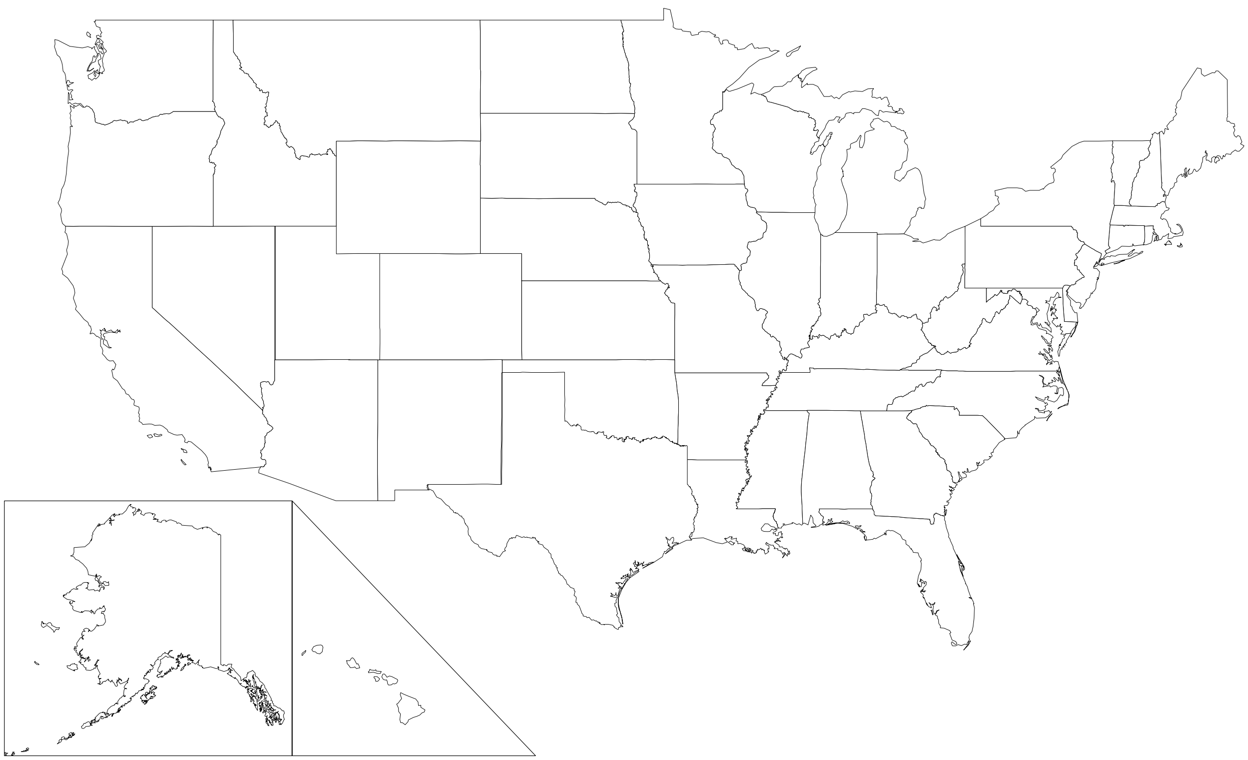
Statewide/Rural Intelligent Transportation Systems (ITS)

2004 Summary Report

July 2005



Prepared for:
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 of state departments of transportation in each of the 50 states, conducted in 2004. 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 deployment of ITS technology 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 Safety, Traffic Management, Operations and Maintenance, Surface Transportation Weather, and Traveler and Tourism Information. For each of these major areas, surveys were developed to gather data on key 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 2004 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 is sponsored by the Federal Highway Administration (FHWA) and has been gathering data on ITS deployment since 1997. Previous to 2002, the survey was limited to metropolitan areas. In 2002, the scope of this project was expanded to include tracking rural deployments in each state. The 2004 survey results are an update of the previous survey.

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

In the 2004 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 shows the states that have deployed 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.

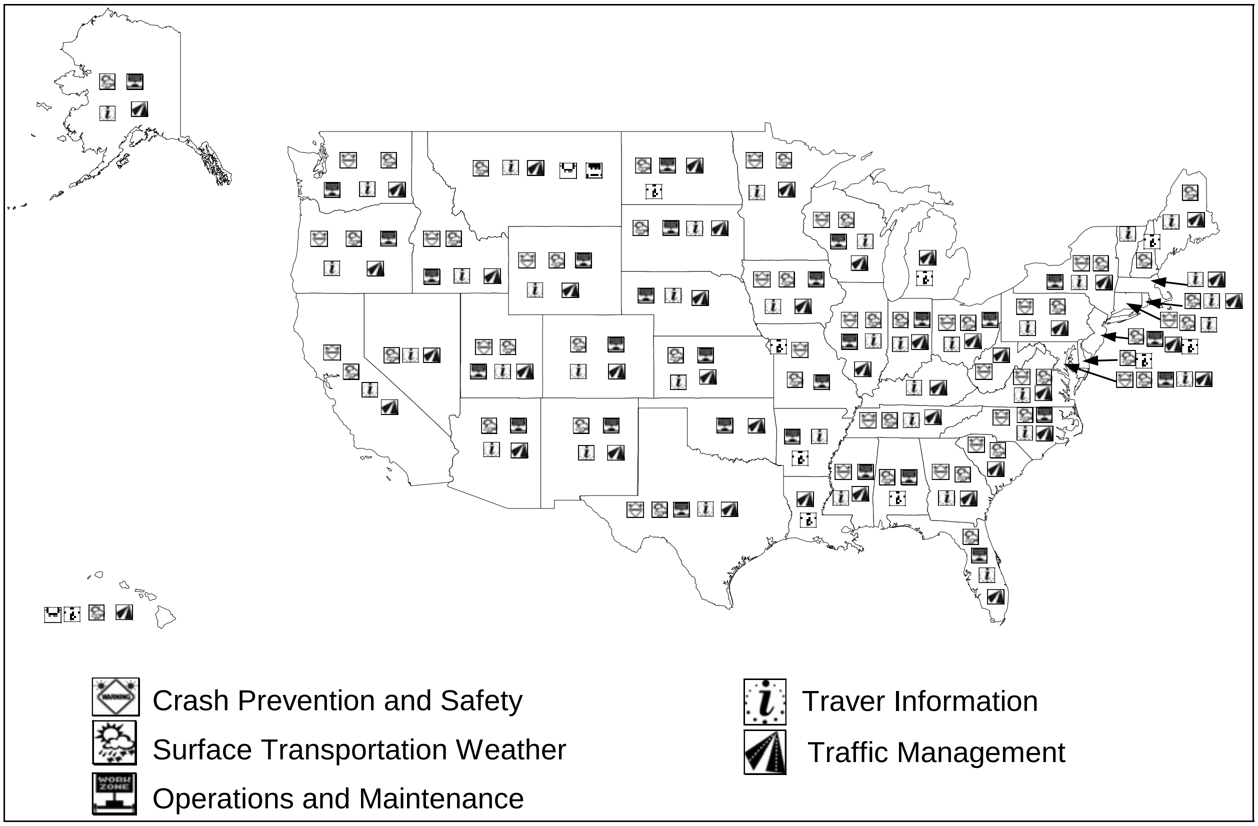


Figure 1. Statewide/Rural ITS Deployments

Crash Prevention and Safety Systems

Crash Prevention and Safety 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 2004 survey covered a variety of types of Crash Prevention and Safety 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.

- <u>Environmental Road Hazard Warning Systems</u>. 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 providing means to mitigate the hazard for travelers, such as the use of in-pavement lights to aid visibility. A total of 21 states reported deployment of Environmental Road Hazard Warning Systems. While most often reported on freeways, these systems were also deployed on other multi-lane highways and two-lane highways. The most common hazard detected is fog, followed by ice on roads and bridges.

- 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 13 states identified 143 separate Road Geometry Warning Systems. These systems were deployed generally on all types of highways. The most commonly deployment location was curves, with truck roll over warning systems the most widely deployed.

- Other types of Crash Prevention and Safety 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.

- Media for Information Dissemination. Traveler Information Systems disseminate information using a variety of media. Most frequently used, not surprisingly, is the Internet. Roadside information media are next in importance, consisting of dynamic message signs, both mobile and static, and highway advisory radio. 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: email, non-511 automated telephone, fax, television, and kiosks.

- Traveler Information Websites. The use of statewide traveler information websites was reported by 41 states. 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 these websites 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.

- Statewide 511. Statewide 511 systems are widely deployed. The variety of sources providing input to statewide 511 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, providing information on construction areas and work zones. The next most commonly reported source is state police, followed by the national weather service. Many additional sources are reported as well, including a variety of sensors and agencies; these systems appear to offer users a widely varied set of choices for traveler information.

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 2004 survey.

- Closed Circuit Television. The use of statewide and rural CCTV was reported by 35 states. The survey results show that the most important function supported by statewide CCTV systems is to monitor weather and roadway conditions, followed by detection and verification of incidents. Other important functions are to verify dynamic message signs, event management, and security. Cameras are located most frequently at major interchanges and high accident areas.

- Dynamic Message Signs (DMS). Statewide deployments of DMS support a variety of functions by providing different types of information. A total of 33 states reported deployment of rural DMS. 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 accident sites, diversions, roadway status, weather alerts, special events, and congestion. 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 30 states report deployment of Traffic Surveillance Systems. Information on traffic volume and speed are most frequently gathered by these systems, followed by vehicle classification, incidents, and travel time. The most common type of sensor deployed is loop detectors, closely followed by radar detectors.

- 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. A total of 17 states have deployed Roadway Closure Systems. These systems are deployed on all classes of highway, although most frequently on freeways.

- 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. 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 21 states have deployed Route Diversion Management Systems.

- Traffic Management Centers (TMC). A total of 22 states have deployed rural Transportation Management Centers.

Operations and Maintenance

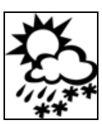
Operations and maintenance systems support safety and improve operational capabilities, and include Automatic Anti-icing Systems, Avalanche/Slide Management Systems, and Work Zone Management. Maintenance Fleet Management Systems, also included in the survey, can improve operations and take advantage 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. A total of 18 states have deployed Automatic Anti-Icing Systems. The majority of states (16) deploy these systems on bridges, but 5 states also deploy on overpasses. The most important reasons for deploying these systems are related to safety, but increasing the level of service on roadways is also an important consideration as well as reducing costs of highway treatment.

- 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. Five western states report deployment of 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. A total of 12 states report deployment of Maintenance Fleet Management Systems, most commonly for managing snow plows. 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 19 states report the use of ITS technology in rural work zones. The most function of sensors deployed at work zones is to detect travel time, followed by sensors to detect queue length and vehicle speed. 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 flashing lights and highway advisory radio.



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 42 states gather weather information to support operations.

- 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 public safety agencies, traffic management centers, and traveler information systems.

- 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, go to the ITS Deployment Tracking web site at http://www.itsdeployment.its.dot.gov. This web site contains a detailed report of all statewide/rural data received for each state. 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 2004 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, 2002, and 2004. The survey was originally limited to metropolitan areas. However, limiting the scope of the effort to major metropolitan areas did not provide a true national picture of the status of ITS deployment and missed important deployments in medium sized cities and non-urban (rural) statewide areas. During the spring and summer of 2002, the ITS Joint Program

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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.

Office undertook a new data collection effort for the 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. These surveys were again carried out in 2004.

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

In the 2004 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 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.

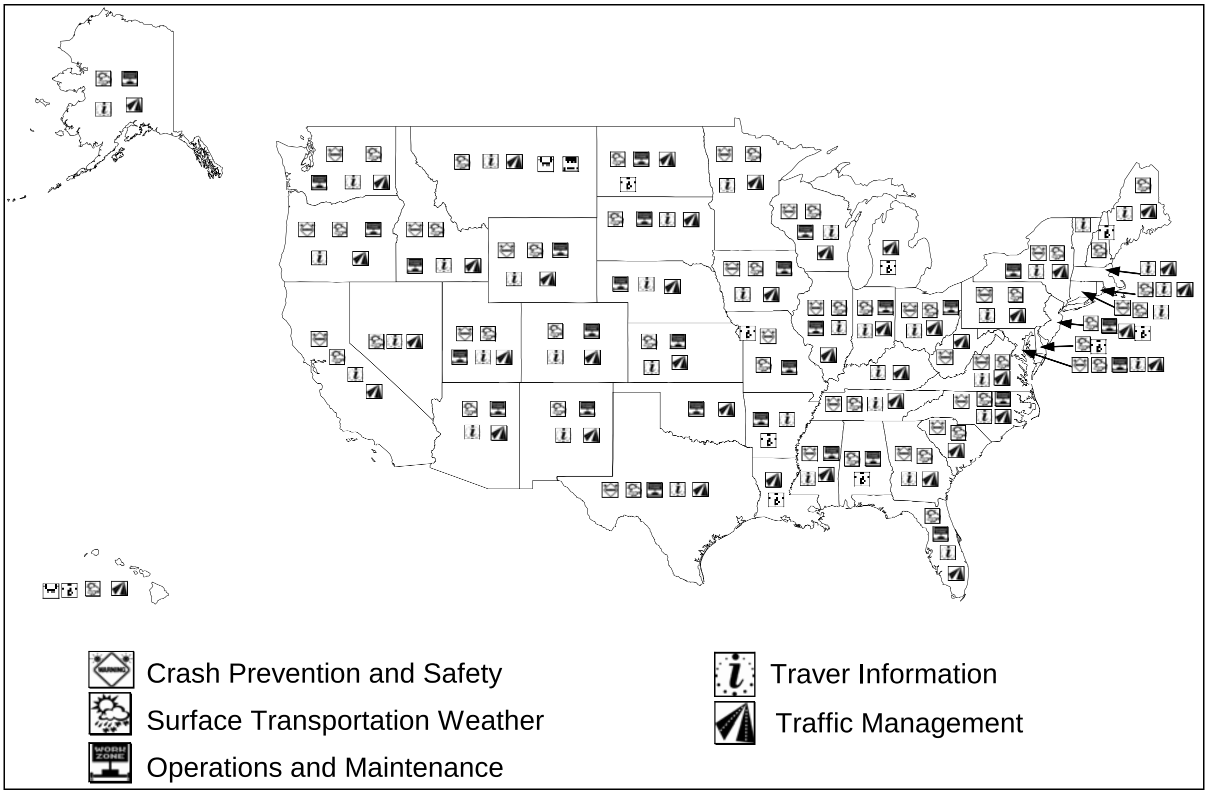

Figure 2. Statewide/Rural ITS Deployments

Subsequent sections of this report contain summarized data on each of the development tracks gathered nationwide. For those interested in more detailed information, the entire data set of the survey results is available at the ITS Deployment Tracking web site at http://www.itsdeployment.its.dot.gov. 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. 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 Safety

Crash Prevention and Safety 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 2004 survey covered a variety of types of Crash Prevention and Safety 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 Environmental Road Hazard Warning Systems. A total of 21 states reported the deployment of these systems.

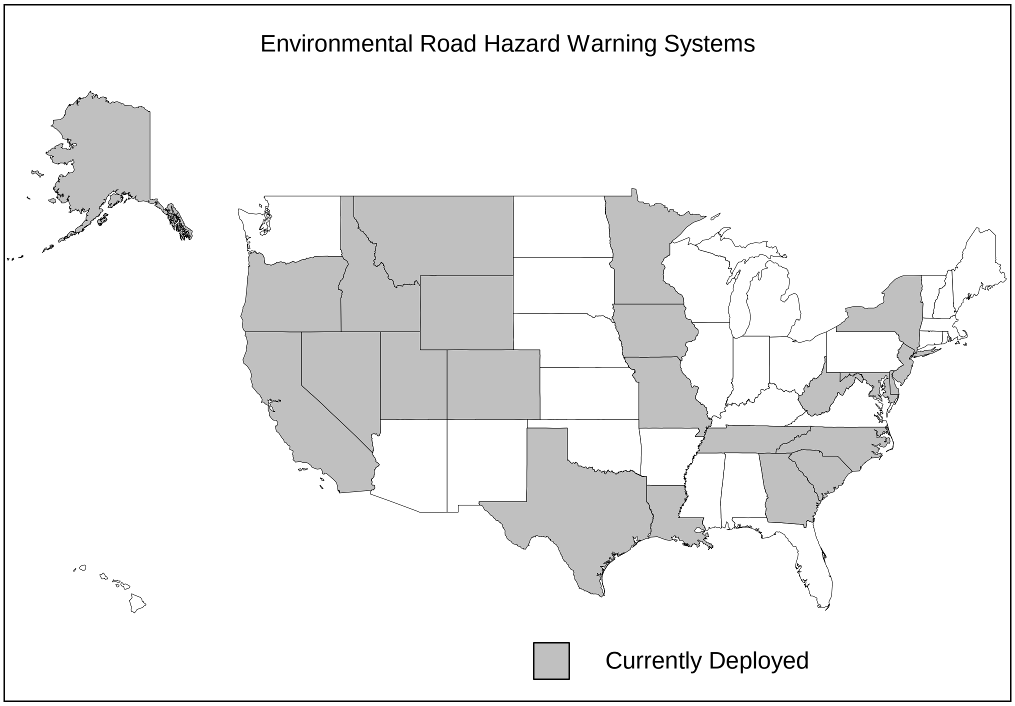

Figure 3. States Deploying Environmental Road Hazard Warning Systems

As Figure 4 illustrates, the most common placement of Environmental Road Hazard Warning Systems (147 out of 273 for which the location was reported) is on freeways. However, a substantial number of systems are also deployed on multi-lane roads (66 systems) and two lane highways (60 systems).

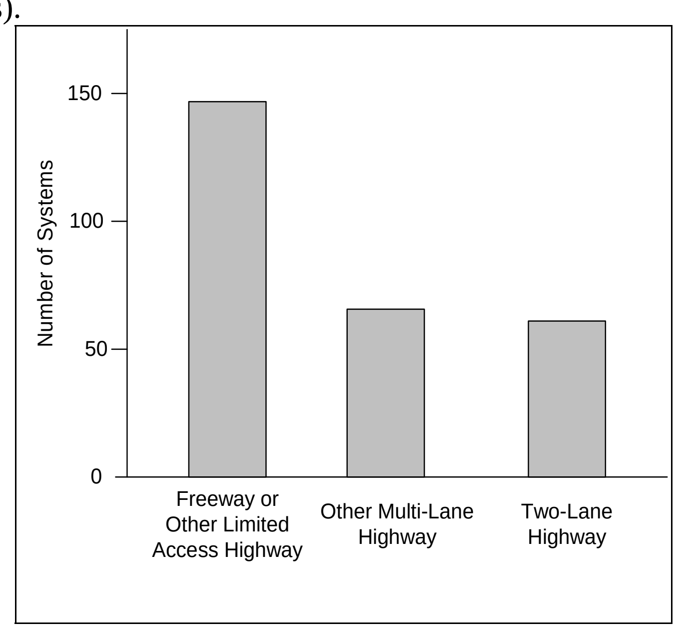

Figure 4. Road Classification of Environmental Road Hazard Warning System Locations

Environmental Road Hazard Warning systems are designed to detect a wide range of potential hazards. The number of states (out of a total of 21 states deploying these systems) reporting the capability to detect various hazards with their environmental road hazard warning systems is shown in Figure 5. The types of hazards detected include: visibility restrictions resulting from fog, snow, dust or sand, smoke; dangerous road surface conditions resulting from flooding, ice, and standing water; and, hazardous driving conditions caused by high winds. The hazard detected most often among the reporting states is fog, followed closely by ice on roads and bridges.

