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Report to the Committee on Science, Space, and Technology, House of Representatives

March 2012

INTELLIGENT TRANSPORTATION SYSTEMS

Improved DOT Collaboration and Communication Could Enhance the Use of Technology to Manage Congestion

GAO-12-308

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GAO Accountability * Integrity * Reliability

Highlights

Highlights of GAO-12-308, a report to the Committee on Science, Space, and Technology, House of Representatives

Why GAO Did This Study

Traffic congestion burdens the nation's quality of life and will likely grow substantially if current trends continue. Intelligent Transportation Systems (ITS) are a range of technologies that can reduce congestion at less cost than some other approaches. The U.S. Department of Transportation's (DOT) Research and Innovative Technology Administration (RITA) is responsible for promoting and supporting the use of ITS in coordination with other modal administrations, including the Federal Highway Administration (FHWA). Since 1994, DOT has overseen the allocation and expenditure of more than $3 billion for deploying and researching ITS. GAO was asked to address (1) the current and emerging uses of ITS technologies by state and local governments, (2) the challenges these governments face in using ITS, and (3) the extent to which DOT's efforts to promote and support ITS address these challenges and follow leading practices. To conduct this work GAO visited four sites, and interviewed and analyzed documents and data from DOT and state and local transportation officials, ITS experts, and other stakeholders.

What GAO Recommends

GAO recommends that the Secretary of Transportation clearly define the roles of RITA and FHWA in promoting the use of ITS, improve the usefulness of ITS information on the agencies' websites, and include in its strategy plans to further enhance communication on ITS activities. DOT reviewed a draft of this report, said it would consider our recommendations, and provided technical comments.

View GAO-12-308. For more information, contact David J. Wise at (202) 512-2834 or wised@gao.gov.

What GAO Found

State and local governments currently use ITS technologies in various ways to monitor and control traffic and inform travelers. For example, transportation agencies use cameras to monitor traffic conditions, signal technologies to control traffic flow, and dynamic message signs to inform travelers about travel conditions. By interviewing experts, GAO identified several emerging uses of ITS that have significant potential to reduce traffic congestion. For example, integrating traffic and emergency services data can allow for enhanced detection of and response to roadway incidents. However, some cities use ITS and the emerging uses to a much greater extent than others.

State and local governments face multiple challenges in using ITS technologies to manage traffic congestion. For example, some agencies do not fully integrate ITS into their planning processes. Funding the deployment and maintenance of ITS technologies is also an issue, because of funding constraints and competition with other needed infrastructure projects. Further, agencies struggle to attract and retain staff with the skills necessary to manage and maintain ITS systems and may not have leaders who support ITS. Finally, coordination among agencies can enhance the effectiveness of ITS through such activities as synchronized traffic signals along a corridor, but such coordination can be difficult given agencies' differing perspectives and priorities.

RITA's and FHWA's activities to promote and support the use of ITS technologies help address these challenges. Both offer ITS-related training and technical assistance and provide guidance and information on their websites. FHWA estimates that states used about $800 million to $1.3 billion of their eligible 2010 federal aid highway funds and $798 million to $1.3 billion of American Recovery and Reinvestment Act funds on ITS. Further adoption of leading practices could improve these efforts. RITA's and FHWA's respective roles in these efforts are not clearly defined, potentially inhibiting their ability to effectively leverage resources. Some experts and transportation agencies noted that ITS-related information on RITA's and FHWA's websites is not always presented in a way that is useful and some agencies lack awareness of some ITS activities sponsored by DOT. Several options have been proposed to improve communication about ITS-related activities and facilitate the sharing of ITS information among state and local officials. While RITA intends to develop a new strategy in 2012 for promoting the use of ITS, it has not yet determined whether it will incorporate any of these proposals.

Uses of ITS technologies include posting travel times on dynamic message signs (left) and synchronizing traffic signals to increase traffic flow (right).

Sources: Minnesota Department of Transportation (left) and GAO (right).

Contents

Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
DOT	Department of Transportation
FHWA	Federal Highway Administration
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
RITA	Research and Innovative Technology Administration
RITIS	Regional Integrated Transportation Information System
SAFETEA-LU	Safe, Accountable, Flexible, and Efficient Transportation Equity Act, A Legacy of Users
TEA-21	Transportation Equity Act for the 21st Century
TIGER	Transportation Investment Generating Economic Recovery
TRANSCOM	Transportation Operations Coordinating Committee

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Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

March 19, 2012

The Honorable Ralph M. Hall
Chairman
The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

Traffic congestion burdens Americans' quality of life through wasted energy, time, and money; increased pollution; and threats to safety. Estimates of the cost of congestion vary. According to the Department of Transportation (DOT), congestion costs America an estimated $200 billion a year in lost travel time and fuel, and drivers in metropolitan areas spend more than one-quarter of their total annual travel time in congested conditions. Pressures on the surface transportation system are likely to grow substantially if trends that underlie the demand for passenger and freight travel, such as trends in population, continue.

State and local governments have used Intelligent Transportation Systems (ITS) technologies to help manage congestion. ITS technologies consist of a range of communications, electronics, and computer technologies, such as

- systems that collect real-time traffic data and transmit information to the public via dynamic message signs and other means,
- ramp meters to improve the flow of traffic on freeways, and
- synchronized traffic signals that are adjusted in response to traffic conditions.

ITS technologies support strategies to more efficiently use existing roadway capacity by improving traffic flow. As we have previously reported, improved system operations, management, and performance through the strategic use of ITS technologies have the potential to reduce

congestion without major capital investments.[1] Some other congestion reduction strategies, such as building new infrastructure, can be costly. According to DOT's analysis of evaluations of ITS projects, strategies that make use of ITS technologies—such as managing traffic incidents and providing information to travelers—have shown positive effects on traffic mobility.[2] These strategies often also have documented cost savings to transportation providers or travelers. Various policymakers and transportation advocates have pointed to ITS as a way to address congestion, particularly given current federal, state, and local budget constraints and the high cost of building new infrastructure. Other advantages of ITS include increased safety and pollution reduction.

DOT promotes and supports state and local governments' use of ITS through various means—including training, technical assistance, and information sharing—and provides some funds, through federal aid highway programs and demonstration projects, that can be used for ITS deployment. Although Congress previously authorized federal funding specifically for deploying ITS, through a DOT program, this funding ended in 2005. DOT also has ITS research initiatives to test new technologies, systems, and strategies in support of safety, congestion management, and environmental performance goals. Since 1994, DOT has overseen the allocation and expenditure of more than $3 billion for deploying ITS technologies and researching new technologies. DOT's funding of ITS deployment is discussed in more detail later in this report.

Given the potential benefits of ITS to the nation, you asked us to address (1) how state and local governments currently use ITS technologies to manage traffic and emerging uses of these technologies that have the greatest potential to reduce congestion, (2) the types of challenges state and local governments face in using ITS technologies to manage traffic congestion, and (3) how DOT's efforts to promote and support state and local governments' use of these technologies have responded to challenges they face and the extent to which these efforts reflect leading practices for such endeavors.

[1]GAO, *Highway Congestion: Intelligent Transportation Systems' Promise for Managing Congestion Falls Short, and DOT Could Better Facilitate Their Strategic Use,* GAO-05-943 (Washington, D.C.: Sept. 14, 2005).

[2]DOT, Research and Innovation Technology Administration, *Intelligent Transportation Systems Benefits, Costs, Deployment, and Lessons Learned Desk Reference,* FHWA-JPO-11-140 (Washington, D.C.: September 2011).

To meet our research objectives, we analyzed pertinent laws as well as documents and data from DOT, such as DOT's ITS policy and planning documents and 2010 data on ITS deployment. On the basis of interviews with DOT officials and analysis of the 2010 ITS deployment data, we determined that the data were sufficiently reliable for our purposes. We interviewed and obtained documents from officials from DOT's Federal Highway Administration (FHWA) and Research and Innovative Technology Administration (RITA) and representatives of the American Association of State Highway and Transportation Officials (AASHTO) and the Intelligent Transportation Society of America (ITS America). We identified emerging uses of ITS technologies—which we defined as approaches that have begun to be used over the last 5-10 years, including approaches being researched or promoted by DOT—through interviews with DOT officials, experts, and a literature search. We excluded technologies with primary applications outside roadway traffic management, such as transit ITS, except when they had bearing on roadway traffic management. We conducted site visits to four cities: Washington, D.C.; Pittsburgh, Pennsylvania; Austin, Texas; and Los Angeles, California. We selected these sites based on criteria that included high congestion levels and varying levels of deployment of ITS technologies. At each site, we obtained documentation and interviewed officials from one or more state departments of transportation; one or more local government transportation agencies; the metropolitan planning organization; one FHWA division office responsible for the area; and, if applicable, any academics, researchers, or coalitions focused on ITS in that metropolitan area.[3]

We also identified 15 experts from a list of individuals recommended by officials at RITA, FHWA, AASHTO, and ITS America. The primary requirement was that each individual have expertise in at least one of the following ITS fields that are important for traffic management: freeway management, arterial management, traffic incident management, roadway operations and maintenance, traveler information, and road weather management. In making our final selection, we considered publications and ITS experience and aimed to include a mix of individuals from state and local government, transportation associations, academia,

[3]From this point on, we refer to state departments of transportation and local transportation agencies as "transportation agencies." We refer to all others we spoke to on these site visits, including staff from metropolitan planning organizations and FHWA Division Offices, as "stakeholders."

and private industry. We obtained the views of these experts on the emerging uses that have the greatest potential to reduce congestion; the types of challenges state and local governments face in planning, deploying, and operating ITS technologies; and the usefulness of DOT's efforts to promote and support ITS implementation. We identified and reviewed leading practices in literature for promoting and supporting the use of technologies, particularly those that pertain to encouraging state and local governments to adopt transportation technologies. The ones we identified as being the most applicable are (1) developing a strategy to promote and support the use of technologies, (2) choosing appropriate methods to promote the use of technology by the target audience, and (3) monitoring technology adoption.

We conducted this performance audit from January 2011 to February 2012, in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. Additional information about our scope and methodology is provided in appendix I.

Background

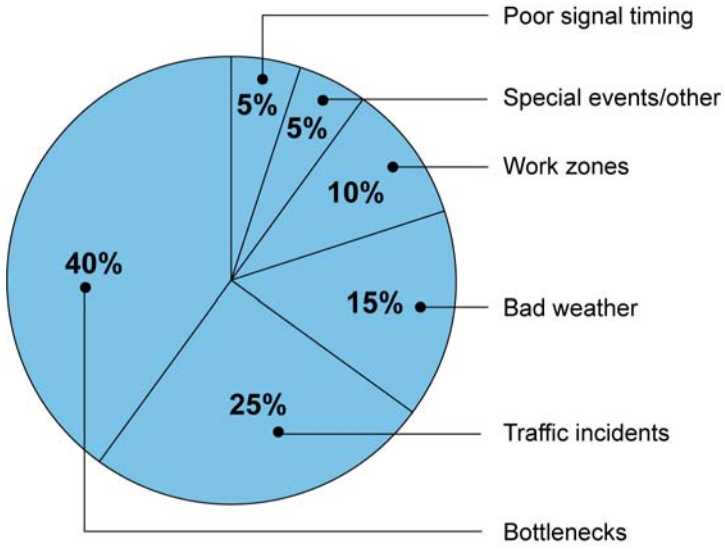
Congestion is geographically concentrated in major metropolitan areas, as close to 80 percent of America's growth and economic development is concentrated in metropolitan areas. Traffic congestion has grown worse in many ways in the past 30 years—trips take longer, congestion affects more of the day and affects more personal trips and freight shipments, and trip travel times are more unreliable. According to AASHTO, travel on the National Highway System has increased fivefold over the past 60 years, from 600 billion miles driven per year to almost 3 trillion in 2009.[4] Annual travel is expected to climb to nearly 4.5 trillion miles by 2050, even with aggressive strategies to cut the rate of growth to only 1 percent per year.[5]

[4]These figures are based on FHWA's highway statistics on vehicle miles of travel, which is the mileage traveled by all vehicles on a road system per year.

[5]American Association of State Highway and Transportation Officials, *Unlocking Gridlock: Restarting America's Most Essential Operating System.* April 2010.

The main types of strategies that state and local governments can use to address traffic congestion are improved traffic operations, public transportation, increased capacity, and demand management.[6] ITS generally fits within traffic operations as a way to better manage existing capacity. According to FHWA, traffic congestion is caused by various factors (see fig. 1). Bottlenecks, which reflect inadequate capacity, cause about 40 percent of urban road traffic congestion. The remaining 60 percent of congestion results from other causes, which, according to FHWA, can be addressed by management and operations strategies.

Figure 1: Causes of Highway Traffic Congestion



Source: FHWA, *Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation, 2005.*

ITS encompasses a broad range of wireless and wire line communications-based information and electronic technologies, including technologies for collecting, processing, disseminating, or acting on information in real time to improve the operation and safety of the transportation system. When integrated into the transportation system's

[6]Traffic operations can be defined as the implementation of management strategies aimed at minimizing the impacts of congestion with the goal of more efficiently operating the surface transportation system. Demand management strategies include a variety of methods to move trips away from the peak travel periods. These are either a function of making it easier to combine trips via ride sharing or transit use, or providing methods to reduce vehicle trips.

infrastructure and in vehicles themselves, these technologies can relieve congestion, improve safety, and enhance productivity.

