

November 2009

# SURFACE TRANSPORTATION

## Efforts to Address Highway Congestion through Real-Time Traffic Information Systems Are Expanding but Face Implementation Challenges





Highlights of [GAO-10-121R](#), a report to congressional requesters

## Why GAO Did This Study

Growing congestion on our nation's roads results in wasted time and fuel, which adversely affects the economy and the environment. State and local government agencies and private companies disseminate real-time traffic information to help travelers decide whether to use alternative, less congested routes. Legislation enacted in 2005 required the U.S. Department of Transportation (DOT) to establish the Real-Time System Management Information Program, in order to provide states the capability to monitor traffic and travel conditions on major highways and share that information. As requested, this GAO report addresses, among other things, (1) how the public and private sectors disseminate real-time traffic information to the public, (2) actions DOT has taken to establish the Real-Time System Management Information Program, and (3) experts' views on the need for a nationwide real-time traffic information system and its potential characteristics.

To conduct this study, GAO visited sites in California and Florida, which have well-developed traffic information systems; reviewed and analyzed DOT reports and data; and interviewed transportation officials, experts, and other stakeholders. GAO is not making any recommendations at this time because DOT has not finalized the proposed rule it issued in January 2009, and there was no consensus from the experts GAO interviewed as to whether an increased federal role in this area is appropriate or what this role might be.

View [GAO-10-121R](#) or [key components](#). For more information, contact David J. Wise at (202) 512-2834 or [wised@gao.gov](mailto:wised@gao.gov).

## SURFACE TRANSPORTATION

### Efforts to Address Highway Congestion through Real-Time Traffic Information Systems Are Expanding but Face Implementation Challenges

#### What GAO Found

States and local agencies and the private sector use a variety of services and technologies to disseminate real-time traffic information to the public. For example, state and local agencies deploy electronic traffic signs and services that provide information via a nationwide 511 phone number, and private companies operate Web sites that provide information for cities across the country. The coverage provided by these services and technologies is expanding, but there are gaps in coverage and variations in aspects of real-time traffic information, such as the quality of the data collected and the extent to which state and local agencies share their data. The private sector is expanding coverage, in part by using newer technologies to increase the collection of traffic data. Like the public sector, the private sector faces limitations to its coverage and data quality.

To establish the Real-Time System Management Information Program, DOT's Federal Highway Administration (FHWA) issued a proposed rule in January 2009 that, when finalized, could improve the coverage, quality, and sharing of traffic information. The rule proposes requirements for states to make available certain traffic information, such as travel time, on major highways and to meet data quality standards, including standards for timeliness. State and local government officials GAO interviewed said that these improvements would allow the public to better select the most efficient route to reach their final destination, which could reduce congestion and yield other benefits. Yet state and local officials also told GAO that the proposed rule's time frames to develop the program are too short and would be difficult to implement without additional funds. DOT expects to issue the final rule in February 2010 and is currently considering options to address such concerns. According to FHWA, its division offices will monitor states' compliance with the final rule.

Experts GAO interviewed generally agreed that a nationwide real-time traffic information system is needed to help address current gaps in information coverage and inconsistencies in data quality. Many of these experts noted that reported mobility and environmental benefits, such as travel time savings and reduced emissions, could be increased under a nationwide system. However, experts held varying views on the potential characteristics of such a system. Some said that the anticipated results of current efforts related to real-time traffic information by DOT, states, and the private sector would lead to the development of a nationwide real-time traffic information system and considered these efforts sufficient. Others envisioned a nationwide system that would go beyond current efforts. For example, in their visions, DOT would take a strong leadership role or partner more with the private sector to disseminate information. However, experts cited potential challenges in designing and implementing a nationwide system, including reaching consensus on the form of the nationwide system and funding constraints.

DOT reviewed a draft of this report and provided a technical comment that GAO incorporated.



GAO

Accountability \* Integrity \* Reliability

United States Government Accountability Office  
Washington, DC 20548

November 30, 2009

## Congressional Requesters

Growing congestion on our nation's roads is a challenge for many metropolitan and nonmetropolitan areas. Traffic congestion results in wasted time and fuel for travelers and commercial truckers, thereby adversely affecting the economy and the environment. According to transportation researchers, in 2007, congestion in urban areas resulted in 4.2 billion hours of time spent waiting in traffic and 2.8 billion gallons of extra fuel used, at a total cost of \$87.2 billion.<sup>1</sup> Among the tools that the U.S. Department of Transportation (DOT) has identified to help reduce congestion are real-time traffic information systems and technologies,<sup>2</sup> which can be used to disseminate traffic information to the public to help travelers—including commuters and long-distance travelers—decide whether to use alternative, less congested routes.

Agencies in state governments and metropolitan areas, as well as private companies, deploy and operate real-time traffic information systems and technologies to provide traffic and travel information to the public. Recognizing the potential for real-time traffic information to decrease congestion, Congress incorporated requirements related to real-time traffic information into the 2005 authorization of federal surface transportation programs. Specifically, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) made DOT responsible for establishing a program—called the Real-Time System Management Information Program—that would provide all states the capability to monitor real-time traffic and travel conditions on major highways and enable them to share that information with state and local governments and the traveling public.<sup>3</sup> Furthermore, DOT has identified real-time traffic information initiatives as high-priority efforts to address congestion.

Given the potential benefits of real-time traffic information to the nation, the House Committee on Transportation and Infrastructure asked us to provide information on existing real-time traffic information systems, current and potential future efforts to improve such

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<sup>1</sup>David Schrank and Tim Lomax, *2009 Urban Mobility Report* (College Station, Texas: Texas Transportation Institute, 2009).

<sup>2</sup>“Real-time” is a relative measure. Information delivery times generally range between 10 and 20 minutes.

<sup>3</sup>In 2005, SAFETEA-LU authorized funding for federal surface transportation programs for highways, highway safety, and transit. See Pub. L. No. 109-59, 119 Stat. 1144. Section 1201 of SAFETEA-LU established the Real-Time System Management Information Program but did not provide separate funding to implement this program. Section 1201 of SAFETEA-LU authorizes states to use their federal-aid highway funding for efforts related to this program.

systems and create a nationwide system, as well as the impacts and costs of existing systems. Our objectives for this review were to determine (1) how state and local agencies and the private sector disseminate real-time traffic information to the public, and the completeness of current coverage; (2) what actions DOT has taken to establish the Real-Time System Management Information Program required by SAFETEA-LU, and stakeholders' views on these actions; and (3) how selected experts view the need for and benefits of a nationwide real-time traffic information system, how they envision such a system, and what the related challenges may be. The results of our work are contained in enclosure I. To address the committee's interest in the impacts and costs of existing systems, we examined what studies have found about the impacts—particularly on mobility, the environment, and the economy—and the costs of these systems. These issues are discussed in enclosure II. This report focuses on real-time traffic information that is disseminated to the public.<sup>4</sup>

To address the first objective, we interviewed—and reviewed relevant reports and studies obtained from—DOT officials; representatives of national organizations involved in real-time traffic information initiatives, such as the Intelligent Transportation Society of America; state and local transportation officials; and private companies involved in real-time traffic information initiatives.<sup>5</sup> We also conducted site visits in California and Florida<sup>6</sup> and analyzed 2007 data from DOT surveys on the deployment of Intelligent Transportation System (ITS) technologies, including real-time traffic information technologies, to determine the types of real-time traffic information technologies used in metropolitan areas and the coverage provided by these technologies.<sup>7</sup> To address the second objective, we reviewed relevant sections of SAFETEA-LU, interviewed DOT officials on actions the department has taken to address SAFETEA-LU's requirement that DOT establish the Real-Time System Management Information Program, and reviewed DOT's proposed rule and guidance related to this program. To determine stakeholders' views on DOT's proposed program, we interviewed selected state and local officials and two private companies that provide real-time traffic data, and also analyzed comments that stakeholders submitted to DOT on the proposed

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<sup>4</sup>Real-time traffic information can also be used for a range of traffic management purposes. For example, traffic managers can use this information to control traffic through signal timing, detect traffic incidents, and monitor congestion trends. However, traffic management is not in the scope of this review.

<sup>5</sup>We selected the four private companies to interview because they were identified by DOT, the American Association of State Highway and Transportation Officials, and the Intelligent Transportation Society of America as key companies involved in real-time traffic information collection, aggregation, and dissemination.

<sup>6</sup>We interviewed state and local officials in California and Florida because, among other reasons, they have well-developed real-time traffic information systems and have deployed a range of technologies to collect and disseminate real-time traffic information.

<sup>7</sup>ITS consists of a range of communications, electronics, and computer technologies—including those that collect, aggregate and translate, and disseminate real-time traffic information—that are designed to improve traffic flow and safety. DOT's ITS deployment surveys sought responses from state and local agencies to questions on the deployment of various ITS technologies, including real-time traffic information technologies, in 108 large metropolitan areas. The metropolitan areas selected are those that have populations of more than 50,000. The most recent surveys were conducted in 2007. We reviewed the reliability of the survey data and determined that the data were sufficiently reliable for the purposes of this report. See enclosure III for more details on our methodology.

program.<sup>8</sup> To address the third objective, we interviewed 19 experts from DOT, state and local transportation agencies, academia, and the private sector. (See enclosure III, table 6.) We identified these experts with assistance from the National Academy of Sciences, seeking geographic diversity and expert knowledge of various aspects of real-time traffic information systems and technologies. Finally, to obtain information on the impacts and costs of real-time traffic information systems, we identified and reviewed relevant studies from selected literature databases. The studies we reviewed quantified the impacts of real-time traffic information technologies and systems, discussed the costs, or reported the results of benefit-cost analyses. We reviewed the methodologies of these studies to ensure that they were sound and determined that they were sufficiently reliable for our purposes.

We conducted this performance audit from January 2009 to November 2009, 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 enclosure III.

## **Background**

Real-time traffic information systems, along with other types of ITS, can be used to improve traffic flow and reduce congestion.<sup>9</sup> Traffic congestion results from many sources, such as recurring high levels of daily traffic, as well as nonrecurring events like traffic incidents, special events, and bad weather that can limit the usable physical capacity of existing roadways. Existing research has shown that real-time traffic information systems can alleviate traffic congestion by providing travelers with information on traffic and other travel conditions, as well as on alternative routes. See enclosure II for information regarding this research. Real-time traffic information is one type of traveler information disseminated to the public. Other types of traveler information include transit, weather, and parking information.