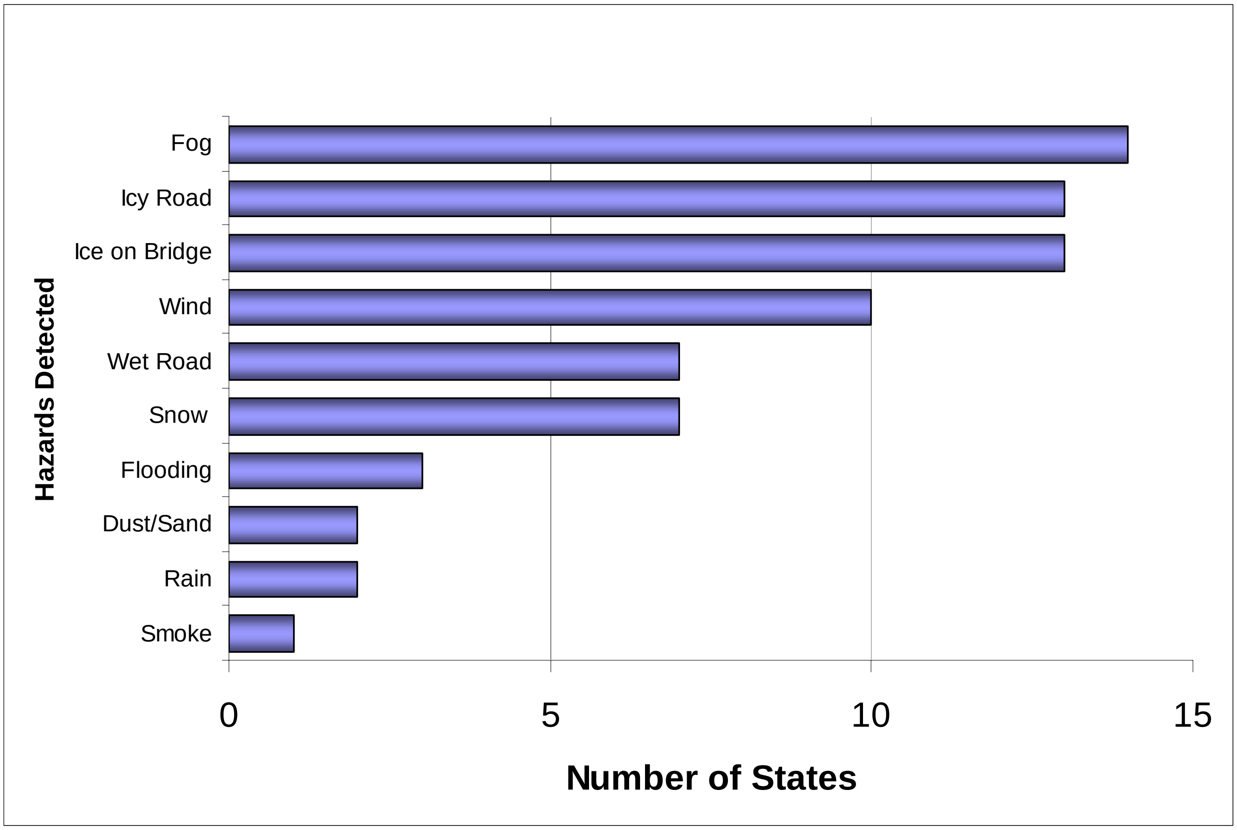

Figure 5. Environmental Road Hazard Warning System Hazards Detected

The number of states reporting the use of various detections technologies in their environmental road hazard warning systems is shown in Figure 6. These detection technologies 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, and in-pavement sensors.

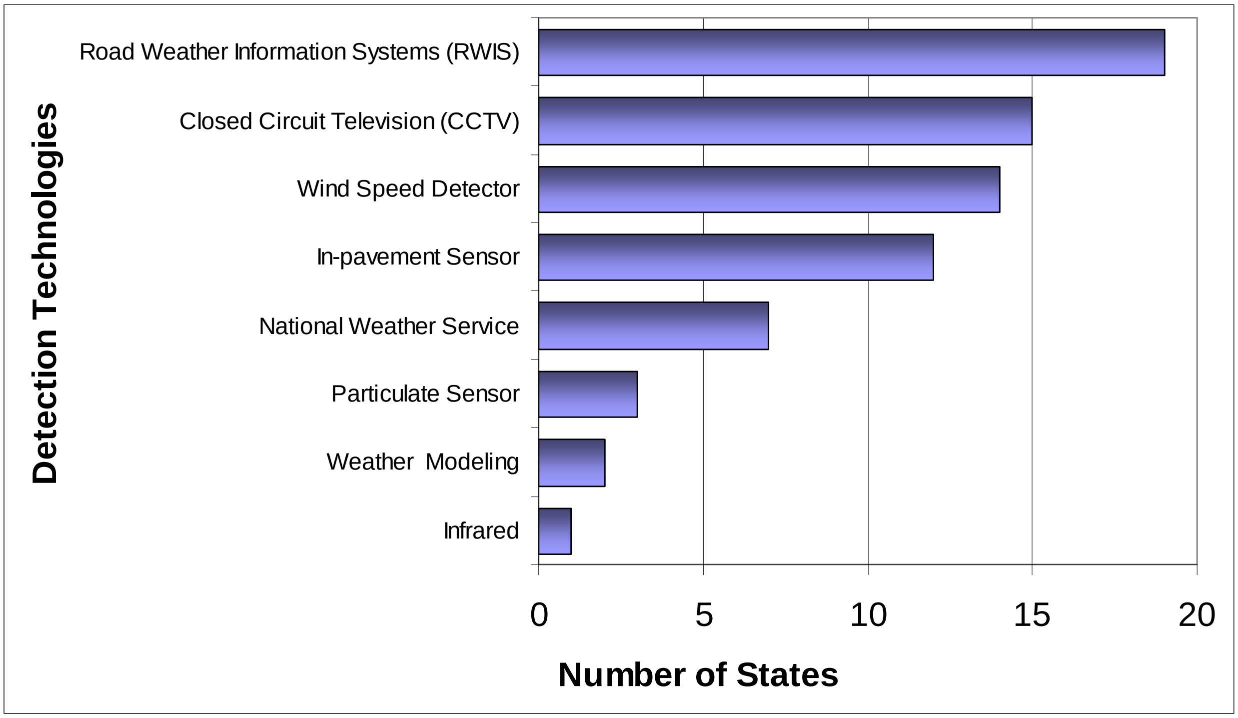

Figure 6. Environmental Road Hazard Warning System Detection Technologies

A variety of information is collected by these systems to assess the need for a warning. Table 1 shows the number of states reporting the collection of different types of information in these systems. These data show that some of the environmental warning systems detect vehicle characteristics, providing these systems with the capability of producing tailored warnings to specific vehicles of a certain classification, speed, and/or weight.

Table 1 Environmental Road Hazard Warning System: Vehicle Information Collected

Information	Number of States
Vehicle speed	9
Vehicle classification	4
Vehicle weight	2

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 9 states that utilize both dynamic message signs and flashing lights in their environmental road hazard warning systems. No states report the use of in-vehicle systems as yet.

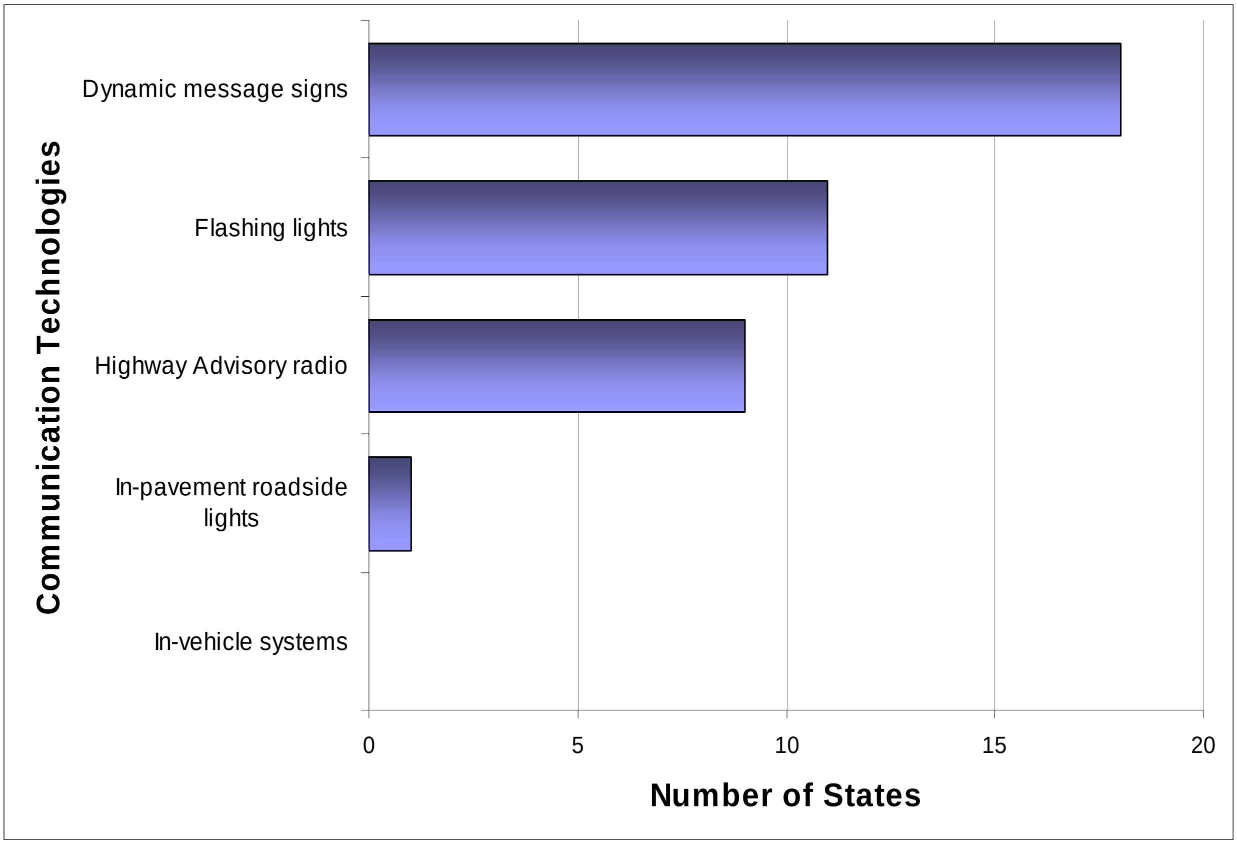

Figure 7. Environmental Road Hazard Warning System Communication Technologies

Environmental Road Hazard Warning Systems appear to be well integrated within the state infrastructure. Of the 21 states with these systems, 12 have interfaces between these systems and another system or agency. Figure 8 shows the key systems or agency types that receive data and the number of states in which Environmental Road Hazard Warning Systems share data with each. The type of agencies and systems included covers a wide range: traffic management agencies are integrated most often, followed closely by traveler information, data archiving, incident management, and various public safety agencies.

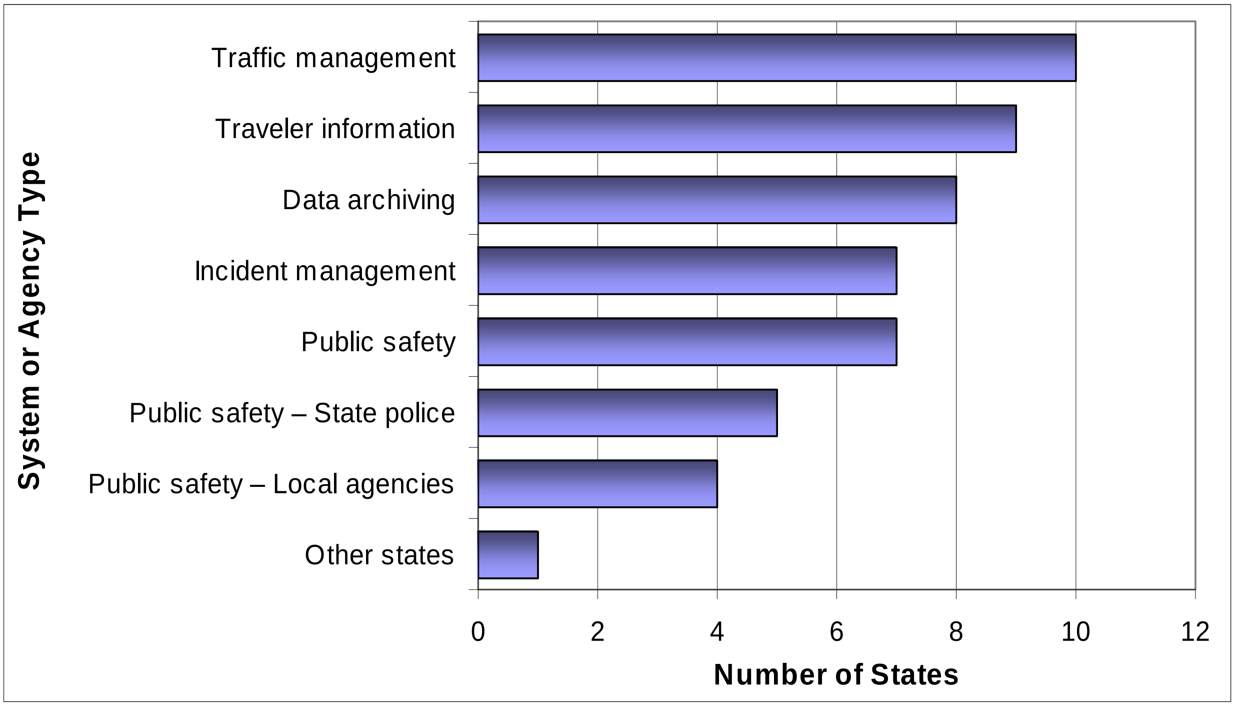

Figure 8. Agencies or Systems Interfacing with Environmental Road Hazard Warning Systems

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 Road Geometry Warning Systems. A total of 13 states have deployed these systems. Respondents identified 143 separate Road Geometry Warning Systems.

Figure 9. States Deploying Road Geometry Warning Systems

Figure 10 shows that Road Geometry Warning Systems are deployed extensively on two-lane roads as well as limited access highways. Most (60%) of the Road Geometry Warning Systems have been deployed on freeway or other limited access highways. About 40% are deployed on two-lane roads.

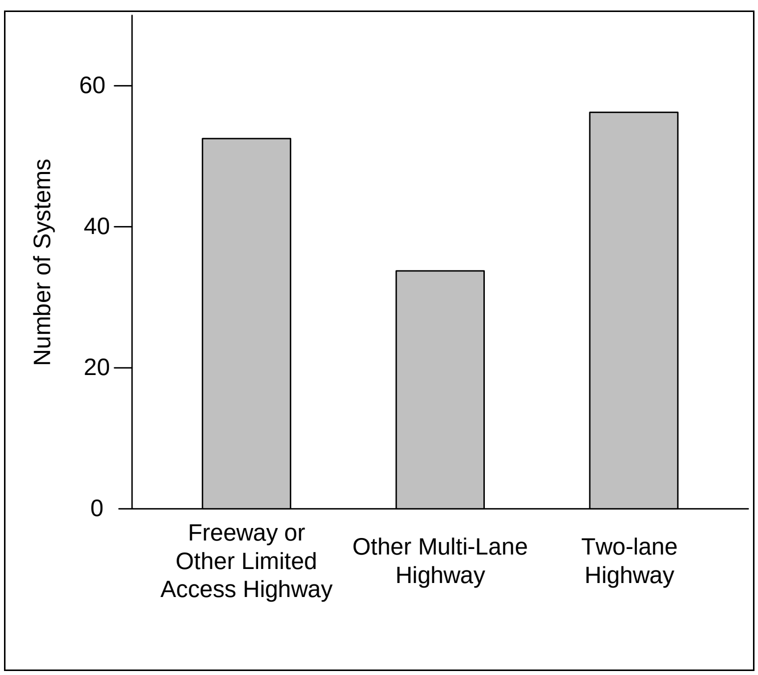

Figure 10. Road Classification of Road Geometry Warning System Locations

Figure 11 shows that the vast majority of states have deployed these systems to prevent truck roll over crashes, with 10 states reporting deployment to prevent truck roll over on curves and four to prevent roll over on steep downhill grades. Deployment of warning systems targeted at all vehicles generally is reported by a smaller number of states, about one half of the number of the states deploying truck-only systems.

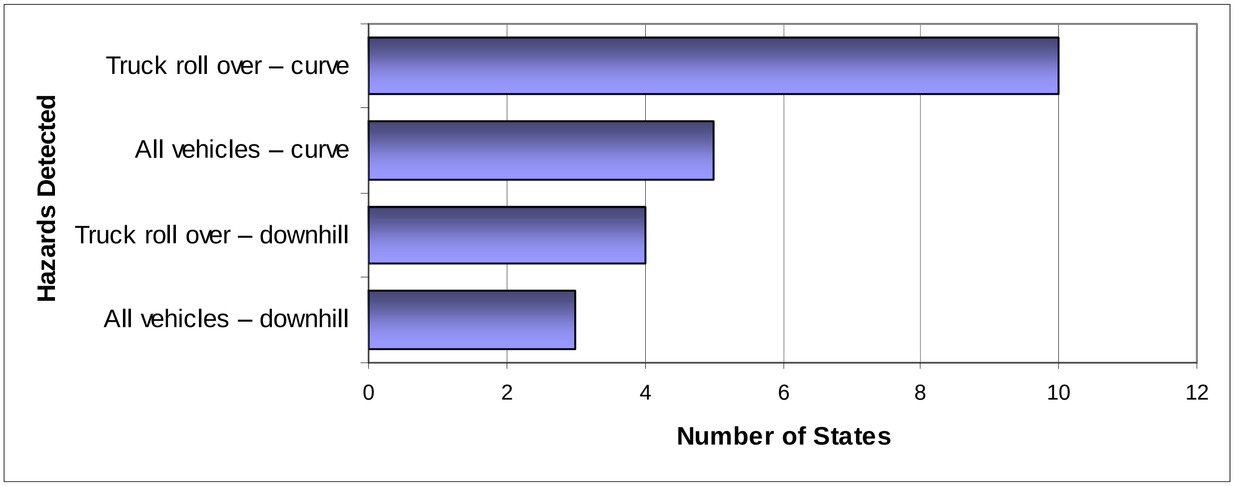

Figure 11. Road Geometry Warning System Hazards Detected

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. With this additional information, these systems have the capability of assessing the danger to individual vehicles based on conditions and characteristics of the vehicle and can provide warnings targeted to specific vehicles.

Table 2 Road Geometry Warning System Information Collected

Information	Number of States
Vehicle speed	9
Vehicle classification	5
Vehicle height	4
Vehicle weight (weigh-in-motion)	3

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 half as many states as employ flashing lights. Highway advisory radio is also employed in one state. No in-vehicle systems are reported as of 2004.

Table 3 Road Geometry Warning System Communication Technologies

Technology	Number of States
Flashing lights	11
Dynamic message signs	7
Highway advisory radio	1
In-vehicle	0

Table 4 shows that states provide tailored information to a specific vehicle, and generic warnings in equal numbers. The widespread use of tailored warnings shows 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 States
Tailored information to specific vehicles	8
Generic warning to all vehicles	8

Table 5 shows that Road Geometry Warning Systems are lightly integrated within the statewide infrastructure.

Table 5 Systems with Which Road Geometry Warning System Interface

System or Agency Type	Number of States
Traffic management	2
Data archiving	2
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 5 states that reported having deployed Rail-Highway Crossing Safety Systems in non-metropolitan areas.

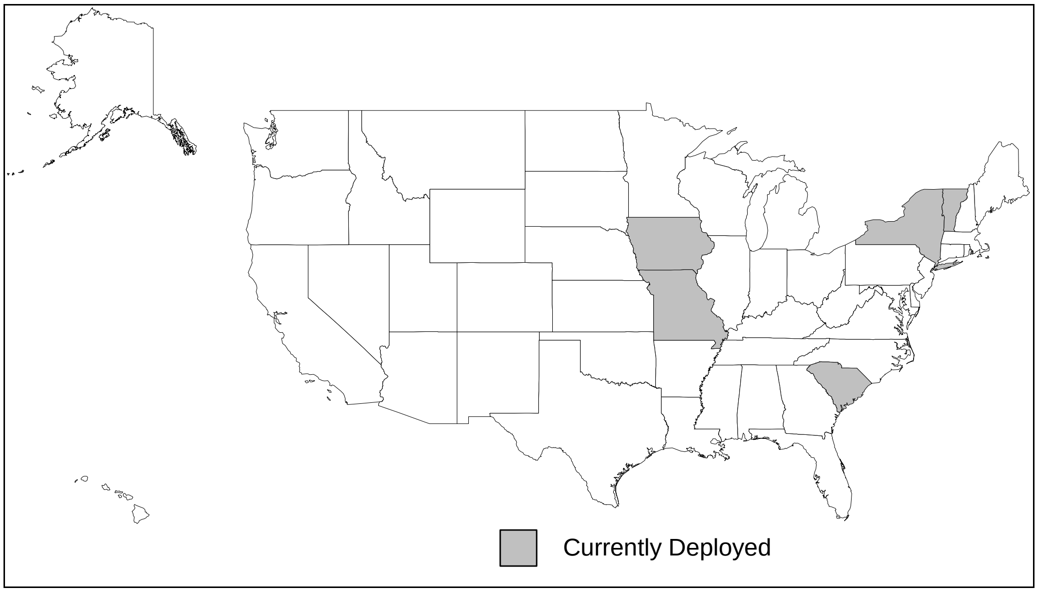

Figure 12. States Deploying Rail-Highway Crossing Safety Systems

Rail-Highway Crossing Safety Systems have been deployed on all three road classifications, as shown in Figure 13. Two states reported placing these systems on each of the three classifications.