Using ITS strategies may require officials to make capital improvements by installing equipment, such as traffic control systems and incident management systems. In highly congested metropolitan areas, ITS infrastructure tends to be complex because it typically consists of a set of systems deployed by multiple agencies. For example, the state government typically manages and operates freeway facilities, and city or county governments manage and operate smaller arterial roadways.[7] In a given metropolitan area, the state transportation department, city traffic department, transit agency, and toll authority may each deploy different ITS technologies that address their transportation needs. Metropolitan planning organizations serve a key role in planning, as they have responsibility for the regional transportation planning processes in urbanized areas.[8]

Congress established the ITS program in 1991 in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA),[9] and DOT created the ITS Joint Program Office in 1994. Since its creation, the ITS Joint Program Office has overseen allocation and expenditure of more than $3 billion for deploying ITS applications and researching new technologies. Under ISTEA and continuing under the Transportation Equity Act for the 21st Century (TEA-21), enacted in 1998,[10] Congress authorized funds

[7]As we reported in 2009, according to DOT officials, the term "freeways," which is used in its ITS deployment surveys, refers to controlled access roads that have no intersections. Arterial roads generally consist of roads that have signalized intersections. See GAO, *Surface Transportation: Efforts to Address Highway Congestion through Real-Time Traffic Information Systems Are Expanding but Face Implementation Challenges,* GAO-10-121R (Washington, D.C.: Nov. 30, 2009). The ITS deployment surveys are administered by RITA. FHWA defines arterials and freeways differently, however, and considers freeways a subset of arterials.

[8]Metropolitan planning organizations represent local governments and coordinate with state departments of transportation and providers of transportation services in developing and periodically updating short-range Transportation Improvement Plans and long-range Metropolitan Transportation Plans. These organizations exist for all U.S. urbanized areas of more than 50,000 people. We have suggested that Congress consider making this transportation planning process more performance-based. See GAO, *Metropolitan Planning Organizations: Options Exist to Enhance Transportation Planning Capacity and Federal Oversight,* GAO-09-868 (Washington, D.C.: Sept. 9, 2009).

[9]Pub. L. No. 102-240, §6051, 105 Stat. 1914, 2189 (1991).

[10]Pub. L. No. 105-178, §5201, 112 Stat. 107, 452 (1998).

specifically for state and local governments to deploy ITS technologies. The Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), enacted in 2005, did not directly reauthorize the ITS deployment program.[11] Although DOT no longer provides dedicated funding for ITS deployment, states can use their federal aid highway program funds for improving traffic operations, including deploying ITS.[12] In addition, state and local governments may use their own funds to finance ITS projects. State funding mainly comes from highway user charges, while local funding primarily comes from general funding allocations, property taxes, sales taxes, and various other taxes and fees. Although DOT does not track state or local spending on ITS, a market research company has estimated that states spent a combined $1.4 billion on ITS in 2010.[13]

The ITS Joint Program Office, within RITA, leads research of new ITS technologies and also carries out several activities to promote the use of existing technologies. In this capacity, the office works with the other modal administrations within DOT, including FHWA, the Federal Transit Administration, the Federal Motor Carrier Safety Administration, the Federal Railroad Administration, the National Highway Traffic Safety Administration, and the Maritime Administration. The Joint Program Office was previously housed in FHWA and moved to RITA in early 2006. FHWA's Office of Operations carries out activities aimed at improving the operations of the surface transportation system, including traffic management, and, as part of these efforts, encourages the use of ITS by state and local governments.

[11]Pub. L. No. 109-59, §5101(a)(6), 119 Stat. 1144, 1779 (2005).

[12]American Recovery and Reinvestment Act funds have also been used for some state and local projects that include the deployment of ITS technologies. Pub. L. No. 111-5, 123 Stat.115 (2009).

[13]IMS Research, *Intelligent Transport Systems in the U.S.—A Market Opportunity Assessment-2010.* July 31, 2010. GAO did not evaluate the data and methodology used in the estimate.

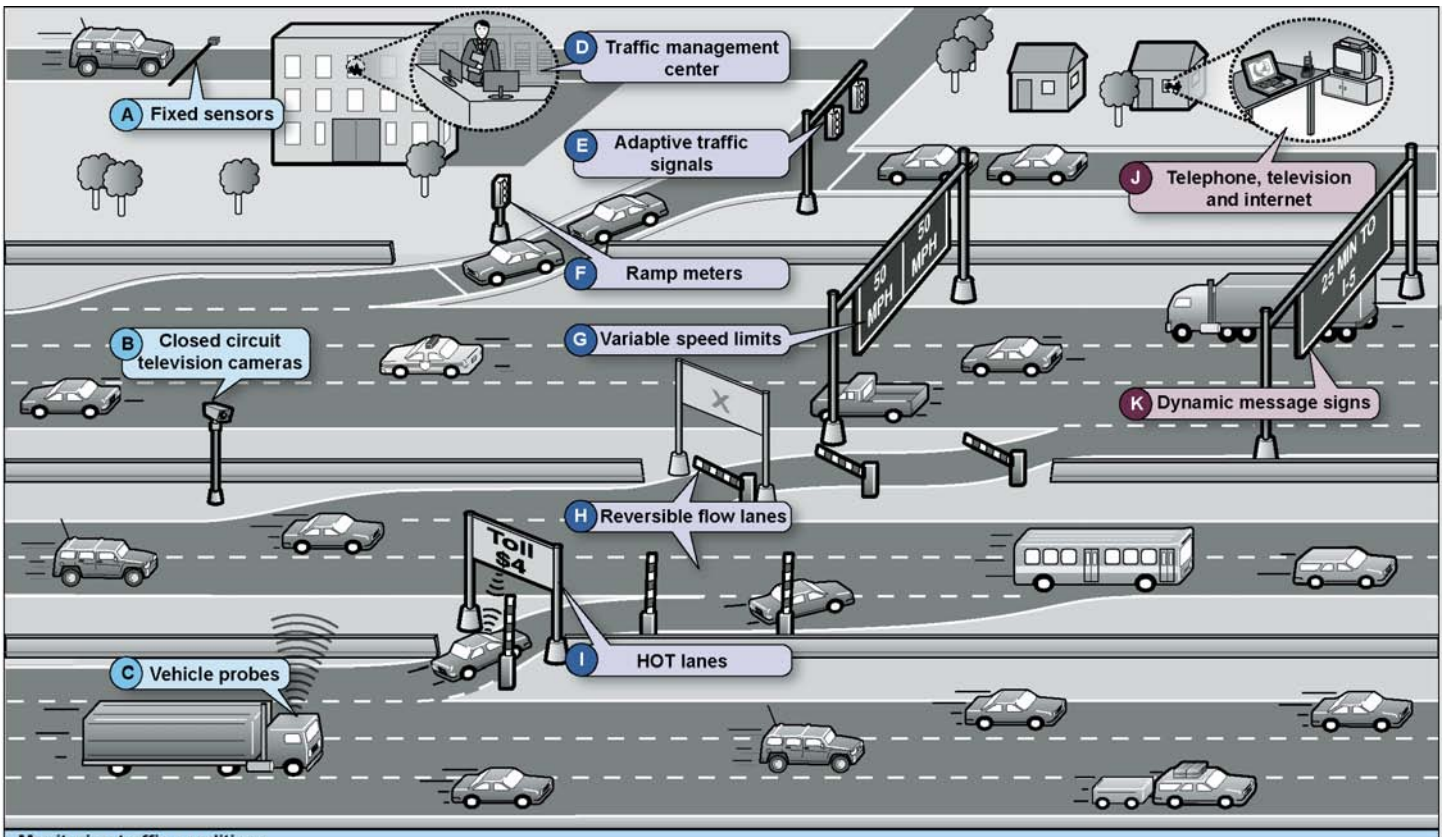
State and Local Governments Use ITS in Various Ways to Manage Congestion, and Some New Uses of ITS Are Promising

State and local governments currently use ITS technologies in a variety of ways to monitor traffic conditions, control traffic flow, and inform travelers. While numerous types of ITS technologies are available for these purposes, their deployment is uneven across the country. We identified several emerging uses of ITS that have significant potential to reduce traffic congestion. These include approaches that use integrated data to manage traffic and inform travelers and use ITS to proactively manage traffic.

State and Local Governments' ITS Deployment

State and local governments use ITS technologies to monitor traffic conditions, control traffic flow, and inform travelers about traffic conditions so they can decide whether to use alternative, less congested routes (see fig. 2).

Figure 2: Select Uses of ITS Technologies to Manage Congestion



Monitoring traffic conditions

A Fixed sensors
Loop detectors which can measure the number and estimate the average speed of vehicles passing

B Closed circuit television cameras
Provides frequent still images or full-motion video to help staff monitor traffic conditions and identify traffic incidents

C Vehicle probes
Technology that uses various forms of cell phone tracking or global positioning tracking to locate specific vehicles as they move along the roadway

Controlling traffic

D Traffic management center
A facility where traffic data is gathered, processed, combined, and used for certain decision-making to control traffic

E Adaptive traffic signals
Traffic signals that can dynamically respond to current traffic conditions

F Ramp meters
Traffic signals on freeway ramps that alternate between red and green signals to control the flow of vehicles entering the freeway

G Variable speed limits
Speed limits that change based on road, traffic, and weather conditions

Informing travelers

H Reversible flow lanes
Electronic signs and other devices that change the direction of roadway traffic to accommodate peak travel demands

I HOT lanes
Lanes that use electronic tolling to charge solo drivers a toll to use carpool lanes

J Telephone, television and internet
Methods for disseminating real-time traffic information to motorists for trip planning

K Dynamic message signs
Portable or permanently-installed displays used to provide traffic-related information to motorists

Source: GAO.

Monitoring Traffic Conditions

Transportation agencies use ITS technologies, such as closed circuit cameras and sensors, to monitor traffic conditions in real time. The availability of real-time information means that agency staff can more rapidly identify and respond to events that impede traffic flow, and develop accurate traveler information.[14] For example, cameras are an important component of incident management. Incident management is a planned and coordinated process to detect, respond to, and clear traffic incidents that can cause traffic jams. Operators can use information from cameras to verify traffic conditions detected through sensors, coordinate response to incidents, and monitor the recovery from the incident. According to DOT's 2010 ITS deployment survey, the percentage of freeway miles[15] covered by cameras increased from approximately 15 percent in 2000 to 45 percent in 2010.[16] The 2010 deployment survey found that 83 percent of freeway management agencies reported a major benefit from cameras—higher than for any other technology. Meanwhile, the level of deployment of cameras on arterials has remained relatively flat. For example, in the 2000 deployment survey, 17 percent of agencies reported deploying cameras on arterials, compared with 21 percent of agencies in 2010. DOT speculated that this may be due to funding limitations at local agencies.

Technologies such as loop detectors, radar detectors, and vehicle probes provide traffic data that allow transportation agencies to monitor traffic conditions.[17] The availability of such data has grown in recent years. In the 2000 deployment survey, 18 percent of freeway miles were covered

[14]See GAO-10-121R.

[15]Freeway miles are the miles within the metropolitan areas surveyed.

[16]In order to track the deployment of ITS technologies, DOT has conducted a nationwide survey of state and local transportation agencies since 1997. The 2010 surveys were distributed to agencies in the country's 108 largest metropolitan areas. In this report we report numbers from the survey of arterial management agencies, which had a 81 percent response rate, and freeway management agencies, which had a 84 percent response rate. Statistics such as percentage of freeway miles are calculated based on the total miles managed by the responding agencies rather than the total freeway miles in the country. For the complete 2010 survey results, see http://www.itsdeployment.its.dot.gov/.

[17]Loop detectors use a fixed roadway sensor to measure the number and estimate the speed of passing vehicles. Radar detectors use microwave radar and are mounted on overhead bridges or poles and transmit signals that are reflected off vehicles back to the sensor. The reflected energy is analyzed to produce traffic flow data, such as volume and speed. Vehicle probes use roaming vehicles and portable devices, such as cell phones and Global Positioning System devices, to collect data on travel times.

by real-time data collection technologies, as compared with 55 percent in 2010. The use of these technologies has also grown on arterial roadways, with the percentage of signalized intersections covered by electronic data collection technologies growing from approximately 20 percent in 2000 to 48 percent in 2010. In addition, private companies are expanding the use of vehicle probes that collect real-time data on travel time and speed, allowing for greater geographic coverage. Partnering with private companies to gain vehicle probe data expands the data that state DOTs use. According to the 2010 deployment survey, 11 state DOTs reported using vehicle probe data collected by a private sector company.

Controlling Traffic Flow

Many technologies can be used to dynamically manage freeway capacity and traffic flow using real-time information. Approximately one-third of the largest U.S. cities deploy traffic control technologies on freeways. Specifically, 35 of the 108 largest metropolitan areas in the United States have deployed one or more of the following freeway technology capabilities:

- *Ramp meters* control the flow of vehicles entering the freeway. According to DOT's 2010 deployment survey, ramp meters are deployed in 27 of the 108 largest metropolitan areas in the country and manage access to 13 percent of freeway miles, about the same level as in 2006.

- *Congestion (or road) pricing* controls traffic flow by assessing tolls that vary with the level of congestion and the time of day. All U.S. congestion pricing projects in operation are High Occupancy Toll lanes, which charge solo drivers a toll to use carpool lanes, or peak-period pricing projects, which charge a lower toll on already tolled roads, bridges, and tunnels during off-peak periods. The deployment of congestion pricing relies on electronic tolling ITS technology. Other ITS technologies used to support congestion pricing include sensors that detect traffic conditions and dynamic message signs that announce toll rates. In 2012, GAO found that congestion pricing projects were open to traffic in 14 major metropolitan areas.[18]

[18]For more information on congestion pricing, see GAO, *Traffic Congestion: Road Pricing Can Help Reduce Congestion, but Equity Concerns May Grow*, GAO-12-119 (Washington, D.C.: Jan. 12, 2012).

- *Reversible flow lanes and variable speed limits* can also be used to control freeway traffic and address congestion. These strategies can incorporate various forms of ITS technologies, including retractable access gates and dynamic message signs. According to the 2010 deployment survey, 11 metropolitan areas use reversible flow lanes or variable speed limits on freeways.