State and local agencies, as well as private companies, deploy real-time traffic information systems that collect real-time traffic data using various technologies, aggregate and translate these data into useful information, and disseminate that information to the public using various technologies (see fig. 1).<sup>10,11</sup> The technologies that support real-time traffic

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<sup>8</sup>The state and local officials we interviewed included those we met with during our site visits and those the National Academy of Sciences identified as experts in the areas covered by our third objective. The private companies we interviewed were those identified as key data providers by the academy, as well as through our own work.

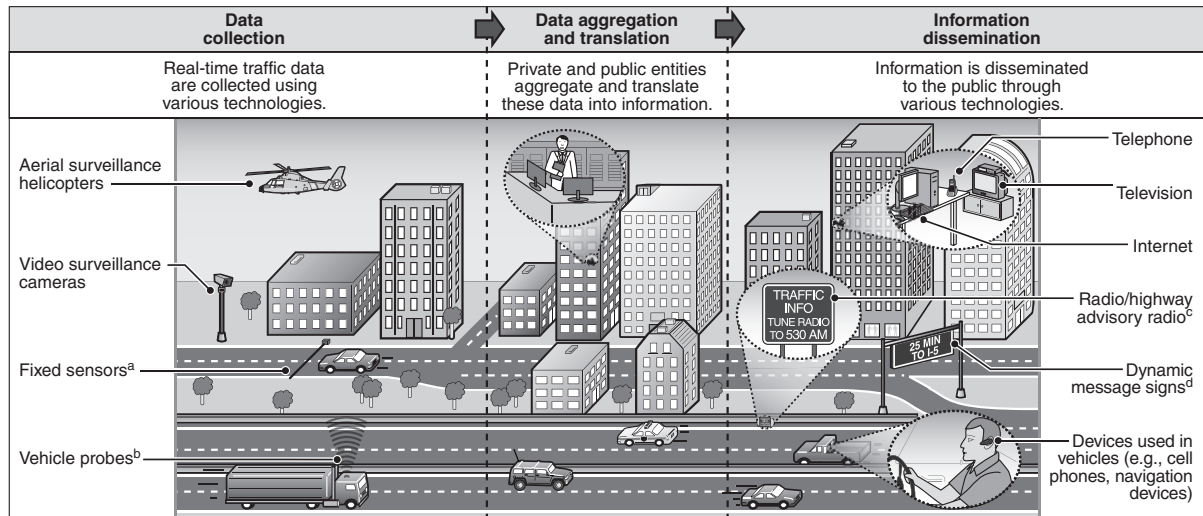
<sup>9</sup>ITS technologies can also be used for improving safety and for transit management. In 2005, we issued a report on the extent to which ITS is used as a tool to reduce congestion. See GAO, *Highway Congestion: Intelligent Transportation Systems' Promise for Managing Congestion Falls Short, and DOT Could Better Facilitate Their Strategic Use*, [GAO-05-943](#) (Washington, D.C.: Sept. 14, 2005).

<sup>10</sup>Some local agencies have agreements with their respective state departments of transportation to collect, aggregate, and disseminate real-time traffic information to the public. Some state and local agencies also contract with private companies to conduct such activities.

<sup>11</sup>Public agencies also use real-time traffic information for traffic management.

information collection and dissemination are rapidly evolving. Travelers, for example, are increasingly using newer technologies—such as cell phones that can access Web sites and receive text messages and in-vehicle navigation devices—to obtain traffic information during travel.<sup>12</sup>

**Figure 1: Examples of Technologies Associated with Real-Time Traffic Information Systems**



<sup>a</sup>A fixed sensor is a technology that is stationary at the roadside or embedded in the road to monitor traffic flow.

<sup>b</sup>Vehicle probes use roaming vehicles and portable devices to collect data on travel times. Vehicle probes include cell phones and Global Positioning System (GPS) devices.

<sup>c</sup>Highway advisory radio uses radio stations to broadcast traffic- and travel-related information to travelers using AM radio.

<sup>d</sup>Dynamic message signs are permanent or portable electronic traffic signs that give travelers information on traffic conditions and travel times, among other things.

Real-time traffic information systems disseminate various types of information to the public such as

- *road closure information*, including road or lane closures that result from construction, maintenance, special events (such as parades), crashes or other incidents;
- *weather conditions* affecting roadways and road conditions; and
- *traffic flow information*, such as travel times, travel delays, or vehicle speeds.

Travelers can use real-time traffic information to help make decisions before they travel

<sup>12</sup>The potential for drivers using cell phones and in-vehicle technologies to become distracted has become a major safety concern. Some states have banned or restricted the use of cell phones while driving. In 2008, GAO addressed safety concerns associated with cell phones and in-vehicle technologies in its report, *Highway Safety: Foresight Issues Challenge DOT's Efforts to Assess and Respond to New Technology-Based Trends*, GAO-09-56 (Washington, D.C.: Oct. 3, 2008). However, the impacts of these technologies on safety are not within the scope of this review.

(pretrip) and during travel (en route). The need for various types of information depends on the traveler. For example, to reach their destination as efficiently as possible, some commuters may need pretrip information, such as travel delays or times, so that they can adjust their route or time of departure. Commercial drivers may be more concerned with obtaining en route information, such as construction or roadway conditions, since their long itinerary does not allow them to observe real-time traffic conditions for their entire trip prior to their departure. Interregional travelers may need traffic information for both their origin and destination, sometimes requiring them to retrieve information from several real-time traffic information systems operated by various agencies.

DOT promotes the deployment of real-time traffic information technologies. For example, DOT's ITS Joint Program Office and the Federal Highway Administration (FHWA) promote the deployment of these technologies through activities such as conducting research, providing technical assistance to state and local agencies, and acting as a clearinghouse for guidance, best practices, and lessons learned. In addition, DOT's Research and Innovative Technology Administration (RITA) ITS Web site includes both deployment statistics and databases on the benefits and costs of various ITS technologies, including real-time traffic technologies. Furthermore, DOT, through cooperative agreements with standards development organizations such as the Institute of Transportation Engineers, helps to develop ITS standards that define, among other things, how ITS systems (including real-time traffic information systems), products, and components can exchange information. In 2005, SAFETEA-LU gave DOT the responsibility of establishing the Real-Time System Management Information Program. SAFETEA-LU also required DOT to establish data exchange formats to facilitate the sharing of traffic data across jurisdictional boundaries and the availability of traffic information nationwide. DOT is currently developing an ITS strategic plan that will identify the direction, goals, and objectives for the department's ITS program over the next 5 years. In developing this strategic plan, DOT is working to further define its role in promoting real-time traffic information systems.

### Agency Comments

We provided a draft of this report to DOT for its review and comment. DOT officials provided a technical comment on our report, which we incorporated.

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We are sending copies of this report to interested congressional committees and the Secretary of Transportation. The report also is available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staff have any questions on this report, please contact me at (202) 512-2834 or [wised@gao.gov](mailto: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 who made contributions to this report are listed in enclosure IV.



David J. Wise  
Director, Physical Infrastructure Issues

Enclosures

*List of Requesters*

The Honorable James L. Oberstar  
Chairman  
The Honorable John L. Mica  
Ranking Member  
Committee on Transportation and Infrastructure  
House of Representatives

The Honorable Peter A. DeFazio  
Chairman  
The Honorable John J. Duncan, Jr.  
Ranking Member  
Subcommittee on Highways and Transit  
Committee on Transportation and Infrastructure  
House of Representatives

The Honorable Mike Rogers  
House of Representatives

The Honorable Russ Carnahan  
House of Representatives



# Dissemination and Coverage

## Federal Role

- The Department of Transportation (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. The rule went into effect in February 2001.
- In response, DOT helped form the 511 Deployment Coalition—a coalition of public agencies, industry groups and associations, and private companies—to encourage the growth of 511 services.
- DOT provided technical expertise and limited start-up funds. DOT offered money to all states, up to \$100,000, for planning the implementation of 511 services.
- DOT's current role is to
  - provide "targeted assistance" with the goal of having 511 deployed nationwide, and
  - create awareness of the 511 system.

## Enclosure I

# Public and Private Sectors Use a Variety of Dissemination Technologies but Gaps in Coverage Exist

## State and Local Agencies Disseminate Traffic Information through 511 Traveler Information Services

- Most states and some local agencies disseminate traffic information, as well as other types of traveler information, through 511 Traveler Information Services (see fig. 2).
  - These services provide information via the telephone (using an interactive voice response automated system) and the Internet. By dialing the three-digit number or accessing the state or local 511 Web site, travelers can obtain various types of traveler information, including information on traffic and road conditions as well as construction- and weather-related traffic problems.
  - The types of information provided by these services vary. For example, some services provide information on travel times and roadway weather conditions, while others do not. In addition, the way that information is presented on 511 Web sites varies.
- According to the 511 Deployment Coalition, as of September 2009, 39 services were operating in 36 states. In addition, 511 services were available to over 181 million Americans (60 percent of the population), according to DOT.
  - Thirty-two were statewide services.
  - Seven were metropolitan or regional services. California has four 511 services operating within its borders.
    - Some metropolitan or regional 511 services, such as those in California, are operated by local agencies; while others, such as those in Missouri and Massachusetts, are operated by the respective state department of transportation.
- While the volume of calls received by 511 services varies significantly, overall, these services have received a large number of calls. According to the 511 Deployment Coalition, as of July 2009, these services have received over 151 million calls nationwide since their inception in 2001.<sup>1</sup>

<sup>1</sup>Similar nationwide usage information is not available for 511 Web sites because this usage is not tracked consistently by DOT, states, or metropolitan areas.

