



INTRODUCTION

Mobility and safety challenges are increasing on the Nation's transportation system. A recent study estimated the cost of traffic congestion in U.S. cities for 2005 at \$78 billion, with 4.2 billion hours of delay and 2.9 billion gallons of fuel wasted.⁵⁷ Fatalities on U.S. highways rose to 43,443 in 2005.⁵⁸ Public transportation systems provided 10.1 billion trips in 2006, the highest in 49 years, with continuing increases documented through the first three quarters of 2007.⁵⁹ Freight volume on U.S. highways is expected to increase to 22.8 billion tons in 2035, up from 11.5 billion tons in 2002.⁶⁰

Intelligent transportation systems (ITS) provide a proven set of strategies for addressing the challenges of assuring safety and reducing congestion, while accommodating the growth in transit ridership and freight movement. ITS improve transportation safety and mobility, and enhance productivity through the use of advanced communications, sensors, and information processing technologies encompassing a broad range of wireless and wireline communications-based information and electronics. When integrated into the transportation system's infrastructure, and into vehicles themselves, these technologies relieve congestion, improve safety, and enhance U.S. productivity.⁶¹ Vehicle infrastructure integration has the potential to enable many services presently provided by infrastructure- or vehicle-based ITS to benefit from enhanced communication between vehicles and the infrastructure.

ITS deployment can impact transportation system performance in six key goal areas: safety, mobility, efficiency, productivity, energy and environment, and customer satisfaction. A wide variety of performance measures are used across the evaluations discussed in this report to assess ITS performance under each of these goal areas. *Safety* is measured through changes in crash rates or other surrogate measures such as vehicle speeds, traffic conflicts, or traffic law violations. *Mobility* improvements have been measured in travel time or delay savings, as well as travel time budget savings, and on-time performance. *Efficiency* findings document the capability of better managed transportation facilities to accommodate additional demand, typically represented through increases in capacity or level of service within existing road networks or transit systems. *Productivity* improvements are typically documented in cost savings to transportation providers, travelers, or shippers. Benefits in the area of *Energy and Environment* are typically documented through fuel savings and reduced pollutant emissions. *Customer Satisfaction* findings measure, usually through surveys, the perception of deployed ITS by the traveling public.

This report presents information on the performance of deployed ITS under each of these goal areas, as well as information on the costs, deployment levels, and lessons learned regarding ITS deployment and operations. The report, and the collection of four Web-based resources upon which it is based, have been developed by the U.S. DOT's ITS Joint Program Office (JPO) to support informed decision making regarding ITS deployment.

To support the deployment of ITS to address the challenges facing the U.S. transportation system, the JPO has developed a suite of knowledge resources. This collection of four Web-based resources provides ready access to information supporting informed decision making regarding deployment and operation of ITS to improve transportation system performance. Information presented in these online knowledge resources is the basis for this document. The four knowledge resources are the ITS Benefits Database, ITS Costs Database, ITS Deployment Statistics Database, and the ITS Lessons Learned Knowledge Resource. A fifth Web site, the ITS Applications Overview, provides access to information from each of the knowledge resources using an organization scheme similar to that used in this report.

Additional information on each finding cited in this document can be found in the online knowledge resources, along with links to the original source documents, when available. See the "About This Report" section, below, for more information on accessing specific citations in this report online. Each of the knowledge resources is briefly described below. Additional information about each resource is available online including details about each site's organization, frequency of updates, and how to contribute information to the resources. When visiting the Web sites, follow the link to the "About This Site" and "Frequently Ask Questions (FAQ)" pages of each site for this information.

ITS Benefits Database

The major objectives of the ITS Benefits Database, available online at www.itsbenefits.its.dot.gov, are to:

- Document findings from the evaluation of ITS deployments pertaining to the effects of ITS on transportation systems performance.
- Provide transportation professionals with convenient access to the benefits of ITS deployment so that they can make informed planning and investment decisions.

Within the ITS Benefits Database, findings from ITS evaluations are presented in a concise summary format. Each benefit summary includes a title in the form of a short statement of the evaluation finding, context narrative, and identifying information such as date, location, and source, as well as the evaluation details that describe how the identified ITS benefit was determined. The ITS Benefits Database documents all findings of ITS evaluations, regardless of outcome, and includes several findings of neutral impact and a few examples of negative impacts under particular goal areas. The Web site includes a useful search capability and also presents findings through several organization schemes including the ITS application areas discussed in chapters of this report, the ITS goal areas, and by location.

