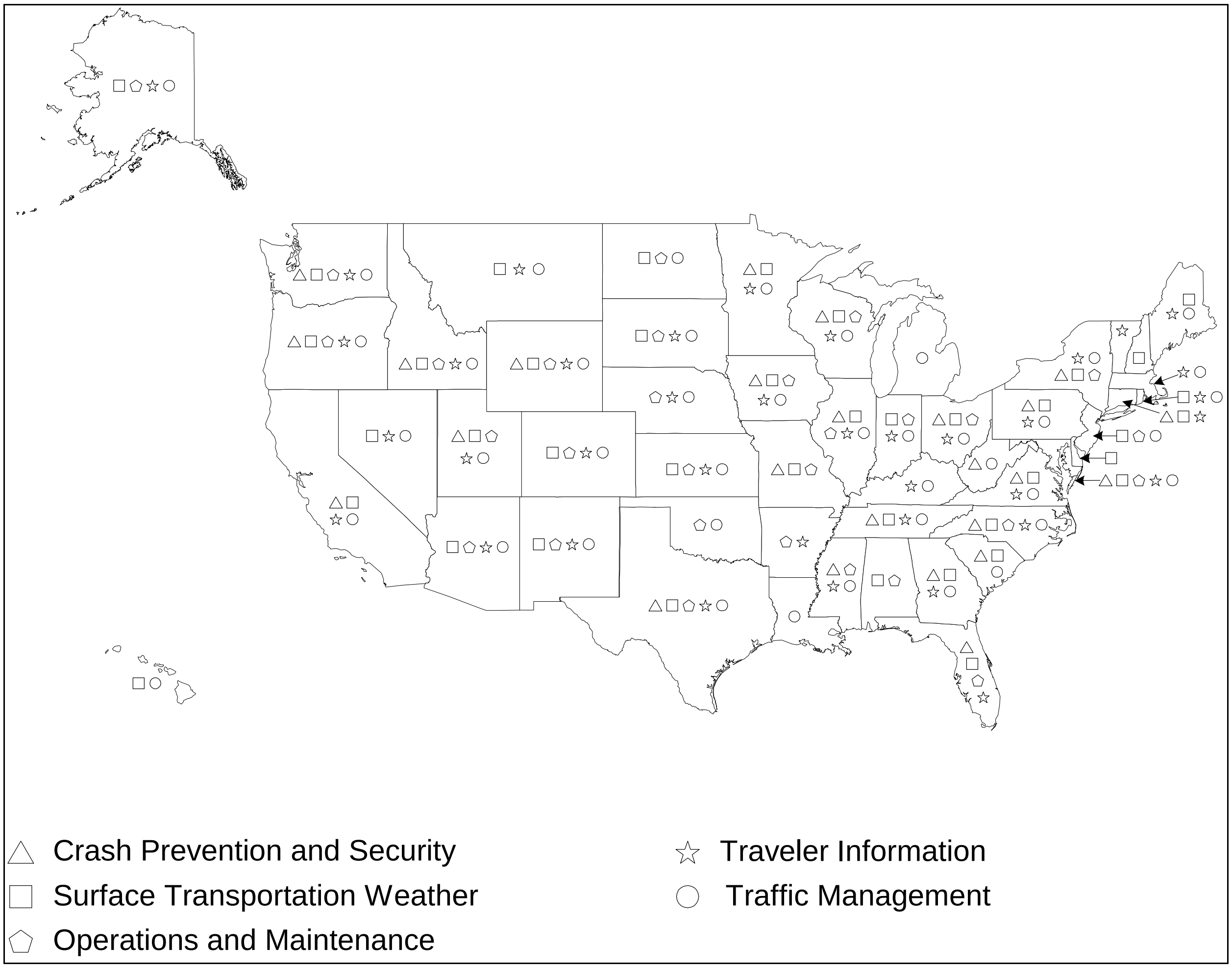

Figure 2. Statewide/Rural ITS Deployments

Subsequent sections of this report contain summarized data on each of the development tracks gathered nationwide. For those interested in more detailed information, access the ITS Deployment Tracking web site at http://www.itsdeployment.its.dot.gov and select the Statewide Results tab. At this web site, users can access a detailed report of all data received for each state. In addition, survey summary reports, which summarize responses to each survey question, are available for each of the five survey types. Since this is the initial data gathering, no trend information is available. Another statewide survey is planned for 2004. Agencies are encouraged to review the data presented in this report for completeness and accuracy and to direct any comments or corrections to either of the contacts listed below:

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Crash Prevention and Security

Crash Prevention and Security Systems employ technology to detect hazards or unsafe conditions, evaluate the severity of the hazard, and present a warning to travelers when warranted. These systems, deployed outside metropolitan areas, are generally designed to operate autonomously and, accordingly, often incorporate sophisticated technology. The 2002 survey covered a variety of types of Crash Prevention and Security Systems, distinguished by the type of hazard the systems address. Systems addressing the following types of hazards were included: environmental, road geometry, highway rail intersection, road intersection, large animal collision, bicyclists, and pedestrian crossings. Results for each of these will be covered separately in this section. The states reporting the deployment of these systems will be shown along with specific details about the characteristics and technologies employed. Finally, the sharing of data from these systems with other statewide agencies will be covered.

Environmental Road Hazard Warning Systems

Environmental Road Hazard Warning Systems detect reduced visibility conditions or other environmental hazards and provide a warning to travelers. These systems employ sensors to detect conditions of low visibility due to fog, heavy rains, or snow white-out, or to detect icy or wet road conditions. Warnings are provided to travelers using changeable message signs or other means. Additional system capabilities sometimes include means to mitigate the hazard for travelers, such as the use of in-pavement lights to aid visibility. These systems are potentially an important source of data for travelers throughout the state, and frequently distribute information to traffic management centers, public safety agencies, or other traffic information systems.

Figure 3 highlights the states that have deployed or are planning to deploy Environmental Road Hazard Warning Systems. The figure includes a number on each highlighted state indicating the number of these systems that were reported by each state. A total of 21 states identified 72 separate Environmental Road Hazard Warning Systems.

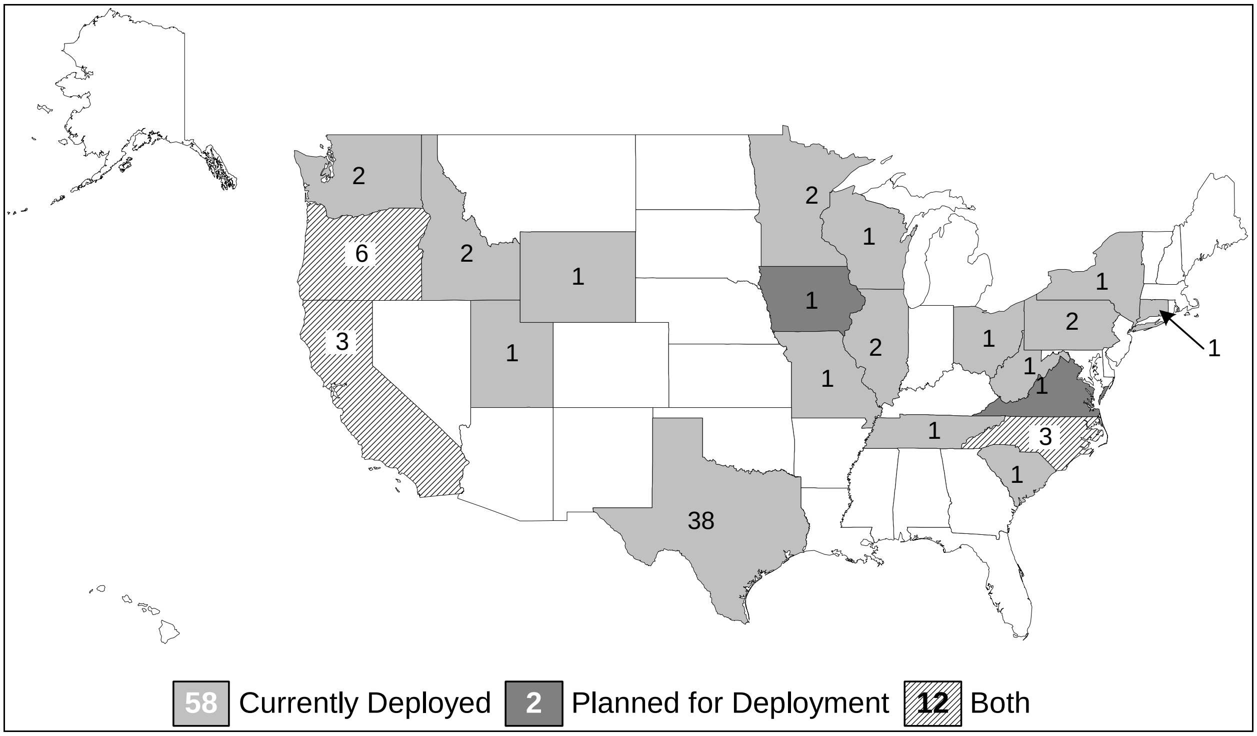

Figure 3. States Deploying Environmental Road Hazard Warning Systems

As Figure 4 illustrates, the majority of the Environmental Road Hazard Warning Systems (60 out of 69 which report the location, or 87%) has been or will be deployed on freeway or other limited access highways. The remaining systems (9 out of 69 which reported, or 13%) have been or will be deployed on two-lane highways.

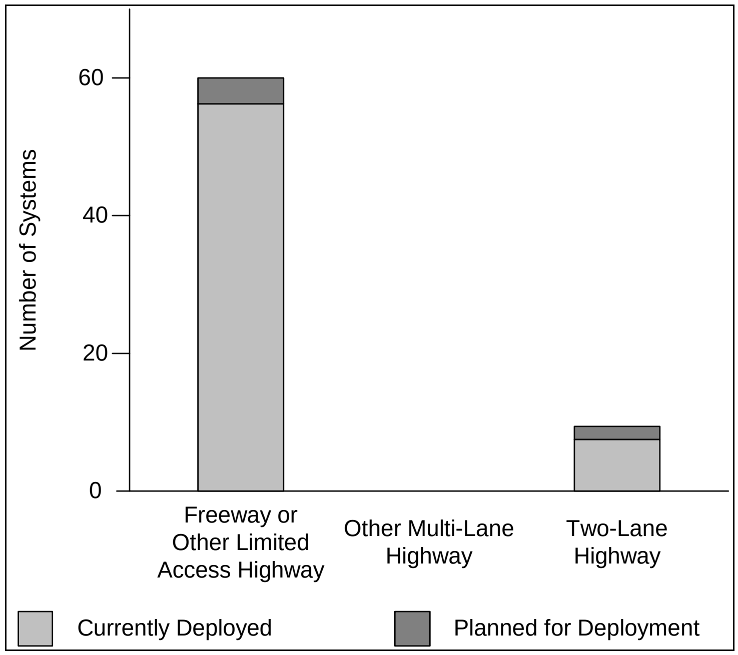

Figure 4. Road Classification of Environmental Road Hazard Warning System Locations

Environmental Road Hazard Warning systems are designed to detect a wide range of potential hazards. The variety of hazards detected and their prevalence in the deployed systems are listed in Figure 5. The types of hazards detected include: visibility restrictions resulting from precipitation, fog, snow, dust, or smoke; dangerous road surface conditions resulting from flooding, ice, and standing water; and, hazardous driving conditions caused by high winds. Precipitation, wind, and flooding are the most commonly reported hazards detected by these systems.

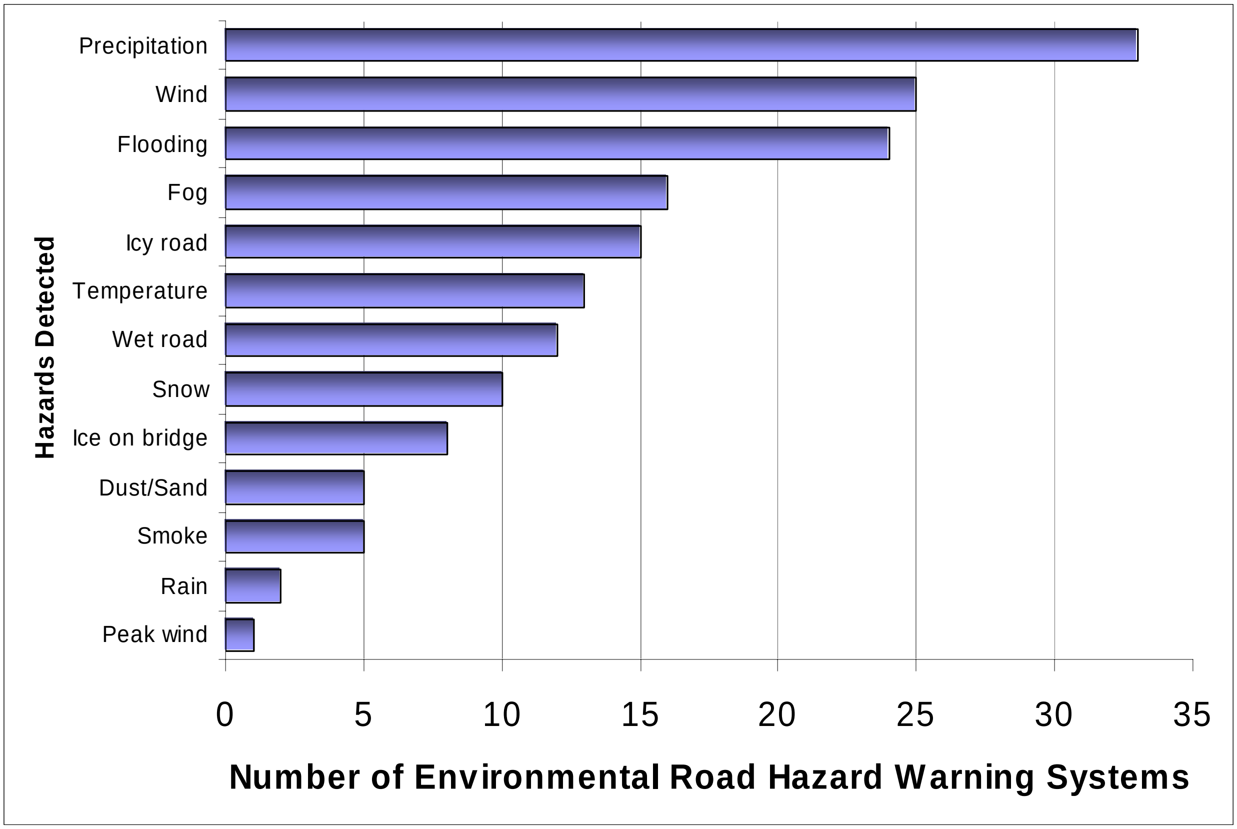

Figure 5. Environmental Road Hazard Warning System Hazards Detected

The technologies used to detect hazards are shown in Figure 6. These include a wide variety of sensors as well as weather stations and the National Weather Service. The use of road weather information systems is the most common detection method, followed by closed circuit television, wind speed detectors, pressure transducers, and in-pavement sensors.

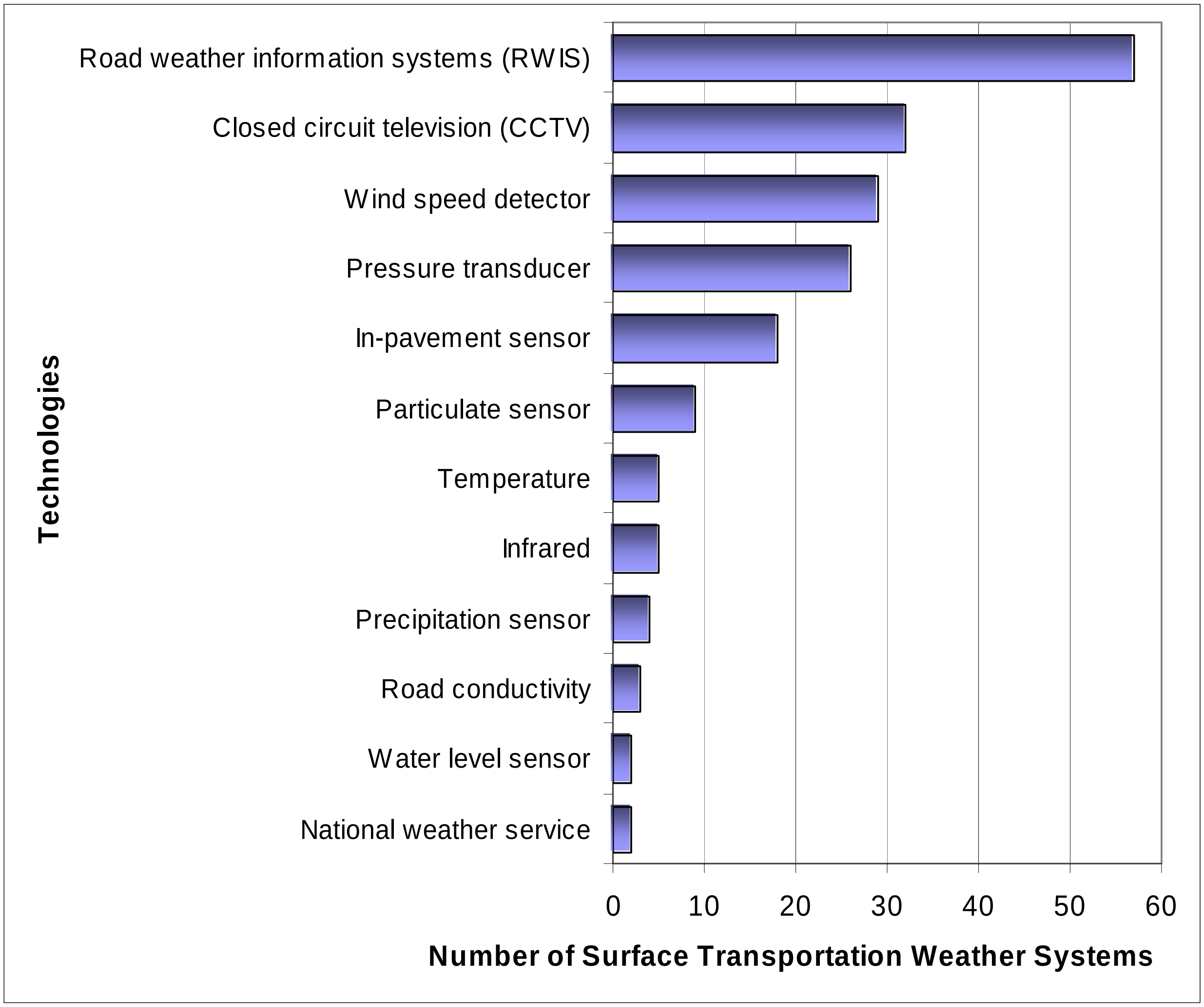

Figure 6. Environmental Road Hazard Warning System Detection Technologies

Table 1 shows that some of the environmental warning systems detect vehicle speed and classification. By incorporating vehicle characteristics, these systems have the capability of providing tailored warnings to specific vehicles of a certain classification or speed.

Table 1 Environmental Road Hazard Warning System: Vehicle Information Collected

Information	Number of Systems (69 total)
Vehicle speed	9
Vehicle classification	1

These systems incorporate a variety of communications technologies to provide warnings to travelers as shown in Figure 7. The most frequently used technology is dynamic message signs, with flashing lights and highway advisory radio also widely employed, but reported about half as often. Many of the systems utilize multiple technologies and there are 10 systems that utilize both dynamic message signs and flashing lights.

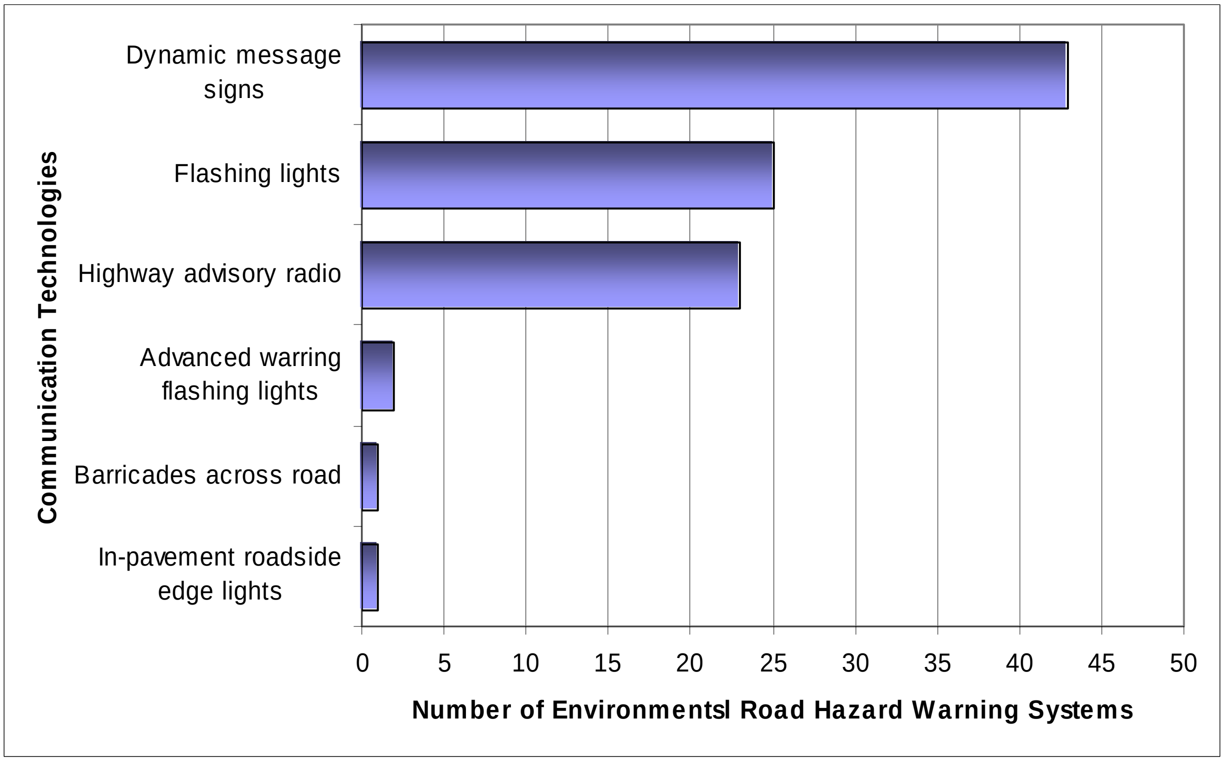

Figure 7. Environmental Road Hazard Warning System Communication Technologies

These systems appear to be well integrated within the state infrastructure. Of the 71 Environmental Road Hazard Warning Systems, a total of 62 have interfaces with another system or agency. Figure 8 shows the key systems or agency types that receive data and the number of Environmental Road Hazard Warning Systems sharing data with each. The type of agencies and systems included covers a wide range: traffic management agencies are integrated most often, followed closely by data archiving, traveler information, incident management, and public safety.