# Dissemination and Coverage



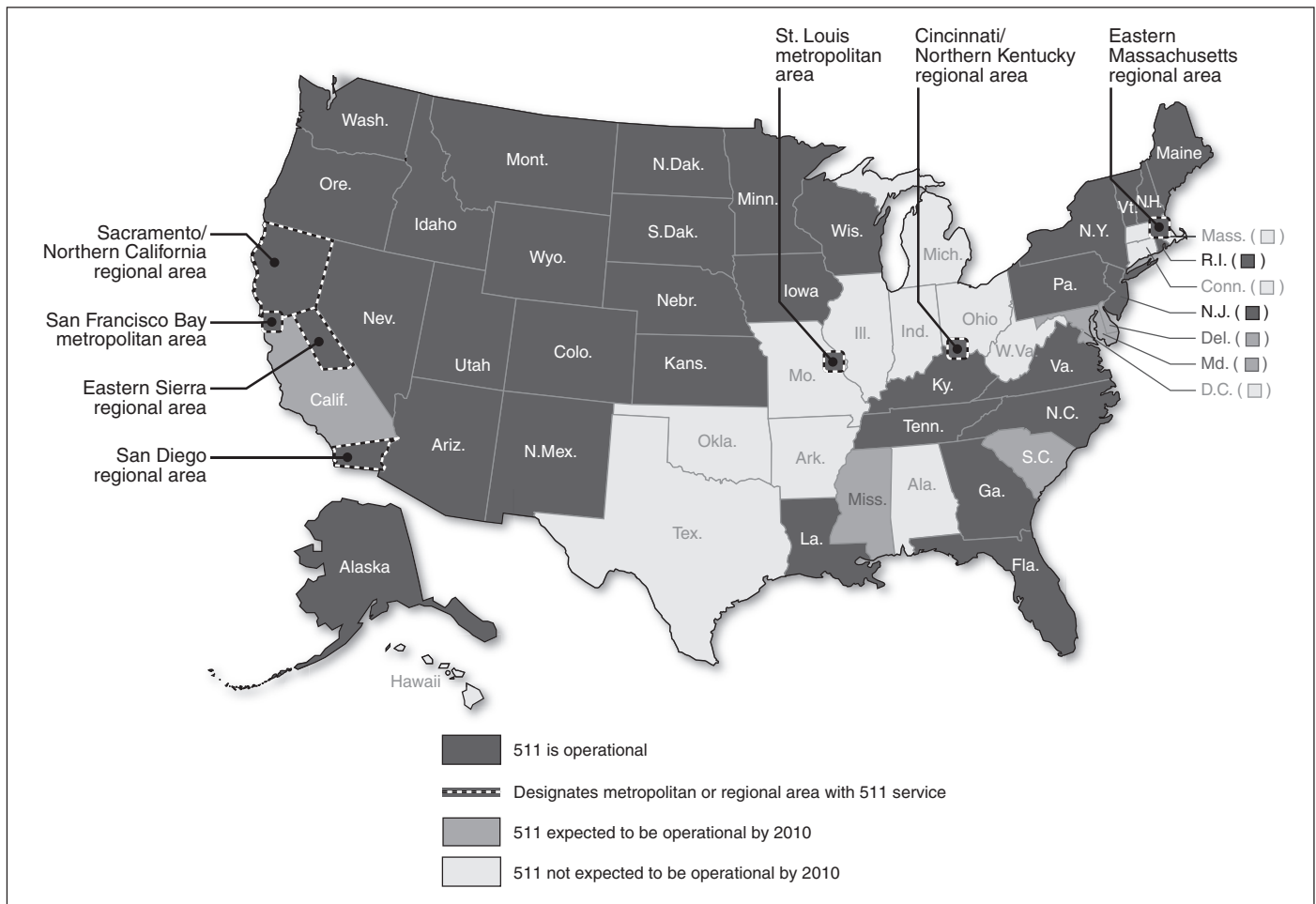
Source: San Francisco Bay Area's Metropolitan Transportation Commission.

511 roadside signs, like the one shown above, are used to promote awareness of the 511 travel service.

## State and Local Agencies' 511 Services (continued)

- 511 services are expanding. For example, Pennsylvania launched its service in September 2009, and a five-county system in Southern California is expecting to launch its service by the end of 2009. Four additional states—Delaware, Maryland, Mississippi, and South Carolina—are planning to have operational 511 services in 2010.
- Although 511 services are expanding, some states, such as Texas and Michigan do not plan to implement such services. States without 511 services may choose not to establish them because they lack adequate traffic data and funding. Furthermore, rather than using 511 services, some states may disseminate traffic information using other methods, such as the Internet and dynamic message signs.

Figure 2: Status of 511 Traveler Information Services, as of September 2009



Sources: 511 Deployment Coalition (data); MapArt (base map).

# Dissemination and Coverage

## Federal Role

DOT has carried out various activities to promote the deployment of real-time traffic information technologies by state and local governments, in addition to its efforts to promote 511 services. For example,

- DOT distributes information on best practices, Intelligent Transportation Systems (ITS) standards, and lessons learned related to the deployment of these and other ITS technologies. DOT also provides some technical assistance on ITS.

## Funding Sources

DOT does not provide funding to state and local governments specifically for the deployment of real-time traffic information technologies and systems.

- The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) authorizes states to use their annual federal-aid highway funding for developing and implementing these technologies and systems. (These funds are derived from the Highway Trust Fund and are provided to the states mostly through formula grant programs.)
- States generally finance real-time traffic information systems and technologies using a combination of federal and state funds. However, the proportions vary. For example, California officials told us that they have mainly used state funds while Florida officials told us that they have mainly used federal funds.

## State and Local Agencies Use Other Methods for Disseminating Real-time Traffic Information

- Based on DOT's most recent surveys of ITS deployment in large metropolitan areas (conducted in 2007), state and local agencies in these areas disseminated real-time traffic information to the public primarily through the Internet, e-mail, television and radio, dynamic message signs, and Highway Advisory Radio.<sup>2</sup>
- These technologies provided information on traffic incidents, travel time, and travel speeds on roads in these metropolitan areas.<sup>3</sup>
  - Most metropolitan areas disseminated information on traffic incidents, and significantly fewer disseminated information on travel times and travel speeds. (See table 1.)
  - State and local agencies disseminated information on freeways more frequently than on arterial roads.<sup>4</sup> (See table 1.)

**Table 1: Percentage of Metropolitan Areas in Which Incident, Travel Time, and Travel Speed Information Was Disseminated to the Public in 2007**

Type of information	Percentage of metropolitan areas	
	Freeways	Arterial roads
Incident	87%	68%
Travel time	36%	19%
Travel speed	32%	16%

Source: GAO analysis of DOT data.

Note: These percentages are based on responses from state and local agencies in large metropolitan areas to DOT surveys on freeway management and arterial management. Ninety-four metropolitan areas responded to the freeway management survey in 2007 (about an 89 percent response rate), and 102 metropolitan areas responded to the arterial management survey in 2007 (about a 95 percent response rate). See enclosure III for more information on the surveys.

- Some states are collaborating to disseminate traffic information across states or across multiple agencies within a jurisdiction. For example:
  - *Northwest Passage Corridor Coalition*: Wisconsin, Minnesota, North Dakota, South Dakota, Montana, Wyoming, Idaho, and Washington coordinate the information they disseminate to the public, particularly on interstates that cross multiple states.

<sup>2</sup>These surveys reflect ITS deployments by state and local agencies, not deployments by private companies. DOT plans to conduct the next survey of ITS deployments in 2010.

<sup>3</sup>These technologies may have provided additional types of information, but DOT's surveys asked only about incidents, travel times, and travel speeds.

<sup>4</sup>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.

# Dissemination and Coverage



Source: DOT.

Dynamic message signs, like the one shown above, are electronic roadside signs displaying traveler information that can be updated in real time. These signs can provide travelers with en route information on incident and closures, travel times, and traffic and weather conditions.



Source: Florida Department of Transportation.

The images shown at this traffic management center, located in Orlando, Florida, were taken from traffic cameras. The traffic cameras collect real-time traffic data, and the center aggregates the data from the cameras and from other technologies and then disseminates relevant traffic information to the public.

## State and Local Agencies Dissemination Methods (continued)

- *Transportation Operations Coordinating Committee (TRANSCOM)*: State and local agencies in New York, New Jersey, and Connecticut formed this coalition, which collects and disseminates real-time incident and construction information to over 100 member agencies and the public in the New York metropolitan area.
- *I-95 Corridor Coalition*: States along the I-95 Corridor, from Maine to Florida, formed this coalition, which provides information via a Web site on traffic conditions and travel time.

## Geographic Coverage Provided by State and Local Data Collection Technologies Is Limited

- Although state and local agencies disseminate traffic information through various methods, the information available for dissemination to the public is limited because the geographic coverage of the technologies the agencies deploy within their areas of operations to collect traffic data, such as fixed sensors and cameras, is limited.
- Based on DOT's 2007 surveys, technologies used by state and local agencies for collecting real-time traffic data covered about 39 percent of the combined freeway miles in the 64 large metropolitan areas that provided this information.<sup>5</sup> While the percentage is up from 33 percent reported for 2004, it reveals a significant gap, given that urban freeways account for the majority of the nation's traffic, congestion, and travel time variability.
- The cost of deploying and maintaining technologies that collect traffic data, such as fixed sensors, is a major factor limiting the roadway mileage public agencies can cover.
- Although DOT does not have comparable information on the collection of traffic data for arterial and rural roads, DOT and state officials told us that coverage is significantly lower for these roads than for freeways.
- The main factor limiting the collection of accurate data on arterial roads is cost because more data collection technologies are needed to capture traffic data between the many entrances and exits on arterial roads (e.g., for gas stations, shopping centers, and buildings). Also, arterial traffic is a greater challenge to measure because signalized intersections often interrupt traffic flow and make it harder to predict.

<sup>5</sup>While 94 metropolitan areas responded to the 2007 survey on freeway management, 30 of these metropolitan areas did not report information on technologies for collecting real-time traffic data on their freeways.

# Dissemination and Coverage

## Measures of Data Quality

Good data quality is needed to provide useful information to travelers so that they can make the most efficient travel decisions. The quality of traffic data is determined by the data's timeliness, accuracy, and availability.

- *Timeliness*—the time from when an event or condition occurs to when it is reported by real-time information dissemination technology.
- *Accuracy*—how close the reported data are to “ground truth,” or actual conditions.
- *Availability*—how much of the data designed to be collected by the real-time information collection technology is actually made available.

## Geographic Coverage is Limited (continued)

- The coverage in rural areas is lower mainly because the delivery of power and communications to real-time traffic detection technologies in isolated areas can be cost prohibitive unless there is a specific safety demand—such as a high crash rate. Additionally, congestion in rural areas is much lower than in metropolitan areas, lessening the need for real-time traffic information.