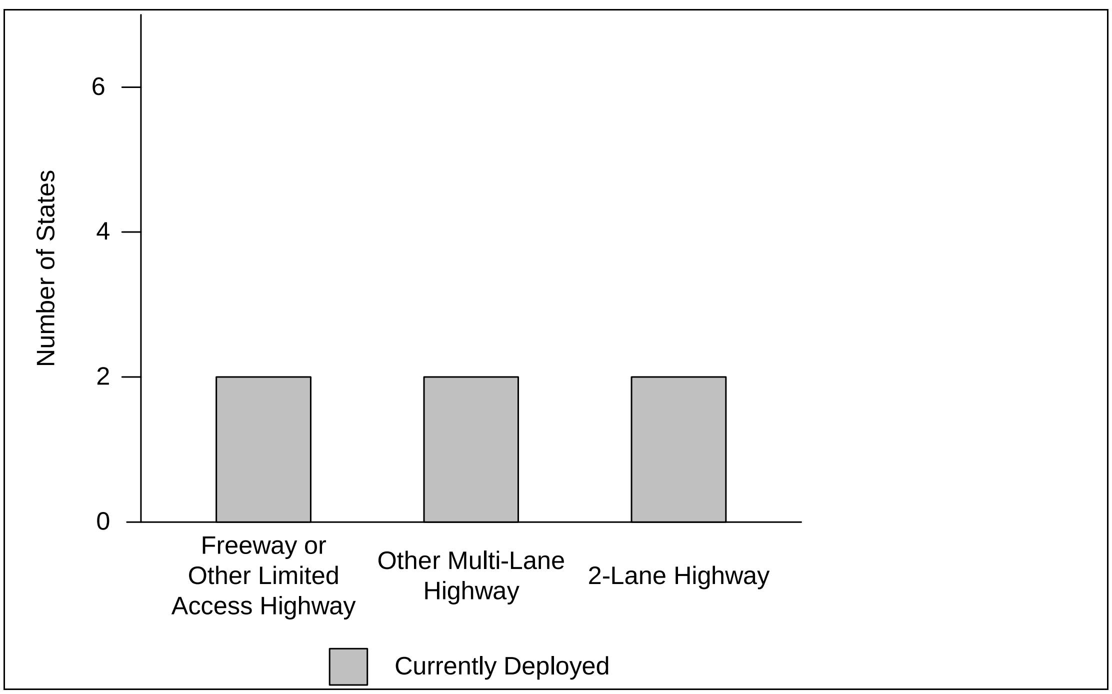

Figure 13. Road Classification of Rail-Highway Crossing Safety System Locations

Table 6 provides a list of the information collected by these systems. Of five states which reported these systems, three reported detection of train presence while one state each reported having systems with the capability of detecting train speed, approach by a second train, or vehicle intrusion.

Table 6 Rail-Highway Crossing Safety System Information Collected

Information	Number of States
Train presence	3
Train speed	1
Second train approaching	1
Detection of vehicle intrusion	1

Table 7 shows that flashing lights and dynamic message signs are reported as communications media. As yet, no in-vehicle communications are reported.

Table 7 Rail-Highway Crossing Safety System Communication Technologies

Technology	Number of States
Flashing lights	2
Dynamic message signs	2
In-vehicle	0
Highway advisory radio	0

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 States
Traffic management	1
Public safety	0
Incident management	0

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 Intersection Crossing Detection Systems. A total of five states have deployed Intersection Crossing Detection Systems.

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.

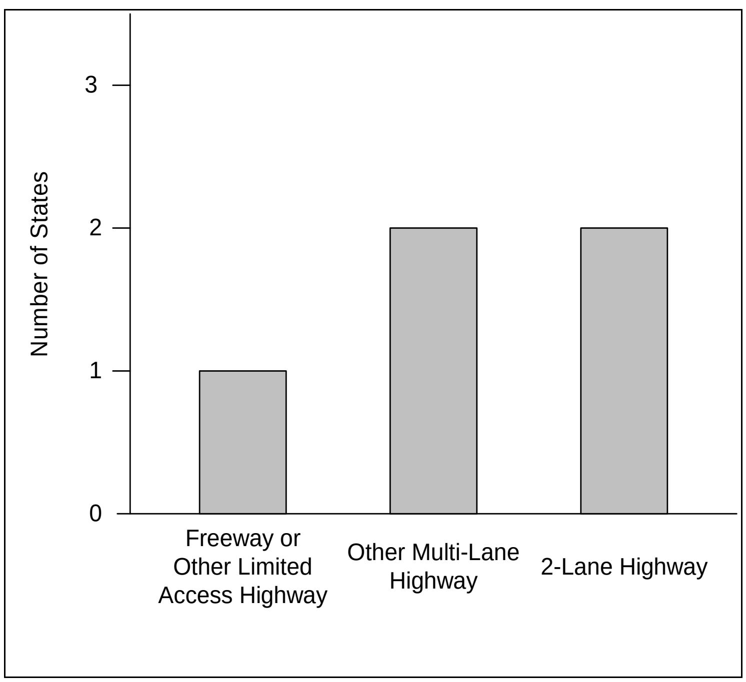

Figure 15. Road Classification of Intersection Crossing Detection System Locations

Table 9 and 10 list the locations of vehicle detectors and the technology used to communicate the presence of vehicles in the intersection respectively. These systems are not well integrated within the statewide infrastructure shown in Table 11.

Table 9 Intersection Crossing Detection System Vehicle Detector Locations

Location	Number of States
Sensor on all legs of an intersection	2
Sensors on the major road only	1
Sensors on the minor road only	2

Table 10 Intersection Crossing Detection System Communication Technologies

Technology	Number of States
Flashing lights	3
Dynamic message signs	3

Table 11 Systems that Intersection Crossing Detection System Interfaces with

System or Agency Type	Number of States
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 Animal Warning Systems. A total of five states reported deployment of Animal Warning Systems.

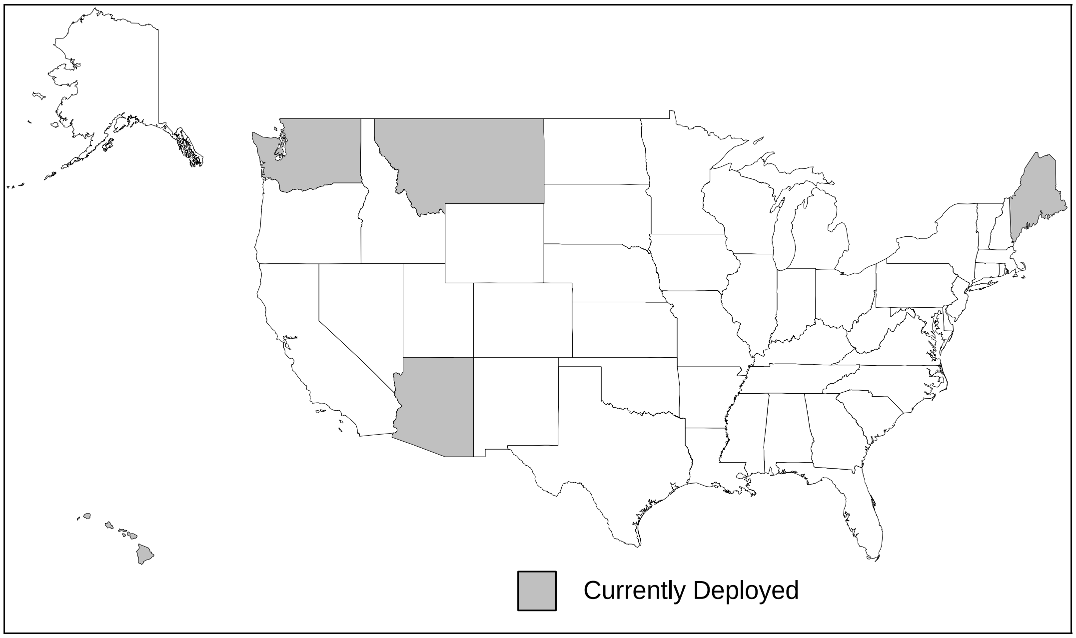

Figure 16. States Deploying Animal Warning Systems

Figure 17 shows that Animal Warning Systems have been deployed on all three road classifications, with most of the states choosing to deploy on two-lane highways.

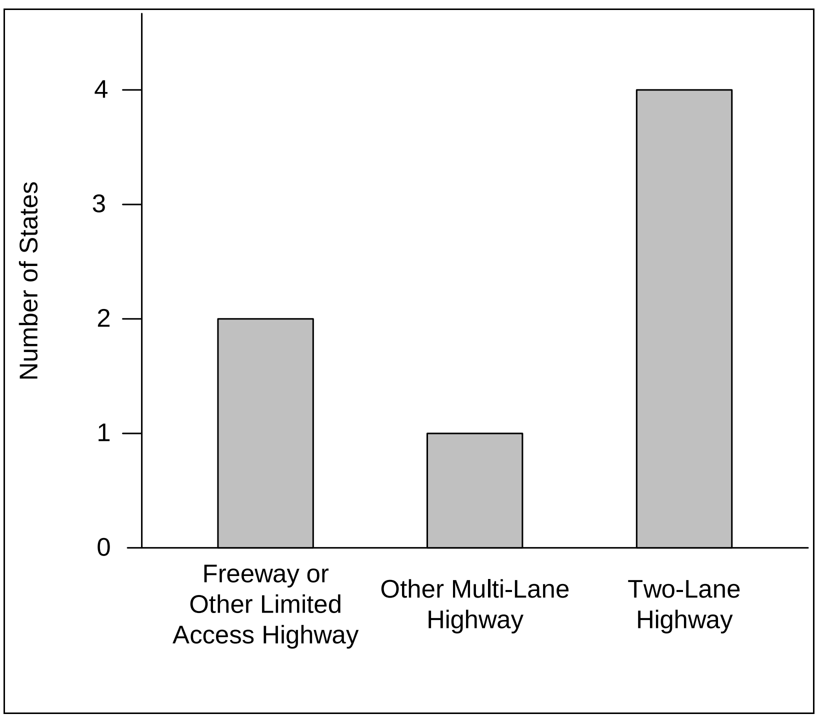

Figure 17. Road Classification of Animal Warning System Locations

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 States
Radio transmitter collars for animals	1
Radar and motion detection	1
Video detectors	1

Table 13 Animal Warning System Communication Technologies

Technology	Number of States
Flashing lights	4
Dynamic message signs	2
Highway advisory radio	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 Bicycle Warning Systems. A total of four states have deployed these systems.

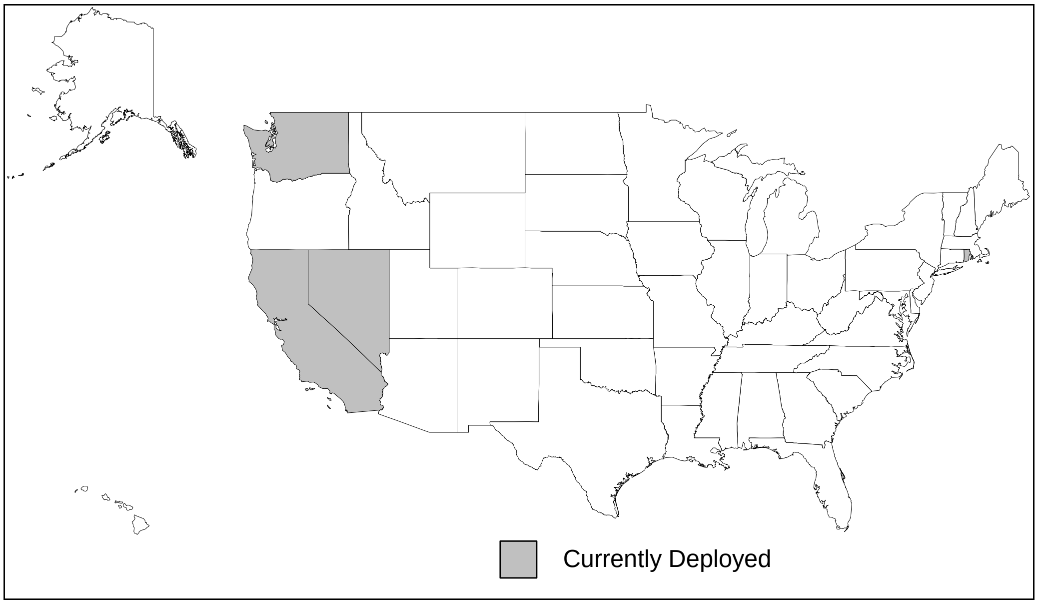

Figure 18. States Deploying Bicycle Warning Systems

All 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 States
Tunnel	3
Road section with restricted visibility	2

Table 15 Bicycle Warning System Detection Techologies

Technology	Number of States
Manual	4
Automatic	2

Table 16 Bicycle Warning System Communication Technologies

Technology	Number of States
Flashing lights	4
Dynamic message signs	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 Pedestrian Safety Systems. A total of nine states reported deployment of these systems.

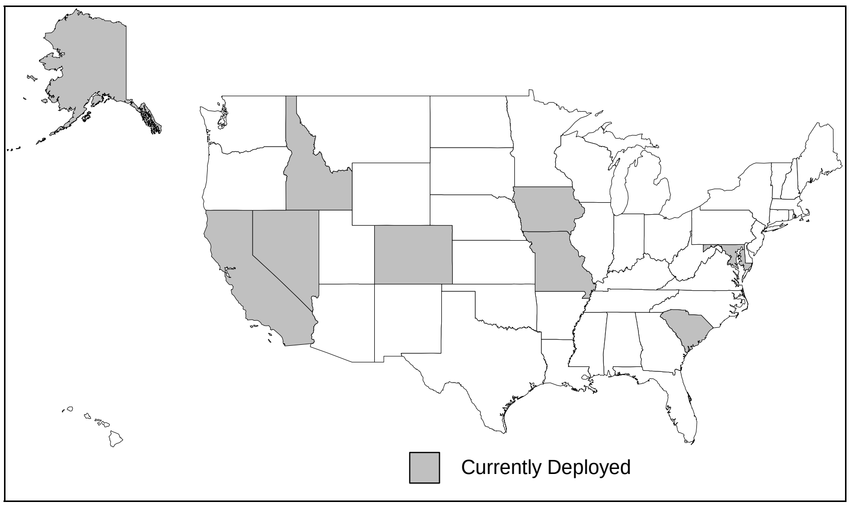

Figure 19. States Deploying Pedestrian Safety Systems

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

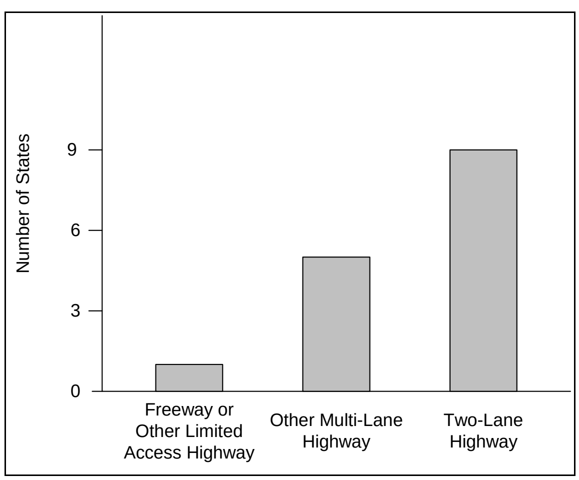

Figure 20. Road Classification of Pedestrian Safety System Locations

Table 17 lists the technologies used to detect pedestrian presence. While the majority of these systems are manual, several states employ sensors to detect the presence of pedestrians or vehicles. 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 poorly integrated with other elements of the statewide infrastructure.

Table 17 Pedestrian Safety System Detection Technologies

Technology	Number of States
Manually operated pedestrian detector	7
Infrared pedestrian detector	3
Microwave pedestrian detector	1
Vehicle detection sensors	1

Table 18 Pedestrian Safety System Communication Technologies

Technology	Number of States
In-pavement lights illuminate crosswalk	7
Flashing lights	5
Illuminated crosswalk signs.	3
Dynamic message signs	1

Table 19 Systems with Which Pedestrian Safety Systems Interface

System or Agency Type	Number of States
Data Archiving	1
Public safety – local agencies	0
Public safety – state police	0
Traffic management	0

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.

Traveler Information Systems disseminate information using a variety of media. Figure 21 shows the different types of media reported in use. Most frequently used is the Internet. Dynamic message signs, both static and mobile are next most frequently reported, followed closely by commercial television. The use of 511 telephone service is an important medium as well, and was reported about one half as frequently as the Internet. Other important media for disseminating traveler information are: email, non-511 automated telephone, fax, staffed telephone, and kiosks.

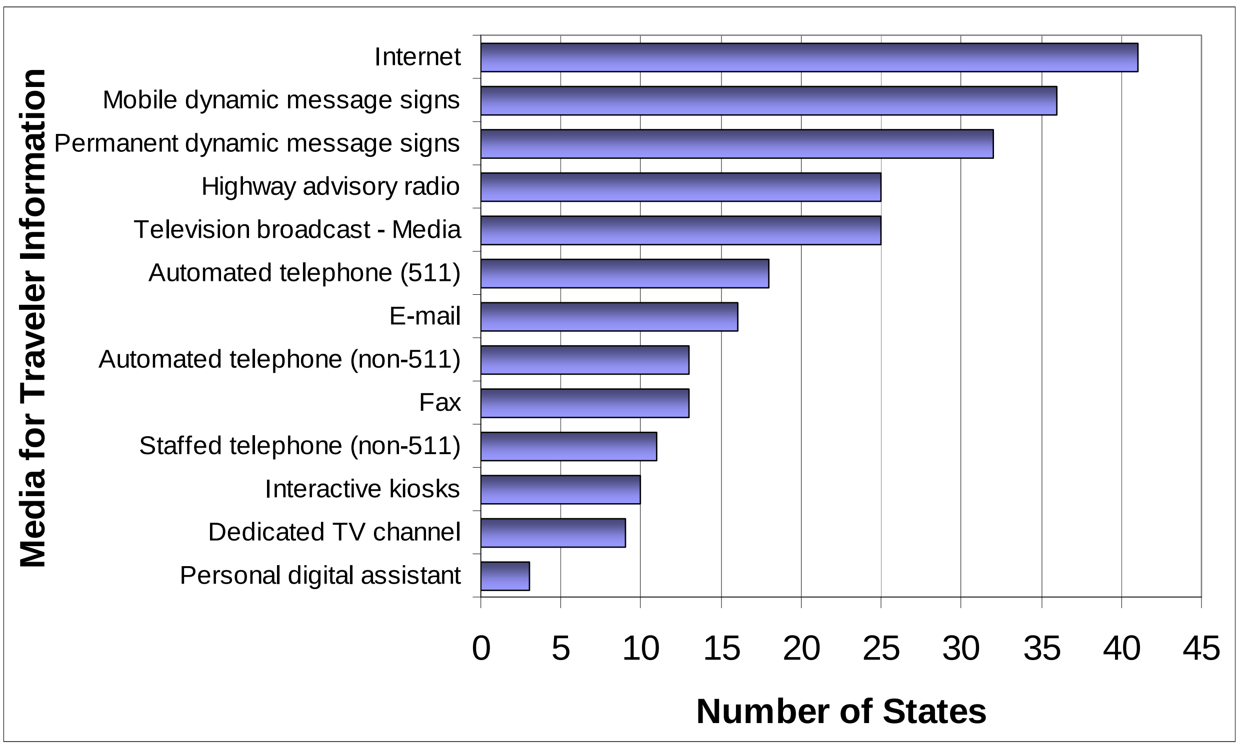

Figure 21. Technologies Used to Disseminate Traveler Information

Statewide Traveler Information Websites

These systems have been widely deployed. Figure 22 highlights the states that have deployed statewide or regional traveler information websites. A total of 42 states reported deployment of these websites. Figure 23 shows that the road classification coverage of these websites is broad, with no particular emphasis on freeways, multi-lane roads, or two-lane highways.