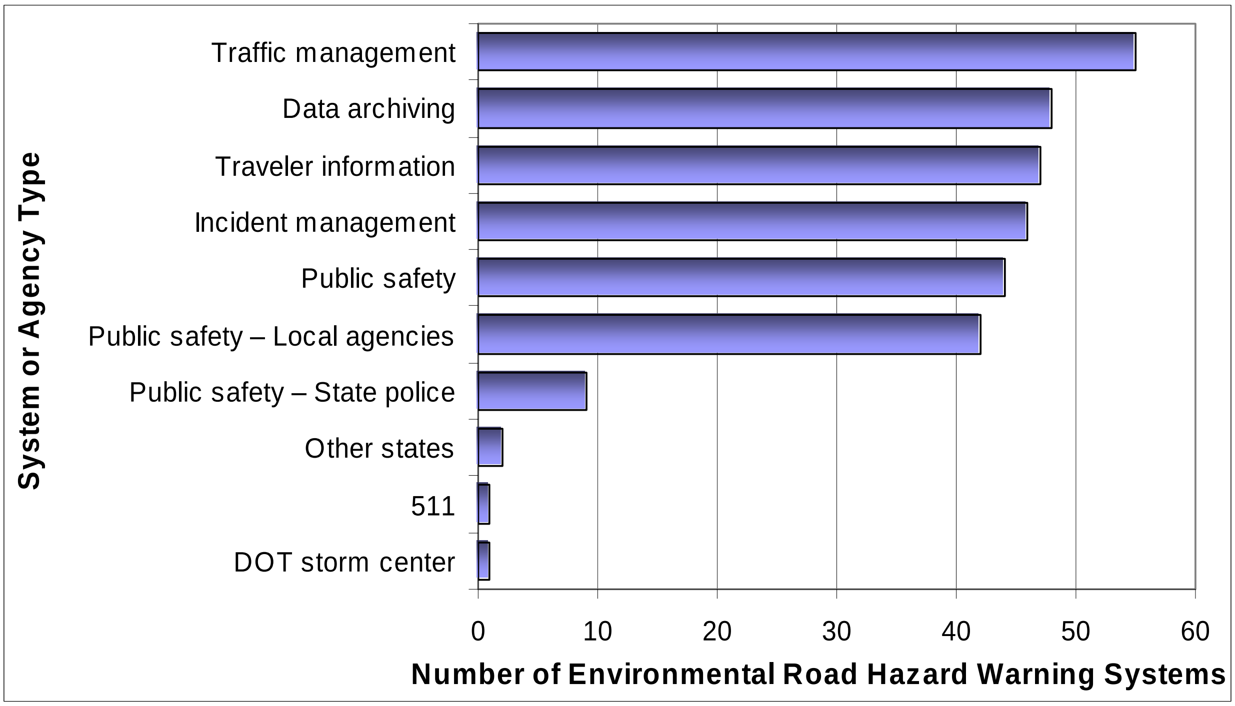

Figure 8. Agencies or Systems Interfacing with Environmental Road Hazard Warning Systems

Road Geometry Warning Systems

Roadway Geometry Warning Systems are deployed to provide warnings to travelers at potentially hazardous roadway geometry features such as sharp curves and steep grades. These systems are often technologically advanced and employ sensors to detect road conditions as well as vehicle weight, height, and speed. Based on these data, warnings can be directed to general traffic or specific vehicles through dynamic messages signs, flashers, variable speed limits, or other means.

Figure 9 highlights the states that have deployed or are planning to deploy Road Geometry Warning Systems. The number on shaded states indicates the number of systems reported. A total of 16 states identified 56 separate Road Geometry Warning Systems.

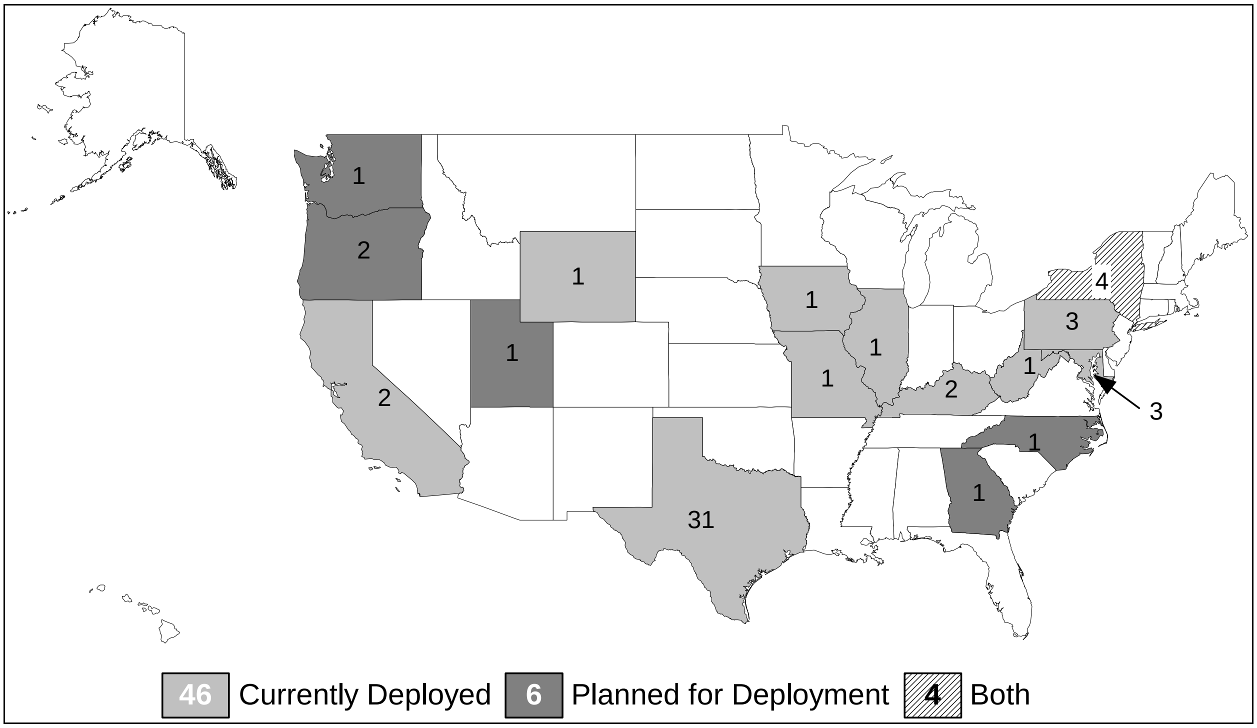

Figure 9. States Deploying Road Geometry Warning Systems

Figure 10 shows that nearly 95% (53 of 56) of all the Road Geometry Warning Systems have been or will be deployed on freeway or other limited access highways. There is one system deployed on other multi-lane highways and one on two-lane highways. The one system where the road classification was not specified is located in a ramp merge area.

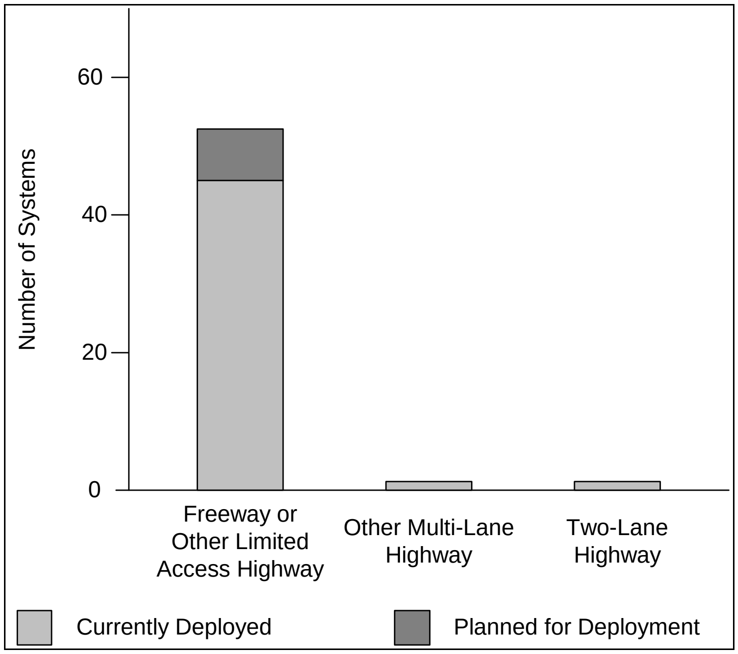

Figure 10. Road Classification of Road Geometry Warning System Locations

Figure 11 shows that the vast majority of these systems are deployed to prevent truck roll over crashes, with 39 of them deployed on curves and five on steep downhill grades. A smaller number of systems, about one third of the number of the truck-only systems, are targeted at all vehicles generally.

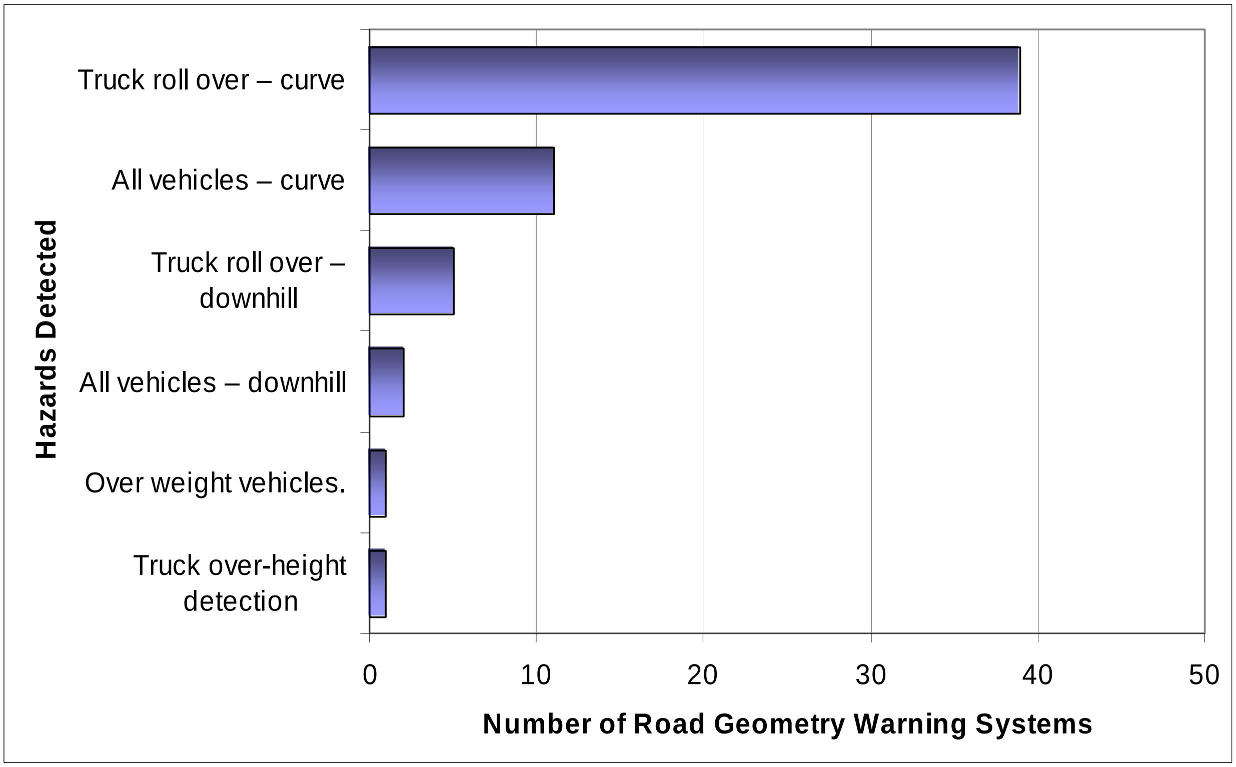

Figure 11. Road Geometry Warning System Hazards Detected

These systems include sensors to detect a variety of information about vehicles approaching the hazard area, as shown in Table 2. Vehicle speed and classification detection are the most frequently reported, while some sophisticated systems also detect vehicle height and weight. These systems have the capability of assessing the danger to individual vehicles based on conditions and characteristics of the vehicle and of providing warnings targeted to specific vehicles.

Table 2 Road Geometry Warning System Information Collected

Information	Number of Systems (56 total)
Vehicle speed	49
Vehicle classification	41
Vehicle height	10
Vehicle weight (weigh-in-motion)	7

Table 3 shows the technologies used to communicate the presence of the hazard to vehicles. By far, the most common method reported is the use of flashing lights to alert drivers to the hazard. This is followed by the use of dynamic message signs by about one third as many systems as employ flashing lights. Highway advisory radio is also employed by two systems.

Table 3 Road Geometry Warning System Communication Technologies

Technology	Number of Systems (56 total)
Flashing lights	45
Dynamic message signs	17
Highway advisory radio	2
Flashers that enhance visibility of existing signs	1

Table 4 shows that the majority (44 of 56) of these systems provides tailored information to a specific vehicle, while about one-fourth as many provides a generic warning. These data show that the Road Geometry Warning Systems employ a high level of technological sophistication.

Table 4 Types of Warnings Provided by Road Geometry Waning Systems

Types of Warnings	Number of Systems (56 total)
Tailored information to specific vehicles	44
Generic warning to all vehicles	10

Table 5 shows that Road Geometry Warning Systems are well integrated with traffic management agencies, however there is little integration reported with other agency types. The only other integration reported is limited interfacing with data archiving systems and public safety systems.

Table 5 Systems with Which Road Geometry Warning System Interface

System or Agency Type	Number of Systems (56 total)
Traffic management	31
Data archiving	3
Public safety	1
Public safety – state police	1

Rail-Highway Crossing Safety Systems

The at-grade intersection of highways and railroads presents two distinct types of transportation problems for rural areas. The first of these problems is safety related to the potential for vehicle-train collisions at these intersections. The second type is the operational problem presented by long trains passing through rural towns that block traffic at the intersection. A variety of technologies have been deployed and tested to detect approaching trains and provide real-time information that could address both types of problems. However, most of these are test deployments. For example, pilot studies have equipped school buses with receivers and display devices capable of announcing the presence of a train by picking up a signal sent out at the intersection. Similar reception devices are considered solutions for emergency vehicles and dispatch centers so they may be alerted to the approaching trains and make provisions for finding crossing points at bridges or underpasses in order to avoid the at-grade crossings.

Figure 12 highlights the 10 states that reported having deployed or planning to deploy Rail-Highway Crossing Safety Systems in non-metropolitan areas. The number on shaded states indicates the number of systems reported.

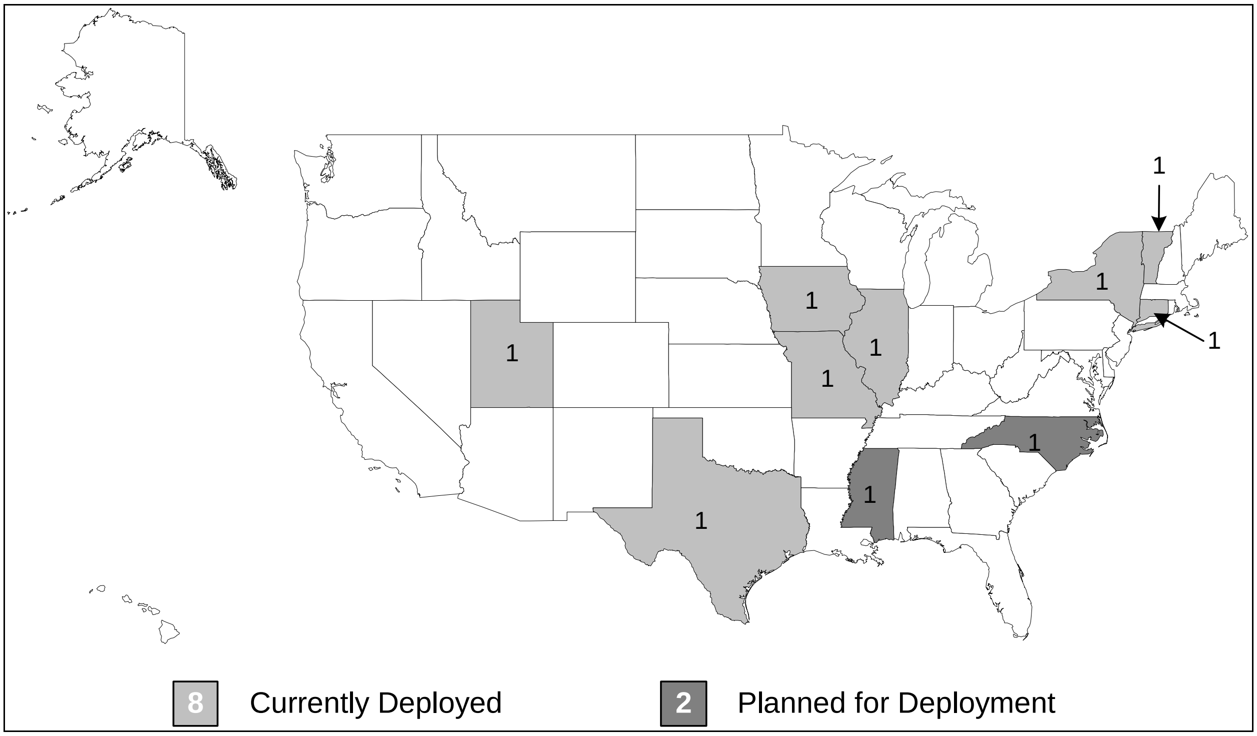

Figure 12. States Deploying Rail-Highway Crossing Safety Systems

Rail-Highway Crossing Safety Systems have been deployed on all three road classifications, as shown in Figure 13. The systems located on freeways or other limited access highways are on entrance or exit ramps.

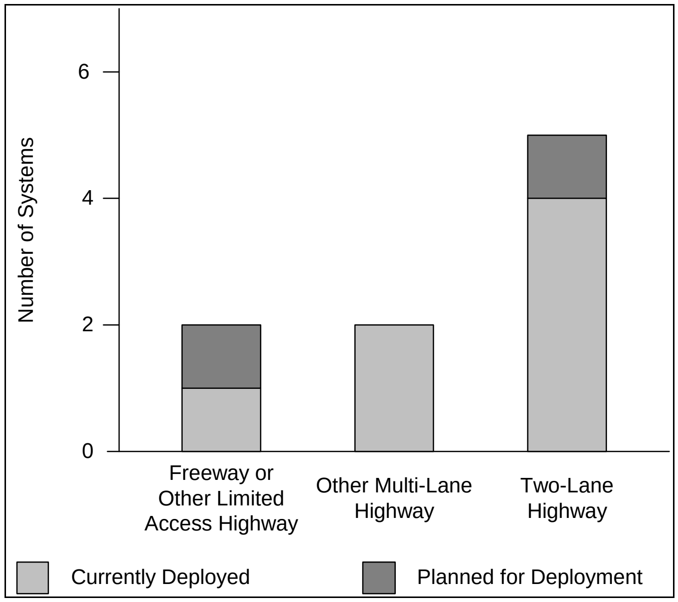

Figure 13. Road Classification of Rail-Highway Crossing Safety System Locations

Table 6 provides a list of the information collected by these systems. Of nine systems for which data were provided, seven of the systems collect information on train presence, three also detect train speed, and three systems will detect the approach of a second train. A small number of systems are particularly sophisticated and employ technology to detect train length and vehicle intrusion, and one supports automatic train stoppage.

Table 6 Rail-Highway Crossing Safety System Information Collected

Information	Number of Systems (10 total)
Train presence	7
Train speed	3
Second train approaching	3
Detection of vehicle intrusion	1
Automatic train control, automatic train stoppage	1
Train Length and approximate time of arrival	1

Table 7 shows that flashing lights are the most commonly used method of warning drivers. Dynamic message signs and warning horns are also employed.

Table 7 Rail-Highway Crossing Safety System Communication Technologies

Technology	Number of Systems (10 total)
Flashing lights	6
Dynamic message signs	3
Horn at the crossing	2
Highway advisory radio	1
Dynamic message sign with adjacent strobe beacon	1

Table 8 shows that these systems are not yet widely integrated within the statewide infrastructure.

Table 8 Systems with Which Rail-Highway Crossing Safety Systems Interface

System or Agency Type	Number of Systems (10 total)
Public safety	4
Traffic management	1
Incident management	1

Intersection Crossing Detection Systems

These systems are aimed at improving the safety of drivers entering intersections, often for vehicles approaching the intersection of a major road from a minor road. In these cases, an Intersection Crossing Detection System is intended to reduce crossing-path crashes at intersections controlled by stop signs on the minor road. Typically a dynamic message sign associated with the stop sign informs the driver of the presence of vehicles on the major road, and the information may include whether these vehicles are approaching from the right or left.

Figure 14 highlights the states that have deployed or are planning to deploy Intersection Crossing Detection Systems. The number on shaded states indicates the number of systems reported. A total of six states have or plan to have an Intersection Crossing Detection System.

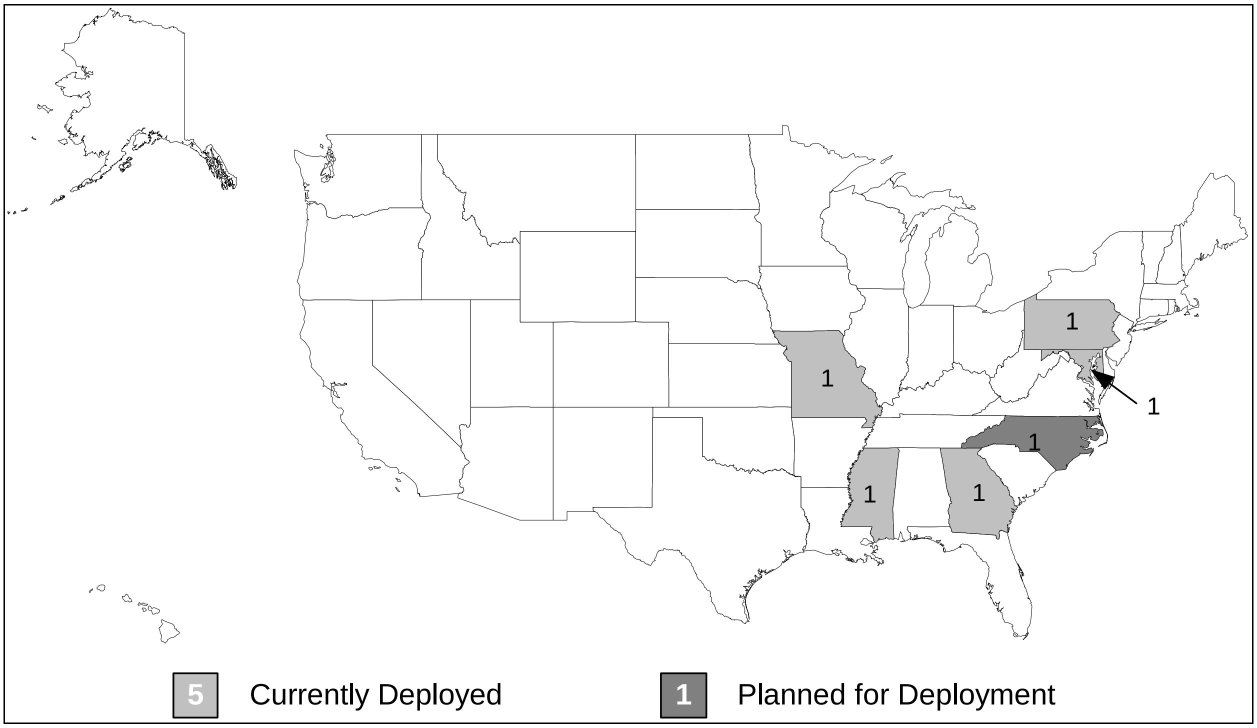

Figure 14. States Deploying Intersection Crossing Detection Systems

Intersection Crossing Detection Systems have been deployed on all three road classifications. Figure 15 shows that the systems tend to be deployed on smaller roads.

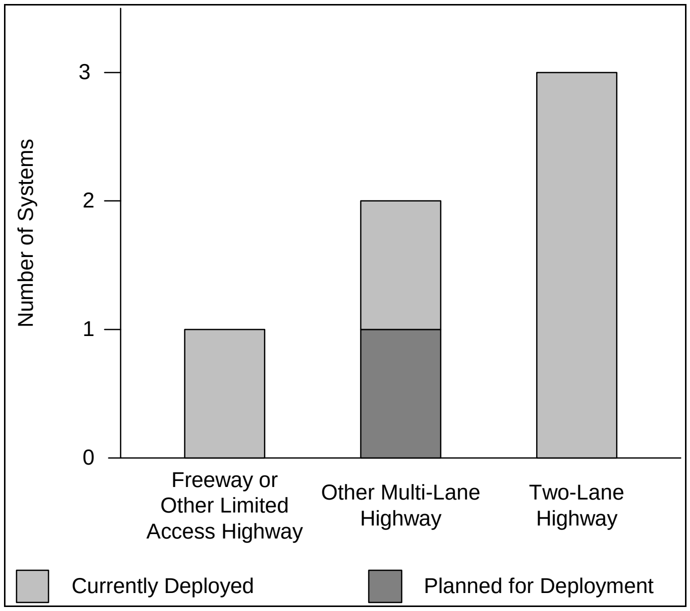

Figure 15. Road Classification of Intersection Crossing Detection System Locations

Table 9 and 10 list the locations of vehicle detectors and the technology used to communicate the presence of vehicles in the intersection respectively. Only a third (2 of 6) of these systems has interfaces to other systems or agencies as shown in Table 11.