Transportation agencies can use ITS technologies to control arterial traffic through traffic signals. Types of advanced traffic signal systems include the following:

- *Operating signals under computerized control*: This capability allows operators to remotely adjust the signals from the traffic management center to respond to current traffic conditions and allows for enhanced control over signals in response to traffic events. According to the 2010 deployment survey, 50 percent of signalized intersections were under centralized computer control—essentially equal to the proportion in 2000.

- *Adaptive signal control technology*: These signals can be automated to adjust signal timings in real time based on current traffic conditions, demand, and system capacity. It allows faster responses to traffic conditions caused by special events or traffic incidents. For example, Los Angeles has developed one of the first fully operating adaptive signal control systems in North America. Despite benefits of adaptive signals, according to DOT, only 3 percent of traffic signals in the country's largest metropolitan areas are controlled by adaptive signal control. According to DOT, agencies have not deployed adaptive signals because of the costs of deploying, operating, and maintaining them, as well as uncertainty about their benefits.[19]

Informing Travelers

Transportation agencies communicate information gathered from traffic monitoring to the traveling public in various ways, including via dynamic message signs, television, websites, e-mail, telephone, and devices used in vehicles such as cell phones. This information—including information about travel times and traffic incidents—allows users to make informed decisions regarding trip departures, routes, and modes of travel.

[19]According to FHWA, its Every Day Counts initiative is developing and providing information related to implementation costs and system benefits of adaptive signal control to agencies to help spur deployment.

Dynamic message signs are popular for communicating traffic information to travelers. According to DOT's 2010 deployment survey, almost 90 percent of freeway agencies, and approximately 20 percent of arterial agencies, reported using dynamic message signs to disseminate traveler information. The number of dynamic message signs deployed on freeways increased from fewer than 2,000 signs in the year 2000 to over 4,000 in 2010, greatly expanding agencies' capabilities to communicate directly with freeway travelers. Arterial agencies also increasingly adopted dynamic message signs, nearly tripling from 10 percent of responding agencies in 2000 to 26 percent in 2010.

The 511 Traveler Information Services are another method of informing travelers. DOT initiated the development of these services and seeks to have states deploy them nationwide.[20] These 511 services provide information via the telephone (using an interactive voice response automated system) and the Internet. State DOTs generally run these services and they operate independently of one another. Currently, 14 states lack 511 service coverage or provide service for only a portion of the state. Additionally, these services vary in the ways they provide information (phone or Internet), the types of information they provide (travel times, roadway weather conditions, construction), and areas they cover (statewide or citywide). To fulfill requirements in SAFETEA-LU, FHWA issued a Final Rule in November 2010 to establish the Real-Time System Management Information Program.[21] The rule contains minimum requirements for states to make information on traffic and travel conditions available through real-time information programs and to share this information. In 2009, 17 of the 19 experts we interviewed about the need for a nationwide real-time traffic information system said such a nationwide system should be developed.[22] Some of these experts noted that state and local transportation agencies generally develop and use

[20]DOT initiated the development of 511 Traveler Information Services by asking the Federal Communications Commission (FCC) to set aside a three-digit telephone number nationwide for traveler information services. FCC granted this request in July 2000 and issued a rule on 511 stating that DOT's role was to "facilitate ubiquitous deployment" of these services. *In the Matter of Petition by the USDOT for Assignment of an Abbreviated Dialing Code (N11) to Access Intelligent Transportation System (ITS) Services Nationwide*, Third Report and Order and Order on Reconsideration in CC Docket No. 92-105, FCC 00-256 (2000).

[21]See 75 *Fed. Reg*. 68418 (Nov. 8, 2010).

[22]GAO-10-121R.

these systems within their own jurisdictions, leading to gaps in coverage and inconsistencies in the quality and types of data collected. Because of these gaps, travelers using 511 systems have to contact different systems while they are traveling and may receive different types of information.

Deployment of ITS Is Uneven

In general, the level of ITS deployment varies by state and locality. For example, the deployment of ITS technologies across the four metropolitan areas we visited greatly varies (see table 1). ITS is also used more on freeways than on arterial roads. For example, in response to DOT's 2010 deployment survey, agencies in 21 metropolitan areas reported deploying real-time traffic data collection technologies such as loop detectors on arterial roadways, compared with agencies in 71 metropolitan areas that reported deploying the same types of technologies on freeways. Several experts we interviewed described the deployment of ITS nationwide as "spotty" or having uneven geographical coverage. DOT officials told us that the pace of ITS adoption by state and local governments has been slow and that upgrades to newer types of technologies have been difficult. In the next section we discuss some of the common challenges state and local governments face in deploying ITS, such as funding constraints.

Table 1: Comparison of 2010 ITS Deployment and Other Characteristics of Four Metropolitan Areas GAO Visited

Category	Indicator	Austin, TX	Los Angeles, CA	Pittsburgh, PA	Washington, DC
Size and congestion level	Population of metropolitan area (in millions)	1.7	12.8	2.4	5.6
	Yearly delay per auto commuter (hours)[a]	38	64	31	74
Monitoring traffic conditions	Percentage of freeway miles covered by cameras	58	37[b]	29	58
	Percentage of freeway miles with real-time data collection technologies	58	39[b]	24	61
Controlling traffic flow	Freeway traffic control strategies that use ITS[c]	None	Ramp meters, congestion pricing	Reversible flow express lanes	Ramp meters, congestion pricing, reversible flow express lanes
	One or more agencies deploy adaptive signal control technology	No	Yes	Yes	No
Informing travelers	Number of dynamic message signs on freeways and arterials	26	350[b]	82	217
	Report travel time data to travelers[d]	No	Yes	Yes	Yes

Sources: GAO analysis of information provided by transportation officials, DOT data, Texas Transportation Institute, and U.S. Census Bureau.

[a]The extra time spent traveling at congested speeds rather than free-flow speeds by private vehicle drivers and passengers who typically travel in the peak periods.

[b]These figures are from the 2007 DOT ITS deployment survey results because of the lack of response of a key agency to the 2010 survey.

[c]Includes ramp metering, congestion pricing, reversible flow express lanes, and variable speed limits.

[d]Includes via webpage, 511, telephone system, e-mail, Twitter or other social networking site, highway advisory radio, and dynamic message signs.

Emerging Uses of ITS Technologies

We identified four emerging uses of ITS technologies that have the greatest potential to reduce traffic congestion, based on views of experts we interviewed (see table 2).[23] We grouped these technology uses into two broad themes: (1) using integrated data to manage traffic and inform travelers, and (2) proactively managing traffic.

[23]As described earlier, we interviewed 15 experts on their views related to ITS. We identified emerging uses of ITS technologies and asked the experts to rate these technologies regarding the extent to which their further implementation has the potential to reduce traffic congestion. See appendix I for more information on our methodology.

Table 2: Emerging Uses of ITS Technologies That Have the Greatest Potential for Reducing Traffic Congestion, Based on Experts' Views

Technology use[a]	Description
Using integrated data to manage traffic and inform travelers	
Real-time data capture, sharing, and management	Creating and expanding access to integrated, high-quality, real-time, multimodal transportation data that are captured from mobile devices, infrastructure and connected vehicles and used to improve transportation management
Enhanced incident response management	Integrating various sources of data—such as traffic, weather, and emergency services data—across jurisdictions to better detect and respond to incidents
Proactively managing traffic	
Active transportation and demand management	A proactive approach for dynamically managing and controlling demand and available capacity of transportation facilities, based on prevailing traffic conditions, using one or a combination of real-time and predictive operational strategies, e.g., improved traffic signal timing and congestion tolling
Work zone management	Proactively anticipating and mitigating the effects of work zones

Source: GAO.

[a]We included only ITS uses that (1) were considered by all the 15 experts we contacted to have at least a medium potential to reduce traffic congestion, and (2) were ranked by at least 9 of the experts as having high potential to reduce traffic congestion.

Using Integrated Data to Manage Traffic and Inform Travelers

ITS technologies generate and use data to support agencies' strategies—such as traffic signal coordination and incident management—for managing congestion. State and local governments within some metropolitan areas, such as Washington, D.C., are employing new traffic management strategies that make use of data integrated from various sources, which were previously "siloed." The objective of these approaches is to collect, manage, integrate, and apply real-time transportation data. The approaches can also enhance traffic operations because they allow agencies to intervene in traffic congestion as it happens and operate the system more efficiently. Better integration of real-time data across jurisdictions facilitates more coordinated strategies and better informs travelers, as it gives them more information on transportation alternatives.

Agencies integrate a variety of real-time information—including incident information, travel time, and weather advisories—obtained from various sources to manage the transportation system and provide relevant information to travelers. The expansion of real-time data collection technologies and coverage in recent years has allowed for greater use of these data in daily traffic operations. As one expert noted, data are the foundation of managing congestion, and the more and better quality the data, the better the tools that can be brought to bear on managing traffic. In addition to supporting a more active role in managing traffic, such data

allow management agencies to provide real-time traffic advisories and support performance measurement.

Collection and integration of data—such as traffic and emergency services data—across jurisdictions can enhance incident management by allowing quick detection and response to incidents. For example, the I-95 Corridor Coalition makes vehicle probe data available to 19 agencies, which use the data to monitor traffic patterns across state boundaries and to respond to incidents and congestion. In 2009, the New York State Police used these vehicle probe data along with data from the New York 511 website to assist in managing holiday traffic congestion. This proactive approach to traffic management led to a 50 percent reduction in traffic queues over previous years. Two-thirds of the experts we interviewed rated enhanced incident management as having a high potential to reduce traffic congestion.

The Regional Integrated Transportation Information System (RITIS) program in the Washington, D.C., area is an example of data integration that allows for improved traffic operations, incident management, and traveler information.[24] RITIS is a system that compiles data across modes of transportation from agencies throughout the metropolitan area, including data on incidents, weather, managed lane status, signal status, and data from public safety computer-aided dispatch systems. RITIS then standardizes these data, and makes them available to participating agencies. Previously, many of the area transportation agencies had implemented stand-alone systems and relied on ad hoc communications that were driven by personal relationships between staff for coordination. RITIS is part of an information-sharing effort, called the Metropolitan Area Transportation Operations Coordination Program, which has been shown to result in cost savings associated with reduced traffic delay and reduced fuel consumption.[25] Additionally, officials we spoke with at the Maryland State Highway Administration noted RITIS was a major improvement to their operation and has improved the ability to know where an accident

[24]RITIS was developed by the University of Maryland's Center for Advanced Transportation Technology Laboratory starting in 2006 with funding from various, mostly public, sources.

[25]Metropolitan Area Transportation Operations Coordination Benefit-Cost Analysis White Paper, June 2010.

has occurred. Similar efforts to provide this level of data integration exist in the Los Angeles and New York City metropolitan areas.

Proactively Managing Traffic

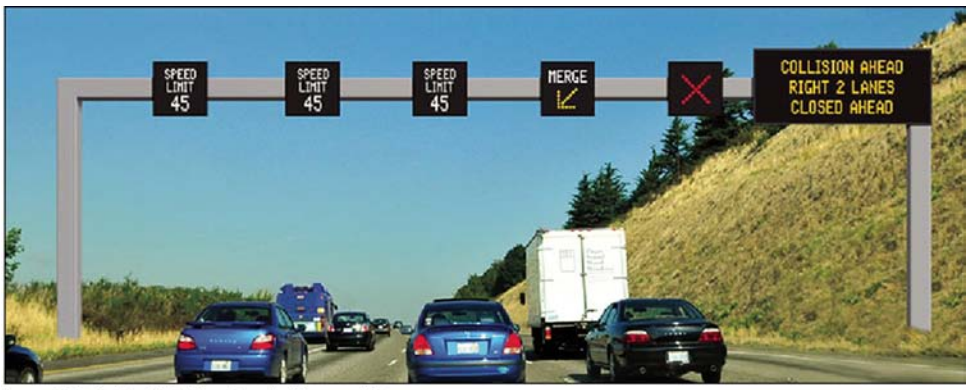
FHWA has noted that the proactive management of roadway capacity and transportation demand is the next step in congestion relief.[26] Technical advances now make it possible to move from relatively passive monitoring to proactive control of traffic through mechanisms like variable speed limits, congestion pricing, and ramp metering. Active transportation and demand management is a proactive approach for dynamic management and control of existing transportation infrastructure based on current traffic conditions using real-time data and information. According to FHWA, this approach considers the real-time management of both supply and demand to prevent, delay, or minimize facility breakdown when travel demand exceeds system capacity.

In Seattle, the Washington State DOT has instituted active traffic management systems. These systems, which are among the few such systems in the country, use overhead signs that display changing speed limits and real-time traffic information for drivers over each lane (see fig. 3). These signs dynamically and automatically reduce speed limits to alert drivers to slow their vehicles when they approach congestion, collisions, or backups at off-ramps. The signs also alert drivers to upcoming lane closures because of traffic incidents or road work and direct them to open lanes. The system also includes dynamic message signs that alert drivers of downstream backups and signs that display estimated travel times. Although a formal evaluation of the systems in Seattle is forthcoming, FHWA has reported that similar systems in Europe, depending on the location and the combination of strategies deployed, have resulted in increases in overall capacity ranging from 3 to 22 percent, increases in travel time reliability, and reductions in primary incidents ranging from 3 to 30 percent.[27]

[26]FHWA, *Active Traffic Management: The Next Step in Congestion Management* (Washington, D.C.: July 2007).

[27]Primary incidents are crashes or other incidents that do not include secondary incidents, such as rear-end crashes, resulting from immediate factors associated with the initial incident.

Figure 3: Active Traffic Management along Interstate 5 in Seattle, Washington



Source: Washington State Department of Transportation.