## State and Local Agencies Vary in the Quality of the Traffic Data They Collect and the Extent to Which They Share Traffic Information

- The quality of real-time traffic data collected, including the data's timeliness, accuracy, and availability, varies by state and local government.
  - The timeliness of dissemination to the public depends on the type of information disseminated (i.e., incident information, travel time) or geographic location (i.e., metropolitan or nonmetropolitan area). For example, it may take longer to disseminate information in rural areas compared with urban areas because state DOTs may not have the available resources or infrastructure to collect and report information quickly in rural areas.
  - Although a key data collection technology used by public agencies—fixed sensors embedded in the roadway—is generally accurate, there is variation in how reliably these sensors function. In cases where sensors do not function, traffic data are not available from them. In California, for example, some districts have sensors that function 50 percent of the time, while other districts' sensors function 90 percent of the time. The poor reliability of the sensors in some districts is generally due to hardware failure, such as broken wiring and missing parts.
- The extent to which states and local agencies share or exchange data and information varies.
  - According to the 511 Deployment Coalition, there are three basic ways to transfer and share data or information from 511 systems: calls, data transfer, and application or database sharing—23 services currently transfer calls, 0 transfer data, and 9 share applications or databases. (See table 2.)
  - Some states, such as Alaska, Louisiana, Massachusetts, and Missouri, do not transfer calls, transfer data, or share databases or applications. The main reason these states do not share data, particularly through data transfer or database sharing, is that they do not want to incur the cost of matching data or developing a matching database for two or more systems.

# Dissemination and Coverage

## State and Local Agencies' Data Quality and Sharing Vary (continued)

**Table 2: Extent to Which 511 Services Share or Exchange Data and Information**

How information and data are shared	Number of states and metropolitan/regional areas	States and metropolitan/regional areas
<p><b>Call transfer</b> One 511 system transfers calls to another 511 system.</p>	23	Sacramento, Cincinnati/Northern Kentucky, Colorado, Florida, Georgia, Idaho, Iowa, Kansas, Maine, Montana, New Jersey, North Dakota, New Hampshire, New Mexico, New York, North Carolina, South Dakota, Tennessee, Utah, Vermont, Virginia, Washington, Wisconsin
<p><b>Data transfer</b> The underlying data systems are accessible to other 511 systems, enabling those systems to exchange information with neighboring jurisdictions without transferring calls.</p>	0	No states or local agencies transfer data.
<p><b>Application or database sharing</b> Deployers use the same underlying application to run their 511 systems.</p>	9	Eastern Sierra (California), Iowa, Kansas, Montana, New Jersey, North Dakota, Rhode Island, South Dakota, Vermont

Source: GAO analysis of 511 Deployment Coalition data.

# Dissemination and Coverage

## Private Companies Disseminate Traffic Information through Newer Technologies

- Historically, privately operated news and media outlets have disseminated traffic information over radio and television broadcasts. In recent years, private companies have begun to disseminate traffic information through newer technologies such as cell phones, the Internet, and navigation devices in vehicles, among others.
- The services provided by the companies that use these newer technologies include
  - e-mail and cell phone alerts about traffic congestion and incidents;
  - Web sites that provide various types of traffic information, including personalized drive times and live video; and
  - navigation devices (in-vehicle and portable) that can provide information on traffic flow and speed, estimated travel times, and lane closures, among other things.
- Some private companies disseminate traffic information directly to the public. These companies provide basic traffic information to the public for free on Web sites and more detailed information for a fee. Some private companies provide traffic information to state and local agencies or other private companies, which then disseminate this information.
- Furthermore, some private companies disseminate traffic information nationally, mainly in metropolitan areas. Following are examples:
  - Westwood One disseminates real-time traffic information to the public nationwide through its affiliations with 2,400 radio stations, more than 170 television stations, and more than 250 Web sites.
  - Clear Channel's Total Traffic Network disseminates real-time traffic data in 95 cities via in-car or portable navigation devices, broadcast media, and wireless and Internet-based services.
  - NAVTEQ Traffic is available in more than 120 markets across the nation. The company disseminates traffic information to the public about road construction, traffic speeds, and incidents through in-vehicle and personal navigation devices, cell phones, and Web sites. NAVTEQ Traffic also provides traffic information to other private companies that disseminate information through navigation devices.
  - A number of other companies, such as Google and Yahoo!, disseminate real-time traffic information—such as traffic flow and speed—nationally via Web sites and other means.

# Dissemination and Coverage

## Federal Role

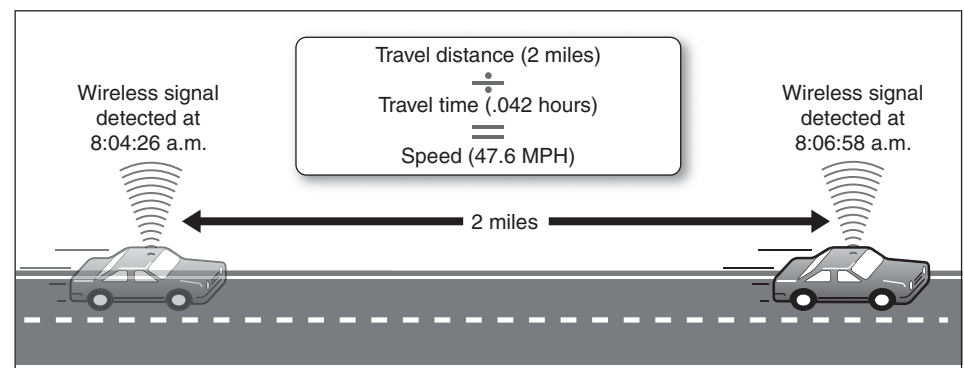
DOT is conducting research and development to improve traffic information coverage by both the public and private sectors.

- Through its Safe Trip-21 initiative, DOT—in partnership with state and local agencies, the private sector, and academia—is testing the use of vehicle probes to generate real-time data and provide travelers with current information on traffic congestion, roadway conditions, and alternative travel options. Vehicle probes use roaming vehicles and portable devices to collect data on travel times and speeds. Vehicle probes include cell phones and Global Positioning System (GPS) devices. Test sites are being operated in the San Francisco Bay area and in the I-95 Corridor along the East Coast.
- DOT has also conducted some evaluations—such as a recent assessment of the current state of traveler information—to help determine what activities are needed to make real-time information more accurate and complete.

## New Private Sector Data Collection Technologies Are Helping to Expand Coverage

- Private companies are expanding the coverage of information that is disseminated by both public and private entities by using new technologies to increase the collection of real-time traffic data.
- Some private companies are using newer technologies, such as vehicle probes, to collect real-time data on travel time and speed (see fig. 3). These companies are collecting data beyond what state and local governments collect. For example, INRIX—a company that focuses on collecting and aggregating real-time traffic data—collects data using commercial fleet vehicle probes and other technologies. An advantage of such technologies is that data are collected on arterial roads and other roads where there are no fixed collection technologies (such as fixed sensors).

**Figure 3: Vehicle Probe Technology for Collecting Real-Time Traffic Data**



Sources: GAO and the I-95 Corridor Coalition.

- Public-private partnerships are expanding data that state departments of transportation can use in disseminating real-time traffic information. For example, the Alabama department of transportation purchased data from INRIX on roughly 125 miles of roads in the Birmingham area to generate travel times for dynamic message signs, and the state plans to expand its contract to cover the entire state.



# Dissemination and Coverage

## Despite Their Advanced Technologies, Private Companies Face Certain Limitations in the Coverage and Quality of Data They Collect

- Private companies face certain limitations in the coverage of data they collect. Some examples are as follows:
  - Market disincentives (e.g., little demand for real-time traffic information) discourage private companies from collecting data on and disseminating information about rural roads and minor arterials.
  - Data collected by vehicle probes in commercial fleets depend on where these fleets travel. More specifically, some commercial fleets, such as delivery companies and taxicabs, may travel only on assigned routes or may not travel on freeways.
  - Some state departments of transportation require that private companies pay for access to public data. However, some private companies told us that although such data could enhance their coverage, they often have chosen not to pay for access because the data are not of high enough quality to merit payment.
- The quality of data collected using the newer technologies has the following limitations:
  - Data from vehicle probes, such as GPS devices and cell phones, may not be collected from enough vehicles to achieve the sample size required for accuracy.
  - Some commercial fleets avoid travel during peak periods. As a result, probe data collected from these fleets may not accurately reflect traffic or travel conditions during peak periods.
- Furthermore, the public sector may not be able to determine the quality of real-time traffic information it receives from private companies because (1) it may have limited access to the underlying data that is collected and aggregated by these companies and (2) the methods these companies use to collect and aggregate the data may be proprietary.

## DOT's Actions

### SAFETEA-LU Requirements

In 2005, Section 1201 of SAFETEA-LU required that the Secretary of Transportation establish a program to provide all states the capability to

- monitor, in real-time, the traffic and travel conditions of major highways, and
- share that information to facilitate national and regional highway traveler information, among other things.

SAFETEA-LU did not include a deadline for the Secretary to establish this program.

SAFETEA-LU *does not provide separate funding* to implement this program. However, Section 1201 of SAFETEA-LU authorizes states to use their annual federal-aid highway funds provided through the Highway Trust Fund to fund implementation of this program, as well as other ITS projects.

## DOT Has Proposed a Program That Has Potential Benefits, but Some Stakeholders Are Concerned about Time Frames and Costs

### DOT Has Proposed a Program that Aims to Improve Traffic Information Coverage, Quality, and Sharing

- To fulfill requirements in SAFETEA-LU, the Federal Highway Administration (FHWA) issued a Notice of Proposed Rulemaking in January 2009 to establish the Real-Time System Management Information Program.<sup>6</sup> The proposed 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.<sup>7</sup>
  - FHWA currently plans to issue a final rule in February 2010.<sup>8</sup>
- The proposed rule aims to create general uniformity among real-time information programs to ensure consistent service to travelers and other agencies. It also aims to improve the availability of information, which could lead to the dissemination of more information to travelers by public agencies and private companies, as well as to better traffic control by public agencies, among other things.
  - The proposed rule requires states to make certain information available on all interstates<sup>9</sup> within 2 years and on selected metropolitan-area, noninterstate "routes of significance" within 4 years.<sup>10</sup> (See table 3.)
- States that do not currently collect this information will have to select an approach to achieve compliance from a variety of options, including installing data collection technologies or contracting with private companies to obtain the data, thus improving real-time traffic information coverage. These requirements could also provide a basis for the development of a new 511 service in states that do not provide this service because they lack sufficient data.