Table 9 Intersection Crossing Detection System Vehicle Detector Locations

Location	Number of Systems (6 total)
Sensor on all legs of an intersection	2
Sensors on the major road only	2
Sensors on the minor road only	2

Table 10 Intersection Crossing Detection System Communication Technologies

Technology	Number of Systems (6 total)
Flashing lights	3
Automated warning signs	3

Table 11 Systems that Intersection Crossing Detection System Interfaces with

System or Agency Type	Number of Systems (6 total)
Traffic management	1
Public safety	1

Animal Warning Systems

These systems are intended to prevent animal-vehicle collisions in areas where animals frequently cross. These systems are located at migration routes and where there is a history of large animal-vehicle collisions. Traditional methods for addressing this hazard include improving visibility and limiting animal presence. Technology applied to this problem detects the presence of animals and provides a warning to on-coming drivers, or detects vehicles and provides a warning to the animals.

Figure 16 highlights the states that have deployed or are planning to deploy Animal Warning Systems. The number on shaded states indicates the number of systems reported. A total of three states reported four separate Animal Warning Systems.

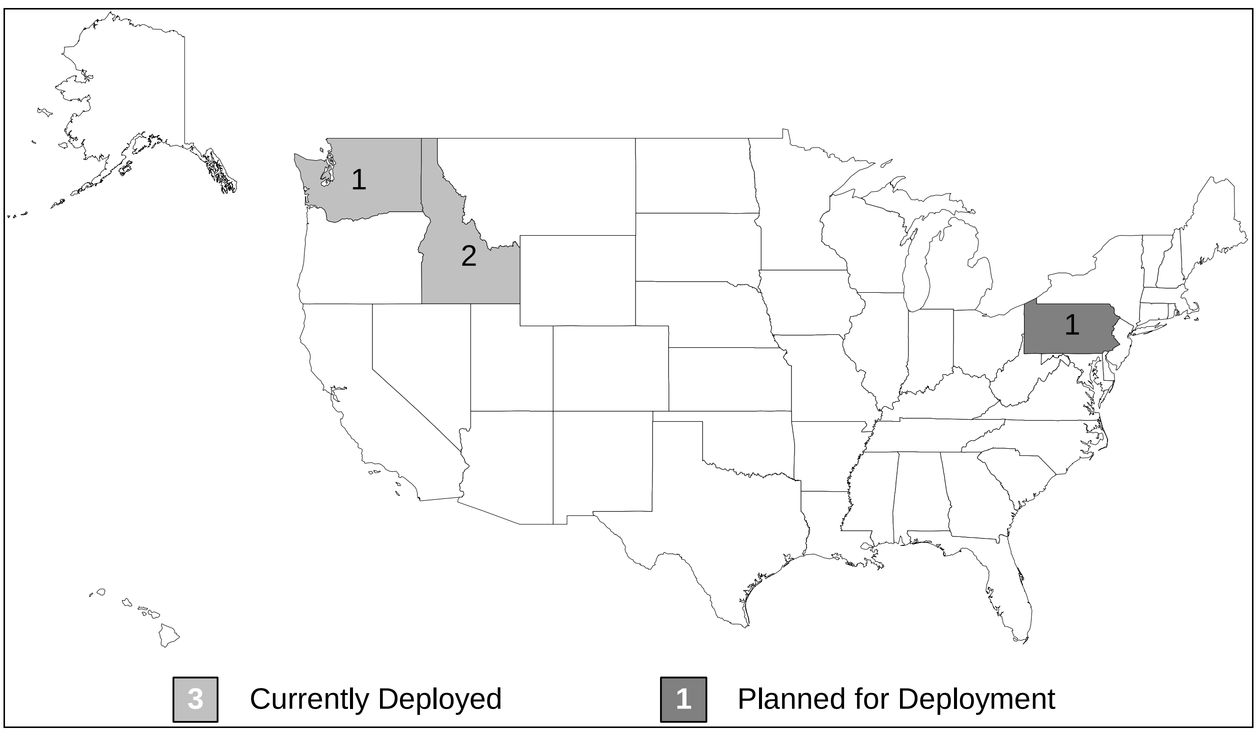

Figure 16. States Deploying Animal Warning Systems

Figure 17 shows that Animal Warning Systems have been or will be deployed on all three road classifications, with half the deployments occurring on two-lane highways.

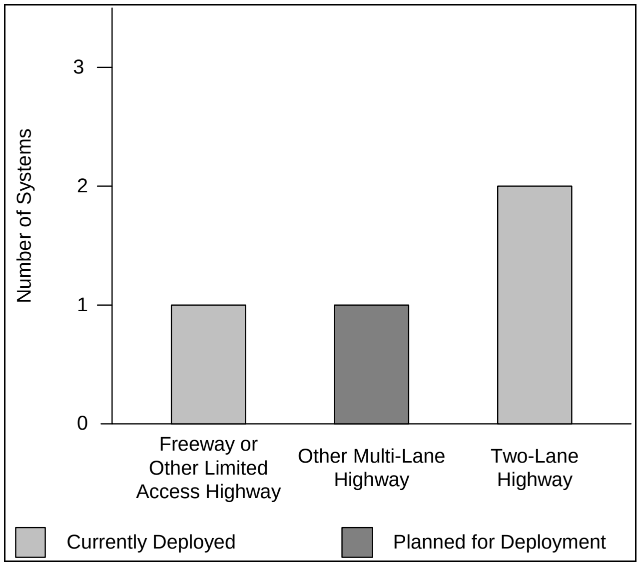

Figure 17. Road Classification of Animal Warning System Locations

The technologies used by the Animal Warning Systems to detect animal presence and alert drivers are listed in Table 12 and Table 13. These Animal Warning Systems do not interface with other systems or agencies.

Table 12 Animal Warning System Detection Techologies

Technology	Number of Systems (4 total)
Radio transmitter collars for animals	2
Radar and motion detection	1
Laser detectors	1

Table 13 Animal Warning System Communication Technologies

Technology	Number of Systems (4 total)
Flashing lights	3
Static signs	1

Bicycle Warning Systems

These systems aid visibility and awareness in those situations where it is difficult to see a bicyclist on the side of the road, especially in tunnels and hilly roadways. These systems function by drawing the attention of the drivers to the presence of bicyclists on the highways. Electronic sensors may be deployed to detect the presence of bicyclists or the system may be manually operated, for example, where the bicyclist activates a warning sign prior to entering a tunnel.

Figure 18 highlights the states that have deployed or are planning to deploy Bicycle Warning Systems. The number on shaded states indicates the number of systems reported. There are a total of three states that have identified three separate Bicycle Warning Systems.

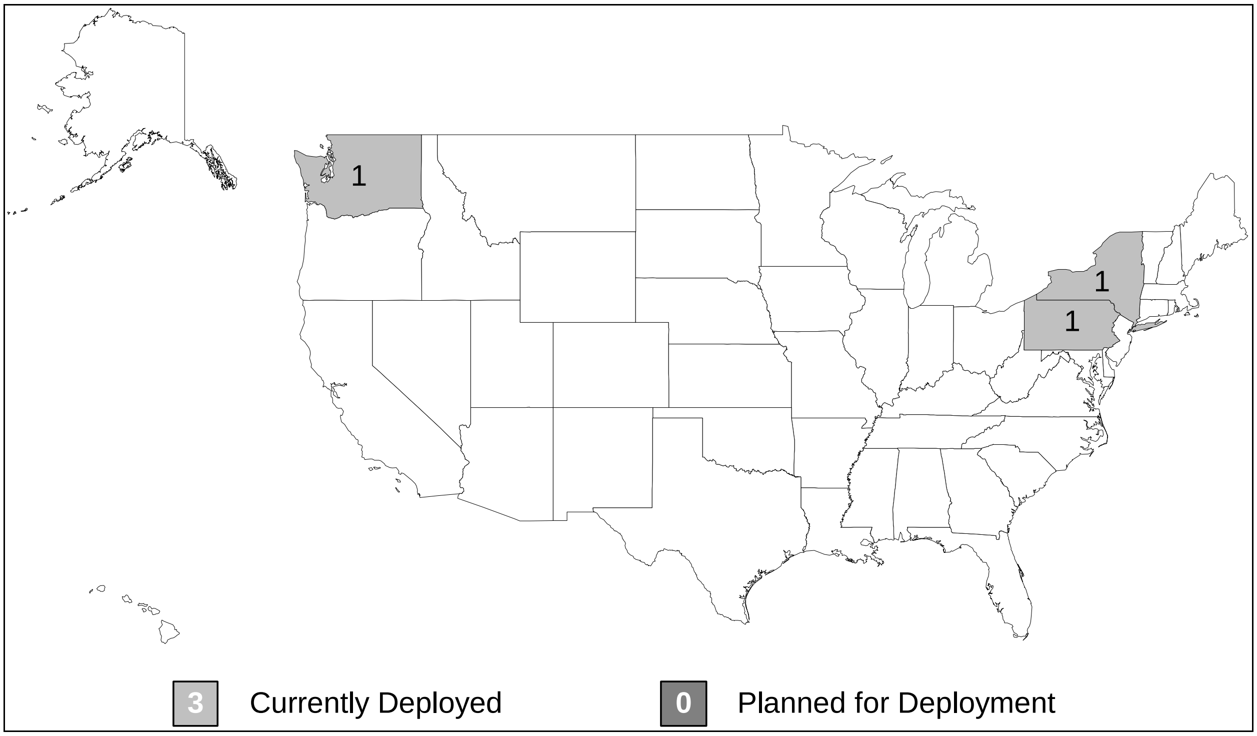

Figure 18. States Deploying Bicycle Warning Systems

All three Bicycle Warning Systems have only been deployed on two-lane highways. The locations of Bicycle Warning Systems are listed in Table 14. The technologies used by the Bicycle Warning Systems to detect bicyclist presence and alert drivers are listed in Table 15 and Table 16. .

Table 14 Bicycle Warning System Locations

Location	Number of Systems (3 total)
Tunnel	1
Signalized intersection	1

Table 15 Bicycle Warning System Detection Techologies

Technology	Number of Systems (3 total)
Manual	1
Type S loop and/or quadrupole bike loop detectors	1

Table 16 Bicycle Warning System Communication Technologies

Technology	Number of Systems (3 total)
Flashing lights	1
Static signs	1
Loop activates traffic signal to accommodate bicycles	1

Pedestrian Safety Systems

These systems are intended to improve safety for pedestrians at crosswalks by providing warnings to drivers about the presence of pedestrians. These are deployed where visual obstructions, such as high medians, parked cars, or traffic impede the driver's view. Pedestrians activate these systems, or sensors may detect the presence of pedestrians. Warning can be provided in the form of illuminated crosswalk signs. Additionally, in-pavement lights may be used at crosswalks to alert motorists to the presence of a pedestrian crossing or preparing to cross the street.

Figure 19 highlights the states that have deployed or are planning to deploy Pedestrian Safety Systems. The number on shaded states indicates the number of systems reported. A total of nine states identified 13 separate Pedestrian Safety Systems.

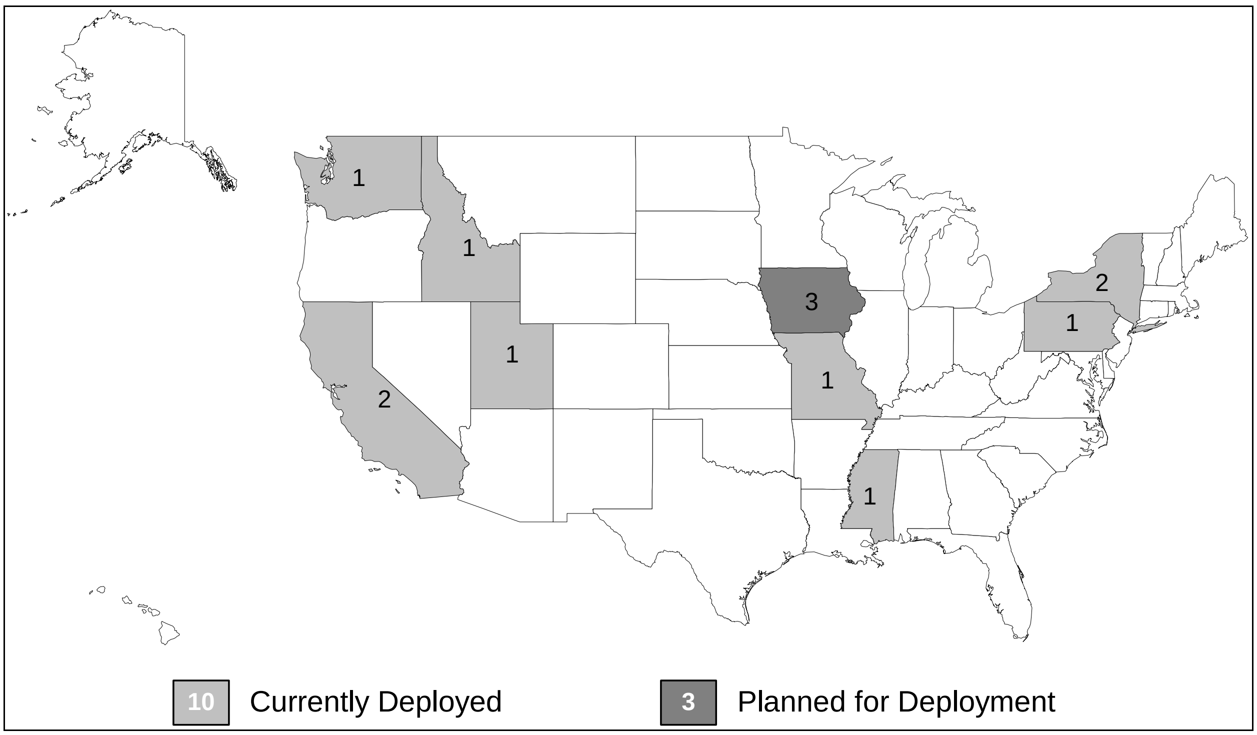

Figure 19. States Deploying Pedestrian Safety Systems

As shown in Figure 20, Pedestrian Safety Systems are deployed on two-lane highways and other multi-lane highways.

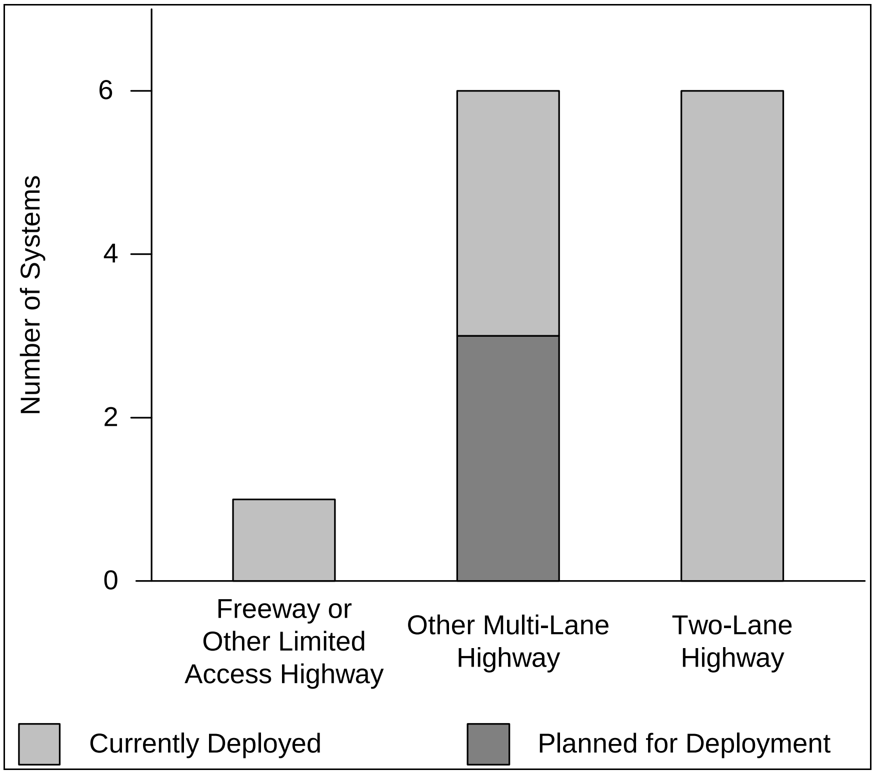

Figure 20. Road Classification of Pedestrian Safety System Locations

Table 17 lists the technologies used to detect pedestrian presence. While the majority of these systems are manual, several systems employ sensors to detect the presence of pedestrians. Table 18 shows the technologies used to warn drivers of pedestrian presence, with the use of in-pavement lights and flashing lights being most often used. Table 19 shows that these systems are mainly integrated with public safety and are not yet widely integrated with systems or agencies outside public safety.

Table 17 Pedestrian Safety System Detection Technologies

Technology	Number of Systems (13 total)
Manually operated pedestrian detector	8
Infrared pedestrian detector	3
Microwave pedestrian detector	2
A tightly collimated beam of modulated light	1

Table 18 Pedestrian Safety System Communication Technologies

Technology	Number of Systems (13 total)
In-pavement lights illuminate crosswalk	7
Flashing lights	6
Countdown, leading pedestrian interval, audible, etc.	2
Illuminated crosswalk signs	1

Table 19 Systems with Which Pedestrian Safety Systems Interface

System or Agency Type	Number of Systems (13 total)
Public safety	3
Public safety – local agencies	2
Public safety – state police	1
Traffic management	1
Traveler information/Information service providers	1

Traveler Information Systems

Traveler Information Systems included in this report have a statewide or at least regional scope. The survey data collected includes the type of data disseminated by these systems as well as the types of technologies employed to disseminate the data, including the use of 511 telephone access.

These systems have been widely deployed. Figure 21 highlights the states that have deployed or are planning to deploy statewide or regional Traveler Information Systems. The number on shaded states indicates the number of systems reported. A total of 39 states identified 65 separate statewide or regional Traveler Information Systems.

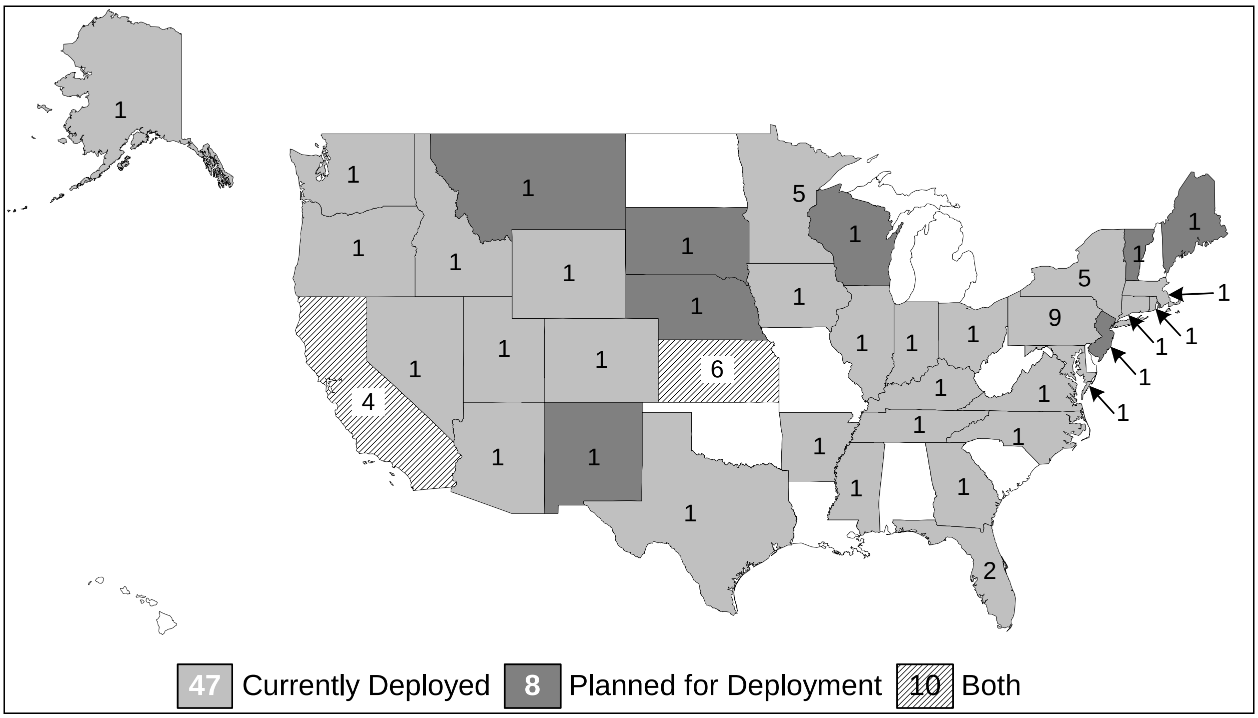

Figure 21. States Deploying Traveler Information Systems

Figure 22 shows the types of information disseminated by the Traveler Information Systems. The data provided by these systems fall into three categories: roadway, tourism, and public transit. Information related to roadway is by far the most common type disseminated, with road closures and work zones most widely included, closely followed by information on incidents, road surface, weather, detours, and road restrictions. Additional real time roadway information provided by of Traveler Information Systems includes congestion, alternate routes, and CCTV images. Information on tourism (maps and directions) and transit (schedules) is also available through these systems, but is less frequently reported.

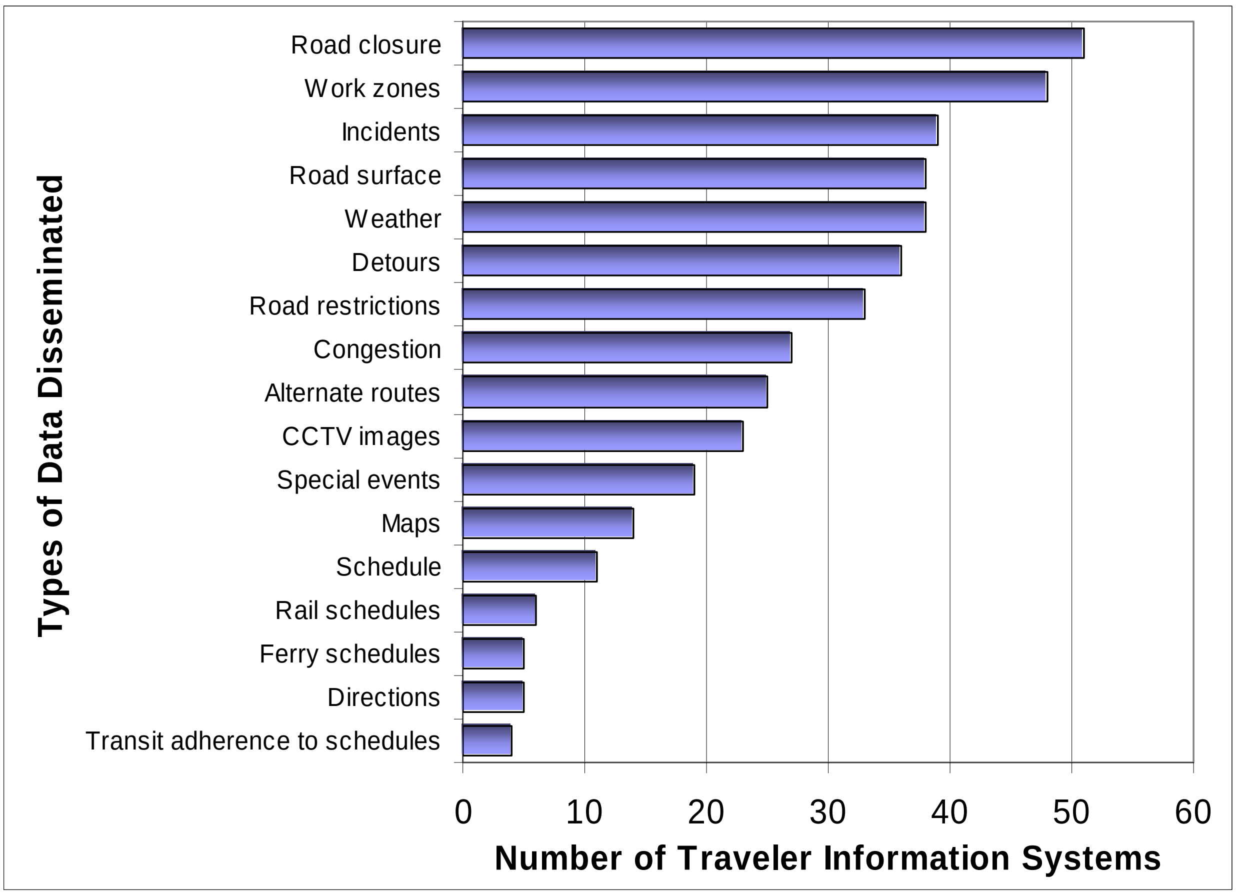

Figure 22. Information disseminated by the Traveler Information System

Traveler Information Systems are designed to meet user needs and a critical factor in designing these systems is deciding who the customers are. Figure 23 shows the intended audience for the Traveler Information Systems reported in the surveys. This figure shows that the most commonly cited intended audience for the information is the general public, followed by rush hour commuters, and commercial vehicle operations. Public safety agencies, both law enforcement and emergency response, are also considered important customers, but to a lesser extent than the first three.