Active transportation management can also include managed lanes, in which officials control traffic lane use by

- granting access to only certain types of vehicles, such as high-occupancy vehicles;
- controlling access, such as designing express lanes where access is restricted to a few points; or
- congestion pricing, where vehicles pay a toll to use the lane.

Another strategy to reduce congestion is road pricing or congestion pricing—assessing tolls that vary with the level of congestion and the time of day. This demand management strategy aims to improve the flow of traffic by motivating drivers to travel by other modes, such as carpools or transit, or by traveling at less congested times. For example, in Los Angeles, the California Department of Transportation and the Los Angeles County Metropolitan Transportation Authority are converting over 50 miles of freeway from High Occupancy Vehicle, or carpool, lanes, to High Occupancy Toll lanes. This is to allow use of excess capacity in the lanes by single occupancy vehicles for a price. Agencies have used electronic fare collection and traveler information ITS technologies to accomplish this conversion. A recent GAO report reviewed evaluations of

five High Occupancy Toll lane projects and found that travel time and travel speed improved on at least some sections of all five projects.[28]

Officials can also proactively manage traffic conditions through ramp metering, which can maintain smooth freeway flow by regulating vehicle entry at entrance ramps. DOT's 2010 deployment survey found that freeway agencies believe ramp control has high benefit, despite the fact that the technology is lightly deployed. Additionally, active transportation and demand management approaches, such as ramp metering, were mentioned as beneficial by five stakeholders and officials from four transportation agencies we spoke with, across all four sites.

Work zone management is another emerging use of ITS to proactively manage traffic. Transportation agencies can use work zone management to reduce the congestion normally associated with construction activities such as lane closures. Agencies use ITS to mitigate the effects of lane closures, detours, and other factors. Examples of ITS technologies used in work zones include using electronic signs to control merging for lane closures and variable speed limit signs. Agencies also use traveler information ITS technologies to notify the public of road closures and work zone-related delays.

Connected vehicle technology, still under development, could significantly change traffic management, both in terms of the amount of traffic data transportation agencies will collect and in how agencies proactively manage traffic.[29] DOT's current ITS research agenda focuses on the department's vision to provide the nation with a national, multimodal transportation system that features wireless communications among vehicles, infrastructure, and portable devices. The importance of data management and integration will continue given that connected vehicle technology has the potential to significantly increase the amount of transportation data available to state and local governments.

[28]GAO-12-119.

[29]We excluded connected vehicle technology, which is an emphasis of DOT's current ITS research plan, because it is currently still under development and has not yet begun to be used by state and local governments.

State and Local Governments Face a Number of Challenges in Using ITS Technologies

State and local governments face various challenges in deploying and effectively using ITS technologies to manage traffic congestion. As mentioned previously, ITS in metropolitan areas tends to be complex and is deployed by multiple agencies, which involves planning and coordination across agencies. Effectively using ITS is dependent upon agencies having the staff and funding resources needed to maintain and operate the technologies. We identified four key challenges agencies face in using ITS: strategic planning, funding deployment and maintenance, having staff with the knowledge needed to use and maintain ITS, and coordinating ITS approaches.

Strategic Planning Challenges

Planning for ITS is a key component of strategically using ITS to address transportation issues and reduce congestion. Transportation planning for metropolitan areas has traditionally focused on building and maintaining basic infrastructure to ensure adequate roadway capacity. ITS, in contrast, focuses on managing already-existing capacity to use it more effectively. Strategically using ITS requires agencies to shift focus from planning construction and maintenance of roadways to planning the operations of the surface transportation system, a shift that, according to DOT, some states and local transportation agencies have not yet fully made.

A RITA official told us that planning is a major challenge that affects agencies' ability to make effective use of ITS. The federal ITS program, as mentioned previously, initially included a DOT program that provided grants to transportation agencies specifically to deploy ITS. As a result, many agencies have deployed ITS based on the availability of funding rather than systematic planning, according to two stakeholders, a national transportation organization representative, a DOT official, and four transportation agencies we interviewed. According to FHWA officials, ITS deployment has not always been clearly connected to a transportation problem or need, or well integrated with other transportation strategies and programs. If state and local governments do not consider the range of available ITS options in developing their congestion management strategies, they may miss opportunities to better manage traffic and make the best use of scarce funds to address congestion.

Most experts we spoke to believed that limitations of planning processes, as well as the availability of information to support sound decision

making, were challenges faced by state and local governments in using ITS.[30] Furthermore, six experts, two stakeholders, and officials from five transportation agencies we contacted noted that there is a need for more planning and analysis information such as cost-benefit information and performance measures.[31] Some of these officials noted that it is currently difficult to calculate and measure the benefits of ITS. For example, in its 2010 deployment survey, DOT found that 25 percent of agencies responsible for managing arterial roadways reported that they had not deployed adaptive traffic signal control technology because of uncertainty about benefits. Lack of quantifiable information about benefits can put ITS projects at a disadvantage compared with other types of transportation projects such as road improvements or bridge replacements, which have more easily quantified benefits. While some studies show that various types of ITS technologies can be cost-effective, conducting such studies can be challenging.[32]

FHWA has emphasized the importance of incorporating transportation operations (including ITS) into transportation planning, along with related objectives and performance measures. Despite FHWA's promotion of the use of such an approach, many metropolitan planning organizations do not fully consider operations in the planning process. A recent FHWA

[30]Eleven of 15 experts we interviewed said that limitations of planning processes constituted a challenge to deploying, operating, and maintaining ITS technologies for traffic management. Of these, 5 said they were a major challenge, 2 said they were between a major and a minor challenge, and 4 said they were a minor challenge. One expert said that limitations of planning processes did not constitute a challenge. The remaining 3 experts said they had no basis to judge. Thirteen of 15 experts we interviewed noted the availability of information to support sound decision making was a challenge state and local governments face in deploying, operating, and maintaining ITS. Specifically, 4 of 15 experts said it was a major challenge, 3 said it was between a major and a minor challenge, and 6 said it was a minor challenge. One expert said it was not a challenge and the other had no basis to judge.

[31]In 2007, we reported that rigorous economic analysis is not a driving factor in most investment decisions by state and local governments. See GAO, *Surface Transportation: Strategies Are Available for Making Existing Road Infrastructure Perform Better,* GAO-07-920 (Washington, D.C.: July 26, 2007).

[32]In 2009, we reviewed studies that quantified the impact of real-time traffic information systems. The studies generally found that the systems improved mobility and had environmental benefits. However, these studies are not generalizable or comparable because they are specific to a particular city or system. We also found conducting cost-benefit analyses of these systems is challenging because of difficulty capturing data about travelers and isolating and attributing transportation impacts to an individual project. See GAO-10-121R for more information.

assessment found that metropolitan planning organizations increasingly address traffic operations (including ITS) in their plans, but only 36 percent include specific, measurable objectives related to operations that meet DOT's recommended criteria.[33] Despite challenges, DOT reports that some regions have effectively incorporated ITS into their planning efforts, including Hampton Roads, Virginia.[34] The Hampton Roads Transportation Planning Organization, the metropolitan planning organization for the area, scores ITS projects for their capacity to support planning objectives and has been able to acquire federal funding for several ITS plans and projects through this process. These include a centralized traveler information system and signal system upgrades.

Funding Challenges

Funding constraints pose a significant challenge to transportation agencies in their efforts to deploy ITS technologies because of competing priorities and an overall constrained funding situation.[35] ITS projects must compete for funding with other surface transportation needs, including construction and maintenance of roads, which often take priority, according to officials from transportation and stakeholder agencies we interviewed. As we reported in 2005, transportation officials often view adding a new lane to a highway more favorably than ITS when deciding how to spend their limited transportation funds.[36] DOT has noted that funding constraints might explain why the rate of adoption of arterial management technologies over the past decade has been flat. In addition, the 2010 deployment survey found that 55 percent of agencies responsible for managing freeways, compared with 36 percent of agencies responsible for managing arterial roadways, plan to invest in new ITS in 2010 to 2013. Transportation agencies face difficult decisions regarding the allocation of their transportation funding, and many have

[33]DOT recommends that objectives be (1) specific, (2) measurable, (3) agreed upon by relevant participants, (4) realistic and (5) time-bound. See http://ops.fhwa.dot.gov/publications/fhwahop10027/chap_2.htm.

[34]The Hampton Roads, Virginia, area includes a number of municipalities—including Norfolk, Virginia Beach, Hampton, and Newport News—located among a number of estuaries of the Chesapeake Bay.

[35]All 15 experts we interviewed rated the ability to fund deployment of ITS in light of resource constraints and competing priorities as a challenge state and local governments face in using ITS. Thirteen rated it a major challenge, 1 between a major and a minor challenge, and 1 a minor challenge.

[36]See GAO-05-943.

faced severe revenue declines in recent years, restricting the availability of funds for transportation improvements. For example, a county transportation official we interviewed reported that the funds for deploying and maintaining ITS have been reduced annually over the last 3 to 4 years because of reduced county revenues, which has led to the county suspending almost all deployment of ITS field devices.

Transportation officials must identify priorities and make trade-offs between funding projects that preserve or add new infrastructure and those that improve operations, such as ITS projects. Preserving infrastructure is a high priority for state and regional decision makers. Traffic growth has outpaced highway construction, particularly in major metropolitan areas, which puts enormous pressure on roads.[37] According to FHWA's most recent projections (using 2006 data), less than half of the vehicle miles traveled in urban areas are on good-quality pavements and about one-third of urban bridges are in deficient condition.[38] As five stakeholders and officials from four transportation agencies we spoke with noted, ITS projects have difficulty competing for funding with other needs, such as road and bridge maintenance projects. For example, one city transportation official told us the city must devote most of its resources to highway and bridge projects rather than new technology, and in some cases the city has resorted to demolishing unsafe bridges because of lack of funds rather than repairing or replacing them.

These funding issues exist within the context of an overall large funding gap for maintaining and improving the nation's surface transportation infrastructure.[39] The Highway Trust Fund has been undergoing a solvency crisis in recent years. Its expenditures have exceeded its revenues, which derive mainly from motor fuel taxes. According to 2006 National Surface Transportation Infrastructure Financing Commission estimates, combined revenues at all levels of government, under current policies, will meet only 58 percent of the capital investment requirements

[37]American Association of State Highway and Transportation Officials, *Rough Roads Ahead, Fix Them Now or Pay For It Later* (Washington, D.C.: 2009).

[38]FHWA, *2008 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance: Report to Congress*. (Washington, D.C.: 2008).

[39]For more information see "Funding the Nation's Surface Transportation System" section of GAO, *High-Risk Series: An Update*, GAO-11-278 (Washington, D.C.: February 2011).

for U.S. highway maintenance and only 41 percent of the costs for highway improvement for the period 2008-2035.[40]

Agencies that are able to deploy ITS often face additional challenges in funding the operations and maintenance of these technologies. Eight experts we interviewed noted that funding operations and maintenance of ITS is more challenging than funding the initial deployment.[41] Two experts we interviewed noted that ITS is often installed and then not fully utilized or maintained. Additionally, in response to FHWA's 2009 proposed requirement for states to make travel information available as part of a Real-Time System Management Information Program, several states identified operation and maintenance costs as a barrier to the implementation of such a program.[42] Ongoing costs of operations for some systems may exceed those of deployment. For example, in 2003, investments for signal control hardware had initial costs of $21,000 to $30,000 and yearly maintenance costs of $9,000 to $10,500 over a 5-year time frame.

FHWA officials told us that it is often difficult for state and local agencies to sustain the operations of ITS technologies because of funding constraints and the higher priority agencies place on basic infrastructure. For example, a county transportation agency official we interviewed reported that the agency's operating budget has been reduced by about 30 percent over the past 2 years, which has led to reduced maintenance of ITS devices. Officials from one local agency told us that one of its big challenges is identifying operations and maintenance funding to support newer systems. Advanced traffic signal systems are one area in which operations and maintenance funding challenges can limit effectiveness and impede greater expansion. According to FHWA, over 50 deployments of these signal systems have occurred over the last two decades. However, over half of the deployments were deactivated because of

[40]National Surface Transportation Infrastructure Financing Commission, *Paying Our Way: A New Framework for Transportation Finance*, (February 26, 2009).

[41]All 15 experts we interviewed rated funding operations and maintenance as a challenge to state and local governments in using ITS. Fourteen said that it was a major challenge and 1 said that it was a minor challenge.

[42]75 *Fed. Reg.* 68418,68422, Nov. 8, 2010. In responding to these comments, FHWA extended its time frames for implementation and modified the final rule's language to include an explicit reference to the eligibility of operations, including applicable preventive maintenance, for federal funding.

insufficient resources or lack of maintenance or operations capabilities. Additionally, a 2010 study on adaptive traffic control systems found that funding—including the high cost of deployments and the lack of funding for operations—was the main factor in why these systems are not more widely deployed.[43] Transportation officials in one metropolitan area we visited told us that it was common for smaller cities to fund the deployment of advanced traffic signals but be unable to fund, maintain, and repair them after deployment, causing signal failures that can impair coordination with neighboring cities and operation of the larger network.

The lack of funding availability for operations and maintenance is compounded by other challenges such as insufficient staffing resources, difficulty in planning maintenance costs, and the fast pace of technological change. RITA officials noted that some local governments will not install ITS because they do not have the staff to do the continual maintenance that the systems require. Three stakeholders and officials from six transportation agencies told us that funding the operations and maintenance of ITS is difficult to plan for, because of challenges accounting for maintenance costs and the fast pace of technology. The life cycle of ITS technologies is short, between 5 and 7 years, according to one ITS researcher, meaning that equipment or software will become obsolete or require retooling within that time frame.

Some states and localities have developed alternative methods for financing congestion reduction efforts, including ITS projects. These supplement traditional funding sources and have included imposing additional tolls, local taxes, or fees; developing partnerships with private industry; and designating separate funding. For example,

- Half of the budget of the Metropolitan Transportation Authority of Los Angeles County comes from a 1.5 percent sales tax dedicated to transportation. This allows the agency to fund and deploy ITS improvements countywide, on arterials, highways, and the transit system.