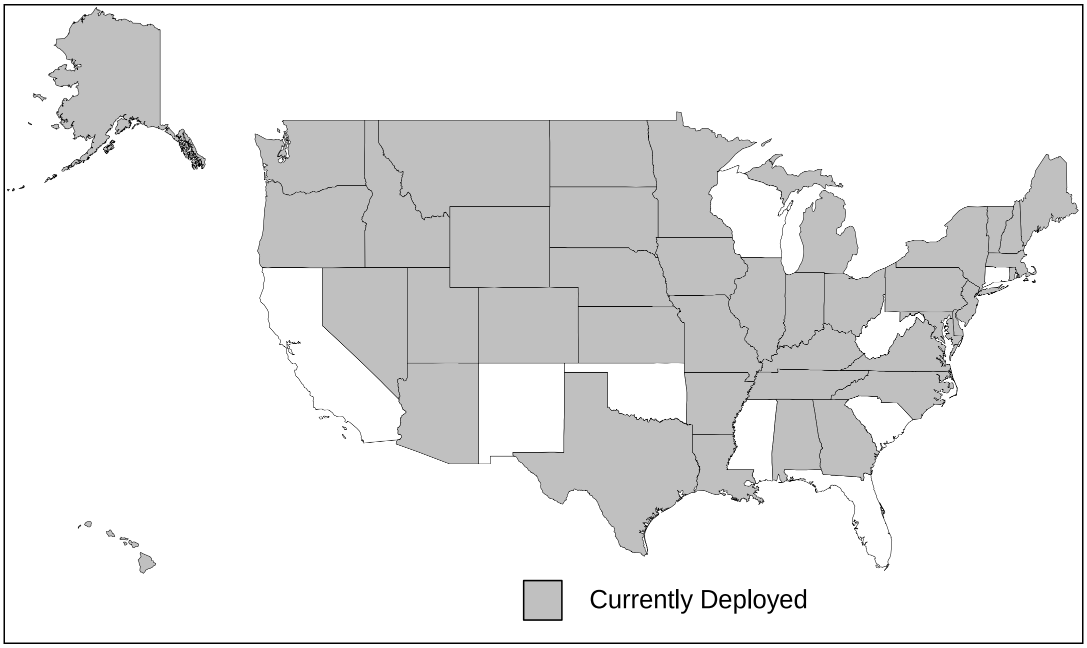

Figure 22. States Deploying Traveler Information Websites

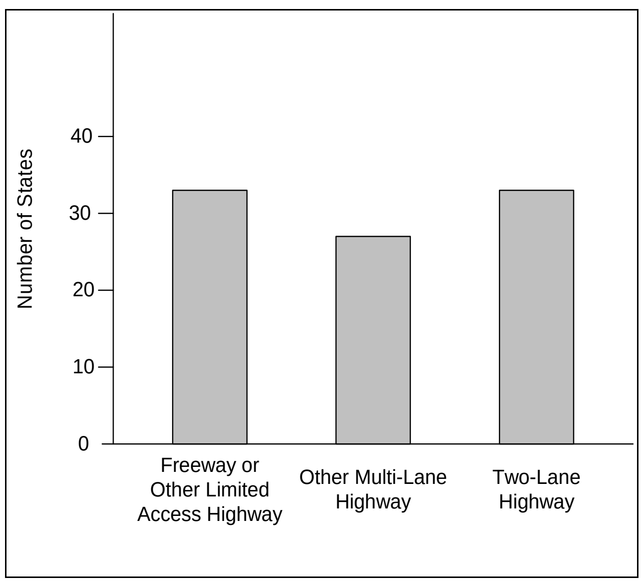

Figure 23. Road Classification of Statewide Traveler Information Websites

Figure 24 shows the types of information disseminated by the traveler information websites. 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 work zones and road closures most widely included, closely followed by information on road surface conditions, incidents, weather, road restrictions and detours. Additional roadway information provided by of traveler information websites includes CCTV images, congestion, alternate routes, and, through the use of traffic surveillance systems, travel speeds and travel times. Information on tourism also available through these systems, but is less frequently reported. The most often reported capability is maps, followed by special event information, and directions. Transit information is also widely included, but less frequently than roadway information with schedules for bus service most often included, followed by rail and ferry schedules. An important additional capability of many of the statewide websites is the reporting of Amber alert information, reported by 20 states.

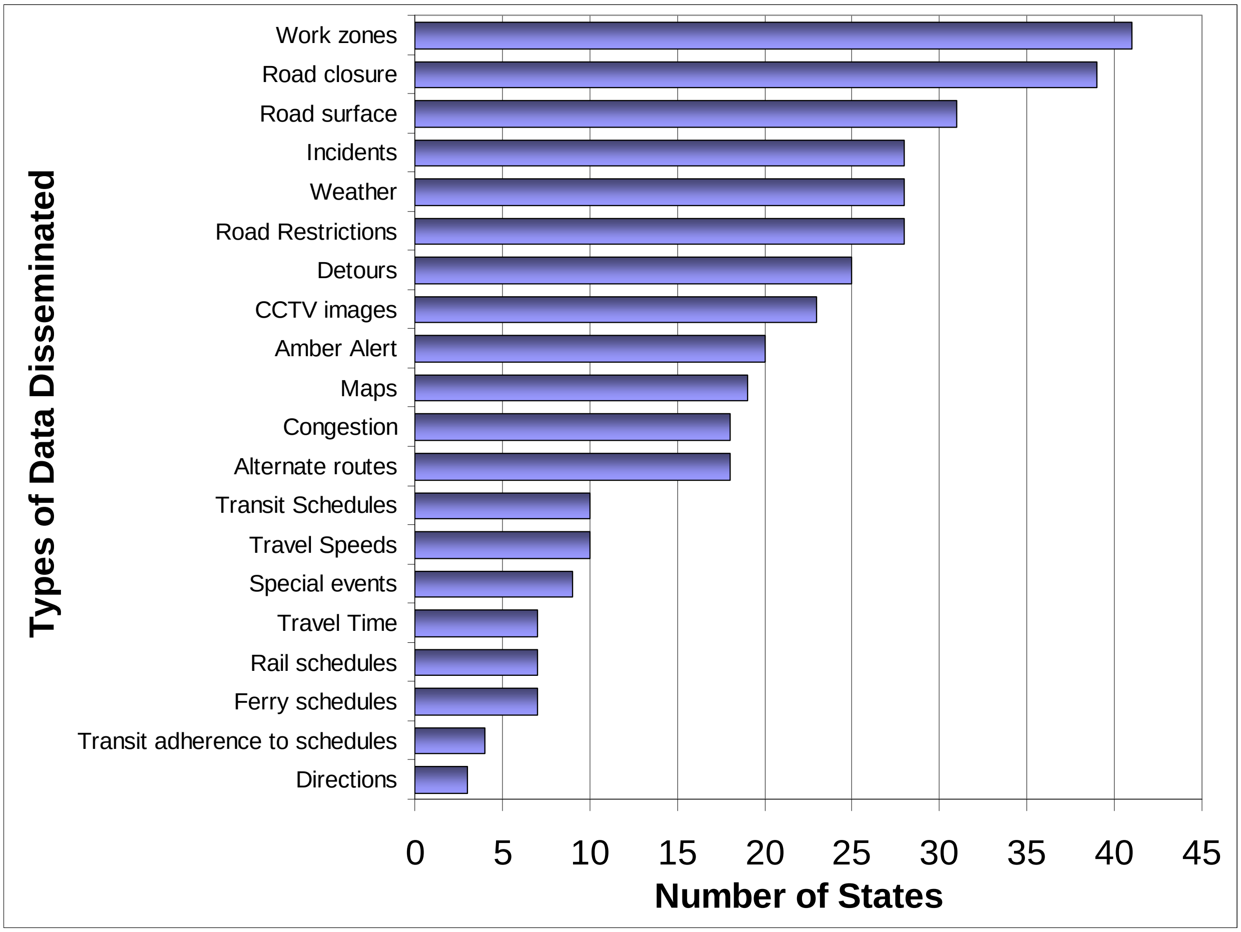

Figure 24. Information disseminated by Traveler Information Websites

Statewide 511

Statewide 511 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, which provide information on construction areas and work zones; public safety, including state and local police; weather information, from the national weather service, weather sensors and road surface sensors; and traffic and incident management, including loop detector data and CCTV images. Information service providers, public transportation, and news media are also mentioned as sources. Overall, this collection of data sources offers users a widely varied set of choices for traveler information from statewide 511 systems.

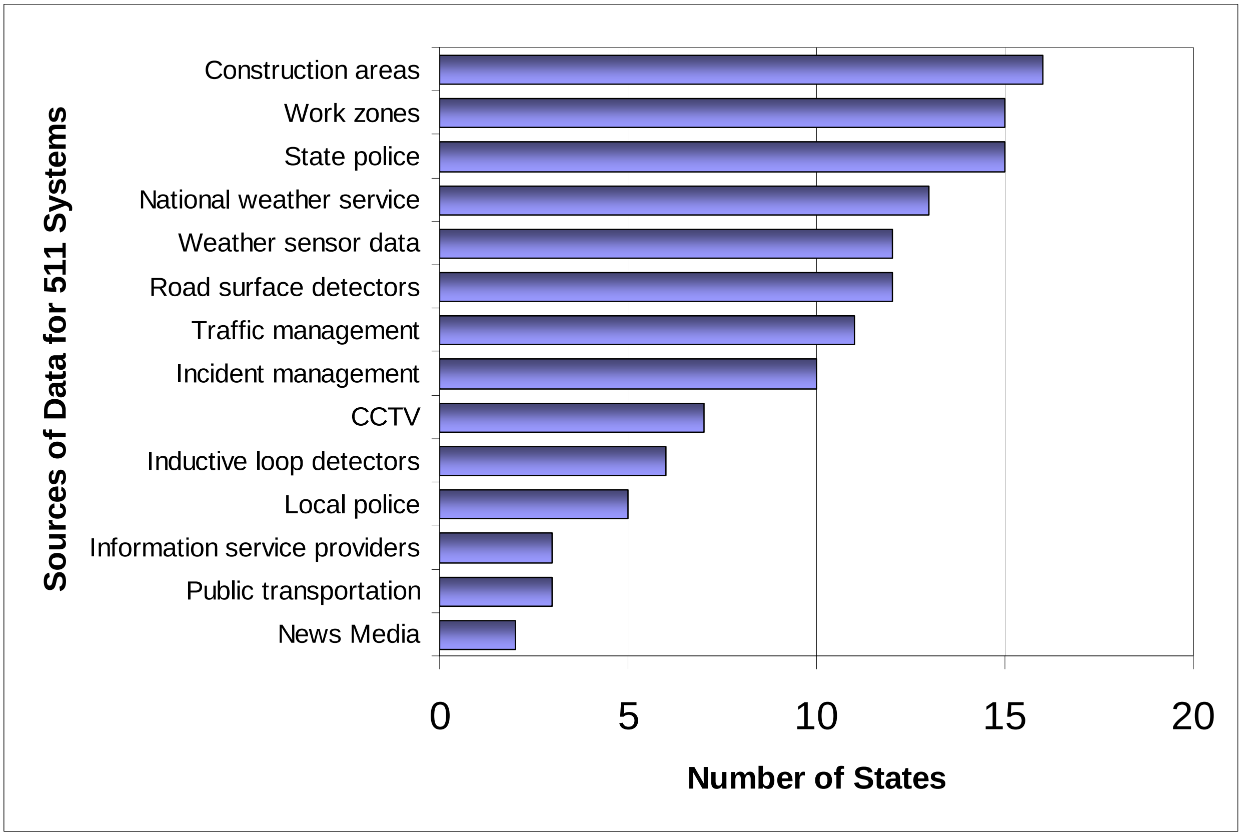

Figure 25. Data Sources for 511 Traveler Information Systems

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 35 states that have deployed Closed Circuit Television Systems in non-urban areas.

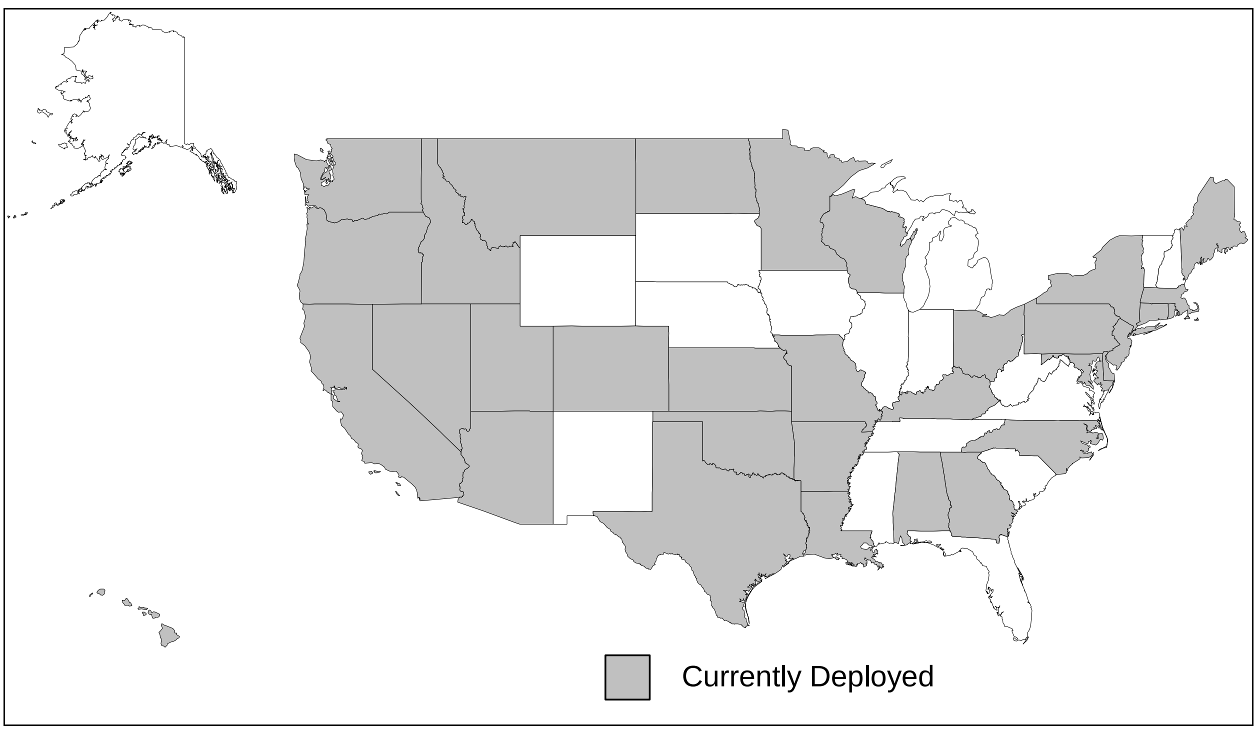

Figure 26. States Deploying Closed Circuit Television Systems

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

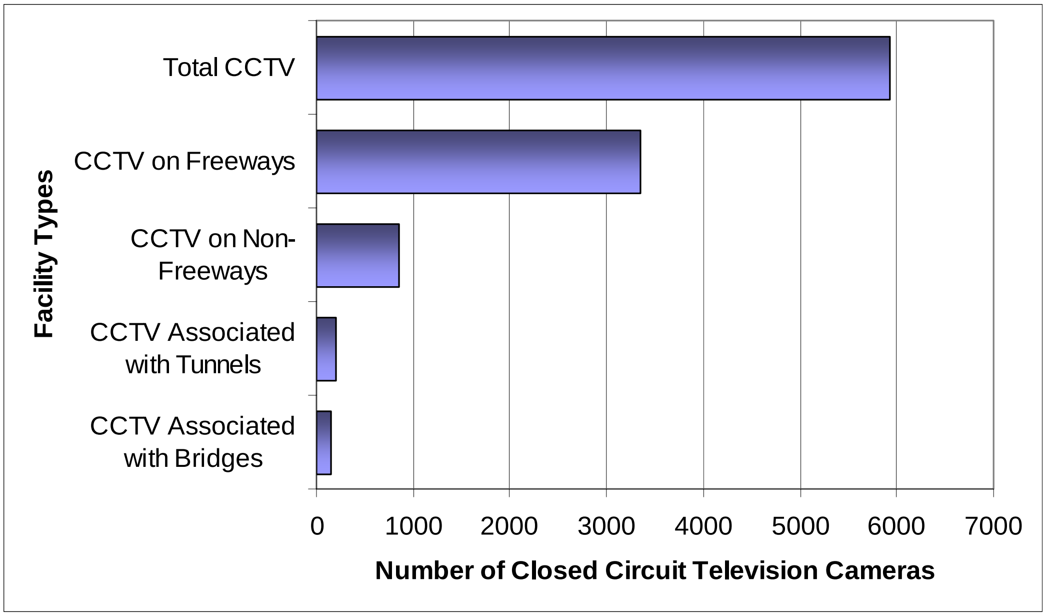

Figure 27. Facilities Supported by Deployment of CCTV

Figure 28 shows the major functions supported by statewide CCTV systems. Three key functions for CCTV in rural settings are reported by 30 or more states: monitoring weather, monitoring roadways, and incident detection and verification. Other important functions are to monitor dynamic message signs, manage events, and provide security.

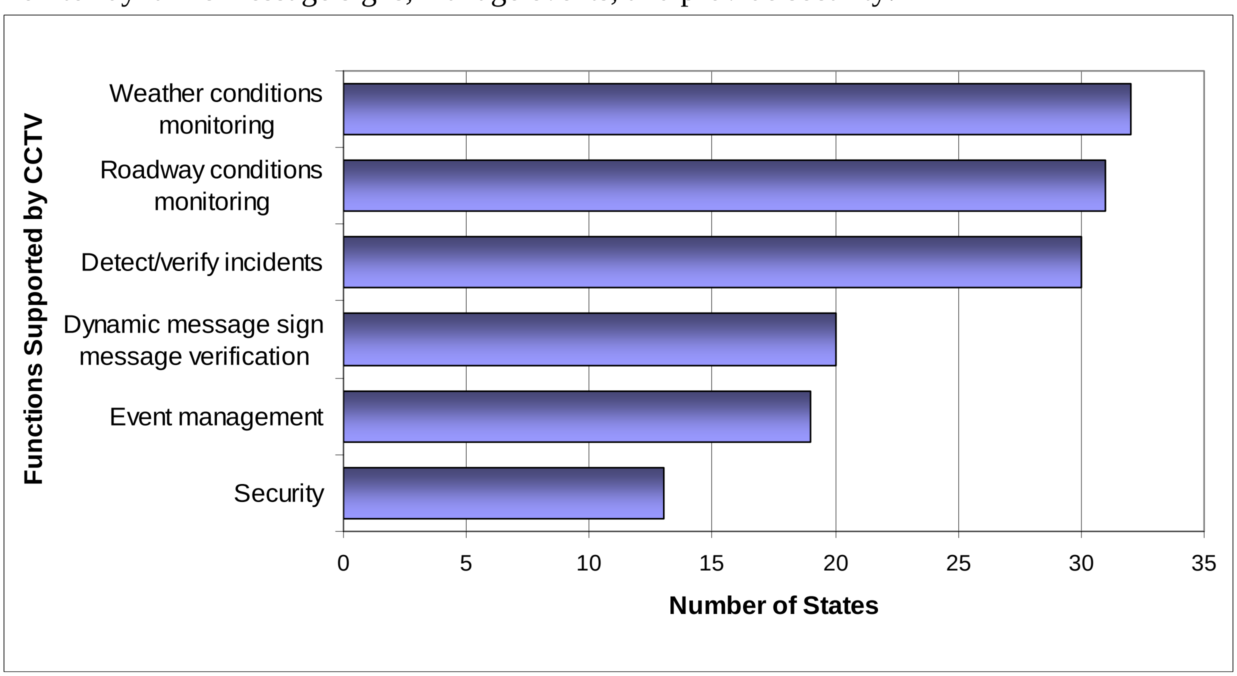

Figure 28. Functions Supported by Statewide CCTV

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.

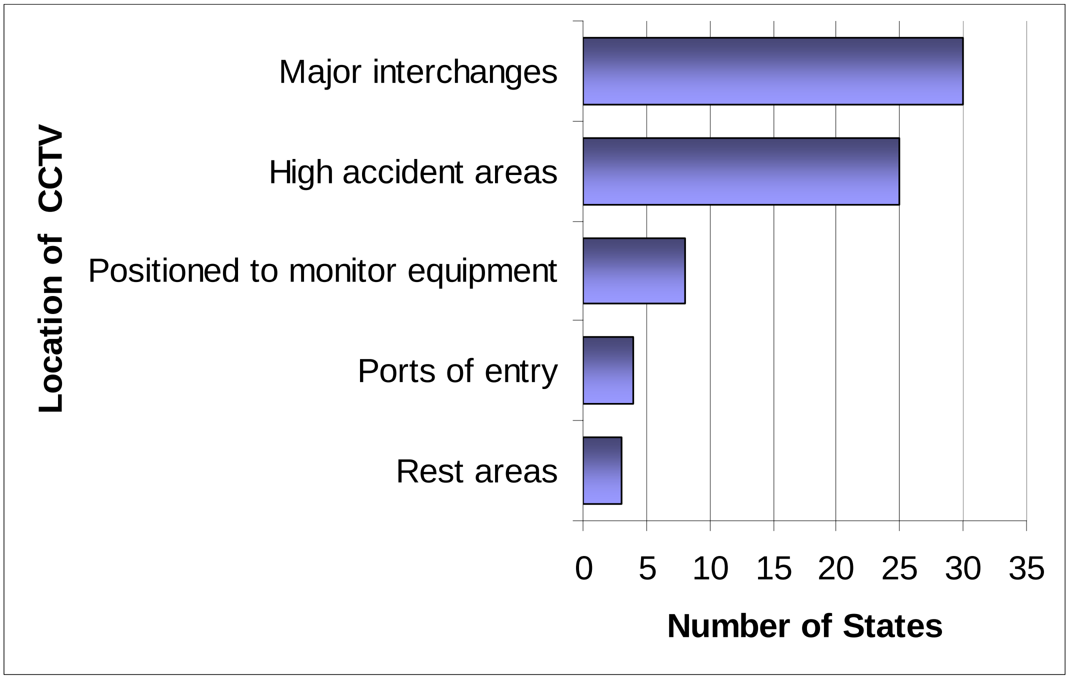

Figure 29. Location of CCTV Cameras

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 33 states that report having deployed DMS in non-urban areas. Figure 31 shows that the number of mobile DMS is about two-thirds that of permanent signs. As yet, the deployment of dynamic message signs on non-freeways is very limited.