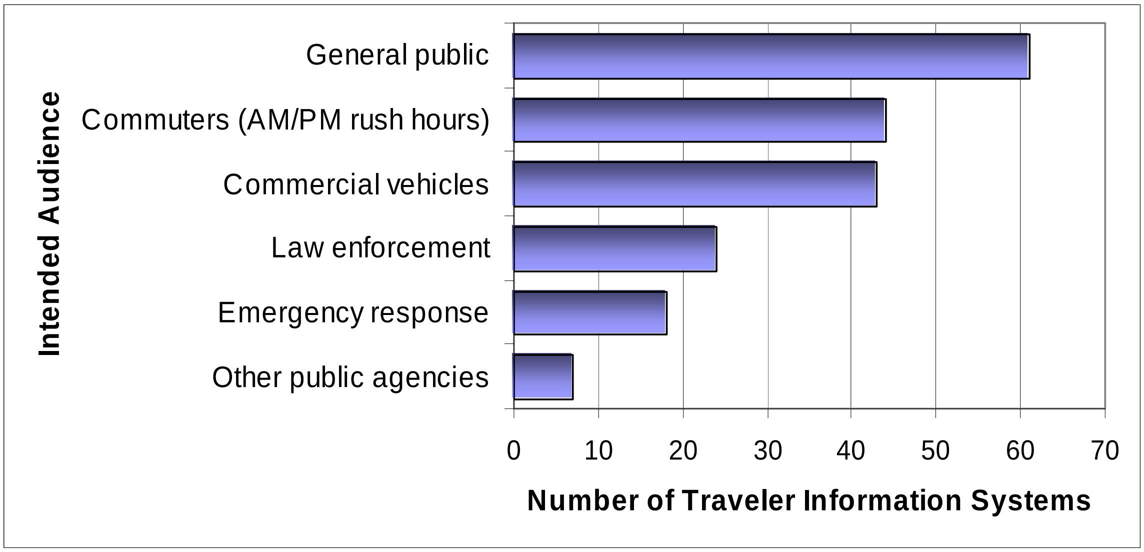

Figure 23. Intended Audience for Traveler Information Systems

Traveler Information Systems disseminate information using a variety of media. Figure 24 shows the different types of media reported in use. Most frequently used, not surprisingly, is the Internet. Statewide conditions reporting systems (also internet based), highway advisory radio, and dynamic message signs are next in frequency of use. The use of 511 telephone service is an important medium as well, and was reported about one third as frequently as the Internet. Other important media for disseminating traveler information are: non-511 automated telephone, email, fax, television, and kiosks.

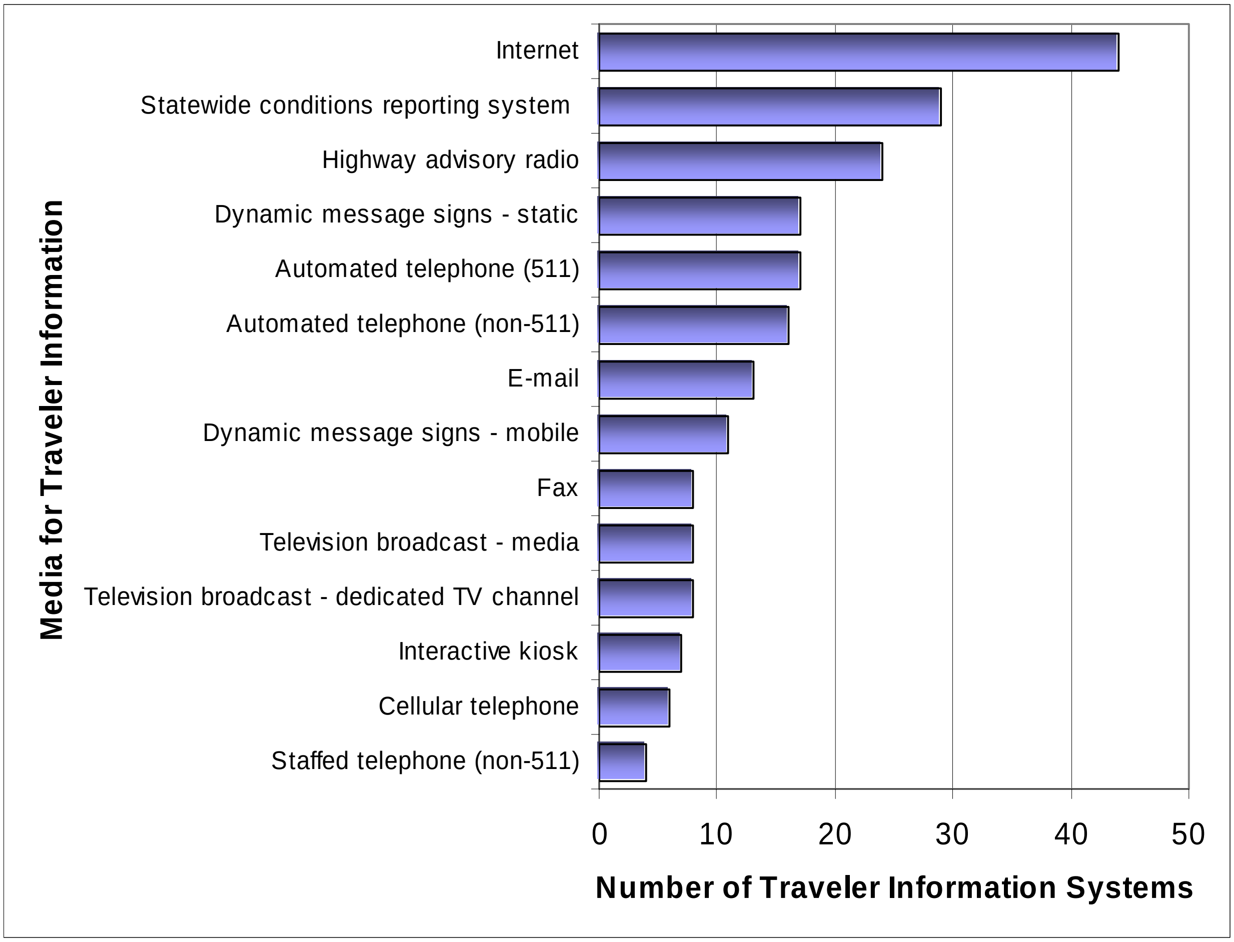

Figure 24. Technologies Used to Disseminate Traveler Information

Statewide Traveler Information Systems receive data from a wide variety of sources, as shown in Figure 25. The most often mentioned sources are operations and maintenance, traffic management, and construction areas, with public safety, work zones, and the state police also mentioned frequently. Many additional sources are reported as well, and these systems appear to offer users a widely varied set of choices for traveler information.

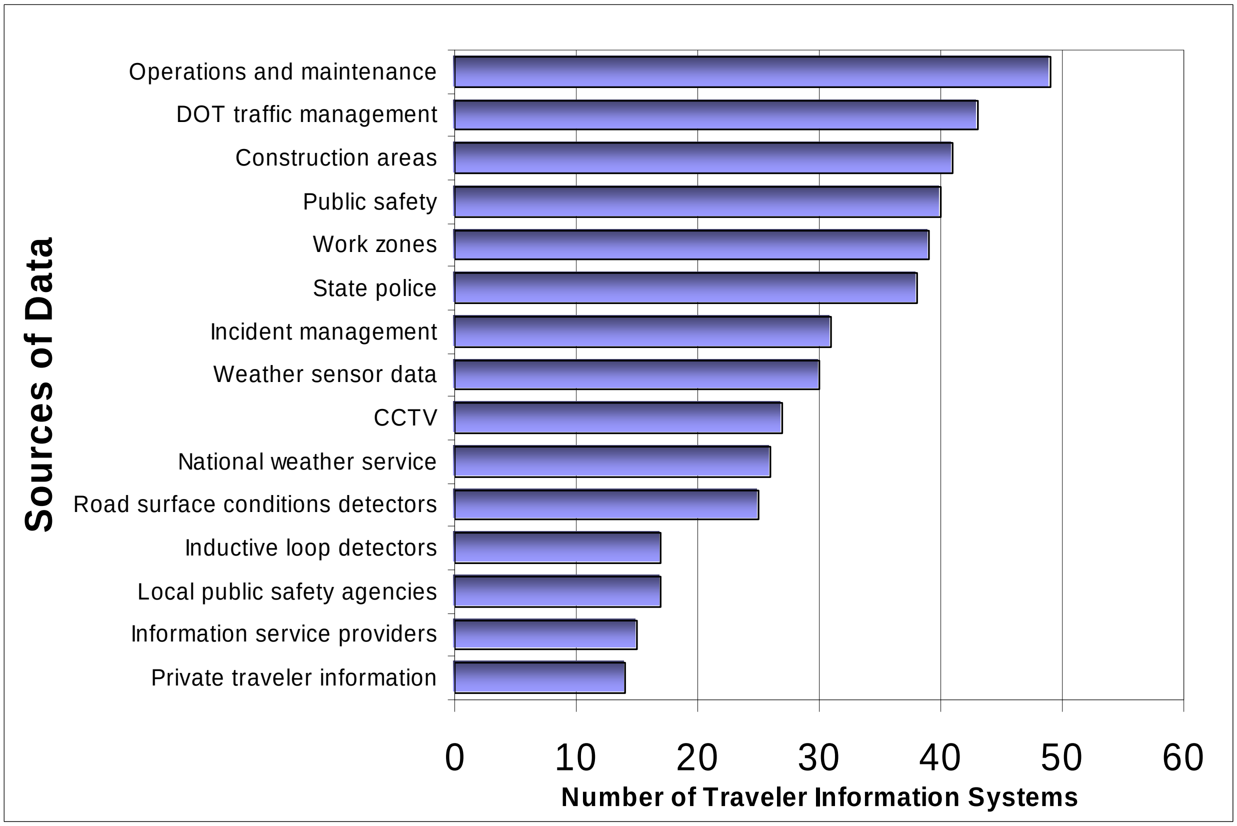

Figure 25. Data Sources for Traveler Information Systems

Traffic Management

Traffic Management in non-urban areas employs many of the same technologies for surveillance, information dissemination, and traffic control as in metropolitan areas, but technology is generally deployed at spot locations rather than continuous miles of instrumentation. This report covers some of the key technologies for surveillance and information dissemination and covers how they are employed. In addition, the deployment of Road Closure Systems and Route Diversion Systems is covered. Finally, data collected concerning Traffic Management Centers are reported.

Closed Circuit Television Systems

Closed Circuit Television Systems are used to monitor facilities and support numerous activities such as incident detection and verification, weather and roadway conditions monitoring, dynamic message sign message verification, and event management. CCTV images can be sent back through wireless communication to an information clearinghouse, via cellular digital packet data (CDPD), and cellular telephone signals.

Figure 26 highlights the 31 states that have deployed Closed Circuit Television Systems in non-urban areas.

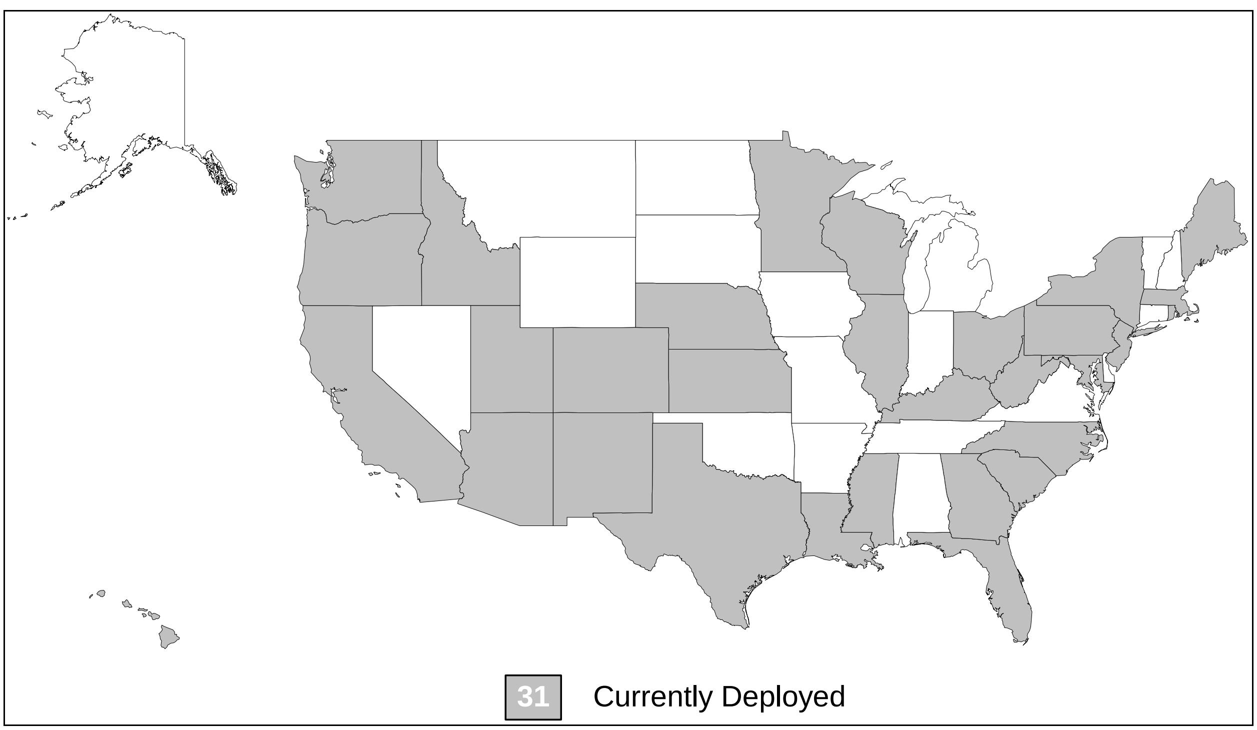

Figure 26. States Deploying Closed Circuit Television Systems

Figure 27 shows that the majority of these cameras are deployed on freeways.

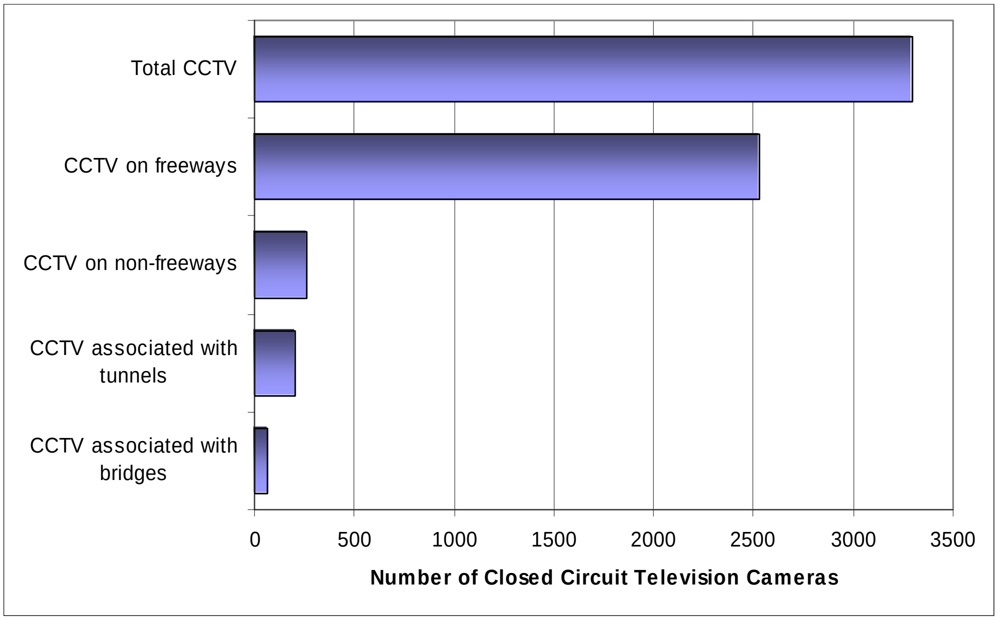

Figure 27. Facilities Supported by Deployment of CCTV

Figure 28 shows the major functions supported by statewide CCTV systems. The most important of these is to detect and verify incidents. Other important functions are to monitor road conditions, manage events, monitor weather, and verify dynamic message signs. Security is mentioned as a consideration for a small number of CCTV deployments.

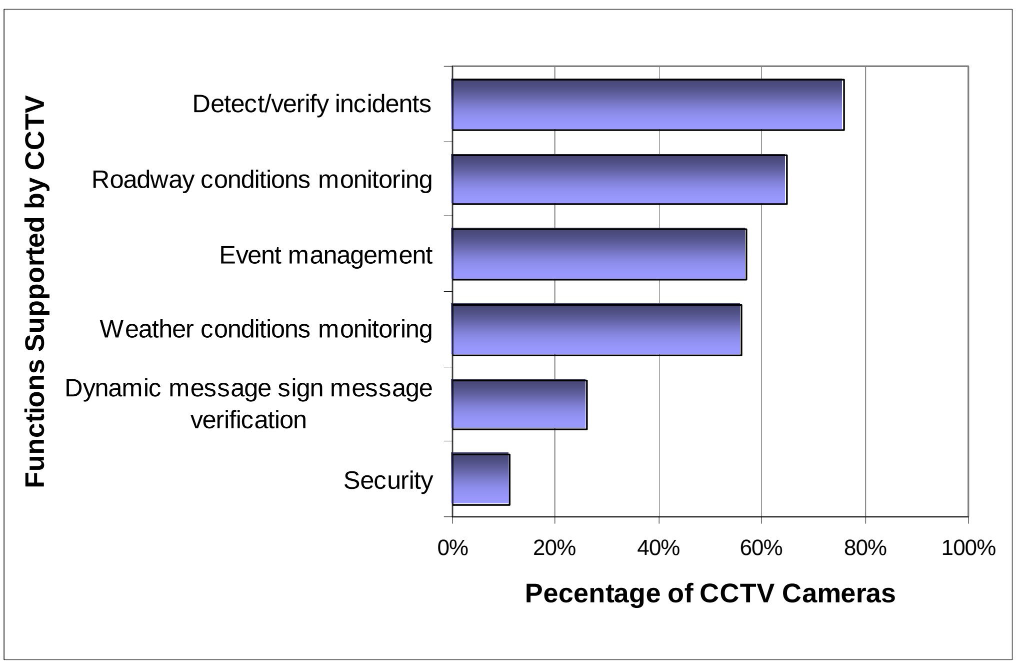

Figure 28. Functions Supported by Statewide CCTV

Figure 29 shows where the CCTV cameras are located. The two most common locations are major interchanges and high accident areas. Other important locations for CCTV are placements to monitor equipment, ports of entry, and rest areas.

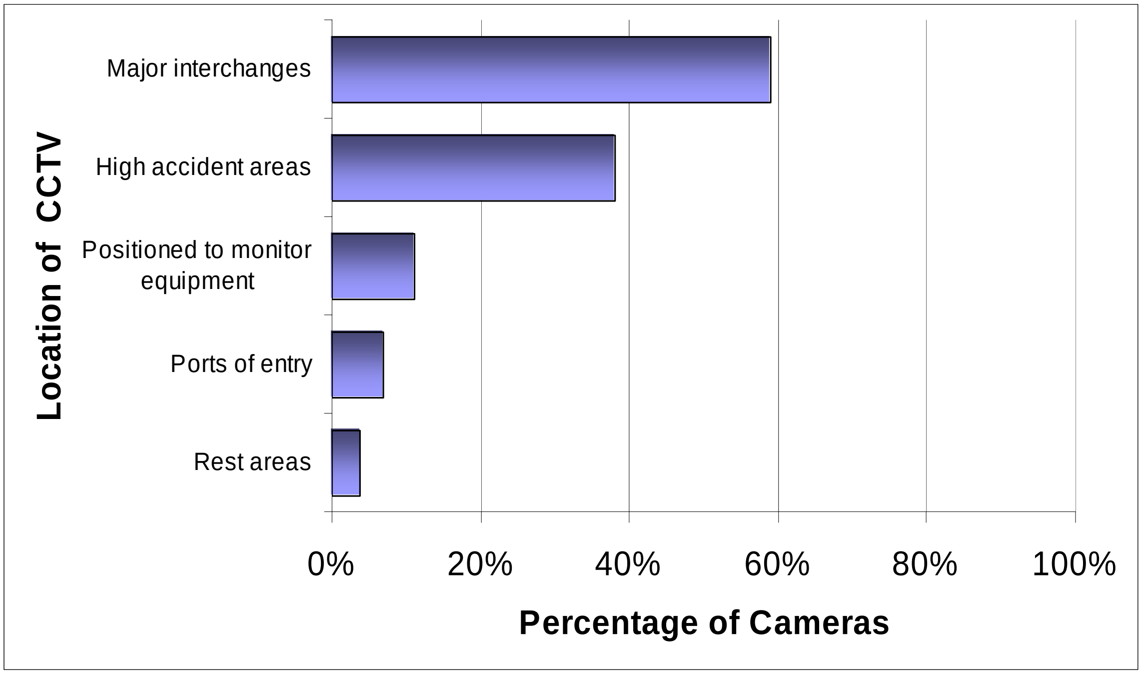

Figure 29. Location of CCTV Cameras

Dynamic Message Signs

Dynamic Message Signs provide text messages that can be varied via a large lighted display. The text the signs display can be programmed from a remote location using a wireless transmitter or phone line and modem. DMS can have either a permanent or portable installation. DMS are useful in disseminating traveler information en-route in case of an unusual event on the road ahead or for a variety of other purposes.

Figure 30 highlights the states that report having deployed DMS in non-urban areas. Figure 31 shows that most of the Dynamic Message Signs are permanent and are located on freeways.