ITS Costs Database

The ITS Costs Database, available online at www.itscosts.its.dot.gov, was established as a national repository of cost estimates for ITS deployments. The purpose of the ITS Costs Database is to support informed decision making by transportation leaders.

OPERATIONS/ITS HELPLINE

1-866-367-7487

ITS APPLICATION OVERVIEW

www.itsoverview.its.dot.gov



The ITS Costs Database contains estimates of ITS costs that can be used for developing project cost estimates during the planning process or preliminary design phase, and for policy studies and benefit-cost analyses. Both non-recurring (capital) and recurring or operations and maintenance (O&M) costs are provided where possible.

Two types of cost data are available: unit costs and system cost summaries. The primary difference in the two types is the level of aggregation. Unit costs are the costs associated with an individual ITS element, such as a video camera for traffic surveillance or a dynamic message sign. A range of costs (e.g., \$500 to \$1,000) is presented for the capital cost and annual O&M cost of each element as well as an estimate of the length in years of its usable life. Unit costs are available in two formats: unadjusted and adjusted. (Adjusted costs are available in Appendix A.) System cost summaries are the costs of an ITS project or portion of an ITS project such as the cost of expanding a statewide road weather information system or the detailed costs for a signal interconnect project. Each entry describes the background of the project, lists the ITS technologies deployed, and presents the costs and what the costs covered.

ITS Deployment Statistics Database

The ITS Deployment Tracking Project collects and disseminates information on the level of deployment and integration of ITS technology nationally. Information is gathered through a series of national surveys, covering metropolitan as well as rural deployment. Data have been collected in a series of national surveys conducted in 1997, 1999, 2000, 2002, 2004, 2005, and 2006. In the most recent survey, conducted in 2006, information was gathered from 108 of the largest metropolitan areas, shown in figure 1 on page 6. Within each metropolitan area, agencies involved with freeway, arterial, and transit management; public safety (law enforcement and fire/rescue/emergency medical services); and toll collection were surveyed. Statewide and rural deployment information was also gathered in a survey of each of the 50 states concerning ITS deployment for crash prevention and safety, road weather management, operations and maintenance, and traveler information. More than 2,100 agencies were covered in the 2006 survey, with a response rate nearly 90 percent. The deployment statistics database serves as a source of information on ITS deployment for the U.S. DOT, State and local transportation agencies, researchers, vendors, and the general public. Results from this survey and all previous national surveys are available online at www.itsdeployment.its.dot.gov. The Web site also provides access to survey results in the form of downloadable reports and fact sheets.

ITS Lessons Learned Knowledge Resource

A lesson learned is the knowledge gained through experience or study. It is a reflection on what was done right, what one would do differently, and how one could be more effective in the future. The ITS Lessons Learned Knowledge Resource, available online at www.itslessons.its.dot.gov, provides the ITS professional community with access to those lessons learned from others' experiences. This knowledge resource serves as a clearinghouse to document and share experiences of transportation practitioners in their planning, deployment, operations, maintenance, and evaluation of ITS to enable informed decision making regarding future ITS projects and programs. ITS lessons are collected primarily from case studies, best practice compendiums, planning and design reviews, and evaluation studies. The ITS Electronic Document Library, the Transportation Research Board's Transportation Research Information Services, international transportation literature databases (e.g., Transport), and conference proceedings are major sources for the documents that are reviewed. Interviews of subject matter experts are also used as sources of new lessons.

THE FOUR WEB-BASED KNOWLEDGE RESOURCES PROVIDE TOOLS TO SUPPORT INFORMED DECISION MAKING REGARDING THE DEPLOYMENT AND OPERATION OF ITS.

The lessons learned in this knowledge resource are based on the experiences of one or more ITS stakeholders from numerous ITS projects and programs in the country. Thus, a major focus for lessons presented in this document has been to gather typical field evidence—evidence-based lessons learned—that other stakeholders could benefit from learning.

Narratives of field evidence for selected key lessons are interspersed throughout this report, while more extensive details for the same and many other lessons can be found on the ITS Lessons Learned Web site (www.itslessons.its.dot.gov). A full chapter of this report is dedicated to the presentation of a synthesis of lessons on key areas of interest, such as ITS planning, procurement, and legal issues.

ITS Applications Overview

The ITS Applications Overview, available at www.itsoverview.its.dot.gov, provides access to each of the four knowledge resources described above, organized by the ITS application areas described in this report. The Web site also provides additional information regarding each ITS application including:

- Evaluation documents available from the ITS JPO
- Related U.S. DOT initiatives and other program activities
- Other resources available through the JPO's ITS/Operations Resource Guide
- Points of contact within the U.S. DOT.