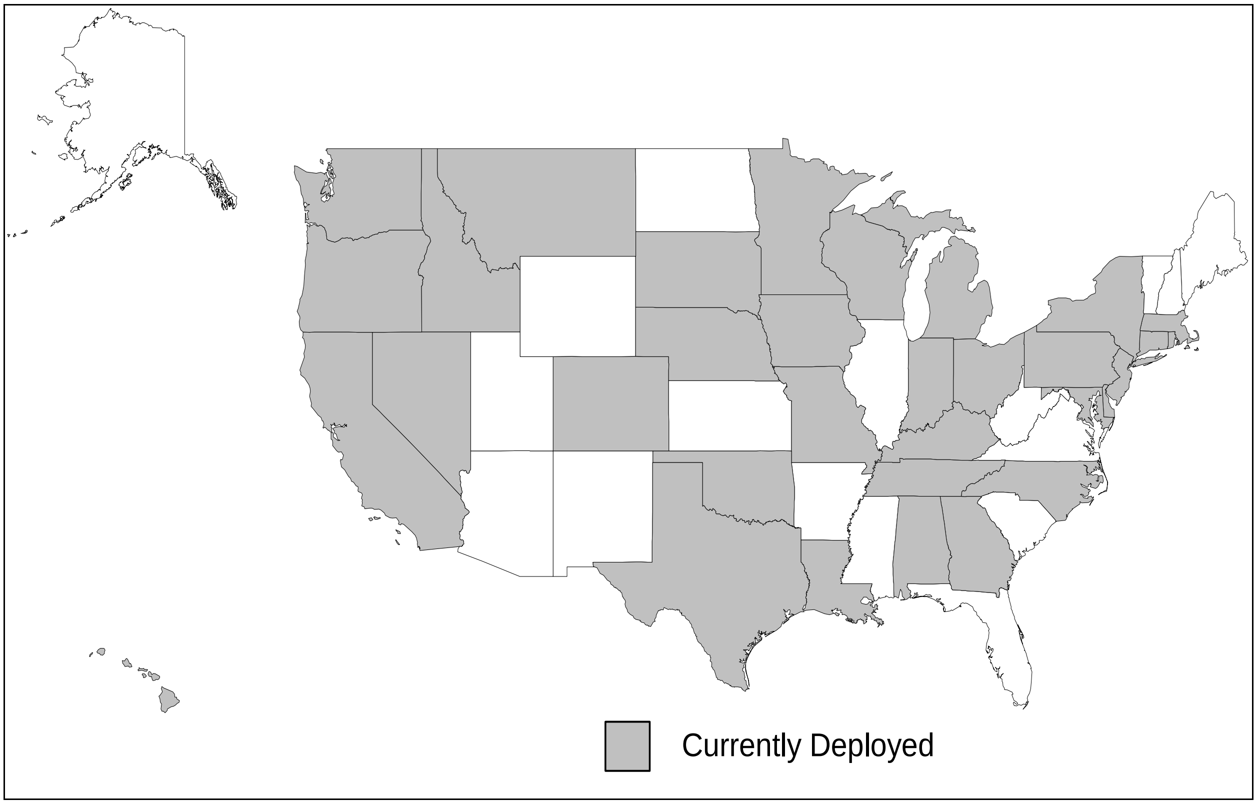

Figure 30. States Deploying Dynamic Message Sign Systems

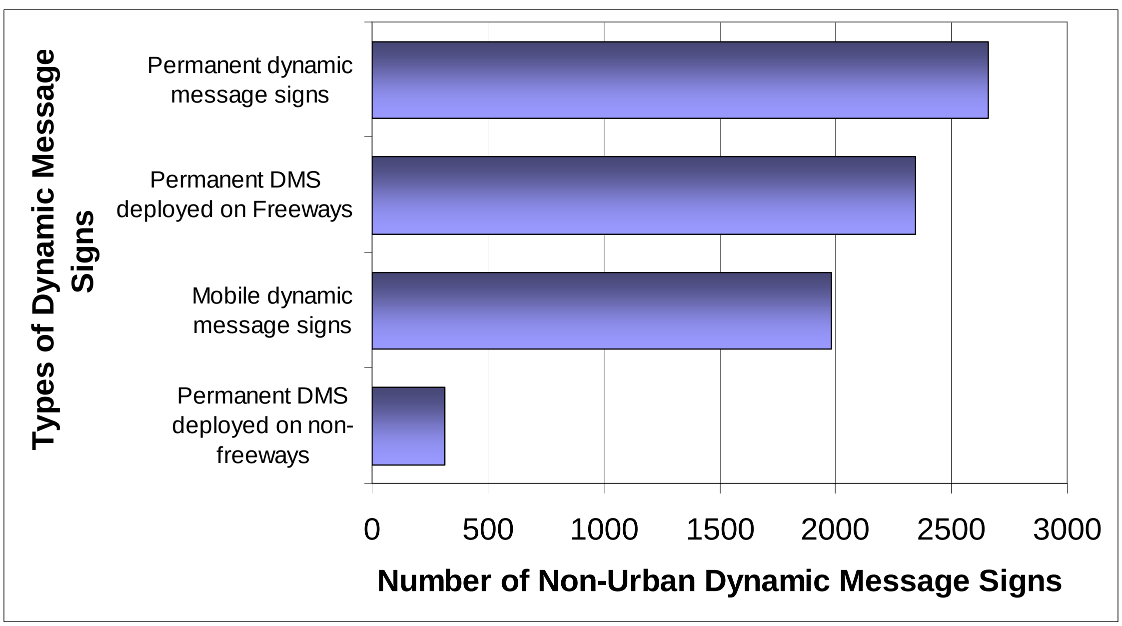

Figure 31. Numbers of Dynamic Message Signs Deployed by Type

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 accident sites, and diversions, and roadway status and congestion reports. 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.

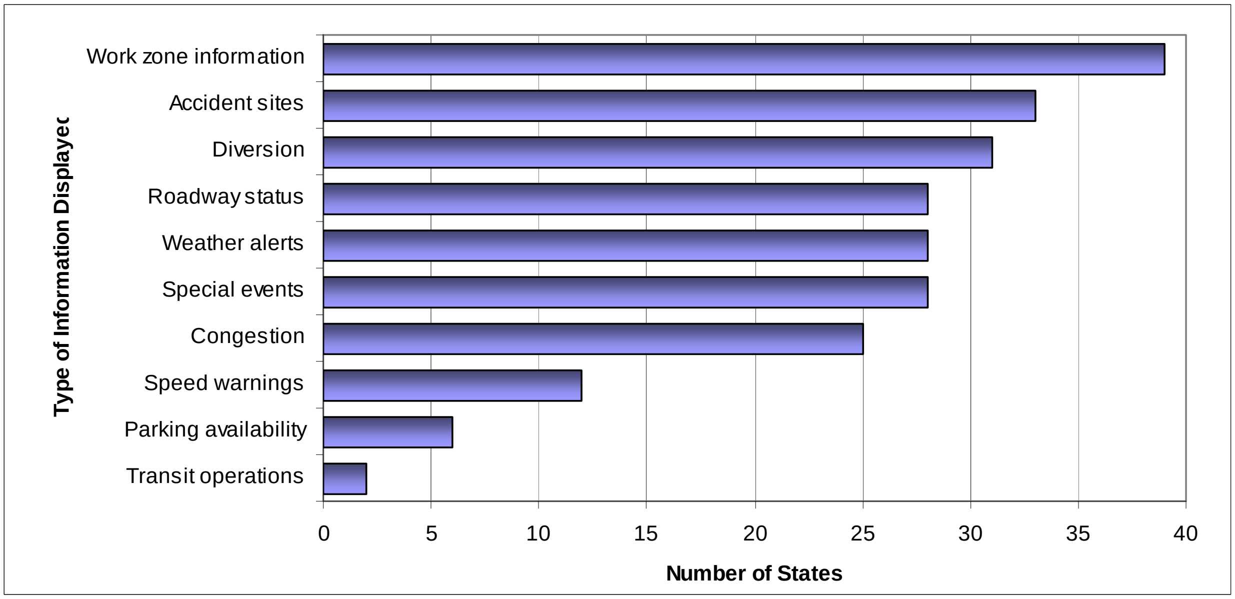

Figure 32. Information Displayed by Dynamic Message Signs

Roadway 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.

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 reported the deployment of Roadway Closure Systems, primarily northern states. Figure 34 shows that states have deployed these systems primarily on freeways, with a significant number of states reporting deployment on limited-access and two lane highways as well.

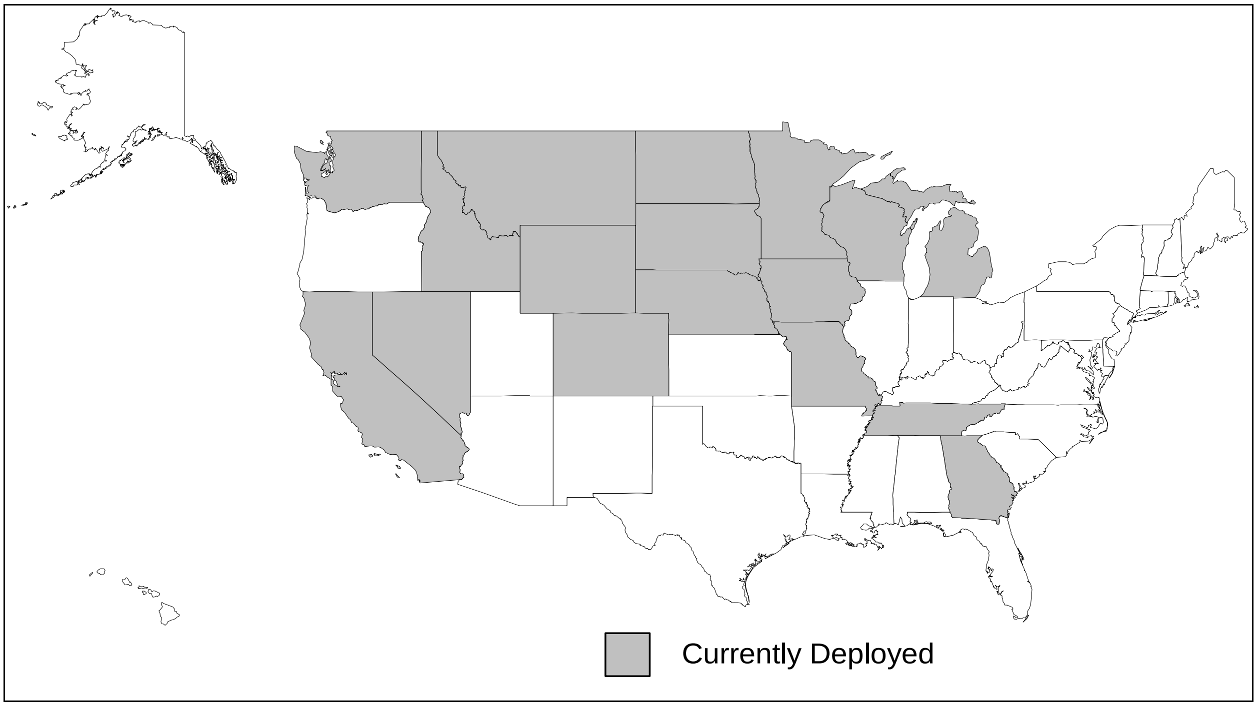

Figure 33. States Deploying Roadway Closure Systems

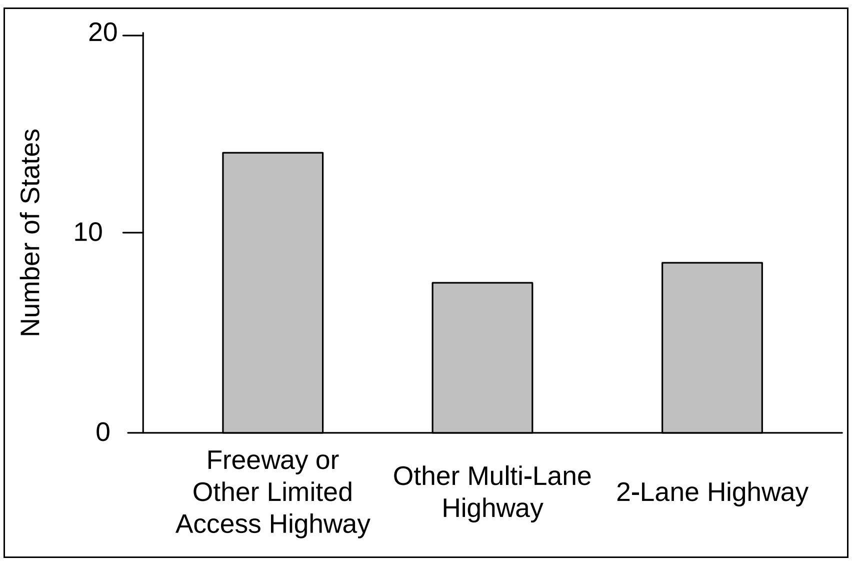

Figure 34. Road Classification of Roadway Closure Systems

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 States
Traffic sensors	5
CCTV	4

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 five states.

Table 21 Methods Used to Control Roadway Access

Access controlled	Number of States
Manual road closure gates	15
Dynamic message signs to alert travelers of closure	14
Automatic road closure gates	5

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 21 states that have deployed Route Diversion Management Systems. These states report either the existence of documented procedures, established protocols, or interagency agreements to support the implementation of alternate route plans.

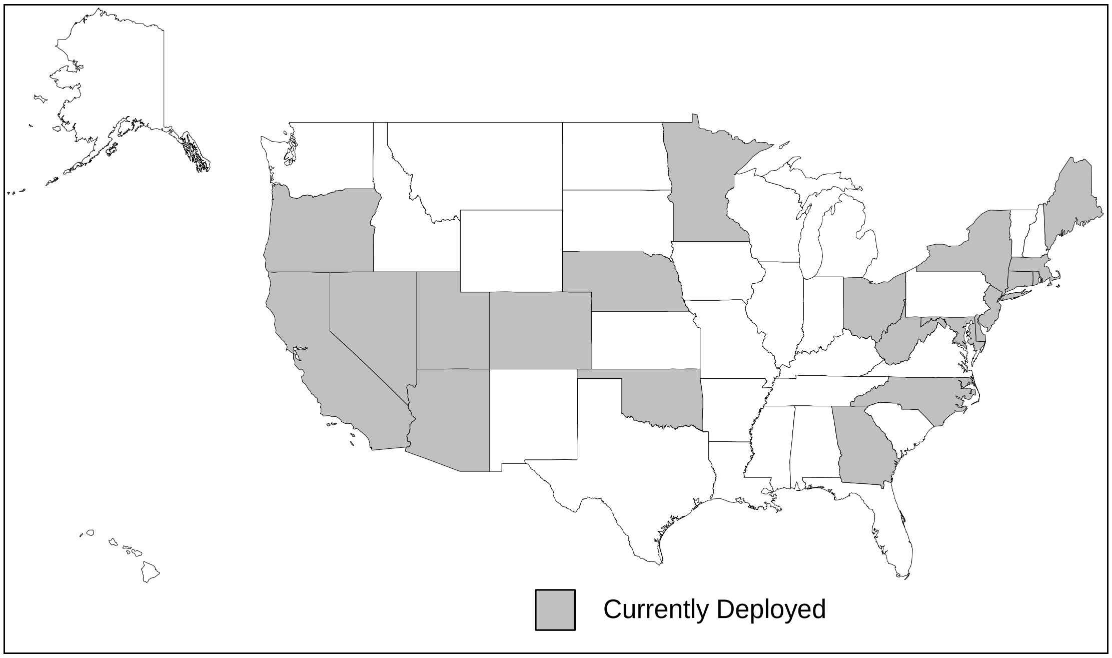

Figure 35. States Deploying Route Diversion Management Systems

The Route Diversion Management Systems is linked to various scenarios under which alternate routing would be needed. Figure 36 shows the most common of the diversion scenarios. Traffic incidents and disasters are the two most common scenarios, followed closely by planning for emergencies or major road maintenance and special events. Three states reported development of route diversion management capability based on weather events.

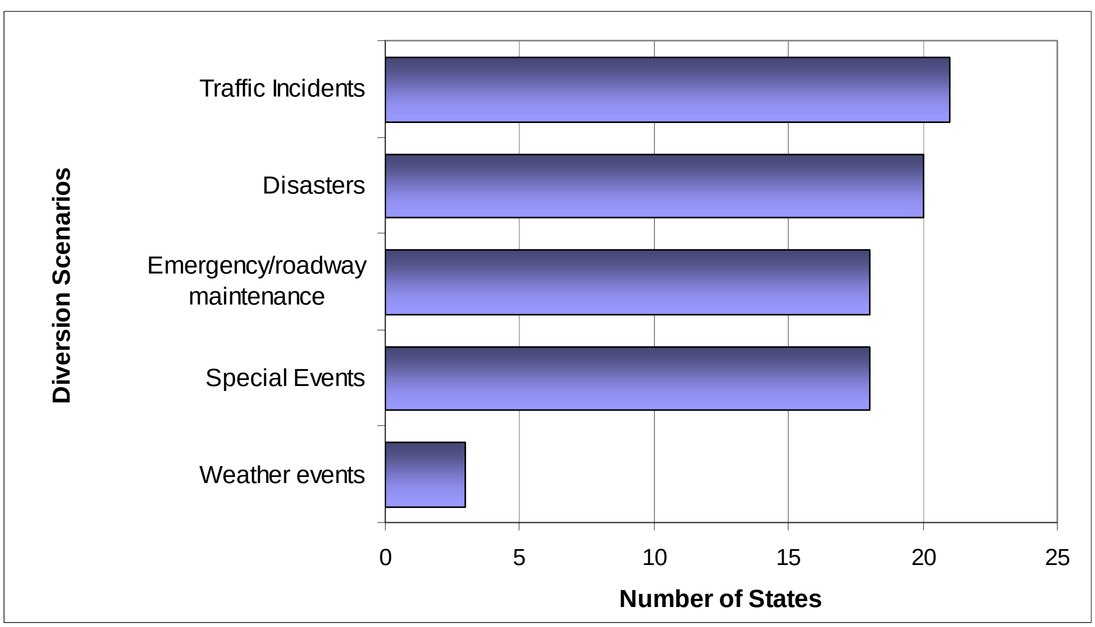

Figure 36. Diversion Scenarios Used in Alternate Route Planning

Figure 37 shows the media used to communicate route diversion information. The most frequently reported media in use is dynamic message signs, with highway advisory radio second. A significant number of states plan to use 511 to relay diversion information. Finally, flashing lights are deployed in some states to guide diverting traffic.

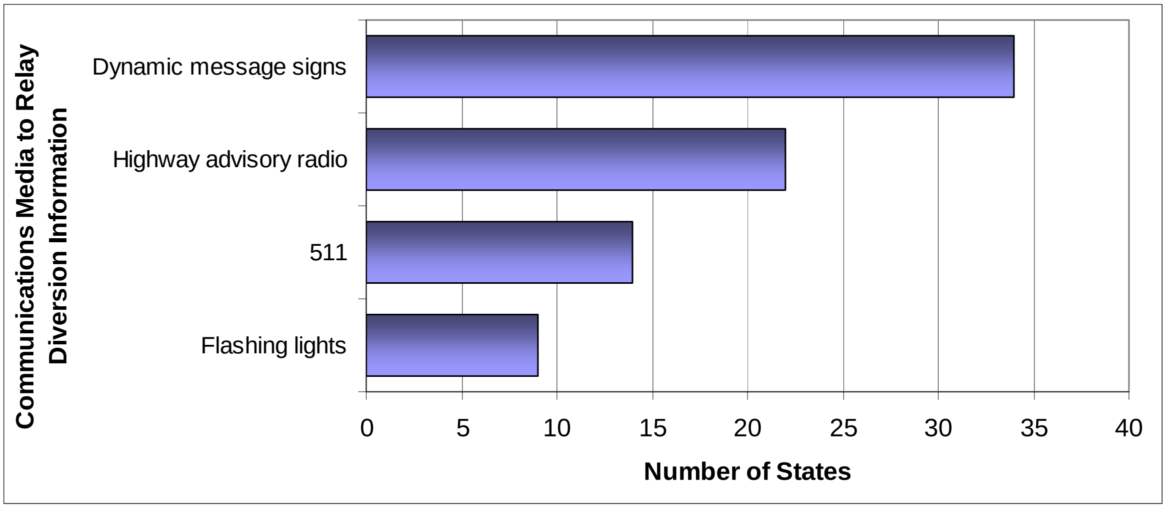

Figure 37. Media Used to Communicate Route Diversion Information

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 30 states report deployment of such Traffic Surveillance Systems.