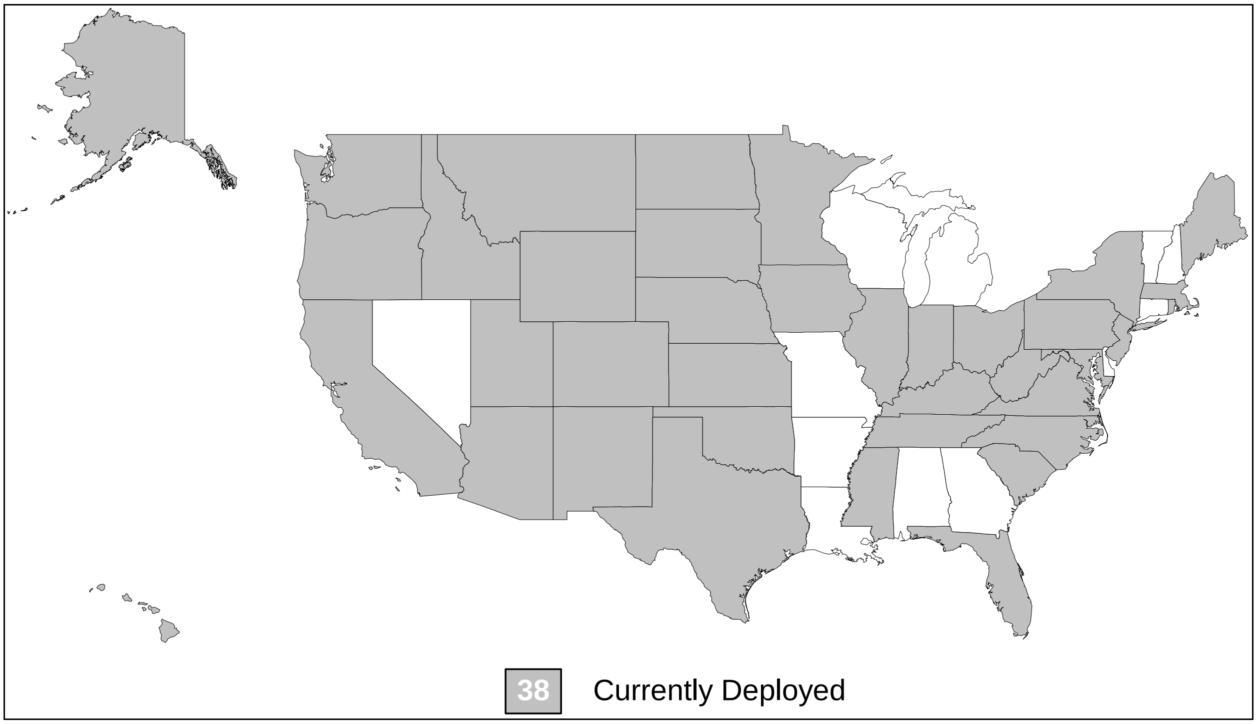

Figure 30. States Deploying Dynamic Message Sign Systems

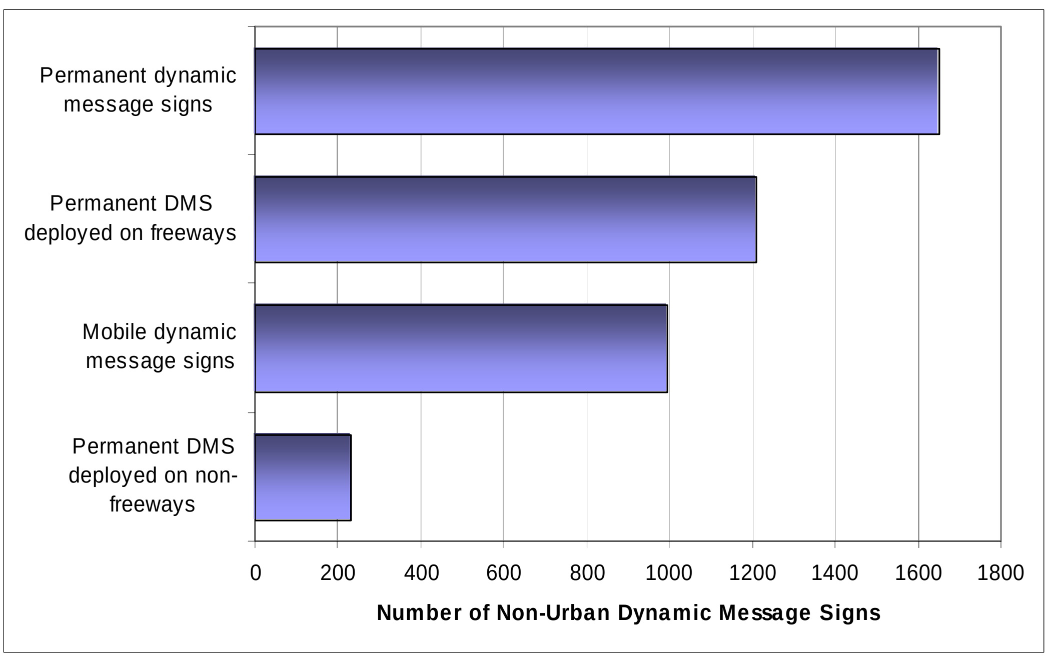

Figure 31. Types of Dynamic Message Signs

Statewide deployments of DMS support a variety of functions by providing different types of information. Figure 32 shows the information that is displayed by these signs. The most common type of information is related to the roadway and includes work zone information, followed closely by roadway status, accident sites, diversions, and congestion. Speed warnings are also provided, but only by about one fourth as many signs as the other roadway information. Other types of information frequently disseminated by DMS are weather alerts and special events. These signs are also used to disseminate information on parking availability and transit operations, but to a much smaller extent.

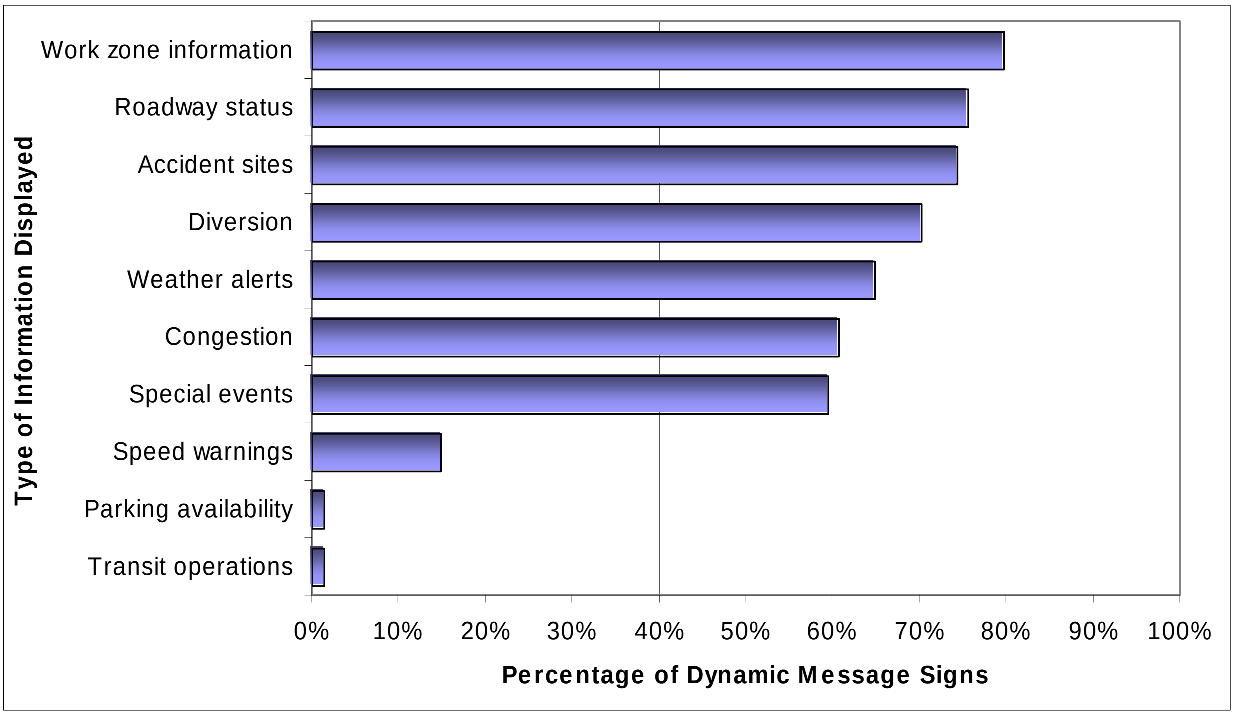

Figure 32. Information Displayed by Dynamic Message Signs

<u>Roadway Closure Systems</u>

Rural freeway incident management systems typically use combinations of freeway closure gates (either remote controlled or manual) and information systems to alert travelers of the closures.

Figure 33 highlights the states that have deployed or are planning to deploy Roadway Closure Systems. The number on shaded states indicates the number of systems reported. A total of 17 states identified 25 separate Roadway Closure Systems. As Figure 34 shows, the majority of these systems are deployed on freeways or limited access highways.

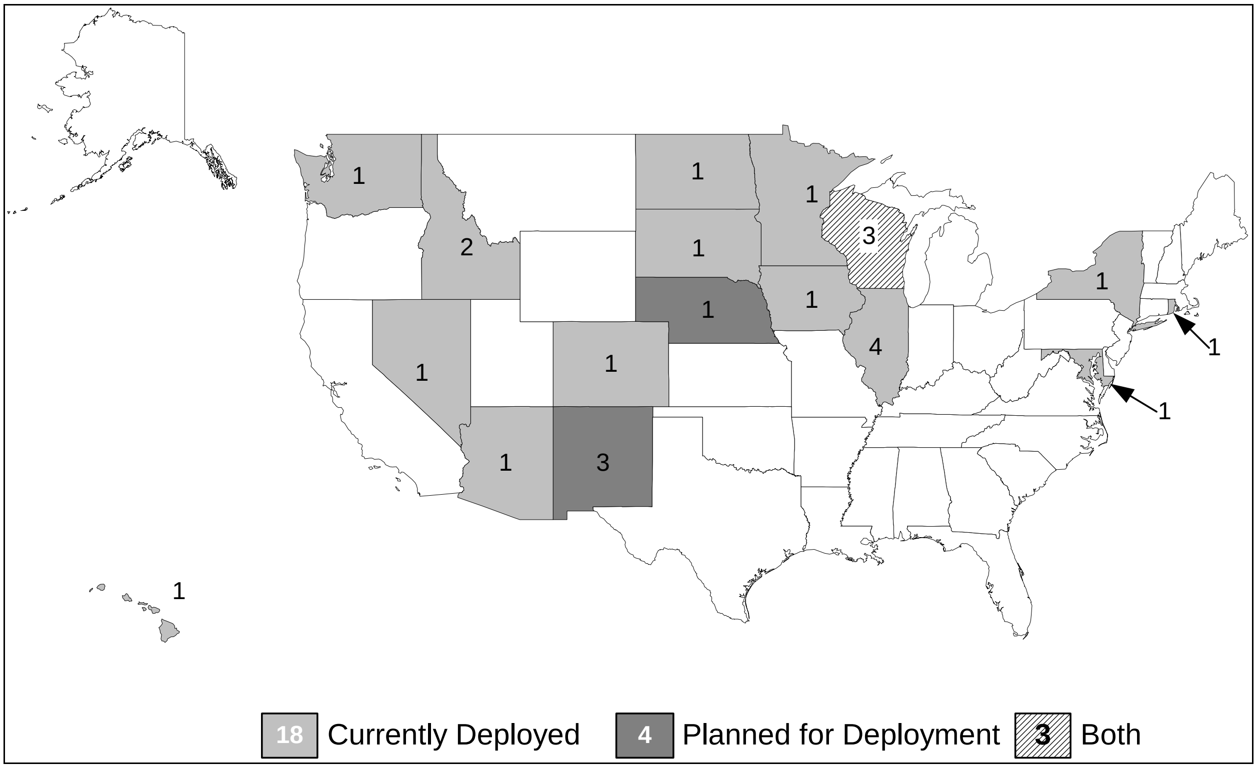

Figure 33. States Deploying Roadway Closure Systems

Figure 34. Road Classification of Roadway Closure Systems

Table 20 shows that both traffic sensors and CCTV are used to detect the presence of vehicles on sections of road to be closed.

Table 20 Technologies used for Detection on Sections of Roadway to be Closed

Technology	Number of Systems (25 total)
Traffic sensors	12
CCTV	9

Table 21 shows that manual road closure gates and DMS are the most common methods used to control access, with the use of automatic road closure gates reported in two cases.

Table 21 Methods Used to Control Roadway Access

Access controlled	Number of Systems (25 total)
Manual road closure gates	14
Dynamic message signs to alert travelers of closure	13
Automatic road closure gates	2

Route Diversion Management Systems

These systems assist in the management of traffic diversions resulting from temporary road closures due to weather or other causes. Route Diversion Management Systems attempt to spread the number of vehicles diverted off freeways over a larger geographic area such that sufficient services, such as hotels and restaurants, are available, and small rural towns are not overcrowded. These systems depend on up-to-date information on resource availability in areas likely to be impacted by a diversion and on information dissemination capability to provide travelers with diversion guidance.

Figure 35 highlights the states that have deployed or are planning to deploy Route Diversion Management Systems. The number on shaded states indicates the number of systems reported. There are a total of 13 states that have identified 19 separate Route Diversion Management Systems.

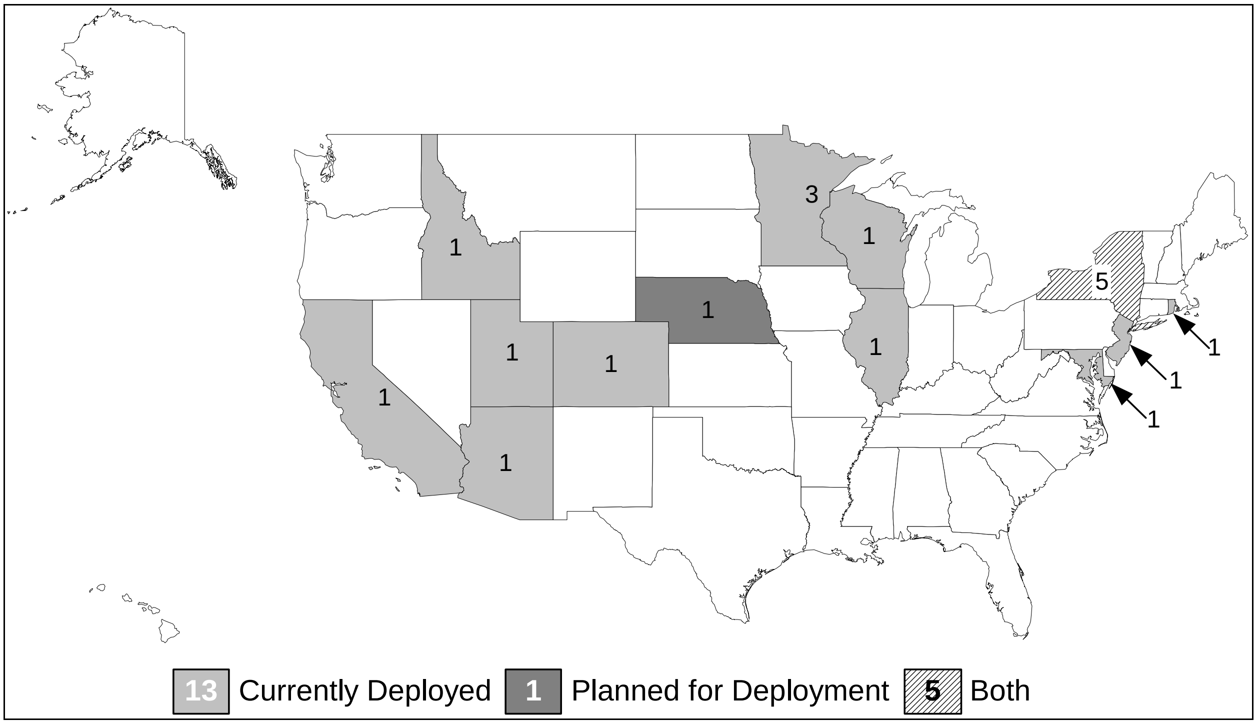

Figure 35. States Deploying Route Diversion Management Systems

The capability of Route Diversion Management Systems is linked to the variety of data available to support diversion decision making. Figure 36 shows that these systems as yet are largely one-dimensional, with information on traffic conditions by far the most often used source to make diversion decisions. The integration of other data related to diversion planning, such as parking availability, hotel capacity, and digital maps, lags significantly.

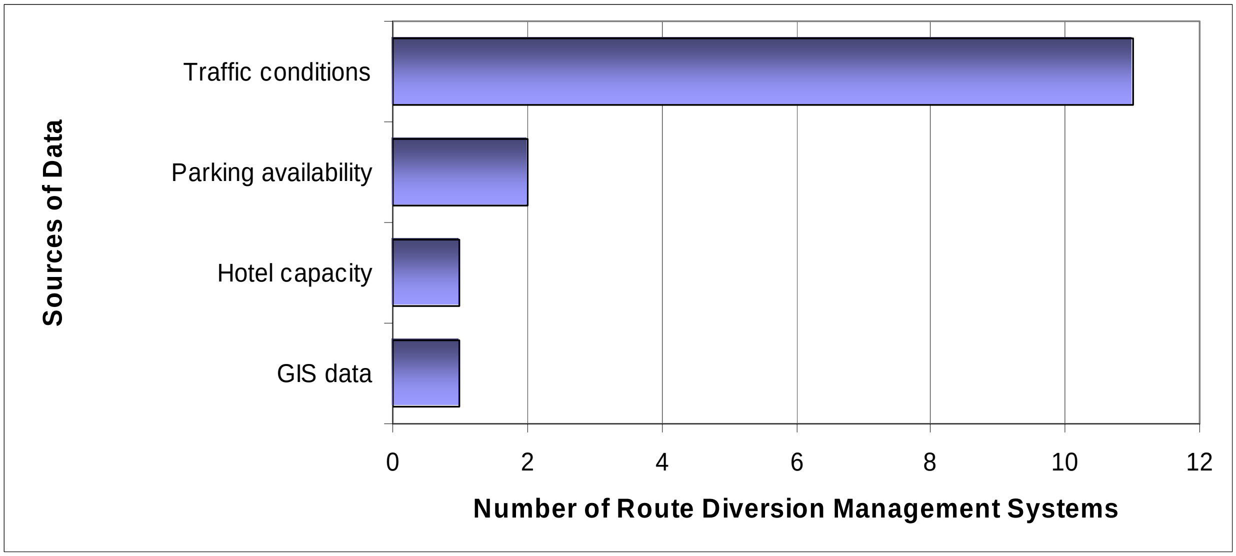

Figure 36. Sources of Data for Making Diversion Decisions

Figure 37 shows the technologies used to communicate route diversion information. The most frequently reported media in use is dynamic message signs, with highway advisory radio second. Flashing lights are used as well; but less frequently. The 511 telephone system is used as a means of disseminating diversion information in three systems.

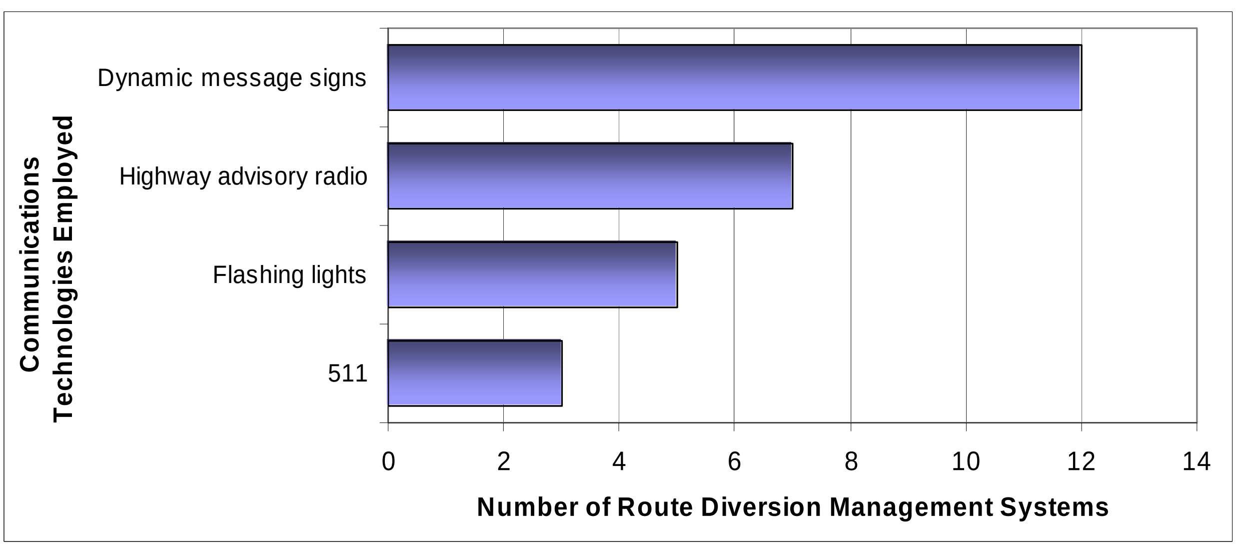

Figure 37. Technologies Used to Communicate Route Diversion Information

Traffic Surveillance Systems

Traffic Surveillance Systems instrument sections of roadway or spot locations to gather information on traffic conditions and incidents. Non-urban applications of these systems are typically located on sections of road with special characteristics or heavy use, such as freight routes, evacuation routes, military deployment routes, special event routes, and snow and ice routes. In addition, surveillance systems may be placed at spot locations such as bridges or tunnel entrances.

Figure 38 highlights the states that have deployed instrumentation to support traffic surveillance in non-urban areas. A total of 23 states report deployment of such Traffic Surveillance Systems.

Figure 38. States Deploying Traffic Surveillance Systems in Non-Urban Areas

Figure 39 shows the type of information collected by these Traffic Surveillance Systems broken out by road category. Traffic volume and speed are most frequently gathered, followed by vehicle classification and detection of incidents, and finally travel time. Collection on freeways is about three times as frequent as the other two road categories.

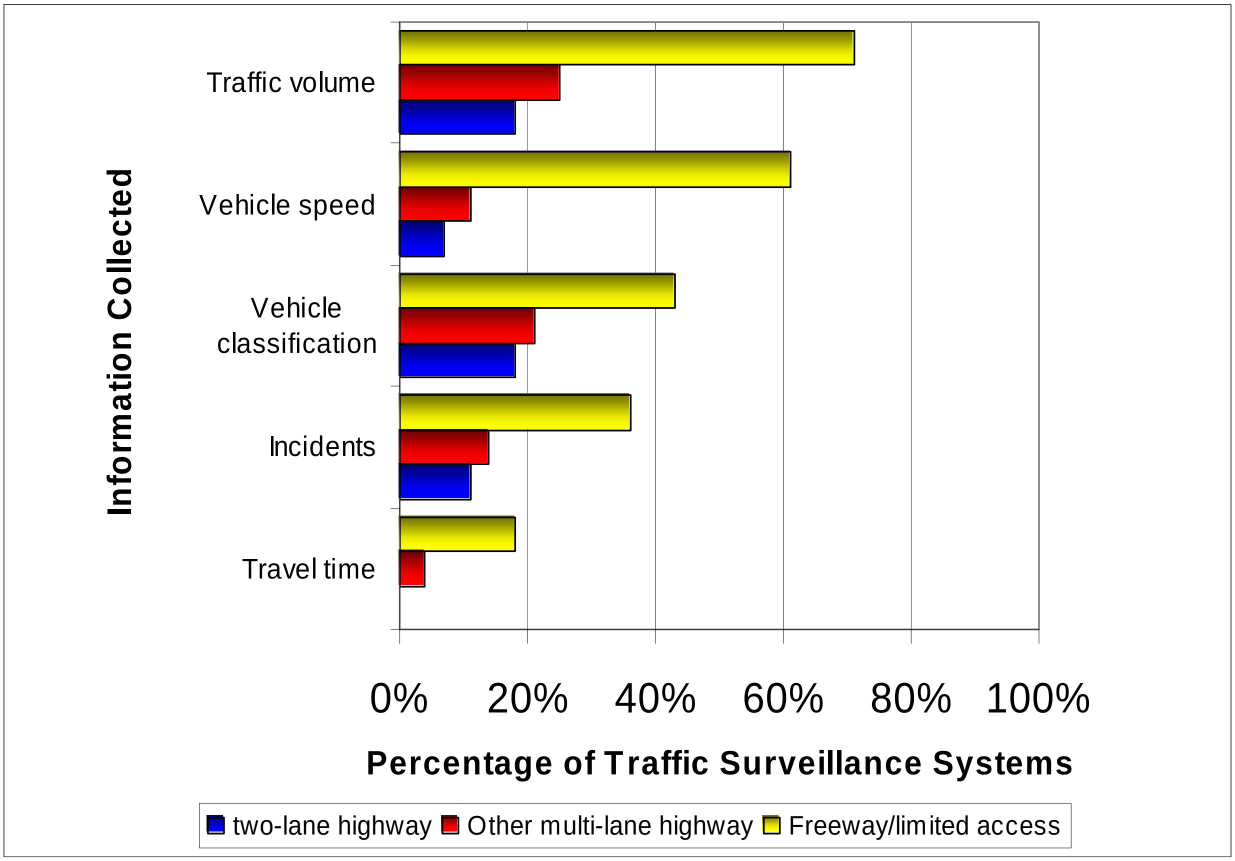

Figure 39. Traffic Surveillance Information Collected by Road Category

Figure 40 shows the types of traffic surveillance sensors deployed on the various types of roads. Loop detectors are the most common, deployed on freeways in about 70% of the Traffic Surveillance Systems. Police reports of congestion and incidents are next in frequency, followed by a variety of sensors including probes and cellular phone monitoring. Loop detectors and police reporting are also important sources of information on two lane and other multi-lane roads, but at about one-third the frequency seen on freeways. Radar detectors, video imaging detectors, and cellular phone monitoring are also reported in use on these roads, but to a lesser extent than on freeways.