About this Report

Eighth in a series of reports based upon evaluation results collected by the ITS JPO, this is the first to include information on ITS deployment statistics. Deployment information is drawn from selected findings of the ITS Deployment Tracking surveys conducted by the ITS JPO. It is also the first to more fully discuss a variety of important lessons learned through ITS deployment and operation, now presented in a series of chapters containing the results of a synthesis of ITS lessons learned knowledge. Sample lessons were provided in the previous version of this report—*Intelligent Transportation Systems Benefits, Costs, and Lessons: 2005 Update*—and in the online knowledge resource launched in September of that year. Previous versions of the report included information on ITS costs, beginning with the 2003 edition, while the original five reports in the series discussed ITS benefits.

Report Organization

Following this introductory chapter, this report begins discussion of 17 different areas of ITS applications. These chapters are divided into two groups discussing technologies deployed on the transportation infrastructure and those deployed within vehicles. The 14 infrastructure applications are further divided into groups of ITS strategies applied to roadways, transit, management and operations, and freight movement. Each chapter broadly describes the various ITS technologies that are typically deployed within a particular application area such as freeway management or commercial vehicle operations. A broad discussion of significant findings from the collected studies within the benefits, costs, and deployment knowledge resources follows. The chapters conclude with a series of specific highlighted findings from the knowledge resources, presented in a tabular format. Significant lessons learned are presented as sidebars within each chapter.

Another chapter of this report includes a synthesis of the lessons learned collected in the ITS Lessons Learned Knowledge Resource. Nine sections present this information

OPERATIONS/ITS HELPLINE
1-866-367-7487

ITS APPLICATION OVERVIEW
www.itsoverview.its.dot.gov



according to significant lesson topic areas such as management and operations, and policy and planning.

A brief conclusion is followed by two significant appendices. Appendix A presents adjusted unit costs (in 2006 dollars) for ITS components, drawn from the ITS Costs Database. Appendix B documents the volume of information available in the ITS Benefits Database, ITS Costs Database, and ITS Lessons Learned Knowledge Resource, presenting the number of findings available for each of the ITS application areas discussed in this report. The concluding references section includes useful information for accessing information on each cited reference within the knowledge resources, further described below.

Accessing Source Documents Online

Many of the findings presented in this report include numbered annotations further described in the “Endnotes” section near the end of the document. These endnotes provide reference information and short identification numbers that can be entered into the Knowledge Resources Web site search feature to quickly access more complete information on the cited finding and a link to the cited source document, if it is available online. The identification numbers are labeled Benefits ID, Costs ID, and Lessons Learned ID. For example, the second endnote includes the following citation:

² Birst, Shawn and Ayman Smadi. “An Evaluation of ITS for Incident Management in Second-Tier Cities: A Fargo, ND Case Study,” Paper Presented at ITE 2000 Annual Meeting. Nashville, Tennessee. 6–10 August 2000. Benefits ID: 2007-00335

Visiting the ITS Benefits Database, at www.itsbenefits.its.dot.gov, and entering 2007-00335 in the search input box will provide direct access to the online summary of findings from this study. To access more detailed costs information, Costs ID numbers should be entered in the ITS Costs Database Web site, at www.itscosts.its.dot.gov, and Lessons Learned ID numbers will provide access to the relevant entries in the ITS Lessons Learned Knowledge Resource, at www.itslessons.its.dot.gov.



Figure 1 – Metropolitan Areas Surveyed Through the ITS Deployment Tracking Project

OPERATIONS/ITS HELPLINE

1-866-367-7487

ITS APPLICATION OVERVIEW

www.itsoverview.its.dot.gov

Assessment of Intelligent Transportation Systems/Commercial Vehicle Operations Users Services: ITS/CVO Qualitative Benefits/Cost Analysis—Executive Summary, American Trucking Associations Foundation. Alexandria, VA. 1996. Benefits ID: 2007-00457

Automated Enforcement in Transportation, Institute of Transportation Engineers, Report No. IR-100. Washington, DC. December 1999. Benefits ID: 2007-00341