- The Virginia DOT is constructing High Occupancy Toll lanes on I-495 through a public-private partnership. This agreement provided Virginia

[43]Transportation Research Board, *Adaptive Traffic Control Systems: Domestic and Foreign State of Practice,* National Cooperative Highway Research Program Synthesis 403 (Washington, D.C.: 2010).

with needed construction funds, as the project would otherwise consume more than a year of the state's construction funds.

- Some state and local governments have purchased traffic data from private companies because they can avoid the costs of data collection, including sensor deployment and operations and maintenance.

ITS Knowledge Challenges

ITS is a rapidly developing field that requires a specialized workforce familiar with emerging technologies. Staff responsible for managing ITS systems need knowledge in a variety of areas, including project management and systems engineering, according to two FHWA division office ITS engineers.[44] Workforce demographic changes, the competitive labor market, new technologies, and new expectations in the transportation industry combine to make attracting and retaining a capable workforce difficult for state and local transportation agencies. In addition, a 2011 National Cooperative Highway Research Program study found that U.S. universities produce too few skilled applicants for state and local DOTs.[45] These issues combine to affect the ability of state and local agencies, especially smaller agencies, to manage ITS.[46]

Many state and local transportation agencies struggle to maintain in-house staff with the skills and knowledge needed to manage ITS projects. Eight of the 15 experts we spoke with noted that agencies face challenges in maintaining staff with the expertise and skills needed for ITS. For example, 1 expert noted that ITS requires skills that civil engineers—with whom transportation agencies are generally well staffed—are not specifically trained in, such as understanding electrical systems, communication networks, and interagency relationship building. Another expert noted difficulty finding staff with other skills necessary to

[44]Systems engineering is an interdisciplinary approach aimed at enabling the realization of successful systems. It focuses on defining client needs and required functionality to address those needs early in planning, and then carries out design and operation while considering the complete problem from both business and technical perspectives.

[45]National Cooperative Highway Research Program, *Strategies to Attract and Retain a Capable Transportation Workforce* (Washington, D.C.: 2011).

[46]Fifteen of 15 experts we interviewed said that lack of sufficient staff expertise constituted a challenge. Nine rated it a major challenge, 1 between a minor and major challenge, and 5 a minor challenge.

ITS management, such as contract management, systems integration, and information technology troubleshooting skills. In addition, the fast pace of technological change and resource limitations put more demands on transportation officials and limit training opportunities. RITA officials told us that transportation agencies need systems engineers to manage ITS deployment and operations but do not have them in sufficient numbers. For example, a local government official told us he has been unable to fill a vacant ITS-related engineering position because of a hiring freeze that has been in effect for over 3 years. According to this official, this makes it difficult to complete ITS projects even when funds for projects are available.

Once ITS professionals have needed skills, agencies find it difficult to retain them. Eight of the 15 experts we spoke with noted that retention of qualified staff is a challenge for agencies. Limitations in salary and career opportunities can limit the ability of state and local governments to retain staff. One expert noted that the ITS staff at his state DOT could double their salary by going elsewhere, and another mentioned a state DOT employee who had multiple job offers from the private sector and whom the state DOT could no longer afford. Additionally, officials from 10 transportation and stakeholder agencies we interviewed noted that retaining staff was a challenge. For example, officials from several transportation and stakeholder agencies noted that, because of budget restrictions, they have been unable to hire ITS staff to replace those who have retired.

This is a particular issue for small agencies, according to two FHWA division office ITS engineers. The agencies controlling arterial roadways and intersections, including traffic signals, are typically county and city governments and are smaller in terms of funding and personnel, on average, than agencies controlling freeways, which are typically state governments. For example, the National Transportation Operations Coalition's 2007 *National Traffic Signal Report Card Technical Report* found that agencies operating very small signal systems scored markedly lower on signal operations than all other agencies, likely because of staff not having specialized knowledge of signal systems operations and maintenance.[47] Additionally, the report found almost one-half of all 417

[47]National Transportation Operations Coalition, *National Traffic Signal Report Card Technical Report* (2007).

survey respondents did not have staff or resources committed to monitor or manage traffic signal operations on a regular basis. According to a paper by two FHWA division office ITS engineers in California, small to medium-size agencies in the state lack qualified staff and, as a result, find it difficult to implement complex ITS projects successfully. The engineers noted that these agencies are not able to maintain staff with project management and systems engineering expertise because of insufficient ITS activity to justify a full-time staff position, high turnover of staff, and difficulty in obtaining ITS training. In the paper, the FHWA engineers proposed several potential solutions for these agencies, such as sharing technical staff within the same agency, sharing ITS staff between agencies, hiring consultants, or hiring another agency to perform some of the needed functions.

Seven experts, six stakeholders, and officials from nine transportation agencies we spoke with noted that agencies often address these issues by hiring consultants for ITS support. State and local agency officials reported hiring consultants to perform a range of ITS tasks, such as maintaining ITS equipment, developing the regional architecture needed to meet federal requirements, and conducting the systems engineering to develop project requirements.[48]

In addition to developing a workforce skilled in ITS, transportation agencies also need leaders who support ITS to plan, fund, and implement projects successfully.[49] As one expert noted, supportive state DOT leaders can find creative ways to fund ITS. However, officials from two transportation agencies and five stakeholders noted that leaders in their areas do not always place a priority on ITS, especially in the context of limited funding, when other projects such as bridge and roadway maintenance and building capacity can take precedence. Officials from some transportation and stakeholder agencies we interviewed said that

[48]FHWA requires that any ITS projects carried out using funds from the Highway Trust Fund conform to the National ITS Architecture. Regions are required to develop a regional architecture to tailor the National Architecture to local needs. This rule also requires that all ITS projects be developed using a systems engineering analysis. 66 *Fed. Reg.*1446 (Jan. 8, 2001). 23 C.F.R. Part 940.

[49]Of the 15 experts we spoke to, 12 rated institutional leadership and support as a challenge facing state and local governments in deploying, operating, and maintaining ITS. Five identified it as a major challenge, 3 as between a major and a minor challenge, 4 as a minor challenge, 2 as not a challenge, and 1 had no basis to judge.

elected and appointed officials lack good understanding of potential ITS benefits, and require reeducation when there is a change in leadership, which can lead to variations in funding and other support. The majority of the experts we interviewed noted that the level of ITS leadership varies across the country and from agency to agency.

Coordination Challenges

As mentioned earlier, in highly congested metropolitan areas, ITS systems tend to be complex and involve multiple agencies. Transportation networks include freeways, arterial roadways, and transit systems that cross state and jurisdictional boundaries; and ITS may be implemented by numerous agencies, such as state DOTs, counties, cities, and transit agencies. For example, in the Pittsburgh metropolitan area, approximately 260 townships manage their own traffic signals, and in the Los Angeles metropolitan area, approximately 120 cities manage their own traffic signals, according to metropolitan planning organization officials. As noted previously, better integration of data across jurisdictions can improve traffic operations and traveler information. According to FHWA, better coordination has the potential to improve a region's integration of ITS approaches, permitting agencies to leverage resources, avoid duplication, and enhance ITS effectiveness. However, we found coordination of various ITS elements and technologies is a challenge for agencies. Fourteen experts, seven stakeholders, and officials from five transportation agencies we interviewed noted that coordination across agencies is a challenge.[50] In addition, the DOT 2010 deployment survey found that about 39 percent of freeway management agencies employ coordinated traffic incident management and only about 16 percent of freeway agencies and 28 percent of arterial agencies engage in cross-jurisdictional traffic signal coordination.

Agencies face difficulty coordinating for many reasons, including differing priorities and perspectives. In 2007, we reported that common challenges transportation agencies face in coordinating include difficulties aligning perspectives when working on regional projects and addressing competing ideas of which jurisdictions should be responsible for the

[50]Fourteen of 15 experts whom we interviewed said that coordination among agencies and across jurisdictions presented challenges to state and local governments in deploying, operating, and maintaining ITS technologies. Five said that coordination presented a major challenge, 1 between a major and a minor challenge, and 8 a minor challenge. One had no basis to judge.

management and funding of ITS projects that cross boundaries.[51] FHWA officials noted that some communities may have priorities that are contrary to the goal of creating free-flowing traffic, such as slowing down traffic through the town. Additionally, officials from six transportation agencies we interviewed discussed differing jurisdictional priorities as obstacles to regional goals. For example, in regard to traffic signals, officials in one metropolitan area we visited told us some cities work together to manage their signals with the purpose of expediting traffic through a corridor, while other cities want to independently manage their signals to slow traffic or discourage additional traffic. In another metropolitan area we visited, metropolitan planning organization officials reported challenges deciding who will bear the financial responsibility for bus priority signals that would allow buses to have priority through traffic signals. While the transit agency that operated the buses wanted a single equipment system to enable buses to move freely at signals in the region's various jurisdictions, cities operating the traffic lights could not afford to modify their systems.[52]

In some cases, agencies are able to work together to achieve common goals to reduce congestion. For example, three jurisdictions outside of Pittsburgh—Cranberry Township, Seven Fields Borough, and Adams Township—worked together in 2008 to implement a signal coordination project along Route 228, a congested arterial corridor. These jurisdictions were able to secure a mix of local and state funding to implement the project and established an agreement to govern the maintenance of the signals. According to an evaluation, the project could yield total benefits of up to approximately $2 million in reduced delay, reduced fuel consumption, and reduced emissions over a 5-year period. For a 5-year cost of $70,000, the public could realize a benefit-to-cost ratio of as much

[51]GAO, *Surface Transportation: Strategies Are Available for Making Existing Road Infrastructure Perform Better,* GAO-07-920 (Washington, D.C.: July 26, 2007).

[52]Officials noted that this problem was eventually alleviated by the use of federal Transportation Investment Generating Economic Recovery (TIGER) grants, part of the American Recovery and Reinvestment Act of 2009, which was intended to provide economic stimulus across the nation.

as 30 to 1.[53] At a regional level, the I-95 Corridor Coalition has worked on a consensus basis to promote better traffic management along the I-95 corridor by involving state and local transportation agencies, toll authorities, and related organizations since the early 1990s. Initially focused on incident management, the coalition now addresses other issues including data sharing to enhance decision making by states. Other areas in which the coalition is now working include integrating tolling systems and promoting availability of real-time truck-parking information along the corridor.

Further Use of Leading Practices Could Enhance DOT's Promotion of ITS and Better Address Challenges

DOT activities sponsored and funded by RITA and FHWA promote and support the use of ITS and address the challenges that state and local governments face in deploying and effectively using ITS technologies. We identified several leading practices for successfully encouraging the adoption of new technologies: developing a strategy to promote and support the use of technologies; choosing appropriate methods to promote the use of technology by the target audience, including making users aware of ITS resources; and monitoring technology adoption. Further use of these leading practices could improve DOT's promotion of ITS while leveraging its resources.

DOT's Efforts to Promote and Support ITS Technologies Help Address State and Local Challenges

DOT agencies—specifically RITA and FHWA—sponsor and fund various activities that promote and support the use of ITS by state and local governments. These activities can be categorized as training and education, technical assistance, publications and guidance, ITS databases, planning and analysis tools, funding, demonstration and pilot projects, and ITS standards and architecture.[54]

[53]Southwestern Pennsylvania Commission, "User Benefits Associated With the Implementation of a Multi-Municipal Signal Coordination Project: State Route 228, Butler County," April 2008. We did not evaluate the data and methodology used in this estimate. However, we have noted some general limitations and sources of errors in the practice of forecasting benefits and costs for transportation projects. See GAO, *Highway and Transit Investments: Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results,* GAO-05-172 (Washington, D.C.: Jan. 24, 2005).

[54]The National Architecture provides a common framework for planning, defining, and integrating ITS. RITA developed the National Architecture and facilitates the development of standards in coordination with transportation organizations and industry. FHWA provides technical assistance to state and local government officials in using the standards and architecture.

RITA's activities focus on conveying knowledge of the value and uses of ITS technologies, while FHWA's activities promote strategies for improving traffic operations, many of which make use of ITS technologies. The activities sponsored by RITA and FHWA help state and local governments address the challenges they face in deploying, operating, and maintaining ITS technologies. For a summary of various DOT activities that address the state and local challenges we have previously identified, see appendix II.

Strategic Planning

DOT has undertaken various activities that can assist state and local governments in addressing challenges they face in planning the strategic use of ITS technologies. FHWA sponsors a program called Planning for Operations aimed at incorporating traffic operations strategies, supported by ITS technologies, into mainstream transportation planning. For example, this approach advocates using operations-based objectives and performance measures, such as reducing delays as a result of incidents, as a basis for choosing congestion management strategies, such as traffic incident management strategies that make use of ITS technologies to identify and respond to incidents more quickly. As part of this effort, FHWA sponsors workshops for metropolitan planning organizations and has written guidance that provides examples of operations objectives, performance measures, and a sample transportation plan that includes different operational strategies. In addition, RITA hosts an ITS portal on its website that includes ITS-related information that can be useful for planning, such as databases with studies highlighting the benefits, costs, and lessons learned associated with ITS deployments.

Funding

Although DOT no longer provides dedicated funding for ITS deployments, several funding mechanisms can be used for ITS-related deployments and operations. SAFETEA-LU authorizes states to use their federal aid highway funding for developing and implementing ITS systems.[55] For example, funds from the Highway Trust Fund's National Highway System,

[55]As noted in the previous section, a large gap exists in financing the nation's surface transportation needs. The National Surface Transportation Infrastructure Financing Commission has proposed a number of options to address this issue. See National Surface Transportation Infrastructure Financing Commission, *Paying Our Way: A New Framework for Transportation Finance*, (February 2009). In addition, we have reported on several strategies that could be used to better align surface transportation expenditures and revenue. GAO, *Surface Transportation: Restructured Federal Approach Needed for More Focused, Performance-Based, and Sustainable Programs*, GAO-08-400 (Washington, D.C.: Mar. 6, 2008).