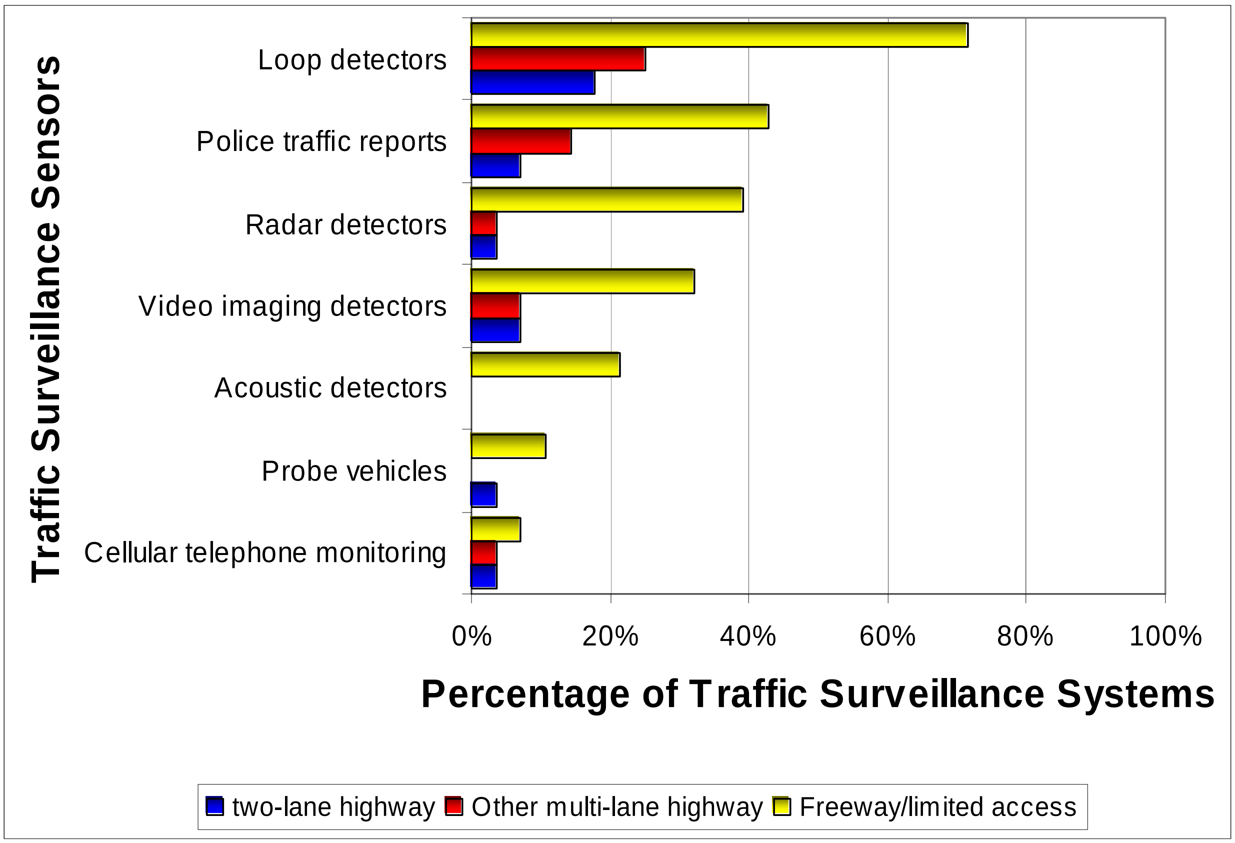

Figure 40. Technologies Used to Collect Information by Road Category

Transportation Management Centers

Figure 41 highlights the states that have deployed or are planning to deploy Transportation Management Centers. The number on shaded states indicates the number of centers reported. There are a total of 27 states that have identified 55 separate Transportation Management Centers.

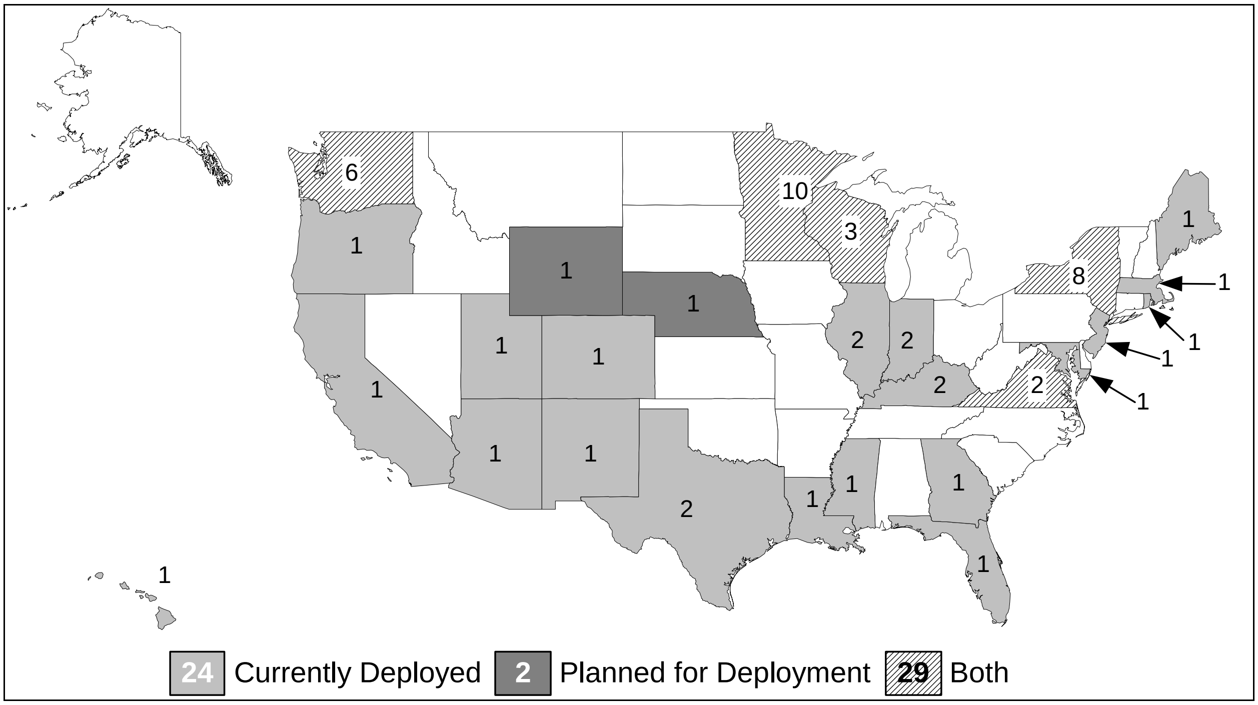

Figure 41. States Deploying Transportation Management Centers

Figure 42 shows the functional capabilities of the Transportation Management Centers. The four key functions, reported by more than half of the TMCs, are: incident management, information dissemination, surveillance, and special event traffic management. Half of the TMCs report providing en-route traveler information, emergency management, and disaster management coordination. About one third support network performance monitoring, environmental monitoring, and corridor management. Fewer than 20% of the TMCs exercise traffic control through ramp or lane management.

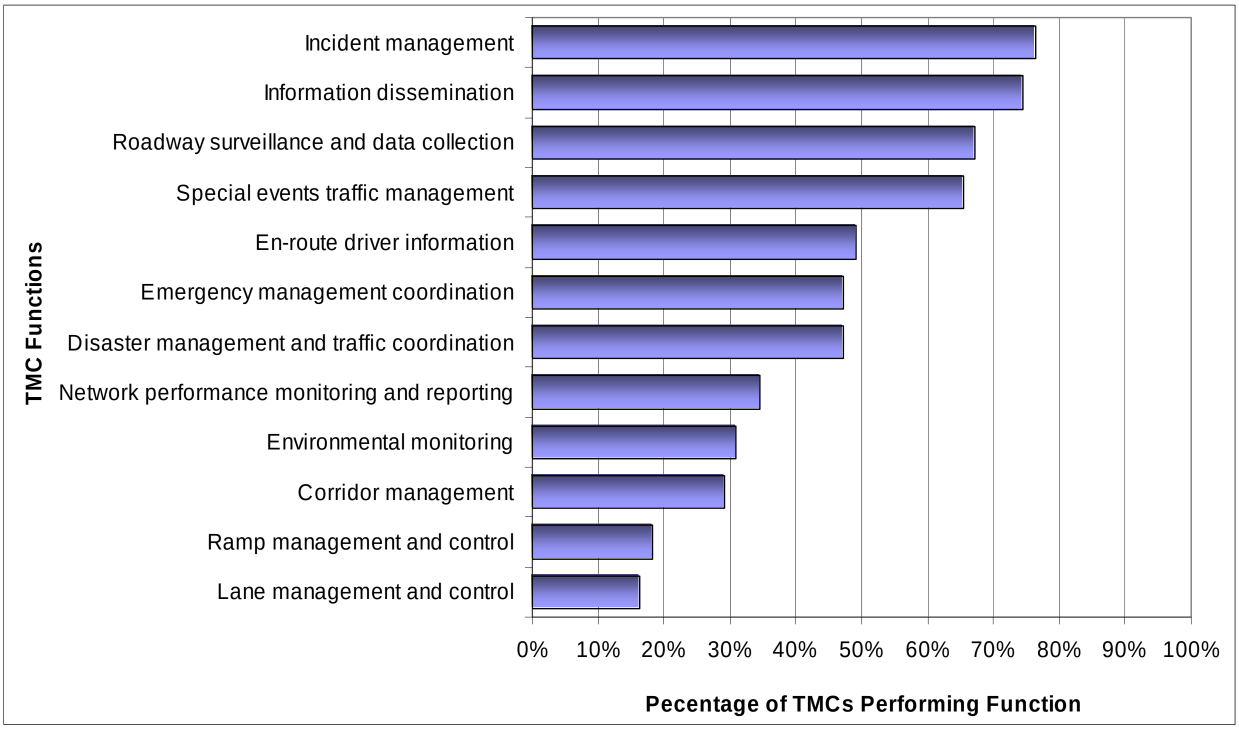

Figure 42. Functional Capabilities of Transportation Management Centers

The majority of TMCs operate year round as shown on Table 22.

Table 22 Operation of Transportation Management Centers

Operation	Number of Systems (55 total)
Year-round	46
During emergencies	4
Seasonal	0

Table 23 shows that most of the TMCs operate 24 hours a day.

Table 23 Hours of Operation of Transportation Management Centers

Hours of operation	Number of Systems (55 total)
24 hours a day	35
Peak hours only	6

Figure 43 shows the systems and strategies used by statewide TMCs to manage traffic. The two most frequently reported technologies are closed circuit television cameras and dynamic message signs. Traffic surveillance is reported by about a third as many TMCs as the first two technologies. Two important rural traffic management strategies, route diversion and roadway closure, are reported by a significant number of TMCs as well.

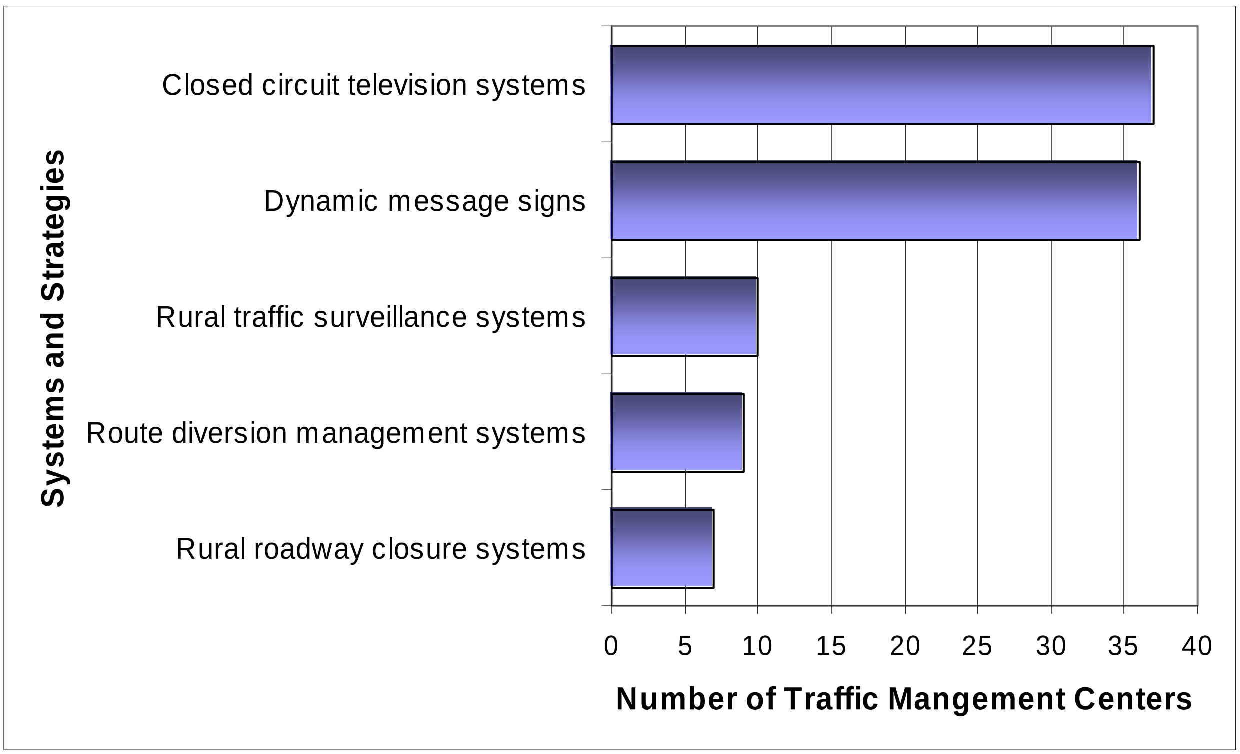

Figure 43. Systems and Strategies Used to Manage Traffic

Operations and Maintenance

Operations and maintenance systems support safety and improve operational capabilities, and include such as Automatic Anti-icing Systems, Avalanche/Slide Management Systems, and Work Zone Management. Maintenance Fleet Management Systems can improve operations and take advantage of maintenance vehicles as a source of information.

Automatic Anti-Icing Systems

These systems address a number of safety issues and provide solutions for improving road conditions by preventing formation of ice in spot locations. Automatic Anti-icing Systems detect conditions conducive to ice formation in locations such as bridge decks or shady areas, and treat the roadway before conditions become hazardous to drivers. These systems require environmental or in-road sensors, a processor to determine when conditions for ice formation exist, and a device for preventing ice formation.

Figure 44 highlights the states that have deployed or are planning to deploy Automatic Anti-Icing Systems. The number on shaded states indicates the number of systems reported. There are a total of 17 states that have identified 21 separate Automatic Anti-Icing Systems. Of the 21 systems, 16 are deployed and five were still in the planning stage.

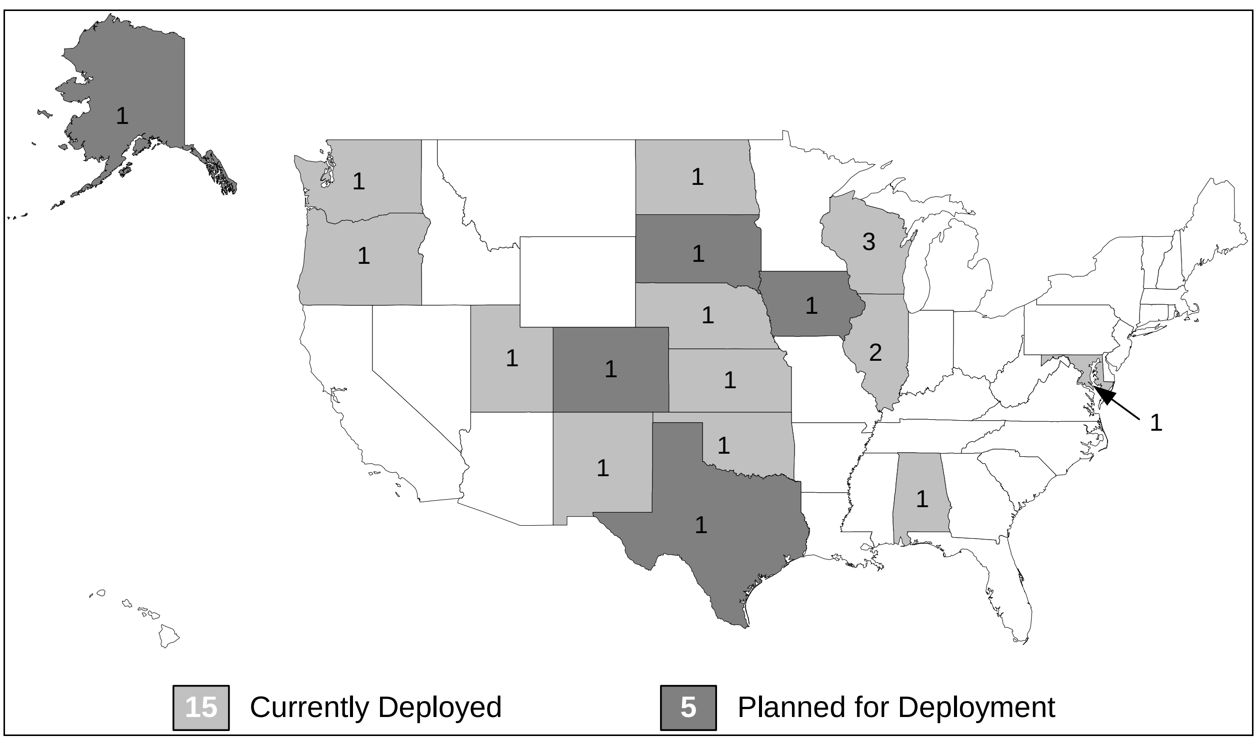

Figure 44. States Deploying Automatic Anti-Icing Systems

Figure 45 shows that over half (11 of 21) of all the Automatic Anti-Icing Systems have been or will be deployed on freeway or other limited access highways. There are six systems that have been or will be deployed on other multi-lane highways and two systems that have been or will be deployed on two-lane highways.

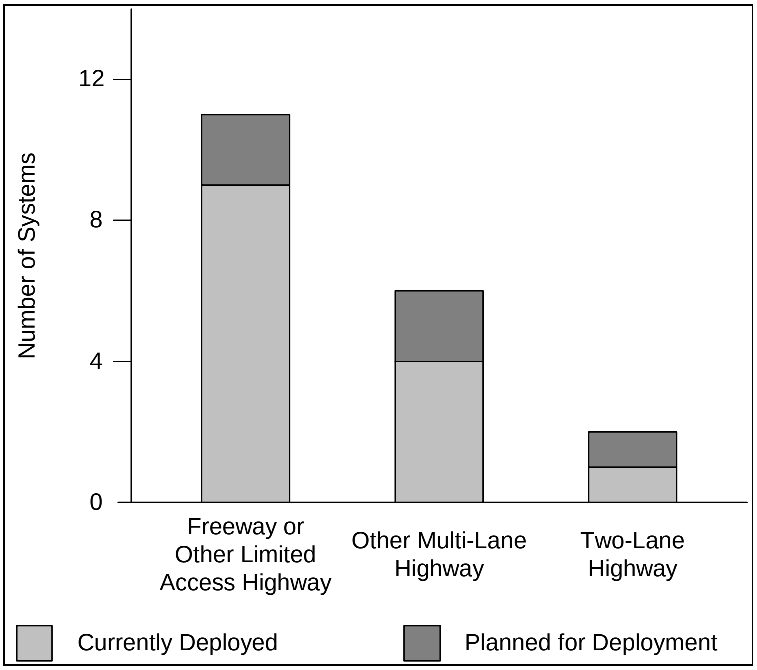

Figure 45. Road Classification of Automatic Anti-Icing System Locations

As Table 24 shows, most of these systems are located on bridges with some on overpasses and only one on exit lanes.

Table 24 Automatic Anti-Icing System Locations

Location	Number of Systems (21 total)
Bridge	15
Overpass	4
Exit lane	1

Figure 46 shows the reason for making the decision to deploy Automatic Anti-Icing Systems. The most common reason for deploying these systems is to evaluate them. However, the majority of these systems were being evaluated in the hopes that they would help in achieving operational goals. The most common operational goal was to improve safety at locations with a high accident history. Other goals included improving locations that are potentially hazardous due to road curvature or grade, as well as keeping a major connector road clear of incidents.

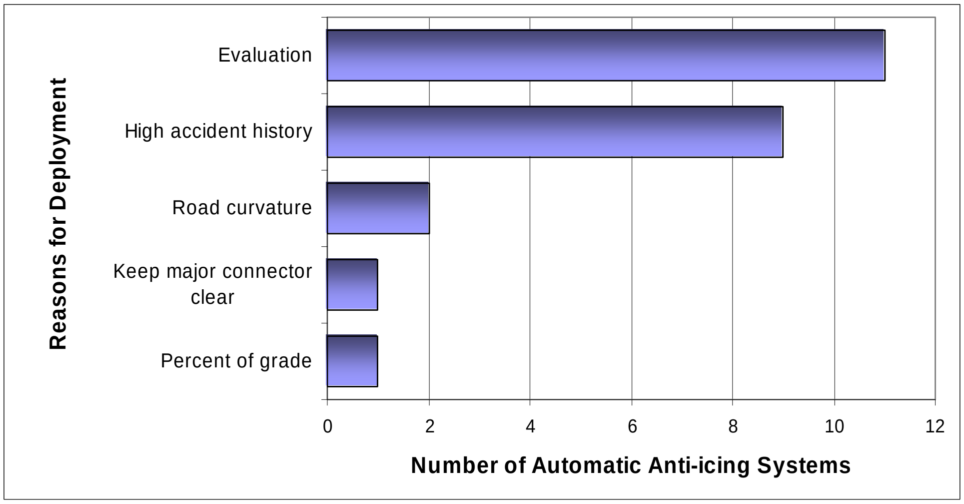

Figure 46. Reasons for Implementing Automatic Anti-icing Systems

Figure 47 shows the kinds of information that these systems collect in order to assess the existence of icing conditions. These include roadway icing and surface temperature as well as other environmental conditions. These systems also detect the roadway chemical concentration to track the impact of treatment.