- 43 *Electronic Intermodal Supply Chain Manifest Field Operational Test Evaluation Final Report*, U.S. DOT Federal Highway Administration, EDL No. 13769. December 2002. Benefits ID: 2003-00254
- 44 *Hazardous Material Transportation Safety and Security Field Operational Test: Final Report—Deployment Team*, U.S. DOT Federal Motor Carrier Safety Administration. 31 August 2004. Costs ID: 2006-00100
- 45 *Integrated Vehicle Based Safety Systems: A Major ITS Initiative*, U.S. DOT, Report No. FHWA-JPO-05-019, EDL No. 14084. August 2005. Benefits ID: 2008-00572
- 46 Kittelson and Associates, et al. *TCRP Report 118: Bus Rapid Transit Practitioner's Guide*, Transportation Research Board, Transit Cooperative Research Program. Washington, DC. 2007. Costs ID: 2008-00148
- 47 *Private Sector Deployment of Intelligent Transportation Systems: Current Status and Trends*, U.S. DOT, Report No. FHWA-JPO-06-028, EDL No. 14266. February 2006. Costs ID: 2008-00175
- 48 *TravTek Evaluation Modeling Study*, U.S. DOT Federal Highway Administration, Report No. FHWA-RD-95-090, EDL No. 4403. January 1996. Benefits ID: 2000-00078
- 49 *Evaluation of Intelligent Cruise Control System: Volume I—Study Results*, U.S. DOT, Report No. DOT-VNTSC-NHTSA-98-3, EDL No. 11843. October 1999. Benefits ID: 2007-00481
- 50 Bose, A. and P. Ioannou. "Evaluation of the Environmental Effects of Intelligent Cruise Control (ICC) Vehicles," Paper Presented at the 80th Annual Meeting of the Transportation Research Board. Washington, DC. 7–11 January 2001. Benefits ID: 2001-00202
- 51 Sources that support these findings:
 - Farmer, C. *Effect of Electronic Stability Control on Automobile Crash Risk*, Insurance Institute for Highway Safety. Arlington, VA. 2004. Benefits ID: 2008-00577
 - Ohono and Shimura. *Results From the Survey on Effectiveness of Electronic Stability Control (ESC)*, National Agency for Automotive Safety and Victims' Aid. 18 February 2005. Benefits ID: 2008-00578
 - Preliminary Results Analyzing the Effectiveness of Electronic Stability Control (ESC) Systems*, U.S. DOT National Highway Traffic Safety Agency, Report No. DOT HS 809 790. September 2004. Benefits ID: 2008-00579
 - "Update on Electronic Stability Control," *Insurance Institute for Highway Safety*, Status Report, Vol. 41, No. 5. 13 June 2006. Benefits ID: 2008-00580
- 52 "Update on Electronic Stability Control," *Insurance Institute for Highway Safety*, Status Report, Vol. 41, No. 5. 13 June 2006. Benefits ID: 2008-00580
- 53 *Private Sector Deployment of Intelligent Transportation Systems: Current Status and Trends*, U.S. DOT Federal Highway Administration, Report No. FHWA-JPO-06-028, EDL No. 14266. February 2006. Costs ID: 2008-00175
- 54 Haselkorn, M., et al. *Evaluation of PuSHMe Mayday System*. Prepared by the Washington State Transportation Center (TRAC) for the Washington State Transportation Commission. September 1997. Benefits ID: 2000-00027
- 55 *Automated Collision Notification (ACN) Field Operational Test (FOT) Evaluation Report*, U.S. DOT National Highway Traffic Safety Administration, Report No. DOT-HS-809-304, EDL No. 13830. February 2001. Benefits ID: 2003-00252
- 56 *Private Sector Deployment of Intelligent Transportation Systems: Current Status and Trends*, U.S. DOT Federal Highway Administration, Report No. FHWA-JPO-06-028, EDL No. 14266. February 2006. Costs ID: 2008-00175
- 57 Schrank, David and Tim Lomax. 2007 *Urban Mobility Report*, Texas A&M University, Texas Transportation Institute. September 2007.
- 58 "FHWA Safety," U.S. DOT Federal Highway Administration, Office of Safety, Web site URL safety.fhwa.dot.gov. Last Accessed 17 December 2007.
- 59 "Public Transportation Ridership Statistics," American Public Transportation Association, Web site URL www.apta.com/research/stats/ridership. Last Accessed 17 December 2007.