<sup>6</sup>See 74 *Fed. Reg.* 1993 (Jan. 14, 2009).

<sup>7</sup>According to DOT's benefit-cost analysis of the Real-Time System Management Information Program, the present value of the total cost for establishing real-time information programs in all states and the nation's 50 largest metropolitan areas and operating these programs through 2018 would be about \$1.2 billion. See enclosure II for more details on this analysis.

<sup>8</sup>Before the rule is finalized, it will have to be reviewed by the Office of the Secretary at DOT and by the Office of Management and Budget.

<sup>9</sup>Interstate highways are routes designated as part of the Dwight D. Eisenhower National System of Interstate and Defense Highways.

<sup>10</sup>The proposed rule notes that states should select routes of significance based on various factors, including their importance for congestion relief, disaster evacuation, economic growth, and safety.

# DOT's Actions

## Proposed Program (continued)

**Table 3: Types of Information Required on Interstate and Selected Noninterstates, in Metropolitan and Nonmetropolitan Areas**

Type of information required	Interstates (implement within 2 years)		Selected noninterstates (implement within 4 years)	
	Metropolitan areas	Nonmetropolitan areas	Metropolitan areas	Nonmetropolitan areas
Roadway or lane closures due to construction activities	✓	✓	✓	Not required
Roadway or lane closures due to traffic incidents	✓	✓	✓	Not required
Roadway weather conditions	✓	✓	✓	Not required
Travel time along highway segments	✓	Not required	✓	Not required

Source: GAO analysis of DOT information.

Note: Metropolitan areas refer to geographic areas with populations over 1 million, designated as Metropolitan Statistical Areas by the Office of Management and Budget. The proposed rule noted that, as of December 31, 2006, 49 metropolitan areas had populations over 1 million.

- The proposed rule indicates that all state real-time information programs that are funded in whole or in part through the Highway Trust Fund would be subject to its requirements and that states would need to demonstrate compliance prior to authorization of funds for ITS projects.
- According to FHWA officials, the agency's division offices, one of which is located in each state, will monitor compliance and will work closely with any states that are facing challenges and allow them flexibility. FHWA plans to provide states with additional guidance to help them meet requirements.
- The proposed rule also establishes minimum data quality requirements for the information that states are required to make available. Specifically, the rule establishes minimum requirements for timeliness, availability, and accuracy. (See table 4.)
- To the extent that states adhere to these requirements, they should improve data quality nationwide or at least improve the quality of data from those entities that do not already meet those minimum requirements.

# DOT's Actions

## Proposed Program (continued)

**Table 4: Timeliness, Availability, and Accuracy Requirements for Real-Time Traffic Information in Proposed Rule**

Type of information required	Requirements			
	Timeliness <sup>a</sup> for metropolitan areas	Timeliness for nonmetropolitan areas	Availability <sup>b</sup>	Accuracy <sup>c</sup>
Roadway or lane closures due to construction activities	10 minutes	20 minutes	90%	85%
Roadway or lane closures due to traffic incidents	10 minutes	20 minutes	90%	85%
Roadway weather conditions	20 minutes	20 minutes	90%	85%
Travel time along metropolitan area highway segments	10 minutes	Not required	90%	85%

Source: DOT.

<sup>a</sup>Timeliness requirements refer to the time it takes to deliver the information.

<sup>b</sup>Availability requirements refer to the percentage of time that the information is expected to be available, at a minimum, based on the design of the real-time information program.

<sup>c</sup>Accuracy requirements refer to the percentage of time that the information is expected to be accurate, at a minimum, based on the design of the real-time information program.

- The proposed rule allows states flexibility in how they will meet the requirements.
  - There is no requirement for a state or other entity using federal funds to apply any particular technology in collecting the data necessary to fulfill the program's specifications. For example, states may use their existing fixed sensors to collect data on travel times on highway segments.
  - States may use any business approach to establish a real-time information program. For example, states can collect data on their own, contract with the private sector to collect all or some of the data, or purchase information products from the private sector.
  - States can employ any technology for disseminating information. States could continue to provide information through 511 services or state Web sites. Additionally, FHWA encourages states to partner with the private sector to disseminate to the public information that is made available under the proposed rule.

# DOT's Actions

## SAFETEA-LU Requirements

SAFETEA-LU also required the Secretary of Transportation to establish data exchange formats within 2 years of the act's enactment to facilitate the sharing of data on traffic and travel conditions across jurisdictional boundaries and the availability of such information nationwide.

SAFETEA-LU further required states to incorporate the data exchange formats established by DOT into their traffic and traveler information systems but did not specify a deadline for states' use of these formats.

## DOT Has Proposed Guidance on Data Exchange Formats

- To fulfill SAFETEA-LU requirements, in 2007, FHWA issued interim guidance on the use of standard formats for exchanging data on traffic and travel conditions. These formats, to the extent that states utilize them, allow the data collected by a state to be available to any other state or jurisdiction that wants to retrieve the data in the same format. FHWA plans to finalize the data exchange format guidance after the Real-Time System Management Information Program regulations are finalized in early 2010.
- Once finalized and adopted by states, the guidance would support the proposed Real-Time System Management Information Program by making it easier for states and jurisdictions to share the basic real-time traffic information the program requires. The exchange formats in the guidance link the proposed program requirements to specific ITS standards for data exchange.<sup>11</sup> To the extent that states use these formats and incorporate these ITS standards, information will be easier to exchange across multiple jurisdictions.
- According to DOT officials, although states are required under SAFETEA-LU to incorporate the data exchange formats, DOT does not plan to require states to use them in the near term because the ITS standards on which the formats are based are still under development.
  - DOT officials said that the department could adopt the ITS standards referenced in the data exchange format guidance when these standards are finalized, and DOT could then require states to use them.<sup>12</sup> However, DOT has no plans to adopt the standards at this time.
- DOT has not obtained information on what data exchange formats states use since its 2004 surveys of ITS deployments in large metropolitan areas, but agency officials said that they may obtain this information in their next ITS deployment survey effort in 2010. Furthermore, according to DOT officials, the agency's division offices will monitor how well states are following the data exchange format guidance.

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<sup>11</sup>ITS standards define how ITS systems, products, and components can be interconnected and exchange information, among other things. Many ITS standards are consensus-based, meaning that all interested parties agreed, through cooperation and compromise, on the published standard.

<sup>12</sup>23 C.F.R. § 940.11(f) requires that all ITS projects funded through the Highway Trust Fund use applicable DOT-adopted ITS standards. For DOT to adopt ITS standards, it must first issue a rule, but it has not yet done so for any of these standards.

## DOT's Actions

### Stakeholders Have Cited Benefits of the Proposed Program

- State and local officials,<sup>13</sup> as well as private sector representatives, have cited a number of potential benefits of the program.
  - Most state and local government officials and private sector representatives we interviewed said that improved coverage and information sharing would provide travelers more information so that they have the opportunity to choose the most efficient route to reach their destination, thus providing the opportunity to reduce congestion and obtain potential benefits to the environment, the economy, and disaster evacuation efforts.
  - Some private companies that submitted comments on the proposed rule said that the program would advance the data collection market and would provide them with additional opportunities to fill gaps in public agencies' data collection.

### State and Local Stakeholders Have Cited Time Frames and Costs as Challenges in Implementing the Proposed Program

- Most state and local government officials that we interviewed cited challenges in implementing the program within the specified time frames and said that the program would be difficult to implement without additional funds. Because some states and local governments are facing budget constraints, the implementation of a real-time information program may not be a priority.
- According to some state and local transportation agencies that submitted comments to the proposed rule, the proposed requirements may not take into account local needs and could be challenging to implement even for states with existing 511 services. For example, the Metropolitan Transportation Commission, which operates San Francisco Bay Area's 511 service, said that there is little need for roadway weather information in areas of the country where weather does not significantly affect travel. Furthermore, Kansas noted that it would be challenging for them to collect certain traffic data, such as on incidents in rural areas, because they may have limited or no resources or infrastructure in these areas to collect this data and report it to their statewide 511 service.
- DOT is currently considering options to address stakeholders' concerns as it finalizes the program's requirements. We are not making recommendations to DOT about the Real-Time System Management Information Program at this time because the agency's efforts to establish the program are still in the preliminary stages.

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<sup>13</sup>Some local agencies have agreements with their respective state departments of transportation to collect, aggregate, and disseminate real-time traffic information to the public. Under such agreements, some local governments may support the state departments in implementing the requirements of the Real-Time System Management Information Program.

# Nationwide System

*Mobility* improvements are typically measured in terms of decreases in delay and travel time, and improvements to the *environment* are measured by decreases in emissions and fuel consumption. See enclosure II for examples of studies that discuss the impact of real-time traffic information systems and technologies on mobility and the environment.

## Most Selected Experts Said a Nationwide System Is Needed, but Their Visions of Such a System Varied

### Most Experts Saw a Need for a Nationwide System

Seventeen of the 19 experts we interviewed said that a need exists for the development of a nationwide real-time traffic information system.

- Some of these 17 experts noted that current approaches to developing real-time traffic information systems are fragmented because state and local transportation agencies generally develop and use these systems within their own jurisdictions, leading to gaps in coverage and inconsistencies in the quality and types of data collected.
- Many of these experts emphasized that, in their view, information coverage would be expanded and data quality improved under the nationwide system they envisioned, resulting in benefits for mobility and the environment beyond existing real-time traffic information systems.
- Some experts also said that they believe that further enhancements in the sharing of information under a nationwide system could provide potential benefits to the economy and improve coordination of emergency response efforts that might not be realized under existing state or regional systems. For example, improved information sharing could allow commercial truckers to better plan their interstate trips and, in turn, reduce delivery times or make delivery times more reliable. It also could allow multijurisdictional areas to communicate better prior to, during, and after an emergency.

Two of the 19 experts we interviewed, however, said that they saw no need for the development of a nationwide system.

- One said that there was no need, in part, because adjoining states or jurisdictions that need to share information have already developed methods for doing so, such as states that are a part of the I-95 Corridor Coalition. This expert said that multiple regional systems across the nation would be sufficient.
- The other said the benefits of such a system would not be sufficient to justify the level of investment that would be needed to develop it.