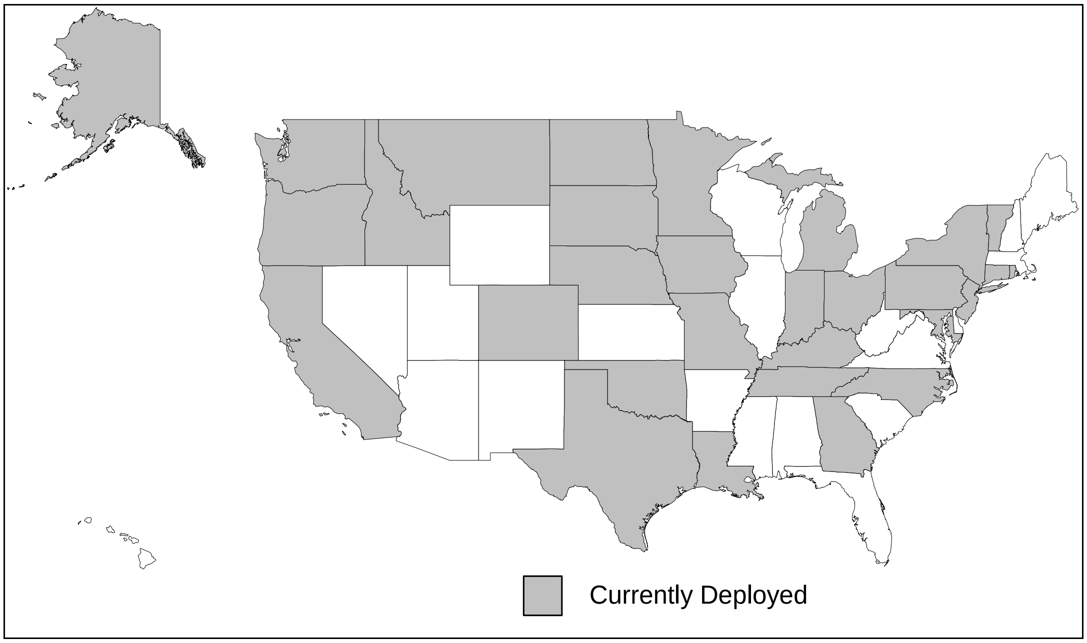

Figure 38. States Deploying Traffic Surveillance Systems in Non-Urban Areas

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. While the majority of deployment is reported on freeways, information gathering is wide spread and involves all road classifications. Collection of data on traffic volume, vehicle speed, and vehicle classification is reported by states about half as frequently on non-freeway highways as on freeways. Incident detection on non-freeways is about a third as common as on freeways.

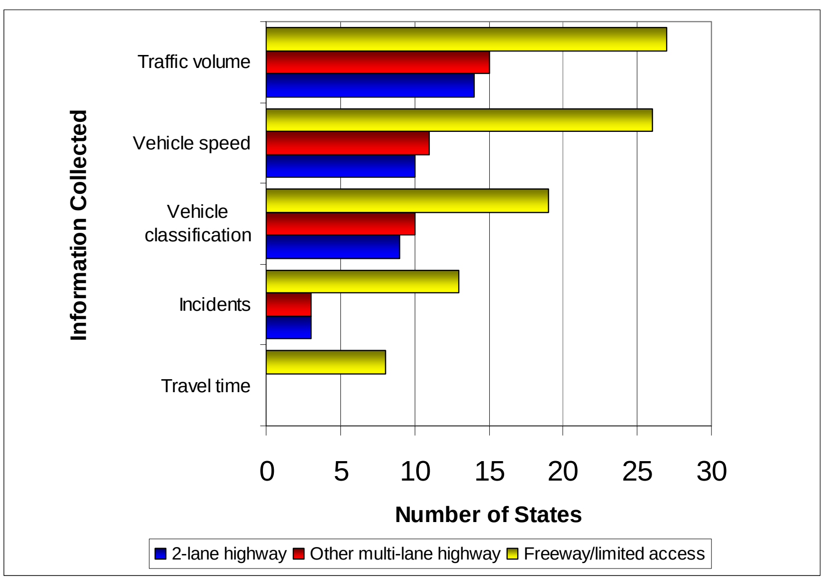

Figure 39. Traffic Surveillance Information Collected by Road Category

Figure 40 shows the types of traffic surveillance sensors deployed on the various types of roads. Loop detectors are the most common, followed closely by radar detectors. Police reports of congestion and incidents are next in frequency, followed by video imaging detectors. Loop detectors are also an important source of data on non-freeway highways, reported by more than half the number of states that reported freeway deployment. Radar detectors, police reporting, and video imaging detectors are also important sources of information on two lane and other multi-lane roads, but at about one-third the frequency seen on freeways.

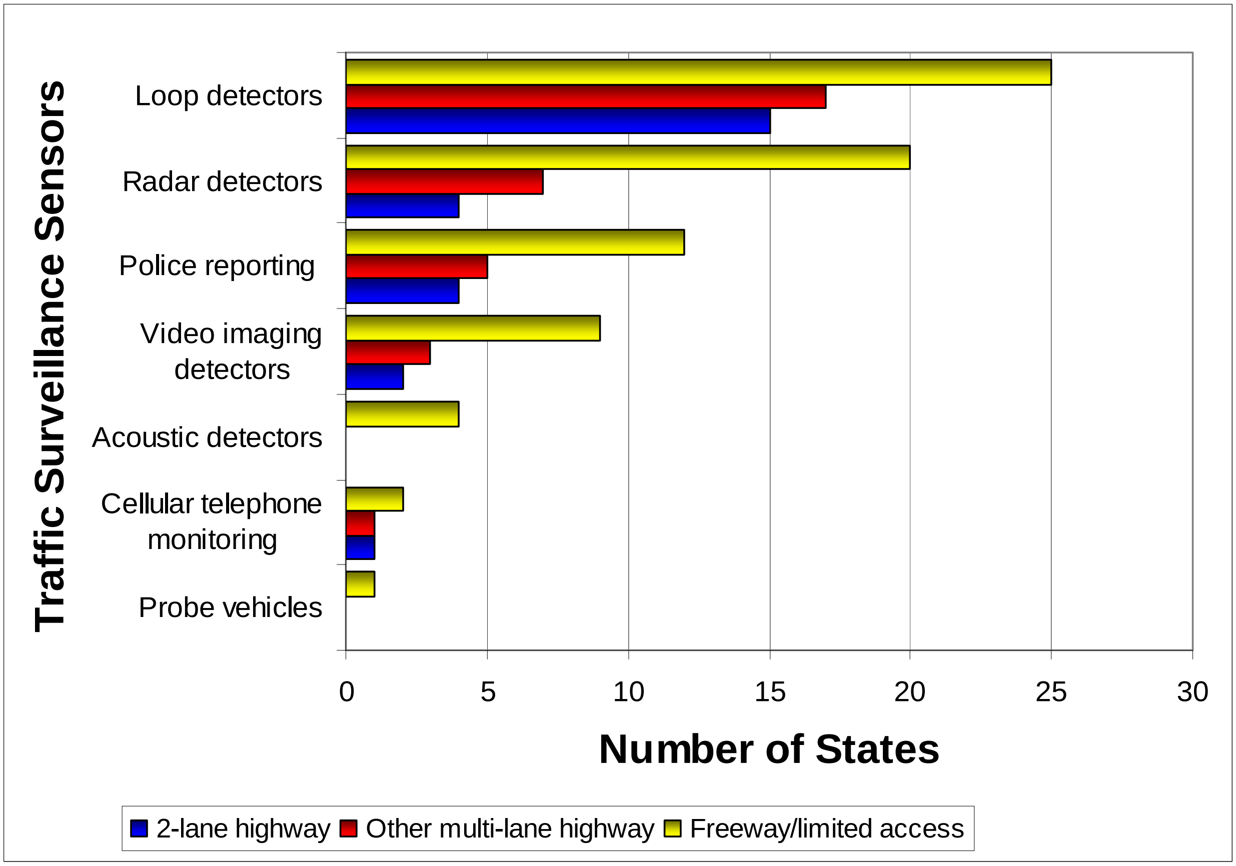

Figure 40. Technologies Used to Collect Information by Road Category

Transportation Management Centers

Figure 41 highlights the states that have deployed Transportation Management Centers. A total of 22 states report deployment of non-urban Transportation Management Centers.

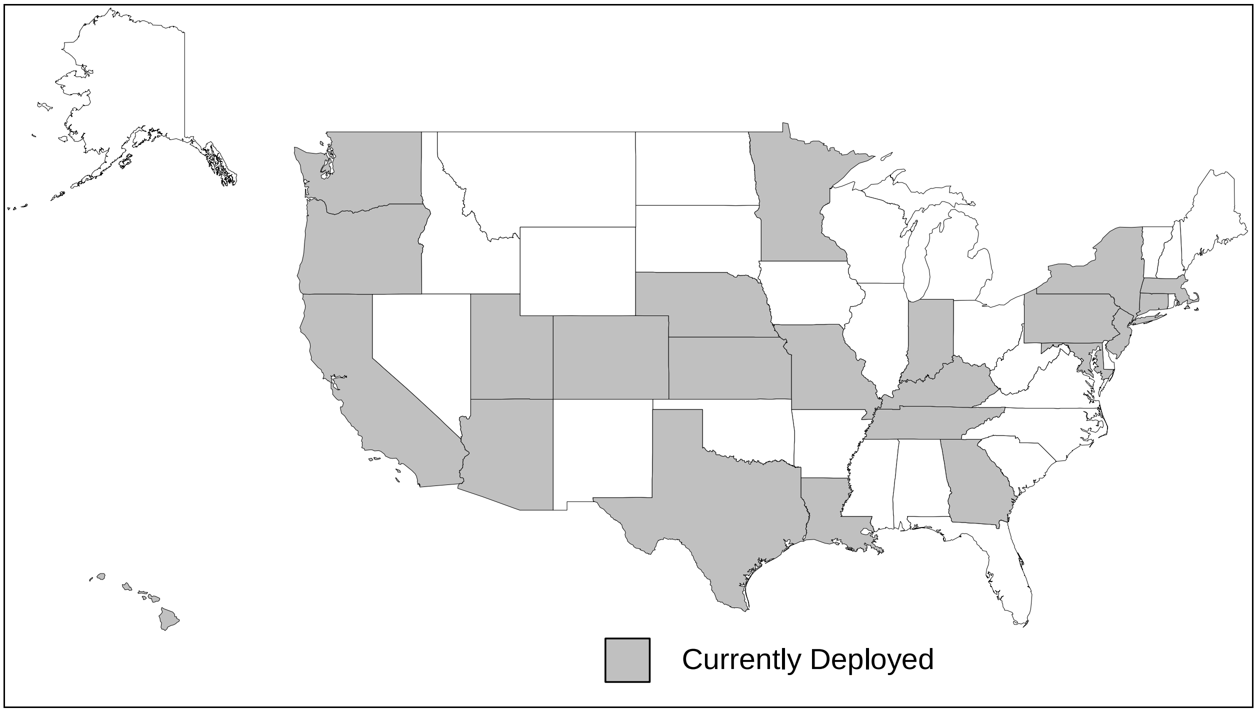

Figure 41. States Deploying Transportation Management Centers

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 42 highlights the states that have deployed Automatic Anti-Icing Systems. A total of 18 states have deployed these systems.

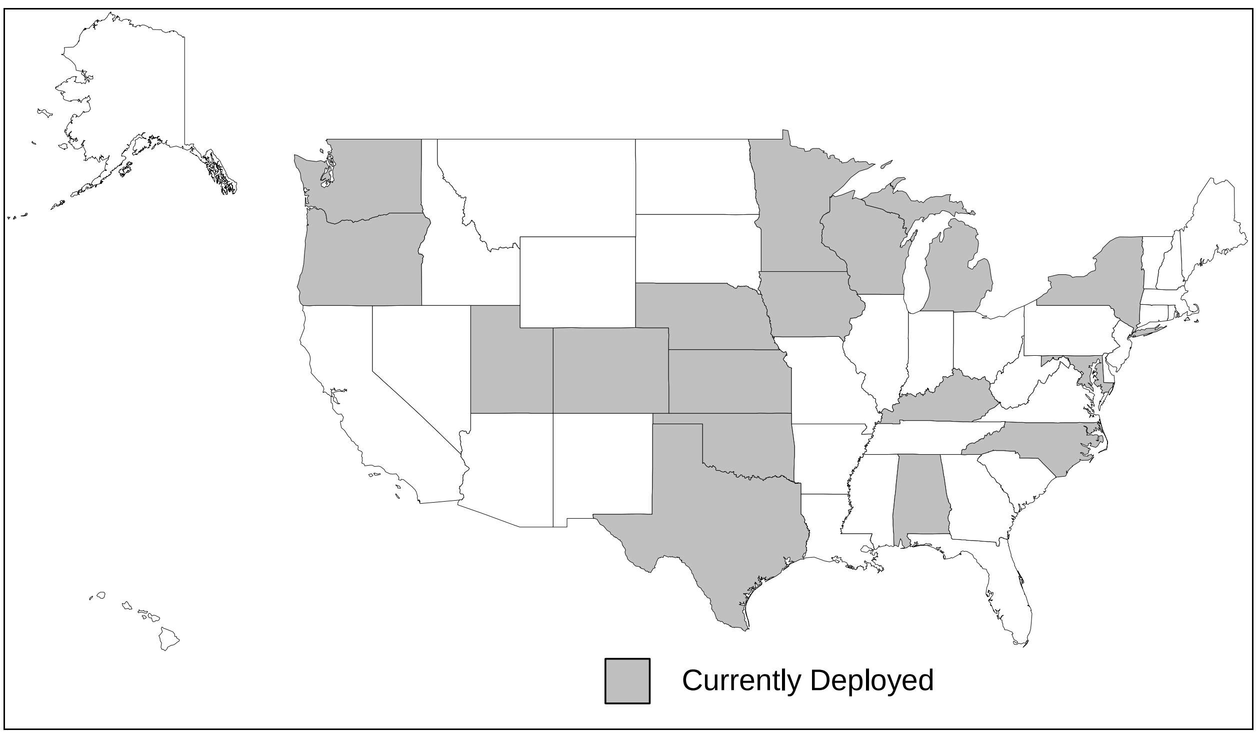

Figure 42. States Deploying Automatic Anti-Icing Systems

Figure 43 shows that Automatic Anti-Icing Systems have been deployed on freeways and non-freeways. While the majority of states have deployed these systems on freeways, there are almost an equal number of states reporting deployment in other multi-lane roads or two-lane highways.

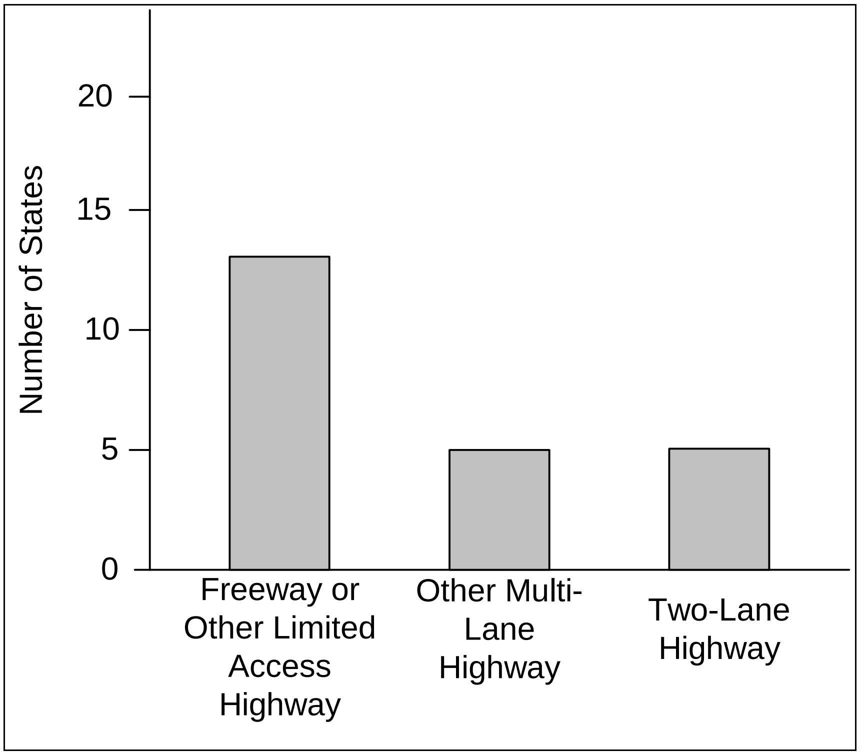

Figure 43. Road Classification of Automatic Anti-Icing System Locations

As Table 22 shows, most of these systems are located on bridges with some on overpasses. One state reported deployment on a sharp curve.

Table 22 Automatic Anti-Icing System Locations

Location	Number of States
Bridge	16
Overpass	5
Sharp Curve	1

Figure 44 shows the reason for making the decision to deploy Automatic Anti-Icing Systems. The reasons states have deployed these systems fall into three broad categories: improving safety, mobility or productivity. The reason reported most often by states is to improve safety by reducing winter crashes. The third most often mentioned reason is also safety related, detecting slick pavement. Improving mobility is also an important factor and was mentioned nearly as often as safety. Improvements to productivity are less frequently mentioned, but are important in some cases as well.

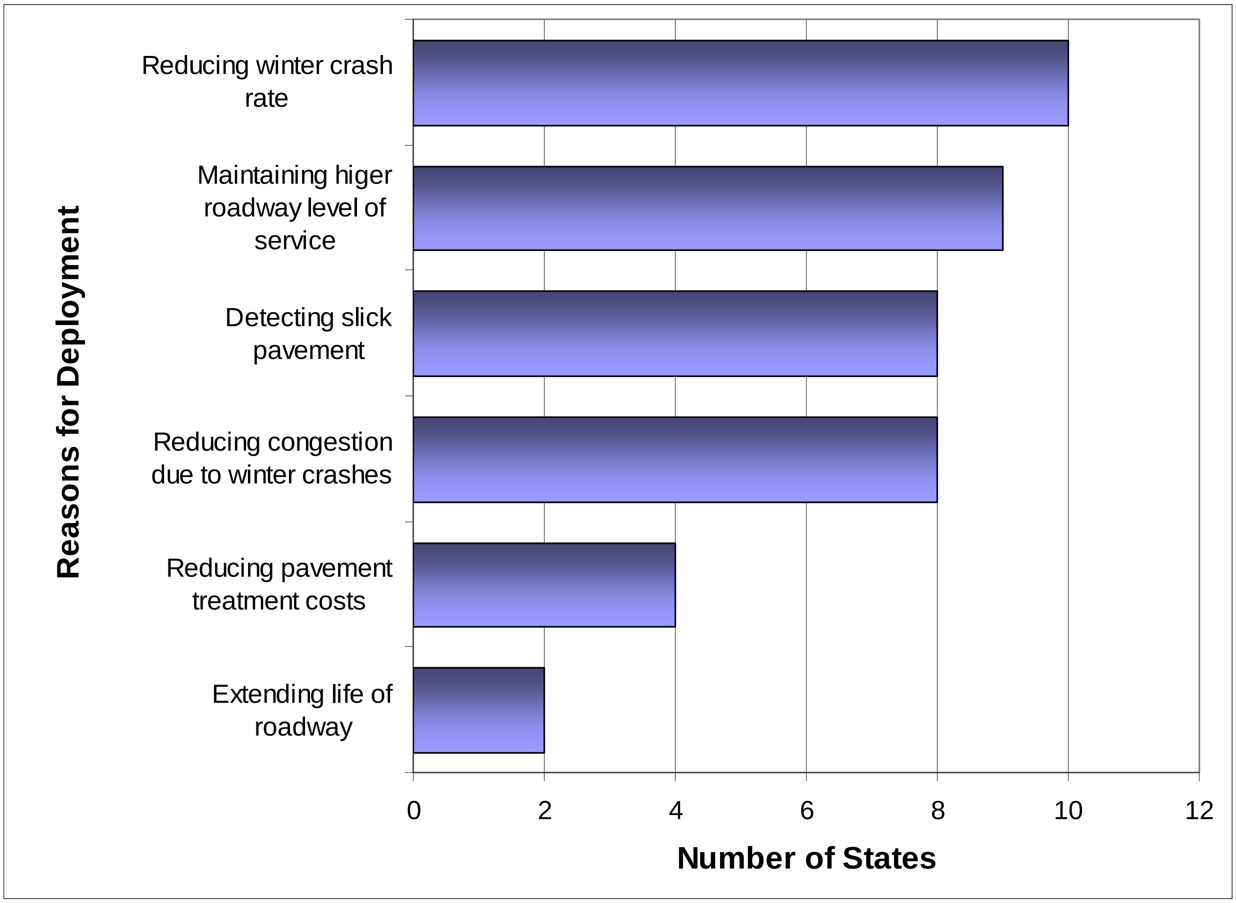

Figure 44. Reasons for Implementing Automatic Anti-icing Systems

Figure 45 shows the kinds of information that these systems collect in order to assess the existence of icing conditions. Most frequently used are data on pavement conditions and weather conditions. Pavement data including surface temperature, condition (wet or dry, icy or flooded), and pavement freeze point temperature, are widely employed. The impact of ongoing treatment is also monitored by systems that track roadway surface chemical concentration. Weather information such as air temperature, wind speed, and precipitation rate are also included in automatic anti-icing systems in many states.