Surface Transportation, and Congestion Mitigation and Air Quality Improvement programs are eligible to be used for the deployment and operations of ITS technologies.[56] Although funding of ITS technologies is not specifically tracked, FHWA officials estimate that approximately 3 to 5 percent, or between $800 million and $1.3 billion for fiscal year 2010, of federal aid highway program funds have been used for ITS technologies.[57] For the most part, this funding is not for pure ITS projects but rather for ITS technologies that are incorporated into larger road and bridge improvement projects. According to FHWA officials, an internal analysis found that a similar percentage of funds, or between about $800 million and $1.3 billion, of FHWA's American Recovery and Reinvestment Act funds were used for ITS deployments, with the majority of the total American Recovery and Reinvestment Act funds being obligated between early 2009 and March 2011.[58] In fiscal year 2010, RITA obligated approximately $28.2 million for research on emerging uses of ITS technologies and obligated an additional $12.3 million to programs supporting the deployment of ITS, including the Professional Capacity Building program.[59]

[56]23 U.S.C. § 103(b)(6)(O)(National Highway System); 23 U.S.C. § 133 (b)(13)(Surface Transportation); 23 U.S.C. § 149(b)(5)(Congestion Mitigation and Air Quality Improvement Program). Operating costs under the Congestion Mitigation and Air Quality Improvement program are restricted to transit and intermodal projects, and traffic operating centers.

[57]Federal aid highway funded projects generally incorporate ITS into larger road improvement projects. This estimate is based on FHWA officials' experience and data as a result of working with these projects and includes funds from the Equity Bonus program, which provides funding to states to ensure a minimum rate of return on contributions to the Highway Account of the Highway Trust Fund. In fiscal year 2010, FHWA apportioned the following federal aid highway funds to states: $7.6 billion in Surface Transportation program funds, $7.2 billion in National Highway System funds, $2.1 billion in Congestion Mitigation and Air Quality Improvement program funds, and $9.6 billion in Equity Bonus Funds, totaling $26.5 billion pursuant to the Surface Transportation Extension Act of 2010, Pub. L. No. 111-147, Title IV, 124 Stat. 71, 78 (2010).

[58]FHWA apportioned approximately $26.6 billion in total funds to states for highway infrastructure investment under the 2009 American Recovery and Reinvestment Act.

[59]In fiscal year 2010, RITA obligated more than $112 million for programs operated under the ITS Joint Program Office, including connected vehicle technology research. Although the ITS Joint Program Office resides within RITA, the funding for the Joint Program Office is provided through the FHWA budget. A formal memorandum of understanding between RITA and FHWA specifies that the Joint Program Office administers ITS program funds under RITA program guidance, while FHWA provides budget and administrative functions.

DOT also provides funding for limited trial deployments of ITS. Since 2005, FHWA has provided about $26.6 million and managed about $150.9 million of RITA's funds for demonstration projects that support the use of ITS technologies in managing traffic congestion, including four Urban Partnership Agreement projects, two Congestion Reduction program projects, and two Integrated Corridor Management projects.[60] In addition, FHWA has sponsored several smaller-scale demonstration projects that examine and test ITS applications, such as a demonstration project to develop an enhanced 511 traveler information system.

ITS Knowledge

DOT sponsors multiple activities and programs aimed at ensuring that the state and local transportation workforce and leaders have adequate ITS knowledge. RITA operates a Professional Capacity Building program that aims to enhance the professional development of current and emerging ITS professionals. According to RITA statistics, between January 2010 and June 2011, the program reached over 3,400 transportation professionals through multiple activities, including 13 webinars, 8 web-based courses, 5 workshops, 6 presentations, and 12 peer-to-peer exchanges on topics such as ITS project management, systems engineering, adaptive signal control technology, and integrated corridor management. The program is in the process of refocusing its efforts in order to prepare transportation professionals for new connected vehicle technologies as well as to allow them to take advantage of proven ITS technologies.

Similarly, FHWA conducts a variety of activities aimed at building the expertise of the state, regional, and local workforce in traffic operations strategies and associated ITS technologies. In addition to offering some training courses through RITA's Professional Capacity Building program, FHWA offers its own training courses, technical assistance, and a variety of publications and guidance aimed at improving the management of traffic operations and the use of ITS. For example, between January 2010

[60]The Urban Partnership program has provided funding to four cities seeking to relieve traffic using four strategies: tolling, transit, telecommuting, and technology. The Congestion Reduction Demonstration was a follow-on to the Urban Partnership program and provided funding to two cities to implement congestion pricing along with complementary transportation solutions, such as transit service and innovative technology. The Integrated Corridor Management Systems initiative funded two projects that focus on operating and optimizing the transportation system along a specific corridor through a combined application of technologies and a commitment of network partners to work together.

and June 2011 FHWA offered 52 workshops, 2 webinars, and 12 peer-to-peer exchanges related to topics such as adaptive signal control technology, traffic incident management, and ITS performance measures. Most of these activities are sponsored by FHWA's Office of Operations under individual program areas, such as traffic incident management, traffic signal management, congestion pricing, and real-time traveler information. FHWA also has an additional initiative—including guidance, training, and technical assistance—aimed at improving traffic signal management.

In addition, RITA and FHWA have activities focused on enhancing the knowledge of state and local leaders about traffic operations and ITS technologies. Through its Professional Capacity Building program, RITA emphasizes leadership awareness through activities such as peer-to-peer exchanges. RITA officials told us they are also considering possible new ways to reach high-level decision makers. FHWA is sponsoring an initiative that provides guidance to leaders in 12 states on how to integrate transportation operations and ITS technologies into the state planning process, with the intent of turning these states into models for other states. Furthermore, FHWA has an effort under way to identify and contact newly appointed state DOT leaders to discuss the benefits of operational strategies that use ITS technologies, including hosting workshops with top-tier leaders.

Coordination

DOT promotes the coordination of ITS approaches among state and local government agencies, emphasizing the benefits of a regional approach. For example, FHWA promotes regional collaboration through its Planning for Operations program as well as the Regional Concept for Transportation Operations initiative. Specifically, this initiative provides state and local officials with various publications that encourage a coordinated regional approach in the planning for and deployment of ITS-based operational strategies, such as traffic incident management or traveler information services. RITA and FHWA also promote regional cooperation by sponsoring demonstration projects through the Integrated Corridor Management initiative. This initiative aims to integrate operational strategies and ITS technologies among transportation operators along a specific corridor, supporting interagency collaboration and the integration of systems. Additionally, RITA and FHWA promote ITS coordination through the development and support of ITS architecture and standards used to facilitate the exchange of information and ensure compatibility among ITS technologies at a regional level. One RITA official told us that the regional architecture is often the catalyst for interagency contact between state and local DOTs.

Furthermore, FHWA encourages regional approaches by supporting alliances of transportation agencies in multiple states. For example, the I-95 Corridor Coalition includes 40 member agencies, toll authorities, and other entities located along the corridor that work together with the aim of creating seamless operations across jurisdictions and modes. The coalition has been supported by RITA funds that are managed by FHWA and used for efforts that benefit all the coalition members, such as purchasing private sector data that are shared among the agencies. Similarly, the North/West Passage Corridor Coalition was created as part of a shared fund study, supported by FHWA, that combines funds among eight member states along the I-90 and I-94 corridors in order to develop effective methods for sharing, coordinating, and integrating traveler information and operational activities across state borders.[61]

Increased Use of Leading Practices Could Improve DOT's Promotion of ITS

The National Academies' Transportation Research Board and we have identified a number of leading practices for successfully encouraging the adoption of new technologies.[62] Of these, the ones we have identified as being most applicable for assessing DOT's efforts to promote and support ITS use by state and local governments fall into three main areas (see table 3).

[61]The member states of the North/West Passage Corridor Coalition include Washington, Idaho, Montana, Wyoming, North Dakota, South Dakota, Minnesota, and Wisconsin.

[62]See Transportation Research Board, *Transportation Technology Transfer: Successes, Challenges, and Needs: A Synthesis of Highway Practice,* National Cooperative Highway Research Program Synthesis 355 (Washington, D.C.: 2005); Transportation Research Board, *Managing Technology Transfer: A Strategy for the Federal Highway Administration,* Special Report 256 (Washington, D.C.: 1999); GAO, *Technology Transfer: Clearer Priorities and Greater Use of Innovative Approaches Could Increase the Effectiveness of Technology Transfer at Department of Energy Laboratories,* GAO-09-548 (Washington, D.C.: June 16, 2009); *Rail Safety: Federal Railroad Administration Should Report on Risks to the Successful Implementation of Mandated Safety Technology,* GAO-11-133 (Washington, D.C.: Dec. 15, 2010); *NextGen Air Transportation System: Mechanisms for Collaboration and Technology Transfer Could Be Enhanced to More Fully Leverage Partner Agency and Industry Resources,* GAO-11-604 (Washington, D.C.: June 30, 2011); *Best Practices: Stronger Practices Needed to Improve DOD Technology Transition Processes,* GAO-06-883 (Washington, D.C.: Sept. 14, 2006).

Table 3: Leading Practices for Successfully Encouraging the Adoption of New Technologies

Leading practice	Description
Developing a strategy to promote and support the use of technologies	Developing a strategy to promote and support technology use is a key component to the successful transfer of knowledge about and adoption of technologies. We have also found that collaborating agencies should work together to define and agree upon their respective roles and responsibilities.[a]
Choosing appropriate methods to promote the use of technology by the target audience	Identifying the primary users of a technology and choosing the appropriate methods to promote the use of a technology by that audience are key steps in fostering the successful transfer of knowledge about and adoption of technologies. We have also found that improving the availability and awareness of DOT resources can assist state and local officials in making decisions regarding transportation projects.[b]
Monitoring technology adoption	Careful monitoring of the acceptance, adoption, and satisfaction among users of technologies being promoted can provide lessons about agency efforts to encourage technology implementation. Reporting this information can demonstrate program results and build support for the agency's efforts.

Source: GAO analysis of GAO and National Academies' Transportation Research Board reports.

[a]See GAO, Results-Oriented Government: Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies, GAO-06-15 (Washington, D.C.: Oct. 21, 2005).

[b]See GAO, Intermodal Transportation: DOT Could Take Further Actions to Address Intermodal Barriers, GAO-07-718 (Washington, D.C.: June 20, 2007).

Develop a Strategy to Promote and Support the Use of Technologies

RITA and FHWA each have strategies that guide their efforts to promote and support the use of ITS technologies at the state and local levels. RITA has developed a strategic plan for its Professional Capacity Building program that outlines goals, performance measures, and an action plan for implementation of professional development activities for ITS professionals and leaders. In addition, RITA is developing a strategy to help ensure that the results of its ITS research become commercially viable and are adopted by the transportation community and is planning to issue this strategy in the third quarter of fiscal year 2012. Likewise, FHWA's Office of Operations has developed a plan that outlines, among other things, the activities associated with promoting better traffic operations among state and local agencies, including the use of ITS technologies. The plan defines goals, performance measures, and activities for each traffic operations program, such as sponsoring workshops on real-time traveler information, developing guidance on the state of the practice for traffic incident management, and creating training courses on road weather traffic management.

RITA and FHWA coordinate on ITS research programs and in developing a strategic research plan for ITS, but they have not fully or clearly defined their roles and responsibilities for promoting and supporting ITS technologies. RITA and FHWA both participate in the ITS Strategic Planning Group, a departmental group that oversees DOT's ITS research

efforts. The Strategic Planning Group's charter, a document that specifies the process for multimodal coordination, describes RITA's leadership role in advocating for advanced ITS technologies that address congestion issues, among other things.[63] However, the respective roles and responsibilities of RITA and FHWA in promoting and supporting ITS are not defined in the charter or in RITA's strategic research plan. In addition, the ITS Professional Capacity Building strategic plan does not discuss the roles and responsibilities of the modal agencies, such as FHWA, in developing activities to support ITS professionals. Although RITA and FHWA officials said that they coordinate informally, we have found that, as part of agreeing to respective roles and responsibilities, collaborating agencies should clarify who will do what.

Without clearly defining their respective roles, RITA and FHWA may not be fully leveraging their resources and their efforts may be fragmented.[64] RITA and FHWA carry out several similar efforts to promote ITS to a similar audience of state and local officials. Both agencies provide training and peer-to-peer exchanges that cover ITS technologies, and have numerous studies and guidance. For example, RITA, FHWA's Office of Operations, and FHWA's Resource Center each offer peer-to-peer exchanges to state and local agencies aimed at resolving issues associated with deploying ITS technologies or operational strategies using ITS. Specifically, between January 2010 and June 2011, RITA conducted one peer-to-peer exchange on adaptive signal control technology and FHWA conducted three peer-to-peer exchanges on the same topic. The Professional Capacity Building strategic plan includes an objective aimed at coordinating the educational efforts of a variety of organizations to avoid overlap, including RITA, FHWA, and their federal training partners, since they each offer multiple courses on ITS

[63]The ITS Strategic Planning Group's charter describes how RITA and the modal agencies should define their roles and responsibilities regarding ITS research programs.