# Nationwide System

For the purposes of this review, *current efforts* that some may see as leading to a nationwide real-time traffic information system include

- DOT's efforts to establish the Real-Time System Management Information Program;
- state and local transportation agencies' efforts to expand coverage of 511 Traveler Information Services; and
- the private sector's efforts to collect, aggregate, and disseminate real-time traffic information across the nation.

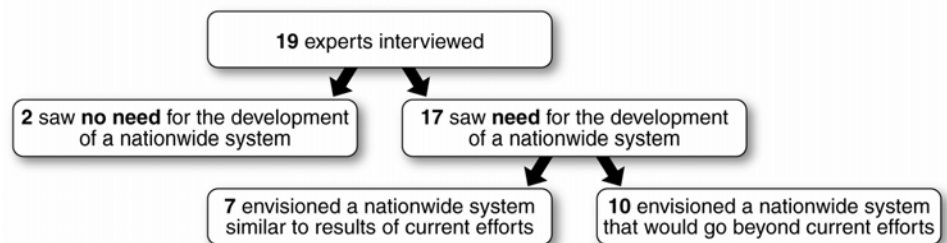
Most of these 10 experts envisioned little change in the *roles of state and local transportation agencies*—that is, the agencies would continue to deploy, or partner with other public agencies or private companies to deploy, real-time traffic information technologies that collect, aggregate, and disseminate real-time traffic information.

## Experts Views on Need for a Nationwide System (continued)

The 17 experts that said there was a need for a nationwide system had varying views on the type of nationwide system that is needed (see fig. 4).

- Seven of these 17 experts either envisioned a nationwide system that would be similar to the anticipated results of current efforts by DOT, state and local transportation agencies, and the private sector or said that current efforts are already leading to a nationwide system.
- Ten of these experts envisioned a nationwide system that would go beyond current efforts, such as a system creating a national user interface for disseminating information, but these visions varied.
- Some experts said that current efforts are not sufficient to develop a nationwide system. For example, one expert noted that DOT's proposed rule on the Real-Time System Management Information Program would actually create statewide systems, rather than a nationwide system.

**Figure 4: Views of Experts on Whether a Nationwide Real-Time Traffic Information System Is Needed and Whether Such a System Should Go Beyond Current Efforts**



Source: GAO.

## Visions of a Nationwide System beyond Current Efforts Varied

The 10 experts that envisioned the development of a nationwide system beyond current efforts had varying views on the appropriate level of involvement for DOT and the private sector, as well as on the form a nationwide system could take. Among the aspects of a nationwide system envisioned by these experts are a strong leadership role by DOT, increased DOT partnerships with the private sector, and a national interface for disseminating information. These differing aspects are not necessarily mutually exclusive. For example, DOT could both take a strong leadership role and partner with the private sector to collect, aggregate, and disseminate real-time traffic information.



# Nationwide System

DOT is currently developing an *ITS strategic plan* that will identify the direction of the department's ITS program over the next 5 years. DOT has sought stakeholders' views in developing this plan, including views on what its role in real-time traffic information systems should be. Some have called for DOT to strengthen its role in this area. For example, one stakeholder commented that it is critical for DOT to develop a variety of standards and guidelines for data exchange and for those standards to be adopted by public and private stakeholders.

## Visions Varied (continued)

- *Strong leadership role by DOT*—A few experts envisioned that DOT would play a strong leadership role in a nationwide system, specifically by developing and enforcing requirements and providing funding for state and local transportation agencies to develop and maintain real-time traffic information systems.
- Some experts said that DOT should take a strong role in developing and enforcing requirements for the types of information to be collected and disseminated, data quality, and common data exchange formats, as well as ITS standards. For example, by ensuring compliance with its new requirements under the Real-Time System Management Information Program, DOT could help ensure consistency in the types of information collected and in the quality of the data.<sup>14</sup> In addition, one expert said that DOT's reluctance to require that states use ITS standards will dilute the effectiveness of those standards.<sup>15</sup>
- Although SAFETEA-LU does not provide separate funding for states to implement the Real-Time System Management Information Program, several experts said additional funding is necessary to develop a nationwide system. One expert envisioned DOT as a grant-giver or funder of real-time traffic information programs. In this vision, by directly funding such programs, DOT could better set and enforce requirements that could improve data coverage, quality, and sharing.
- Other experts said that DOT could act more like the operator of a nationwide system. For example, DOT could enter into and manage agreements with the private sector to collect and disseminate a base level of real-time traffic information nationwide. Or DOT could develop and operate a national user interface—such as a phone number or Internet page—that a traveler, regardless of location, could call or access to obtain, or be directed to, relevant information.

<sup>14</sup>The proposed rule states that FHWA will monitor compliance and may decline to approve federal-aid projects, pursuant to 23 C.F.R. § 1.36, if a state does not comply with the regulations.

<sup>15</sup>DOT, through cooperative agreements with six standards development organizations such as the Institute of Transportation Engineers, helps to develop nonproprietary, industry-based, consensus ITS standards. As noted previously, DOT may adopt ITS standards and require states to follow them by issuing a rule, but DOT has not yet done so.

# Nationwide System

## Visions Varied (continued)

- *Increased partnerships with the private sector*—While some private companies currently partner with state and local transportation agencies, several experts envisioned a nationwide system that would have even more private sector involvement. Some of these experts noted that the private sector is using more advanced technology and that a nationwide system should take advantage of this innovation. Examples are as follows:
  - Two experts envisioned a private company contracted by either DOT or state and local transportation agencies. In the first vision, DOT would contract with a private company, and the single contract with DOT could help ensure the collection of consistent data nationwide. In the second vision, which would replicate the I-95 Corridor Coalition’s business model on a national level, state and local transportation agencies within a region would jointly contract with a single private company to collect and aggregate data and translate the data into real-time traffic information. The state and local transportation agencies would disseminate the information to the public and might also collect and disseminate additional information beyond the data provided to the region under the private contract.
  - Another expert envisioned that DOT would contract with *several* private companies to collect and aggregate data on behalf of state and local transportation agencies. In this vision, the private sector would perform most operations needed to support the nationwide system, and DOT would establish data quality standards and other specific requirements, such as requirements to ensure consistency in the information collected and disseminated. Information could be disseminated to the public by either or both entities.
- *National user interface for disseminating information*—While the current 511 phone number could serve as a national user interface, 511 Traveler Information Services are not available in all states, and the various state and regional services do not provide consistent information. Two experts envisioned a nationwide system—possibly operated by the federal government or the private sector—that would disseminate information through a public user interface, such as a common phone number or Web site. This public user interface would provide consistent information and would be accessible to travelers from anywhere in the nation, at any time.

# Nationwide System

## Visions Varied (continued)

- One expert envisioned a national phone system that would receive calls centrally and disseminate information to travelers to allow state and local agencies to focus their resources on data collection without having to support all the technology required for information dissemination. Another expert envisioned multiple national interfaces managed by both the public and private sectors. For example, while state and local transportation agencies could operate a nationwide user interface that would provide a base level of real-time traffic information, private companies could operate another national phone number, Web site, or other service that would provide more personalized traveler information, but might also require that travelers pay a fee for that information. A centralized interface could help ensure consistency in the types of data collected and in data quality.

## Experts Held Similar Views on Needed Nationwide Coverage

Although experts varied in their views on the form a nationwide system could take, most said that a nationwide system should, at a minimum, cover controlled access roads, such as interstates, in both urban and rural areas. These experts also said that the nationwide system should cover some key arterial roads.

- One expert noted that information for every road all the time would be ideal but not feasible.
- Some experts said that while a nationwide system should cover at least interstates and other controlled-access roads and some key arterial roads, the types of information collected and disseminated could vary depending on the characteristics of the road—controlled access versus arterial and low volume versus high volume.

# Nationwide System

## Experts Cited Challenges in Designing and Implementing a Nationwide System

Some experts predicted that reaching consensus on the form of a nationwide system and the roles of the public and private sectors could be a major challenge.

- Some experts noted that state and local transportation agencies prefer to maintain control over efforts within their borders. Thus, a design that dramatically changed the role or shifted the level of control or responsibility from the state and local levels to the federal level or to the private sector could meet with resistance from states and localities.
- Some experts noted that difficulties in quantifying the benefits and costs of such a system would make it challenging to determine the most cost-effective design.<sup>16</sup> See enclosure II for results of studies that conducted benefit-cost analyses of real-time traffic information systems and the challenges in conducting such analyses.

Experts also cited several potential challenges to implementing a nationwide system that they said would need to be addressed.

- The most common implementation challenge cited by the experts was the availability of funding. As previously discussed, some state and local agencies are already anticipating significant challenges in implementing DOT's proposed Real-Time System Management Information Program because of budget constraints. Any additional modifications, such as in the format for collecting data or disseminating information, could be a challenge for state or local agencies, given resource constraints.

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<sup>16</sup>If DOT were to issue a rule on a nationwide real-time traffic information system, a regulatory benefit-cost analysis could be required to comply with Executive Order 12866 and the Unfunded Mandates Reform Act of 1995. Executive Order 12866 directs agencies to conduct economic analyses of significant regulatory actions and to select the policy that maximizes net benefits to society unless a statute requires otherwise. The Unfunded Mandates Reform Act of 1995 requires agencies to choose the least costly, most cost-effective, or least burdensome option, unless inconsistent with law or the agency head explains why this option was not adopted.

# Nationwide System

## Experts Cited Challenges (continued)

- Other implementation challenges cited by experts included
  - the need for a clear and sustained vision;
  - the need to ensure consideration of local area needs;
  - limited staff expertise, such as states' limited knowledge of emerging technologies;
  - limited understanding of the data quality needed to provide useful information to travelers and of how to measure this quality; and
  - limited public awareness and use of traffic information.<sup>17</sup>

A few experts noted, however, that resistance to change and funding challenges could be minimized if a nationwide system were built on existing efforts or systems, such as 511 Traveler Information Services. In their view, a nationwide system that significantly changed existing efforts or systems would meet with resistance and require more resources.

The above viewpoints may provide information that is useful to policymakers as they consider the future direction of federal efforts related to real-time traffic information systems. We are not making recommendations on this topic at this time, however, because there is no clear consensus among the experts we consulted on whether an increased federal role in this area is appropriate or what this role might be.