- 60** "Freight Facts and Figures 2006," U.S. DOT Federal Highway Administration, Freight Management and Operations, Web site URL ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/06factsfigures/index.htm. Last Accessed 17 December 2007.
- 61** "ITS Overview," U.S. DOT, ITS Joint Program Office, Web site URL www.its.dot.gov/its_overview.htm. Last Accessed 17 December 2007.
- 62** *National Strategy to Reduce Congestion on America's Transportation Network*, U.S DOT. May 2006.
- 63** "Integrated Corridor Management (ICM) Quarterly Newsletter—Spring 2007," U.S. DOT ITS Joint Program Office, Web Site URL www.its.dot.gov/icms/index.htm. Last Accessed 13 November 2007.
- 64** Sources that support these findings (individual cities implementing coordinated signal timing):
- Hetrick, Stephen and Curtis B. McCollough. "How to save \$4.2 Million a Year," *ITS International Newsletter*. June 1996. Benefits ID: 2007-00349
- Skabardonis, Alexander. "ITS Benefits: The Case of Traffic Signal Control Systems," Paper Presented at the 80th Annual Transportation Research Board Meeting. Washington, DC. 7–11 January 2001. Benefits ID: 2007-00356
- Sunkari, Srinivasa. "The Benefits of Retiming Traffic Signals," *ITE Journal*. April 2004. Benefits ID: 2007-00393
- Syracuse Signal Interconnect Project: Before and After Analysis Final Report*, Prepared by DMJM Harris for the New York State DOT. September 2003. Correspondence with DMJM Harris. Benefits ID: 2007-00398
- White, Jeris, et al. *Traffic Signal Optimization for Tysons Corner Network Volume I. Evaluation and Summary*, Virginia DOT, Report No. TPE. R7D.03.08.00. March 2000. Benefits ID: 2007-00395
- Additional sources that reference findings for two statewide programs (California and Texas):
- Skabardonis, Alexander. "ITS Benefits: The Case of Traffic Signal Control Systems," Paper Presented at the 80th Annual Transportation Research Board Meeting. Washington, DC. 7–11 January 2001. Benefits ID: 2007-00356
- Sunkari, Srinivasa. "The Benefits of Retiming Traffic Signals," *ITE Journal*. April 2004. Benefits ID: 2007-00393
- 65** Sources that support these findings:
- Hetrick, Stephen, and Curtis B. McCollough. "How to save \$4.2 Million a Year," *ITS International Newsletter*. June 1996. Benefits ID: 2000-00065
- ITS Impacts Assessment for Seattle MMDI Evaluation: Modeling Methodology and Results*, U.S. DOT, EDL No. 11323. September 1999. Benefits ID: 2007-00358
- Phoenix Metropolitan Model Deployment Initiative Evaluation Report (Final Draft)*, U.S. DOT, Report No. FHWA-OP-00-015, EDL No. 12743. April 2000. Benefits ID: 2007-00378
- Syracuse Signal Interconnect Project: Before and After Analysis Final Report*, Prepared by DMJM Harris for the New York State DOT. Syracuse, NY. September 2003. Benefits ID: 2004-00273
- White, Jeris, et al. *Traffic Signal Optimization for Tysons Corner Network, Volume 1: Evaluation and Summary*, Virginia DOT, Report No. TPE. R7D.03.08.00. March 2000. Benefits ID: 2000-00126
- 66** *Automated Enforcement: A Compendium of Worldwide Evaluations of Results*, U.S. DOT National Highway Traffic Safety Administration, Report No. DOT HS 810 763. July 2007. Benefits ID: 2008-00505
- 67** The estimate of \$2,500 to \$3,100 is based on information from the following sources:
- Conversation with Mr. Jerry Luor. Traffic Engineering Supervisor, Denver Regional Council of Governments (DRCOG). October 2006. Costs ID: 2007-00117
- Fee Estimate—Millennia Mall Retiming and Scope and Schedule—Millennia Mall Retiming*, Bid submitted by TEI Engineering to the City of Orlando, FL. October 2005. Costs ID: 2007-00113
- Heminger, S. "Regional Signal Timing Program—2005 Cycle Program Performance," Memorandum to the California Metropolitan Transportation Commission's Operations Committee. Oakland, CA. October 2006. Costs ID: 2007-00112
- Harris, J. "Benefits of Retiming Traffic Signals: A Reference for Practitioners and Decision Makers About the Benefits of Traffic Signal Retiming," Presented at the ITE 2005 Annual Meeting and Exhibit. Melbourne, Australia. 7–10 August 2005. Costs ID: 2007-00115
- Sunkari, Srinivasa. "The Benefits of Retiming Traffic Signals," *ITE Journal*. April 2004. Costs ID: 2007-00116