[64]We have previously identified a number of surface transportation programs where potential duplication, overlap, or fragmentation could exist. See GAO, *List of Selected Federal Programs That Have Similar or Overlapping Objectives, Provide Similar Services, or Are Fragmented across Government Missions,* GAO-11-474R (Washington, D.C.: Mar. 18, 2011). We have used the term "fragmentation" to refer to those circumstances in which more than one federal agency (or more than one organization within an agency) is involved in the same broad area of national need. The presence of fragmentation and overlap can suggest the need to look closer at the potential for unnecessary duplication. However, determining whether and to what extent programs are actually duplicative requires programmatic information that is often not readily available.

technologies.[65] However, according to a RITA official, the focus of this effort is currently on meeting with select universities to identify the learning providers. One expert and a transportation agency said that the roles of RITA and FHWA should be better defined so that state and local government officials are aware of which agency is playing which role.

Furthermore, in comparing RITA and FHWA websites related to ITS, we found that each of the sites provided links to different studies and guidance for several of the same or similar ITS uses. For example, in a search for the benefits associated with arterial management applications, RITA's and FHWA's websites provided different documents with no clear coordinated approach to addressing the topic.[66] Similarly, when searching for training opportunities on arterial management, we looked at two FHWA websites and a RITA website and found 16 different courses cited. FHWA officials noted that such inconsistencies exist because each agency has a different outlook on ITS technologies. In addition, the large array of information and pace of development make it difficult to completely align the websites.

In addition, RITA's role in promoting ITS technology is changing, and without defined roles and responsibilities for RITA and FHWA, it is difficult to assess how this change will affect DOT's overall efforts for promoting and supporting the use of ITS technologies. As previously discussed, RITA's Professional Capacity Building program is refocusing its agenda to prepare the transportation workforce to adopt new connected vehicle technologies and take better advantage of proven ITS technologies. This will result in activities sponsored by RITA to be more focused on connected vehicle technologies, according to a RITA official, resulting in fewer available resources to support the use of more mainstream ITS technologies. At the same time, as previously discussed, state and local governments face challenges using ITS, especially in building and maintaining ITS knowledge among staff. Not fully or clearly defining the roles of each agency may result in the inefficient use of resources that,

[65]Federal training partners include the National Highway Institute and National Transit Institute. In addition, RITA and FHWA also work with other training providers, such as universities, professional associations, and private sector vendors of ITS.

[66]RITA's and FHWA's websites provide some links to each other's ITS resources, such as between FHWA's Arterial Management program and Adaptive Signal Control Technologies program and RITA's ITS databases.

given the current fiscal environment, may inhibit RITA and FWHA from fully leveraging their resources to promote ITS.

Choosing Appropriate Methods to Promote the Use of Technology by the Target Audience

Identifying Users and Selecting Methods

RITA and FHWA have defined their target audiences for promoting and supporting ITS technologies. RITA's Professional Capacity Building strategic plan defines the target audience as the ITS practitioner, including federal, state, and local level professionals from all surface modes, decision makers, researchers, and students. However, a RITA official told us that the agency intends to more narrowly define its target audience to better focus its efforts. According to FHWA officials, FHWA defines its main audience as state DOTs, in part because of its role in administering the federal aid highway program. FHWA is building stronger relationships with metropolitan planning organizations and transportation agencies in major metropolitan areas as part of its efforts to promote improved traffic operations, according to an FHWA official. However, the official noted that it is difficult to work with local transportation agencies, since there are so many of them. As previously mentioned, smaller transportation agencies tend to face additional challenges in deploying ITS technologies, such as having limited time or knowledge to plan for ITS and difficulty recruiting and retaining a qualified workforce to manage ITS.

RITA and FHWA involve stakeholders in the process of developing activities and information on traffic operations and related ITS technologies. RITA has elicited input from stakeholders in developing its activities. For example, the agency conducted three user workshops in developing the Professional Capacity Building strategic plan, getting feedback from 148 multimodal public and private sector users in two interactive web meetings. RITA issued a request for information in July 2011, seeking input from interested public, private, and academic entities in identifying the needs for ITS learning among transportation professionals and innovative techniques for delivering ITS learning.[67] FHWA also involves stakeholders at the program-planning level, specifically when major products are being developed. For example, an FHWA official told us that the Planning for Operations program used peer groups from metropolitan planning organizations to develop and review guidance materials.

[67]See *76 Fed. Reg.* 45334 (July 28, 2011).

Experts, transportation agencies, and stakeholders we interviewed considered some of the activities sponsored by RITA and FHWA more useful than others. The 14 experts we interviewed considered training and education activities, including webinars, as well as technical assistance activities, such as the peer-to-peer exchanges, to be the most useful of the activities offered by RITA and FHWA.[68] Many of the transportation agencies and stakeholders we interviewed found webinars particularly useful. Additionally, experts and transportation agencies we interviewed, as well as stakeholders with whom RITA consulted indicated that opportunities to share information among their peers, either via workshops or peer-to-peer exchanges, provide valuable ways to learn from others' experiences.

A RITA official told us that the peer-to-peer program may be phased out as RITA refocuses the agenda of the Professional Capacity Building program on connected vehicle technologies, leaving less of a focus on mainstream ITS. In RITA's planning workshops, users indicated that they primarily would like real-world experience "from the source," stating that opportunities to learn from peers, including peer-to-peer exchanges, are a desirable way to learn. In our interviews, two transportation agencies and three experts also said that it would be useful to have more opportunities to learn from peers. RITA's refocused agenda could decrease the opportunities for state and local officials to participate in an effective method for relaying ITS information and technical assistance to DOT's target audience.

In contrast, other resources, such as the information sources sponsored by RITA and FHWA may not be as useful to state and local officials. According to the experts we interviewed, RITA's and FHWA's publications and guidance related to ITS, as well as the ITS databases, were not considered as useful as other activities.[69] While several transportation agencies noted that FHWA's website is helpful, four experts and one

[68]We interviewed 15 experts, but the responses from 1 expert were not included because the expert was a provider of some of the activities sponsored by DOT. In the interviews, we asked experts their opinions on RITA's and FHWA's resources for training and education, technical assistance, outreach and publications, ITS databases, demonstration and pilot projects, planning and analysis tools, and policy and standards development. However, we did not ask experts specifically about the funding of ITS as part of the questions on RITA's and FHWA's resources.

[69]In May 2011, RITA made a new user interface available for the ITS databases.

state and local official said that RITA's and FHWA's websites have too much information and are not well organized. In addition, three experts and one transportation agency commented that it is difficult to identify needed information given the amount of information available. Specifically, one expert noted there was little effort to highlight or summarize the most important information on these websites.

Users that RITA surveyed, as well as some experts and transportation agencies we interviewed, indicated that they would like specific benefit information related to ITS deployment.[70] At the same time, the majority of experts we interviewed said that the ITS databases housing this type of information were only somewhat useful. Likewise, one transportation stakeholder did not think the databases were useful and found them difficult to navigate, while another stakeholder did not think the studies in the databases were useful. In addition, we searched the ITS database for the benefits associated with arterial management projects and found 125 separate studies in six categories dated from 1994 to 2011. Of these studies, 21, or only 17 percent, were completed in the last 5 years.

RITA officials told us that there are fewer evaluations being completed to include in the ITS databases, since DOT no longer provides dedicated funds for ITS deployments. In addition, as previously mentioned, DOT's current ITS research agenda focuses on connected vehicle technologies. RITA officials also acknowledged that the information in the databases may be dated, but noted that the information is still useful. According to a RITA official, the information in the databases is updated on a rolling basis as DOT reports are completed and other external reports are submitted by state and local governments. A RITA official also stated that RITA tracks the monthly usage statistics for the ITS databases, although this doesn't measure the usefulness of the databases. ITS-related information that is not easily accessible, timely, and relevant will not effectively meet the needs of state and local officials as they plan for and deploy ITS technologies, resulting in underused resources.

[70]Future evaluations for the Urban Partnership Agreement demonstration project reports and the Integrated Corridor Management demonstration project reports will feature benefit-cost analyses that fulfill the Office of Management and Budget's guidance.

Making Users Aware of ITS Resources

Transportation agencies may not be aware of all of the ITS-related activities and information offered by RITA and FHWA. In an informal poll that a RITA official recently conducted of transportation professionals at two outreach events sponsored by transportation organizations, RITA officials found that 10 of 29 professionals polled, or 35 percent, were not aware of the activities and information available through RITA, and 21 percent were not aware of activities and information on transportation operations offered by FHWA. Likewise, four experts, a transportation agency, and a stakeholder we interviewed said that DOT could improve communications about ITS activities and information with state and local governments, for example, by becoming more engaged with state and local officials. For example, two experts said that transportation agencies were not aware of how to contact the ITS specialists in FHWA's Resource Center that offer ITS technical assistance. According to two FHWA division office ITS engineers in California, although DOT sponsors Internet-based training, most local agencies have not taken advantage of these activities. An FHWA official also acknowledged that it is difficult to match users with their activities and get state and local officials to take advantage of the activities available.

RITA and FHWA are taking some steps currently to improve access to and awareness of ITS-related information and assistance. For example, RITA is developing plans to target audiences through partnerships with professional associations that may have more direct access to ITS practitioners, such as the Institute of Transportation Engineers and ITS America. It also plans to more effectively use University Transportation Centers, which are established to "advance significantly the state-of-the-art in transportation research and expand the workforce of transportation professionals."[71] RITA is also planning to use video more aggressively to promote ITS activities and develop testimonials to promote the Professional Capacity Building program. FHWA is focusing on outreach and marketing as a critical element of an implementation plan for its traffic signals program, with the aim of increasing awareness and directly engaging stakeholders on the benefits and applicability of the strategy. SAFETEA-LU set a cap of $250,000 per fiscal year for DOT's funding of

[71]SAFETEA-LU §5402(a) (49 USC 5506(b)).

outreach for ITS-related activities, but this cap may be lifted in the next reauthorization of surface transportation programs.[72]

As noted earlier, RITA is developing a strategy, to be issued in the third quarter of fiscal year 2012, to help ensure that the results of its ITS research become commercially viable and are adopted by the transportation community. Such a strategy could provide an opportunity for RITA, as well as its partner FHWA, to further identify methods for improving access to and awareness on the part of state and local transportation agencies of ITS resources related to traffic management. Also, as noted previously, RITA is considering phasing out its peer-to-peer program, while experts and transportation agencies we interviewed as well as stakeholders RITA consulted indicated that methods for sharing information among peers provide valuable ways to learn from others' experiences. Therefore, this strategy could also provide an opportunity to identify ways to facilitate the exchange of information among state and local officials. However, RITA has not yet determined to what extent its strategy will address these issues.

Several options have been proposed for improving communication about ITS resources and facilitating learning exchanges. A 2011 report solicited by RITA to identify best practices for promoting ITS technologies included a recommendation that the agency create an ITS Partners program that would incorporate a number of its activities under a single brand, encourage and support the deployment of ITS by public agencies, and increase collaboration among federal agencies, state and local agencies, universities, and industry.[73] Activities would include marketing the program, implementing an interactive website where agencies can share experiences, and establishing networks of individuals interested in specific topics.

While RITA is planning to enhance partnerships with professional associations and University Transportation Centers to leverage its resources, RITA has not yet decided on the extent to which it will

[72]SAFETEA-LU limits DOT's use of funds for ITS activities consisting of outreach, public relations, displays, tours, and brochures to no more than $250,000 per fiscal year. See Pub. L. No. 109-59, §5302(a), 119 Stat. 1144, 1805 (2005).

[73]U.S. Department of Transportation, RITA ITS Joint Program Office, *Key Findings and Recommendations for Technology Transfer at the ITS JPO* (Washington D.C.: Mar. 21, 2011).

implement this recommendation. Officials cited restricted funding as a factor in their implementation decision. In addition, RITA's Professional Capacity Building strategic plan includes a goal to establish an ITS learning portal for "one-stop shopping" of training courses, technical assistance, and peer-to-peer events. According to a RITA official, this effort is currently on hold, awaiting the results of a National Cooperative Highway Research Program study. This study, which is being conducted by the Transportation Research Board, is focusing on designing an Operations Center of Excellence that would facilitate implementation of best practices for traffic operations, including ITS, and promote collaboration among state and local government officials in developing best practices. The study will assess the needs of state and local transportation agencies, inventory the available resources, and analyze alternative methods to implement and fund such a center. The study is expected to be completed in early 2012.[74] DOT has not yet defined its role in establishing, supporting, and implementing such a center. A RITA official said that the organization would need extra funds if it was tasked with operating such a center and will wait for the outcome of the study to determine the role it can play. FHWA officials told us that they envision that they would be heavily involved in setting up the Operations Center of Excellence, but would prefer that it not be funded by DOT. Participation in this effort, if and when it is implemented, could allow both RITA and FHWA to identify and potentially take advantage of opportunities to leverage their ITS promotion and support activities with those of external organizations. Such leveraging is particularly important given federal fiscal constraints. As RITA develops its strategy for ensuring that the results of its ITS research become commercially viable and are adopted by the transportation community, it could benefit from working with FHWA to consider this range of options for improving communication about ITS resources related to traffic management, thereby enhancing access to and awareness of these resources, and facilitating learning exchanges among state and local governments, while leveraging its resources.

Monitoring of Technology Adoption

Both RITA and FHWA collect information to monitor the adoption of ITS technologies and use this information to understand the level of deployment and make decisions on how to encourage the future deployment of ITS technologies, according to officials from both agencies.

[74]The Transportation Research Board is also examining ways to improve the transfer of knowledge in order to improve traffic operations and use of ITS.

Nearly every year since 1997, RITA has conducted a national survey of state and local government agencies on the deployment of various ITS technologies and reported the results on its website. The deployment survey also gauges the factors affecting decisions to purchase ITS, views on benefits associated with ITS, and plans for continued investment. According to a RITA official, the agency uses the information on the level of current ITS deployments to help make decisions about future research. In addition, the survey provides feedback to RITA officials on the level of stakeholder interest in deploying specific ITS technologies and operational strategies. For example, the survey results assist the Professional Capacity Building program in determining the locations where ITS technologies are deployed and any gaps in deployment that merit attention.