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<sup>17</sup>Some of these challenges currently exist for real-time traffic information systems and could continue to be challenges for a nationwide system.

# Impacts and Costs

We conducted a literature review to identify studies from 2004 onward on the impacts (on mobility, the environment, and the economy) and costs of real-time traffic information systems and technologies. Specifically, we targeted our literature search to a few literature databases, including the Transportation Research Information Services database—a bibliographic database on transportation issues. We also searched DOT's ITS Benefits and Costs databases, which are publicly available. We reviewed the methodologies of studies identified as relevant to this report and determined that they were sufficiently reliable. See enclosure III for more details on our objectives, scope, and methodology.

## Enclosure II

### Studies Found Positive Impacts of Real-Time Traffic Information Systems or Technologies and Identified Costs

#### Studies Found Improvements to Mobility and the Environment, but Results Are Not Generalizable

- Studies we reviewed that quantified the impact of real-time traffic information systems or technologies found that these systems or technologies improved mobility and the environment.<sup>18</sup> Some of these studies evaluated real-time traffic information technologies specifically, while others evaluated the technologies as part of an overall ITS.
  - For example, a study of a traveler information system—consisting of various technologies that collect, aggregate, and disseminate information on traffic and travel conditions—for a freeway network in Los Angeles, California, found that deploying this system decreased travel time by up to 14 percent. See table 5 at the end of this enclosure for more details on this study, as well as the results of other studies we reviewed.
- The quantitative impacts of these studies are not generalizable or comparable because these studies are generally specific to a particular city or road network and evaluate a specific system or technology.
- Few of the studies we reviewed found negative impacts associated with these systems. One study, however, found that traveler information systems that recommend alternative routes (such as dynamic message signs) may, in some cases, cause congestion on these alternative routes. As a result, a traveler may not experience the intended travel time reduction.

#### No Studies Quantified Impacts on the Economy

- We did not identify any studies that quantified the impacts of real-time traffic information systems and technologies on the economy, such as on the nation's gross domestic product (GDP).
- However, to the extent that real-time traffic information systems and technologies reduce congestion and improve mobility, there may be economic benefits.
  - According to the Texas Transportation Institute, in 2007, the cost of congestion to the nation's urban economy was about \$87 billion.<sup>19</sup>
- Some private sector representatives we interviewed told us that, based on their observations, real-time traffic information technologies can foster economic expansion by speeding the delivery of people, goods, and services.

<sup>18</sup>Mobility improvements are typically measured in terms of decreased delay and travel time, and environmental improvements are measured by decreased emissions and fuel use.

<sup>19</sup>Schrank and Lomax.

# Impacts and Costs

In its ITS Benefits and Costs databases, DOT compiles and summarizes studies on the benefits and costs of ITS, including real-time traffic information systems. In addition to providing summaries of studies, DOT's ITS Costs database also provides information on the capital, operations, and maintenance costs associated with individual ITS technologies, including those such as video surveillance cameras and dynamic message signs that can be used to collect or disseminate traffic information.

## Studies Have Found That Costs Vary with a Range of Factors

- The costs to deploy, operate, and maintain real-time traffic information systems and technologies vary based on a range of factors including the size, complexity, usage, coverage, and content provided, among other things.
  - For example, a case study published by the 511 Deployment Coalition in 2006 summarized the costs of six statewide 511 services. Of the 511 services reviewed, Virginia's had the largest total cost (about \$5.2 million) and Kansas had the smallest total cost (about \$990,000).<sup>20</sup> See table 5 for examples of other studies that documented the costs associated with real-time traffic information systems and technologies.
- According to a draft study conducted for DOT, the costs of technologies and systems that disseminate real-time traffic information, such as 511 systems, can be more easily measured and tracked than the costs of technologies and systems that collect and aggregate data.
  - The costs of technologies used to collect and aggregate data are more difficult to isolate because the infrastructure supports multiple operations, including traffic and incident management operations.

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<sup>20</sup>The costs of the two services varied because Virginia's 511 service covered many roads within the state, and because the state collected data and ensured data quality 7 days a week. By contrast, Kansas' 511 service shared infrastructure with several other states, which may have contributed to its lower cost.

# Impacts and Costs

## Studies That Conducted Benefit-Cost Analyses Found That Benefits Outweighed Costs

- Of the 20 studies we reviewed, 8 of these studies compared the benefits with the costs.
- The 8 studies that included a benefit-cost analysis found that the benefits were greater than the costs. See table 5 for examples of studies that included benefit-cost analyses.
  - A majority of these 8 studies evaluated real-time traffic information technologies as part of a larger system, such as an Intelligent Transportation System.
  - One study—DOT's analysis of the Real-Time System Management Information Program—conducted a benefit-cost analysis of a national real-time information program.<sup>21</sup> As noted previously, this program contains minimum requirements for all states to make information available on traffic and travel conditions via real-time information programs.
    - This study found that the present value of total cost savings (about \$30.2 billion) due to benefits to mobility, the environment, and safety would be greater than the present value of the costs (about \$1.2 billion) to establish and operate the program. See table 5 for more details.

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<sup>21</sup>DOT prepared a benefit-cost analysis of the Real-Time System Management Information Program to satisfy Executive Order No. 12866 and the Unfunded Mandates Reform Act of 1995.



# Impacts and Costs

*Impacts that are simulated* use assumptions about traveler behavior. However, travelers' actual responses to information may differ from the assumed responses used in the estimate. For example, travelers may choose not to change their travel plans despite receiving information about heavy congestion. Or, drivers who switch to other modes of transportation after receiving information on roadway congestion may later decide to switch back to driving on these roadways.

## Efforts to Determine Impacts and Conduct Benefit-Cost Analyses Pose Challenges and May Have Limitations

- It is challenging to determine the comprehensive impacts and conduct benefit-cost analyses of real-time traffic information systems and technologies. Furthermore, although studies quantify benefits associated with these systems and technologies, these studies may have limitations that affect the certainty of the results. Specifically, challenges and limitations exist with capturing data, isolating impacts, and simulating impacts.
  - *Capturing data.* It is challenging to capture data about travelers and their responses to real-time information, particularly since some travelers may receive information anonymously anywhere, at any time (e.g., through the radio or through the Internet).
  - *Isolating impacts.* It is challenging to isolate the quantitative impacts of real-time traveler or traffic information systems because external factors can influence evaluation outcomes. As we have previously reported, once transportation investments are completed, they become part of an entire transportation system and, therefore, the effects of the individual project become difficult to isolate, evaluate, and attribute to the individual project.<sup>22</sup>
  - *Simulating impacts.* Many of the estimated impacts of real-time traffic information systems or technologies are simulated. One limitation of using simulation methodologies to quantify impacts is that the methodologies depend on simplified assumptions—such as about traveler behavior—and therefore, the simulated outcomes may differ from actual outcomes.

## DOT Is Considering Research on Impacts and Is Encouraging Benefit-Cost Analyses

- DOT is considering a variety of research programs and activities for inclusion in its ITS strategic plan, which it expects to issue in early 2010. As part of the strategic planning process, DOT has sought input from stakeholders on ITS research needs.
  - One stakeholder group, the American Association of State Highway and Transportation Officials (AASHTO), noted to DOT that there is a need to identify and document the benefits of real-time information for mobility and the environment, as well as for safety, particularly since collecting and analyzing this information can be costly for most states.

<sup>22</sup>GAO, *Highways and Transit Investment: Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results*, GAO-05-172 (Washington, D.C.: Jan. 24, 2005).

# Impacts and Costs

## DOT Research on Impacts and Benefit-Cost Analyses (continued)

- DOT officials told us that research that addresses mobility impacts, or impacts on the environment and the economy, of real-time traffic information systems and technologies is being considered for inclusion in the strategic plan.
- In response to our 2005 recommendation that DOT encourage cost-effectiveness analyses, as well as benefit-cost analyses of ITS, including real-time traffic information systems,<sup>23</sup> DOT has
  - included benefit-cost analyses of ITS deployments in a database on ITS benefits that DOT makes available on its Web site, and
  - promoted a software program—in a guide on resources and tools for state and local planners—that can be used to evaluate the benefits and costs associated with ITS investments, including real-time traffic information systems and technologies.

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<sup>23</sup>GAO-05-943.

**Table 5: Examples of Studies That Quantified Benefits of Real-Time Traffic Information Programs, Systems, or Technologies; Identified Costs; or Conducted Benefit-Cost Analyses**

City or road network evaluated/year study published	Program, system, or technology evaluated	Benefits	Costs	Benefit-cost analysis
Road network in Irvine, California; 2004	Traveler information system	<p><i>Mobility</i></p> <p>Savings in travel time of around 5 percent during morning peak hours (5:45 a.m. to 10 a.m.), assuming that 15 to 20 percent of travelers followed instructions of the traveler information system.</p> <p>Decrease in the average time to clear incidents by 7 minutes, based on historical data.</p>	Information not available.	Information not available.
Freeway network in Los Angeles, California; 2006	Traveler information system	<p><i>Mobility</i></p> <p>Savings in travel time of up to 14 percent. Travel time savings were larger during the evening peak hours (4:00 p.m. to 7:00 p.m.).</p> <p>Decrease in travel time variability of up to 50 percent, depending on the type of information.</p>	Information not available.	Information not available.
A construction work zone on an Interstate in Devore, California; 2006	Sensor to collect travel time data, software to estimate travel time, dynamic message signs, and a Web site	<p><i>Mobility</i></p> <p>Decreased traffic volumes during weekday peak-hour traffic in the work zone, causing a reduction in traffic delay from an expected 90 minutes to an actual 50 minutes. Traffic volumes on neighboring freeways increased but the increase in travel time on these roads was insubstantial.</p>	The total cost of leasing and maintaining the technologies and of analyzing the data was about \$0.2 million.	See table note below.
Arizona, North Carolina, Utah, Virginia, Kansas, and Washington; 2006	Statewide 511 services	Information not available.	On average, the statewide 511 services cost \$2.5 million to design, implement, and operate and maintain for 1 year. Virginia had the largest total cost (about \$5.2 million), and Kansas had the smallest total cost (about \$990,000).	Information not available.
U.S. highway in a rural area north of Spokane, Washington; 2004	Environmental sensor stations that collect and transmit road weather data, video surveillance cameras, and Highway Advisory Radio	Information not available.	The total cost to construct and install these technologies was \$446,807.	Information not available.