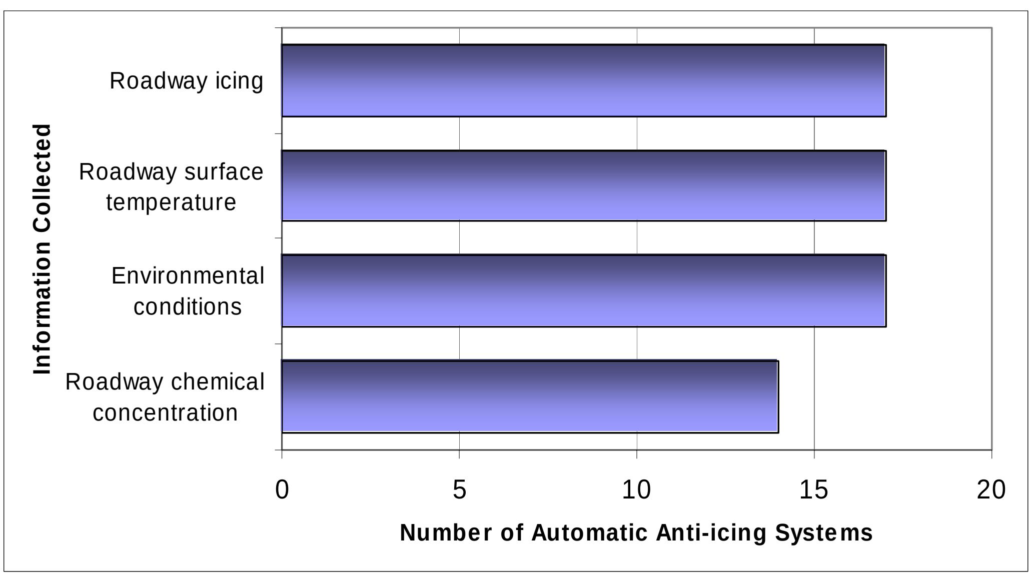

Figure 47. Automatic Anti-Icing System Information Collected

Automatic Anti-Icing Systems are technologically sophisticated and provide a variety of remote control options. Table 25 shows the remote control capabilities of the deployed anti-icing systems. These systems are generally automatically activated with a variety of operator reporting and override options.

Table 25 Automatic Anti-Icing System Remote Control Capabilities

Capability	Number of Systems (21 total)
Automatically activated	18
Automatically activated – when environmental conditions make icing likely	14
Automatically activated – when ice detected on road surface	11
Automatically activated – system automatically reports when activated	9
System may be overridden or manually operated remotely	14
Status can be queried remotely	13
Interface with fax, e-mail, message boards	1
Manually operated	1

Avalanche/Slide Management Systems

Avalanche/Slide Management Systems are designed to improve safety along roadways with a high number of avalanches or slides. Traffic logging stations are installed at either end of an avalanche/slide prone corridor, and avalanche/slide sensors are installed at the roadside. When a hazardous situation is detected, based on readings from the roadside sensors, automatic gates prevent drivers from entering the corridor. Since traffic counts will be made at the entry and exit of the corridor, it can be determined if any vehicles remain in the corridor at the onset of the avalanche/slide, providing an aid to rescue operations.

Figure 48 highlights the states that have deployed or are planning to deploy Avalanche/Slide Management Systems. The number on shaded states indicates the number of systems reported. Four states have identified five separate Avalanche/Slide Management Systems. All of these systems are currently deployed on two lane highways except for the system deployed in Alabama, which is deployed on a multi-lane highway.

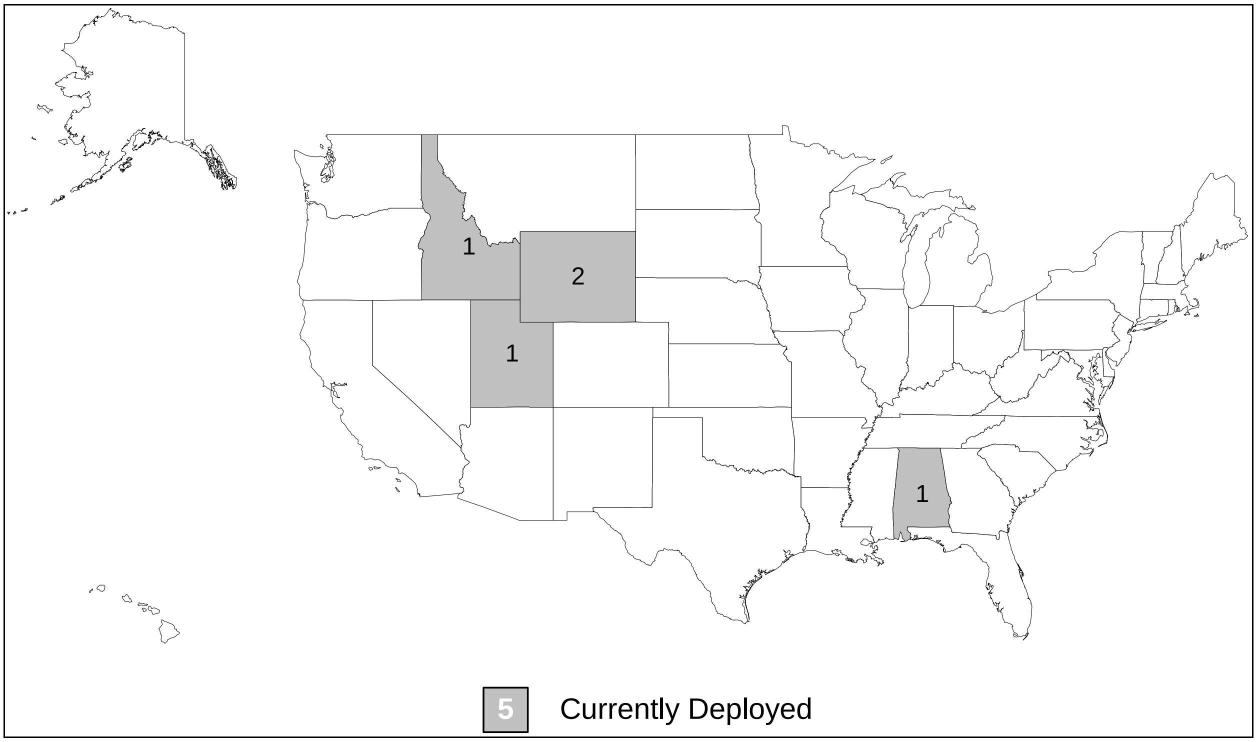

Figure 48. States Deploying Avalanche/Slide Management Systems

Table 26 shows that deployment of these Avalanche/Slide Management Systems is generally for evaluation or research purposes, although two of the systems have been deployed to address operational problems as well. Table 27 shows the types of information collected by the system, with almost all of the systems incorporating an avalanche detection sensor. Table 28 shows that the use of a coupled gate to close affected roads is the preferred method for limiting access.

Table 26 Avalanche/Slide Management System Purpose for Implementation

Purpose	Number of Systems (5 total)
Evaluation	4
High accident history	2
Avalanche prediction and detection	2
Sudden multiple slides without notice	1
Research and development	1

Table 27 Information Collected by System

Information	Number of Systems (5 total)
Avalanche/slide detection sensors	4
Vehicle detection sensors on corridors prone to avalanches	1
Weather information	1

Table 28 Methods Used to Limit Access

Limit Access Methods	Number of Systems (5 total)
Coupled gate to close road	2
Manned gate	1
Signs	1
Portable traffic control devices	1

Maintenance Fleet Management Systems

Maintenance Fleet Management Systems are designed to increase the efficiency of public vehicle fleet management operations. The widespread use of new technologies such as global positioning systems and hand-held computers with wireless capability allows for many new and innovative ways of improving operations efficiency in many transportation-related areas. With regard to fleet management, GPS can be used to locate and deploy vehicles to incident sites for congestion mitigation, or for special applications, such as salting and snow plowing. Hand-held computers allow vehicle inspectors in the field to enter information on-site and then synchronize it with their office PC. This process eliminates the redundancy of reentering information, and also allows for on-site comparison with data from previous years.

Figure 49 highlights the states that have deployed or are planning to deploy Maintenance Fleet Management Systems. The number on shaded states indicates the number of systems reported. A total of 15 states identified 24 separate Maintenance Fleet Management Systems.

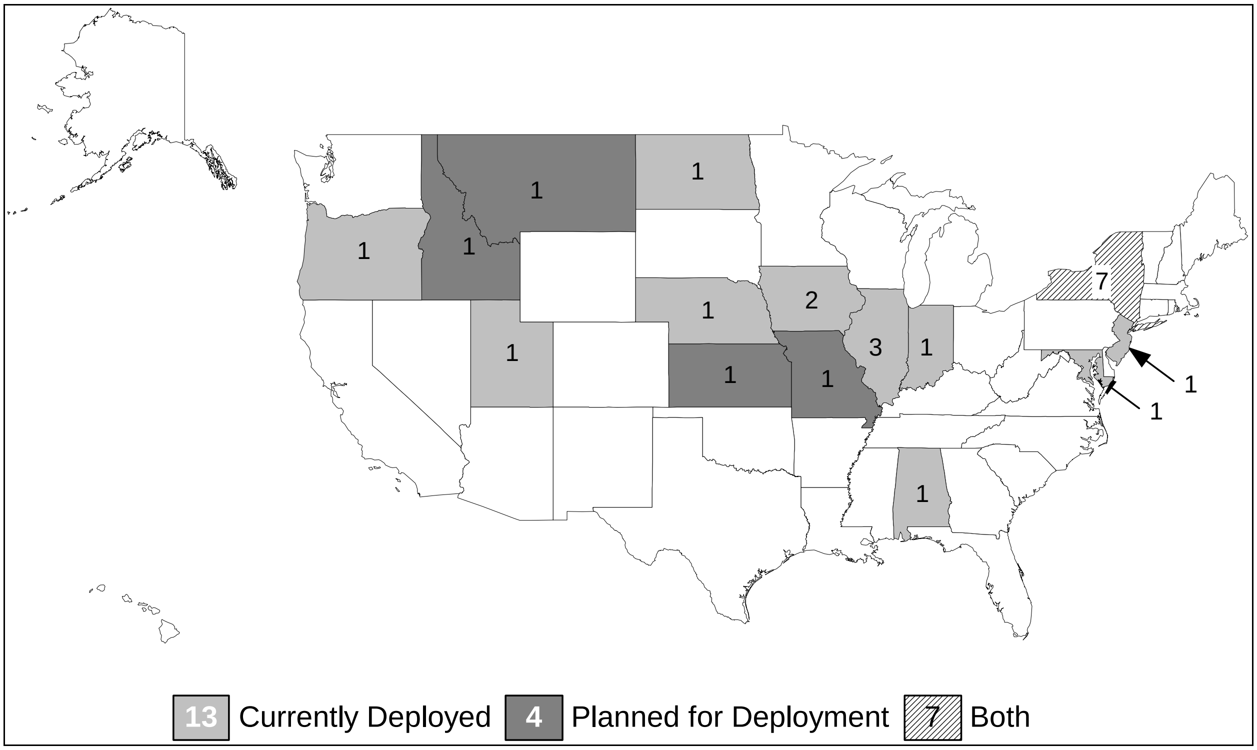

Figure 49. States Deploying Maintenance Fleet Management Systems

Figure 50 shows the types of fleets managed by these systems. The most common type reported was snow removal, followed closely by maintenance. Three states manage their incident management fleets and two states their entire inventory through dedicated fleet management systems.

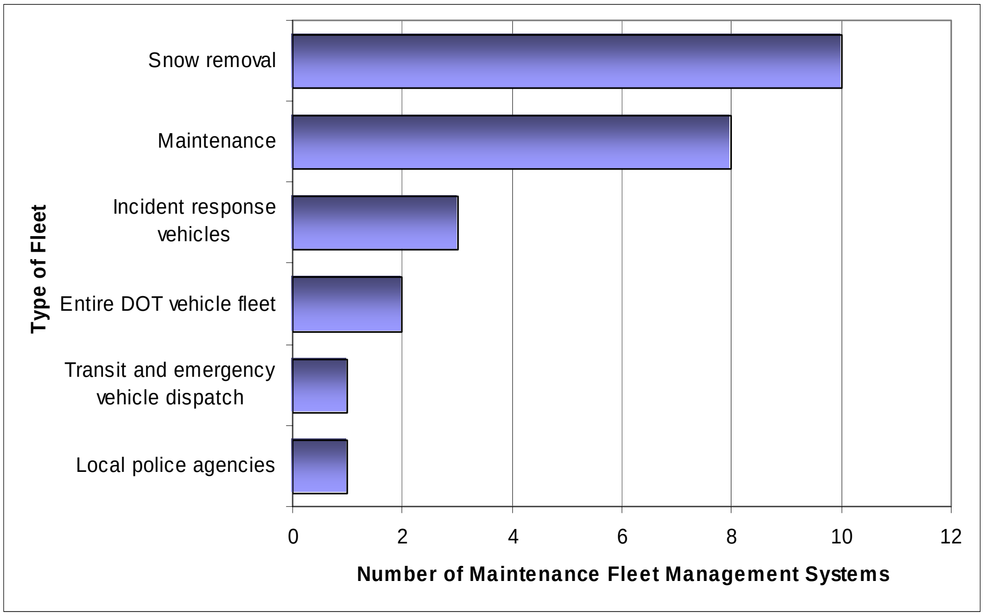

Figure 50. Types of Fleets Being Managed

Figure 51 shows the variety of sensors and technologies that are deployed on these vehicles. The two most common technologies reported are AVL and road surface condition sensors. Several sensors support snow removal vehicles, automatically monitoring the rate of chemical application, snow plow blade position, and inventory of chemicals, and controlling the spreader. A number of systems include weather sensors on the vehicles, supporting the use of these vehicles as weather probes.

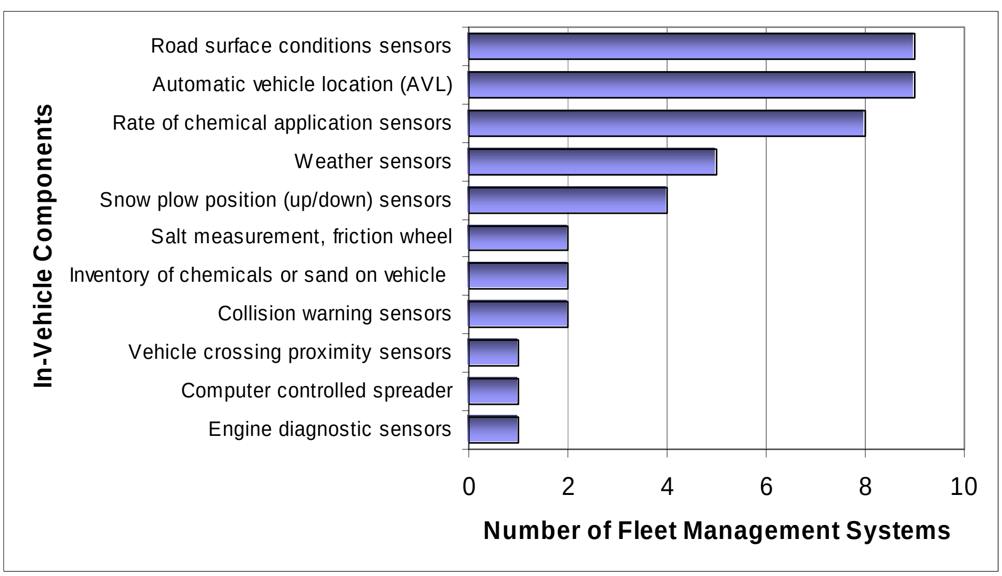

Figure 51. In-vehicle Technology Used to Collect Information

An important aspect of these fleet management systems is the sharing of information from the field. Table 29 shows that a number of these systems provide the means for multi-agency coordination of reporting of crashes, road conditions, and weather conditions, as well as assistance in credentialing and incident management.

Table 29 Information Shared Through Coordinated Multi-agency Reporting

Information	Number of Systems (24 total)
Crashes	6
Road conditions	5
Weather conditions	5
CVO credentials	1
Incident and disabled vehicle information	1
Vehicle clearance and credentials	1

Table 30 shows that these systems also support emergency services as well as a number of other services through multi-agency dispatch centers.

Table 30 Services Coordinated Through a Multi-agency Dispatch Center

Service	Number of Systems (24 total)
Emergency services	6
Maintenance activities	3
Snow removal	2
Incident response	1
Traveler Clearance information	1

Work Zone Management Systems

The purpose of these systems is to ensure safe roadway operations and improve operational efficiencies during construction and other work zone activities. Work Zone Management Systems provide automated systems that enforce speed limits, provide vehicle intrusion warnings, and track individual crew movements. Through interfaces with other systems, information concerning location, duration, and operational impact of work zones are communicated to travelers.

Figure 52 highlights the states that have deployed or are planning to deploy Work Zone Management Systems. There are a total of 14 states that report the use of ITS technology in rural work zones. Figure 53 shows that these systems are mostly deployed on freeways or other limited access highways.

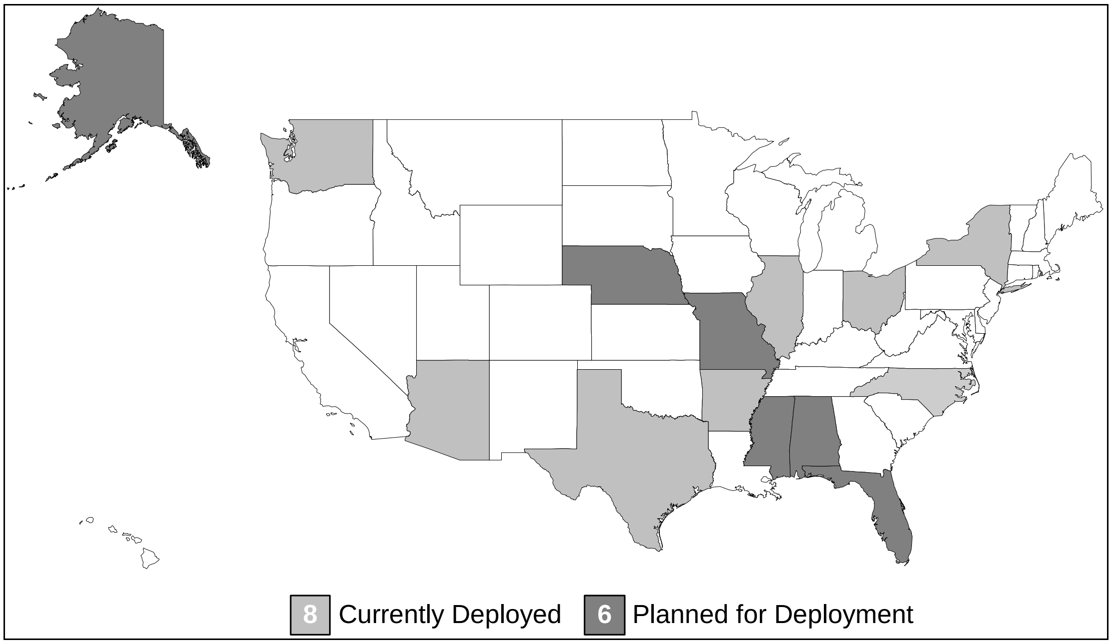

Figure 52. States Deploying Work Zone Management Systems

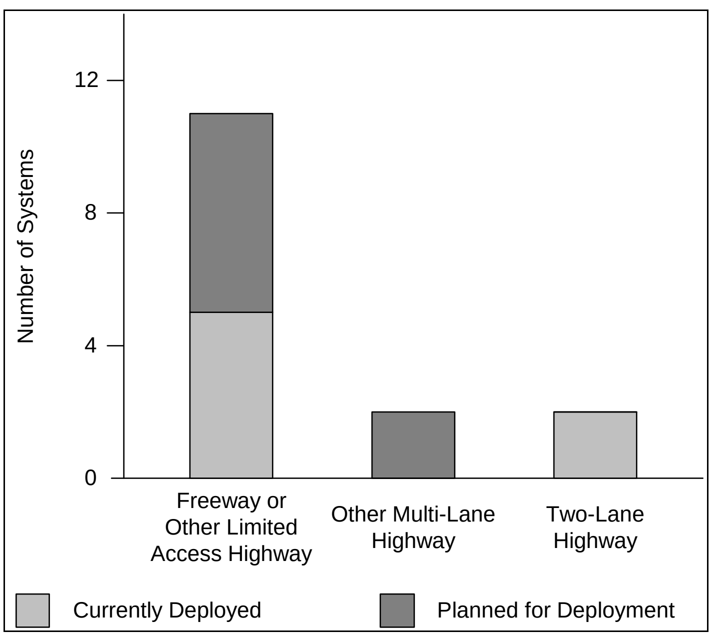

Figure 53. Road Classification at Work Zone Management System Location

Figure 54 shows that half of the systems deployed use a portable traffic management center to manage traffic at work zones.

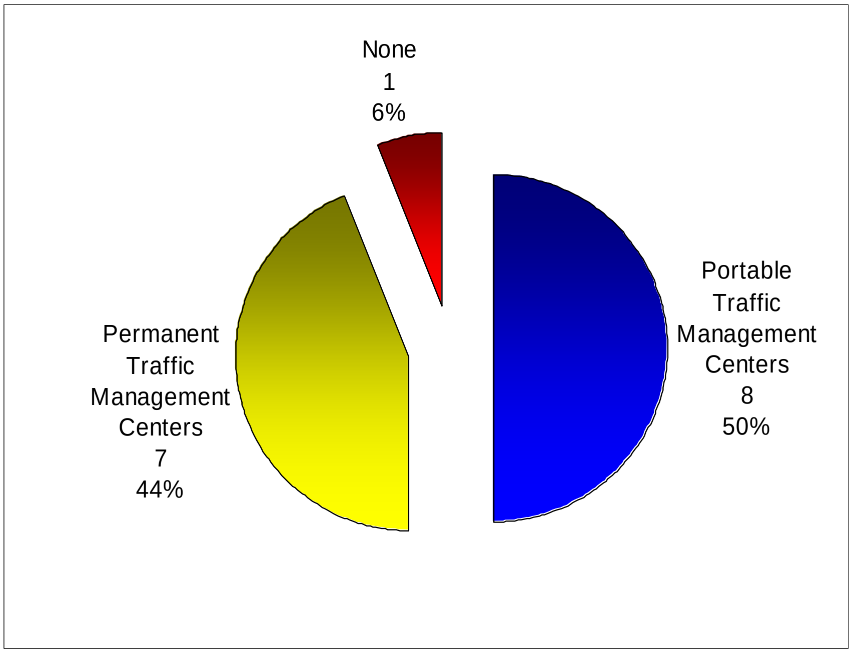

Figure 54. Type of Work Zone Traffic Management Center

Figure 55 shows the type of sensors that are deployed in work zones to improve safety and assist in traffic management. The most common sensor deployed at work zones detects vehicle speed. Traffic volume and travel time through the work zone are tracked by about half the reported systems.

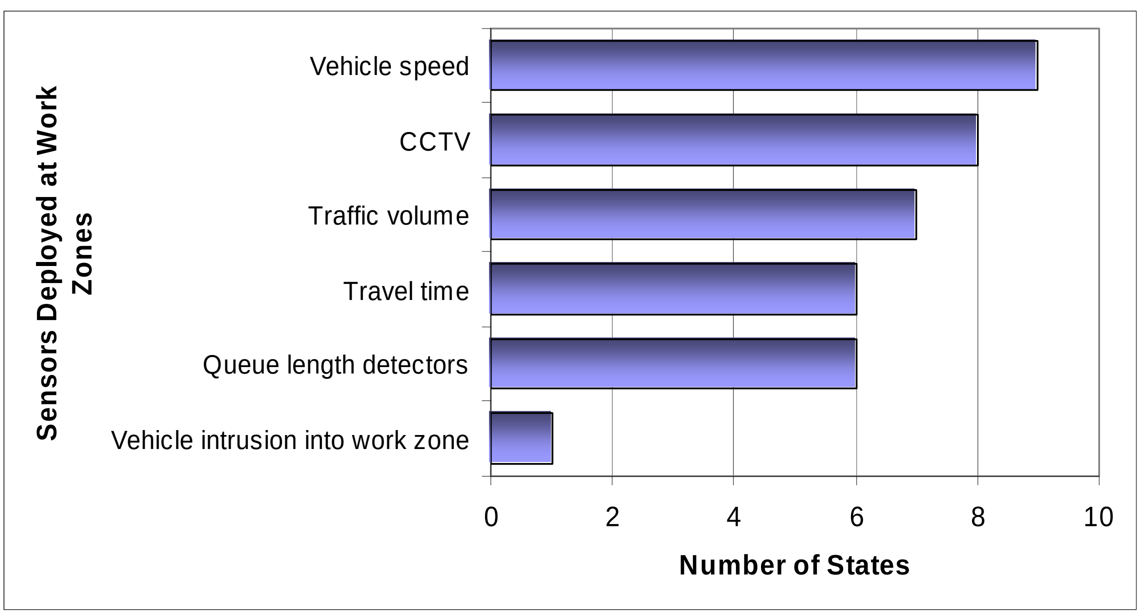

Figure 55. Types of Sensors Deployed at Work Zones

A variety of technologies are deployed to communicate warnings to vehicles operating near work zones. The use of dynamic message signs, both mobile and permanent, is the most commonly reported communications method, followed by highway advisory radio as shown in Figure 56. The use of temporary speed limits, a control strategy enabled by the deployment of ITS communications technology, is deployed widely as well.