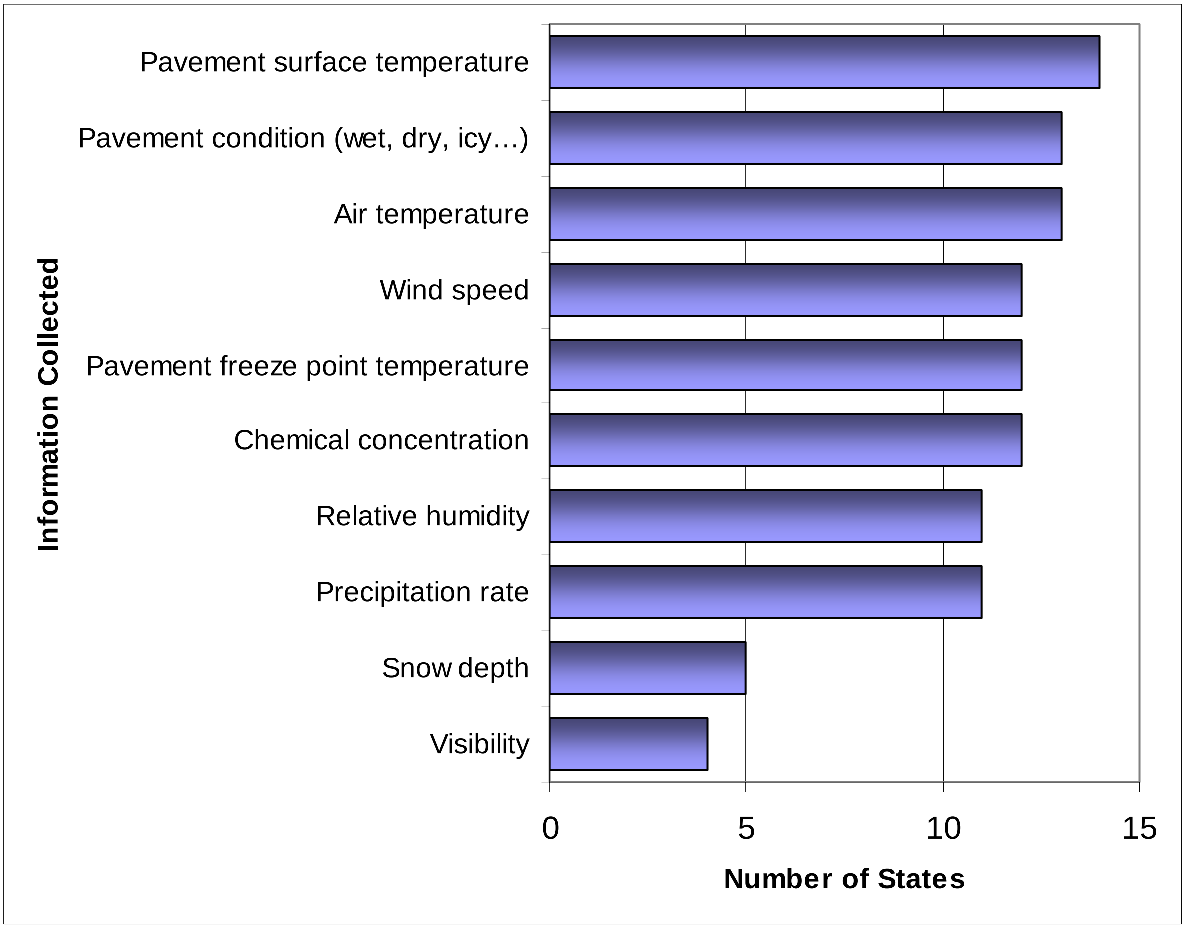

Figure 45. Automatic Anti-Icing System Information Collected

Automatic Anti-Icing Systems are technologically sophisticated and provide a variety of remote control options. Table 23 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. Some states report systems that require manual activation, operated by maintenance or operations personnel.

Table 23 Automatic Anti-Icing System Remote Control Capabilities

Capability	Number of States
Controlled by a central computer	17
Automatically activated by central computer – fully automatic	11
Semi-automatically activated – requires operator approval	5
Automatically activated by remote computer	3
Manually activated by maintenance personnel	5
Manually activated by operations personnel	2

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 46 highlights the states that have deployed Avalanche/Slide Management Systems. Five western states reported deployment of Avalanche/Slide Management Systems. Figure 47 shows that these systems are predominantly deployed on two-lane highways.

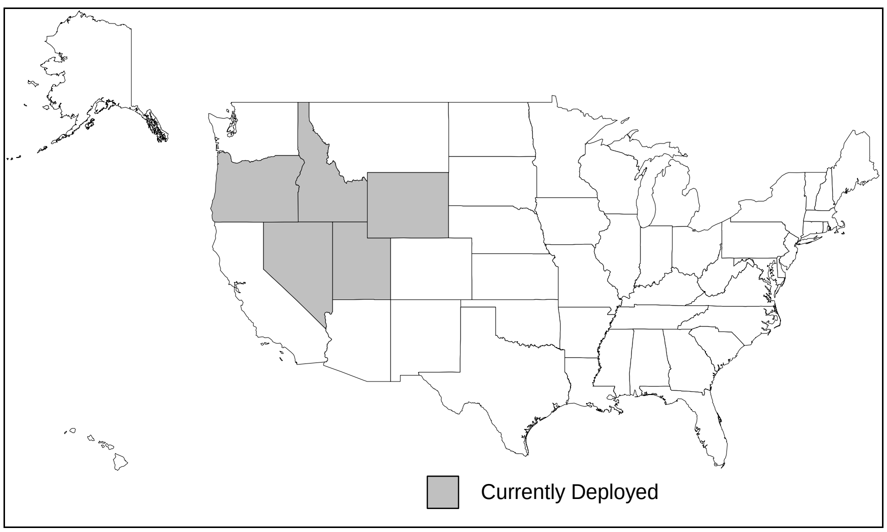

Figure 46. States Deploying Avalanche/Slide Management Systems

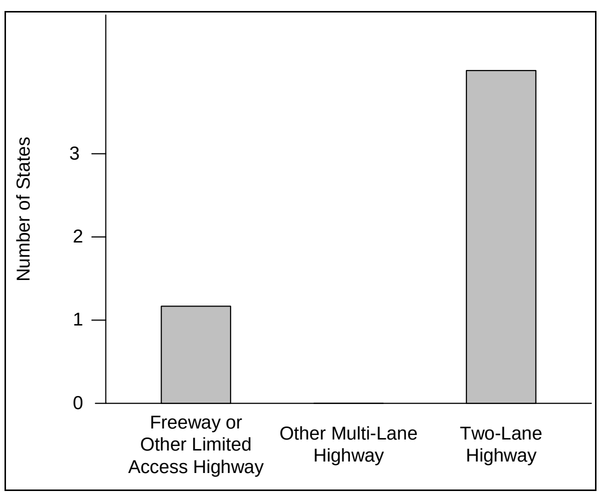

Figure 47. Road Classification of Avalanche/Slide Management Systems

Table 24 shows that Avalanche/Slide Management Systems are generally deployed to address operational needs rather than research or evaluation. Four states report deploying these systems at sites of frequent avalanches, and other operational trouble areas are targeted as well. Only one state reports deploying these systems for evaluation. Table 25 shows the types of information collected by the system, with almost all of the systems incorporating an avalanche detection sensor. Table 26 shows that the most common methods for providing alerts of avalanche/slide hazards are dynamic message signs and flashing lights.

Table 24 Avalanche/Slide Management System Purpose for Implementation

Purpose	Number of States
Areas of frequent avalanche episodes	4
Evaluation	1
Road curvature	1
High accident locations	1

Table 25 Information Collected by System

Information	Number of States
Avalanche/slide detection sensors	3
Department of forestry modeling	1
Avalanche triggering system	1

Table 26 Technologies Used to Communicate with Vehicles

Limit Access Methods	Number of States
Dynamic message signs	3
Flashing lights	3
Highway advisory radio	1
Radio contact with maintenance vehicles	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 48 highlights the states that have deployed Maintenance Fleet Management Systems. A total of 12 states report deployment of Maintenance Fleet Management Systems.

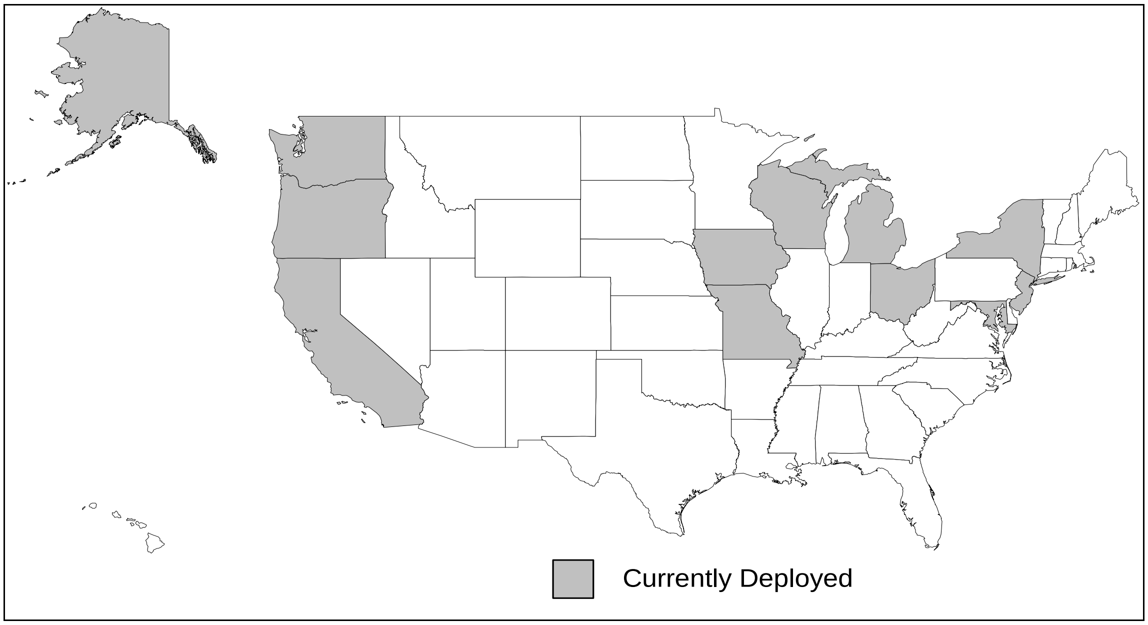

Figure 48. States Deploying Maintenance Fleet Management Systems

Figure 49 shows the types of fleets managed by these systems. The most common type of fleet being managed is snow plows, followed by incident response vehicles. Other fleets reported are street sweepers, snow removal supervisors, and earth moving equipment.

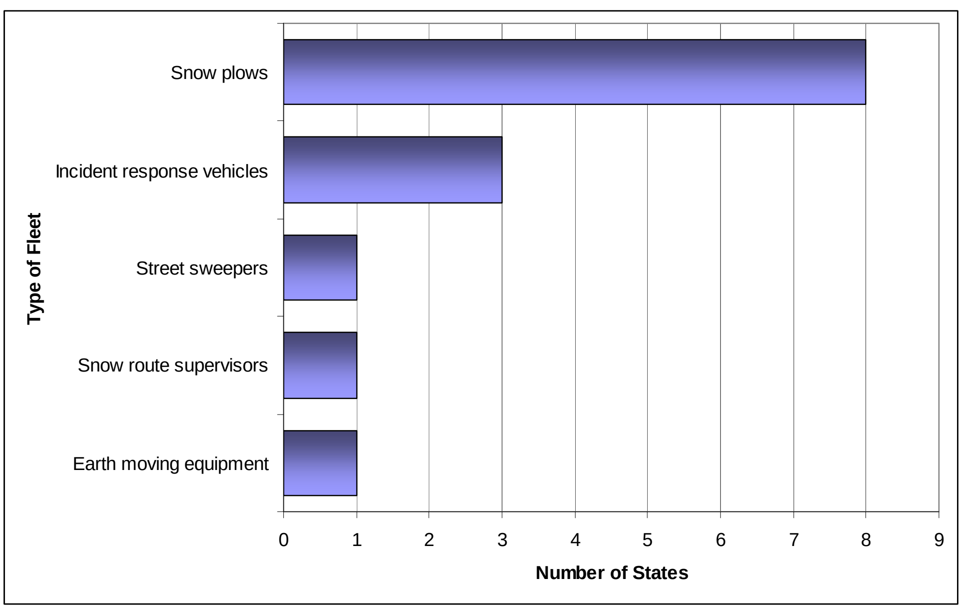

Figure 49. Types of Fleets Being Managed

Figure 50 shows the capabilities provided to central managers of fleets by the variety of sensors and technologies that are deployed on these vehicles. The most common capability reported is monitoring vehicle location through AVL. Also widely reported is the capability to monitor snow plow operations, including the position of the plow, chemical application rate, and the inventory of chemicals on board. Additional capabilities are route management through schedule optimization and the ability to transmit route changes to vehicles. Finally, some of these fleets send back data from mobile environmental sensors systems concerning pavement temperature and condition and air temperature, supporting the use of these vehicles as weather probes.

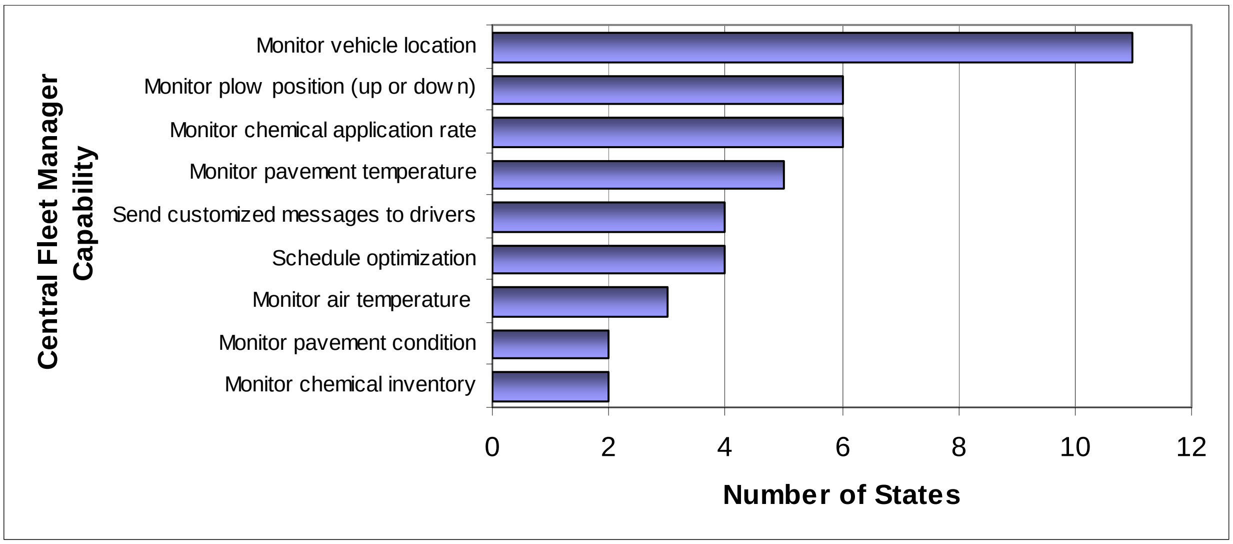

Figure 50. Central Fleet Manager Capabilities

Deployment of these fleet management systems produce benefits in a number of areas. Table 27 shows the most often reported benefit is improved productivity of routes, followed by improved coordination of fleet operations. Other areas of improvement are general mobility, safety, interagency coordination, and data collection on winter operations.

Table 27 Benefits of Maintenance Fleet Management Systems

Areas of improvement	Number of States
Productivity of routes	3
Coordination of fleet operators	2
Mobility	1
Safety	1
Interagency coordination	1
Data collection of winter operations	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 51 highlights the states that have deployed Work Zone Management Systems. A total of 19 states report the use of ITS technology in rural work zones. Figure 52 shows that these systems are most often deployed on freeways, but are also deployed in many states on other multi-lane highways as well as two-lane highways.

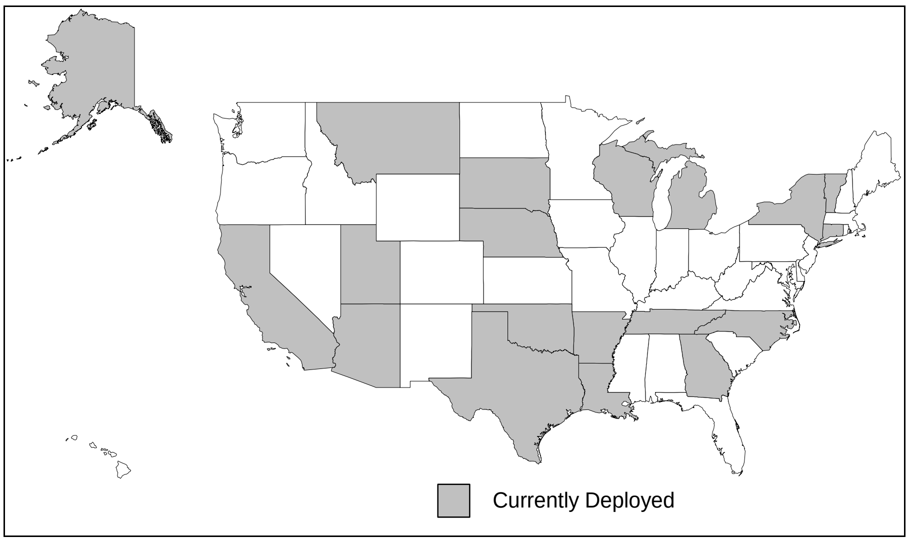

Figure 51. States Deploying Work Zone Management Systems

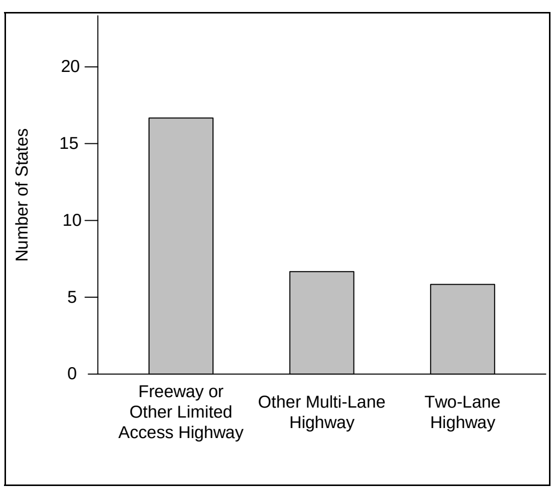

Figure 52. Road Classification at Work Zone Management System Location

Figure 53 shows the reasons reported by the states for deploying work zone management systems. The most important reasons are safety related. The number one reason is improving worker safety, which is followed closely by a desire to reduce crashes. Another important reason is to reduce traveler frustration by supplying information on the work zone. Reducing congestion is also an important consideration in deploying ITS technology to work zones.

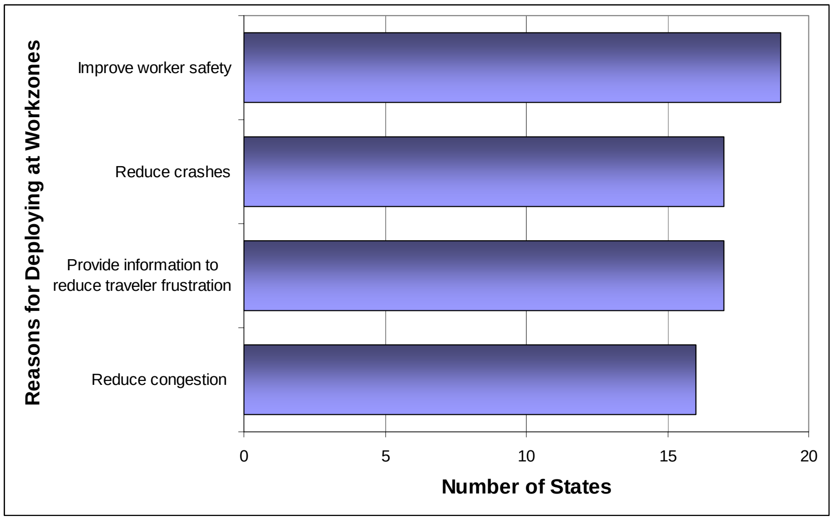

Figure 53. Reasons for Deploying Work Zone Management Systems

Figure 54 shows the type of technologies that are deployed in work zones to improve safety and assist in traffic management. The most common use of technology is to assess travel time through a work zone. Other important technologies are queue length detectors and speed sensors. A few states report sophisticated systems supporting dynamic lane merge and vehicle intrusion detection and warning.