City or road network evaluated/year study published	Program, system, or technology evaluated	Benefits	Costs	Benefit-cost analysis
Tucson, Arizona; 2005  (a forecast for the year 2025) <sup>a</sup>	ITS—consisting of 35 technologies including Highway Advisory Radio, dynamic message signs, a telephone- and Web-based traveler information system, and kiosks.	<p><i>Mobility</i></p> <p>Expected decrease in delay due to recurring congestion by about 6 percent, expected decrease in incident-related delay by more than 70 percent on freeways, and expected decrease in annual travel time by 7 hours per resident.</p> <p><i>Environment</i></p> <p>Expected reduction in annual fuel use by 11 percent and expected reduction in annual carbon monoxide, hydrocarbon, and nitrous oxide emissions between 10 and 16 percent.</p>	The expected average annual cost for implementing, operating, and maintaining all 35 ITS technologies was about \$72 million. More specifically, the expected annual cost for implementing, operating, and maintaining the regional telephone- and Web-based traveler information system and 5 kiosks was \$2.1 million.	The expected average annual benefit of the ITS to mobility, the environment, safety, and other areas (\$455 million) was greater than the expected average annual cost to implement, operate, and maintain the ITS. The benefits outweighed the costs by a ratio of 6.3 to 1.
Nationwide; 2009	Real-Time System Management Information Program	<p><i>Mobility</i></p> <p>Savings in incident delays of about 321 million hours, annually.</p> <p><i>Environment</i></p> <p>Reduced annual hydrocarbon and nitrous oxide emissions by about 8,200 tons and 11,600 tons, respectively. Reduced annual gasoline use by about 447 million gallons.</p>	The present value of the total cost for establishing real-time information programs in all states and the nation's 50 largest metropolitan areas and operating these programs through 2018 would be about \$1.2 billion.	The present value of total cost savings (about \$30.2 billion) due to benefits to mobility, the environment, and safety would be greater than the present value of the costs to establish and operate the program. Specifically, the present value of the benefits would exceed the present value of the costs by about \$29 billion through 2018.

Source: GAO analysis of select studies.

Note: Dollar figures are in current dollars, not adjusted for inflation. The study in Devore, California, found that the net benefit of implementing the technologies during 18 days of closures due to construction was estimated to be about \$3.6 million. However, we could not confirm the reliability of this estimate.

<sup>a</sup>This study forecasted the impact of ITS technologies on mobility, the environment, and other areas in 2025 based on traffic forecasts and planned ITS deployments for that year.

## Objectives, Scope, and Methodology

### Objectives

The objectives of this report were to determine (1) how state and local agencies and the private sector disseminate real-time traffic information to the public, and the completeness of current coverage; (2) what actions DOT has taken to establish the Real-Time System Management Information Program required by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), and stakeholders' views on these actions; and (3) how selected experts view the need for and benefits of a nationwide real-time traffic information system, how they envision such a system, and what the related challenges may be. We also examined what studies have found about the impacts of real-time traffic information systems and technologies—particularly on mobility, the environment, and the economy—and their costs.

### Scope

This report focuses on real-time traffic information that is disseminated to the public. Real-time traffic information that is used for traffic management purposes is not in the scope of this report.

### Methodology

- To determine how state and local agencies and the private sector disseminate real-time traffic information to the public and the completeness of current coverage, we interviewed—and reviewed relevant reports and studies obtained from—DOT officials; representatives from national organizations involved in real-time traffic information initiatives, such as the American Association of State Highway and Transportation Officials (AASHTO) and the Intelligent Transportation Society of America (ITS America); state and local transportation officials; and four private companies involved in real-time traffic information initiatives. More specifically, we interviewed state and local officials during site visits in California and Florida. We selected these locations for site visits because they have well-developed real-time traffic information systems, have deployed a range of technologies to collect and disseminate real-time traffic information, have 511 Traveler Information Services, and have differing public-private partnership models for collecting, aggregating, and disseminating real-time traffic information. Furthermore, officials from DOT, and representatives from AASHTO and ITS America, suggested that we visit these locations. The four private companies that we interviewed collect, aggregate, and disseminate real-time traffic information. To identify these companies, we obtained recommendations from DOT, AASHTO, and ITS America as to which companies play key roles in those areas.

We also reviewed and analyzed survey data from DOT's ITS Deployment Tracking Database for 2007, the most recent survey year. This database contains state and local agencies' responses to multiple surveys on the deployment of various ITS technologies, including real-time traffic information technologies, in the nation's 108 largest metropolitan areas. The metropolitan areas selected are those that have populations of more than 50,000. We focused our review on agency responses to two surveys—one on the deployment of ITS technologies on freeways and the other on ITS deployments on arterial roads. Nearly all metropolitan areas responded to both the surveys. We used the survey data in the database to determine the types of technologies and systems in use and their coverage. Based on interviews with DOT officials and our analysis of the data, we determined that the data were sufficiently reliable for the purposes of this report, which was to provide (1) general information on the types of technologies and systems used to collect and disseminate real-time traffic information to the public and (2) general estimates of the coverage of these technologies, including the number of metropolitan areas in which incident, travel time, and travel speed information were disseminated to the public in 2007.

- To determine what actions DOT has taken to establish the Real-Time System Management Information Program, we reviewed and analyzed Section 1201 of the 2005 transportation authorization—SAFETEA-LU—which made DOT responsible for establishing the program. We also interviewed DOT officials on their actions to establish the program, and reviewed and analyzed the proposed rule and related guidance that DOT published in the *Federal Register*. To determine stakeholders' views on the expected benefits and challenges to implementing the proposed program, we interviewed selected state and local transportation officials and representatives of AASHTO and two private companies that provide real-time traffic data. The state and local officials we interviewed on this issue were those that we met with during our site visits and those selected by the National Academy of Sciences (NAS). Later in this section we provide further details on how NAS selected state and local government officials and other stakeholders. The private companies we interviewed were those identified as key data providers by our own work and NAS. To further identify expected benefits of, and challenges to implementing the program, we reviewed and analyzed comments that state and local agencies, private companies, and organizations submitted to DOT in response to the proposed rule and related guidance that DOT published in the *Federal Register*.
- To determine experts' views on a nationwide system, we conducted semistructured interviews with—and reviewed relevant documentation from—19 experts about options for implementing a nationwide real-time traffic information system, including the need for, potential benefits of, and challenges to implementing such a system.<sup>24</sup> The individuals we interviewed from state and local transportation agencies, academia, and the private sector (consultants and data providers) were selected by NAS. NAS selected these experts based on geographic diversity and their knowledge of various aspects of real-time traffic information systems and technologies, including the roles of the federal, state, and local governments and the private sector; key technologies used in collecting, aggregating, and disseminating traffic information to the public; various models for providing traffic information services; and current efforts to implement a nationwide real-time traffic information system. We identified three officials from DOT as experts because these individuals work on issues, policies, and regulations related to real-time traveler or traffic information and were identified by DOT as points of contact in these areas. The 19 experts we interviewed and their affiliations are listed in table 6.

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<sup>24</sup>We did not evaluate the experts' options for a nationwide system, including factors such as the feasibility and implementation costs associated with these options.

## Methodology (continued)

**Table 6: Names of Experts We Interviewed and Their Affiliations**

<b>DOT</b>	<b>State level associations</b>	<b>State Departments of Transportation</b>	<b>Local transportation agencies</b>	<b>Academia</b>	<b>Private industry (consultants)</b>	<b>Private industry (data providers)</b>
<i>Jane Lappin</i> Volpe National Transportation Systems Center	<i>George Schoener</i> I-95 Corridor Coalition	<i>Anthony Bradford</i> Georgia Department of Transportation	<i>Matt Edelman</i> Transportation Operations Coordinating Committee (TRANSCOM)	<i>Mark Hallenbeck</i> Washington State Transportation Center	<i>Dean Deeter</i> Athey Creek Consultants	<i>John Collins</i> Transportation Business Law and Strategy (formerly with NAVTEQ Traffic)
<i>James Pol</i> ITS Joint Program Office	<i>James Wright</i> American Association of State Highway and Transportation Officials (AASHTO)	<i>David Huft</i> South Dakota Department of Transportation	<i>David Fink</i> Houston TransStar	<i>Christopher Poe</i> Texas Transportation Institute	<i>Les Jacobson</i> Telvent Farradyne Inc.	<i>Rick Shuman</i> INRIX
<i>Robert Rupert</i> Federal Highway Administration		<i>Greg Krueger</i> Michigan Department of Transportation	<i>Carol Kuester</i> Metropolitan Transportation Commission	<i>Philip J. Tarnoff</i> University of Maryland		
		<i>David Lively</i> California Department of Transportation				

Source: GAO.

## Other Aspects of Our Work

- To describe what studies have found about the impacts (on mobility, the environment, and the economy) and costs of real-time traffic information technologies and systems, we conducted a literature review to identify pertinent studies. Specifically, we targeted our literature search to the Transportation Research Information Services database—a bibliographic database on transportation issues—and DOT’s ITS Benefits and Costs databases. Our search of these databases did not yield studies on the impacts of real-time traffic information systems and technologies on the economy. Therefore, we extended our literature search to additional databases, including the EconLit bibliographic database—a database in the field of economics—and the ProQuest and WorldCat databases. Our literature search covered studies published from 2004 onward.

Through the literature search, we identified a number of studies that discussed technologies and systems that disseminate, or support the dissemination of, real-time traffic information to the public. We further limited our review to studies that evaluated real-time traffic information technologies and systems in the United States and that (1) quantified the impacts of real-time traffic information technologies and systems on mobility, the environment, or the economy; (2) identified the costs of these systems or technologies; or (3) conducted benefit-cost analyses. Based on these criteria, we identified a total of 20 studies that were relevant and applicable to our report. We reviewed the methodologies of these studies to ensure that they were sound and determined that they were sufficiently reliable for describing the impacts and costs of real-time traffic information systems and technologies.<sup>25</sup>

We conducted this performance audit from January 2009 to November 2009, 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 the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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<sup>25</sup>Dollar figures used to describe the costs or cost savings of real-time traffic information systems and technologies are in current dollars, not adjusted for inflation.



## GAO Contact and Staff Acknowledgments

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