FHWA also uses the deployment survey to understand ITS deployment trends. FHWA officials said they use the deployment statistics when developing operations-based initiatives, such as selecting the states to include in a program aimed at accelerating the integration of ITS and operational strategies into mainstream transportation planning. In addition, FHWA recently used the 2010 survey results when issuing a Final Rule for the Real-Time System Management Information Program, which requires states to establish programs to collect traffic and travel information. The survey was used to establish a baseline for the deployment of 511 traveler information services and determine the effect this rule would have on the expansion of 511 services, according to a RITA official.[75] FHWA's Office of Operations' plan also incorporates deployment assessments for specific operations programs, such as the Road Weather Management program. This program tracks the rate of adoption of road weather technologies, such as a decision support system that helps winter maintenance managers make road treatment decisions.

Conclusions

As traffic congestion is projected to grow and state and local governments face fiscal constraints, ITS technologies and operational strategies supported by ITS provide opportunities for state and local governments to manage traffic congestion on the nation's existing roadways. Furthermore, emerging uses of ITS technologies have the potential to

[75]See 75 *Fed. Reg*. 68418 (Nov. 8, 2010).

build upon existing investments in ITS by integrating real-time traffic information and instituting proactive management techniques. However, the challenges that state and local governments face in planning and funding ITS use, ensuring that staff and leaders have adequate knowledge of ITS, and coordinating ITS approaches impede their ability to make the most effective use of ITS technologies in addressing congestion.

While DOT's efforts to promote and support the use of ITS technologies help state and local agencies address these challenges, the department could improve the effectiveness of these efforts through greater use of leading practices for promoting technology use. The lack of clearly defined respective roles and responsibilities of RITA and FHWA in promoting and supporting ITS raises questions about whether DOT could better leverage its resources and provide a more specific, cohesive strategy for ITS as it evolves. In addition, DOT's activities may not be achieving maximum results, as state and local officials may have difficulty identifying the most relevant information or may not be aware of all of the ITS-related activities sponsored by RITA and FHWA. Taking steps to more effectively target efforts and leverage resources by further exploring internal and external opportunities to promote and support ITS technologies could better ensure that DOT's activities achieve their intended purposes. Some options currently under consideration hold promise for facilitating the exchange of ITS information among state and local governments as well as for enhancing communication to improve access to and awareness of ITS-related resources. It will be important for DOT to work with its external partners and determine its role in these efforts to ensure it is fully leveraging its resources in promoting the use of ITS and maximizing its reach. If DOT does not effectively target and leverage its efforts to promote and support the use of current and emerging ITS technologies by state and local transportation agencies, DOT may struggle in helping these agencies transition to the next generation of ITS.

Recommendations for Executive Action

To effectively target efforts, leverage resources, better promote and support the use of ITS technologies by state and local governments, and improve access to and awareness of ITS resources, we recommend that the Secretary of Transportation take the following three actions:

- clearly define and document the respective roles and responsibilities of RITA and FHWA in promoting and supporting the use of ITS,

- revise ITS information on RITA and FHWA websites to improve its usefulness for state and local audiences based on their needs, and
- include in RITA's strategy for promoting the adoption of ITS technologies plans for collaborating with external partners to (1) further enhance communication about the availability of ITS resources and (2) facilitate learning exchanges.

Agency Comments

We provided a draft of this report to the Department of Transportation for review and comment. DOT said it would consider our recommendations, and provided technical clarifications that we incorporated into the report as appropriate.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to interested congressional committees and the Secretary of Transportation. In addition, the report will be available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or wised@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff that made significant contributions to this report are listed in appendix III.

David J. Wise
Director, Physical Infrastructure Issues

Appendix I: Objectives, Scope, and Methodology

This report addresses (1) how state and local governments currently use Intelligent Transportation Systems (ITS) technologies to manage traffic and emerging uses of these technologies that have the greatest potential to reduce congestion, (2) what types of challenges state and local governments face in using ITS technologies to manage traffic congestion, and (3) the extent to which the Department of Transportation's (DOT) promotion and support of state and local governments' use of ITS technologies have met leading practices and responded to challenges they face.

To determine how and to what extent state and local governments currently use ITS technologies to manage traffic, we analyzed DOT's policy and planning documents and data on ITS deployment from its 2010 ITS deployment survey. On the basis of interviews with DOT officials and analysis of the data, we determined that the data were sufficiently reliable for our purposes. We also analyzed pertinent legislation, documents, and studies of traffic management approaches and ITS deployment in the United States. We synthesized information from interviews with officials from DOT, including the Research and Innovative Technology Administration (RITA) and Federal Highway Administration (FHWA). We also interviewed officials from related associations such as the American Association of State Highway and Transportation Officials (AASHTO) and the Intelligent Transportation Society of America (ITS America).

We conducted site visits to Washington, D.C.; Pittsburgh, Pennsylvania; Austin, Texas; and Los Angeles, California. At each site, we obtained documentation and interviewed officials from one or more state departments of transportation; one or more local government transportation agencies; the metropolitan planning organization; one FHWA division office responsible for the area; and, if applicable, any academics, researchers, or coalitions focused on ITS in that metropolitan area. We selected these locations from those with high congestion levels as determined by the Texas Transportation Institute's 2010 *Urban Mobility Report* and varied ITS deployment levels as determined by DOT's 2007 deployment survey database. We made a final selection of sites that included cities of different sizes and geographical representation, and one metropolitan area that spans more than one state (Washington, D.C.). We are not able to generalize our findings in these site visits to the whole country but used the other sources mentioned above to gain a more general perspective.

We also conducted a literature search to identify background materials on emerging ITS technologies, published research by prospective ITS experts, and leading practices in promoting and supporting the adoption of new

transportation technologies. The literature search focused on databases with transportation and engineering journal articles and conference proceedings (e.g., ProQuest and Transport Research International Documentation) as well as government reports (e.g., National Technical Information Service). The search terms used were related to using ITS for managing traffic congestion (e.g., incident response management).

We conducted semistructured interviews with 15 experts, whom we selected based on recommendations from officials at RITA, FHWA, AASHTO, and ITS America using several criteria. The primary requirement was that each individual have expertise in at least one of the following ITS fields that are important for traffic management: freeway management, arterial management, traffic incident management, roadway operations and maintenance, traveler information, and road weather management. In addition, we selected individuals with experience in the operations or deployment of ITS; planning, development, or evaluation of ITS projects; or experience with DOT's efforts to promote and support the use of ITS technologies. In making our final selection, we considered publications and ITS experience and aimed to include a mix of individuals from state and local government, transportation associations, academia, and private industry. We selected experts based on how frequently they were recommended, a proxy for their standing within the ITS community, and to obtain a representative mix of officials from state and local government, academia, transportation associations, and private industry (such as consultants and ITS service or equipment providers). Through this representative mix, we believe that we have obtained a balanced set of perspectives.

We identified emerging uses of ITS technologies, which we defined as approaches that have begun to be used over the last 5-10 years, including approaches being researched or promoted by DOT, through interviews with DOT officials, experts, and a literature search. We excluded technologies with primary applications outside roadway traffic management, such as transit ITS, except when it had bearing on roadway traffic management. The scope of our work did not include connected vehicle technology or uses of ITS primarily aimed at other than managing and reducing traffic congestion, such as rural safety. To determine what emerging uses of ITS technologies have the greatest potential to reduce congestion, we presented the experts with a list of emerging uses of ITS technologies that we identified. This list consisted of (1) real-time data capture, sharing, and management; (2) real-time traveler information; (3) integrated corridor management; (4) active transportation and demand management; (5) enhanced incident response management; (6) weather

responsive traffic management; and (7) work zone management. We asked the experts if there were other emerging uses of ITS technologies that they believe have significant potential to reduce traffic congestion, and asked them to rate these and the above ITS uses on their potential to reduce traffic congestion. On the basis of the expert ratings, we selected the four emerging uses that all experts ranked as having at least medium potential to reduce traffic congestion, and which the most experts (at least 9 of the 15) rated as having high potential to reduce traffic congestion.

Table 4: Names of Experts We Interviewed and Their Affiliations

State departments of transportation
• John Corbin, Director of Traffic Operations, Wisconsin DOT
• Bill Legg, State ITS Operations Engineer, Washington State DOT
• Tom Sorel, Commissioner, Minnesota DOT
• Kirk Steudle, Director, Michigan DOT
Local and regional agencies
• Tom Batz, Deputy Executive Director, Transportation Operations Coordinating Committee (TRANSCOM)
• Randell Iwasaki, Executive Director, Contra Costa Transportation Authority
• Andy Mao, Chief Traffic Engineer, Harris County, Texas, Public Infrastructure Department
Academia
• Stephen Albert, Director, Western Transportation Institute, Montana State University
• Peter Sweatman, Director, University of Michigan Transportation Research Institute
• C. Michael Walton, Ernest H. Cockrell Centennial Chair in Engineering, Department of Civil Engineering, the University of Texas at Austin
Professional organizations
• Siva Narla, Chief Engineer and ITS Standards Program Manager, Institute of Transportation Engineers
• Jim Wright, 511 Program Manager, ITS, AASHTO
Private sector
• Abbas Mohaddes, Chief Executive Officer and President, Iteris, Inc.
• Robert Rausch, Vice President ITS Division, TransCore
• Ted Trepanier, Executive Director, Public Sector, INRIX

Source: GAO.

To determine what types of challenges state and local governments face in using ITS technologies to manage traffic congestion, we conducted interviews with and obtained documents from RITA and FHWA officials, and AASHTO and ITS America representatives; conducted interviews with identified experts; reviewed published research on ITS challenges identified through a literature search; gathered information through

interviews and documents collected during the site visits described above; and analyzed these various interviews and documents to identify the most frequently cited challenges. We did not otherwise assess the extent of these challenges in the locations visited, such as determining actual funding or staffing levels.

To determine the extent to which DOT's promotion and support of state and local governments' use of ITS technologies responded to challenges they face and met leading practices, we collected information on DOT's ITS promotion and support through interviews with RITA and FHWA officials and reviews of RITA's and FHWA's program and strategic planning documents, including documents related to the professional capacity-building program and traffic operations improvement efforts. In addition, we reviewed RITA's and FHWA's efforts to promote and support ITS technologies, including various studies, guidance, websites, demonstration project and highway funding, and RITA's ITS databases. We limited our work to DOT's activities and information relevant to the promotion and support of state and local governments' use of ITS, not including DOT's efforts aimed at bringing new technologies to market. We determined how DOT is required to promote and support the use of ITS technologies through reviews of pertinent laws. To determine the extent to which DOT's efforts are meeting the challenges and leading practices, we reviewed literature on promoting and supporting the use of new technologies, including prior GAO reports, Transportation Research Board publications, and other academic publications, particularly focusing on leading practices that encourage the adoption of transportation technologies by state and local governments. On the basis of the scope and nature of DOT's efforts, we identified the following practices as most applicable: (1) developing a strategy to promote and support the use of technologies; (2) choosing appropriate methods to promote the use of technology by the target audience; and (3) monitoring technology adoption. We compared DOT's efforts with these leading practices and evaluated any areas needing improvement. We also obtained the views of identified experts and state and local officials interviewed during site visits about the usefulness of DOT's efforts and any needed improvements.

We conducted this performance audit from January 2011 through February 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Examples of DOT Activities That Address State and Local Challenges

Challenge	Type of activity	Examples
Strategic planning	Training and education	FHWA's Planning for Operations program sponsors webinars, case studies, and workshops.
	Technical assistance	FHWA's Resource Center and division offices provide assistance related to planning for operations, including ITS expertise.
	Publications and guidance	FHWA provides planning-related guidance on its website, including case studies, a desk reference on benefit/cost analysis, guidebooks, and reports.
	ITS databases	RITA's databases provide information on the benefits and costs associated with ITS technologies.
	Planning and analysis tools	FHWA's ITS Deployment Analysis System assists in planning for ITS deployments.
Funding ITS	Federal aid highway funding	FHWA provides federal aid highway funds to states, some of which can be applied to ITS projects. FHWA has estimated that between 3 and 5 percent of the total funds, or $800 million to $1.3 billion in fiscal year 2010, has been used for funding ITS.
	Demonstration and pilot projects	RITA and FHWA fund various projects aimed at applying ITS technologies, such as projects funded under the Urban Partnership Agreements, Congestion Reduction Program, and Integrated Corridor Management Program, totaling more than $177 million since 2005.
ITS knowledge	Training and education	RITA's Professional Capacity Building program offers webinars, workshops, and presentations for ITS professionals. FHWA's Office of Operations and Resource Center provide seminars, training courses, and workshops for traffic operations managers as part of their efforts to improve traffic operations, such as traffic signal management. FHWA also sponsors workshops to develop local ITS champions and educate newly appointed leaders at state DOTs.
	Technical assistance	RITA and FHWA facilitate peer-to-peer exchanges to transfer ITS knowledge and experiences from model users to agencies with less experience. FHWA's Resource Center and division offices provide assistance and guidance on ITS-related issues, such as systems engineering, regional architecture, and traffic operations.
	Publications and guidance	RITA's website includes a searchable ITS library with a variety of studies and guidance. FHWA provides studies and guidance related to improving traffic operations in areas such as traffic incident management, traffic signal management, congestion pricing, and real-time traveler information, among others.
Coordination	Publications and guidance	FHWA's Regional Concept for Transportation Operations initiative offers studies and guidance to promote a regional approach to transportation management and operations
	Demonstration and pilot projects	DOT's Integrated Corridor Management projects, jointly run by RITA and FHWA, promote interjurisdictional partnerships to transform the way a corridor operates.
	ITS standards and architecture	These standards and architecture, supported by efforts of RITA and FHWA, define and support a common structure for regional ITS projects with interoperable technologies.

Source: GAO.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

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