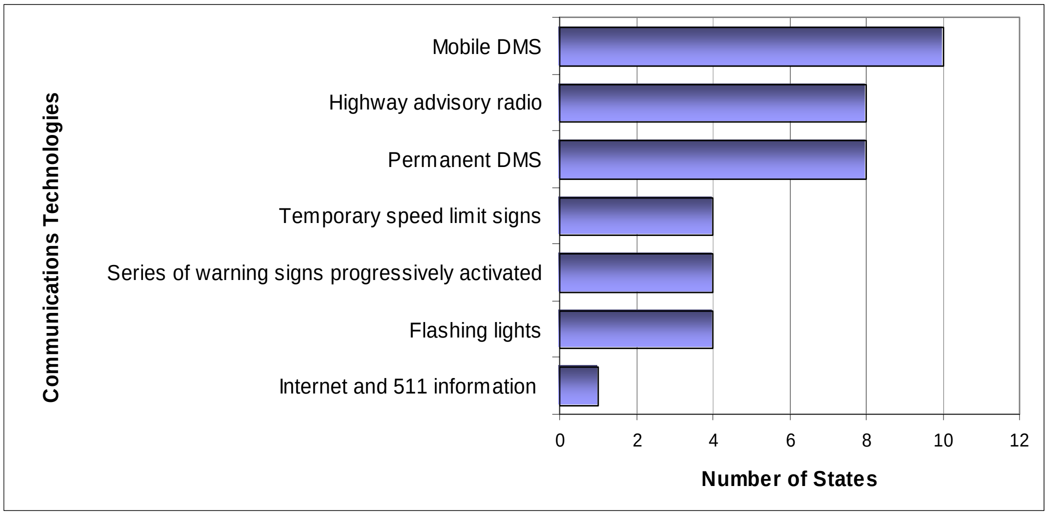

Figure 56. Technologies used to Communicate with Vehicles near Work Zones

The states reporting the use of technology in work zone management also report a significant level of integration. Figure 57 shows that half of the systems interface with traveler information/information service providers, public safety agencies, and state police. Incident management and traffic management agencies also receive work zone data in a number of cases, and this extends to other states as well.

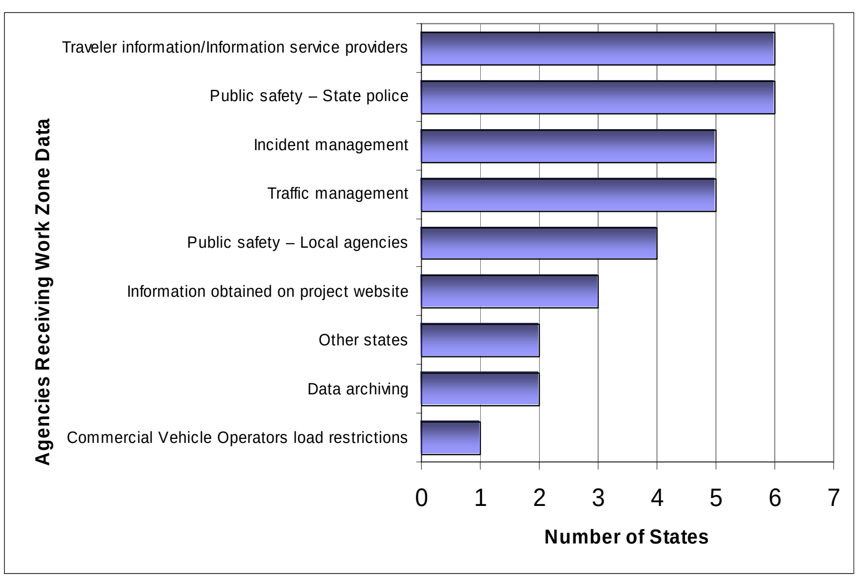

Figure 57. Agencies and Individuals that Receive Data on Work Zone Status

Surface Transportation Weather

Information for evaluating surface transportation weather is gathered from a variety of sources, including national and statewide databases. In addition, sensors are deployed throughout a state to gather atmospheric conditions as well as road surface temperature and conditions, and subsurface temperatures.

Figure 58 highlights the states that have deployed or are planning to deploy Surface Transportation Weather Systems. There are a total of 41 states that have deployed or are planning to deploy statewide weather systems. The total number of systems reported was 55, as some states have multiple regional systems.

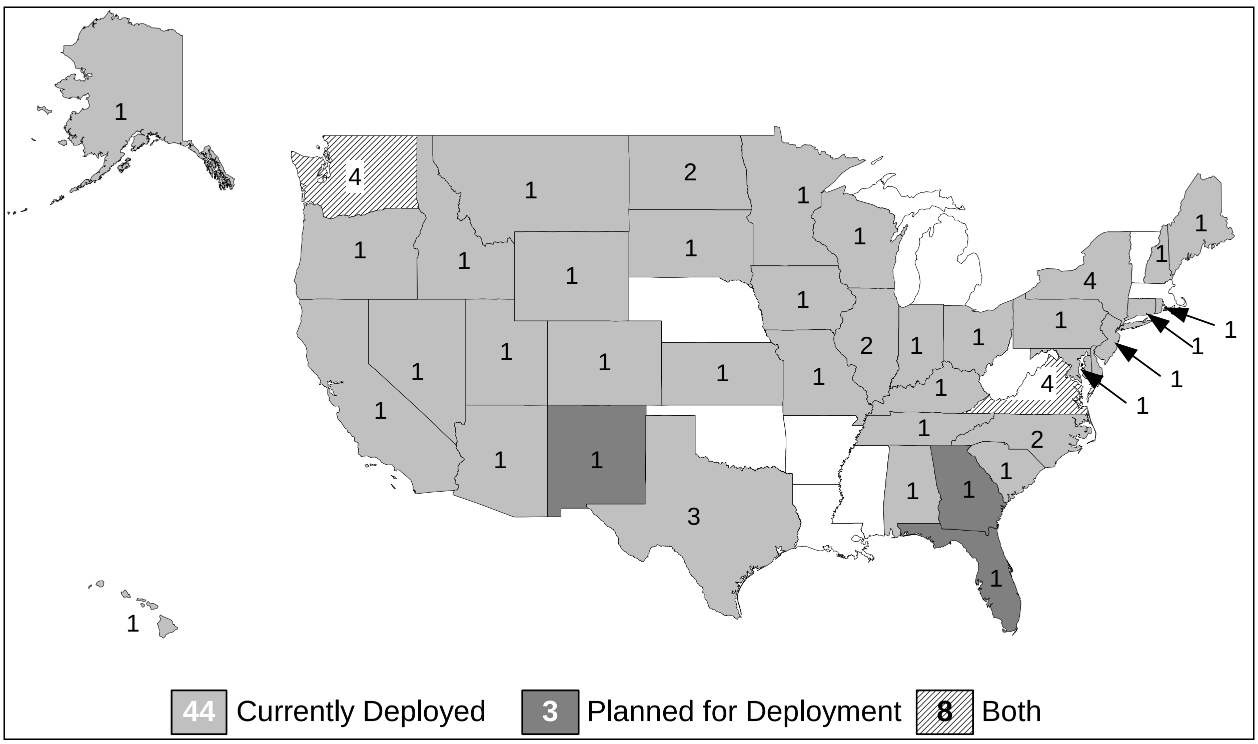

Figure 58. States Deploying Surface Transportation Weather Systems

Figure 59 shows that statewide weather systems receive data from a wide variety of sources. The most common of these are data from DOT environmental sensor stations, followed by the National Weather Service. Also included are sensor inputs from other agencies, including airports, agricultural stations, air pollution sensors, and vehicle probes.

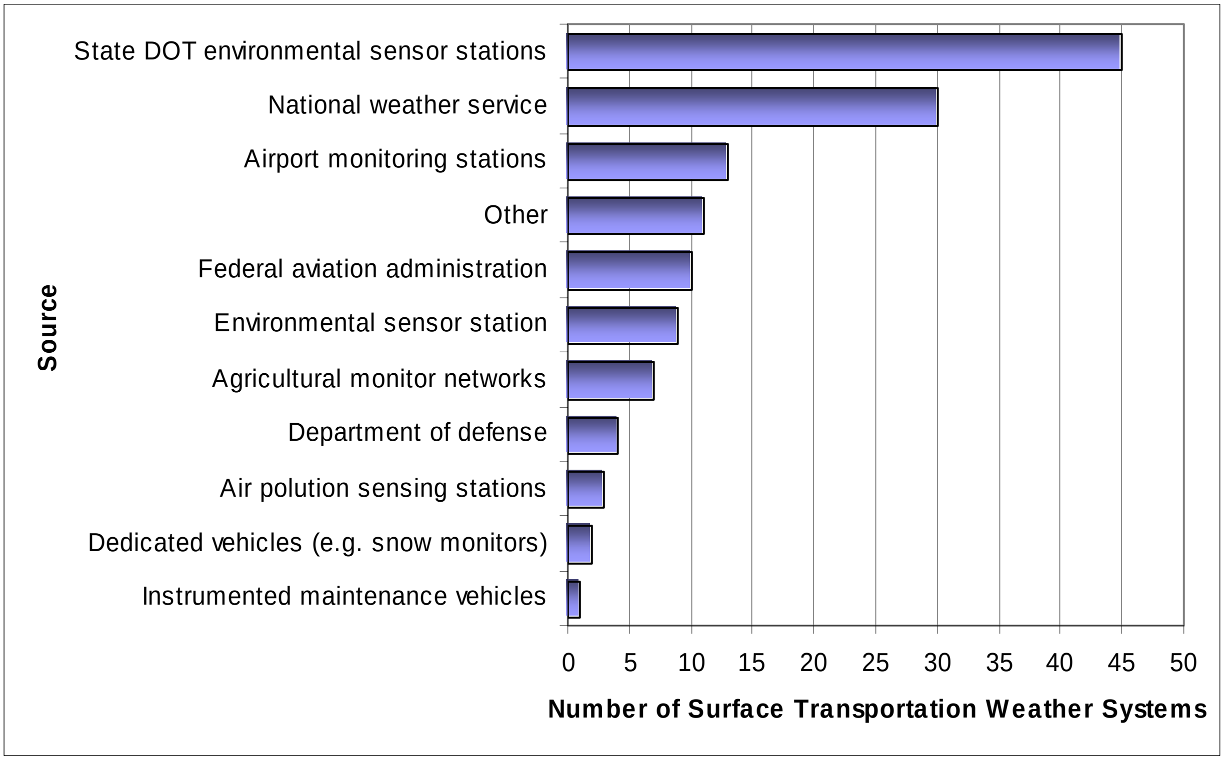

Figure 59. Surface Transportation Weather Systems Data Sources

Figure 60 shows the states that coordinate data gathering for weather with at least one other state. About one-third of the states do so.

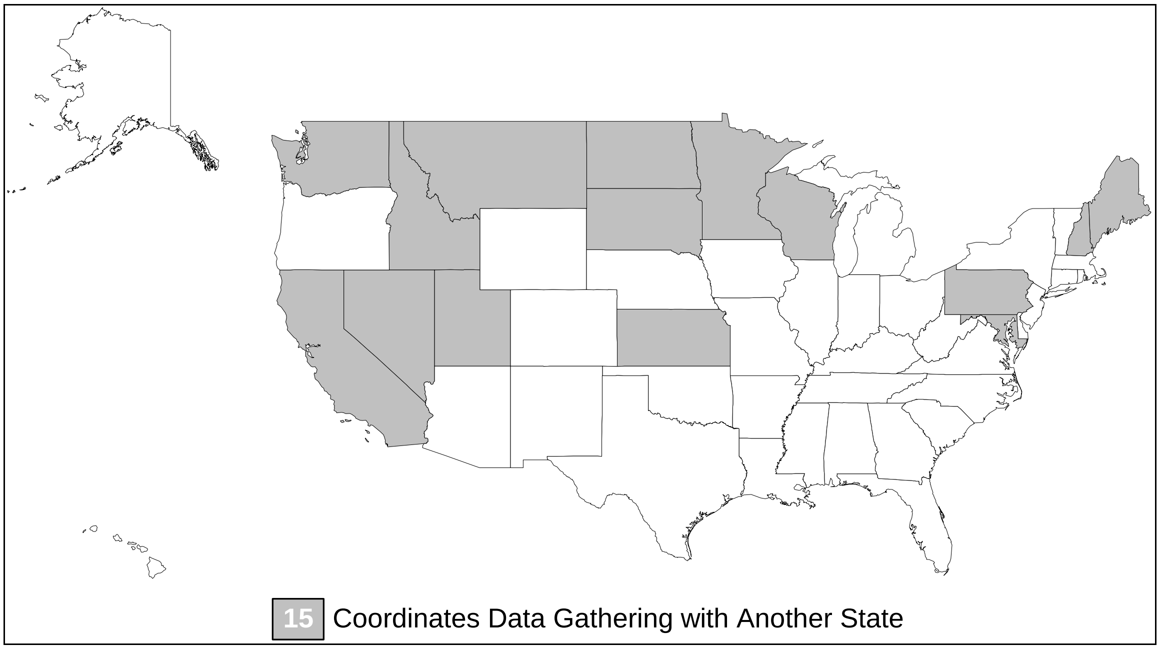

Figure 60. States that Coordinate Data Gathering

Figure 61 shows the number of environmental sensor stations (ESS) deployed in states with Surface Transportation Weather Systems.

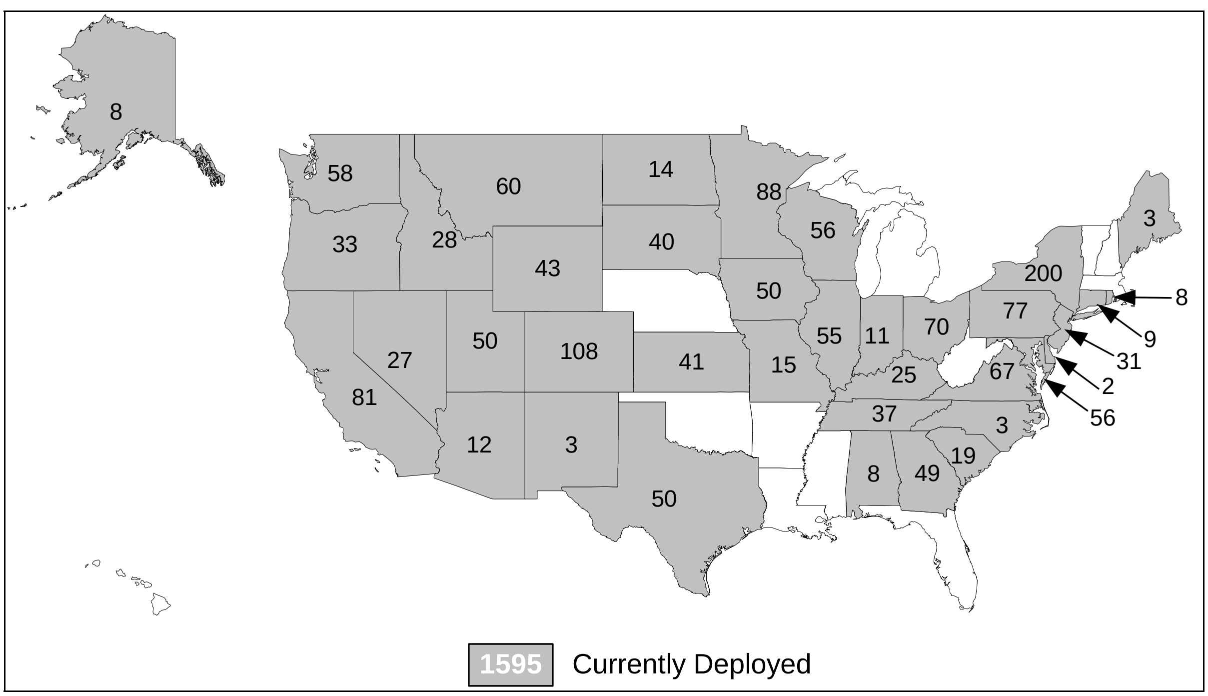

Figure 61. Number of Environmental Sensor Stations

Figure 62 shows the data gathering capabilities of the environmental sensor stations. These include detection of environmental as well as pavement conditions.

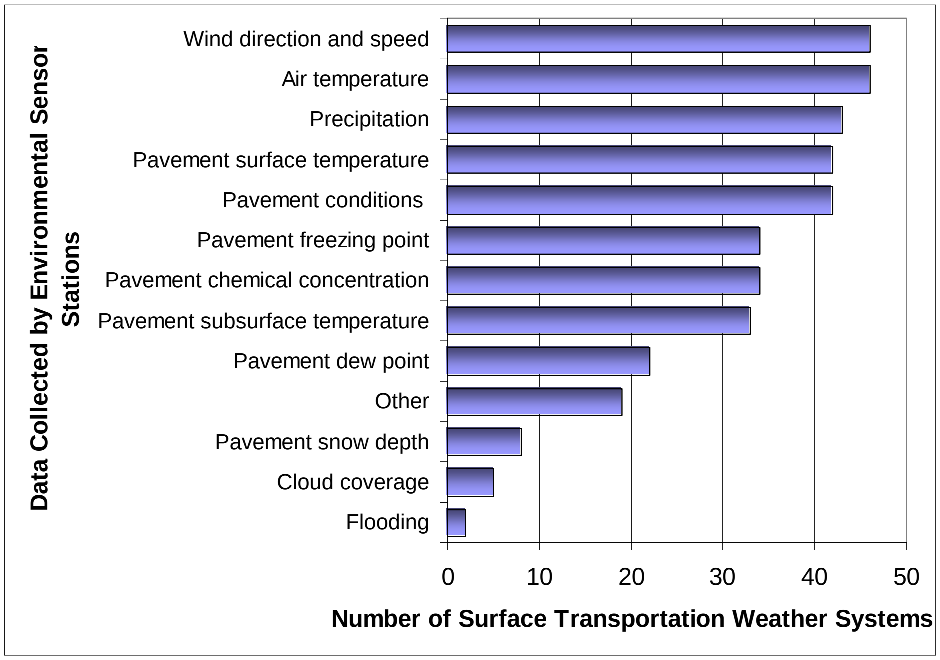

Figure 62. Data Collection Capabilities of Environmental Sensor Stations

Figure 63 shows the wide range of methods for sharing transportation weather information. The most popular method of weather information dissemination is the Internet followed closely by dynamic message signs.

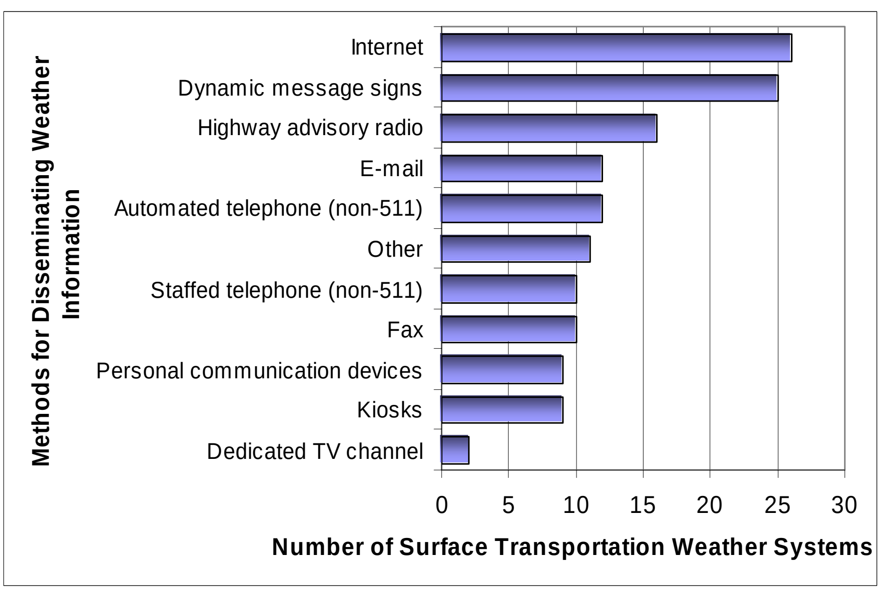

Figure 63. Methods to Disseminate Transportation Weather Information

Figure 64 shows that the Surface Transportation Weather Systems provide tailored weather products to a number of agencies. Maintenance crews are the biggest user of tailored products, followed by traffic management centers, traveler information systems, and public safety as the main users of tailored products.

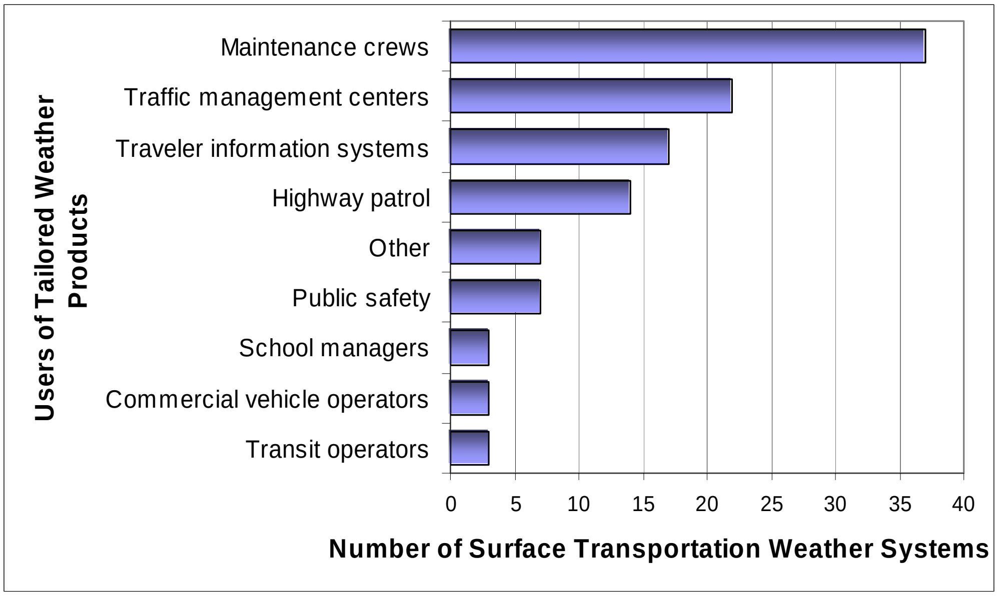

Figure 64. Services or Agencies Provided with Tailored Weather Products

Conclusion

The 2002 statewide survey demonstrated that data could be collected in sufficient quantity to provide an assessment of the national status of non-urban ITS deployment. The results from 2002 statewide deployment tracking survey effort show that ITS technology is lightly deployed in non-urban areas. However, where deployed, non-urban systems tend to be more sophisticated than in metropolitan areas, and generally targeted at critical safety needs. Deployment of crash prevention and safety systems is widespread, if not numerous, and is mainly focused on alerting travelers to environmental and road geometry hazards. These safety systems are marked by their sophisticated stand-alone capability, integrating sensors, computers, and warning equipment. In support of operations and maintenance, advanced stand-alone systems that detect the road surface and environmental conditions and automatically apply anti-icing treatments are being deployed, and maintenance fleets are being managed more effectively through the use of ITS technology. Traveler information systems and transportation weather systems are the most widely deployed of the five major areas tracked. The widespread deployment of traveler information systems is offset, however, by the scarcity of traffic surveillance systems in non-urban areas providing input for these systems.