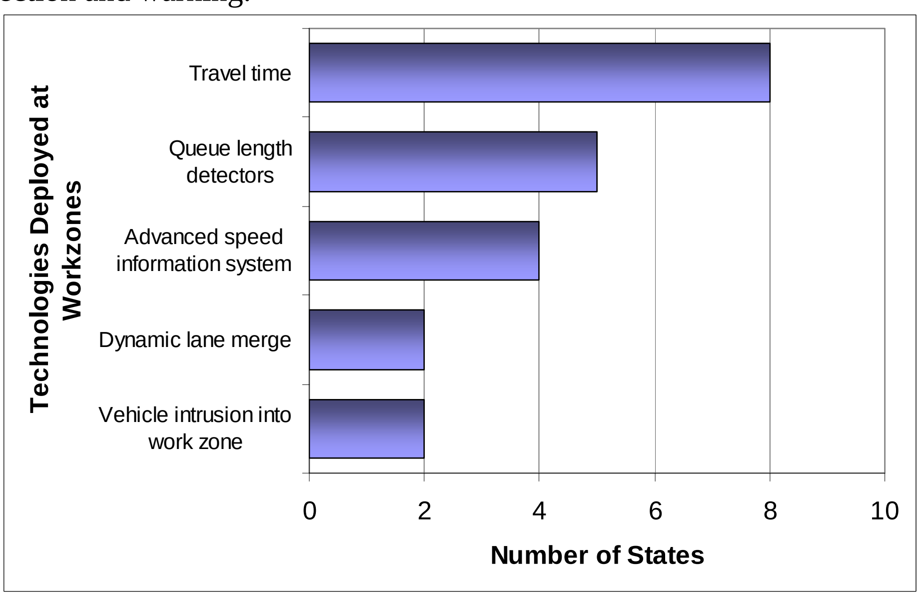

Figure 54. Types of Technologies Deployed at Work Zones

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 flashing lights and highway advisory radio as shown in Figure 55. The use of temporary speed limits, a control strategy enabled by the deployment of ITS communications technology, is deployed widely as well.

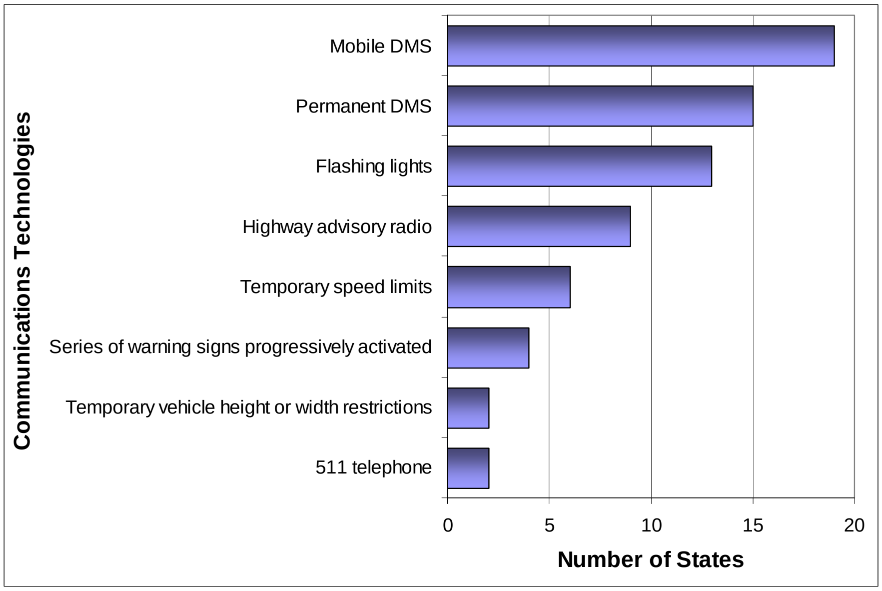

Figure 55. Technologies used to Communicate with Vehicles near Work Zones

The states reporting the use of technology in work zone management also report a significant level of integration. Figure 56 shows that ten of the nineteen states deploying these systems report sharing information on work zones with information service providers, while in eight, the information is shared with traffic management agencies. Public safety, both state and local police are also well integrated with work zones. Four states report sharing information on work zones with other states.

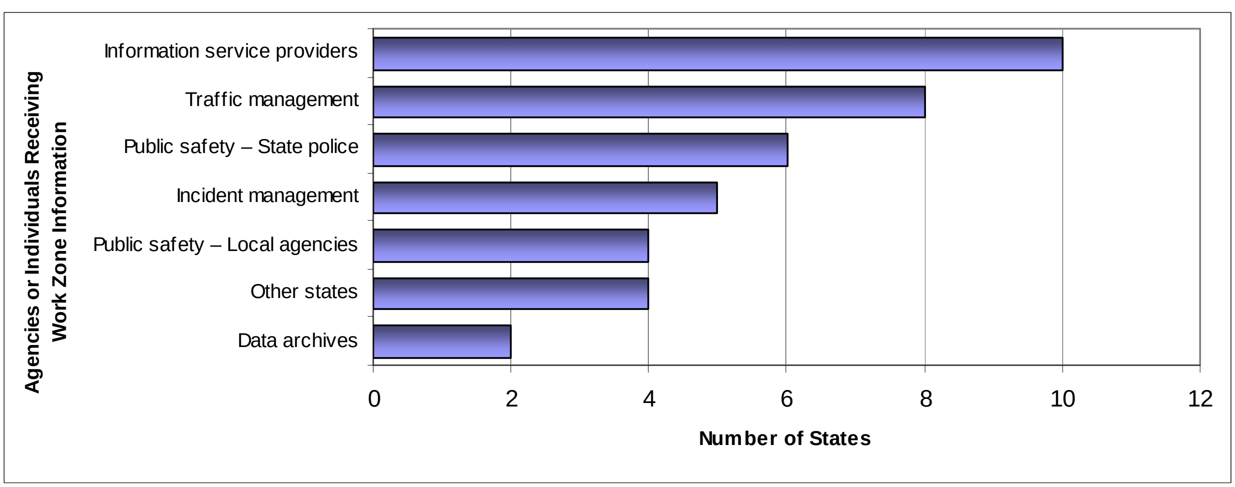

Figure 56. Agencies and Individuals that Receive Data on Work Zone Status

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 57 highlights the states that have deployed Surface Transportation Weather Systems. A total of 42 states report the collection of weather information to support operations.

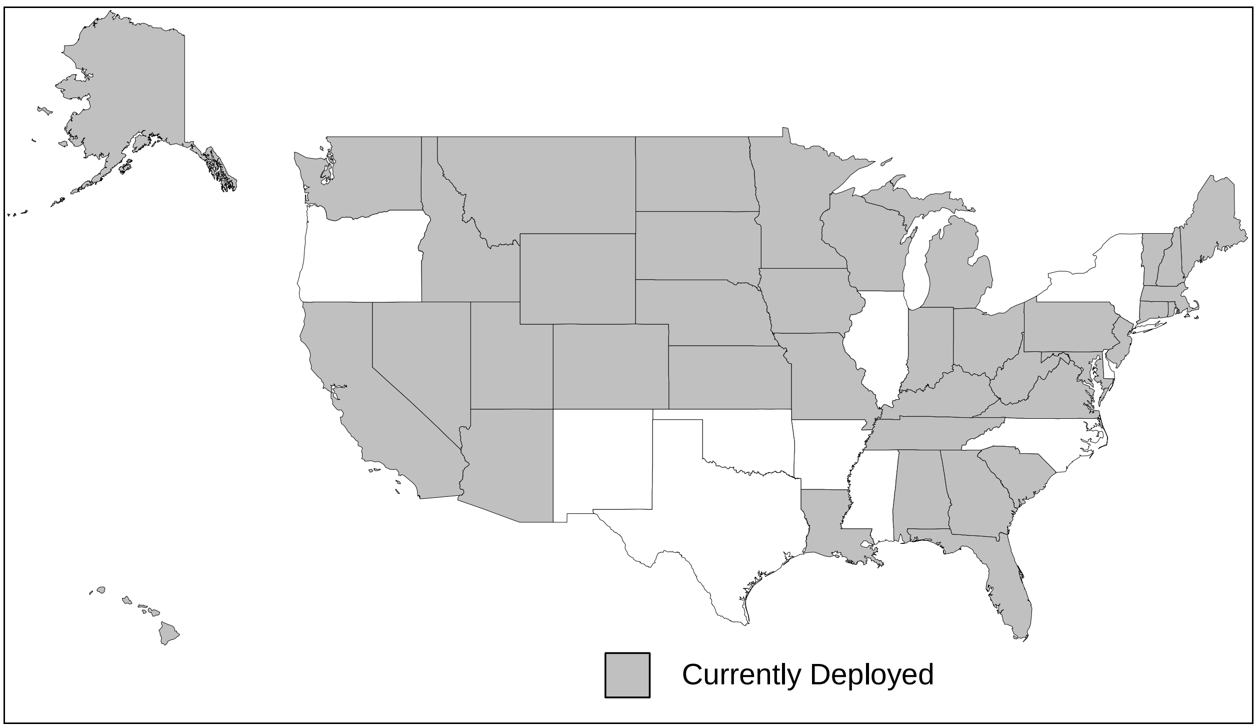

Figure 57. States Deploying Surface Transportation Weather Systems

Figure 58 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 closely by the National Weather Service. Other types of sensors used by states to gather information in rural areas include closed circuit television, airport monitoring systems, mobile sensors, agricultural sensor stations, instrumented maintenance vehicles, and air pollution sensing systems. Also included are inputs from other agencies, including the National Hurricane center, Federal Aviation Administration, US Geological Survey, and the Department of Defense.

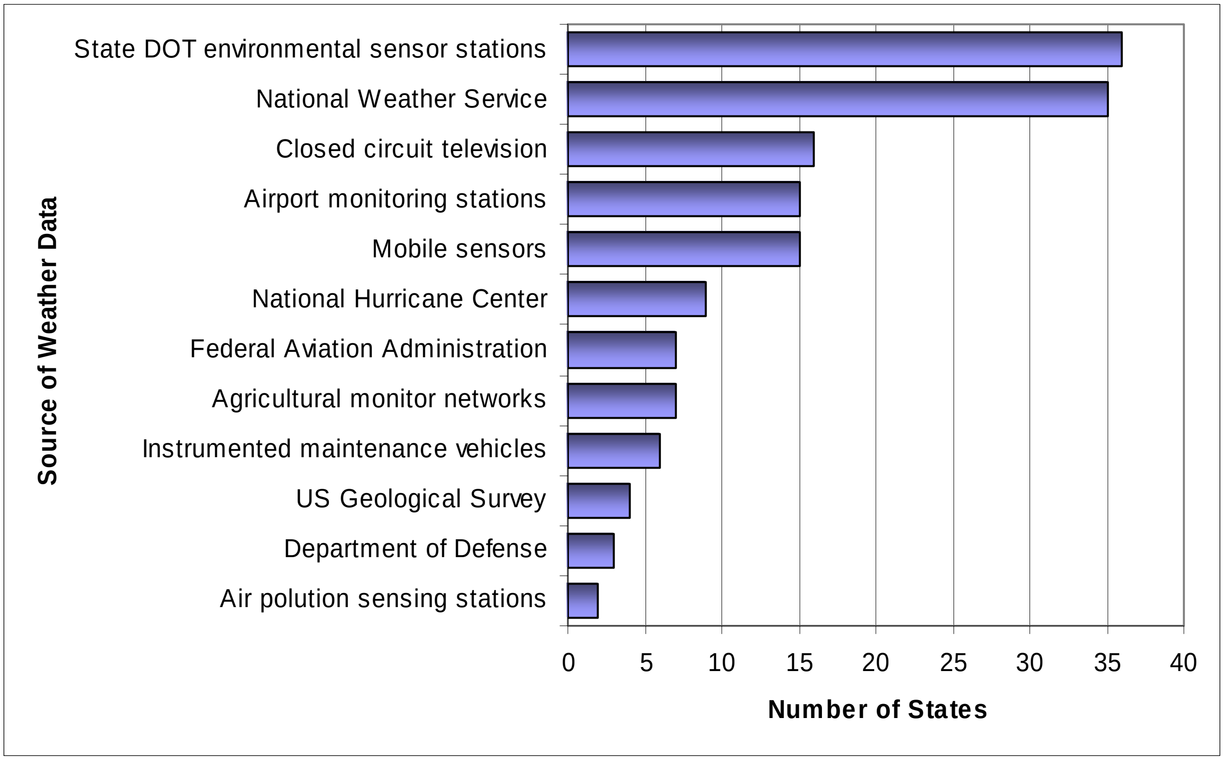

Figure 58. Surface Transportation Weather Systems Data Sources

Figure 59 shows the types of environmental data gathered by transportation agencies to support operational decision-making. Air temperature and wind speed are the most often reported. Information on wind direction and speed, precipitation type and rate, and visibility are also gathered. A substantial amount of information concerning pavement conditions is also gathered. These data include temperature, dew point, freezing point, chemical concentration, subsurface temperature, snow depth, water depth, and friction coefficient.

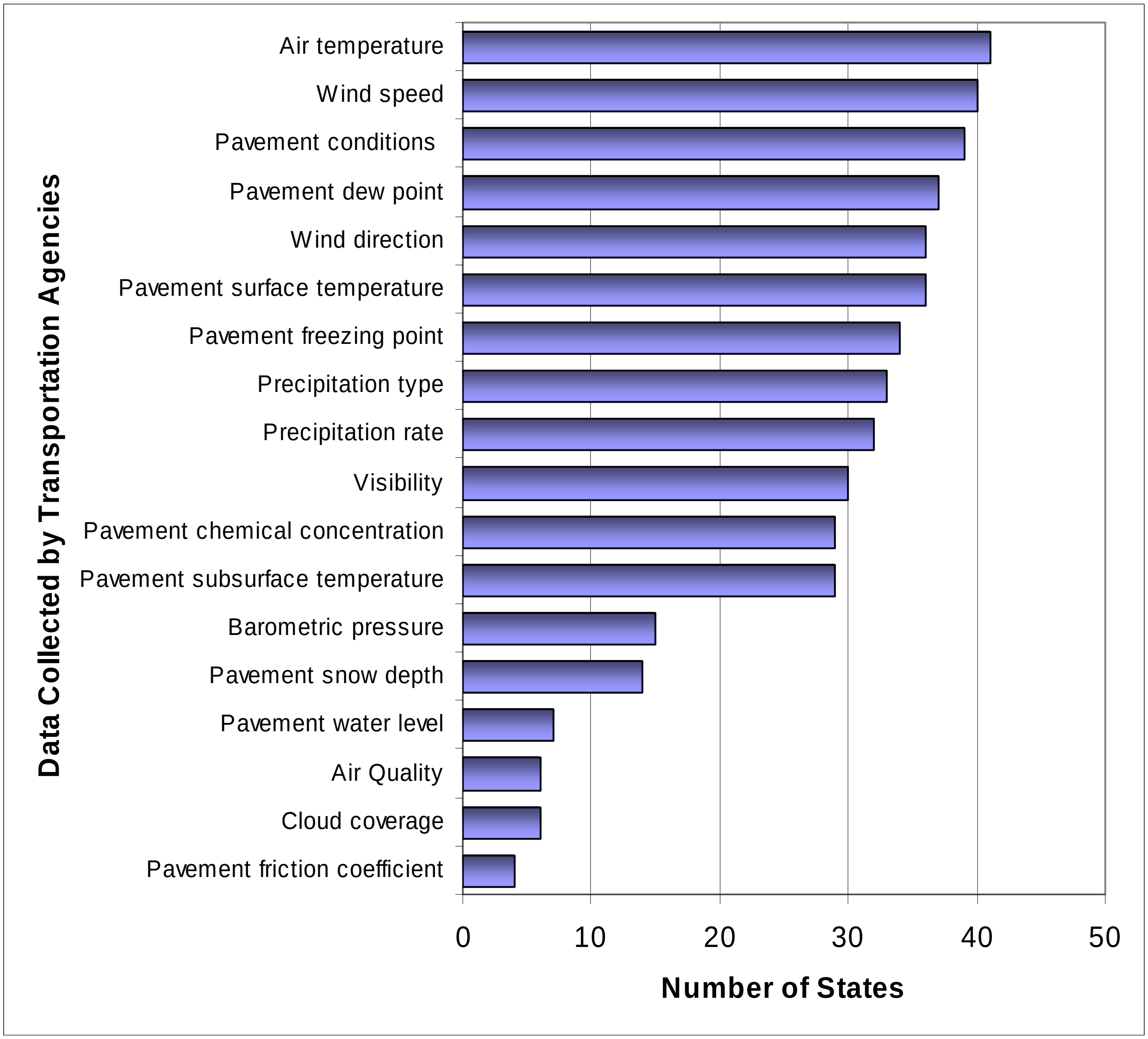

Figure 59. Environmental Data Collected by Transportation Agencies

Figure 60 shows the wide range of methods for sharing transportation weather information. The most popular method of weather information dissemination is the Internet. The next most popular method is 511 telephone. The use of roadside devices, HAR and DMS is reported by about half as many states as internet. Another important medium for distributing weather information is non-511 telephone,

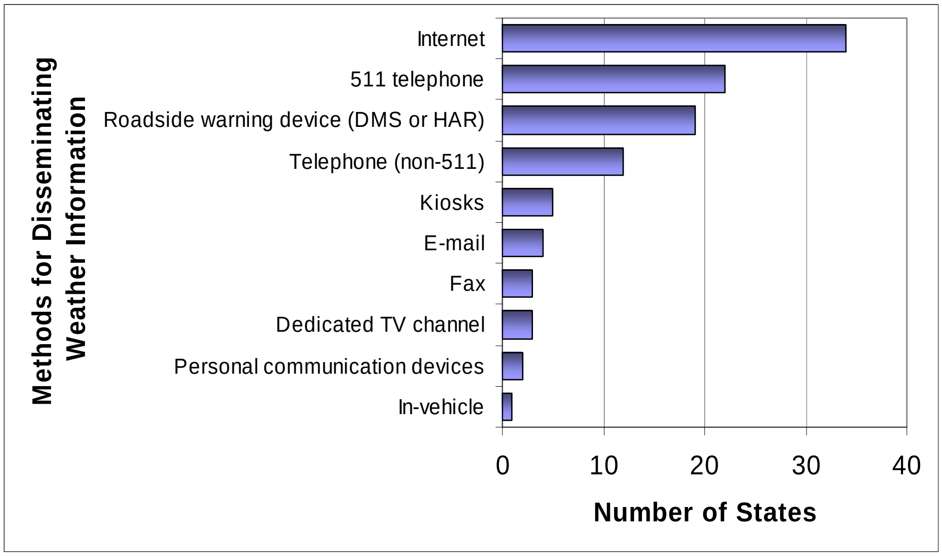

Figure 60. Methods to Disseminate Transportation Weather Information

Figure 61 shows that statues use their Surface Transportation Weather Systems to provide tailored weather products to a number of agencies. Maintenance crews and public safety are the biggest users of tailored products, followed by emergency management agencies and traffic management centers. A smaller number of states also distribute weather information to information service providers, commercial vehicle operators and transit agencies.

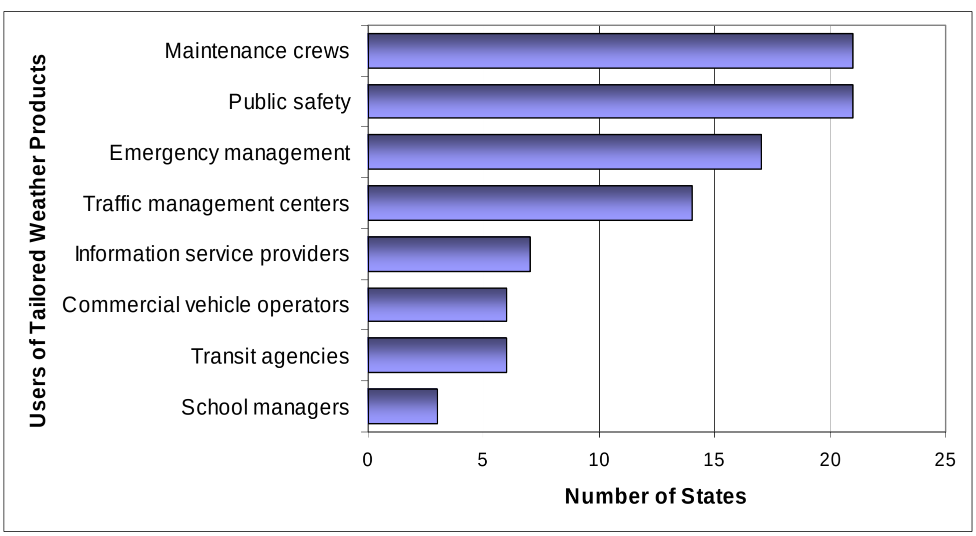

Figure 61. Services or Agencies Provided with Tailored Weather Products

Conclusion

The results from the 2004 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.